

INCH-POUND

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DETAIL SPECIFICATION

MANUALS, TECHNICAL:

GENERAL ACQUISITION AND DEVELOPMENT REQUIREMENTS, GENERAL SPECIFICATION FOR



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## MIL-DTL-24784D(NAVY)

## CONTENTS

<u>PARAGRAPH</u>	<u>PAGE</u>
1. SCOPE.....	1
1.1 Scope .....	1
2. APPLICABLE DOCUMENTS .....	1
2.1 General .....	1
2.2 Government documents.....	1
2.2.1 Specifications, standards, and handbooks.....	1
2.2.2 Other Government documents, drawings, and publications .....	1
2.3 Non-Government publications.....	3
2.4 Order of precedence.....	4
3. REQUIREMENTS .....	4
3.1 Specification sheets .....	4
3.1.1 Technical content requirements .....	4
3.1.1.1 Commercial off-the-shelf (COTS) equipment manuals .....	5
3.1.1.2 Technical repair standards (TRS) .....	5
3.1.1.3 Training aid booklet (TAB) .....	5
3.1.1.4 Ship information book (SIB) .....	5
3.1.1.5 Combat system technical operations manual (CSTOM).....	5
3.1.1.6 Hull, mechanical, and electrical (HM&E) manuals .....	5
3.1.1.7 Electronic, (including service test electronic, experimental electronic, and interior communication [ICs]) system, and equipment manuals.....	5
3.1.1.8 Weapon systems and weapon equipment manuals .....	5
3.1.1.9 Illustrated parts breakdown (IPB).....	5
3.2 General .....	5
3.3 TM development products and reports .....	5
3.3.1 TM organization plan (TMOP).....	5
3.3.2 TM quality assurance (TMQA) products.....	5
3.3.3 TM schedules and status reports.....	6
3.3.4 TM cost reports.....	6
3.4 TM product development requirements.....	6
3.4.1 TM products .....	6
3.4.1.1 New TM.....	6
3.4.1.2 Supplements.....	6
3.4.1.3 Revisions .....	6
3.4.1.3.1 Superseding revision.....	6
3.4.1.3.2 Non-superseding revision .....	7
3.4.2 TM issues.....	7
3.4.2.1 Review draft copy (RDC).....	7
3.4.2.2 Preliminary TM (PTM).....	7
3.4.2.3 Final TM (FTM) .....	7
3.4.2.3.1 Delivery of the FTM in an iPDF.....	7
3.4.3 TM digital data requirements.....	7
3.4.3.1 Digital data requirements for chapter-format TMs .....	8
3.4.3.2 Digital data requirements for modular-format TMs/IETMs .....	8
3.4.4 Publication and distribution .....	8
3.5 General development requirements .....	8
3.5.1 Source data .....	8
3.5.2 Maintenance coverage .....	8
3.5.3 Advertising .....	8
3.5.4 Copyrights and proprietary information credit line .....	9
3.5.5 Information security.....	9
3.5.6 Technical assistance and deficiency reporting information .....	9
3.5.7 Energy efficiency requirements .....	9
3.6 Cover/title page requirements.....	9

## MIL-DTL-24784D(NAVY)

<u>PARAGRAPH</u>	<u>PAGE</u>
3.6.1 Security classification .....	9
3.6.2 TMIN .....	9
3.6.3 Volume/part identification number .....	9
3.6.4 Revision designator .....	9
3.6.5 Title.....	10
3.6.6 Manufacturer .....	10
3.6.7 Contract number .....	10
3.6.8 Seal .....	10
3.6.9 Supersedure notice.....	11
3.6.10 Supplement notice .....	11
3.6.11 Volume notice.....	11
3.6.12 Disclosure notice .....	11
3.6.13 Distribution statement.....	11
3.6.14 Export control notice .....	11
3.6.15 Destruction notice.....	11
3.6.16 Copyright and proprietary information credit line .....	11
3.6.17 Authority notice .....	11
3.6.18 Publication date .....	11
3.6.19 National stock number (NSN) .....	11
3.7 Style and format.....	12
3.7.1 Style of writing .....	12
3.7.1.1 Writing style principles.....	12
3.7.1.2 Standard English grammar.....	13
3.7.1.3 Vocabulary (permitted words).....	13
3.7.1.4 Word order.....	13
3.7.1.5 Use of “shall”, “will”, “should”, and “may” .....	13
3.7.1.6 Paragraphs .....	13
3.7.1.7 Sentences and phrases.....	13
3.7.1.8 List form .....	13
3.7.1.9 Procedures .....	13
3.7.1.9.1 Writing style for procedures .....	14
3.7.1.9.2 Procedural step content.....	14
3.7.1.9.3 Dual-level presentation.....	14
3.7.2 Level of writing .....	14
3.7.2.1 Readability.....	14
3.7.2.2 Sample selection .....	14
3.7.2.3 Raw data collection.....	15
3.7.2.4 Word count .....	15
3.7.2.5 Sentence count.....	15
3.7.2.6 Syllable count .....	15
3.7.2.7 Grade level calculations.....	16
3.7.2.7.1 Sample grade levels .....	16
3.7.2.7.2 Overall grade level (OGL).....	16
3.7.3 References .....	17
3.7.3.1 External document referencing .....	17
3.7.3.2 Text reference placement.....	17
3.7.4 Use of terminology, nomenclature, numbers, and equations .....	17
3.7.4.1 Abbreviations and acronyms .....	17
3.7.4.2 Automatic electronic test and checkout terminology.....	18
3.7.4.3 Military terms .....	18
3.7.4.4 Nomenclature.....	18
3.7.4.5 Noun modifiers .....	18
3.7.4.6 Placard data, switch positions, panel markings, and equipment readings.....	18
3.7.4.7 National stock numbers .....	18

## MIL-DTL-24784D(NAVY)

<u>PARAGRAPH</u>	<u>PAGE</u>
3.7.4.8 Part numbers .....	18
3.7.4.9 Symbols .....	18
3.7.4.10 Measurements .....	18
3.7.4.11 Equations .....	18
3.7.5 Safety and health requirements .....	18
3.7.5.1 Guidance and coordination .....	19
3.7.5.2 Health hazards .....	19
3.7.5.3 Hazardous materials warnings .....	19
3.7.5.3.1 Use and placement of hazardous materials warnings .....	19
3.7.5.3.2 Hazardous material symbols .....	19
3.7.5.4 Safety warning symbols .....	19
3.7.5.5 Nuclear hardness .....	20
3.7.5.5.1 Nuclear hardness symbol .....	20
3.7.5.5.2 Nuclear hardness symbol explanation .....	20
3.7.5.6 Electrostatic discharge sensitive (ESDS) parts .....	20
3.7.5.6.1 Electrostatic discharge (ESD) symbol .....	20
3.7.5.6.2 ESD symbol explanation .....	20
3.7.5.7 Environmental protection .....	20
3.7.5.8 Ozone depleting substances (ODS) .....	21
3.7.5.9 Dangers, warnings, cautions, and notes .....	21
3.7.5.9.1 When to use danger, warning, or caution statements .....	21
3.7.5.9.2 Wording and structure of danger, warning, and caution statements .....	22
3.7.5.9.3 When to use note statements .....	22
3.7.5.9.4 Placement of danger, warning, caution, or note statements .....	22
3.7.5.9.5 Display of dangers, warnings, cautions, and notes .....	23
3.7.5.9.5.1 Dangers .....	23
3.7.5.9.5.2 Warnings .....	23
3.7.5.9.5.3 Cautions .....	23
3.7.5.9.5.4 Notes .....	23
3.7.5.10 Safety summary .....	24
3.7.5.11 Quality control of dangers, warnings, and cautions .....	24
3.7.6 Tabular material .....	25
3.7.6.1 Tables, charts, and graphs .....	25
3.7.6.2 Table column head titles and rules .....	25
3.7.6.3 Lists .....	25
3.7.7 Numbering .....	26
3.7.8 Graphics .....	26
3.7.8.1 Illustrations, drawings, diagrams, and photographs .....	26
3.7.8.2 Graphic types and development techniques .....	26
3.7.8.2.1 System/equipment illustration (frontispiece) .....	26
3.7.8.2.2 Block diagrams .....	26
3.7.8.2.2.1 Power and grounding circuit FBDs .....	27
3.7.8.2.3 Requirements for preparing FBDs .....	27
3.7.8.2.4 Functional circuit diagrams (FCDs) .....	29
3.7.8.2.4.1 Unit power and grounding FCD .....	29
3.7.8.2.5 Requirements for preparing FCDs .....	30
3.7.8.2.6 FBD and FCD drafting requirements .....	31
3.7.8.2.7 System functional diagrams (SFDs) .....	32
3.7.8.2.7.1 Digital SFDs .....	32
3.7.8.2.7.2 Power distribution SFDs .....	32
3.7.8.2.8 System control function diagrams .....	32
3.7.8.2.9 Control diagrams .....	33
3.7.8.2.10 Logic diagrams .....	33
3.7.8.2.10.1 Basic logic diagrams .....	33

## MIL-DTL-24784D(NAVY)

<u>PARAGRAPH</u>	<u>PAGE</u>
3.7.8.2.10.2 Detailed logic diagrams .....	33
3.7.8.2.10.3 Digital logic diagrams.....	33
3.7.8.2.11 Maintenance schematic diagrams .....	33
3.7.8.2.12 Mechanical schematic diagrams .....	34
3.7.8.2.13 Simplified electrical and electronic schematic diagrams .....	34
3.7.8.2.14 Hydraulic and pneumatic schematics.....	35
3.7.8.2.15 Single-function diagrams .....	35
3.7.8.2.16 System data function diagrams .....	35
3.7.8.2.17 Signal flow diagrams .....	35
3.7.8.2.17.1 Types of signal flow diagrams.....	36
3.7.8.2.17.1.1 Types of elements on signal flow diagrams.....	36
3.7.8.2.17.1.2 Cross-referencing in signal flow diagrams .....	37
3.7.8.2.18 Power distribution diagrams .....	38
3.7.8.2.19 Timing circuit diagrams.....	38
3.7.8.2.20 Piping diagrams .....	38
3.7.8.2.20.1 Simplified piping diagrams.....	38
3.7.8.2.20.2 System piping run diagrams .....	38
3.7.8.2.21 Interconnection diagrams.....	39
3.7.8.2.22 Cable run diagrams .....	39
3.7.8.2.23 Wiring diagrams and wire run list .....	39
3.7.8.2.24 Parts location illustrations.....	39
3.7.8.2.24.1 Exploded views.....	39
3.7.8.2.24.2 Sectional views and location drawings.....	39
3.7.8.2.24.3 Printed-circuit board .....	39
3.7.8.2.25 Line graphs .....	39
3.7.8.3 General graphic requirements .....	40
3.7.8.4 Illustration details. ....	40
3.7.8.4.1 Lettering and line spacing.....	40
3.7.8.4.2 Border rules .....	41
3.7.8.4.3 Use of human figures.....	41
3.7.8.4.4 Credit lines.....	41
3.7.8.4.5 Callouts.....	41
3.7.8.4.5.1 Index numbers .....	41
3.7.8.4.5.2 Nomenclature.....	41
3.7.8.4.5.3 Leader lines and arrowheads.....	41
3.7.8.4.6 Legends.....	41
3.7.8.4.7 Reference designations .....	41
3.7.8.4.8 Zoning on diagrams .....	41
3.7.8.4.9 Notes for diagrams.....	42
3.7.8.4.9.1 General notes .....	42
3.7.8.4.9.2 Specific notes.....	42
3.7.8.4.10 Multi-sheet illustrations .....	42
3.7.8.4.11 Multi-section illustrations.....	42
3.7.8.4.12 Color in graphics, illustrations, and photographs .....	42
3.7.8.4.13 Photographs and line drawings.....	42
3.7.8.4.13.1 Photographic details.....	42
3.7.8.4.13.1.1 Retouching.....	43
3.7.8.4.13.2 Line drawing details.....	43
3.7.8.4.14 Designations, diagrams, and symbols.....	43
3.7.8.4.15 Continuous tone artwork.....	43
3.7.8.4.16 Combination artwork .....	43
3.7.8.5 Changes to illustrations.....	43
3.7.8.6 Review of illustrations.....	43
3.7.8.7 Graphic and multimedia source file formats.....	44

## MIL-DTL-24784D(NAVY)

<u>PARAGRAPH</u>	<u>PAGE</u>
3.7.9 Style, format, and content for revisions .....	44
3.7.9.1 Renumbering and removal.....	44
3.7.9.2 Revision designator .....	44
3.7.9.3 Revision change markings .....	44
4. VERIFICATION .....	44
4.1 TMQA program and responsibilities .....	44
4.1.1 Written operating procedures.....	45
4.1.2 TMQA program organization .....	45
4.1.3 TMQA program functions .....	45
4.1.3.1 Guidance and quality planning conference.....	45
4.1.3.2 Quality program reviews .....	46
4.1.3.3 Quality reviews.....	46
4.1.3.3.1 Corrective action.....	46
4.1.3.3.2 Source data control .....	46
4.1.3.3.3 Task identification matrix or equivalent.....	46
4.1.3.3.4 Control of subcontractors and vendors .....	46
4.1.3.3.5 Sampling.....	46
4.1.3.3.6 Classification of defects (CD).....	46
4.1.3.4 In-process reviews (IPRs).....	47
4.1.3.4.1 IPR review location .....	47
4.1.3.4.2 IPR records .....	47
4.1.3.4.3 Disposition of IPR findings .....	47
4.1.3.5 Validation .....	47
4.1.3.5.1 Engineering reviews .....	48
4.1.3.5.2 Validation performance .....	48
4.1.3.5.3 Support equipment.....	48
4.1.3.5.4 Validation of readability .....	48
4.1.3.5.5 IETM system validation .....	48
4.1.3.5.6 Disposition of validated data .....	48
4.1.3.5.7 Validation certification .....	48
4.1.3.6 Verification.....	49
4.1.3.6.1 Verification support requirements .....	49
4.1.3.6.2 Verification discrepancy/disposition records.....	49
4.1.3.6.3 Verification incorporation certification .....	49
4.1.3.7 Combined validation and verification.....	49
4.2 TMQA product development.....	49
4.2.1 TMQA program plan .....	49
4.2.2 Validation plan .....	49
5. PACKAGING.....	49
5.1 Packaging .....	49
6. NOTES .....	50
6.1 Intended use.....	50
6.2 Acquisition requirements.....	50
6.3 Technical manuals .....	51
6.4 Definitions.....	51
6.4.1 Accuracy.....	51
6.4.2 Adequacy.....	51
6.4.3 Assembly .....	51
6.4.4 Component .....	51
6.4.5 Comprehensibility .....	51
6.4.6 DTD.....	51
6.4.7 Electronic technical manual (ETM).....	52
6.4.8 Foldout.....	52
6.4.9 Functional division .....	52

## MIL-DTL-24784D(NAVY)

<u>PARAGRAPH</u>	<u>PAGE</u>
6.4.10 Leading .....	52
6.4.11 Maintenance concept .....	52
6.4.12 Major function .....	52
6.4.13 Overhaul .....	52
6.4.14 PIN.....	52
6.4.15 Schema .....	52
6.4.16 Set.....	52
6.4.17 SGML.....	52
6.4.18 Subassembly .....	52
6.4.19 Supplement.....	52
6.4.20 System .....	52
6.4.21 TM.....	53
6.4.22 TMCR.....	53
6.4.23 Unit.....	53
6.4.24 XML .....	53
6.5 Acronyms and abbreviations .....	53
6.6 Subject term (key word) listing. ....	55
6.7 Changes from previous issue.....	55
A.1 SCOPE.....	100
A.1.1 Scope .....	100
A.2 DEVELOPMENT OF PAGE-BASED CHAPTER-FORMAT TECHNICAL MANUALS .....	100
A.2.1 General.....	100
A.2.2 Development products. ....	100
A.2.2.1 Book plan.....	100
A.2.2.1.1 Model manual .....	100
A.2.3 Divisions and arrangement. ....	100
A.2.3.1 TM divisions .....	100
A.2.3.1.1 Volumes .....	100
A.2.3.1.2 Parts .....	100
A.2.3.1.3 Chapters .....	100
A.2.3.1.4 Sections.....	100
A.2.3.2 TM arrangement .....	100
A.2.3.2.1 Front matter .....	101
A.2.3.2.1.1 Cover/title page.....	101
A.2.3.2.1.2 Record of revisions .....	101
A.2.3.2.1.3 Foreword.....	101
A.2.3.2.1.4 Table of Contents.....	101
A.2.3.2.1.5 List of Tables .....	101
A.2.3.2.1.6 List of Illustrations.....	101
A.2.3.2.1.7 Safety summary .....	101
A.2.3.2.1.8 Frontispiece.....	101
A.2.3.2.2 Technical content.....	101
A.2.3.2.3 Rear matter.....	102
A.2.3.2.3.1 Appendices .....	102
A.2.3.2.3.2 Glossaries.....	102
A.2.3.2.3.3 TMDER .....	102
A.2.3.2.3.4 Back cover and backbone .....	102
A.2.4 Style and format.....	102
A.2.4.1 Page size, reproduction area, and margins .....	102
A.2.4.2 Column format.....	102
A.2.4.3 Text placement.....	102
A.2.4.4 Type style, capitalization, and vertical spacing .....	102
A.2.4.5 Margin data.....	103
A.2.4.5.1 Running heads and feet.....	103

## MIL-DTL-24784D(NAVY)

<u>PARAGRAPH</u>	<u>PAGE</u>
A.2.4.5.1.1 Running heads.....	103
A.2.4.5.1.1.1 Security classification .....	103
A.2.4.5.1.1.2 TMIN .....	103
A.2.4.5.1.2 Running feet.....	103
A.2.4.5.1.2.1 Page number .....	103
A.2.4.5.1.2.2 Security classification .....	103
A.2.4.5.1.2.3 Foldout figure number and title .....	103
A.2.4.6 Paragraphs.....	103
A.2.4.7 Procedural steps.....	104
A.2.5 References.....	104
A.2.5.1 Textual references.....	104
A.2.5.2 Post-maintenance action referencing .....	104
A.2.6 Use of terminology, nomenclature, numbers, and equations.....	105
A.2.6.1 Abbreviations and acronyms.....	105
A.2.7 Tabular material.....	105
A.2.7.1 Table titles .....	105
A.2.7.2 Continued table material .....	105
A.2.7.3 Footnotes in tables .....	105
A.2.8 Numbering .....	105
A.2.8.1 Cover and title pages.....	105
A.2.8.2 Front matter .....	105
A.2.8.3 Volumes.....	105
A.2.8.4 Parts .....	105
A.2.8.5 Chapters .....	105
A.2.8.6 Sections.....	105
A.2.8.7 Paragraphs.....	105
A.2.8.8 Procedural steps .....	106
A.2.8.9 Sequential lists .....	106
A.2.8.10 Pages, tables, and illustrations .....	106
A.2.8.11 Blank pages.....	106
A.2.8.12 Foldout figure numbers.....	106
A.2.8.13 Foldout page numbers.....	106
A.2.8.14 Footnotes.....	106
A.2.8.15 Glossary pages .....	106
A.2.8.16 Appendices .....	107
A.2.9 Graphics.....	107
A.2.9.1 Graphic types and development techniques.....	107
A.2.9.1.1 Operational and procedural step illustrations.....	107
A.2.9.1.2 Fault logic diagrams.....	107
A.2.9.1.3 Flowcharts.....	107
A.2.9.2 General graphic requirements.....	108
A.2.9.2.1 Illustration titles .....	108
A.2.9.2.2 Illustration placement .....	108
A.2.9.2.3 Foldout pages.....	109
A.2.10 Style, format, and content for revisions .....	109
A.2.10.1 Display of new or changed material .....	109
A.2.10.2 Record of Revisions.....	109
B.1 SCOPE.....	130
B.1.1 Scope.....	130
B.2 DEVELOPMENT OF PAGE-BASED MODULAR-FORMAT TECHNICAL MANUALS .....	130
B.2.1 General.....	130
B.2.2 Development products.....	130
B.2.2.1 Book plan.....	130
B.2.2.1.1 Model manual .....	130

## MIL-DTL-24784D(NAVY)

<u>PARAGRAPH</u>	<u>PAGE</u>
B.2.3 Divisions and arrangement.....	130
B.2.3.1 TM divisions .....	130
B.2.3.1.1 Volumes .....	130
B.2.3.1.2 Modules.....	130
B.2.3.2 TM arrangement.....	130
B.2.3.2.1 Front matter.....	130
B.2.3.2.1.1 Cover/title page .....	131
B.2.3.2.1.2 Revision summary.....	131
B.2.3.2.1.3 Table of Contents .....	131
B.2.3.2.1.4 List of Illustrations .....	131
B.2.3.2.1.5 List of Tables .....	131
B.2.3.2.2 Technical content .....	131
B.2.3.2.2.1 Module title block .....	131
B.2.3.2.3 Rear matter .....	131
B.2.3.2.3.1 Acronyms and abbreviations list .....	132
B.2.3.2.3.2 Alphabetical index .....	132
B.2.3.2.3.3 TMDER.....	132
B.2.3.2.3.4 Back cover and backbone.....	132
B.2.4 Style and format .....	132
B.2.4.1 Page size, reproduction area, and margins .....	132
B.2.4.2 Column format .....	132
B.2.4.3 Text placement.....	132
B.2.4.4 Type style, capitalization, leading, and vertical spacing .....	132
B.2.4.5 Margin data .....	132
B.2.4.5.1 Running heads and feet .....	133
B.2.4.5.1.1 Running heads.....	133
B.2.4.5.1.1.1 Security classification .....	133
B.2.4.5.1.1.2 TMIN .....	133
B.2.4.5.1.1.3 Module number .....	133
B.2.4.5.1.2 Running feet.....	133
B.2.4.5.1.2.1 Page number.....	133
B.2.4.5.1.2.2 Security classification .....	133
B.2.4.5.1.2.3 Foldout figure number and title.....	133
B.2.4.6 Paragraph titles.....	133
B.2.4.7 Procedural steps .....	133
B.2.5 References.....	134
B.2.5.1 Textual references .....	134
B.2.5.2 Frequently used maintenance tasks .....	134
B.2.5.3 Tasks performed by other work centers .....	134
B.2.5.4 Post maintenance action referencing.....	134
B.2.6 Use of terminology, nomenclature, numbers, and equations. ....	135
B.2.6.1 Abbreviations and acronyms.....	135
B.2.7 Tabular material .....	135
B.2.7.1 Table format.....	135
B.2.7.1.1 CALS tables and simple tables .....	135
B.2.7.1.2 Standardized information tables.....	135
B.2.7.2 Table titles.....	135
B.2.7.3 Continued table material .....	135
B.2.7.4 Footnotes in tables .....	135
B.2.8 Numbering .....	136
B.2.8.1 Cover and title pages.....	136
B.2.8.2 Front matter.....	136
B.2.8.3 Volumes .....	136
B.2.8.4 Module number .....	136

## MIL-DTL-24784D(NAVY)

<u>PARAGRAPH</u>	<u>PAGE</u>
B.2.8.5 Paragraphs.....	136
B.2.8.6 Procedural steps .....	136
B.2.8.7 Sequential lists .....	136
B.2.8.8 Pages, tables, and illustrations .....	136
B.2.8.9 Blank pages.....	136
B.2.8.10 Foldout figure numbers.....	136
B.2.8.11 Foldout page numbers.....	136
B.2.8.12 Footnotes.....	137
B.2.9 Graphics.....	137
B.2.9.1 General graphic requirements .....	137
B.2.9.1.1 Illustration titles .....	137
B.2.9.1.2 Illustration placement.....	137
B.2.9.1.3 Legends .....	137
B.2.9.1.4 Foldout pages .....	137
B.2.10 Style, format, and content for revisions .....	137
B.2.10.1 Display of new or changed material.....	138
B.2.10.2 Revision summary.....	138
C.1 SCOPE.....	146
C.1.1 Scope.....	146
C.2. DEVELOPMENT OF MODULAR-FORMAT INTERACTIVE ELECTRONIC TECHNICAL MANUALS .....	146
C.2.1 General.....	146
C.2.2 Development products.....	146
C.2.2.1 IETM content plan .....	146
C.2.2.1.1 Model manual .....	146
C.2.3 Divisions and arrangement.....	146
C.2.3.1 IETM divisions .....	146
C.2.3.1.1 Modules.....	146
C.2.3.2 IETM arrangement.....	146
C.2.3.2.1 Front matter.....	146
C.2.3.2.1.1 Title page .....	147
C.2.3.2.1.2 Revision summary.....	147
C.2.3.2.1.3 Acronyms and abbreviations list.....	147
C.2.3.2.1.4 Table of contents.....	147
C.2.3.2.1.5 List of Illustrations and multimedia .....	147
C.2.3.2.1.6 List of Tables .....	147
C.2.3.2.1.7 "How to use this IETM" information.....	147
C.2.3.2.2 Technical content .....	147
C.2.4 Style and format .....	148
C.2.4.1 IETM display screen layout .....	148
C.2.4.2 Paragraph titles.....	148
C.2.4.3 Procedural steps .....	148
C.2.5 References.....	148
C.2.5.1 Textual references.....	148
C.2.5.2 Frequently used maintenance tasks .....	149
C.2.5.3 Tasks performed by other work centers .....	149
C.2.5.4 Post maintenance action referencing.....	149
C.2.5.5 Maintenance procedure leading to IPB information .....	149
C.2.6 Use of terminology, nomenclature, numbers, and equations.....	149
C.2.6.1 Abbreviations and acronyms.....	149
C.2.7 Tabular material .....	149
C.2.7.1 Table format.....	149
C.2.7.1.1 CALS tables and simple tables .....	149
C.2.7.1.2 Standardized information tables.....	150

## MIL-DTL-24784D(NAVY)

<u>PARAGRAPH</u>	<u>PAGE</u>
C.2.7.2 Table titles.....	150
C.2.7.3 Footnotes in tables .....	150
C.2.8 Numbering .....	150
C.2.8.1 Paragraphs.....	150
C.2.8.2 Procedural steps .....	150
C.2.8.3 Sequential lists .....	150
C.2.8.4 Tables, illustrations, and multimedia .....	150
C.2.9 Multimedia.....	151
C.2.9.1 Multimedia presentation .....	151
C.2.9.1.1 Audio .....	151
C.2.9.1.2 Video.....	151
C.2.9.1.3 Animation .....	151
C.2.9.1.4 3D modeling.....	151
C.2.9.2 Figure titles .....	151
C.2.9.3 Oversized illustrations.....	151
C.2.9.3.1 Supplements.....	151
C.2.9.4 Illustration placement.....	152
C.2.10 Style, format, and content for revisions .....	152
C.2.10.1 Display of new or changed material.....	152
C.2.10.2 Revision summary.....	152

## MIL-DTL-24784D(NAVY)

## LIST OF FIGURES

<u>FIGURE</u>	<u>PAGE</u>
FIGURE 1. Technical assistance and deficiency reporting information.....	56
FIGURE 2. Cover/title page.....	57
FIGURE 3. Hazardous materials warnings symbols.....	58
FIGURE 4. Safety warnings symbols.....	59
FIGURE 5. Frontispiece, typical equipment.....	62
FIGURE 6. FBD, master.....	63
FIGURE 7. FBD, primary.....	64
FIGURE 8. FBD, secondary.....	65
FIGURE 9. FBD, lowest level.....	66
FIGURE 10. FBD, unit power.....	67
FIGURE 11. Signal referencing on the same sheet.....	68
FIGURE 12. FBD signal referencing between two or more functional parts.....	68
FIGURE 13. FBD reference between units.....	68
FIGURE 14. FBD, master with reference to keyed text.....	69
FIGURE 15. Zone numbers.....	70
FIGURE 16. FCD, analog logic.....	71
FIGURE 17. FCD, detailed.....	72
FIGURE 18. FCD, unit power and grounding.....	73
FIGURE 19. Hardware boundary.....	74
FIGURE 20. Functional boundary.....	74
FIGURE 21. Interconnecting lines.....	75
FIGURE 22. Symbols.....	76
FIGURE 23. On-drawing and off-drawing connectors and miscellaneous symbols.....	77
FIGURE 24. System functional diagram.....	78
FIGURE 25. System functional diagram – power distribution.....	79
FIGURE 26. Control diagram.....	80
FIGURE 27. Logic diagram.....	81
FIGURE 28. Maintenance schematic diagram.....	82
FIGURE 29. Simplified schematic diagram.....	83
FIGURE 30. Functional schematic diagram.....	84
FIGURE 31. Pneumatic/hydraulic schematic.....	85
FIGURE 32. Single function diagram.....	86
FIGURE 33. Signal flow diagram, functional dependency type.....	87
FIGURE 34. Power distribution diagram.....	88
FIGURE 35. Timing circuits diagram.....	89
FIGURE 36. Piping diagram.....	90
FIGURE 37. Interconnection diagram, typical.....	91
FIGURE 38. Interconnecting cable run/piping diagram.....	92
FIGURE 39. Wiring diagram.....	93
FIGURE 40. Exploded view.....	94
FIGURE 41. Sectional view.....	95
FIGURE 42. Location drawing.....	96
FIGURE 43. Printed circuit board, typical.....	97
FIGURE 44. Multisection illustration.....	98
FIGURE 45. Web-safe color palette.....	99
FIGURE A-1. Example record of revisions.....	110
FIGURE A-2. Example Table of Contents (chapter-format TMs).....	111
FIGURE A-3. Example List of Illustrations and List of Tables (chapter-format TMs).....	112
FIGURE A-4. Example safety summary.....	113
FIGURE A-5. Example back cover.....	116
FIGURE A-6. Style, capitalization, leading, and vertical spacing (chapter-format TMs).....	118
FIGURE A-7. Example operational illustrations.....	121

## MIL-DTL-24784D(NAVY)

<u>FIGURE</u>	<u>PAGE</u>
FIGURE A-8. Example procedural illustrations.....	122
FIGURE A-9. Fault logic diagram (sample).....	123
FIGURE A-10. General flow.....	124
FIGURE A-11. Terminal blocks.....	124
FIGURE A-12. Annotation/comment block.....	125
FIGURE A-13. Process blocks.....	125
FIGURE A-14. Decision blocks.....	125
FIGURE A-15. On-page connectors.....	126
FIGURE A-16. Multiple on-page connector variant.....	126
FIGURE A-17. Off-page connectors.....	127
FIGURE A-18. Use of multiple input off-page connectors.....	128
FIGURE A-19. Line intersections.....	128
FIGURE A-20. Example revision indicators.....	129
FIGURE B-1. Example Table of Contents (modular-format TMs).....	139
FIGURE B-2. Example List of Illustrations and List of Tables (modular-format TMs).....	140
FIGURE B-3. Example of a module title block.....	141
FIGURE B-4. Example of an alphabetical index information package.....	142
FIGURE B-5. Style, capitalization, leading, and vertical spacing (modular-format TMs).....	143
FIGURE B-6. Example revision indicators (modular-format TMs).....	145

## LIST OF TABLES

<u>TABLE</u>	<u>PAGE</u>
TABLE I. Determining basic number of samples.....	15
TABLE II. Line weights and uses.....	43

## MIL-DTL-24784D(NAVY)

This specification is approved for use by the Department of the Navy and is available for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification establishes the general acquisition and development requirements needed to prepare digital technical information for multi-output presentation of NAVSEA Technical Manuals (TMs) (see 6.4.21). The technical content, style, and format requirements contained in this specification can be used to develop and assemble complete TMs for ships, shipboard systems (see 6.4.20), and equipment. The requirements apply to the output of paper TMs or to the display of Electronic Technical Manuals (ETMs), both page-oriented linear and non-linear (see 6.4.7) on an Electronic Display System (EDS).

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

## FEDERAL STANDARDS

FED-STD-313 - Material Safety Data, Transportation Data, and Disposal Data for Hazardous Materials Furnished to Government Activities

## DEPARTMENT OF DEFENSE SPECIFICATIONS

(See ASSIST database for list of specification sheets.)

## DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1309 - Definitions of Terms for Testing, Measurement and Diagnostics

MIL-STD-1686 - Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

(Copies of these documents are available online at <http://quicksearch.dla.mil/>.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

## DEFENSE LOGISTICS INFORMATION SERVICE CATALOGING HANDBOOKS

H6 - Federal Item Name Directory (ITEM NAME)

(Copies of this document are available online at <https://public.logisticsinformationservice.dla.mil/H6/search.aspx>.)

MIL-DTL-24784D(NAVY)

DEPARTMENT OF DEFENSE DOCUMENTS

- DoDI 5200.01 - DoD Information Security Program and Protection of Sensitive Compartmented Information (SCI)
- DoDM 5200.01 Volume 1 - DoD Information Security Program: Overview, Classification, and Declassification
- DoDM 5200.01 Volume 2 - DoD Information Security Program: Marking of Classified Information
- DoDM 5200.01 Volume 3 - DoD Information Security Program: Protection of Classified Information
- DoDM 5200.01 Volume 4 - DoD Information Security Program: Controlled Unclassified Information (CUI)
- DoDI 5230.24 - Distribution Statements on Technical Documents
- DoDD 5230.25 - Withholding of Unclassified Technical Data from Public Disclosure
- DoDI 6050.05 - DoD Hazard Communication (HAZCOM) Program

(Copies of these documents are available online at [www.dtic.mil/whs/directives/](http://www.dtic.mil/whs/directives/).)

- JCS Pub 1-02 - DoD Dictionary of Military and Associated Terms

(Copies of this document are available online at [www.dtic.mil/doctrine/dod\\_dictionary/](http://www.dtic.mil/doctrine/dod_dictionary/).)

DEPARTMENT OF THE NAVY DOCUMENTS

- OPNAVINST 5100.23 - Navy Safety and Occupational Health Program Manual
- SECNAVINST 5510.36 - Department of the Navy (DON) Information Security Program (ISP) Instruction
- SECNAV M-5510.36 - Department of the Navy Information Security Program Manual

(Copies of these documents are available online at <http://doni.daps.dla.mil/default.aspx>.)

DON Policy on Digital Product/Technical Data

Guidance on Acquisition and Conversion of Product/Technical Data to Digital Form

(Copies of these documents are available online at <http://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Carderock/Resources/Technical-Information-Systems/Policy-Guidance.aspx>.)

FEDERAL ACQUISITION REGULATION (FAR)

Federal Acquisition Regulation (FAR)

Defense Federal Acquisition Regulation Supplement (DFARS)

(Copies of these documents are available online at <https://www.acquisition.gov/far>.)

FEDERAL REGISTER – EXECUTIVE ORDERS

Executive Order 12196 - Occupational Safety and Health Programs for Federal Employees

Executive Order 13693 - Planning for Federal Sustainability in the Next Decade

(Copies of these documents are available online at <https://www.archives.gov/federal-register/executive-orders>.)

MIL-DTL-24784D(NAVY)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST Special Publication 811 - Guide for the Use of the International System of Units (SI)

(Copies of this document are available online at <http://nvl.nist.gov/>.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) FORMS

Form NAVSEA 4160/1 - NAVSEA/SPAWAR Technical Manual Deficiency/Evaluation Report (TMDER)

(Copies of this form are available online at <https://nsdsa.dc3n.navy.mil/refdocs/forms.aspx>.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

OP 1700 - Standard Fire Control Symbols

SE000-01-IMB-010 - Navy Installation and Maintenance Book

SL160-AA-LST-010/TM-WORDS - Baseline Wordlists for NAVSEA Technical Manuals

(Copies of these documents are available online via Technical Data Management Information System [TDMIS] at <https://mercury.tdmis.navy.mil/> by searching for the document number without the suffix. Refer questions, inquiries, or problems to: DSN 296-0669, Commercial [805] 228-0669. These documents are available for ordering via the Naval Logistics Library (NLL) at <https://nll.ahf.nmci.navy.mil>. For questions regarding the NLL, contact the NLL Customer Service at [nllhelpdesk@navy.mil](mailto:nllhelpdesk@navy.mil), (866) 817-3130, or (215) 697-2626/DSN 442-2626.)

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

OSHA Public Law 91-596 - Occupational Safety and Health Act of 1970

29 CFR 1910.1200 - Hazard Communication

(Copies of these documents are available online at [www.osha.gov](http://www.osha.gov).)

UNITED STATES GOVERNMENT PRINTING OFFICE

United States Government Printing Office (GPO) Style Manual

(Copies of this document are available online at <http://catalog.gpo.gov>.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/NEMA Z535.3 - Criteria for Safety Symbols

ANSI/NEMA Z535.6 - Product Safety Information in Product Manuals, Instructions, and Other Collateral Materials

(Copies of these documents are available online at <http://webstore.ansi.org/>.)

ASME INTERNATIONAL

ASME Y14.38 - Abbreviations and Acronyms for Use on Drawings and Related Documents

ASME Y32.18 - Symbols for Mechanical and Acoustical Elements as Used in Schematic Diagrams

(Copies of these documents are available online at [www.asme.org](http://www.asme.org).)

MIL-DTL-24784D(NAVY)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

- IEEE 315 - Standard for Graphic Symbols for Electrical and Electronics Diagrams (Including Reference Designation Letters)
- IEEE 945 - Recommended Practice for Preferred Metric Units for Use in Electrical and Electronics Science and Technology
- IEEE 991 - Standard for Logic Circuit Diagrams

(Copies of these documents are available online at [www.ieee.org](http://www.ieee.org).)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

- ISO/IEC 8632 - Information Technology – Computer Graphics – Metafile for the Storage and Transfer of Picture Description Information (Parts 1 through 4)
- ISO 8879 - Information Processing – Text and Office Systems – Standard Generalized Markup Language (SGML)
- ISO 32000-1 - Document Management – Portable Document Format – Part 1: PDF 1.7

(Copies of these documents are available online at <http://www.iso.org>.)

SAE INTERNATIONAL

- SAE-AS1290 - Graphic Symbols for Aircraft Hydraulic and Pneumatic Systems
- SAE-J1780 - Hydraulic System Diagrams and Associated Tables for Marine Vehicles

(Copies of these documents are available online at [www.sae.org](http://www.sae.org).)

WEBSTER'S INTERNATIONAL DICTIONARY OF THE ENGLISH LANGUAGE

Webster's International Dictionary of the English Language

(Available online at <http://www.merriam-webster.com/>.)

WORLD WIDE WEB CONSORTIUM (W3C)

Extensible Markup Language (XML) 1.0 W3C Recommendation

(Copies of this document are available online at <http://www.w3.org/TR/REC-xml/>.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.1.1 Technical content requirements. The technical content requirements necessary for the development of the types of NAVSEA TMs are identified in the specification sheets described in 3.1.1.1 through 3.1.1.9 (see 6.2). The specification sheets contain some technical content requirements that may not apply to all types of NAVSEA TMs. Selective application and tailoring of requirements shall be accomplished as appropriate.

## MIL-DTL-24784D(NAVY)

3.1.1.1 Commercial off-the-shelf (COTS) equipment manuals. Manuals available off-the-shelf from commercial sources, which include operation, maintenance, and other instructions to support equipment in the commercial market, shall be acquired and evaluated in accordance with MIL-DTL-24784/4.

3.1.1.2 Technical repair standards (TRS). A TRS shall be developed for Hull, Mechanical, and Electrical (HM&E) electronic and ordnance equipment in accordance with MIL-DTL-24784/7.

3.1.1.3 Training aid booklet (TAB). A TAB shall be developed in accordance with MIL-DTL-24784/10.

3.1.1.4 Ship information book (SIB). A SIB shall be developed in accordance with MIL-DTL-24784/11.

3.1.1.5 Combat system technical operations manual (CSTOM). Combat system information concerning design, detailed intersystem interface data, testing, maintenance, and capabilities in Fleet user-oriented language and format shall be developed in accordance with MIL-DTL-24784/22.

3.1.1.6 Hull, mechanical, and electrical (HM&E) manuals. A manual for HM&E systems, equipment, or single components (see 6.4.4) shall be developed in accordance with MIL-DTL-24784/22.

3.1.1.7 Electronic, (including service test electronic, experimental electronic, and interior communication (ICs)) system, and equipment manuals. A manual shall be developed for electronic, service test electronic, experimental electronic, and IC equipment in accordance with MIL-DTL-24784/22.

3.1.1.8 Weapon systems and weapon equipment manuals. Manual for weapon systems as well as separate independent weapon equipment shall be developed in accordance with MIL-DTL-24784/22.

3.1.1.9 Illustrated parts breakdown (IPB). An IPB shall be developed in accordance with MIL-DTL-24784/23.

3.2 General. The range and depth of subject matter coverage and the method of delivering information required by all potential users (electronic display or hardcopy) shall be considered for new or revised TMs. Special attention shall be given to the Fleet, overhaul, and training communities' need to have certain long-line diagrams (oversized schematics, timing circuit diagrams, test setup diagrams, wiring diagrams, etc.) delivered as a separately packaged hardcopy supplement (see 6.4.19) or re-authored to be easily viewed on screen and printed. Specific style, format, functionality, and presentation requirements for TMs required by this specification are provided in the following:

- a. Appendix A - Specific Development Requirements for Page-Based Chapter-Format Technical Manuals.
- b. Appendix B - Specific Development Requirements for Page-Based Modular-Format Technical Manuals.
- c. Appendix C - Specific Development Requirements for Modular-Format Interactive Electronic Technical Manuals (IETMs).

This specification contains some requirements that may not be applicable to the preparation of all TMs. Selective application and tailoring of requirements shall be accomplished as appropriate. The applicability of some requirements is also designated by one of the following statements, unless otherwise specified by the acquiring activity or as/when specified by the acquiring activity.

3.3 TM development products and reports. The following paragraphs establish the requirements for TM development data products and associated management reports.

3.3.1 TM organization plan (TMOP). When specified by the acquiring activity (see 6.2), a TMOP shall be developed. A TMOP is required for ship and major system acquisitions. The TMOP shall describe the general processes, procedures, terms, and conditions governing the planning, selection, preparation, and submission of TMs required for a ship or major/complex system acquisition. The TMOP shall be submitted to the acquiring activity for review and acceptance prior to the development of TMs, as specified (see 6.2). Format and content requirements for the TMOP shall be as specified (see 6.2).

3.3.2 TM quality assurance (TMQA) products. When specified by the acquiring activity (see 6.2), the following TMQA products shall be developed in accordance with 4.2:

- a. TMQA program plan (see 4.2.1).

## MIL-DTL-24784D(NAVY)

- b. Validation plan (see 4.2.2).
- c. Validation records (see 4.1.3.5).
- d. Validation certification (see 4.1.3.5.7).
- e. Verification discrepancy/disposition records (see 4.1.3.6.2).
- f. Verification incorporation certification (see 4.1.3.6.3).

3.3.3 TM schedules and status reports. TM schedules and status reports shall be prepared and delivered as specified (see 6.2). The TM schedule and status report contains the requirements of the approved contract/task schedule, current status of TM development/maintenance tasks, and contract/task accomplishments. Format and content requirements for the reports shall be as specified (see 6.2).

3.3.4 TM cost reports. TM cost reports shall be prepared and delivered, as specified (see 6.2). The TM cost report contains the charges for development of the manual (i.e., effort and material needed to produce the manual from source data). Format and content requirements for the reports shall be as specified (see 6.2).

3.4 TM product development requirements. The following paragraphs establish the requirements for the various TM products, issues, and digital data requirements.

3.4.1 TM products. The acquiring activity shall specify the TM products to be developed and delivered as defined below.

3.4.1.1 New TM. New TMs shall be developed to cover new equipment or systems or when an existing manual does not meet the requirements in technical content, format, and style to support the modified equipment or system. (For example, a new TM is required for a major modification to an existing equipment/system, when a hardcopy TM exists, but the acquiring activity requires a modular-format IETM.)

3.4.1.2 Supplements. Supplements may be developed for classified information, safety instructions, or operational information. When specified by the acquiring activity (see 6.2), supplements shall conform to the style and format requirements of the manual being supplemented. Supplements shall contain the minimum amount of information required to protect security and maintain continuity of thought. Government approval is required for each supplement. The following are examples of when a supplement could be used:

- a. Where classified information will comprise 10 percent or less of the manual's content and could be concentrated in one area of the manual, such information shall normally be prepared as a classified supplement to the manual, permitting the basic manual to be issued at a lower classification or as an unclassified manual.
- b. When it is necessary to segregate or provide proprietary information, configuration-unique information (e.g., coverage for an engineering development model for testing), operational information, or other types of data either unavailable or not covered in the basic manual. Where the information contained in the supplement is required only by a limited user community, independent to the overall hardware population.
- c. When it is necessary to have a hardcopy set of discrete long-line drawings, a supplement can be developed to complement an IETM (i.e., intended exclusively for electronic display).

3.4.1.3 Revisions. When specified by the acquiring activity (see 6.2), a superseding or non-superseding revision shall be developed in accordance with requirements specified in 3.7.9 and the appendices. Revisions shall incorporate current information from previously issued changes to the existing manual. Revisions shall be such that the TM is issued in its entirety as a revised manual as opposed to being assembled by the user.

3.4.1.3.1 Superseding revision. A superseding revision shall be acquired when an existing manual is acceptable in format and style, but does not completely cover the ship, system, or equipment because of a modification made after the manual was issued. A superseding revision shall incorporate configuration modifications, outstanding corrections, and deficiencies to the existing manual. The superseding revision shall be developed in accordance with the style, format, content, and arrangement of the existing manual. The revision shall be assigned a revision number and include a supersedure notice.

## MIL-DTL-24784D(NAVY)

3.4.1.3.2 Non-superseding revision. A non-superseding revision shall be acquired when a separate manual is needed to cover a different configuration of a ship, system, or equipment for which there is a high degree of commonality with an existing manual. The revision shall be developed in accordance with the style, format, content, and arrangement of the existing manual. The revision shall incorporate required configuration modifications and outstanding corrections and deficiencies. Non-superseding revisions shall be classified as “original” and have a unique Government TM identification number (TMIN). The non-superseding revision shall not include a supersedure notice.

3.4.2 TM issues. The acquiring activity shall specify the TM issues to be developed and delivered as defined below (see 6.2).

3.4.2.1 Review draft copy (RDC). An RDC shall be developed for review and coordination for technical accuracy (see 6.4.1) and adequacy (see 6.4.2) to evaluate the preparing activity’s progress and assess compliance with applicable specifications and terms of the contract. An RDC shall identify areas of the manual (format or technical content) that are not completed. An RDC shall be submitted for acceptance prior to development of the preliminary or final TM.

3.4.2.2 Preliminary TM (PTM). A PTM shall be developed for review and coordination for technical accuracy and adequacy to evaluate the preparing activity’s progress and assess compliance with applicable specifications and terms of the contract. A PTM shall be developed for interim use to make the technical information available for test, verification, training, and operational use pending receipt and distribution of the final manual. A PTM shall be submitted for acceptance prior to development of the final TM.

3.4.2.3 Final TM (FTM). The FTM shall include all necessary changes made as a result of reviews, validation, verification, and the acquiring activity conditions of acceptance or approval. In accordance with the Department of the Navy (DON) Policy on Digital Product/Technical Data and the Guidance on Acquisition and Conversion of Product/Technical Data to Digital Form, delivery of the FTM to the Government shall include the following digital data deliverables, as specified (see 6.2):

- a. Standard Generalized Markup Language (SGML) or Extensible Markup Language (XML) (see 6.4.17 and 6.4.24) source files.
- b. Multimedia, graphic, illustration, and photograph source files shall be in accordance with approved formats (see 3.7.8.7). All source files, regardless of format, shall be delivered as specified (see 6.2).
- c. An indexed Portable Document Format (iPDF) TM (see 3.4.2.3.1) or an IETM (final run-time version) generated using a NAVSEA-approved publishing application.

3.4.2.3.1 Delivery of the FTM in an iPDF. When specified by the acquiring activity (see 6.2), the FTM shall be delivered in an iPDF developed in accordance with ISO 32000-1. The TM shall include linked bookmarks. Each bookmark shall be linked to its appropriate destination or shall serve as a “drop-down” (indented) menu. Bookmarks shall be collapsed into their respective sections. The entire title page and bookmarks shall be visible in the “fit in window” view when opening the TM. Links shall be created within paragraphs, steps, and tables to internal references. For chapter-format TMs, all bookmark entries shall be sequenced according to the Table of Contents, List of Tables, and List of Illustrations. For modular-format TMs, bookmarks shall be generated as follows:

- a. A bookmark entry for the TM title page shall be labeled “TITLE PAGE”.
- b. As applicable, a bookmark entry for the Revision Summary shall be labeled “REVISION SUMMARY”.
- c. A bookmark entry for the Table of Contents shall be labeled “TABLE OF CONTENTS”. All bookmark entries shall be sequenced according to the Table of Contents.
- d. A bookmark entry for the List of Illustrations and List of Tables shall be labeled “LIST OF ILLUSTRATIONS” and “LIST OF TABLES”.
- e. A bookmark entry for the Technical Manual Deficiency/Evaluation Report (TMDER) form shall be labeled “TMDER”.

3.4.3 TM digital data requirements. TMs shall be acquired, authored, and developed as specified in the following paragraphs.

## MIL-DTL-24784D(NAVY)

3.4.3.1 Digital data requirements for chapter-format TMs. Chapter-format TMs shall be acquired, authored, and developed in SGML (see 6.4.17) in accordance with ISO 8879 and the NAVSEA Class 2 ETM Document Type Definition (DTD) (see 6.4.6) suite (see 6.2). The suite shall be obtained from the Navy XML/SGML Repository (<http://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Carderock/Resources/Technical-Information-Systems/Navy-XML-SGML-Repository>).

3.4.3.2 Digital data requirements for modular-format TMs/IETMs. Modular-format TMs/IETMs shall be acquired, authored, and developed in XML (see 6.4.24) in accordance with 1.0 W3C Recommendation using a NAVSEA-approved DTD/Schema suite (see 6.2). The DTD/Schema suite includes Tagging and Authoring Guidelines, providing guidance to authors on how to tag and author data for a DTD/Schema-compliant TM. The DTD/Schema suite shall be obtained from the Navy XML/SGML Repository (<http://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Carderock/Resources/Technical-Information-Systems/Navy-XML-SGML-Repository>). The “NAVSEA Interactive Electronic Technical Manual (IETM) Viewer Software Performance Requirements,” providing IETM developers with information on the interface, functionality, and presentation expected of the IETM Viewer, can also be obtained from the technical reports section of the Navy XML/SGML Repository (<http://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Carderock/Resources/Technical-Information-Systems/IETMs/TechReps/>).

3.4.4 Publication and distribution. TMs shall be developed using NAVSEA accepted tools, products, and processes. TMs shall be authored for publishing using a NAVSEA accepted publishing application. As specified by the acquiring activity, TMs shall be developed as either an indexed PDF or as an IETM to be displayed using a NAVSEA accepted viewer (see 6.2). Use of the NAVSEA accepted tools, products, and processes will help ensure TMs are in compliance with the current Navy infrastructure, security requirements, specifications, and Fleet user display requirements. In addition to the initial distribution of the final TM:

a. For iPDF TMs, Print-On-Demand (POD) compatible-TMs will be made available for hardcopy printing from the NAVSEA TM Print-On-Demand System (TMPODS), to support subsequent requisitioning by the Fleet. To ensure usability of a hardcopy, the acquiring and preparing activities shall factor in the anticipated final printed size of the manual prior to actual development. When the manual will exceed 1,500 printed pages (750 sheets), then the TM content shall be broken up and managed as separate volumes/manuals (with unique TMINs). Files for oversized illustrations (long lines or foldouts) contained in an unclassified TMPODS-compatible TM, will also be bundled separately for use within TMPODS to facilitate printing of just the long lines/foldouts (see 6.4.8) to support subsequent hardcopy requisitioning by the Fleet.

b. For IETMs, if specified (see 6.2), a POD-compatible supplement of the oversized illustrations (long lines or foldouts) contained in the IETM will be developed and made available for hardcopy printing from the NAVSEA TMPODS to support subsequent hardcopy requisitioning by the Fleet.

3.5 General development requirements. The following requirements are applicable to all TM types.

3.5.1 Source data. The primary source data for TMs should be engineering drawings and applicable Logistics Management Information (LMI) products.

3.5.2 Maintenance coverage. Unless otherwise specified by the acquiring activity (see 6.2), each type of TM shall contain, in detail, the maintenance coverage prescribed for the applicable maintenance level(s) based on the maintenance concept or approved maintenance plan.

3.5.3 Advertising. TMs shall contain no advertising unless the contract specifies that the equipment manufacturer shall be identified on the cover/title page. No logos shall be used.

## MIL-DTL-24784D(NAVY)

3.5.4 Copyrights and proprietary information credit line. TMs shall not contain copyrighted material except as specified in the Federal Acquisition Regulations (FAR) and Defense Federal Acquisition Regulation (DFAR) Supplement. When copyrighted material is to be included in a TM, the developer shall obtain prior written permission from the copyright owner or authorized agent for its use. The signed, written permission shall be delivered together with the final TM in accordance with the contract. The written permission shall contain a statement declaring whether or not a copyright credit line is required. When it is necessary to include copyright and proprietary material, it shall be clearly identified and the following warning statement shall be included on the title page:

“This document contains copyright or proprietary materials. Infringement of copyright or proprietary material may violate existing Federal laws and statutes and result in criminal penalties, imprisonment, or removal from office.”

3.5.5 Information security. The handling, production, marking, and protection of classified and controlled unclassified information, material, and removable electronic storage media shall be in compliance with DoDI 5200.01 and SECNAVINST 5510.36 (see 6.2).

3.5.6 Technical assistance and deficiency reporting information. The TM shall include current information on contacting Navy Distance Support and on reporting TM deficiencies (see [figure 1](#)). Refer to the appendices and specification sheets as appropriate for placement of this information.

3.5.7 Energy efficiency requirements. When specified (see 6.2), TMs covering products that directly consume energy in normal operations and commonly have a method of expressing energy efficiency shall include their energy efficiency.

3.6 Cover/title page requirements. The manual shall have a title page. When specified (see 6.2), a front cover shall also be prepared. When there is both a cover and title page, the date shall be omitted from the cover page. Detailed requirements for the cover/title page are included in the following paragraphs; [figure 2](#) illustrates these requirements. Spacing between the information should be such as to result in an attractive, well-balanced cover/title page.

3.6.1 Security classification. The overall security classification assigned to a TM shall agree with the highest classification assigned to any portion within. The security classification markings and applicable associated markings assigned by the acquiring activity shall be as specified in 3.5.5, when the manual itself is classified. Associated markings include those markings that identify the source of classification (or for original decisions, the authority and reason for classification), downgrading and declassification instructions, warning notices, intelligence control markings, and other miscellaneous markings. When the cover/title page is unclassified, it shall include the additional statement “THIS PAGE IS UNCLASSIFIED” centered under the classification marking at the bottom of the page.

3.6.2 TMIN. The acquiring activity shall furnish the Government-assigned TMIN(s). If the manual will be jointly used by more than one Service, the acquiring Service’s TMIN shall be listed first. The using Service’s TMINs shall then be listed in alphanumeric sequence and be prefixed with the word Army; Navy (NAVSEA), (NAVAIR), (SPAWAR); Marine Corps; Coast Guard; or Air Force as appropriate. All numbers shall appear above the ruled line, left justified.

3.6.3 Volume/part identification number. Required for multi-volume/multi-part sets only (see 6.4.14), the number shall be located below the TMIN.

3.6.4 Revision designator. When applicable, a revision designator shall be specified by the acquiring activity as follows:

a. Superseding revisions are identified numerically and carry the same basic TMIN as the existing manual. The superseding revision shall also include a Government-assigned revision number (e.g., “REVISION 1”) below the TMIN.

b. Non-superseding revisions are classified as original and shall have unique Government-assigned TMINs.

## MIL-DTL-24784D(NAVY)

3.6.5 Title. The title is required to provide all information necessary to relate the manual to its subject and content, such that readers can discern the applicability of the manual and can discriminate between manuals of similar applicability. The TM title shall consist of the following:

- a. Heading (as applicable): The words “REVIEW DRAFT COPY”, “DRAFT”, “FINAL DRAFT”, or “PRELIMINARY” shall appear in the upper center portion of the page to indicate the issue status of the TM.
- b. Type of publication: The type of publication identifies the technical content of the manual (e.g., Electronic Equipment, HM&E System, CSTOM) and shall be placed in the upper center portion of the page, below the heading, if any.
- c. Maintenance level (if restrictive): The designated maintenance level for the system/equipment (i.e., Organizational, Intermediate, or Depot) shall be placed beneath the publication type. When only one maintenance manual is being acquired to support a weapon, equipment, or hardware, no level shall be specified unless restrictive, since it shall be the only manual available for repair and maintenance at any designated maintenance level.
- d. Prime title (type and model): The nomenclature of the system/equipment shall be positioned below the words identifying the publication type or maintenance level and may include type, model, part number, or subject (blocks, serial numbers, or registration numbers, if appropriate). When specified by the acquiring activity (see 6.2), the national stock number and identification of other equipment covered in the manual shall be indicated. The classification of the system/equipment nomenclature shall be indicated, in compliance with DoDI 5200.01/DoDM 5200.01, when the manual itself is classified. The prime title shall be the same on all volumes of a multi-volume TM set.
- e. Subtitle (as applicable): A subtitle shall be used and located immediately below the prime title to indicate the contents of every separately bound volume of a TM.

3.6.6 Manufacturer. When specified by the acquiring activity (see 6.2), the identification of the manufacturer of the equipment shall appear below the equipment nomenclature or subtitle.

3.6.7 Contract number. When specified by the acquiring activity (see 6.2), the original contract number shall be included below the equipment nomenclature or subtitle and carried forward on all subsequent cover/title pages. If the contract number for a revision is different from the original number, the number applicable to the revision shall be indicated on the cover/title page in addition to the original number. No more than two contract numbers, the original and the latest, need appear.

3.6.8 Seal. The Navy seal with Naval Sea Systems Command as the command identifier is placed below the contract number(s) (see example below). The seal shall be 1¼ to 1½ inches in diameter and be a well-balanced, 4-tiered, black and white circle figure. The inner space contains a stylized spread-wing eagle perched on an anchor within a scribed circle. The next outer tier contains the words “UNITED STATES NAVY” in all capital letters located in the upper quadrant. Two, five-point (one point up) stars bisect the tier (one on either side). The lower quadrant contains the words “SEA SYSTEMS COMMAND” in all capital letters. The outer perimeter is bounded by a stylized/symbolic circular rope frame.

Example Navy seal with Naval Sea Systems Command as the command identifier:



## MIL-DTL-24784D(NAVY)

3.6.9 Supersedure notice. When a manual supersedes a previous issue or another manual, a supersedure notice shall be included below the seal. Superseded issues/manuals shall normally be listed individually, unless several alphabetically or numerically sequenced issues/manuals are superseded, then they shall be grouped. When specified (see 6.2), the FTM that supersedes a PTM shall include a supersedure notice. The applicable portions of the following supersedure notice shall be used:

“Supersedure Notice: This (manual or revision) supersedes (applicable manual or revision number or portions of) dated (date of superseded document), including (superseded supplement numbers).”

3.6.10 Supplement notice. A supplement notice is used to show dependent and supporting TMs when one cannot be used without the other. They apply to supplements, supplemental or partial manuals, and basic manuals. Dependency is shown by such statements as “Supplement Notice: Incomplete without SWXXX-XX-XXX-XXX” or “Supplement Notice: Use with SWXXX-XX-XXX-XXX”, located below the seal. Supporting TMs are depicted by such statements as “Supplement Notice: This publication supplements SWXXX-XX-XXX-XXX.” Cross-reference notes to supplements or to augmented manuals, shall be placed on the cover/title page initially or at time of change or revision.

3.6.11 Volume notice. When specified (see 6.2), the cover/title page of each volume shall contain a statement below the seal indicating that the applicable volume is incomplete without the other volumes in the set.

3.6.12 Disclosure notice. When specified (see 6.2), a special disclosure notice shall be placed on the cover/title page below the seal.

3.6.13 Distribution statement. In accordance with DoDI 5230.24, a distribution statement shall be placed below the seal on the cover/title page of each TM and modification thereto to denote the extent to which it is available for secondary distribution, release, and dissemination without additional approvals or authorizations. The acquiring activity will provide the appropriate distribution statement and specific text to be used in accordance with SECNAVINST 5510.36 (see 6.2).

3.6.14 Export control notice. When the manual contains export-controlled technical data as defined in DoDD 5230.25, then the export control notice specified in DoDI 5230.24 shall be included on the cover/title page below the seal.

3.6.15 Destruction notice. In accordance with DoDI 5200.01, DoDI 5230.24, and SECNAVINST 5510.36, TMs that are marked with Distribution Statements B, C, D, E, or F shall also include the following destruction notice on the cover/title page, below the seal:

**“DESTRUCTION NOTICE:** DESTROY BY ANY METHOD THAT WILL PREVENT DISCLOSURE OF CONTENTS OR RECONSTRUCTION OF THE DOCUMENT.”

3.6.16 Copyright and proprietary information credit line. When applicable, a copyright and proprietary information credit line shall be included as specified in 3.5.4.

3.6.17 Authority notice. The authority notice indicates the authority under which the manual is acquired and issued/published. The authority notice will be provided by the Government and shall read similar to “PUBLISHED BY DIRECTION OF COMMANDER, NAVAL SEA SYSTEMS COMMAND.” Manuals to be jointly used shall show a joint authority notice. The notice shall appear above the bottom ruled line.

3.6.18 Publication date. The publication date of the manual shall be the cutoff date from which no further changes to the manual are permitted without issuing a formal revision. This is normally the “approved date”; that is, the date the Government accepts the manual subject to the inclusion of specified comments. If the Government does not advise the preparing activity the exact date to use, the publication date shall be the date at which the last material to be included was received (copy freeze date). The publication date shall be shown as the day, month, and year in that sequence (for example, 15 MARCH 2006), below the bottom ruled line.

3.6.19 National stock number (NSN). An NSN is required for all new and revised final issue TMs and shall appear on the cover/title page below the bottom ruled line. The acquiring activity shall furnish the Government-assigned NSN. Each NSN is unique to a final, published TM and can never be reused. The NSN shall be displayed on the cover/title page (see details in appendices).

## MIL-DTL-24784D(NAVY)

3.7 Style and format. This specification contains requirements for specific TM types to be produced in page-oriented chapter-format, and in modular-format for electronic display or for page-oriented printing. General (common) style and format requirements that apply to all TM types are provided in the following paragraphs. Specific style, format, and presentation requirements for TMs required by this specification are provided in Appendices A, B, and C.

3.7.1 Style of writing. The following paragraphs provide general requirements applicable to all TM types.

3.7.1.1 Writing style principles. TMs written to this specification shall conform to the following writing style principles:

a. Technical content shall be presented in language free of vague and ambiguous terms, using the simplest words and phrases that will convey the intended meaning. All essential information shall be included, either by direct statements or by reference. To ensure comprehensibility (see 6.4.5), technical information shall:

- (1) Describe the system and components, identifying special or outstanding features.
- (2) Describe what functions are performed, including inputs, outputs, and interfaces with other systems, and emphasize end results.
- (3) Describe how the functions are performed, including associated principles of operation.
- (4) Describe at what point in an overall system process the function is performed.
- (5) Describe the location of the component or part.
- (6) Associate explanatory text to the graphic or table.
- (7) Directly support the immediate task of the user.
- (8) Minimize the need for reading, studying, and conceptualizing skills.
- (9) Present descriptive text in a logical order (e.g., in operational sequence or in signal flow sequence) and include summary headers for individual paragraphs whenever needed for clarity.
- (10) Keep descriptive text consistent in terminology, style, and format throughout the TM. Technical words shall be used only when no other wording will convey the intended meaning. Whenever possible, limit words to those that are short and familiar to the target audience. Concrete and specific language shall be used to reduce vagueness.

b. The United States Government Printing Office Style Manual shall be used as a general guide for capitalization, punctuation, compounding of words, numerals in the text, and spelling of non-technical words. Punctuation shall be used in a manner that aids in reading and prevents misreading.

c. The current version of Webster's International Dictionary of the English Language shall be used to determine and convey the proper spelling and meaning of words.

d. Hyphenation shall not be used to display normally non-hyphenated words on successive lines.

e. Nomenclature shall be consistent within a manual and throughout parts lists, parts breakdowns, and other directly related manuals.

f. Only bold font shall be used for emphasis. No other markings, such as quotation marks or underscoring, shall be used for emphasis.

g. Courier New font in the color blue may be used to indicate user typed input.

h. Use of synonyms to provide variety in technical writing can lead to confusion. If there are several synonyms for a concept or object, only one shall be selected and used consistently throughout the manual. For example, words with more than one meaning that will fit the context in which they are used, such as "replace" for "reinstall", shall not be used.

i. When it is necessary to indicate time, begin sentences with "when" clauses. Example: "When power supply voltage stabilizes..."

j. Headings shall be descriptive of the contents of the division they head; "General" and "Miscellaneous" shall not be used unless no other title will suffice. Headings shall be limited to 10 words or less.

## MIL-DTL-24784D(NAVY)

k. Statements that explain applicability for individual items of equipment shall use specific serial number(s), block designation(s), specific model designation(s), or similar identification. Such terms as “on later equipment” and “on early serial numbers” shall not be used.

l. TMs shall make no reference to age, sex, race, or national origin. Use sex neutral terms, except avoid use of the word “person” (terms such as “midshipman” and “workman” are considered sex neutral). Terms such as male and female connectors, pins, and so forth, are acceptable.

3.7.1.2 Standard English grammar. Rules of grammar for standard American English shall be used. Colloquial, substandard, and slang expressions shall not be used. Infinitives may be split and sentences may be ended with prepositions in cases where not doing so sounds awkward or stilted and is likely to distract the user’s attention from comprehending the content. Third person indicative mood shall be used for description and discussion. First person pronouns shall be used to avoid indefinite passive construction.

3.7.1.3 Vocabulary (permitted words). Permitted word lists for preparation of TM textual and procedural steps are contained in SL160-AA-LST-010/TM-WORDS. Words identified during the preparing activity’s quality assurance (QA) process that are not on these lists shall be eliminated and replaced with the “permitted” words, unless the comprehensibility of a given passage requires the use of a “non-permitted” word. In such a case, the exception shall be submitted to the Government for approval of any “non-permitted” word. Terminology shall be used consistently throughout the TM (e.g., the same word for a given tool shall be used throughout the TM).

3.7.1.4 Word order. Sentences and clauses shall be written using simple word order (subject, verb, object) to the extent possible. Modifiers, including prepositional phrases, shall be as close as possible to the word modified. These word order requirements shall be relaxed only to the extent necessary to avoid ambiguity or distortion of meaning.

3.7.1.5 Use of “shall”, “will”, “should”, and “may”. Use “shall” whenever a manual expresses a provision that is binding. Use “should” and “may” whenever it is necessary to express non-mandatory provisions. “Will” may be used to express a declaration of purpose. It may be necessary to use “will” in cases where simple futurity is required.

3.7.1.6 Paragraphs. Text shall be divided into primary paragraphs and subordinate paragraphs. Single subordinate paragraphs may be used, but a minimum of two is recommended. Paragraphs may also be divided into procedural steps. Procedural steps may be further divided if necessary. Limit paragraphs to a single idea. The average paragraph should not exceed six sentences. The desired paragraph length is three to four sentences. Each paragraph shall have a topic entry or sentence. All material in the paragraph shall relate to and develop the topic sentence.

3.7.1.7 Sentences and phrases. Sentences shall be short and concise. Limit sentences to a single thought; use no compound or complex sentences. Sentences shall be rewritten when extensive punctuation is necessary for clarity. Sentence length shall not exceed an average of 20 words. If a sentence has more than one clause and is more than 20 words in length, it shall, whenever possible, be rewritten as two or more simple sentences. Eliminate long, complex sentences and paragraphs by using lists. Complicated phrases shall be avoided.

3.7.1.8 List form. Long complex sentences and paragraphs shall be eliminated through the use of lists. If any series of three items or more appears in a sentence, the sentence shall be written so the items shall appear in explicit list form.

3.7.1.9 Procedures. Procedural steps present detailed, step-by-step instructions for performing an operational or maintenance task – such as turning on a test set; changing oil; replacing a part; repairing an assembly; or inspecting, cleaning, or removing an item of equipment. Procedural steps are presented in a logical sequence and reflect the sequence in which the tasks are actually performed. Procedural steps shall not be prefaced by a lead-in that duplicates the procedure title. Prior to the listing of procedural steps, introductory information shall be provided to help the user carry out the procedure without interruption. Each separate procedure shall be limited to a maximum of 10 steps.

## MIL-DTL-24784D(NAVY)

3.7.1.9.1 Writing style for procedures. Sentences directing the actions of the user shall be in the active voice, second person, and imperative mood. If more than one person is involved, the directions shall be in the active voice, third person, and indicative mood. Procedural steps shall be in positive form (e.g., “Close the container” rather than “Do not leave the container open”) unless the meaning demands the negative form. Procedural steps shall start with an active (transitive) verb: lubricate, remove, tighten, and so forth. Articles may be eliminated when it is necessary to abbreviate procedural text.

3.7.1.9.2 Procedural step content. A procedural step shall be limited to a single operation or to repetitions of a single operation with the following exceptions:

- a. If simultaneous operations are required, they shall be listed together in the same step.
- b. If the step is a major step in a dual-level presentation, the major step shall express the action with a single verb; for instance, “Turn equipment ON”.
- c. If the step represents a detailed procedure, as in b above, but the procedure is so basic that the details should rarely be needed by the intended users, or if the procedure is very frequently repeated, such as turn on, turn off, and calibration procedures, the step shall refer to the procedure with a single verb and cite a reference to the detailed steps; for instance, “Turn equipment ON (see 3-46 for details)”.
- d. Verification of the result of an operation may be included in the step.

3.7.1.9.3 Dual-level presentation. If users of a procedure are expected to vary widely in experience and capability, the Government may direct that certain procedures be presented in a dual-level format. In this format, detailed steps appropriate for inexperienced users shall be listed under major steps. The major steps, without reference to the detailed steps, shall be sufficient to support the performance of experienced users. Dual-level, step-by-step procedures shall be provided in any of the following cases:

- a. When accomplishment of the required action would not be obvious to a journeyman mechanic unfamiliar with the peculiar equipment covered by the manual.
- b. When a peculiar or special action is required.
- c. When safety-related or precautionary procedures are required to prevent personnel injury or equipment damage.
- d. When the required action involves an area with a known history of failure due to improper procedures.
- e. When, because of complexity of a particular procedure, it is necessary to maintain the continuity of the manual.
- f. When verification of the manual demonstrates the need for a step-by-step procedure to satisfactorily complete the required action.

3.7.2 Level of writing. The following paragraphs provide general requirements applicable to all TM types.

3.7.2.1 Readability. The reading grade level (RGL) shall be nine. TMs shall be written to the capability of the target audience for which they are intended. The method employed to determine readability of narrative material is optional. Computation of RGL may be automated provided the results meet the requirements of this specification. Non-narrative material, such as procedural steps, is not subject to RGL. The overall grade level (OGL) shall not exceed the appropriate RGL by more than one grade level. The grade level (GL) of each sample shall not exceed the appropriate RGL by more than three GLs.

3.7.2.2 Sample selection. Samples of text shall be analyzed for readability. Samples shall be selected as follows:

- a. Count the number of pages or panes of text in the manual. The count shall include all full and partial pages or panes that contain text in the form of consecutive sentences. The count shall not include pages or panes containing only illustrations, tables, lists, and so forth. Record the number of text pages or panes.
- b. The basic number of samples shall be determined by using [table I](#).

## MIL-DTL-24784D(NAVY)

TABLE I. Determining basic number of samples.

Number of text pages or text panes	Divisor divided by "N"	Basic number of samples	
		Min.	Max.
90 and above	10	9	30
54 to 89	9	6	9
32 to 53	8	4	6
1 to 31	6	2	4

c. Divide the number of text pages or text panes by the appropriate divisor, "N". Round off the quotient to the next lowest whole number. For example: quotients of 17.3 and 17.7 shall both be rounded off to 17. This quotient shall equal the basic number of samples to be analyzed.

d. For manuals that contain fewer than 12 pages or text panes, randomly select 2 samples and mark them for analysis.

e. For manuals that are 12 pages or text panes or more, randomly select a number between 1 and "N". The number selected shall be marked as the first page or pane of text to be analyzed. Starting at the selected page or text pane, mark every "Nth" page or pane of text to the end of the TM. The marked pages or text panes shall identify starting points for the basic samples to be analyzed.

f. Mark the pages or text panes to verify that at least one sample has been selected for each chapter or topic of the TM. If any chapter or topic has been missed, randomly select one text page or text pane from that chapter or topic and add it to the basic samples to be analyzed.

3.7.2.3 Raw data collection. For each sample marked, raw data shall be collected. Data collection shall consist of counts of the numbers of words, sentences, and syllables in each sample. The size of each sample is based on the number of words to be analyzed. Samples shall start at the beginning of the first full paragraph on each marked sample page or text pane. If a sample falls on a page or text pane containing procedural instructions, the sample shall start at the beginning of the first full sentence on the page or text pane. Headings, captions, and paragraph titles shall not be counted in the sample.

3.7.2.4 Word count. For each sample, the number of words shall be counted as follows:

a. For each sample, count all words up to the end of the sentence containing the 200<sup>th</sup> word. If the marked sample page or text pane contains fewer than 200 words, the sample can be extended to the next page or pane of text; however, do not extend the sample into a new chapter, topic, or text pertaining to a completely new subject.

b. Count as a word all numbers, letters, symbols, and groups of letters surrounded by white spaces. Hyphenated words and contractions count as one word. For example, each of the following would count as one word: couldn't; GFE; that is; 32,008; 19-inch; +250 °F; left-hand. Therefore, a sentence like, "The left-hand MLG door shouldn't open more than 250." consists of 9 words.

c. Record the number of words in each sample.

3.7.2.5 Sentence count. For each sample, the number of sentences shall be counted as follows:

a. Count all sentences in sample including the sentence that contains the 200<sup>th</sup> word.

b. Count as a sentence each unit of thought that can be considered grammatically independent of another sentence or clause. A period, question mark, exclamation point, and semicolon usually denote independent clauses and thus mark the end of a sentence.

c. Record the number of sentences in each sample.

3.7.2.6 Syllable count. For each sample, the number of syllables shall be counted as follows:

a. For most words, count syllables the way the word is normally pronounced aloud. For example: "at" is one syllable, "maintain" is two syllables, "area" is three syllables, "panoramic" is four syllables, and "recuperated" is five syllables.

## MIL-DTL-24784D(NAVY)

b. Count all numbers as one syllable. For example: 5.1, 65, and 300 all count as one syllable each. However, if a numeric expression contains several numbers separated by hyphens, count each number as a syllable. For example, the expression “9-1025-240-10” is counted as four syllables.

c. Acronyms and abbreviations are counted as one syllable unless they actually spell out a word of more than one syllable. For example: Hz and DVM each count as one syllable, but TRADOC and ARRCOM each count as two syllables.

d. Count as one syllable all words that are included in a baseline word list for Navy TMs (see SL160-AA-LST-010/TM-WORDS) and all expanded versions of those lists that are authorized for TM acquisitions.

e. Record the number of syllables in each sample.

### 3.7.2.7 Grade level calculations.

3.7.2.7.1 Sample grade levels. The GL of each sample shall be calculated as follows:

a. Calculate the average sentence length (L). Divide the number of words in the sample (V) by the number of sentences in the sample (T):  $(L = V/T)$ . Round off quotient to the nearest one hundredth.

b. Calculate the average number of syllables per word (D). Divide the number of syllables (C) in the sample by the number of words (V) in the sample:  $(D = C/V)$ . Round off quotient to the nearest one hundredth.

c. Calculate the GL of each sample by the following formula. Round off each GL to the nearest integer.

$$GL = 0.39(L) + 11.8(D) - 15.59$$

3.7.2.7.2 Overall grade level (OGL). The OGL of a TM shall be calculated as follows:

a. Add the total number of words (W) from all samples combined. Record total.

b. Add the total number of sentences (S) from all samples combined. Record total.

c. Add the total number of syllables (P) from all samples combined. Record total.

d. Calculate the average sentence length (A). Divide total number of words (W) by total number of sentences (S):  $(A = W/S)$ . Round off quotient to the nearest one hundredth. Record quotient.

e. Calculate the average number of syllables per word (B). Divide total number of syllables (P) by total number of words (W):  $(B = P/W)$ . Round off quotient to the nearest one hundredth. Record quotient.

f. Calculate the OGL of the manual by the following formula. Round off the OGL to the nearest integer.

$$OGL = 0.39(A) + 11.8(B) - 15.59$$

Sample computations to demonstrate use of formulas:

Sample	Total words	Total number of sentences	Total number of syllables
1	250	30	500
2	220	35	475
3	245	28	420
4	223	22	400
5	256	32	510
6	215	27	398
7	219	26	395
8	230	30	400
9	225	29	380
10	226	28	370
TOTALS: 10	W = 2309	S = 287	P = 4248

## MIL-DTL-24784D(NAVY)

$$\begin{array}{lll} A = W/S & A = 2309/287 & A = 8.05 \\ B = P/W & B = 4248/2309 & B = 1.84 \end{array}$$

$$\text{OGL} = 0.39(A) + 11.8(B) - 15.59$$

$$\text{OGL} = 0.39(8.05) + 11.8(1.84) - 15.59$$

$$\text{OGL} = 3.14 + 21.71 - 15.59$$

$$\text{OGL} = 9$$

3.7.3 References. The following are general requirements applicable to all TM types. See the appendices for unique requirements. Excessive referencing shall be avoided, and the need for the user to refer to other parts of the TM or to other information sources during performance of a task shall be minimized. References shall be limited to Government approved documents that will enhance the clarity and support the intended use of the TM.

3.7.3.1 External document referencing. External document referencing shall conform to the following:

- a. Only reference other documents available and authorized to the user.
- b. Only COTS manuals that have Government-assigned TMINs may be referenced.
- c. Embedding referenced documents, publications, specifications, or standards within the TM is not allowed.
- d. When specified by the acquiring activity, the TM may include links to external referenced documents as long as the each link's destination or target is to the infrastructure location that allows document access for all end users (e.g., shipboard, shore-based, repair facility, and training sites utilizing the Advanced Technical Information Support [ATIS], Technical Data Management Information System [TDMIS], or stand-alone computers) (see 6.2).
- e. Reference to specific content contained within a higher maintenance level TM from a lower maintenance level TM is not allowed.
- f. Reference the basic number for Government specifications and standards unless it is essential to reference a specific revision. Reference to Government specifications and standards for completion of maintenance tasks is not allowed.

3.7.3.2 Text reference placement. Placement of references shall conform to the following:

- a. When a reference applies to one item within a sentence, place the reference parenthetically immediately after the item being referenced.
- b. When a reference applies to an entire sentence, place the reference parenthetically at the end of the sentence with a period outside the parenthesis, or show the reference in a complete sentence.
- c. When a reference applies to an entire paragraph or paragraphs, place the reference parenthetically within the lead-in sentence.
- d. Titles shall not contain references.

3.7.4 Use of terminology, nomenclature, numbers, and equations. The following are general requirements applicable to all TM types.

3.7.4.1 Abbreviations and acronyms. Abbreviations and acronyms used shall be in accordance with ASME Y14.38, except that abbreviations may be plural (s) or possessive ('s) after the first use. New abbreviations and acronyms shall not be created for words or terms that already have abbreviations and acronyms established in ASME Y14.38. When abbreviations or acronyms are used as markings on the equipment, the same abbreviations and acronyms shall be used in the TM. Spell out the abbreviation/acronym where confusion may exist or when usability is enhanced by doing so. An excellent rule to follow is "when in doubt, spell it out". Abbreviations and acronyms that are accepted as words (e.g., radar, sonar, laser, and so forth) need not be spelled out. When a phrase is being abbreviated or made an acronym, the first letter of each word shall be capitalized and elements shall not be separated by periods.

## MIL-DTL-24784D(NAVY)

3.7.4.2 Automatic electronic test and checkout terminology. Terms used for automatic electronic test and checkout shall be in accordance with MIL-STD-1309.

3.7.4.3 Military terms. Military terms used shall be in accordance with Joint Chiefs of Staff (JCS) Pub 1-02, or any dictionary or glossary of military terms of the appropriate Service.

3.7.4.4 Nomenclature. In each section supporting a single user task, official nomenclature shall be used for the first reference to a hardware item. Official nomenclature shall be used wherever the use of a shortened name might be ambiguous. Nomenclature of identical systems, subsystems, equipment, support equipment, components, and parts of the end item shall be consistent throughout the manual. The official designation of equipment shall be expressed in specific terms, such as model number, type, serial number range, or similar terms. The preparing activity shall develop nomenclature lists for associate preparing activities and sub-preparing activities to ensure consistency throughout the manual. The correct nomenclature shall be derived from one of the following sources (listed in the order of precedence):

- a. "AN" nomenclature;
- b. Nameplate nomenclature, nomenclature appearing on the equipment in the form of decals, engraved legends, or other markings;
- c. Cataloging Handbook H6 assigned nomenclature; or
- d. Nomenclature on the drawing from which the item was manufactured.

3.7.4.5 Noun modifiers. Noun modifiers shall be added to the description of parts as required to ensure positive identification, such as cotter pins/taper pins. These modifiers need not appear on the preparing activity's graphic. Noun modifiers, once added for clarity, shall be used throughout the technical data.

3.7.4.6 Placard data, switch positions, panel markings, and equipment readings. Reference to equipment placard data, switch positions, and panel markings shall be referenced exactly as marked on the equipment. Reference to temperature readings shall be as calibrated on the equipment. If other than Fahrenheit, the equivalent in Fahrenheit shall follow in parentheses. General temperature references, such as room temperature, shall normally be given in degrees Fahrenheit. References to speed, distance, and other instrument readings shall be as calibrated on the equipment.

3.7.4.7 National stock numbers. National stock numbers shall not appear in descriptive text but may be included in the parts data information.

3.7.4.8 Part numbers. Part numbers shall not be used in text or on illustrations except when necessary for clarity.

3.7.4.9 Symbols. Symbols used in inline text shall be large enough to be readable but not larger than two times the line spacing within the normal text. When new or unusual graphics symbols are required, they shall be identified at each occurrence. It is permissible to spell out symbols that cannot be reproduced on the equipment on which the data is being prepared.

3.7.4.10 Measurements. Measurements shall be in U.S. standard units (ounces, pounds, gallons, inches, feet, knots, miles, and so forth) except instances in which metric measurements are required. When the metric system is used on the equipment, conversion to U.S. standards shall follow in parentheses. If required, conversion of U.S. measurements to metric measurements shall be indicated. Metric practices, measurement units, symbols, and so forth shall be in accordance with NIST Special Publication 811 and IEEE 945.

3.7.4.11 Equations. Use of equations shall be held to a minimum as required to ensure comprehensibility by the user.

3.7.5 Safety and health requirements. Unless otherwise indicated below, the requirements identified in the following paragraphs are applicable to all TM types.

## MIL-DTL-24784D(NAVY)

3.7.5.1 Guidance and coordination. The following paragraphs identify standard practices for the inclusion of Occupational Safety and Health (OSH) guidance in the text of TMs, as well as requirements for the inclusion of dangers, warnings, and cautions associated with the operation, maintenance, or overhaul (see 6.4.13) of shipboard systems and equipment. ANSI/NEMA Z535.3 provides general criteria for the design, evaluation, and use of safety symbols to identify and warn against specific hazards and provide information to avoid personnel injury. The effective inclusion of safety and health guidance shall be accomplished by the coordinated effort of system experts, safety professionals, technical writers, and the potential user. Careful consideration of environmental factors, equipment design or layout, human nature, and other human factors will help ensure the overall integrity of the task procedures. Questions arising from this process shall be referred to the appropriate Safety Office and the Government acquiring activity. Existing contractual or Command requirements shall be included.

3.7.5.2 Health hazards. Procedures prescribed for the operation of equipment shall be consistent with the safety standards established by OSHA Public Law 91-596 and Executive Order 12196. When exposure to hazardous chemicals or other adverse health factors or use of equipment cannot be eliminated, guidance pertaining to the exposure shall be included in the safety summary or a warning.

3.7.5.3 Hazardous materials warnings. The hazardous materials warnings shall be developed from information provided by chemical manufacturers in safety data sheets (SDS) required by 29 CFR 1910.1200. SDSs used within DoD shall be entered into the Hazardous Materials Information System (HMIS) addressed in DoD 6050.05. DoD 6050.05 contains SDSs submitted under the provisions of FED-STD-313. Additional information related to hazardous material requirements is provided in OPNAVINST 5100.23.

3.7.5.3.1 Use and placement of hazardous materials warnings. Hazardous materials warnings shall be presented in the standard danger or warning format. In cases where hazardous materials are being used in a non-routine application, the hazardous materials symbol(s) shall also be used; otherwise, use of the symbol(s) is optional. Hazards that result from a combination of materials shall clearly be identified to indicate that mixing or combining the materials creates the hazard. The safety summary shall include the applicable symbols used within the TM, their related explanation, and the complete danger or warning applicable to all hazardous materials addressed in the TM (see 3.7.5.10.e).

a. Format for hazardous materials warnings with symbols: Hazardous materials warnings with symbols shall consist of the signal word DANGER or WARNING (see 3.7.5.9.2), the symbol(s), and a full description of the hazardous material and the precautions to be taken.

b. Abbreviated format for hazardous materials warnings with symbols: For commonly used substances only (e.g., dry cleaning solvent, hydraulic fluids, paints, etc.), an abbreviated format may be used for hazardous materials warnings. The abbreviated format consists of the signal word DANGER or WARNING, the symbol(s), and the nomenclature and specification or part number (e.g., ISOPROPYL ALCOHOL, TT-I-735) of the hazardous material. The full hazardous materials warning shall be placed in the safety summary.

3.7.5.3.2 Hazardous material symbols. [Figure 3](#) contains a list of approved hazardous materials symbols that may be included in dangers and warnings to provide quick recognition of the hazard by the user. Images of the symbols shall be obtained from the Navy XML/SGML Repository under U.S. Navy Hazard Icons (<http://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Carderock/Resources/Technical-Information-Systems/Navy-XML-SGML-Repository>). The acquiring activity shall approve the use of symbols other than those presented on [figure 3](#). The safety summary shall include the applicable symbols used within the TM along with their related explanation (see 3.7.5.10).

3.7.5.4 Safety warning symbols. [Figure 4](#) contains a list of safety warning symbols that may be included in the text of dangers, warnings, or cautions to provide quick recognition of the safety hazard by the user. Images of the symbols shall be obtained from the Navy XML/SGML Repository under U.S. Navy Hazard Icons (<http://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Carderock/Resources/Technical-Information-Systems/Navy-XML-SGML-Repository>). The acquiring activity shall approve the use of symbols other than those presented on [figure 4](#). The safety summary shall include the applicable symbols used within the TM and their related explanation (see 3.7.5.10).

## MIL-DTL-24784D(NAVY)

3.7.5.5 Nuclear hardness. If equipment to be operated, maintained, or overhauled has nuclear survivability requirements (that is, over pressure and burst, thermal radiation, electromagnetic pulse, or transient radiation effects on electronics), applicable cautions shall be incorporated into TMs to ensure that hardness of equipment is not degraded during operation and maintenance.

3.7.5.5.1 Nuclear hardness symbol. All Hardness Critical Processes (HCP) shall be marked with the symbol:

HCP

- a. When the entire procedure and all subordinate steps relate to establishing nuclear hardness, the symbol shall be placed prior to the procedure title.
- b. When all subordinate steps do not contribute to establishing nuclear hardness, only those which do contribute shall be annotated by placing the symbol between the step number and text.
- c. Maintenance actions that could degrade hardness, but that are not directly involved in establishing nuclear hardness, shall not be annotated with the symbol, but shall be preceded by a caution.

3.7.5.5.2 Nuclear hardness symbol explanation. When applicable, the foreword, safety summary, or introduction shall include the symbol and an explanation and other pertinent information as necessary to emphasize the uniqueness of hardness features. The nuclear hardness symbol explanation shall state that all paragraphs, procedures, and steps identified by the symbol shall be followed as written to ensure nuclear hardness is not degraded. This explanation shall be preceded by a CAUTION signal word.

3.7.5.6 Electrostatic discharge sensitive (ESDS) parts. If equipment to be handled or maintained contains ESDS parts, components, or circuits, applicable cautions and symbols shall be incorporated into TMs to ensure ESDS parts are not damaged or degraded during handling or maintenance.

3.7.5.6.1 Electrostatic discharge (ESD) symbol. All procedures that address handling or maintenance that could damage ESDS parts shall be identified by the following symbol indicating a sensitive electronic device:



- a. When the entire procedure and all subordinate steps describe handling or maintenance that could damage ESDS parts, the ESD symbol shall be placed prior to the procedure title.
- b. When all subordinate steps do not describe handling or maintenance that could damage ESDS parts, then only those that do shall be annotated by placing the ESD symbol between the step number and the text.
- c. Maintenance actions that could damage ESDS parts, but are not directly related to handling or maintenance of ESDS parts, shall not be annotated with the ESD symbol, but shall be preceded by a caution.
- d. Illustrations, drawings, and schematics shall be marked with the ESD symbol in accordance with MIL-STD-1686.

3.7.5.6.2 ESD symbol explanation. When applicable, the foreword, safety summary, or introduction shall include the ESD symbol and an explanation of the ESD symbol. Other pertinent information shall be included as necessary to emphasize the uniqueness of ESDS parts. The ESD symbol explanation shall state that the ESD symbol requires that all ESDS parts be handled according to ESDS device handling procedures in MIL-STD-1686. This explanation shall be preceded by a CAUTION signal word.

3.7.5.7 Environmental protection. All TMs that describe the use; transportation; handling; storage; or disposal of fuels, toxic and hazardous substances, chemicals, ordnance and munitions, and so forth, shall meet the requirements of the Federal Environmental Protection Standards.

## MIL-DTL-24784D(NAVY)

3.7.5.8 Ozone depleting substances (ODS). Per Executive Order 13693, agencies shall purchase sustainable products and services identified by Environmental Protection Agency (EPA) programs, including Significant New Alternative Policy (SNAP) chemicals or other alternatives to ozone-depleting substances (ODS) and high global warming potential hydrofluorocarbons, where feasible, as identified by SNAP. Including information on the use of ODS materials in NAVSEA TMs is prohibited. A list of these substances may be obtained from the acquiring activity.

3.7.5.9 Dangers, warnings, cautions, and notes.

3.7.5.9.1 When to use danger, warning, or caution statements. Procedures or practices that, if not correctly followed, will or could result in death or injury to personnel, damage or destruction of equipment, or improper system operation shall be highlighted by danger, warning, or caution statements. The danger, warning, or caution, statement shall be preceded by the appropriate signal word "DANGER", "WARNING", or "CAUTION". Use of signal words and associated statements for dangers, warnings, and cautions shall be as follows:

- a. **Danger**. Use the signal word "DANGER" to highlight a statement or some other notification about an operating or maintenance procedure, practice, or condition that, if not strictly observed, **will** result in death or serious injury, or threaten the primary mission of the ship. The use of the signal word "DANGER" shall be limited to the extreme situations.
- b. **Warning**. Use the signal word "WARNING" to highlight a statement or some other notification about an operating or maintenance procedure, practice, or condition that, if not strictly observed, **could** result in death, injury, or long-term health hazards.
- c. **Caution**. Use the signal word "CAUTION" to highlight a statement or other notification about an essential operating or maintenance procedure, practice, or condition that, if not strictly observed, could result in damage to or destruction of equipment or loss of mission effectiveness.
- d. Danger, warning, or caution statements are not to be used for environmental protection concerns or security information.
- e. Specific direction as to which specific procedures require the use of danger, warning, or caution statements may be obtained from many sources, including Logistics Support Analysis Record (LSAR), LMI, system safety analysis, engineering analysis, maintenance analysis, and operating and support hazard analysis. The responsible safety office should be requested to review TM procedures for compliance with safety concerns.
  - (1) Risk assessment, and the related issue of whether additional emphasis is required, is somewhat subjective. Decisions concerning these issues should be based on as much information as possible, including historical mishap data from related systems, research, and the experience of all those involved in the TM development process. Often, the latter is the best indicator of the need for additional comment.
  - (2) Danger, warning, and caution statements should be used for those unique conditions, steps, or processes that require additional emphasis because of the inherently dangerous nature of the task or the potential for a "surprise" not otherwise readily obvious from the procedure.
  - (3) A warning statement should be used to advise of potential injury or occupational illness, but only when based on the reasonable likelihood that the reader's health or safety will be impacted in such a manner as to cause immediate concern and that a disabling injury or occupational illness will result if the task procedure or stated precaution is not closely followed.
    - (a) Injury is defined as a traumatic bodily harm caused by a single or 1-day exposure to an external force; toxic substance (usually associated with accidents and spills in work places where the specific agent is not normally in the environment); or physical agent that will result in restricted duty, lost time, or worse.
    - (b) Occupational illness is defined as any abnormal physical condition or disorder, other than one resulting from an injury (as defined above), caused by repeated exposure to chemical, biological, or physical agents associated with the occupational environment that will result in restricted duty, lost time, or worse.

## MIL-DTL-24784D(NAVY)

3.7.5.9.2 Wording and structure of danger, warning, and caution statements. A DANGER, WARNING, or CAUTION shall consist of the following in conformance with ANSI Z535.6:

- a. A signal word panel consisting of the safety alert symbol (for dangers and warnings only) and the signal word DANGER, WARNING, or CAUTION. (The safety alert symbol is used to indicate a potential personal injury hazard. It is composed of an equilateral triangle surrounding an exclamation mark.)
- b. A safety warning symbol or hazardous material symbol(s) (if used).
- c. A concise statement of the hazard.
- d. Minimum precautions.
- e. The possible result if the danger, warning, or caution statement is disregarded, unless obvious.

For example:



Cleaning with compressed air can create airborne particles that may enter eyes or penetrate skin. Pressure shall not exceed 30 psig. Wear goggles. Do not direct compressed air against skin.

- f. Following the format of statement first, precaution second, and result third is often the most clear and concise method. Brevity is important. If the possible result is obvious, it need not be included.
- g. A precaution is a short statement of hazard mitigation that tells the reader to take care, for example, “use eye protection”, or “keep arms and hands clear”. Certain precautions may reference other publications or direct people to consult with another agency (for example, “...consult Bioenvironmental Engineering”). However, guidance of this nature shall be considered for inclusion in a safety summary.
- h. Danger, warning, or caution statements shall not contain procedures critical to the effective and safe completion of the task.
- i. Negatively worded statements (for example, “Failure to adhere...” or “Do not use...”) are acceptable and sometimes the best way to convey the message.
- j. Multi-paragraph or excessively long danger, warning, or caution statements should not be used. Lengthy statements are a good indication that the task procedures are not written with the needed safety steps or procedures included.
- k. Pay strict attention to the definitions of “shall”, “will”, “should”, and “may” in this specification. The use of these words shall be consistent with exposures or conditions that require comparable danger, warning, or caution statements.

3.7.5.9.3 When to use note statements. A note statement shall be used when it is necessary to add, emphasize, or clarify essential information of special importance or interest. A note shall not be used to convey safety information that should otherwise be contained in a danger, warning, or caution statement. The signal word “NOTE” shall be used to identify note statements.

3.7.5.9.4 Placement of danger, warning, caution, or note statements. Placement of danger, warning, caution, or note statements shall be as follows:

- a. Dangers, warnings, and cautions shall precede the text but follow the paragraph heading to which they apply. Notes shall be placed before the text to which they refer. The same danger, warning, caution, or note need not be repeated within a procedure as long as the emphasis and impact of the danger, warning, caution, or note is not lost because of a break in the procedures.
- b. There is no stated maximum on the number of unrelated dangers, warnings, cautions, or notes that can be placed on a page or screen display. Under no conditions should they be so numerous as to obscure the procedures. Properly written procedures should eliminate the need for consecutive warnings. Sandwiching short procedures between dangers, warnings, and cautions should be avoided.

## MIL-DTL-24784D(NAVY)

c. When a danger, warning, caution, or note consists of two or more paragraphs, the signal word DANGER, WARNING, CAUTION, or NOTE shall not be repeated above each paragraph, nor shall the paragraphs be numbered.

d. If it is necessary to precede a paragraph by a combination of dangers, warnings, cautions, or notes, they shall appear in this order: DANGER, WARNING, CAUTION, and NOTE.

3.7.5.9.5 Display of dangers, warnings, cautions, and notes. The signal word panel for dangers, warnings, cautions, and notes shall be as shown below in conformance with ANSI Z535.6. Color shall be as specified in 3.7.5.9.5.1 through 3.7.5.9.5.4, in conformance with ANSI Z535.6. Safety warning symbols or hazardous material symbols (if used) shall be placed immediately after the signal word panel and before the statement. The signal word panel shall be centered above the danger, warning, caution, or note statement. For IETMs, the format and display of dangers, warnings, cautions, and notes used in text are controlled by the NAVSEA-approved IETM Publisher/Viewer. The signal word panel, the statement, and the safety warning or hazardous material symbols (if used) are contained within an alert border. When specified (see 6.2), dangers, warnings, cautions, and notes shall require user acknowledgement prior to allowing the user to continue. For page-based TMs:

a. When used within a regular text page, all lines of the danger, warning, caution, and note statement should be block indented 1 inch from both the left and right margins.

b. When used within tables, the danger, warning, caution, or note statement left margin should be 10 percent of the cell width and the right margin should be 5 percent of the cell width.

c. When used within a graphic, the danger, warning, caution, or note shall be developed as part of the graphic itself. All lines of the danger, warning, caution, or note statement shall be block indented and formatted to conserve space.

3.7.5.9.5.1 Dangers. The signal word “DANGER” shall be in white letters on a safety red background. The signal word panel shall include the safety alert symbol.



3.7.5.9.5.2 Warnings. The signal word “WARNING” shall be in black letters on a safety orange background. The signal word panel shall include the safety alert symbol.



3.7.5.9.5.3 Cautions. The signal word “CAUTION” shall be in black letters on a safety yellow background. The safety alert symbol shall not be used with CAUTION.



3.7.5.9.5.4 Notes. The signal word “NOTE” shall be in white letters on a safety blue background.



## MIL-DTL-24784D(NAVY)

3.7.5.10 Safety summary. All TMs shall include a safety summary. Inclusion of general guidance does not preclude the need for a DANGER, WARNING, or CAUTION signal word and statement within the TM. An excessively long safety summary is discouraged. The safety summary shall include the following (as applicable):

a. General safety or health precautions and instructions tailored to the TM (e.g., high voltage warning, warning against servicing alone, and resuscitation statement). General safety information provides notice of general safe practice or rules related to health, first aid, and sanitation and housekeeping and guidance pertaining to the exposure of hazardous chemicals or other adverse health factors. The following examples are provided as guidance:

(1) Live circuitry guidance is probably not applicable to a TM containing procedures for corrosion control. This does not preclude the possibility, however, of a warning in the text of that TM if the text establishes the likelihood of exposure to injurious current.

(2) It would be appropriate to include live circuitry guidance in the safety summary of a maintenance TM. However, warning statements inserted in the text prior to every point of potential current exposure would not be required, as long as the procedures identify the proper controls (e.g., “discharge capacitor XXXX” or “...turn off power and tag out [lock out] switch”). It is reasonable to assume a trained maintenance technician is fully aware of the hazards of live circuitry; emphasis beyond a safety summary would be needed only in the event that the equipment, procedures, or work environment presented an unusual situation to the technician.

(3) General guidance related to air pressures (30 psig), chip guarding, eye protection, etc., could be provided in the safety summary; however, the task procedures within the TM shall include the minimum required controls (e.g., pressure regulation). A caution statement may still be required if the text specifies 15 psig for a delicate piece of equipment that would be damaged if the technician proceeded under the general guidance included in the safety summary.

(4) In a TM that frequently calls for routine solvent applications, WARNINGS would not be needed throughout the text as long as the minimum required controls are called for in the task procedures. General guidance regarding solvents could be included in the safety summary. Additional emphasis would then be required only if a procedure calls for a non-routine application, such as heating the solvent, or an unusual, potentially more toxic solvent. In that event, a DANGER or WARNING could be used, depending on the ability of the process to cause immediate safety or health concerns. This approach can be used for many of the occupational health concerns associated with commonly used substances (e.g., hydraulic fluids, oils, fuels, paints, thinners, adhesives, and sealants).

b. The definitions for danger, warning, and caution, and a description detailing their significance and use in the TM.

c. When specified by the acquiring activity (see 6.2), include a compilation of all dangers, warnings, and cautions used within the TM, including reference to the page(s) or module(s) within the TM where the specific danger, warning, or caution appears.

d. Safety warning symbols used within the TM and their explanation.

e. For hazardous material warnings, include:

(1) Hazardous material symbols used within the TM and their related explanations.

(2) The complete DANGER or WARNING used within the TM, the hazardous material symbol(s) (if used), the nomenclature and specification of the hazardous material, and personal protective equipment requirements.

(3) When applicable, a statement that symbols are used to save space in the TM while still conveying a clear message of the hazard to the technician using the TM.

(4) A general warning that, when a hazardous chemical spill or other adverse health condition cannot be safely contained or eliminated by available maintenance personnel, emergency and damage control procedures (which are not part of the TM), or damage control personnel, if available, shall be consulted.

3.7.5.11 Quality control of dangers, warnings, and cautions. The Government will recommend rewrite of dangers, warnings, and cautions under the following conditions:

a. When any part of a procedure, danger, warning, caution, or safety summary is not consistent with existing OSHA and Service safety requirements or is detrimental to existing Service safety and health programs.

## MIL-DTL-24784D(NAVY)

- b. When danger, warning, or caution statements are misused outside of the intent of this specification.
- c. When danger, warning, or caution statements contain procedural steps. Minimum protective equipment requirements or minimum precautions are allowable.
- d. When danger, warning, or caution statements are excessively long.
- e. When danger, warning, or caution statements are so numerous on a page or screen display that necessary task procedural steps are visually obscured.
- f. When safety summaries are used to the exclusion of dangers, warnings and cautions in the text, unless indicated by the nature and type of hazard associated with the text or when otherwise used outside of the intent of this specification (that is, they shall provide tailored, general guidance).
- g. When statements detailing the significance and use of danger, warning, and caution statements are not provided in the safety summary.
- h. When the wording of dangers, warnings, or cautions varies throughout the text even though the same or very comparable conditions are being emphasized.
- i. When a procedure lacks required emphasis because of its inherently dangerous nature or a step requires additional emphasis because of its critical safety impact.
- j. When dangers, warnings, or cautions contain vague precautionary statements such as “avoid all contact”, or rely too frequently on references to other TMs or outside agencies. In these cases, inclusion in a safety summary shall be recommended as appropriate.
- k. When danger, warning, or caution statements contain general safety precautions.

3.7.6 Tabular material. The following are general requirements applicable to all TM types.

3.7.6.1 Tables, charts, and graphs. Reference data (other than illustrations, drawings, diagrams) shall be presented in tabular, chart, or graph form. Any other type of data that lends itself to tabular, chart, or graph form may also be so presented. Charts shall be presented as tables or illustrations; whichever is most appropriate. Graphs shall be considered illustrations. Each table shall be included as part of a paragraph or follow as closely as possible to its first reference in the narrative text. Tables shall conform to the following:

- a. Single space entries within the table.
- b. Align related entries in different columns.
- c. Align entries within columns containing numerical data as follows:
  - (1) Decimal numbers on decimal points.
  - (2) Scientific notation on the multiplication symbol.
  - (3) All other numeric data flush right.
- d. Alphabetic or alphanumeric data flush left.
- e. Insert a dash (-) to indicate an entry that is intentionally left blank.
- f. Specify units of measurement in row or column headings.

3.7.6.2 Table column head titles and rules. The first letter of the first word and of each principal word of table column and row head titles shall be capitalized. Tables may be vertically ruled as required for clarity. A horizontal rule shall be placed at the beginning (head) and at the end (foot) of a table and following column heads. The closing rule shall be omitted at the foot of a continued row.

3.7.6.3 Lists. Lists may be used in lieu of tables, when appropriate. Three types of allowed lists are identified below.

- a. Definition list: The definition list shall consist of the term and the definition. The definition list shall have the headers “Term” and “Definition” above the appropriate sections of the list. All text shall be blocked.
- b. Random list: The random list shall consist of one or more items in a random order. The list may be preceded by a title. List items shall be preceded with a dash for the first level items, a bullet for the second level items, and a dash for the third level items. All text shall be blocked.

## MIL-DTL-24784D(NAVY)

c. **Sequential list:** The sequential list shall not be used in procedural steps. The list may be preceded by a title. A sequential list shall consist of one or more items and be numbered (see the appendices). All text shall be blocked. Each level of list items shall begin two spaces below the preceding list item and shall be indented an additional two spaces.

3.7.7 **Numbering.** Refer to the appendices for unique requirements.

3.7.8 **Graphics.** The following are general requirements applicable to all TM types. Refer to the appendices for unique requirements.

3.7.8.1 **Illustrations, drawings, diagrams, and photographs.** Style and techniques shall be of a quality such as to produce artwork that clearly, accurately, and economically portray the information to be illustrated. Text and illustrations shall complement each other to communicate the required information. Nomenclature shall be consistent throughout the manual. Illustrative material shall be used to:

- a. Describe an item or idea if this can be done more efficiently and effectively by graphic methods.
- b. Clarify text; present phases difficult to describe by text alone.
- c. Call attention to details.
- d. Furnish graphic identification of parts and tools.

3.7.8.2 **Graphic types and development techniques.** The following are requirements for specific types of graphics discussed in this specification for use in NAVSEA TMs. Not all graphic types apply to all TM types. See 3.7.8.3 for general graphic requirements.

3.7.8.2.1 **System/equipment illustration (frontispiece).** A frontispiece shall illustrate the system, equipment, or repairable item covered in the manual (see [figure 5](#)). For installations consisting of more than one unit (see 6.4.23) or assembly (see 6.4.3), a pictorial illustration representing the equipment or all units comprising the equipment shall be included. If two units of the equipment differ between models, the alternate units shall be shown side-by-side (if clarity is not sacrificed) and designated by applicable model numbers. If more than two units differ, two frontispieces shall be furnished. The illustration shall show the major units of the equipment, relative size of each unit, basic interconnections between units, and their relationship with other equipment.

3.7.8.2.2 **Block diagrams.** A system of functional block diagrams (FBDs) shall be used to depict the functional divisions (see 6.4.9) of the system/equipment. The diagrams shall depict the system/equipment in an integrated manner; that is, a master FBD shall show each function of the equipment; primary FBDs shall show the functional divisions of the equipment; and secondary or lower-level FBDs shall show further functional subdivisions of complex sub-functions. The lowest level of FBD shall be directly referenced to functional circuit diagrams (FCDs) (see 3.7.8.2.4) or to the hardware reference designator where the function is performed. See 3.7.8.2.3 and 3.7.8.2.6 for additional requirements.

a. **Master FBD:** The master FBD depicts the system/equipment functions and major signal paths within the system/equipment (see [figure 6](#)). Each major block on the master FBD shall represent a major functional element and shall be identified by functional and hardware boundary lines and descriptive names. These functional elements shall be connected by signal path and control lines, also identified with descriptive names. Each block on the master FBD shall contain a reference to a primary FBD and the paragraph number (as applicable) or a link to the paragraph that describes the block (not the keyed text paragraph).

b. **Primary FBD:** Primary FBDs (see [figure 7](#)) shall contain system/equipment function and sub-function information. The functional divisions shall be interconnected by signal path and control lines, each identified with a descriptive name and proper line weight (line weights shall be as specified in 3.7.8.2.6). The primary FBD shall illustrate the interconnection of sub-functional elements in order to describe how the functions work within the system/equipment. Primary FBDs may show system/equipment boundaries if appropriate to the function being shown. They shall provide a reference to secondary diagrams and the paragraph number (as applicable) or a link to the paragraph that describes the block (not the keyed text paragraph). The secondary diagrams may be FBDs or FCDs. If there are no secondary diagrams for reference, the reference shall be made directly to the hardware by reference designation. A direct relationship shall be maintained in regard to the number and nomenclature of interface lines between a primary FBD and other interfacing primary FBDs.

## MIL-DTL-24784D(NAVY)

c. Secondary FBD: When the functional divisions represented on the primary FBD are sufficiently large, further division of the functions is sometimes necessary. The secondary FBD provides the transition between the major functional elements on the primary FBD and the FCDs, or to actual hardware by reference designator where the function depicted is performed. The sub-functional segments illustrated on the secondary FBD shall often be further subdivided to effectively depict equipment operation. In this case, the secondary FBD provides the transition between the primary FBD and lower levels of FBDs (see [figure 8](#)). The secondary and lower-level FBDs are generated by dividing the functional elements into discrete segment (sub-function) blocks. Each block shall be identified by a descriptive name. The blocks shall reference the paragraph number (as applicable) or a link to the paragraph that describes the block (not the keyed text paragraph). These segments shall be interconnected in the same manner as the major blocks on the primary FBD; that is, with signal path and control lines identified by names and having the proper line weights. Each sub-functional block shall be identified by a descriptive name. A direct relationship shall be maintained in regard to the number and nomenclature of interface lines between a secondary FBD and other interfacing secondary FBDs. The lowest-level FBD block shall contain a reference to an FCD or to the hardware reference designator where the function depicted is performed (see [figure 9](#)).

3.7.8.2.2.1 Power and grounding circuit FBDs. The following paragraphs describe the preparation of power and grounding circuit FBDs.

a. System/equipment power FBD: The system/equipment power FBD shall show the distribution of primary power from the power source to the various units comprising the system/equipment. The FBD shall be a part of the master FBD and shall reference the associated unit power and grounding FBDs and FCDs. Power conversion and distribution within the system/equipment units shall be shown by a separate power FBD for each unit unless the power circuits within the unit do not warrant a separate FBD because of their simplicity.

b. Unit power FBD: The unit power FBD shall show the distribution of primary power and control power from the primary power source and associated interface units to the power elements within each unit (see [figure 10](#)). The FBD shall represent the power elements as functional blocks and shall show power conversion, power control monitoring, and indicating between the unit power elements. The diagram shall be laid out in a logical left-to-right sequence to clearly define the power operations within the unit. Each functional block shall contain a reference to an FCD. This FBD shall be the last sheet(s) of the FBDs.

3.7.8.2.3 Requirements for preparing FBDs. A clear and complete referencing system is required for use on FBDs because of the interrelationship between FBDs and FCDs and the interconnection between sheets of FBDs. The referencing system shall include all or a portion of the following reference information:

a. Signal names:

(1) Signal names on FBDs shall be descriptive names. The Automated Interface Listing (AIL) (the wire lists for the system cabling), or their equivalent, shall be used as the source of signal names between units. Engineering schematics and cabling wire lists shall be used as the source of signal names internal to a unit.

(2) Power-on reset signals on the data FBDs shall be shown entering from external to the function. No function block for power reset shall be shown on the data FBDs. The generation of the power-on reset shall be shown on the power and grounding FBDs.

(3) All signal lines between functional blocks on the FBDs shall be identified by descriptive signal names. Signal lines that interface from one FBD sheet to another FBD sheet shall have the identical signal name on each sheet. Signal lines that are identified on different level FBDs (a signal level shown both on the primary FBD and on the secondary FBD) shall be identified by the same signal name.

(4) Reference designations shall not be used as signal names except in cases where no other name exists.

(5) The FBD number, sheet, and zone shall be used to identify signal origins and destinations when referencing from one FBD to another.

b. Signal referencing for FBDs:

(1) Signal referencing on the same sheet: An on-sheet reference to show a continuous line between two points shall be shown by a circle enclosing double capital letters with a lead arrow indicating direction (see [figure 11](#)). Letters shall start with AA, then AB, AC, and so forth. Zone reference shall not be used.

(a) Signal lines shall show signal name on flow line before the reference symbol.

## MIL-DTL-24784D(NAVY)

(b) An inverted triangle symbol shall not be used except for an A or B (primarily found on the power FCDs) to indicate grounds.

(2) Signal referencing between two or more functional parts: To show a continuous line between two points on different sheets of a functional breakdown (a function broken into Parts 1 of 2, 2 of 2, and so forth), an irregular pentagon shall be used. Double capital letters starting with BA then BB, BC, and so forth, shall be enclosed within this symbol. Zone references shall be indicated. See [figure 12](#).

(3) Signal referencing between units: Referencing between units shown on the diagram shall be accomplished at equivalent levels (that is, primary levels shall interface, second levels shall interface; however, a primary level shall not interface with a second level). See [figure 13](#).

(4) Grouping of signals: Brackets may be used when all of a group of signals come from or go to the same zone or destination.

c. Keyed text: The FBDs may be prepared with or without keyed text. Each block on the FBD shall contain a circled number. The circled number corresponds to a brief paragraph (referred to as “keyed text”) that describes the purpose and function of that block. The circled numbers shall start with the circle number 1 in the first block at the top left of the FBD and progress in a logical manner (either by data flow, or top-to-bottom and left-to-right) on the FBD until all blocks are numbered. The “keyed text” paragraph shall be located on a page facing the FBD to which it applies or be linked from the FBD. See [figure 14](#).

d. Diagram type: The diagram type (FBD or FCD) shall be included above the title block of the drawing or on sheet 1 only. The title block shall appear only on sheet 1. Sheets 2 and on shall not contain the diagram type block or the title block.

e. Equipment names: Equipment name or reference designation shall be used to identify hardware boundaries on the FBDs.

f. Function names: Each functional area of each unit shall be identified by a descriptive name. These functional areas shall then be further broken into sub-functions, each being assigned a descriptive name. Once a function name has been assigned, the identical name shall always appear whether it appears on an FBD or on an FCD to identify the functional boundary. No two functional areas may be assigned the same name.

g. Diagram (drawing) numbers: In systems with fully implemented unit numbers, all FBDs shall be numbered FBDXXXX, where XXXX is equal to the unit number (that is, 1001, 1002, 1107, and so forth), except for the master FBD or FCD. The master FBD or FCD shall be numbered FBD0000 or FCD0000. For those cases where one FBD (or FCD) is used for multiple and identical units, the lowest unit number shall be used (that is, units 1071 and 1072 shall be FBD1071). In other systems, FBDs shall be numbered chronologically.

h. Sheet numbers: FBDs or FCDs having multiple sheets shall be assigned sheet numbers starting with the number one (1). The drawing sheet number and zone number shall be used to identify signal interconnections between sheets of the same FBD or FCD.

i. Zone numbers:

(1) The zone number and sheet number shall be used to identify signal interconnections between sheets of an FBD and when referencing between FBDs or from FBDs to FCDs and vice versa. Sheet and zone numbers shall be as shown on [figure 15](#).

(2) Zone number references shall call out the drawing coordinates of the referenced detailed signal name rather than call out the drawing coordinates of the symbol itself.

j. Reference designations: Reference designations shall be used to correlate circuit symbols to actual hardware locations. All hardware boundaries, logic symbols, electrical symbols, and analog symbols shall be identified by the reference designations assigned to the hardware being depicted.

## MIL-DTL-24784D(NAVY)

3.7.8.2.4 Functional circuit diagrams (FCDs). An FCD shows in symbolic form the interrelationship of the circuits required to perform a function. The FCD consists of symbols representing circuit modules and electrical parts complete with physical location and interconnection information. FCDs shall be prepared for control and indicator circuits, analog logic, and power and grounding circuits. See [figure 16](#) for an example of an analog logic FCD. An explanation of power and grounding FCDs is given in 3.7.8.2.4.1. If FCDs are required for a unit having all three types of the above circuits, all circuits shall be shown on the same drawing numbered FCD. See 3.7.8.2.5 and 3.7.8.2.6 for additional requirements.

a. Schematics: Schematics are not required for unit wiring or similar interconnecting hardware devices because complete interconnecting information appears on the FCDs. Components such as switches, relays, and terminating resistors mounted directly on the cabinet shall be shown in schematic form on the FCD using the rules for detailed FCDs (see e below).

b. Layout techniques: An FCD shall be prepared for each function defined on the lowest level of FBD where it is necessary to show circuits that are not located on pluggable modules and for the power and grounding circuits. Layout of the symbols on the FCD shall provide a left-to-right functional flow. Circuit symbols shall be functionally divided by thin lines in direct relationship to a functional block on a related FBD, and the functional division on the FCD shall be identified by the same function name. If the equipment is sufficiently complex, an FCD may consist of multiple sheets; then functional flow shall be left-to-right from sheet to sheet. All inputs and outputs of the function depicted on the FCD shall be identified by signal names. Inputs shall be referenced to the source FCD and outputs shall be referenced to the destination FCD. For smaller systems or equipments, an FCD sheet may contain more than one function and possibly the entire equipment.

c. Analog functions: In analog functions, the FCD details the operating elements (e.g., emitter followers and amplifiers) within the function using special block symbols or schematic symbols. The special block symbols shall be used to detail replaceable circuit elements or modules that are used as building blocks in the analog equipment.

d. Schematic symbols: Schematic symbols shall be used to detail circuits of assemblies or modules having replaceable parts. The resulting FCD may have both symbolic and electrical schematic characteristics with functional grouping techniques applied. Schematic representations on the FCD shall be formed using the rules set forth for detailed FCDs.

e. Detailed FCDs: Detailed FCD drawing techniques shall be used, where necessary, to show cabinet-mounted components (e.g., switches, relays, and termination resistors) and for detailing circuits of assemblies or modules having replaceable parts. Separate detailed FCDs are required for the unique repairable circuits used as building blocks for analog equipment; one detailed FCD is required for each type of building block.

(1) Layout techniques: Detailed FCDs present all circuit information, including component values, test points, and sensors (see [figure 17](#)). Circuit parts shall be grouped functionally and arranged to make signal flow obvious from left-to-right and top-to-bottom. Emphasis shall be placed on arranging the circuit parts to enhance functional understanding. One technique that simplifies the circuit presentation is to completely separate each power and ground connection. Common ground or return points should not be tied together merely to conserve symbols.

3.7.8.2.4.1 Unit power and grounding FCD. Unit power and grounding FCDs shall show the generation and distribution of power to all assemblies within the unit. All cable, connector, and pin numbers shall be shown, except those listed on sheet 1, as unused. Cabinet-mounted parts shall be shown in schematic form. All power supplies and regulators that are packaged as complete assemblies shall be shown in symbolic form. Lowest level replaceable assemblies shall not be further detailed in detailed FCD form. Since a power and grounding FCD is a schematic diagram rather than a wiring diagram, it does not show routing of wires, but it shall show the continuities that exist. Several types of circuit returns may exist in the system: (1) ground, (2) chassis or frame connection, and (3) common connections. Each of these grounds shall be shown by using symbols where it shall simplify the FCDs. See [figure 18](#).

a. Prime power inputs shall be shown on the left of the FCD and signal flow shall be left-to-right. Grounds shall be shown by using the symbols illustrated in IEEE 315. The layout of circuit parts shall follow a logical arrangement and be consistent with other unit-oriented power and grounding diagrams, for example, primary alternating current (AC) distribution, power control and indication, interlocks, gate monitoring and gate distribution. Unnecessary long lines shall be shortened to conserve space. The hardware boundaries can be distorted, where necessary, to preserve smooth signal flow. Crossed lines and “doglegs” shall be kept to a minimum.

## MIL-DTL-24784D(NAVY)

b. Each relay and switch element or contact set shall be identified. If the switch is a front panel control, and it is accessible during normal equipment operation, the nomenclature of the switch, exactly as it appears on the front panel, shall be placed adjacent to the switch symbol. When multi-section switches or relays have more than one element or contact set, the sets or elements shall be identified individually but with some alphanumeric relationship. Contact sets shall be aligned if possible, but not at the expense of disturbing functional flow. Relays and switches shall not necessarily have their contact sets in the same functional area; often they function in different circuits. When this occurs, the various sets of contacts and actuating elements shall be connected by a dashed line (if on different FCD sheets, sheet and zone references shall be used to connect the dashed line) to illustrate mechanical linkage. Spare contact sets of switches and relays shall not be shown on the body of the diagram.

3.7.8.2.5 Requirements for preparing FCDs. A clear and complete referencing system is required for use on FCDs because of the interrelationship between FBDs and FCDs and the interconnection between sheets of FCDs. The referencing system shall include the following reference information, as applicable:

a. Signal names.

(1) Major or important signal paths on an FCD shall be identified by descriptive signal names. All signal lines that interface between FCD sheets shall be identified by descriptive signal names. The signal name shall be identical on all FCD sheets. No signal name shall be used for more than one signal path.

(2) Reference designations shall not be used as signal names except in cases where no other name exists (primarily on power FCDs).

(3) The FBD or FCD number, sheet, and zone shall be used to identify signal origins and destinations when referencing from one FCD to another or from an FCD to an FBD.

b. Signal referencing: Signal referencing for FCDs shall be in accordance with 3.7.8.2.3.

c. General format items: The following shall, at a minimum, be located on the FCD first sheet.

(1) Notes that apply specifically to that FCD.

(2) Special abbreviations (that is, P/O).

(3) A note to explain the position (energized/de-energized, on/off) of any relays or switches shown on the FCD.

(4) All assemblies shall reference an internal schematic when necessary for troubleshooting and maintenance.

(5) Power and logic FCDs shall carry specific signal names on the flow lines. If signal names are not readily available, then the signal name may indicate a hardware destination point (e.g., K3-82).

d. Diagram type, equipment names, and function names: Diagram type, equipment names, and function names shall be in accordance with 3.7.8.2.3.

e. Key codes: In certain applications, both digital and analog modules shall be assigned key codes. Most key codes consist of three letters (KDM, KDN, and so forth). The logic or analog symbol on the FCD shall contain the key code for the circuit module (or portion of the circuit module) depicted. These key codes permit the users to locate a text description of circuit operations located in the TM.

f. Numbers: Diagram (drawing) numbers, sheet numbers, and zone numbers shall be in accordance with 3.7.8.2.3.

g. Reference designations: Reference designations shall be in accordance with 3.7.8.2.3.

h. Test points: All monitored and non-monitored test points shall be incorporated in all FCDs. These test points shall be shown as part of the circuitry they are testing and shall indicate the following information and parameters:

(1) Test point number.

(2) Test point operational connector pin (if applicable).

(3) Circuitry associated with test point (e.g., divider network).

(4) Test point symbology in accordance with IEEE 315.

## MIL-DTL-24784D(NAVY)

3.7.8.2.6 FBD and FCD drafting requirements. Requirements for line weights, methods of depicting interconnecting lines, and symbol sizes in the preparation of FBDs and FCDs are as follows:

a. Line weights: Hardware or functional boundaries and boundary titles shall be prepared as described in the following paragraphs.

(1) Hardware boundary: A hardware boundary shall be a long-dash, short-dash light line (0.005 inch or equivalent point size). The length of the long-dash in relation to the length of the short-dash should be drawn so that the long-dash does not give the impression of a solid line. The hardware boundary title shall be positioned as illustrated on [figure 19](#).

(2) Functional boundary: A functional boundary shall be a solid medium line (0.01 inch or equivalent point size). The functional boundary title shall be positioned as illustrated on [figure 20](#).

b. Interconnecting lines: Interconnecting (data, signal, and control) lines shall be prepared in the following manner (see [figure 21](#)):

(1) Line bends shall be 90 degrees, unless a particular junction requires a different bend. Bend corners shall not be rounded.

(2) Data lines shall be single, solid heavy lines (0.02 inch or equivalent point size).

(3) Signal and control lines shall be single, solid medium lines (0.01 inch or equivalent point size).

(4) Signal lines that contain closely related information may be grouped into one line. However, care shall be exercised to not group signal lines indiscriminately. Grouping of signal lines into one line is called a highway.

(5) Highways shall be solid medium lines (0.01 inch or equivalent point size) for signal and control, and heavy lines (0.02 inch or equivalent point size) for data.

(a) Any changes in the flow direction of the basic highway shall be indicated by square corners (see [figure 21](#)[a][1]).

(b) Any input or output of a highway shall be indicated by a 45-degree connecting line. The direction of the angle implies flow direction (see [figure 21](#)[a][2]).

(c) The end points (a highway may have several) of a highway are indicated by square corners (see [figure 21](#)[a][3]).

(d) A highway does not necessarily contain a uniform number of signals over its entire length. Therefore, when a highway is identified by a name, that name applies to its entire length.

(e) Each individual signal contained within a highway shall be identified with a detailed signal name.

(f) The signal names used as inputs to a highway may be different from the highway signal name; for example, Built-in Test (BIT) 5 and BIT 4 may be individual inputs to a highway having a signal name of INTERFACE REG SET OUTPUT. There shall be a logical relationship between the input and highway signal names (see [figure 21](#)[b]).

(g) The signal names used as outputs to a highway may be different from the highway signal name; for example, BIT 9 and BIT 6 may be individual outputs to a highway having a signal name of ADDRESS. There shall be a logical relationship between the highway signal name and the output (see [figure 21](#)[c]).

(h) Highway inputs and outputs to logic symbols are illustrated on [figure 21](#)(d). The input shall contain the input signal name and input pin number; the output shall contain the output pin number and signal name.

(i) Highway fan-outs and fan-ins shall have the highway signal name indicated above the signal line and the highway output or input signal names with its appropriate sheet and zone reference below the signal line (see [figure 21](#)[e]).

c. Symbols: Symbols shall be prepared in the following manner:

(1) FBD rectangular blocks shall be drawn as medium lines (0.01 inch or equivalent point size) and, insofar as possible, conform to a 2-to-1 aspect ratio. Minimum block size shall be 0.05 inch by 1 inch. The block nomenclature shall be positioned for ease of reading.

## MIL-DTL-24784D(NAVY)

(2) FCD logic symbols shall be drawn as medium lines (0.01 inch or equivalent point size). Other symbols depicting assemblies shall be drawn rectangular and to the minimum size which will allow inputs and outputs to be depicted. Include all reference data within the symbol. All like symbols shall be drawn to the same size. FCD logic symbol nomenclature shall be positioned as illustrated on [figure 22](#) to ease reading.

(3) On-drawing and off-drawing connectors and miscellaneous symbols shall be drawn as medium lines (0.01 inch or equivalent point size) and in accordance with the dimensions depicted on [figure 23](#).

**3.7.8.2.7 System functional diagrams (SFDs).** SFDs shall be developed to provide complete coverage of a system in all modes of operation (see [figure 24](#)). They are to serve as illustrations supporting the detailed functional description and as system troubleshooting reference drawings. Each diagram shall show the generation, transmission, switching, and use of one or more functions on a system basis. An SFD shall show signal flow across equipment interfaces and include those circuits that significantly modify the signal. One-lining, which is the superimposition of two or more wires or circuit elements, shall be used where no loss of clarity is involved. All test points needed for system troubleshooting and all devices, such as dials and indicators that are monitored during system testing, shall be shown. The correct voltage, waveform, reading, or other condition for each shall be indicated as appropriate. When space on the diagram is insufficient, particularly in the case of test point data for multiple problems or setups of a system test, these data may be provided on associated tabulation sheets. Wiring tabulation sheets that are keyed to the diagrams shall be used when necessary to list ship's cable and associated wire designations, plus all pertinent terminal board, terminal, and pin and jack numbers entering and leaving subsystems and equipment. An SFD, such as a data functional and control functional, which schematically portray data-gathering paths and control paths through the system, will be largely redundant with the content of equipment manual diagrams, but somewhat greater detail is expected in the individual equipment diagrams. The tabulation sheets associated with each SFD shall be compiled as a table and appropriately located to enable the best possible use of the SFD. Tabulation sheets may also be identified as sheets of an SFD, bearing the same figure number and title (as applicable) of the SFD. In this case, tabulation sheets shall be located immediately ahead of the associated SFD and shall be the first, second, in sequence, sheet of the SFD.

**3.7.8.2.7.1 Digital SFDs.** Digital SFDs shall depict, by logic symbols and supplementary notations, the details of signal flow and control existing in a system involving two-state devices. Logic symbology on the SFDs will be in accordance with IEEE 991. Digital SFDs shall illustrate the processing of variable signal inputs and resultant outputs and shall portray signal flow for major output functions and logical functions such as units, modules, and subassemblies. Where multiple output signals are time shared through groups of identical units, such as, gates, clamps, inverters, and counters, one time-shared signal flow line shall be arbitrarily chosen to illustrate the signal flow. Where identical digital units are grouped, only the one through which the arbitrarily chosen main signal path goes shall be shown in detail. The depth of detail shown on digital functional diagrams depends on the complexity of the equipment and shall be as determined by the Government upon receipt of the initial submittal of samples.

**3.7.8.2.7.2 Power distribution SFDs.** Power distribution SFDs shall be provided for each power system used to supply power to subsystems or equipment. These SFDs shall show ships power from the generators, or other originating source, through the interconnecting switchboards and weapon control switchboards to the subsystems and equipment. Distribution of each control or reference power system shall be illustrated from source to the equipment and to subunits of the equipment. Depict such signal flow as receive, transmit, Range Horizontal Indication (RHI) display, Plan Position Indication (PPI) display, bearing data, antenna rotation, and elevation data. The diagrams shall show all circuit breakers, control relays, transformers, meters, fuses, indicators, and lamps. Interconnections between sheets or zones shall be cross-referenced. Wiring tabulation sheets shall list initiating and receiving units, terminal numbers, interconnecting cables, and wire numbers for each diagram. Junction box or connection box numbers shall be listed as required (see [figure 25](#)).

**3.7.8.2.8 System control function diagrams.** System control function diagrams shall be provided for all system control circuits. The control function diagrams shall be at the system level but shall be constructed in accordance with 3.7.8.2.9. The diagrams shall show essential fault isolation test points or comparable indicators and shall include appropriate references to equipment manuals.

## MIL-DTL-24784D(NAVY)

3.7.8.2.9 Control diagrams. Control diagrams shall be included for all control circuits (see [figure 26](#)). Control circuits shall be grouped according to energizing voltage, control function, mode of operation, or physical limits of the cabinet or assembly, as applicable. Supporting information required to clarify the use of the diagram shall be provided in the general notes. The functional name and reference designation for each relay, switch, lamp, and so forth shown shall be included. All relay energizing circuits shall be shown with all tie points and terminals and with switches and relay contacts in their operating positions. All terminal connections, switches, interlocks, contacts, or other relays in series with the energizing path, plus lamps or indicators (electrically connected in the energizing or indicating status of contact closures), shall be shown. The following note shall appear on all control diagrams: “All switches and relay circuits are shown in operating positions.” In cases of multiple operating positions, switch and relay positions shall be explained by a specific note on the diagram.

3.7.8.2.10 Logic diagrams. Logic diagrams shall be provided for digital devices and digital circuitry of electronic equipment in accordance with IEEE 991. Distinctive shapes shall be utilized. Internal and external data shall be included. Logic diagrams shall cover digital functions such as input-output control, memory control, data transfer, clock-pulse generation and distribution, and so forth. Emphasis shall be placed on functional development and presentation rather than on hardware groupings. See [figure 27](#).

3.7.8.2.10.1 Basic logic diagrams. Basic logic diagrams shall depict logic functions with no reference to physical implementations. Basic logic diagrams shall consist primarily of logic symbols that are used to simplify logic relationships to make them comprehensible. Non-logic functions are not normally shown.

3.7.8.2.10.2 Detailed logic diagrams. Detailed logic diagrams shall depict all logic functions and non-logic functions, socket locations, pin numbers, test points, and other physical elements necessary to describe the physical and electrical aspects of the logic. The symbols shall be connected by lines that represent signal paths. The diagrams shall illustrate signal priority based upon the function of the equipment.

3.7.8.2.10.3 Digital logic diagrams. Digital logic diagrams shall illustrate logical functions of modules, nests, and assemblies. Design or engineering drawings shall be used as source data to develop digital logic diagrams. Diagrams shall illustrate combinational, storage, delay, and sequential functions to define processing of variable signal input(s) and resultant output(s). Graphic symbols for logic diagrams shall be in accordance with IEEE 315.

3.7.8.2.11 Maintenance schematic diagrams. Maintenance schematic diagrams (see [figure 28](#)) shall include unit-to-unit interconnection diagrams, intra-unit interconnection diagrams, and unit, assembly, and subassembly (see 6.4.15) schematic diagrams. Complete coverage of the equipment shall be provided by these diagrams. Maintenance schematic diagrams shall be prepared as follows:

- a. The schematic diagram for each unit shall be drawn so that, together with the interconnecting diagrams, all circuit elements are included and all circuits can be traced from unit to unit.
- b. Schematic diagrams may be zoned by alphanumeric coordinates in accordance with 3.7.8.4.8. For diagrams containing more than 100 parts, the location of all circuit elements by zones shall be included in a table or included as a link. When a part is drawn in sections at different locations, list as many coordinates as necessary to locate all sections.
- c. Major and minor signal paths shall be represented by different line weights. The heavier line weight shall show the major signal path. Whenever possible, signal flow shall be from left to right and from top to bottom. Arrowheads denoting the direction of signal flow shall be placed on the signal flow lines.
- d. Ground and voltage buses should not be used except in the power supply; however, voltage bus connections can be shown by broken lines directly beneath the connection. As a substitute for ground buses, individual grounds shall be used and appropriate notes shall be included to indicate sources. If separate AC, direct current (DC), and signal grounds are actually used in the equipment, they shall be shown by keyed symbols.
- e. All significant voltages at buses, tube pins, transistor elements, and so forth, shall be shown except when this data can be presented best in a voltage chart (see j below). Indicate whether the voltage is AC or DC; DC voltages shall be shown by polarity. Where critical voltages occur within the equipment, tolerances for those voltages shall be shown in the illustrations.

## MIL-DTL-24784D(NAVY)

f. The functional names of all operating controls and adjustments shall be conspicuously marked on the schematic. For example:



In addition, any operating front panel markings on the equipment shall be set off in a rectangular box. For example:



The functional name of all stages (tubes, transistors, and so forth) also shall be included.

g. The function, source, and destination of all input and output circuits shall be identified and indicated by figure number.

h. Power and signal frequencies shall be designated in hertz (Hz). Resistance values, if more than 1 ohm, shall be noted for all wire-wound devices such as motors, relay coils, and transformers.

i. Rated current and voltage values of primary and secondary windings of power transformers shall be indicated.

j. A resistance and voltage chart for a schematic diagram shall be provided. This chart shall give the normal resistance and voltage to ground (or other points of significance) for each tube socket pin. In addition, list all conditions that affect the resistance or voltage values given, such as control settings, equipment connections, tubes removed from sockets, and so forth. If semiconductors (transistors, diodes, and so forth) are employed in circuits, caution notices shall be included to prevent damage to these devices when making resistance measurements in the circuit. No intra-element resistance measurements (that is, between emitter, base, and collector) are required to be made on transistors. Also, resistance of power supply buses and other points of significance shall be indicated.

k. Each schematic diagram shall be identified by the reference designation number located in the lower right-hand corner of the image area.

l. Schematic diagrams shall be presented in alphanumeric order corresponding to the referenced designation of units, assemblies, subassemblies, and so forth. When two or more identical assemblies or modules are used, redundant schematic diagrams need not be repeated. However, a table that cross-references the reference designation to the figure number of the common schematic diagram shall be provided immediately preceding the schematic diagram. For identification purposes, schematic diagrams covering more than one unit, assembly, or module shall include all the reference designations of the unit, assemblies, and modules to which they refer and shall be located on the illustration or provided as a link.

m. Circuit elements shall be grouped functionally and arranged to make signal flow obvious from left to right and top to bottom. Circuit elements shall not be arranged to fill up white space or to maintain tube or transistor alignment. Circuit elements shall be arranged in textbook form for the convenience of the user. Layout shall not be distorted to achieve fit.

n. Breaks in lines shall be used as frequently as possible to avoid cluttered diagrams. Add necessary notes or text to explain how to use break symbols, where to find mating ends of broken lines on drawings, and so forth.

3.7.8.2.12 Mechanical schematic diagrams. These diagrams shall show sufficient detail to explain the operational sequence and arrangements of a mechanical device, including the electrical control circuits. Nomenclature, symbols, Part Identification Number (PIN) (see 6.4.14), and necessary descriptive data shall be shown. Gears, shafts, clutches, levers, mechanically driven switches, motors, synchros, and so forth, shall be shown in functional arrangement. Gear ratios or number of teeth and direction of rotations, and so forth, shall be given. Symbols used on these diagrams shall conform to ASME Y32.18.

3.7.8.2.13 Simplified electrical and electronic schematic diagrams. These diagrams (see [figures 29](#) and [30](#)) shall show, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. These diagrams shall be arranged functionally to show the operation of the circuits in the same manner as illustrated in the IETM for Navy Installation and Maintenance (N0002400003).

## MIL-DTL-24784D(NAVY)

3.7.8.2.14 Hydraulic and pneumatic schematics. Hydraulic system diagrams (see [figure 31](#)) shall be developed in accordance with SAE-J1780. Where necessary, hydraulic and pneumatic schematics shall be prepared as orthographic diagrams and pattern coded to show hydraulic and pneumatic devices and associated mechanical and electrical devices and actuating mechanisms, using standard symbols where possible. The illustration shall be developed for color symbolization only if such patterns do not convey the necessary information and if the acquiring activity authorizes use of color (see 3.7.8.4.13). A series of hydraulic schematics shall show mechanical actions and sequential functions of parts through a complete cycle. Arrows shall be used to show directional flow.

3.7.8.2.15 Single-function diagrams. Single-function diagrams (see [figure 32](#)) for nonprogrammable devices that result in a unique output function may be prepared to the requirements of signal flow diagrams (see 3.7.8.2.17).

3.7.8.2.16 System data function diagrams. System data function diagrams shall show in detail the system information needed to isolate faults within signal or data flow paths. Data function diagrams shall include tolerance values and shall contain references to equipment publications where necessary. All inputs required to develop the output shall be shown. The data function diagrams shall be constructed in accordance with 3.7.8.2.17.

3.7.8.2.17 Signal flow diagrams. Signal flow diagrams (see [figure 33](#)) shall consist of detailed block diagrams illustrating the functional development of each major function (see 6.4.12) from its origin to its measurable output. The flow path shall begin with one or more initial inputs (or appropriate interface conditions) and proceed through each unit, assembly, and subassembly influencing the signal flow. Each hardware level block shall reference a schematic diagram to isolate the faulty part. All items shown on the signal flow diagram shall be identified by their reference designations. The following shall apply.

- a. Titles of diagrams shall correspond to the signal flow described.
- b. Diagrams shall depict such signal flow as: receive, transmit, RHI display, PPI display, bearing data, antenna rotation, elevation data, and so forth.
- c. All test points necessary to isolate the trouble to the lowest level of hardware block shall be shown. Include test parameters required to define satisfactory operation. Where signal flow diagrams depict signal flow in more than one mode of operation, data for all modes shall be presented or provided as a link. Notes (or a linked table) shall also include test data for test equipment setup. All inputs and outputs shall have signal description information.
- d. References shall be made to the functional description, troubleshooting procedures, corrective actions, and so forth, as appropriate, by paragraph number (as applicable) or a link to the paragraph. Normally, these references should be included with the notes.
- e. The display of more than one function or mode of operation on one diagram shall be allowed only if clarity is not sacrificed and the functions are relatively simple.
- f. Screwdriver adjustments, dial adjustments, and adjustable controls shall be shown.
- g. The reference designations shall be placed in each hardware block. Reference to the figure number of the schematic diagram shall be placed adjacent to the reference designation.
- h. All input and output signals, connectors, and terminals in the signal path shall be shown. Identify the signal and show all lead numbers, connector numbers, and terminal identifiers.
- i. All built-in controls and monitoring devices shall be shown. Do not show external test equipment, unless it is a permanent part of the equipment.
- j. Hull grounds, chassis grounds, signal grounds, and power grounds shall be shown.
- k. All leads of components, such as motors, generators, synchros, and so forth, shall be identified.
- l. All relay coils that are energized by the signal shall be shown.
- m. All relay contacts and relay terminals in the flow path shall be shown and identified. All relay contacts shall be depicted in operational mode. References to control diagrams on which the relay coils appear shall be shown adjacent to the relay contacts.
- n. All switches that affect signal flow shall be shown and identified. Switch terminals and panel markings corresponding to the switch positions shall also be shown.
- o. Mechanical couplings of all controls, switches, potentiometers, synchros, and so forth, shall be shown.

## MIL-DTL-24784D(NAVY)

- p. Signal paths shall be identified by weighted lines and arrowheads.
- q. Test instruction procedures and test data shall be shown on the diagrams or provided as a link.

3.7.8.2.17.1 Types of signal flow diagrams. Signal flow diagrams shall be either a physical dependency type or a functional dependency type.

- a. Major subdivisions on the physical dependency type shall be shown as either cabinet, chassis, or unit limits indicated by broken lines.
- b. Functional dependency type, as it relates to functional dependency boxes, shall be shown in solid lines.
- c. The method selected shall remain consistent for all signal flow diagrams in the manual. When the cabinet or chassis limit method is used, both diagrams shall refer to schematic diagrams, but they shall not necessarily group test and testable points together.
- d. The determination of descriptive limits, physical or functional dependency, shall result from the maintenance analysis.

3.7.8.2.17.1.1 Types of elements on signal flow diagrams. The following functional elements, such as connections, monitoring devices, and test points with values, shall be shown on signal flow diagrams, as applicable.

- a. All adjustable parts or subassemblies: Identify any screwdriver setting, dial setting, or adjustable knob.
- b. Amplifiers: Identify all leads or terminals that are part of the depicted signal flow.
- c. Chassis and cabinet (unit) limits: Show the enclosures where the functional elements are installed. Identification of cabinets; major assemblies; and chassis within a cabinet, including unit designations, shall be placed in the upper left-hand corner of each outline. Reference to schematics shall be placed immediately below the unit designation.
- d. Coaxial cable and waveguides: Label the signal being transmitted and show significant functions.
- e. Inter-cabinet and intra-cabinet connections: Label all connections other than soldered joints. Identify the lead, connector, or terminal number of both sides of the connection. Where the location of the connection in an equipment is obvious from adjacent unit limits, it need not be indicated beside the connection; where it is not obvious, added information identifying the physical location of the connection shall be placed adjacent to the symbol.
- f. Dials and meters: Show dials and meters that are a physical part of the equipment as required by engineering layout as quick-look features with the panel nomenclature within the quick-look box. Meters that have to be plugged in to take a measurement shall be excluded.
- g. Fire control symbols and mathematical quantities: Identify all applicable quantities defined in NAVSEA OP 1700 by the corresponding standard fire control symbols. The preparing activity's symbols, where different, or mathematical quantities shall be entered beneath the standard symbols.
- h. Grounds: Differentiate between hull ground, chassis ground, and common returns. Use appropriate symbols and identifiers, which shall be specifically identified on the graphic itself or provided in a link.
- i. Hand-set values for static tests: Indicate hand-set values by use of a rectangular box tied with a dashed line to the generation path signal to indicate the mechanical connection. The rectangular box shall contain the panel nomenclature of the dial, indicator knob, and the hand-set values below the nomenclatures. If more than two values are to be shown, see n below.
- j. Motors and generators (electrical): Do not show any internal parts of electrical motors and generators, but identify all leads.
- k. Potentiometers: Give the range of the potentiometer if it is restricted to less than full travel. Show mechanical coupling if motor-driven.
- l. Relay coils and solenoids: Give the reference designation or other specific identifiers. Identify coil terminals.

## MIL-DTL-24784D(NAVY)

m. Relay contacts: Identify the energizing bus above and give the relay reference designation below. Identify associated terminals. All contacts shall be depicted assuming the relays in de-energized condition, unless otherwise specifically and clearly noted.

## NOTE

When relay pin or terminal identification is difficult because of a specialized type of relay, a relay pin identification diagram shall be provided that presents a schematic bottom view of the relay(s) shown on the signal flow diagram. The pin or terminal identification diagram shall be located on the graphic itself or provided in a link.

n. Readout values for static tests: If only one or two problems are used, show values in a box representing the test point or dial (see i above). If more than two problems are used, indicate the panel nomenclature of the readout device in the box and place the values for the respective problems in a specific note or provide as a link.

o. Scale factors: Show scale factors where applicable, such as at outputs of computing amplifiers, computing potentiometers, and resolvers. For transformers where scale factor values are involved, show the relative values at both the primary and secondary windings.

p. Switches: Identify switch terminals. Identify actuating condition for other than manually actuated switches, including pressure limits for hydraulically or pneumatically actuated switches.

q. Summing network: Identify leads or terminals of summing networks. Show impedance value or ratio to unit impedance for each input lead, as applicable.

r. Terminal boards: Identify the terminal board. Show only the terminals that apply to the circuit. Identify leads or terminal numbers, as applicable.

s. Testable points: Identify all applicable testable points. Give the same information for a testable point as required to be illustrated for a built-in test point jack.

t. Transformers: Indicate both primary and secondary sides; identify all leads or terminals.

u. Synchros and resolvers: Identify the functional type of synchro. Identify all leads. Show mechanical coupling if motor-driven. Indicate relative speeds when multi-speed synchros are used.

v. Valves: Illustrate fluid transmission from valve ports in path of signal flow. Give pressure limits for pressure control of bypass valves.

w. Pumps or compressors: Illustrate pump in operation giving flow rate. Also indicate pressure, if pressure control is integral with the pump.

x. Mechanisms: Illustrate mechanisms, as required to show continuity and sequence of mechanical actions, contributing to the output function.

y. Flasks or accumulators: Indicate working pressure range of flasks and accumulators. Also give allowable overall leakage rate, if applicable.

z. Motors and actuators (hydraulic or pneumatic): Include as required.

aa. Fixed resistors, capacitors, and coils: Fixed resistors, capacitors, and coils shall be shown if their presence contributes significantly to modification of the signal. These components need not be identified by reference designation or value unless they reveal a test point; in which case, a validated waveform or voltage shall be provided.

3.7.8.2.17.1.2 Cross-referencing in signal flow diagrams. Where substantial portions of circuitry or mechanism are common to two or more output functions, or in different modes of operation for the same output function, the common portion of generation paths shall be shown on one diagram and cross-referencing used for referring to the common points from other signal flow diagrams. Cross-referencing in signal flow diagrams shall be in accordance with the following subparagraphs.

a. Each signal break, whether a point of coincidence between diagrams or between sheets of the same diagram, shall be identified by the name of the signal or by specific connecting terminals to permit cross-referencing. Except where lines cross from one sheet to the following sheet, signal flow diagram zones shall be included in the reference and referenced points need not be brought out to either end of the sheet.

## MIL-DTL-24784D(NAVY)

b. Since the signal flow diagrams are read in either direction, a TO or a FROM notation shall be given at each signal break. For each end of a break, the choice of TO or FROM shall be in accordance with the direction of flow in that path.

c. In those instances where referencing is required and the signal does not have a name, a common referable point or a connecting terminal between changing sheets, use an upper case letter inside a circle to indicate where the signal path stops on one sheet and picks up on another. The reference notes shall include the circled letter.

d. In those instances when a signal flow between the point of origin and final output become modified by an interfacing equipment, depict the logic treatment of that signal within the interfacing equipment.

3.7.8.2.18 Power distribution diagrams. Power distribution diagrams shall depict the distribution of primary AC power, secondary AC power, and DC power from the terminal board, breaker, or fuse box to the various assemblies, subassemblies, or modules of the equipment (see [figure 34](#)). Normally, a separate diagram shall be developed for each voltage level used within the equipment. The following rules shall apply in the preparation of power distribution diagrams:

- a. Show and identify motors, transformers, regulators, power supplies, assemblies, subassemblies, and modules.
- b. Show and identify all power line devices such as fuses, circuit breakers, switches, and relay contacts.
- c. Show and identify all connections including plugs, jacks, and terminal boards in the distribution path.
- d. Use dot and dash lines to set off hardware boundaries such as units, assemblies, and subassemblies. Identify each unit, assembly, and subassembly by reference designation. Include a figure reference to the schematic diagram covering the unit, assembly, and subassembly.
- e. Reference all relay contacts to the appropriate control diagrams. All relay contacts shall be shown in the operating condition.
- f. Include voltages and tolerances, as required.
- g. Show and identify all metering circuits and indicators.
- h. Show all grounds, commons, neutrals, and return lines.
- i. Display the power path from left to right and from top to bottom, whenever practicable.
- j. Mark the functional names of all "main line" switches and circuit breakers. In addition, set off any power control markings engraved or stenciled on the equipment in a rectangular box; for example:

MAIN POWER

k. Show all relay coils in series with the main power distribution path. Relay control circuits shown on control diagrams need not be repeated on distribution diagrams.

3.7.8.2.19 Timing circuit diagrams. Timing circuit diagrams (see [figure 35](#)) shall be provided for all significant timing relationships. These diagrams shall show the exact timing relationships and the origins of all timing signals (conventional and digital).

3.7.8.2.20 Piping diagrams. Piping diagrams (see [figure 36](#)) shall be developed for fluid cooling, air, gas, steam, oil, and hydraulic systems. Symbols for hydraulic systems shall be in accordance with SAE-AS1290. These diagrams shall show, when significant, flow rate, temperature, pressure, and all devices that measure, control, or modify the flow.

3.7.8.2.20.1 Simplified piping diagrams. These diagrams (hydraulic, pneumatic, or fluid) shall show the interconnection of components by piping, tubing, or hose and sequential flow in the system. Pumps, heat exchangers, valves, gauges, and similar components shall be clearly identified.

3.7.8.2.20.2 System piping run diagrams. Isometric diagrams shall be used to indicate the location of all system piping runs between compartments and areas. Each piping run diagram shall indicate by deck, compartment, and frame identification the location of all pipes, valves, fittings, tanks, and similar components.

## MIL-DTL-24784D(NAVY)

3.7.8.2.21 Interconnection diagrams. Interconnection block diagrams (see [figure 37](#)) shall be presented with each equipment or component shown as a block. All cables running between equipments shall be identified by cable number. The number of active and spare leads in each cable shall be included. The illustrations shall also indicate all junction boxes, switchboards, and so forth, into which interconnection cables enter or leave.

3.7.8.2.22 Cable run diagrams. Isometric diagrams shall be used to indicate the location of all cable runs between compartments or areas. Each cable run diagram shall indicate by deck, compartment, and frame identification the location of all cables shown on the interconnecting diagrams (see [figure 38](#)).

3.7.8.2.23 Wiring diagrams and wire run list. Wiring diagrams (see [figure 39](#)) and wire run lists shall be arranged functionally. When wiring diagrams are included in a manual, wire run lists shall not be included.

3.7.8.2.24 Parts location illustrations. Illustrations shall be included to provide positive and rapid location of parts. Types of parts location illustrations include exploded views, sectional views, engineering drawings, and illustrations of printed-circuit boards, as applicable.

3.7.8.2.24.1 Exploded views. Exploded-view isometric drawings shall be used whenever necessary to show the proportionate size of machinery parts, proper relation to other parts, and assembly or disassembly sequence. It is preferable that all parts be exploded in isometric projection of their line of assembly axis. Exploded views (see [figure 40](#)) of the equipment shall be used in parts breakdowns and for reference in disassembly and assembly instructions. Index numbers shall be used to identify parts. If the equipment is of such a nature that it cannot be accurately illustrated by a single exploded view, it shall be exploded by subassemblies as separate views. In such cases, an exploded view showing the complete equipment exploded into its major subassemblies shall be shown first. Parts that attach and connect the major assemblies together shall be shown on the exploded view illustration. These views and those in parts breakdowns shall be the same, with the sequence of index numbers in the order of disassembly. Parts in an exploded view shall be shown in proportional size. The spacing of parts shall achieve maximum clarity and effective use of space. The relationship of parts shall be shown by the use of assembly lines where the main line of exploded parts has been broken into two or more groups for convenience of layout. Leader lines and index numbers shall be used to assist in locating parts. Parts for which disassembly is not required, such as wafers, switches, and so forth, need not be exploded.

3.7.8.2.24.2 Sectional views and location drawings. Sectional views may be illustrated for units with few components as long as clarity is not sacrificed (see [figure 41](#)). Location drawings may be used to show the position of the components relative to the unit or assembly and to represent the view most favorable for illustration (see [figure 42](#)). Sectional views or item location drawings shall be used to indicate where critical measurements shall be taken or when the information presented is easier to understand when depicted as a cross-sectional view. As a rule, sectional drawings are not needed when isometric drawings are available.

3.7.8.2.24.3 Printed-circuit board. Printed-circuit boards shall be illustrated foil side up. When printed wirings appear on both sides of the board, both sides shall be illustrated. All parts mounted on the board shall be outlined in black solid (front) or dashed line (rear) (even though mounted on the reverse side of the board) and their connections to the printed wiring clearly illustrated. If insufficient room exists, separate illustrations, top and bottom views, shall be provided. Each part shall be labeled with the applicable reference designation. To facilitate parts location, a locating grid and corresponding guide chart shall be provided when more than 30 items are mounted on a board. See [figure 43](#).

3.7.8.2.25 Line graphs. Line graphs shall conform to the following:

- a. The number of ideas conveyed per graph shall be minimized. Line graphs shall have a maximum of four lines (that is, lines that show the relationship of variables). Such lines shall be coded for easy identification.
- b. If there is a natural orientation for the axes (for example, altitude on vertical axis), the axes shall be so oriented.
- c. Grid lines shall support the intended use (that is, more grid lines shall be provided where accurate interpretation is required). Grid lines shall be no less than 0.1 inch apart when reduced to final size and shall be lighter than the graph line.

## MIL-DTL-24784D(NAVY)

d. Graph scales shall be linear unless nonlinear are required for proper comprehension and use. They shall include the zero value of the variables. One line break may be used per scale in order to include the zero value if this saves space without jeopardizing clarity.

e. For complex graphs, instructions shall be provided for use and interpretation.

3.7.8.3 General graphic requirements. The following paragraphs provide general requirements applicable to all graphic types.

a. Illustration use: Liberal use of illustrations is encouraged to ensure clarity of descriptive text and procedural steps. Illustrations shall not contain procedural steps. Exploded views shall be used to the greatest extent possible. If several identical parts are used in the same assembly, only one of them should be illustrated if it is possible to positively allocate them to their respective location and orientation. Redundant drawings shall not be included. When only a part of an existing drawing is required, only that section of the drawing shall be provided.

b. Multiple use of illustrations: Whenever possible, one illustration shall be used in support of two or more requirements. For example, illustrations prepared to support the parts list data shall be used to support the maintenance procedures. However, additional illustrations may be developed to support the maintenance procedures if the parts list illustration does not provide the guidance to perform the maintenance procedures.

c. Illustration consistency: A standard referencing system for associated text, signal flow, and equipment nomenclature shall be used between illustrations and text. Standard graphic symbols shall be used when possible. If special graphic symbols are required, they shall be made visually distinctive from other graphic symbols used and included in a special symbols chart. Official nomenclature shall be used for hardware, controls, indicators, switches, and so forth. Consistent, standard nomenclature shall be used for functions, signals, and so forth.

d. Illustration placement: Refer to the appendices for specific requirements.

e. Material or parts list: When applicable, a material or parts list shall be included on the illustration. Only those parts referenced in the supporting text shall be identified on the illustration. All parts shall be listed on the illustration when specifying disassembly in accordance with disassembly sequence numbers.

f. Acceptability of drawings and illustrations: Engineering drawings and illustrations that are not prepared primarily for TM illustration purposes shall be acceptable if the copy print is legible, reproducible, and readable when reduced to manual size. All unnecessary or irrelevant data that would reduce the comprehension or clarity of the illustration shall be removed.

g. Signal flow: Signal flow, especially for electrical and electronic equipment, critically affects the understandability of diagrams. To assist the TM user in following the diagram, where possible, major signal or pressure flow shall be from left to right, and feedback or return flow shall be from right to left.

h. Scale: Illustrations shall be prepared to as small a scale as possible, consistent with effective use of space, with all essential detail legible. Illustrations shall be the same size as areas they shall occupy in the manual or be of such oversize as to permit uniform reduction to this size. Drawings that are to scale but not dimensioned shall be reduced for inclusion in the manual. A line approximately 3 to 6 inches long, indicating the actual scale of the subject drawing, shall be added to the drawing before reduction. The scale shall then be reduced in the same proportion as the drawing.

i. Drawing identification: Drawings reproduced or modified from an existing approved blueprint or drawing shall contain information identifying the drawing.

#### 3.7.8.4 Illustration details.

3.7.8.4.1 Lettering and line spacing. Lettering and line spacing shall be accomplished in the following manner:

a. All lettering on the diagrams shall be uppercase sans-serif 8-point minimum.

b. Lowercase lettering shall not be used for general lettering on a diagram. Lowercase letters may be used when:

- (1) Lower case lettering appears on the physical part (such as connector pins).
- (2) Symbols requiring lowercase letters are used on drawings.
- (3) Signal names contain lowercase letters such as an abbreviation like "Db".

c. The distance between two lines shall at least be equal to the sum of the thickness of these lines.

## MIL-DTL-24784D(NAVY)

3.7.8.4.2 Border rules. Border rules shall not be used for single illustrations, but shall be used to separate multi-section illustrations on the same graphic.

3.7.8.4.3 Use of human figures. Where it is necessary to illustrate an operation, procedure, or installation, illustrations may include a human figure or parts of the body. Jewelry shall not appear in any illustration. The human figure shall not be permitted to obscure details of the equipment necessary for a complete understanding of its operation. The human figure shall be clothed as designated by the Government. A cross-section of races and sexes shall be used.

3.7.8.4.4 Credit lines. The artist's name shall not appear on any artwork; neither shall a manufacturer's name, symbol, or trademark appear on artwork for the purpose of identifying the illustration. A contractor's identification number may be used. When used, such numbers shall be in approximately 4- to 6-point type and placed in the lower right-hand corner of the illustration sufficiently removed to avoid being confused as part of the illustration or margin data.

3.7.8.4.5 Callouts. Index numbers, reference designations, nomenclature, leader lines, legends, and so forth, shall be used, when necessary, to identify significant features. Leader lines and arrows may be used, in combination with the callouts, to enhance the illustration. Type size shall be no smaller than 8-point and no larger than 10-point. Lettering shall be in upper case. Nomenclatures shall appear on illustrations only if it can be done without crowding or reducing type size so as to make reading difficult. Callouts shall be placed in the background areas of illustrations when practical. Care shall be taken not to introduce clutter and distractions.

3.7.8.4.5.1 Index numbers. Index numbers for each separate figure shall start with Arabic numeral 1 and continue consecutively. The preferred font size is 10-point. All multi-sheet illustrations shall be considered one figure. Sequence on exploded views used to show assembly or disassembly shall be in disassembly order. Otherwise, sequence shall be from top to bottom or clockwise, when possible. All functional items shown on exploded views shall be identified except for exploded views used for disassembly or assembly. When an illustration is changed, index numbers added between existing numbers may be the same as the preceding index number with added alpha characters (e.g., 22A, 22B). This system may also be used in basic manuals when errors are discovered so late in preparation that renumbering of all following index numbers would delay submittal.

3.7.8.4.5.2 Nomenclature. Nomenclature of more than one line shall have the left margin justified. All lines of copy shall parallel the horizontal edges of the figure, whenever possible. When applicable, a cross-reference shall list the official nomenclature and its corresponding acronym or general usage nomenclature.

3.7.8.4.5.3 Leader lines and arrowheads. Leader lines and arrowheads may end close to the callout and object or may touch the objects to which they apply. Lines shall be uniform and as short and straight as possible; however, dogleg shaped lines shall be permitted. Lines and arrowheads shall not cross or come in contact with other callout lines or arrowheads nor shall they obscure essential details. A line shall be highlighted or changed from black to white to make the line easier to follow. Arrowheads may be added for clarity. Arrowheads shall be uniform in shape and size.

3.7.8.4.6 Legends. Only that information that is necessary to clearly identify the items shall be included in a legend. Legends shall be included on, adjacent to, or facing the artwork. When index numbers are used, a legend consisting of their numerical listing and their identification shall be included.

3.7.8.4.7 Reference designations. Where applicable, reference designations shall be included. Reference designations marked on equipment take precedence.

3.7.8.4.8 Zoning on diagrams. Diagrams containing the symbols for more than 100 parts shall be zoned. Diagrams shall be divided into equally spaced horizontal zones (ordinates) designated A, B, and so forth, from bottom to top along the outside left and right borders. Diagrams shall be divided into equally spaced vertical zones (abscissa) designated 1, 2, 3, and so forth, from right to left along the outside top and bottom borders. The zone size shall be as needed to clearly locate referenced points.

## MIL-DTL-24784D(NAVY)

3.7.8.4.9 Notes for diagrams. Notes on diagrams shall be confined to clear spaces of the image area. Notes shall be identified with the legends GENERAL NOTES and SPECIFIC NOTES, as applicable. General notes shall precede specific notes and shall be identified by capital letters (A, B, and so forth). Specific notes shall be identified by Arabic numerals (1, 2, and so forth).

3.7.8.4.9.1 General notes. General notes shall apply to the entire diagram and shall appear only on the first sheet of multi-sheet diagrams. No reference shall be made to general notes from the diagram or from specific notes. Examples of general notes include: the general instructions for positioning switches and a list of the test equipment needed to take measurements.

3.7.8.4.9.2 Specific notes. Specific notes shall apply only to a specific item on the diagram. Specific notes shall be repeated on each sheet of a multiple sheet diagram to which they apply and it shall not be required to refer to a specific note on another sheet of a diagram.

3.7.8.4.10 Multi-sheet illustrations. Illustrations having multiple sheets shall be assigned sheet numbers starting with the number one (1). The first sheet of a multi-sheet illustration shall include the total number of sheets following the figure title. For example: "Figure 1. Power Distribution (Sheet 1 of 4)." The remaining sheets shall be numbered in consecutive, order such as "(sheet 2 of 4), (sheet 3 of 4)" and so forth.

3.7.8.4.11 Multi-section illustrations. Each section of a multi-section illustration shall be identified by a capital letter. Sections may be captioned, but if one section is captioned, all shall be captioned. Each caption, with the identifying letter as its first character, shall be centered with respect to the section to which it applies. Where captions are not used, the identifying letters shall be centered. Identifying letters and captions shall be larger and bolder than any other lettering on the illustration. Sections shall be separated by lines. Separation by shading shall not be used. See [figure 44](#).

3.7.8.4.12 Color in graphics, illustrations, and photographs. When approved by the acquiring activity (see 6.2), color graphics, illustrations, and photographs may be used. Developers should be aware that not all display devices will display full color. Color shall be viewable in the safe color palette colors (see [figure 45](#)) without loss of content or meaning, and shall also be printable in grayscale. When use of color is authorized, the below rules shall apply. When color is not authorized, shadings, cross-hatchings, and patterned lines may be used instead of color.

- a. In critical situations, colors shall be supported with another method of identification such as distinctive symbols, markings, or wording.
- b. If color is assigned a unique meaning to perform a described procedure, then no more than six colors shall be used.
- c. The colors red, orange, and yellow are associated with dangers, warnings, and cautions; limit the use of these colors to preserve this convention and avoid confusion.
- d. Consideration shall be given to the ability to display correctly as intended in unusual environments, such as night vision, red lighting, or emergency situations.
- e. Consideration shall be given to the use of color and the potential impact on Print-On-Demand System compatibility requirements.

3.7.8.4.13 Photographs and line drawings. Unless otherwise specified by the acquiring activity (see 6.2), photographs shall not be used. Line drawings may be used in lieu of photographs. The use of a photograph instead of a line drawing shall be determined by the practical considerations of the purpose and suitability of the illustration in the TM. Photographs shall not be used in foldouts. Existing illustrations and engineering drawings shall be used where they meet the requirements of this document. In the early development of equipment, a line drawing may be prepared from the source data if the equipment is not available for photographing.

3.7.8.4.13.1 Photographic details. When specified for use (see 6.2), photographs shall be detailed and sharp, free of heavy shadows; distorted objects; cluttered foregrounds or backgrounds; and give good contrast from white, middle tones, and black.

## MIL-DTL-24784D(NAVY)

3.7.8.4.13.1.1 Retouching. Photographic retouching shall be held to a minimum. Retouching shall be used only to emphasize detail, exclude unwanted detail, correct slight photographic defects, and eliminate undesirable shadows for those portions of the photograph related to the text only. The quality of retouched photographs shall be such that tonal values are held when reproduced. The image shall still be prepared with its proportions constrained and present a view and scale that is most favorable for the user. Text, annotations, and symbology overlaid on photographs shall be kept to a minimum and important consideration is to be given to potential changes. If text is required to be within the photographic image, then it shall be placed in a white box and existing illustration rules will apply.

3.7.8.4.13.2 Line drawing details. The darkness and sharpness of lines shall be sufficient to reproduce clearly without additional treatment. The table below provides a summary of line weights and their use. The distance between parallel lines on wiring and schematic diagrams shall be at least equal to the sum of the thickness of these lines. Secondary lines, such as those used to indicate extensions or measurement, shall be lighter but strong enough to reproduce clearly. Shading may be used to give substance and form to the item depicted, to sharpen the contrast between the subject and its background, or to increase effectiveness. Shadows shall be used only when necessary to provide a clear understanding of form, shape, or depth. Shading effects shall not be used for decorative purposes. Accented lines may be used to emphasize detail. Lines, cross-hatching, or mechanical patterns used for coding shall remain clearly defined when reduced to final size.

TABLE II. Line weights and uses.

<b>Line Weight Use</b>	<b>Color Illustration, 2 line weights (inches)</b>	<b>Color Illustration, 3 line weights (inches)</b>	<b>Black/White Illustration, 3 line weights (inches)</b>
Hidden lines, leader lines and center/projection lines, line shading and section lines, location drawings, reference structure/items	0.007	0.007 (or 0.010)	0.007 (or 0.010 )
Illustration of items	0.007	0.014	0.014
Highlighted items and highlighted reference structure	0.020	0.020	0.020

3.7.8.4.14 Designations, diagrams, and symbols. Designations, diagrams, graphic symbols, and letter symbols shall be consistent, and the source or reference for these items shall be identified.

3.7.8.4.15 Continuous tone artwork. Such artwork, whether photograph or drawing, shall be clear in detail, sharp in contrast of tones, and with light and shadow in proper relation to a consistent light source. The background shall be an intense white. It shall extend the full width and depth of the artwork.

3.7.8.4.16 Combination artwork. Presentation of a subject by combining photographs or continuous tone artwork with line drawings shall be limited to where this presents the subject more accurately or more clearly.

3.7.8.5 Changes to illustrations. When changes are made to illustrations, the original artwork shall be used unless the development of new artwork is less expensive.

3.7.8.6 Review of illustrations. Illustrations shall not be furnished separately for review. If a TM is reviewed, illustrations forming a part of the TM shall be included in the review.

## MIL-DTL-24784D(NAVY)

3.7.8.7 Graphic and multimedia source file formats. Graphics and multimedia include illustrations, drawings, diagrams, photographs, audio, video, animation, and three-dimensional (3D) modeling. All graphic and multimedia source files shall be delivered to the acquiring activity. The source file formats shall be in accordance with ISO/IEC 8632 and in compliance with W3C standards. Refer to the applicable Tagging and Authoring Guidelines and the NAVSEA IETM Viewer Software Performance Requirements for acceptable graphic and multimedia source file formats. For graphic files:

- a. Vector: New 2-D drawings, schematics, and illustrations shall be delivered in vector format. Images developed and maintained in vector format shall also be provided in a raster format.
- b. Raster: Legacy raster images may remain in their raster format. The preferred resolution is 300 dots per inch (dpi). Legacy 2-D drawings, schematics, and illustrations may use raster images for the simple capture of existing drawings not already in vector format. Raster graphics should not be used where there is a requirement to attach metadata or added information to text or graphic elements within the image for navigation (hot-spotting, hyper-linking).
- c. All source Computer-Aided Design (CAD) files (i.e., DWG, CATIA, JT, and PRT) required for life-cycle maintenance shall be provided.
- d. Photographic file formats: The preferred resolution for color and grayscale photographic images is 300 dpi. Original images that do not include any enhancements or changes shall be delivered as source data.

3.7.9 Style, format, and content for revisions. The revised TM shall be in accordance with the style, format, content, and arrangement of the existing manual. The following are general requirements applicable to all TM types. Refer to the appendices for unique requirements.

3.7.9.1 Renumbering and removal. All pages, paragraphs, subparagraphs, procedural steps, list items, illustrations (including index numbers used within an illustration), and tables shall be renumbered, as necessary, to eliminate all number suffixes and to establish correct sequence. All previous revision indicators shall be eliminated.

3.7.9.2 Revision designator. Superseding revisions are identified numerically and carry the same basic TMIN as the existing manual. The superseding revision shall also include a Government-assigned revision number (e.g., "REVISION 1"). The non-superseding revision shall be classified as "ORIGINAL" and shall have a unique TMIN as assigned by the Government.

3.7.9.3 Revision change markings. When specified by the acquiring activity (see 6.2), after all previous change markings have been eliminated, new change markings shall be inserted to identify technical changes in text, illustrations, and tables.

- a. Change markings from a previous revision shall be deleted when information is subsequently updated. Markings shall show current updates only.
- b. Change markings are not required for changed or added front matter material (except for the Table of Contents), replacement or addition of a complete chapter or section or information package, or for correction of minor inaccuracies, such as spelling, punctuation, relocation of material, or renumbering, unless such correction changes the meaning of the information.

#### 4. VERIFICATION

4.1 TMQA program and responsibilities. The preparing activity shall establish a TMQA program to ensure the development of technically accurate and complete TMs. The preparing activity shall be responsible for the implementation of the TMQA program and for product quality. The TMQA program shall be in accordance with documented QA procedures as approved by the Government. Review requirements will be specified by the acquisition documents. The preparing activity's TMQA program shall encompass the accountability for and development of quality control functions required for the management of TM program elements such as:

- a. Source data collection and control: Relationship of the TM authoring process to acquisition and use of relevant source data (particularly Logistics Support Analysis/Logistics Support Analysis Record [LSA/LSAR] and drawings) shall be specifically addressed.
- b. Intermediate products.

## MIL-DTL-24784D(NAVY)

- c. Participation in quality reviews and In-Process Reviews (IPRs).
- d. Graphics and illustrations.
- e. Authoring system capability.
- f. Validation.
- g. Internal coordination (documentation of preparing activity operating procedures).
- h. Recordkeeping.
- i. Verification support.
- j. Final product.

4.1.1 Written operating procedures. Preparing activity personnel, subcontractors, and vendors involved in TM generation shall operate in accordance with written operating procedures. Portions of these procedures that relate directly to product quality shall be cited in the TMQA program plan, identified by name, number, and date. Such procedures shall be originated, revised, and controlled within the framework of the overall TMQA program, and shall periodically be reviewed, evaluated, and updated as required. Current operating procedures shall be made available for Government inspection (see 4.1.3.2).

4.1.2 TMQA program organization. The preparing activity's TMQA program organization shall have well-defined responsibility, authority, and the organizational freedom to identify and evaluate QA problems and to recommend and initiate solutions.

4.1.3 TMQA program functions. All TM program elements and processes shall be evaluated by preparing activity and Government QA personnel at various stages of development, using any or all of the following QA program functions:

- a. Guidance and quality planning conferences.
- b. Quality program reviews.
- c. Quality reviews.
- d. IPRs.
- e. Validation.
- f. Verification.

4.1.3.1 Guidance and quality planning conference. The guidance and quality planning conference (also referred to as the TMQA guidance conference or start of work meeting) shall be conducted soon after contract award to ensure the preparing activity understands applicable specifications, contract requirements, instructions, established policies, and program requirements. Such conferences may be requested by either the preparing activity or Government. Attendance shall include all key Government and preparing activity personnel who will be involved in the TMQA program. At a minimum, the following should be addressed:

- a. Use of the Technical Manual Contract Requirement (TMCR): Ensure the preparing activity understands the requirements within the TMCR (see 6.4.22) and address the "unless or as/when specified" statements contained within the TMCR to determine how to implement these specific requirements. When necessary, identify any tailoring of this document that may be needed.
- b. Discussion of deliverables and methods of delivery, including:
  - (1) Review of contract/task schedules and applicable Contract Data Requirements Lists (CDRLs [DD Form 1423]) to ensure the development and submission schedules for the TM and associated data items and that the TM management and development events support the requirements of the program or project.
  - (2) Review or establish schedules for conducting quality program reviews; TM and data item IPRs, validation, and verification.
  - (3) Review or establish the mechanics of TM and data item review comment submittal by the acquiring activity (e.g., submittal of written comments on a comment form, mark ups of the TM or data item).

## MIL-DTL-24784D(NAVY)

c. When applicable, discussion of the use of Government-furnished information or property to be provided in support of the TM effort and the disposition of that information or property after contract/task completion.

d. Explanation of the preparing activity's established or proposed TMQA program, showing how the program meets the requirements of the contract/task and this document, and how the program will function to ensure quality products. Anticipated QA problems should also be identified and potential resolutions proposed.

4.1.3.2 Quality program reviews. The preparing activity shall support quality program reviews as requested by the Government and provide access to QA records as specified in the TMQA program. During the quality program review, the preparing activity shall demonstrate to the Government the operation of the TMQA program and establish that product quality reviews are being correctly implemented, defects are being identified, and appropriate corrective actions are being taken. This shall include review of data generated during preparing activity quality reviews and quality-related reports and records. TMQA program reviews chaired by a Government representative shall be conducted at the preparing activity's facility. All quality review results will be documented by the Government. Quality program reviews should not be confused with technical reviews of TMs.

4.1.3.3 Quality reviews. The preparing activity's QA organization shall conduct quality reviews to ascertain compliance with the TMQA program and provide for corrective action. Quality reviews shall be conducted to evaluate the availability and adequacy of materials, processes, procedures, and intermediate products that constitute TM development. The preparing activity shall maintain objective records of all quality reviews. Objective evidence of the preparing activity's compliance shall be demonstrated by the ease of retrieval of specific information from records and their accuracy, currency, and completeness at the time of the Government representative's request. The records shall document quality problems and disposition recommendations. The records shall identify the items in the manual(s) to which the comments and recommendations apply.

4.1.3.3.1 Corrective action. The preparing activity shall initiate a process of corrective action for all recorded and detected deficiencies. The preparing activity shall implement preventive action programs to counter any apparent deficiency trends. The detection of deficiencies that are recognized and are not cited in the Classification of Defects (CD) table shall be added. Objective evidence of the effectiveness of the corrective action program for each deficiency shall be maintained.

4.1.3.3.2 Source data control. The preparing activity shall ensure source data is controlled through a systematic management and recording process to ensure the presence, accuracy, currency, and completeness of the source data utilized for TM development.

4.1.3.3.3 Task identification matrix or equivalent. The preparing activity shall ensure the TM content and organization is consistent with a task identification matrix or equivalent. The task identification matrix or its equivalent shall be used to ensure that all required levels of maintenance are sufficiently detailed and complete. The task identification matrix or equivalent shall be in agreement with the LMI task analysis data; approved maintenance concept (see 6.4.11) or plan; and approved Source, Maintenance, and Recoverability (SM&R) codes.

4.1.3.3.4 Control of subcontractors and vendors. The preparing activity shall ensure the quality of TMs developed by subcontractors and suppliers. The preparing activity's quality program shall not be deemed acceptable to the Government unless that preparing activity requires from the subcontractor a quality control program satisfying the requirements of this specification or equivalent control over the subcontractor.

4.1.3.3.5 Sampling. All TM products, regardless of percentage of completion, shall be sampled and evaluated as a method of determining the acceptability of products in development.

4.1.3.3.6 Classification of defects (CD). The CD table associated with the preparing activity's sampling procedures shall be made available during the guidance and quality planning conference and other quality reviews and IPRs. The CD table shall be used for product evaluation to identify TM defects. The preparing activity and the acquiring activity may jointly classify additional defects applicable to the specific products being acquired.

## MIL-DTL-24784D(NAVY)

4.1.3.4 In-process reviews (IPRs). IPRs will be authorized and convened by the Government to ensure that TMs are accurate, meet user requirements, and are in compliance with the contract and cited specifications. The preparing activity shall support IPRs and provide access to TM source materials, intermediate, and final products. IPRs shall include evaluation of source data, TM preparation methods, readability, conformance to the book plan/content plan, and intermediate and final TM deliverables (including completed text and artwork). As applicable, IPRs are convened to monitor the preparation of IPBs to ensure coverage is in accordance with the approved SM&R codes. IPRs will also be conducted during the preliminary development stages of the IETM to ensure adequacy and accuracy of IETM navigation, functionality, usability, and presentation. Safety and nuclear weapon procedures identified by the Government shall require a 100 percent IPR. The Government and the preparing activity will jointly establish the frequency and timing of IPRs, and the Government shall have final approval authority for the schedule. Additional IPRs may be required based on the preparing activity's or Government's evaluation of the TM development process or criticality/complexity of the material covered. The IPR schedule will be agreed upon at the guidance and quality planning conference, and the Government approved IPR schedule shall be contained in the guidance and quality planning conference minutes.

4.1.3.4.1 IPR review location. IPRs intended for locations other than the preparing activity's facility will be approved by the Government.

4.1.3.4.2 IPR records. The Government will act as recorder and record decisions, results, and findings during the IPR. The Government will provide a copy of all recorded IPRs to the preparing activity.

4.1.3.4.3 Disposition of IPR findings. The preparing activity shall work with the Government to resolve IPR findings that involve problem areas or findings that require further evaluation before final disposition. Any discrepancy or deficiency found as the result of the IPR shall be corrected prior to certification and acceptance of the TM.

4.1.3.5 Validation. Validation is a preparing activity QA responsibility that shall be accomplished for all TMs, changes, and revisions thereto. Validation shall provide a measure of the overall quality of the manual. The validation shall be performed by individuals who are of approximately the same education, experience, and skill level as the actual target audience for the TM. Where it is not possible to obtain such personnel for validation, validation personnel shall at least exclude those who cannot be expected to provide a realistic test of the validity of the TM (e.g., graduate engineers or those involved in authoring the TM). The Government reserves the right to witness validation. The preparing activity shall notify the Government of the validation schedule prior to commencement. A TM shall not be considered validated until the following conditions have been fulfilled:

- a. Preparing activity's engineering technical review has been completed (see 4.1.3.5.1).
- b. Information reflects configuration of the systems and equipment.
- c. Procedural instructions are readily understandable by the intended user, include necessary safety precautions, and include the information necessary to perform all intended functions.
- d. Adequacy of data is checked to ensure that it supports the approved maintenance and support plan.
- e. Hardware of the proper configuration is available for the validation effort. An operational environment shall be used, if possible, or simulated, if practicable.
- f. Source files are tagged to the level and depth required by the applicable DTD and the technical content requirements contained in this specification.
- g. Records of all validations performed shall be maintained. These records shall indicate the affected manuals, system/equipment, component part number, or serial number. The records shall be maintained by the preparing activity and be available for Government review. Records shall be maintained of the inspections and shall include the signatures of the inspectors, identification of the deliverables inspected, any discrepancies found, and corrections made resulting from validation. The preparing activity shall certify that the TM delivered to the Government for verification has been validated, that all corrections have been made, and that all contract requirements have been met.

## MIL-DTL-24784D(NAVY)

4.1.3.5.1 Engineering reviews. The preparing activity shall conduct appropriate engineering reviews of the technical information to ensure that it is safe, complete, logical, technically accurate, and comprehensible. Based on this review, the preparing activity shall certify prior to validation that the technical information permits efficient performance of the intended equipment-support functions and that the technical information is ready for validation. All errors noted during this engineering review shall be corrected prior to validation. The preparing activity shall maintain engineering review records.

4.1.3.5.2 Validation performance. Theory and principles of operation, system and component description, SM&R codes (when applicable), schematic, and wiring data shall be validated against engineering source data in accordance with the validation plan. Operating and maintenance procedures, including checkout, alignment, removal and replacement instructions, and associated checklists shall be validated against the system and equipment by actual demonstration. Malfunctions shall not be introduced into the system or equipment for the purpose of validation unless specifically required for certification of procedural tasks or system tests. Destructive malfunctions shall not be introduced into the system or equipment for any purpose.

4.1.3.5.3 Support equipment. Government-approved support equipment shall be utilized in the performance of validation. Simulation or substitution of support equipment shall be approved by the Government. It is the responsibility of the preparing activity to request Government-furnished equipment (GFE) in order to support the validation effort. The preparing activity shall provide all consumable and expendable items required to support validation.

4.1.3.5.4 Validation of readability. Narrative text shall be validated for conformance to readability standards specified in 3.7.2.1. If the OGL (including tolerance) is exceeded, the manual shall be rewritten as required to meet the specified RGL. If a sample GL is exceeded, the entire text surrounding each sample shall be rewritten as required.

4.1.3.5.5 IETM system validation. An IETM system consists of the operating and presentation software of the display device, the IETM, and the display device hardware. The display device can be a desktop computer, laptop, or a hand-held device utilizing NAVSEA-accepted viewer software, depending on the deployment of the IETM. Validation of the IETM system shall be performed by demonstration on the expected deployed hardware and software configuration. The extent of the demonstration shall be in accordance with the preparing activity's validation plan. The field version of the IETM system hardware and software shall be demonstrated to the extent required to establish its accuracy, adequacy, capabilities, and compatibility with Government systems and contractual requirements. The IETM system validation shall:

- a. Demonstrate the general visibility and readability of the IETM on the display device.
- b. Check that all data access links and branches are valid and operable.
- c. As applicable, ensure that there are no "open loops" in the fault isolation tasks (i.e., that each task ends in a single resolution, and each retrieval string ends in successful isolation and repair of a discrete fault).
- d. Ensure that there are no un-referenced or inaccessible data in the system.
- e. Demonstrate all required functionalities are fully operable. Demonstration shall include navigation through the IETM including Table of Contents, internal and external links, and graphic hotspots.

4.1.3.5.6 Disposition of validated data. Corrections and significant comments resulting from validation shall be incorporated prior to issue of the validation certification.

4.1.3.5.7 Validation certification. A TM validation certificate shall be prepared and delivered. The certificate is the preparing activity's certification that the TM product is accurate and complete and when applicable, provides an indicator when some portion of the validation could not be accomplished. The completed validation certificate assures the acquiring activity that the preparing activity has satisfactorily validated the TM in accordance with the requirements of the contract and the approved TM validation plan (as applicable). Format and content requirements for the validation certificate shall be as specified (see 6.2).

## MIL-DTL-24784D(NAVY)

4.1.3.6 Verification. Verification shall be accomplished under the jurisdiction of the Government and, when specified (see 6.2), shall include preparing activity support. Verification is a responsibility of the approval authority or authorized representative. The purpose of verification shall be to ensure that the preparing activity's products and services are in conformity with the requirements of this specification. The preparing activity shall maintain records (that document the preparing activity's analyses of verification comments) and correct TM discrepancies recorded during verification. Records shall be available for the acquiring activity review.

4.1.3.6.1 Verification support requirements. Preparing activity support of verification shall consist of the following:

- a. Serve as verification recorder, if required. Record and maintain records of changes associated with performance of verification.
- b. Provide assistance in performing verification tasks, if required.
- c. Certification that all discrepancies and defects noted during verification have been corrected or resolved.

4.1.3.6.2 Verification discrepancy/disposition records. TM verification discrepancy/disposition records shall be prepared and delivered as specified (see 6.2). The records will contain the preparing activity's dispositions and resolutions to documented TM verification discrepancies and findings. Format and content requirements for the records shall be as specified (see 6.2).

4.1.3.6.3 Verification incorporation certification. The TM verification incorporation certificate shall be prepared and delivered as specified (see 6.2). The certificate assures the acquiring activity that the preparing activity has resolved and incorporated into the final TM, corrections resulting from discrepancies and findings noted during TM verification. Format and content requirements for the certificate shall be as specified (see 6.2).

4.1.3.7 Combined validation and verification. When authorized by the Government, verification shall be performed concurrently with validation. Final acceptance of the TM will be made upon receipt of the validation and verification incorporation certifications.

4.2 TMQA product development. The following are general requirements applicable to all TM types.

4.2.1 TMQA program plan. The TMQA program plan shall be developed and delivered as specified (see 6.2). The TMQA program provides details of the preparing activity's TMQA program, including the organization, planning, and data control to be performed on TMs being procured and developed. The plan will provide evidence of the preparing activity's intent and methods for complying with the QA provisions contained within this document. As specified (see 6.2), the plan shall be submitted to the acquiring activity for review and acceptance. Format and content requirements for the plan shall be as specified (see 6.2).

4.2.2 Validation plan. The TM validation plan shall be developed and delivered as specified (see 6.2). The TM validation plan defines the preparing activity's methods, procedures, controls, and resources that will be used to accomplish validation of the TM(s) being procured and developed. As specified (see 6.2), the validation plan shall be submitted to the acquiring activity for review and acceptance. Format and content requirements for the plan shall be as specified (see 6.2).

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## MIL-DTL-24784D(NAVY)

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This specification is intended for use in the development of NAVSEA TMs that furnish information on the description, installation, operation, test, maintenance, repair, and overhaul of a ship, system, or equipment. This specification sets forth the style, format, and technical content standards for these TMs.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification (or any TMCR referencing this specification).
- b. When a new TM is required to support a ship, system, or equipment, the manual type must be specified (see 3.1.1).
- c. For ship and major system acquisitions, that a TMOP is required (see 3.3.1).
- d. Specific data item description (DID) covering format and content requirements for the TMOP (see 3.3.1).
- e. The TMQA products required to be developed and delivered (see 3.3.2, 4.1.3.6.2, 4.1.3.6.3, 4.2.1, and 4.2.2).
- f. Requirements for TM schedules and status reports (see 3.3.3).
- g. Specific DID covering format and content requirements for TM schedules and status reports (see 3.3.3).
- h. Requirements for TM cost reports (see 3.3.4).
- i. Specific DID covering format and content requirements for TM cost reports (see 3.3.4).
- j. If a supplement is required (see 3.4.1.2).
- k. Whether long-line diagrams (oversized schematics, timing circuit diagrams, test setup diagrams, wiring diagrams, etc.) require re-authoring to be easily viewed on screen and printed or are to be delivered as a separately packaged hardcopy supplement (see 3.4.1.2).
  - l. If a revision should be developed (see 3.4.1.3).
  - m. Types of manual issues required for delivery (RDC, PTM, FTM) (see 3.4.2).
  - n. Whether Portable Document Format (PDF) or IETM is required for delivery, and specify if additional document functionality is required for the FTM (see 3.4.2.3, 3.4.2.3.1, and 3.4.4).
  - o. The specific DTD or Schema (including the version) to be used to develop the TM (see 3.4.3.1 and 3.4.3.2).
  - p. The tagging guidelines document and style sheets to be used (see 3.4.3.1 and 3.4.3.2).
  - q. If a supplement containing oversized illustrations should be developed for IETMs (see 3.4.4 and C.2.9.3.1).
  - r. The level(s) of maintenance coverage required (see 3.5.2).
  - s. Applicable security classification (see 3.5.5).
  - t. If energy efficiency information is required (see 3.5.7).
  - u. The cover and title page requirements (see 3.6, 3.6.5, 3.6.6, 3.6.7, 3.6.9, 3.6.11, and 3.6.12).
  - v. The distribution statement to be placed on the cover/title page (see 3.6.13).
  - w. If the TM may include links to external referenced documents (see 3.7.3.1).
  - x. If user acknowledgement of dangers, warnings, cautions, and notes are required (see 3.7.5.9.5).
  - y. If a compilation of dangers, warnings, and cautions used within the TM is required (see 3.7.5.10).
  - z. If color is approved for use in graphics, illustrations, and photographs (see 3.7.8.4.12).
  - aa. If photographs may be used (see 3.7.8.4.13 and 3.7.8.4.13.1).
  - bb. If new revision change symbols should be provided in the revision (see 3.7.9.3).
  - cc. If preparing activity support is required for verification (see 4.1.3.6).
  - dd. Specific DID covering format and content requirements for validation certificate (see 4.1.3.5.7).

## MIL-DTL-24784D(NAVY)

- ee. Specific DID covering format and content requirements for verification discrepancy/disposition records (see 4.1.3.6.2).
- ff. Specific DID covering format and content requirements for verification incorporation certification (see 4.1.3.6.3).
- gg. Specific DID covering format and content requirements for TMQA program plan (see 4.2.1).
- hh. Specific DID covering format and content requirements for validation plan (see 4.2.2).
- ii. Packaging requirements (see 5.1).
- jj. If a book plan/IETM content plan should be developed (see A.2.2.1, B.2.2.1, and C.2.2.1).
- kk. Specific DID covering format and content requirements for book plan/IETM content plan (see A.2.2.1, B.2.2.1, and C.2.2.1).
- ll. If an existing manual/model manual should be used to develop the book plan/IETM content plan (see A.2.2.1.1, B.2.2.1.1, and C.2.2.1.1).
- mm. If appendices should be developed (see A.2.3.2.3.1).
- nn. If a backbone should be prepared (see A.2.3.2.3.4 and B.2.3.2.3.4).
- oo. If double column is required (see A.2.4.2).
- pp. If foldout pages are allowed in the manual (see A.2.9.2.3 and B.2.9.1.4).
- qq. If an alphabetical index is required (see B.2.3.2.3.2).
- rr. If new or changed material should be identified (see B.2.10.1 and C.2.10.1).
- ss. If hot spots are required to link all abbreviations, acronyms, and uncommon terms to the complete explanations and listings (see C.2.3.2.1.3 and C.2.6.1).
- tt. If multimedia presentations may be included in the IETM (see C.2.9.1).

6.3 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, specifications and standards that have been authorized and assigned an Acquisition Management Systems Control (AMSC) number or a TMCR based on those specifications and standards must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract.

#### 6.4 Definitions.

6.4.1 Accuracy. The precision and technical correctness of the contents of a manual. Accuracy includes the requirements that the TM reflect the “as built” or “as is” configuration of the associated hardware.

6.4.2 Adequacy. A depth of scope of coverage sufficient to support all tasks and functions at the prescribed level of the user, consistent with the equipment to be used and the mission environment in which the manual is to be utilized.

6.4.3 Assembly. A number of parts or subassemblies or any combination thereof joined together to perform a specific function and capable of being disassembled.

6.4.4 Component. A composite fabricated unit (generally complete within itself) that is designed to perform a stated service when installed in its proper position.

6.4.5 Comprehensibility. The completeness with which a user in the target audience understands the text or text-graphics combination.

6.4.6 DTD. Rules determined by an application that apply SGML or XML to the markup of documents of a particular type.

## MIL-DTL-24784D(NAVY)

6.4.7 Electronic technical manual (ETM). A TM that has been scanned or developed in a digital format for electronic display. An ETM is delivered digitally to an end user and is intended primarily for electronic display. ETMs include both linear and interactive or non-linear ETMs.

a. Linear ETM. In a linear ETM, the sequence of the data presentation is largely predefined by the data author. It is an organization of technical data that replicates the order of information found in a page-based document. There is generally one primary "path" through the technical data.

b. Interactive ETM (IETM). An IETM provides high levels of interactivity between the data and the user. The sequence of presentation is dictated by inputs by the user, external sources, or events (as in diagnostics). IETMs have an organization of content that does not follow a document or page-based paradigm. There are multiple paths through the data. Individual paths through the data are generally determined based on user or other input via dialog boxes.

6.4.8 Foldout. A foldout has the same height as, but is wider than, a standard 11-inch page. Foldout pages are folded either 2 or 4 times (depending on width) to assume the dimensions of a standard page.

6.4.9 Functional division. A function or a portion of a function that performs a particular task in relationship to the entire system/equipment.

6.4.10 Leading. The vertical spacing between lines of type measured from baseline to baseline (bottom of line to bottom of next line below). Leading is measured in points.

6.4.11 Maintenance concept. The planned concept by which the equipment, assemblies, units, components, modules, or piece parts are to be repaired or replaced by designated maintenance level activities (organizational, intermediate, or depot).

6.4.12 Major function. An essential functional operation that is fundamental to operation (as opposed to a circuit) of the equipment (for example, transmit, receive, display, hoist, and so forth).

6.4.13 Overhaul. The process of reconditioning a system or equipment to conform to the stated performance and technical specifications of the system or equipment with a life expectancy equivalent to similarly configured new systems or equipment. Overhaul is also performed to repair or replace parts and components that have failed or are of marginal quality because of wear, deterioration, or damage so as to preclude premature failure. Installation of authorized approved engineering or field changes may be included as part of the overhaul.

6.4.14 PIN. An alphanumeric designator that identifies parts, items, or bulk materials that are covered by a specification or standard. The number derived from a defense specification such as M46010-1, or a military specification sheet (formerly known as military standards) such as MS18282.

6.4.15 Schema. A structured set of rules used to define the allowed component structures of the XML document. The component structures are used to populate the content of the document.

6.4.16 Set. A number of individual manuals or volumes that comprises a complete package of operational and maintenance information for an item.

6.4.17 SGML. An abstract syntax used to define document markup languages using the constructs defined in ISO-8879.

6.4.18 Subassembly. A portion of an assembly or unit, which is replaceable as a whole, but also has a part or parts that are individually replaceable. (The distinction between an assembly and a subassembly is determined by the individual application. An assembly in one instance may be a subassembly in another, where it forms a portion of an assembly.)

6.4.19 Supplement. A subsidiary document that complements information in a related manual.

6.4.20 System. Two or more equipments (sets) or components, each having its own identity and nomenclature, arranged and interconnected to perform a specific operation or function.

## MIL-DTL-24784D(NAVY)

6.4.21 TM. Publications that are used to install, operate, maintain, test, repair, overhaul, or provide logistic support for ships, systems, or equipment. TM information may be presented in various forms or possess various characteristics including, but not limited to, hardcopy, audio and visual displays, discs, and other electronic devices. Publications falling under this definition are installation, operation, and maintenance manuals for all levels of support; system and subsystem manuals; technical repair standards; check-off cards and sheets; troubleshooting procedures and aids; lubrication charts and procedures; equipment training manuals and aids; parts lists; field changes; and alteration procedures.

6.4.22 TMCR. Provides the required content, format, and style requirements for the preparation and delivery of one or more TMs and TM management data items in a definitive contractual document. The TMCR consolidates the requirements from various government specifications and standards and tailors those requirements to produce a TM that satisfies specified user needs.

6.4.23 Unit. A major building block for a set or system, consisting of a collection of basic parts, subassemblies, and assemblies packaged together as a physically independent entity. Refer to IEEE 200 for a detailed description.

6.4.24 XML. A unique markup language defined in a W3C specification that is a fully conforming subset of SGML and intended chiefly for the electronic exchange of data.

6.5 Acronyms and abbreviations. The acronyms and abbreviations used in this specification are defined as follows:

AC - Alternating Current  
 ACN - Advance Change Notice  
 AIL - Automated Interface Listing  
 ANSI - American National Standards Institute  
 ASME - American Society of Mechanical Engineers  
 ATIS - Advanced Technical Information Support  
 BIT - Built-In Test  
 CD - Classification of Defects / Compact Disk  
 CD-ROM - Compact Disk-Read Only Memory  
 COTS - Commercial Off-the-Shelf  
 CSTOM - Combat System Technical Operations Manual  
 DC - Direct Current  
 DFAR - Defense Federal Acquisition Regulation  
 DID - Data Item Description  
 DTD - Document Type Definition  
 EDS - Electronic Display System  
 EPA - Environmental Protection Agency  
 ESD - Electrostatic Discharge  
 ESDS - Electrostatic Discharge Sensitive  
 ETM - Electronic Technical Manual  
 FAR - Federal Acquisition Regulations  
 FBD - Functional Block Diagram  
 FCD - Functional Circuit Diagram  
 FTM - Final Technical Manual  
 GFE - Government Furnished Equipment

MIL-DTL-24784D(NAVY)

GIF - Graphic Interchange Format  
GL - Grade Level  
GPO - Government Printing Office  
HAZCOM - Hazardous Communication  
HCP - Hardness Critical Process  
HM&E - Hull, Mechanical, and Electrical  
HTML - Hypertext Markup Language  
HTTP - Hypertext Transfer Protocol  
HZ - Hertz  
IC - Interior Communication  
ID - Reference Identifier  
IEEE - Institute of Electrical and Electronics Engineers  
IETM - Interactive Electronic Technical Manual  
IM - Information Module  
IP - Information Package  
IPB - Illustrated Parts Breakdown  
iPDF - Indexed Portable Document Format  
IPR - In-Process Review  
ISO - International Organization for Standardization  
JCS - Joint Chiefs of Staff  
LMI - Logistics Management Information  
LSA - Logistics Support Analysis  
LSAR - Logistics Support Analysis Record  
NAVSEA - Naval Sea Systems Command  
NSDSA - Naval Systems Data Support Activity  
NSN - National Stock Number  
N/A - Not Applicable  
ODS - Ozone Depleting Substance  
OGL - Overall Grade Level  
OSH - Occupational Safety and Health  
OSHA - Occupational Safety and Health Agency  
PDF - Portable Document Format  
PIN - Part Identification Number  
POD - Print-On-Demand  
PPI - Plan Position Indication  
PTM - Preliminary Technical Manual  
QA - Quality Assurance  
RDC - Review Draft Copy  
RGL - Reading Grade Level  
RHI - Range Horizontal Indication  
SDS - Safety Data Sheet (formerly known as Material Safety Data Sheet or MSDS)

MIL-DTL-24784D(NAVY)

SFD - System Functional Diagram  
SGML - Standard Generalized Markup Language  
SIB - Ship Information Book  
SM&R - Source, Maintenance, and Recoverability  
SNAP - Significant New Alternative Policy  
SPAWAR - Space and Naval Warfare Systems Command  
SUW - Surface Warfare  
TAB - Training Aid Booklet  
TDMIS - Technical Data Management Information System  
TIFF - Tiled Image File Format  
TM - Technical Manual  
TMCR - Technical Manual Contract Requirement  
TMDER - Technical Manual Deficiency/Evaluation Report  
TMIN - Technical Manual Identification Number  
TMOP - Technical Manual Organization Plan  
TMPODS - Technical Manual Print-On-Demand System  
TMQA - Technical Manual Quality Assurance  
TRS - Technical Repair Standard  
UHF - Ultra High Frequency  
V - Volts  
W3C - World Wide Web Consortium  
XML - Extensible Markup Language

6.6 Subject term (key word) listing.

Book plan  
Chapter-format  
Content plan  
Final technical manual  
Modular-format  
Preliminary technical manual  
Quality assurance  
Review draft copy  
Revision  
Supplement  
Validation  
Verification

6.7 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

## MIL-DTL-24784D(NAVY)

**NAVY DISTANCE SUPPORT (DS) CUSTOMER ASSISTANCE CONTACT INFORMATION.** Fleet users of this technical manual (TM) may request NAVY 311 assistance. NAVY 311 is the Fleet's single point of entry for technical and logistics support whenever routine sources of support are unavailable or are not readily identifiable. NAVY 311 is operated via the Global Distance Support Community (GDSC) of geographically dispersed, centrally coordinated, Tier 1/2 call centers that function on a 24/7 basis. Point of entry options:

Phone: 1-855-NAVY311 (1-855-628-9311)/DSN 510-NAVY311 (510-628-9311)

Navy Distance Support/Navv 311 Web: <http://www.navy311.navy.mil/> (unclassified) or <https://www.navy311.navy.smil.mil/> (classified). (Provides program information and links to an online Support Request Form and Support Request Status, Live CHAT with a Call Center Rep, Knowledge Base Searching, etc.)

Email: [Navy311@navy.mil](mailto:Navy311@navy.mil) or [Navy311@navy.smil.mil](mailto:Navy311@navy.smil.mil).

**TMDER INSTRUCTIONS.** Ships, training activities, supply points, depots, Naval Shipyards, and Supervisors of Shipbuilding are requested to arrange for the maximum practical use and evaluation of NAVSEA and SPAWAR TMs. All errors, omissions, discrepancies, and suggestions for improvement to NAVSEA and SPAWAR TMs shall be submitted as a Technical Manual Deficiency/Evaluation Report (TMDER). All feedback comments shall be thoroughly investigated and originators will be advised of action resulting there from.

*(Use this statement if the TM is distributed as a hard copy or PDF)* The NAVSEA/SPAWAR TMDER form, NAVSEA 4160/1, is included at the back of the TM.

The following methods are available for generation and submission of TMDERs against unclassified TMs:

For those with a Technical Data Management Information System (TDMIS) account, the most expedient and preferred method of TMDER generation and submission is via the TDMIS website at <https://mercury.tdmis.navy.mil/>.

For those without a TDMIS account, generate and submit a TMDER via the Naval Systems Data Support Activity (NSDSA) website at [https://mercury.tdmis.navy.mil/def\\_external/pubsearch.cfm](https://mercury.tdmis.navy.mil/def_external/pubsearch.cfm). (TDMIS accounts may be requested at the NSDSA website at <https://nsdsa.dc3n.navy.mil/> by submitting a Customer Service Request [CSR].)

When internet access is not available, submit a TMDER via hardcopy to:

COMMANDER NAVAL SURFACE WARFARE CENTER  
NAVAL SYSTEMS DATA SUPPORT ACTIVITY  
4363 MISSILE WAY  
ATTN: CODE 310 BLDG 1389 TMDERS  
PORT HUENEME, CA 93043-4307

Additional copies of the TMDER form may also be downloaded from the NSDSA website at <https://nsdsa.dc3n.navy.mil/> by clicking on the blue tab labeled "Reference Docs/Forms".

TMDERs against classified/restricted TMs (includes all NOFORN) must be submitted using the hardcopy method cited above.

Urgent priority TM deficiencies shall be reported by naval message with transmission to Port Hueneme Division, Naval Surface Warfare Center (Code 310), Port Hueneme, CA. Local message handling procedures shall be used. The message shall identify each TM deficiency by Technical Manual Identification Number (TMIN) and title. This method shall be used in those instances where a TM deficiency constitutes an urgent problem (i.e., involves a condition, which if not corrected, could result in injury to personnel, damage to the equipment, or jeopardy to the safety or success of the mission).

Complete instructions for TMDER generation and submission are detailed on the NSDSA website at <https://nsdsa.dc3n.navy.mil/> by clicking on the blue tab labeled "TMDER/ACN" and then clicking on the gray button labeled "TMDERS".

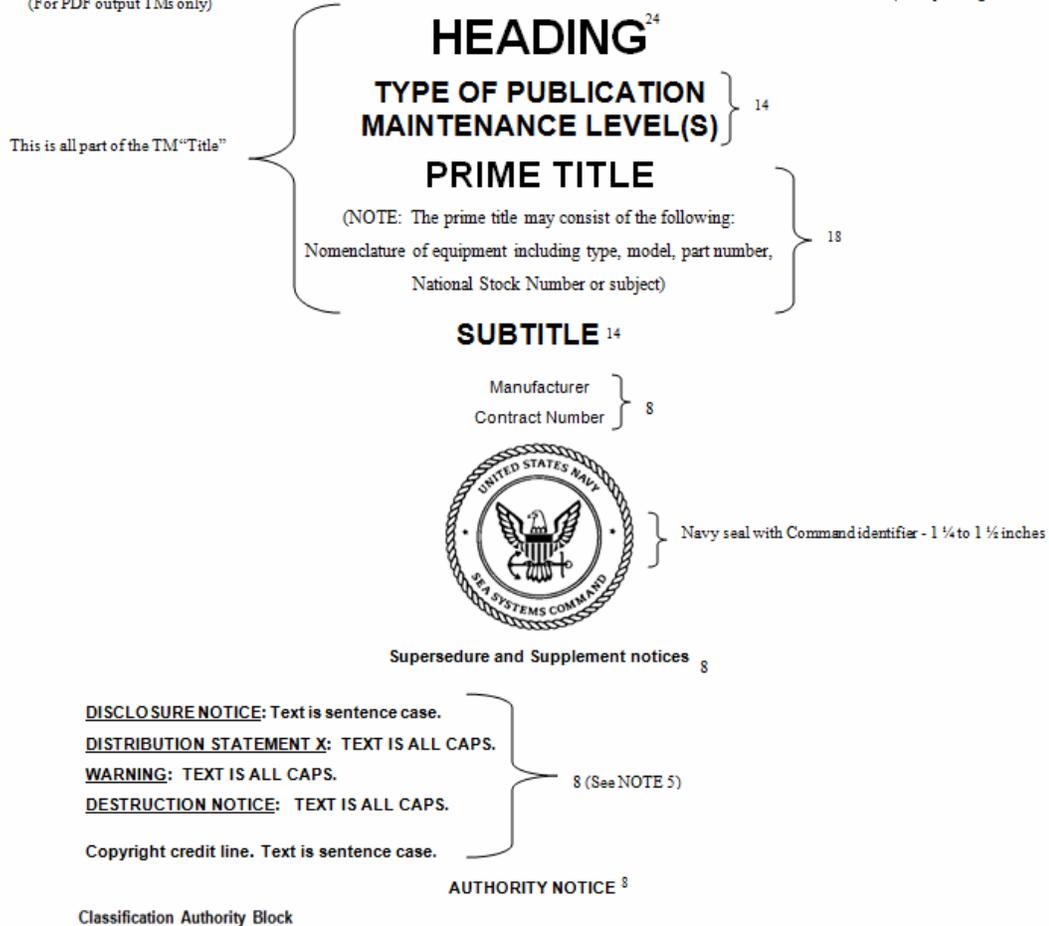
**NOTE:** Sample only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 1. Technical assistance and deficiency reporting information.

MIL-DTL-24784D(NAVY)

# SECURITY CLASSIFICATION <sup>24</sup> Only required on classified TMs

## TM IDENTIFICATION NUMBER <sup>24</sup>

**VOLUME NO./PART NO.** <sup>14</sup>(For PDF output TMs only)**REVISION NUMBER** <sup>14</sup>(For superseding revisions only)**Bar Code and National Stock Number** <sup>18</sup>(Bar code for PDF  
output TM only)**PUBLICATION DATE** <sup>18</sup>**SECURITY CLASSIFICATION** <sup>24</sup>Only required on classified TMs

NOTE 1: See the TMCR/TMSR for details. Vertical spacing on this example is compressed and may be adjusted as necessary.  
 NOTE 2: Numbers in small type indicate the preferred type point size; however, type size may be adjusted when necessary to fit contents onto one page.  
 NOTE 3: All entries shall be in sans serif bold except the Manufacturer and contract number which is sans serif regular.  
 NOTE 4: Alignment and capitalization shall be as shown in this example.  
 NOTE 5: These entries shall be block indented. Entries (except for copyright credit line) shall include the captions as shown (e.g., "**WARNING:**").

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 2. Cover/title page.

MIL-DTL-24784D(NAVY)



BIOLOGICAL - abstract symbol bug shows that a material may contain bacteria or viruses that present a danger to life or health.



CHEMICAL - drops of liquid on hand shows that the material will cause burns or irritation to human skin or tissue.



CRYOGENIC - hand in block of ice shows that the material is extremely cold and can injure human skin or tissue.



EXPLOSION - rapidly expanding symbol shows that the material may explode if subjected to high temperatures, sources of ignition or high pressure.



EYE PROTECTION - person with goggles shows that the material will injure the eyes.



FIRE - flame shows that a material may ignite and cause burns.



POISON - skull and crossbones shows that a material is poisonous or is a danger to life.



RADIATION - three circular wedges shows that the material emits radioactive energy and can injure human tissue.



VAPOR - human figure in a cloud shows that material vapors present a danger to life or health.

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 3. Hazardous materials warnings symbols.

MIL-DTL-24784D(NAVY)



EAR PROTECTION - headphones over ears shows that noise level will harm ears.



ELECTRICAL - electrical wire to arm with electricity symbol running through human body shows that shock hazard is present.



ELECTRICAL - electrical wire to hand with electricity symbol running through hand shows that shock hazard is present.



FALLING PARTS - arrow bouncing off human shoulder and head shows that falling parts present a danger to life or limb.



FLYING PARTICLES - arrows bouncing off face shows that particles flying through the air will harm face.



FLYING PARTICLES - arrows bouncing off face with face shield shows that particles flying through the air will harm face.



HEAVY OBJECT - human figure stooping over heavy object shows physical injury potential from improper lifting technique.



HEAVY PARTS - hand with heavy object on top shows that heavy parts can crush and harm.

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 4. Safety warnings symbols.

MIL-DTL-24784D(NAVY)



HEAVY PARTS - foot with heavy object on top shows that heavy parts can crush and harm.



HEAVY PARTS - heavy object on human figure shows that heavy parts present a danger to life or limb.



HEAVY PARTS - heavy object pinning human figure against wall shows that heavy, moving parts present a danger to life or limb.



HELMET PROTECTION - arrow bouncing off head with helmet shows that falling parts present a danger.



HOT AREA - hand over object radiating heat shows that part is hot and can burn.



LASER LIGHT - laser light hazard symbol indicates extreme danger for eyes from laser beams and reflections.



MOVING PARTS - human figure with an arm caught between gears shows that the moving parts of the equipment present a danger to life or limb.



MOVING PARTS - hand with fingers caught between gears shows that the moving parts of the equipment present a danger to life or limb.

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 4. Safety warnings symbols – Continued.

MIL-DTL-24784D(NAVY)



MOVING PARTS - hand with fingers caught between rollers shows that the moving parts of the equipment present a danger to life or limb.



RADIO FREQUENCY EMITTER – waves of signal show that a device emits radio frequency that may present a danger to health



SHARP OBJECT - pointed object in hand shows that a sharp object presents a danger to limb.



SHARP OBJECT - pointed object in hand shows that a sharp object presents a danger to limb.



SHARP OBJECT - pointed object in foot shows that a sharp object presents a danger to limb.

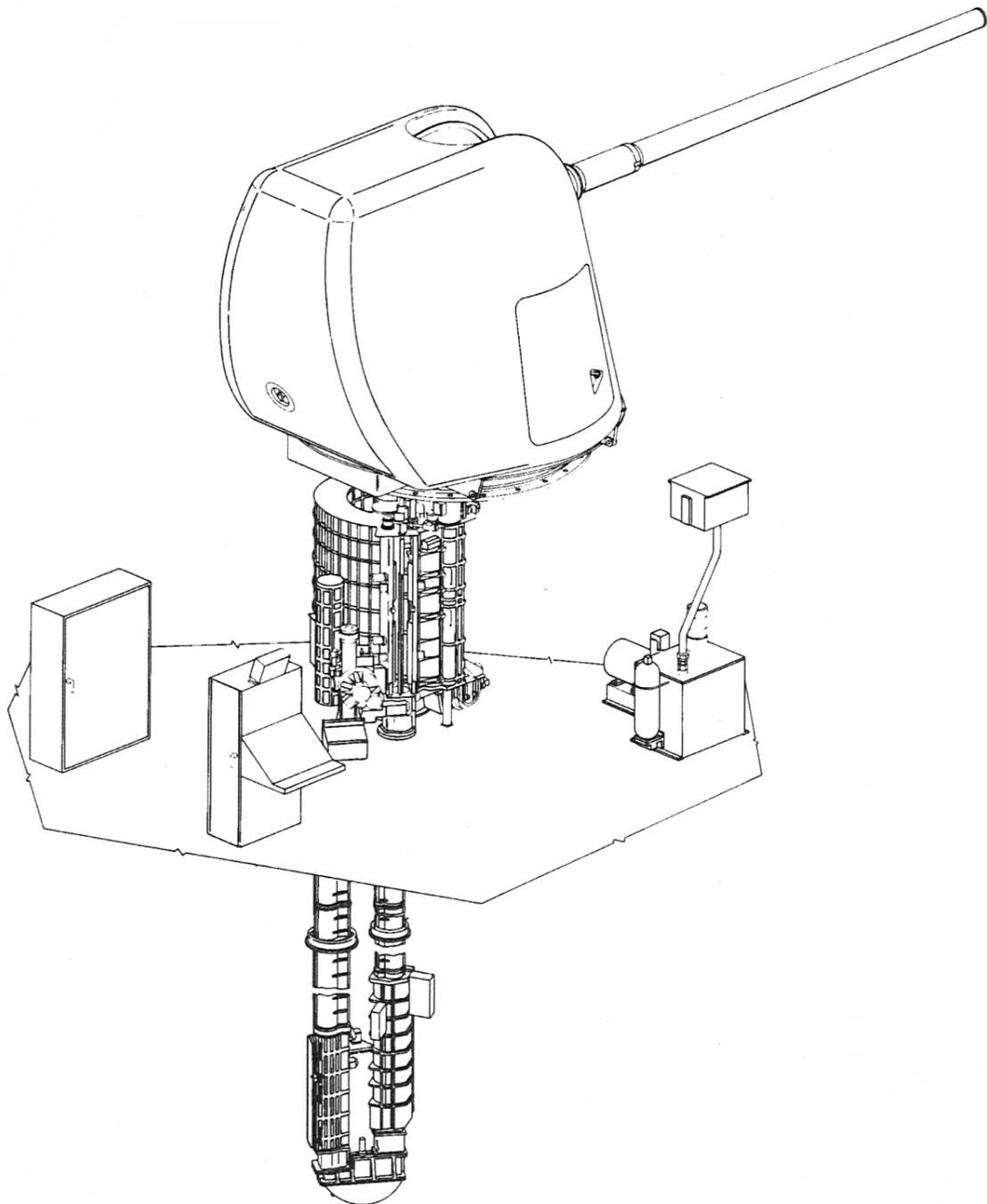


SLICK FLOOR - wavy line on floor with legs prone shows that slick floor presents a danger for falling.

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

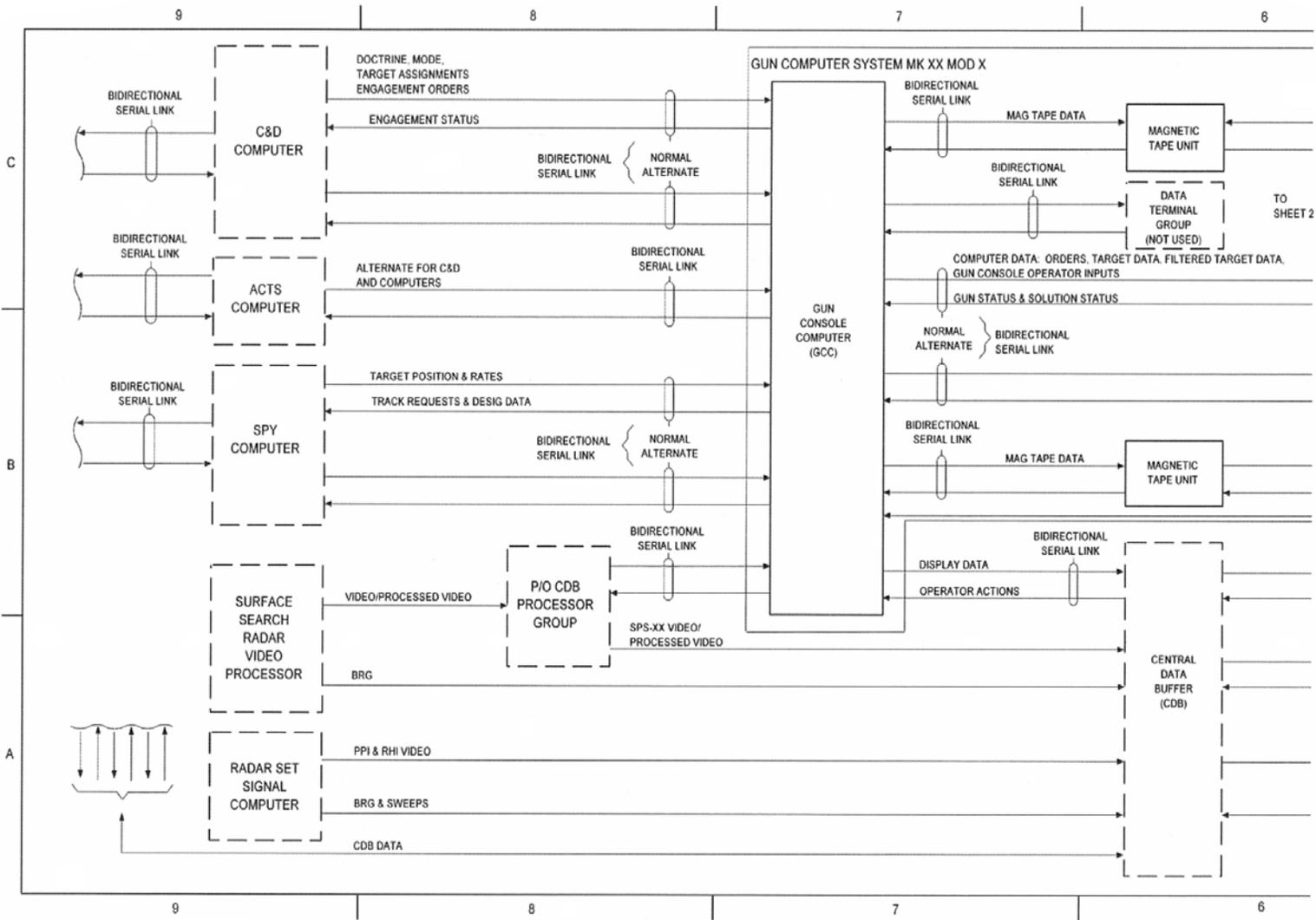
FIGURE 4. Safety warnings symbols – Continued.

MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 5. Frontispiece, typical equipment.

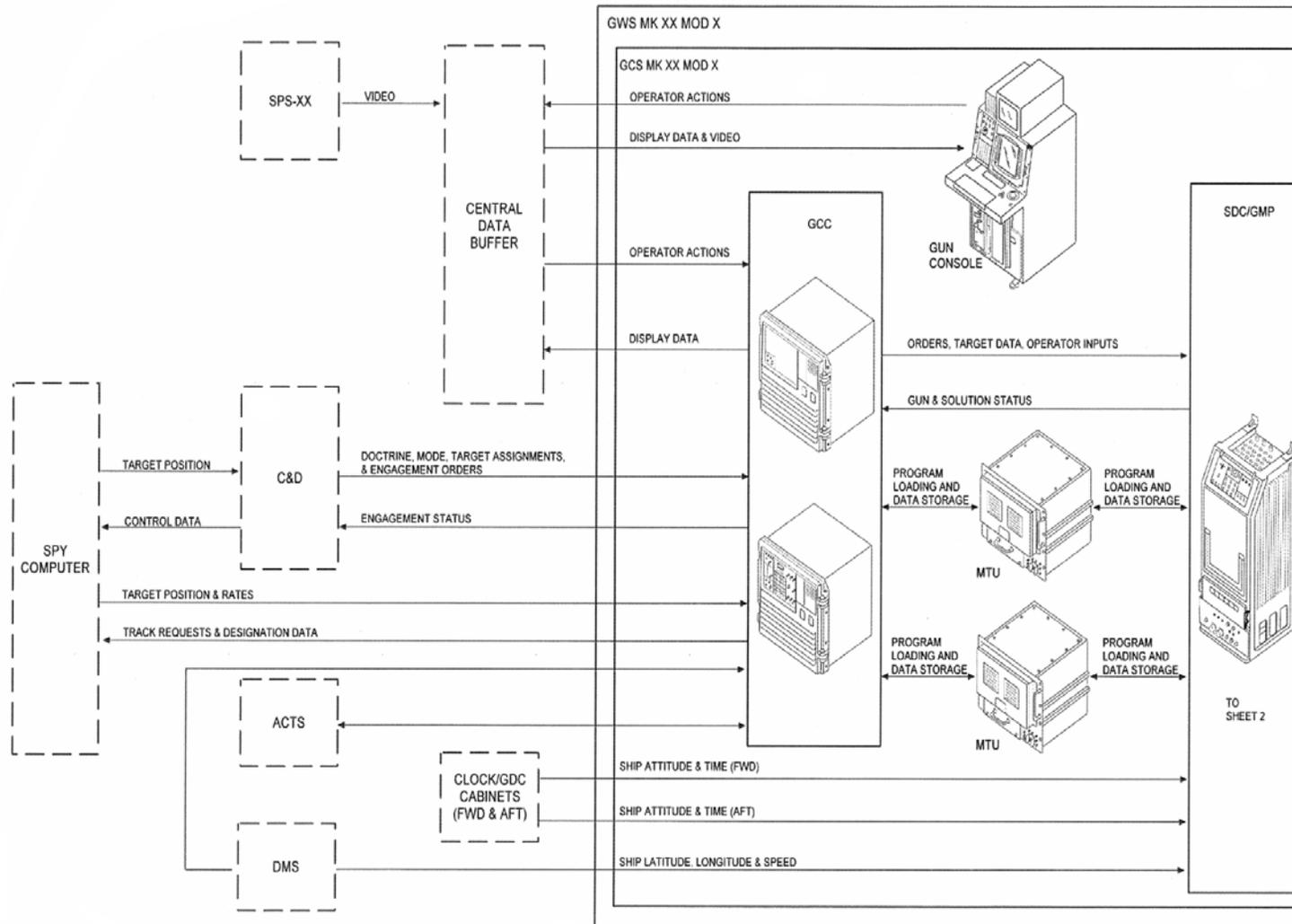


63

MIL-DTL-24784D(NAVY)

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 6. FBD, master.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

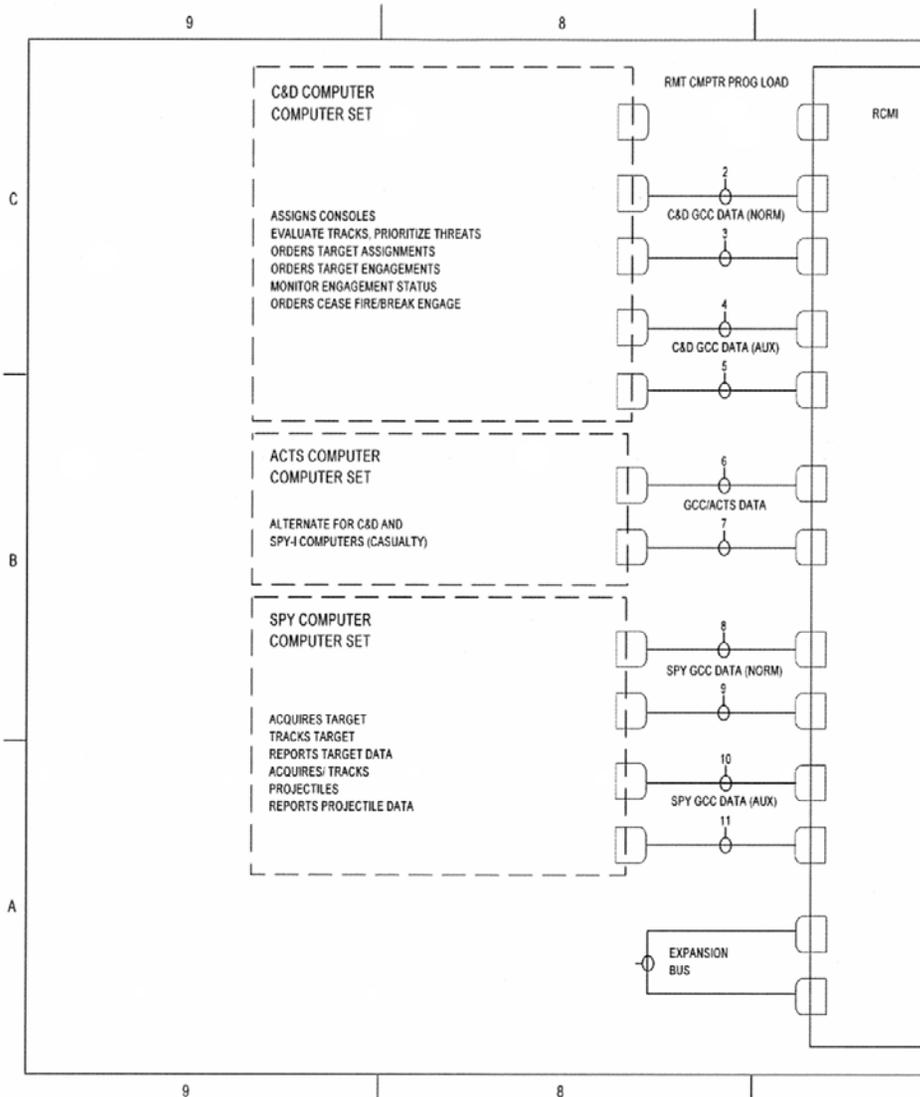
FIGURE 7. FBD, primary.

GENERAL NOTES:

A. DASH LINES INDICATE EQUIPMENT NOT PART OF GCS.

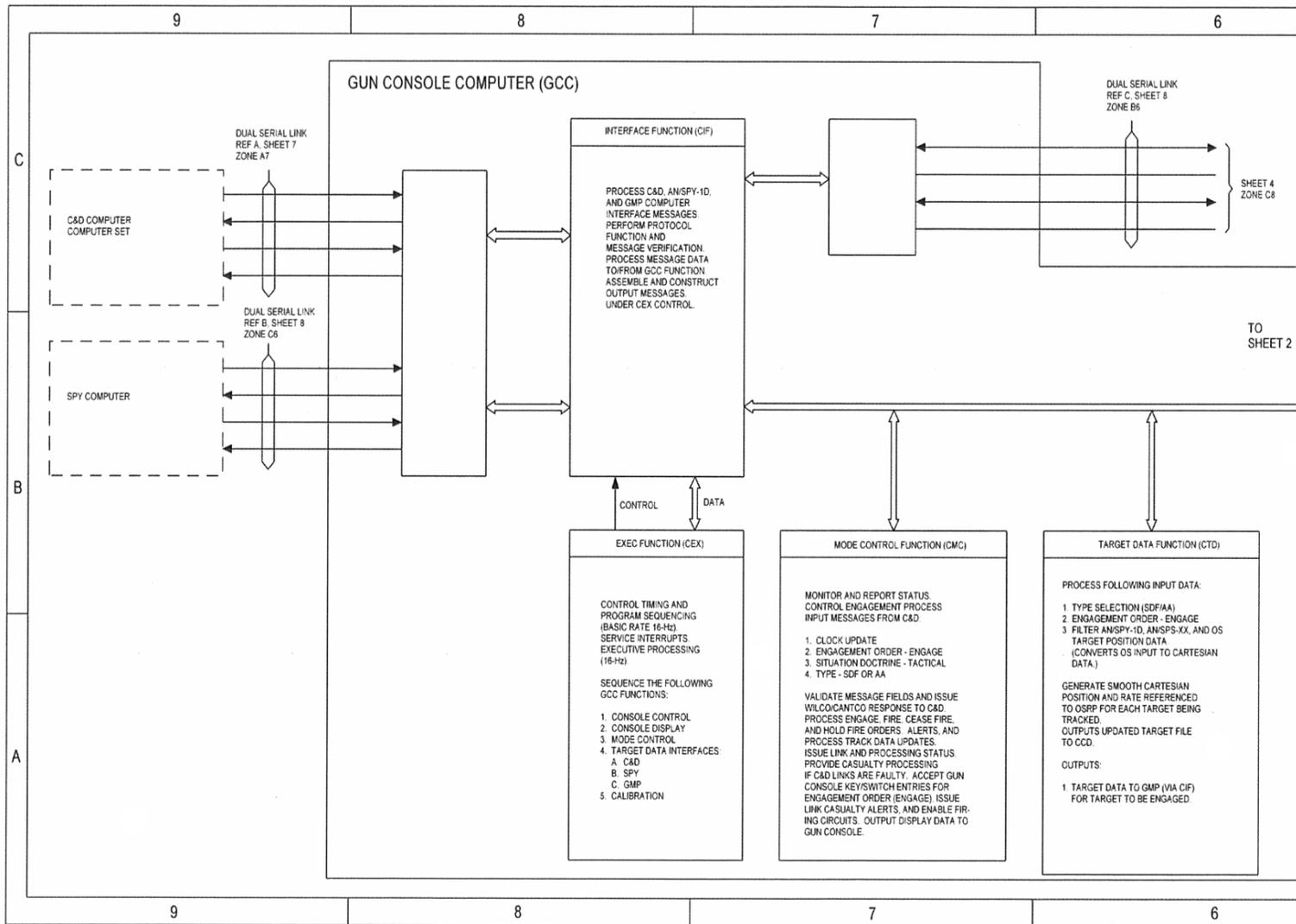
SPECIFIC NOTES:

1. THE GCC IS SHOWN AS A SINGLE UNIT FOR SIMPLICITY. HOWEVER THERE ARE TWO CABINETS: THE XXX CABINET AND THE EXPANSION CABINET. IOC 0 CHANNELS ARE PHYSICALLY LOCATED IN THE XXX CABINET AND IOC 1 CHANNELS ARE PHYSICALLY LOCATED IN THE EXPANSION CABINET.
2. CABLE AND CONNECTOR DESIGNATIONS ARE PROVIDED FOR REFERENCE ONLY. THOSE WHICH ARE NOT CONSISTANT BETWEEN HULLS ARE OMITTED FOR CLARITY.



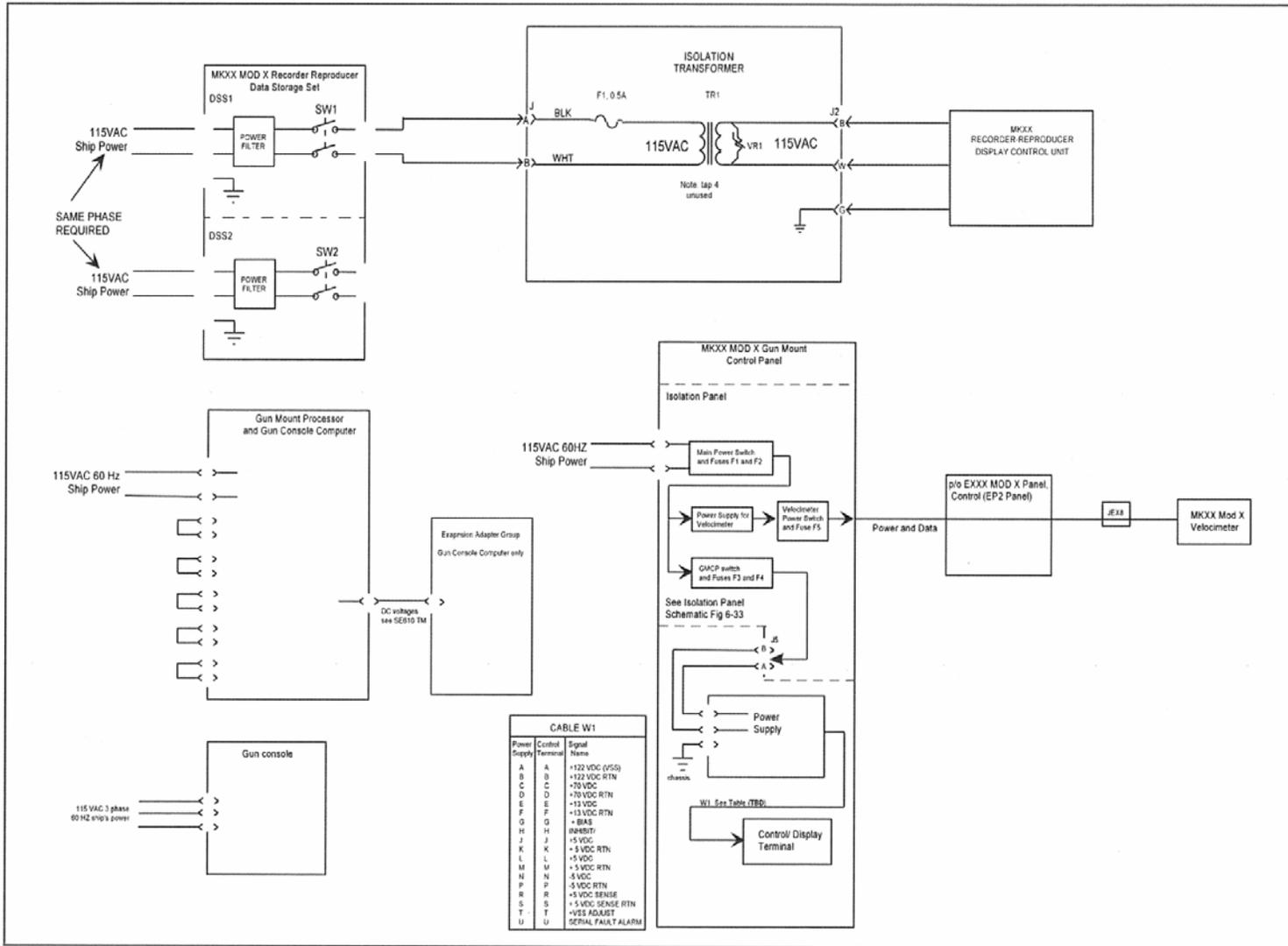
NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 8. FBD, secondary.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

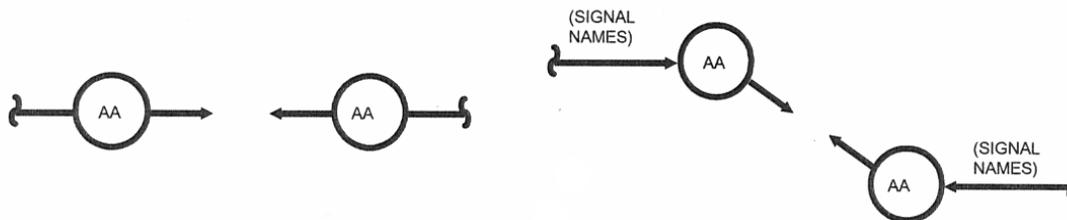
FIGURE 9. FBD, lowest level.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

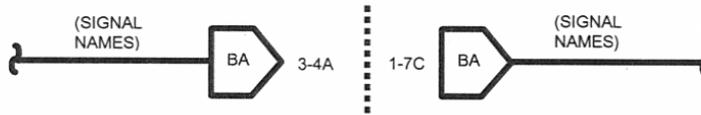
FIGURE 10. FBD, unit power.

MIL-DTL-24784D(NAVY)



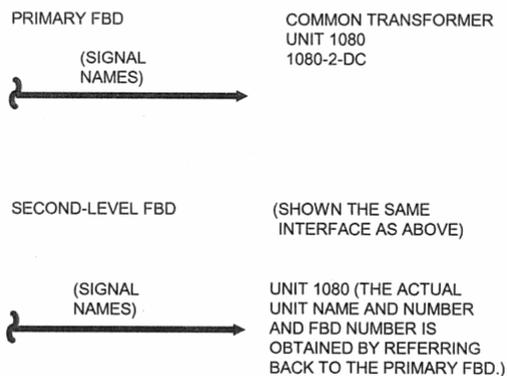
NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 11. Signal referencing on the same sheet.



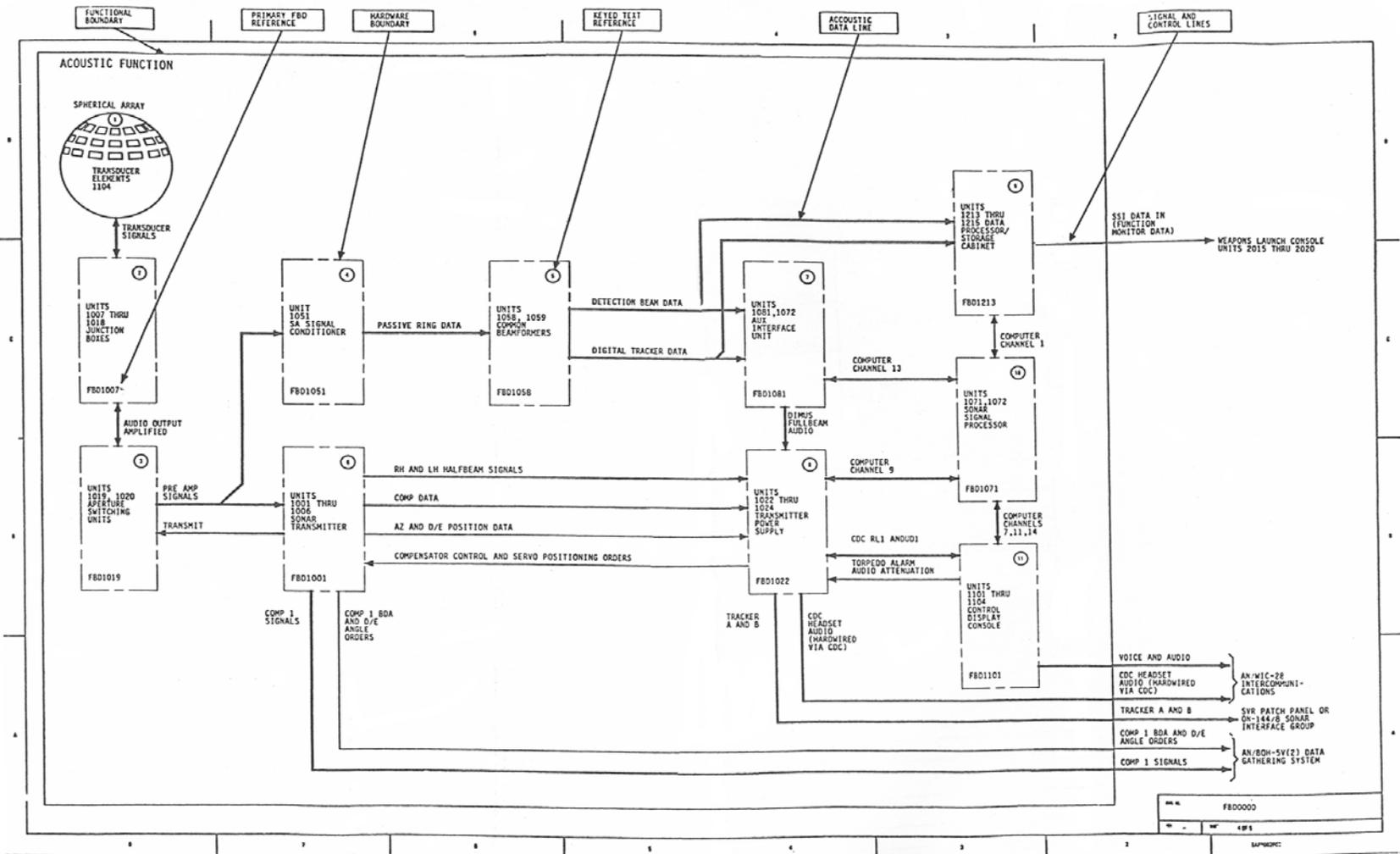
NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 12. FBD signal referencing between two or more functional parts.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 13. FBD reference between units.

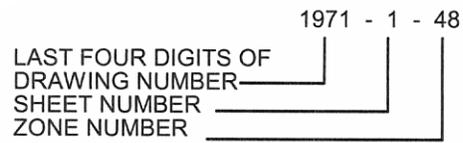


MIL-DTL-24784D(NAVY)

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

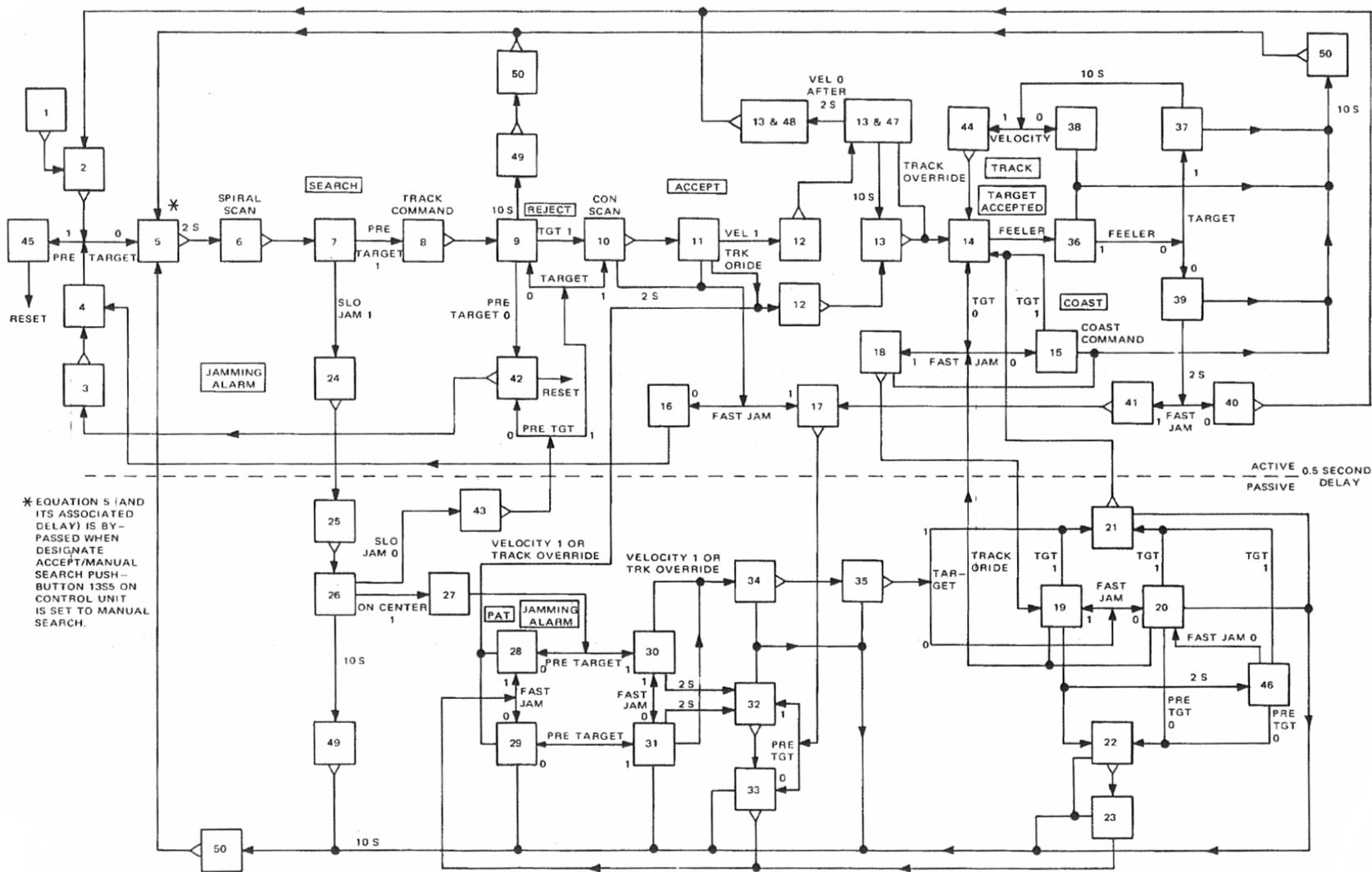
FIGURE 14. FBD master with reference to keyed text.

MIL-DTL-24784D(NAVY)



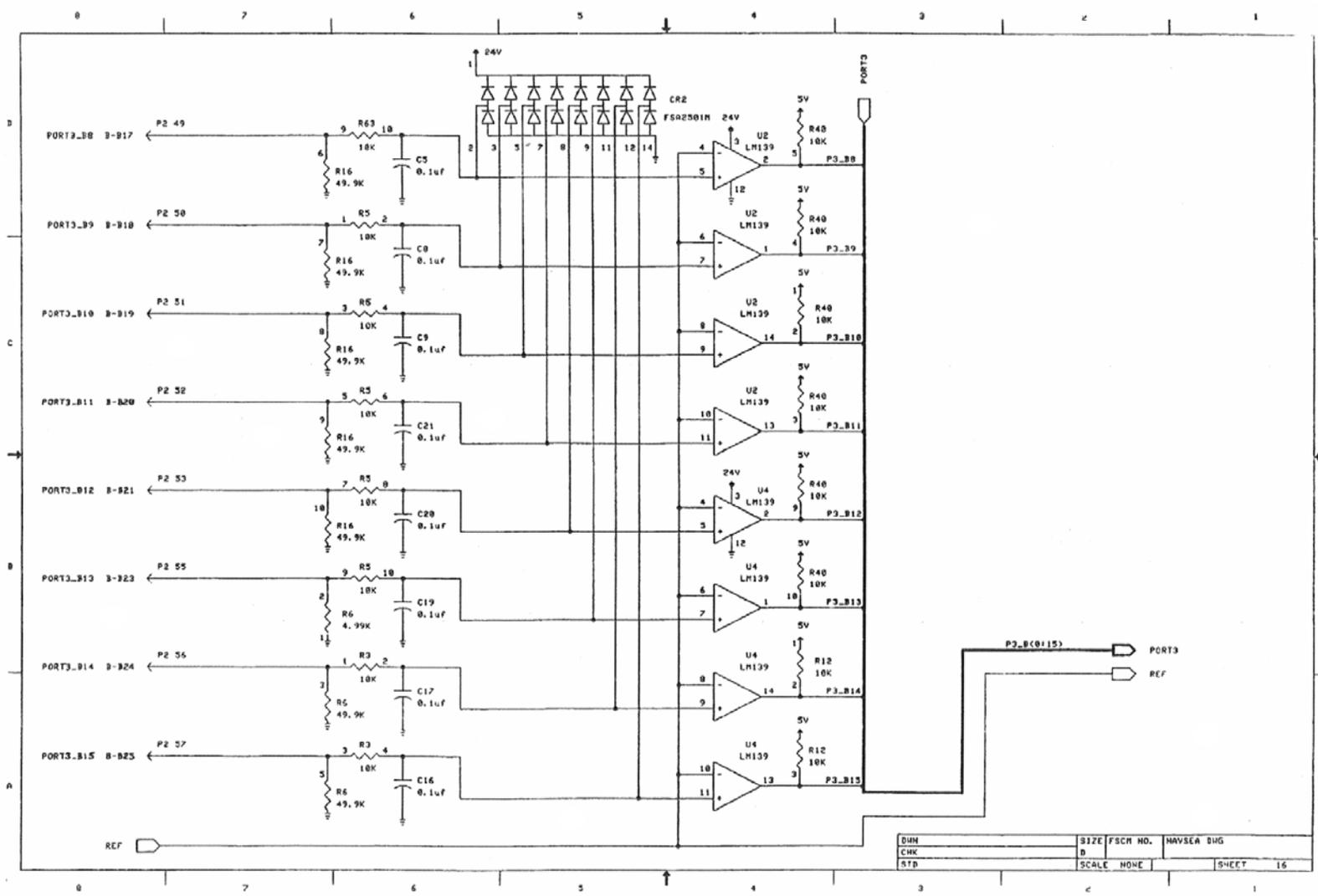
NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 15. Zone numbers.



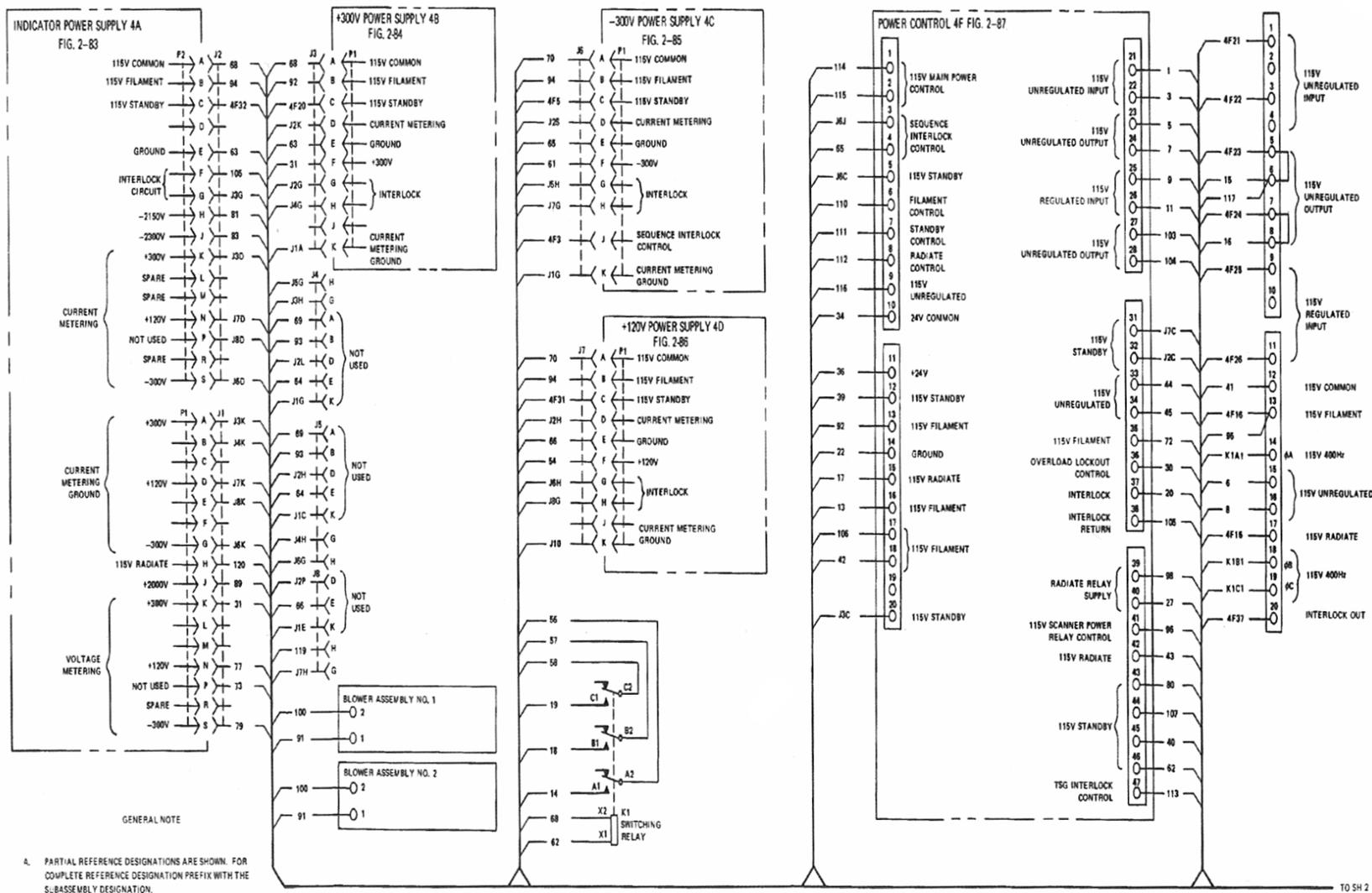
NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 16. FCD, analog logic.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 17. FCD, detailed.

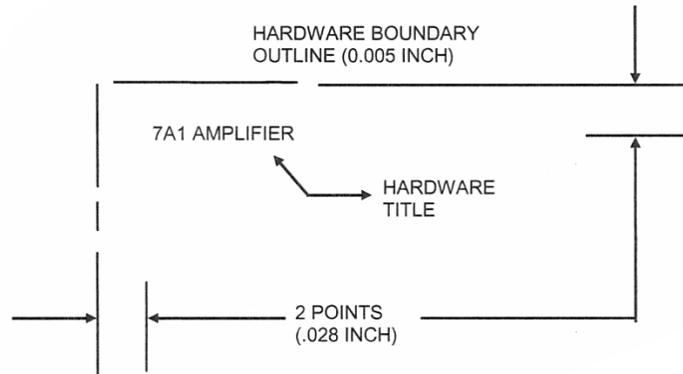


MIL-DTL-24784D(NAVY)

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

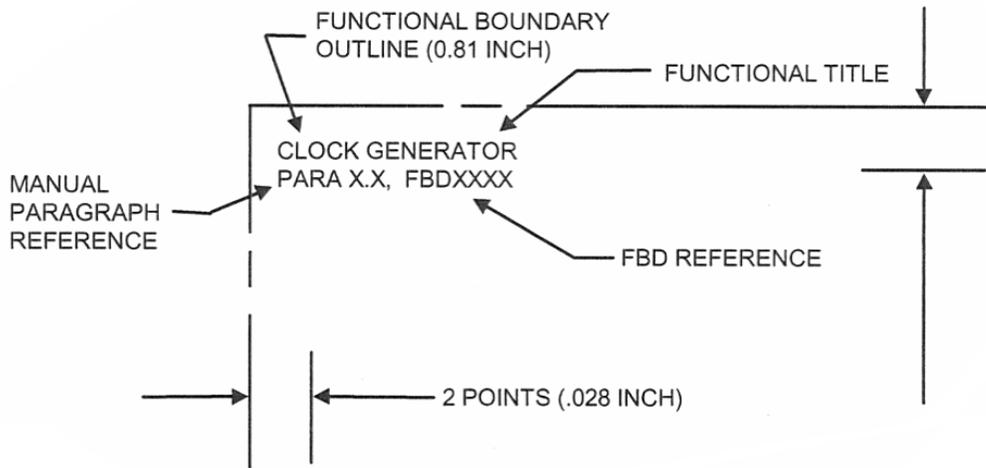
FIGURE 18. FCD, unit power and grounding.

MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

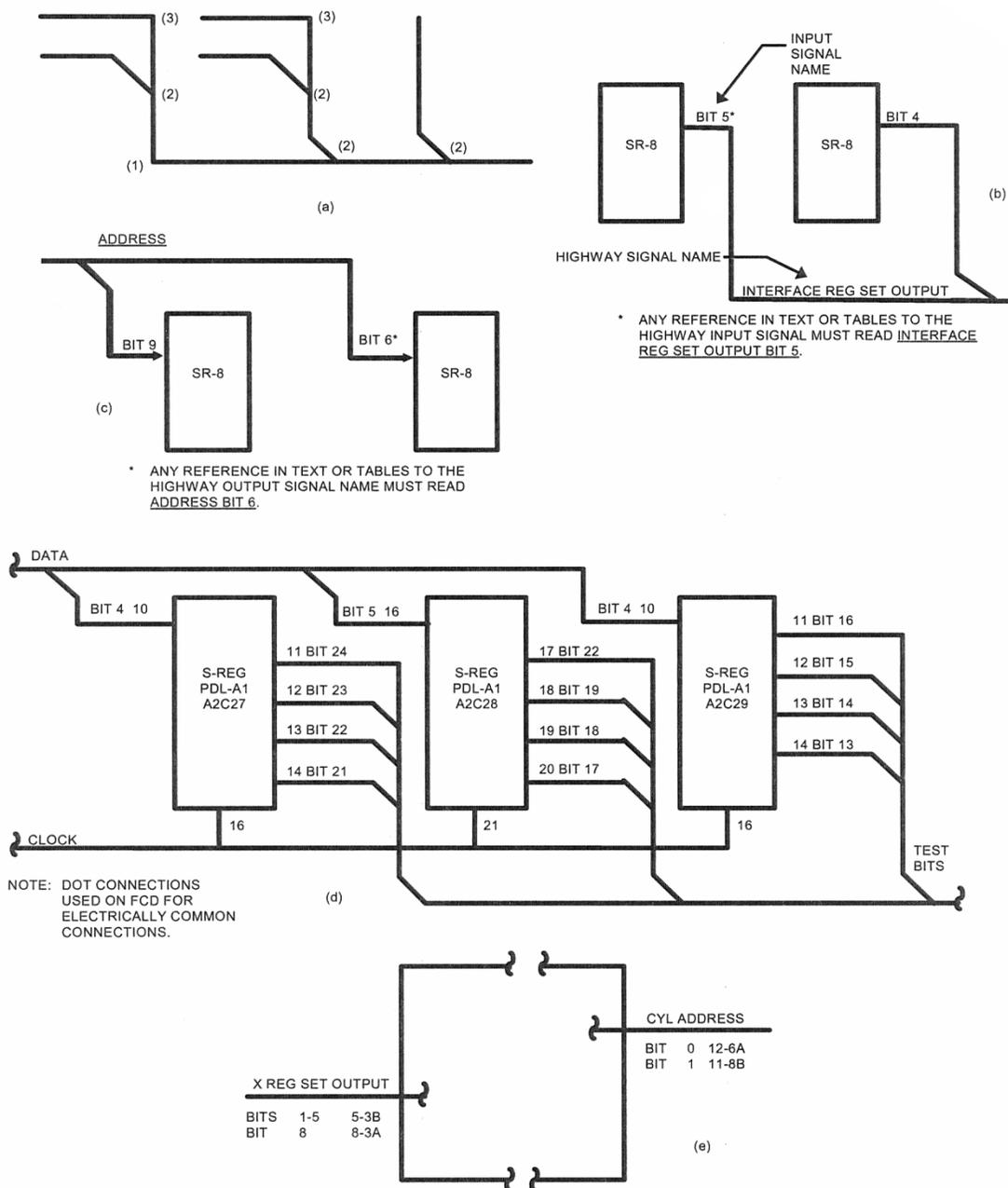
FIGURE 19. Hardware boundary.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 20. Functional boundary.

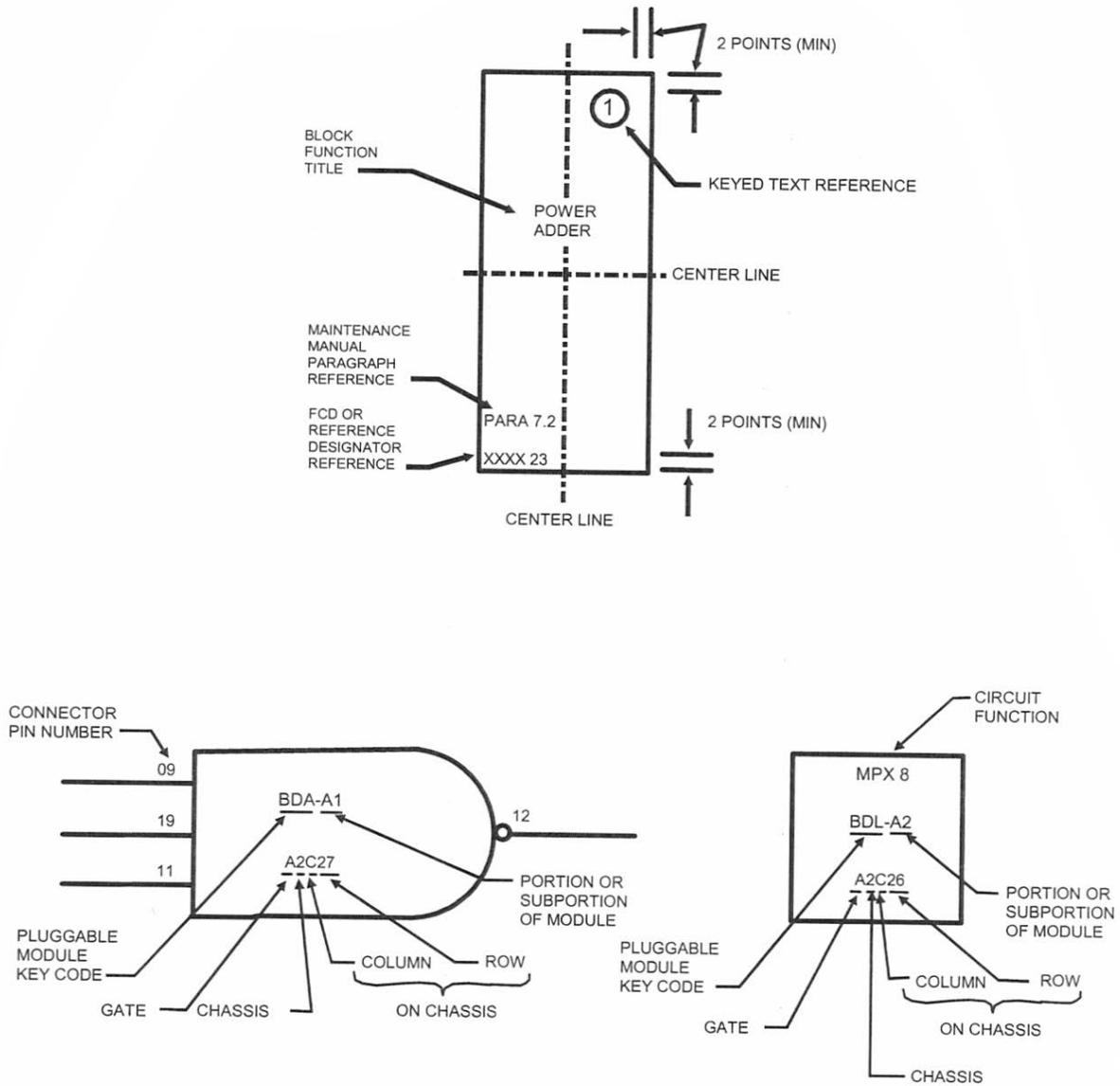
MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 21. Interconnecting lines.

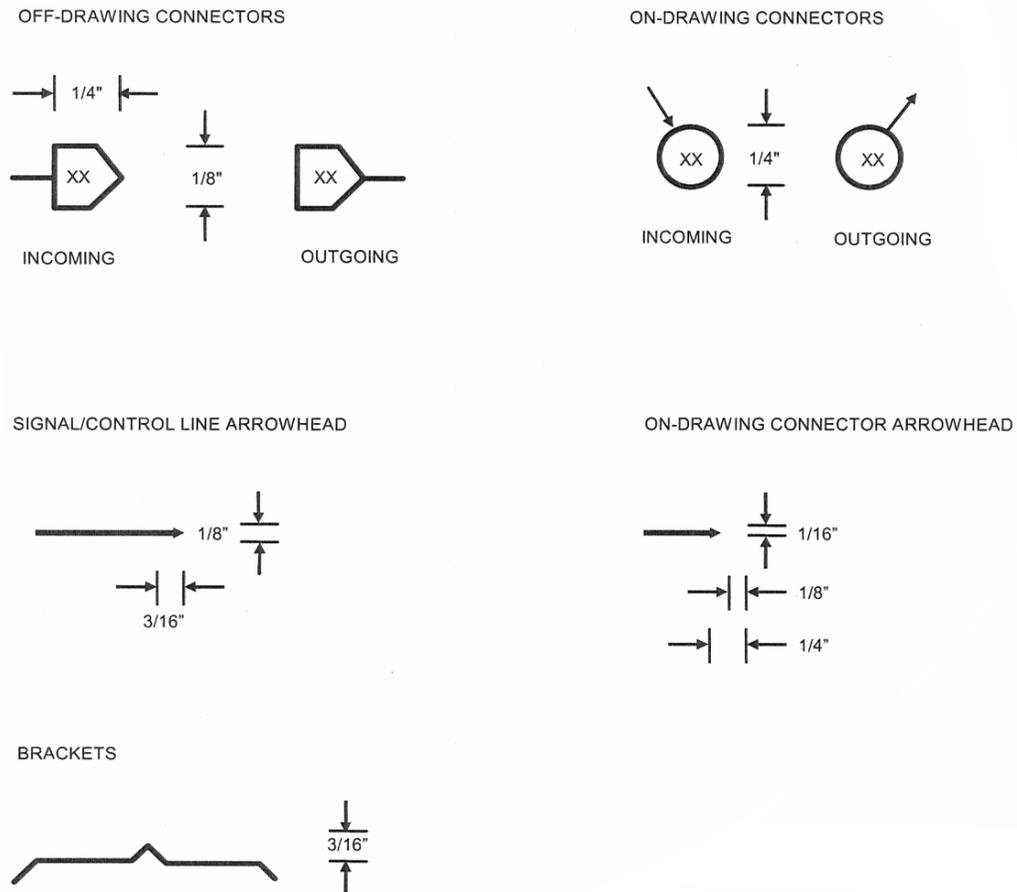
MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

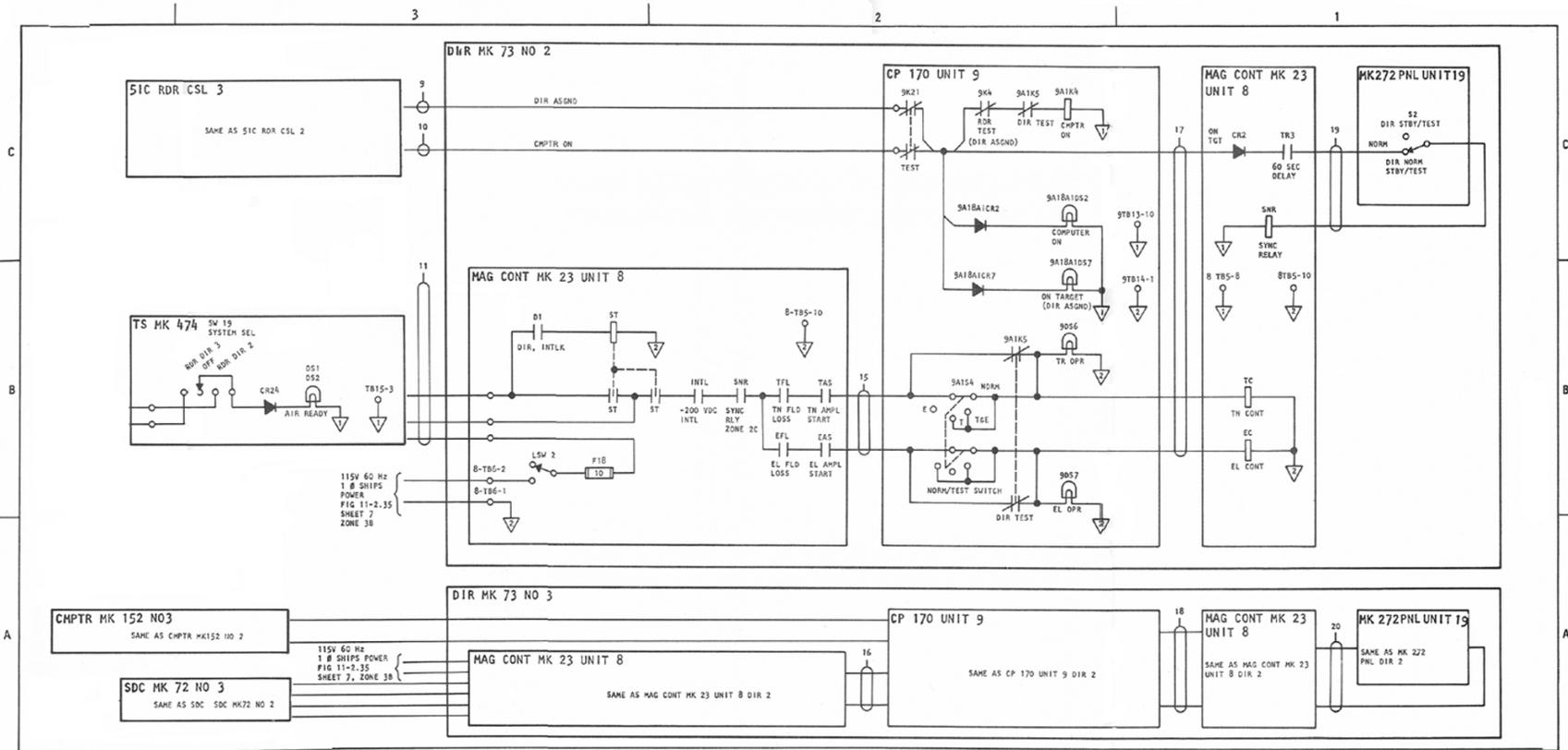
FIGURE 22. Symbols.

MIL-DTL-24784D(NAVY)



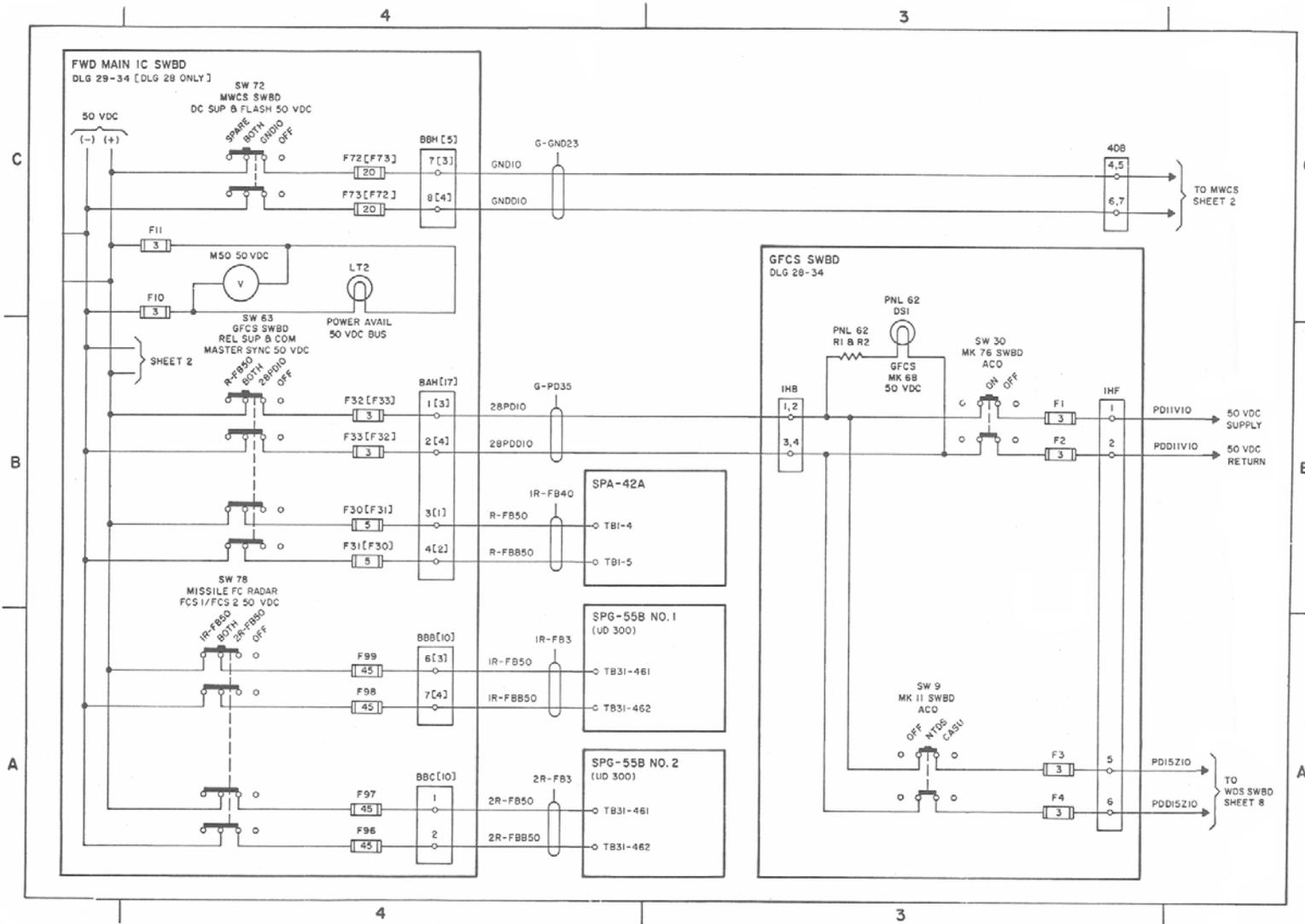
NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 23. On-drawing and off-drawing connectors and miscellaneous symbols.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 24. System functional diagram.

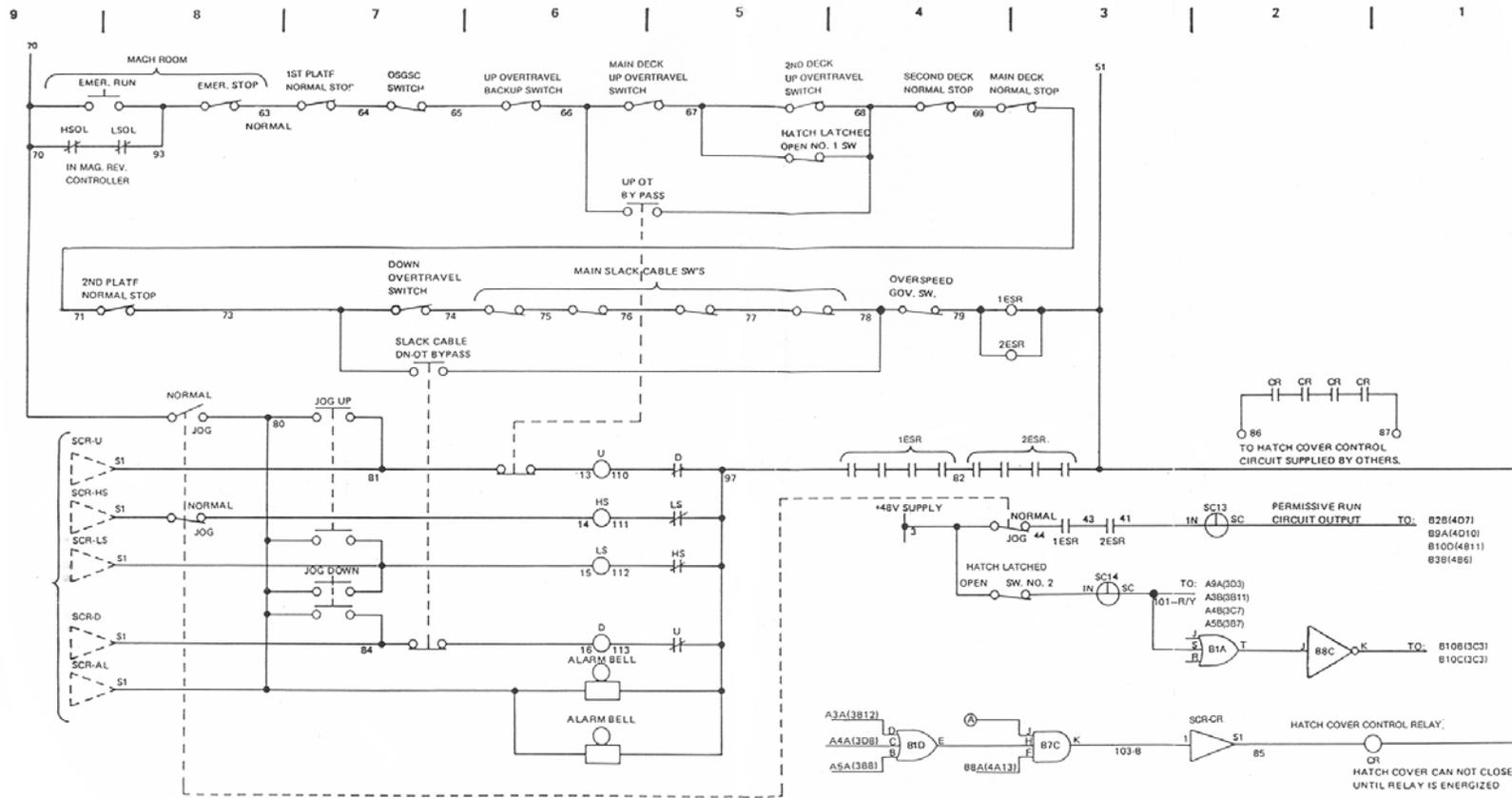


79

MIL-DTL-24784D(NAVY)

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

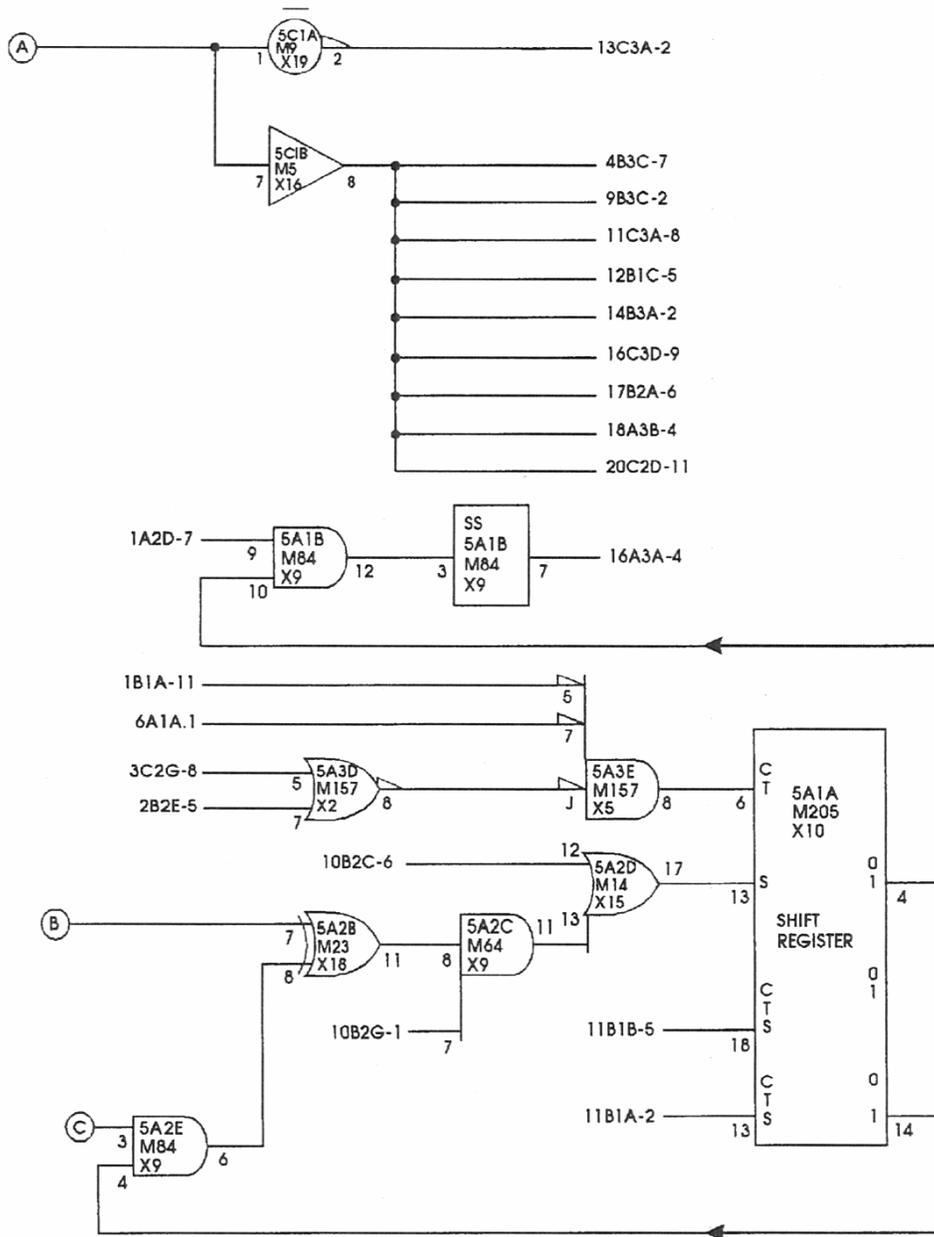
FIGURE 25. System functional diagram – power distribution.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 26. Control diagram.

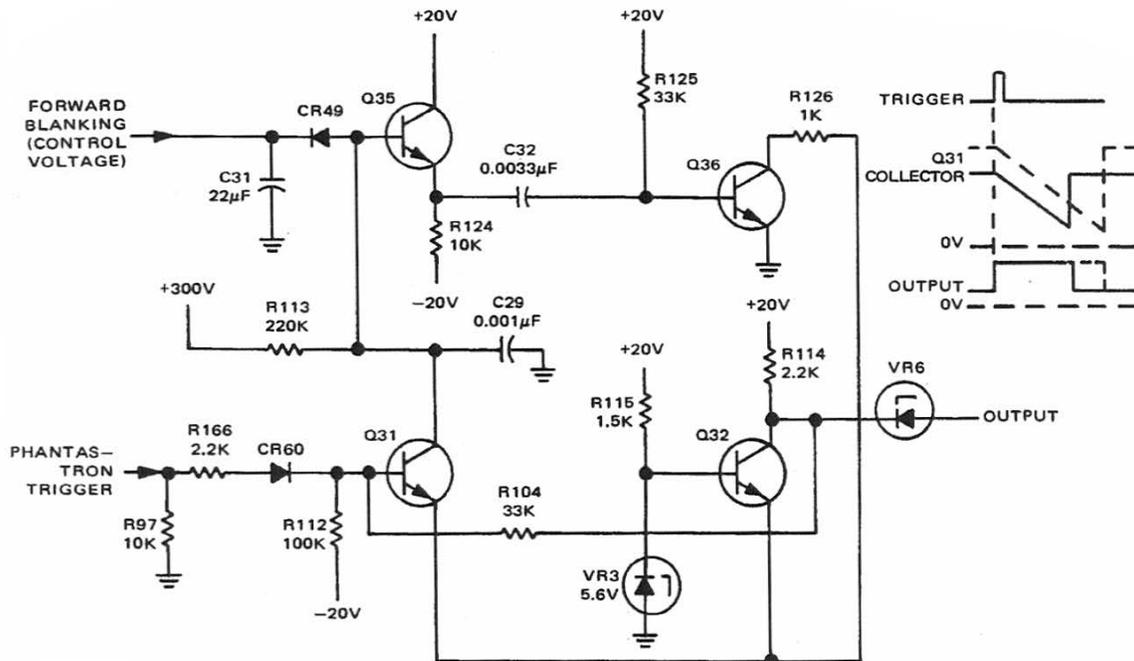
## MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 27. Logic diagram.

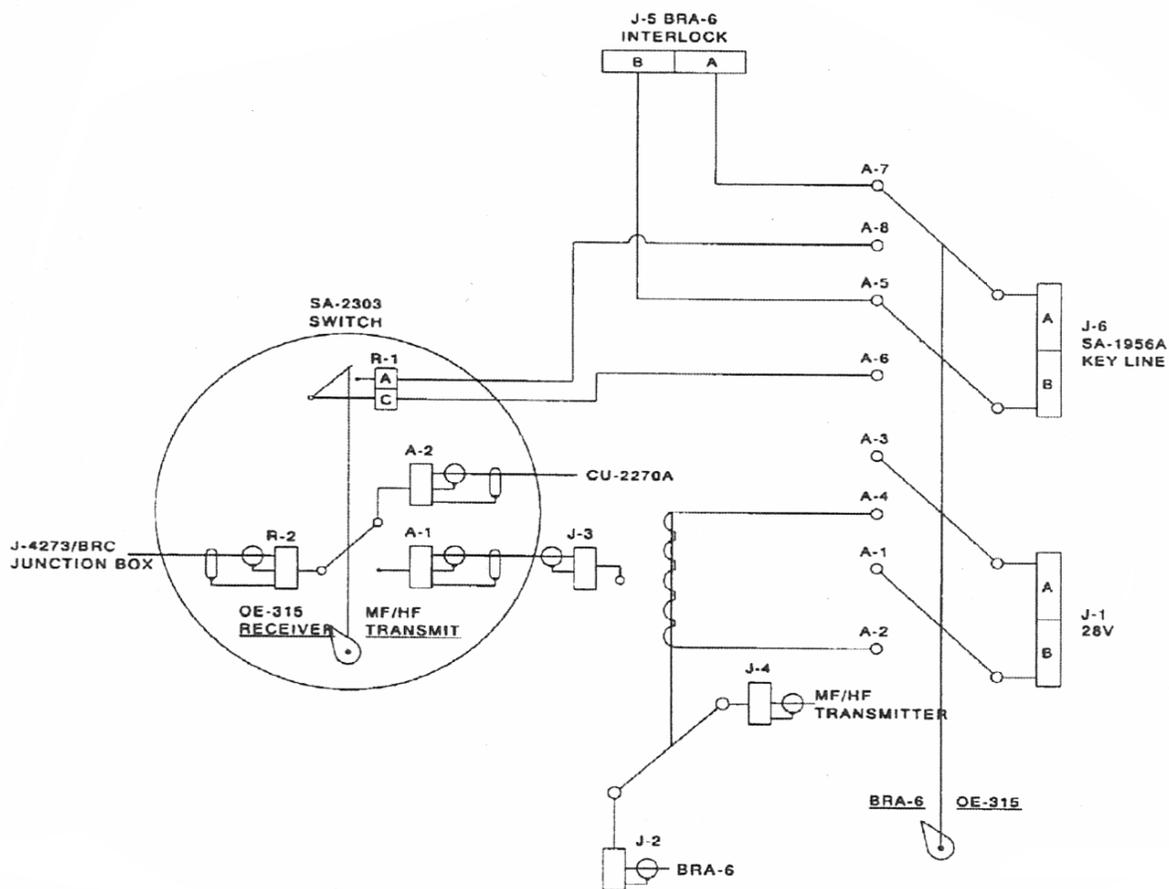
## MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 28. Maintenance schematic diagram.

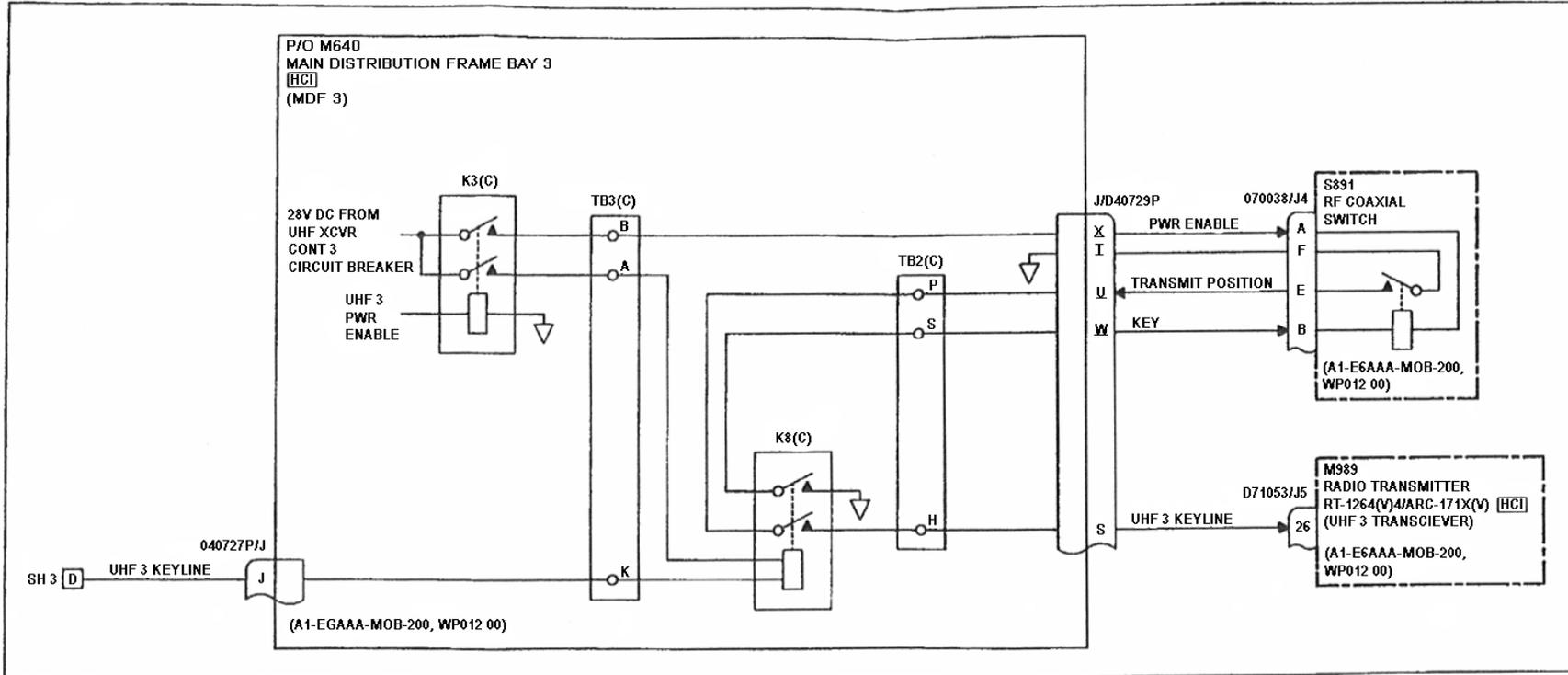
## MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 29. Simplified schematic diagram.

E43 R/T CABINET BAY 3

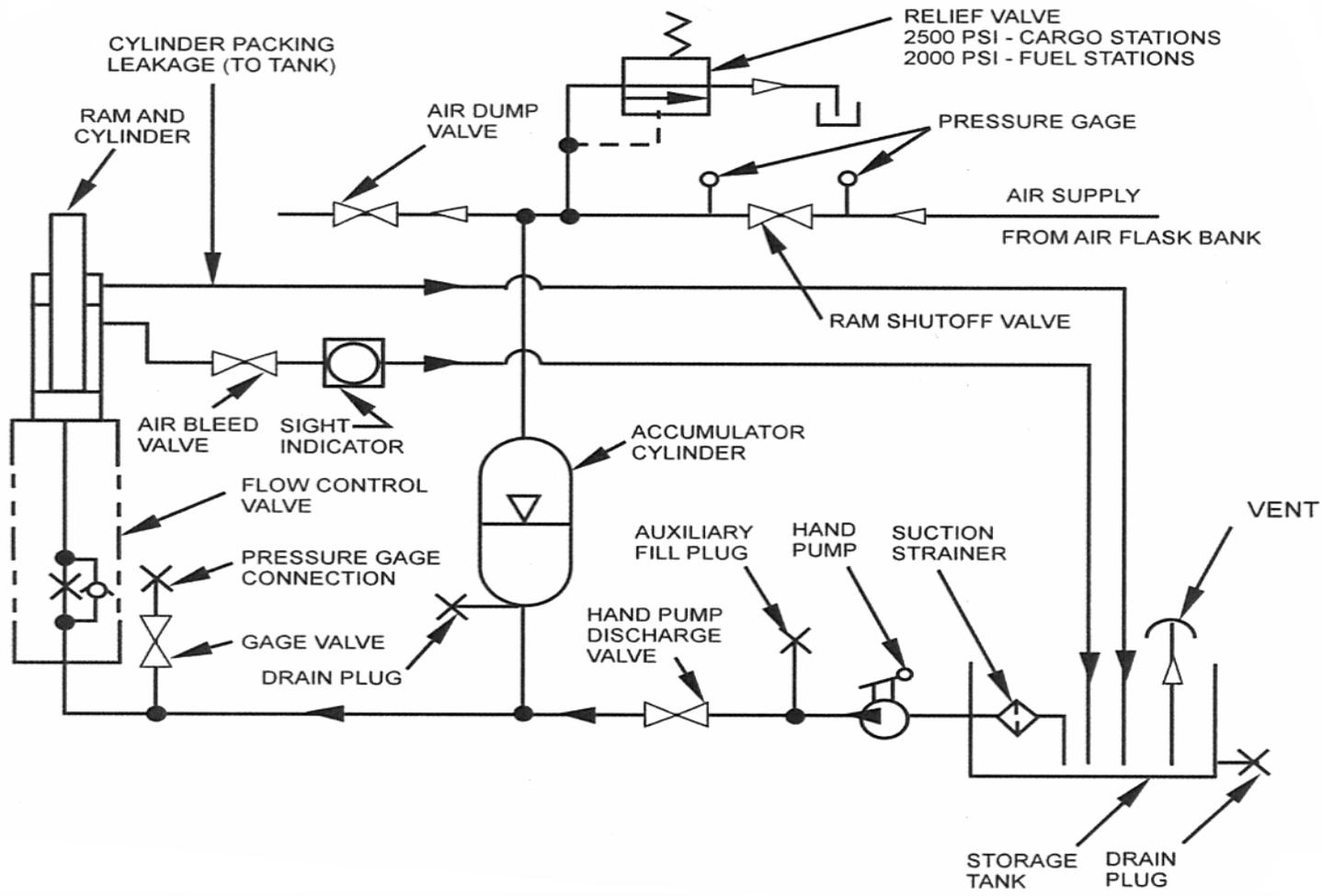


84

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 30. Functional schematic diagram.

MIL-DTL-24784D(NAVY)

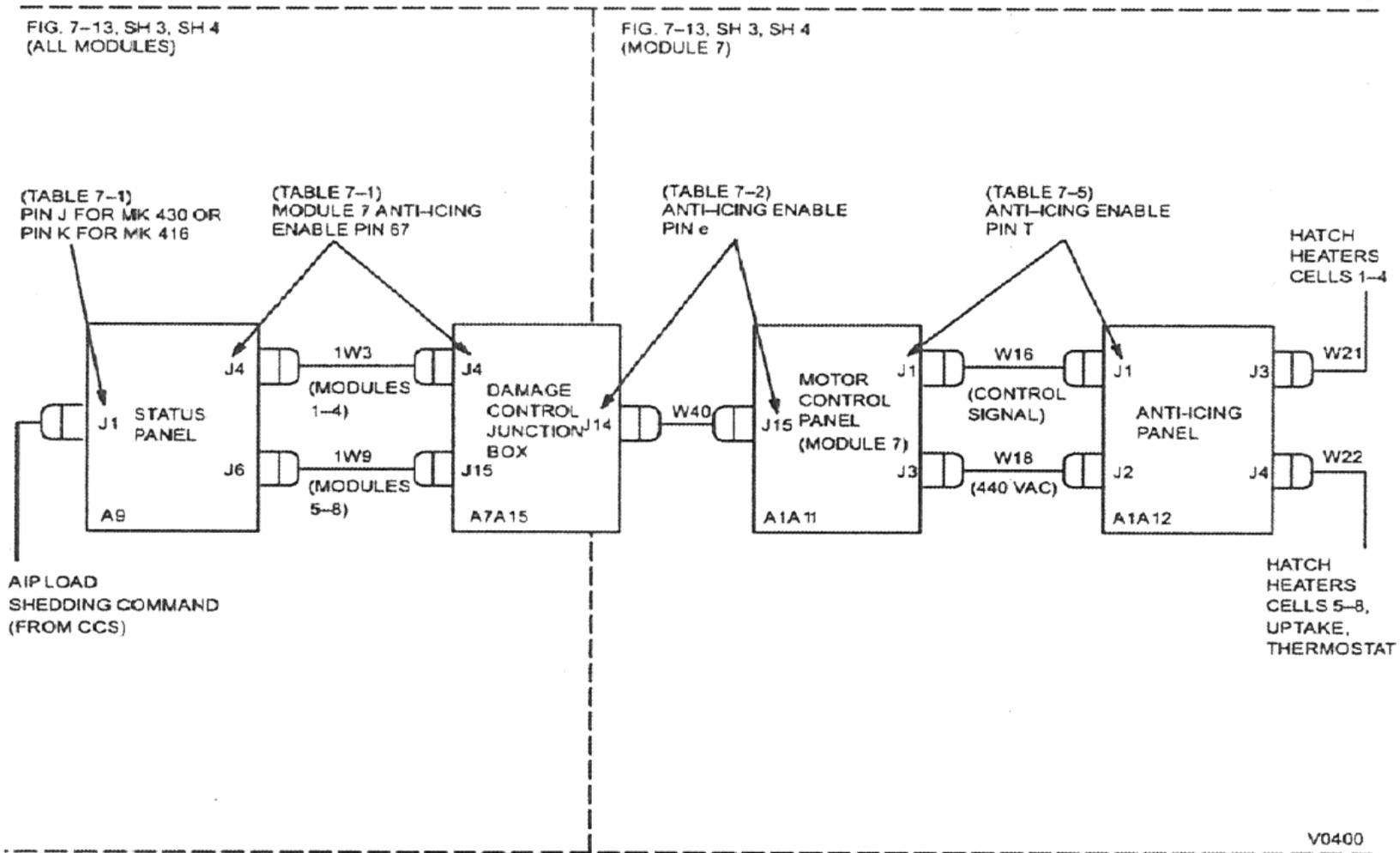


85

MIL-DTL-24784D(NAVY)

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 31. Pneumatic/hydraulic schematic.



98

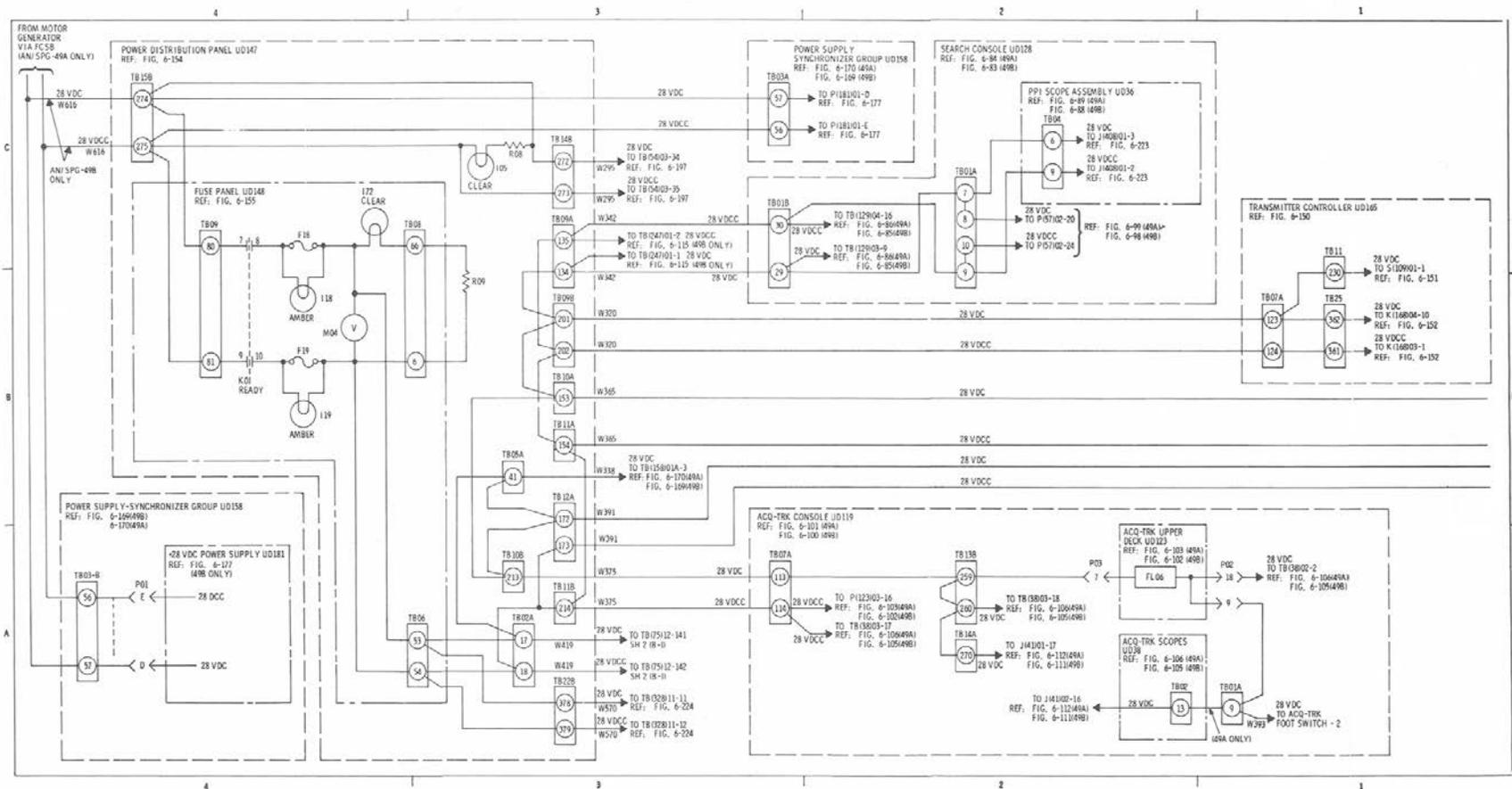
MIL-DTL-24784D(NAVY)

V0400

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 32. Single function diagram.



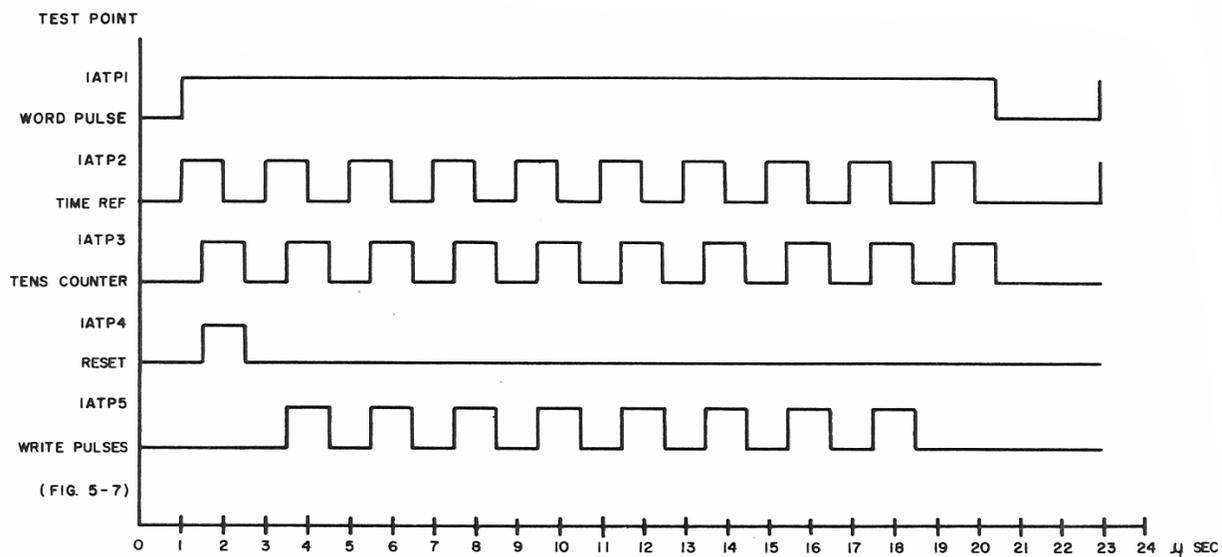


MIL-DTL-24784D(NAVY)

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

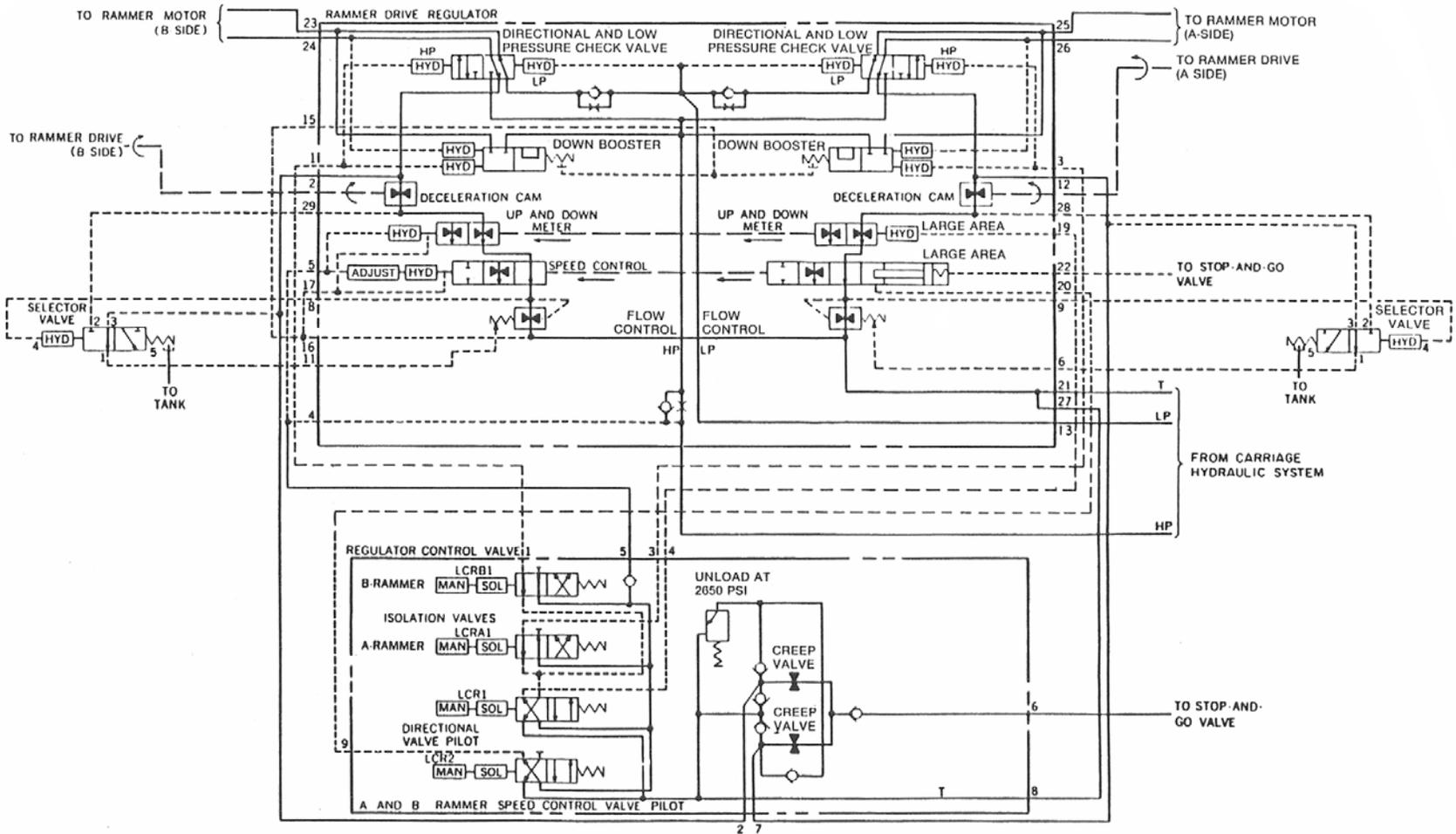
FIGURE 34. Power distribution diagram.

## MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

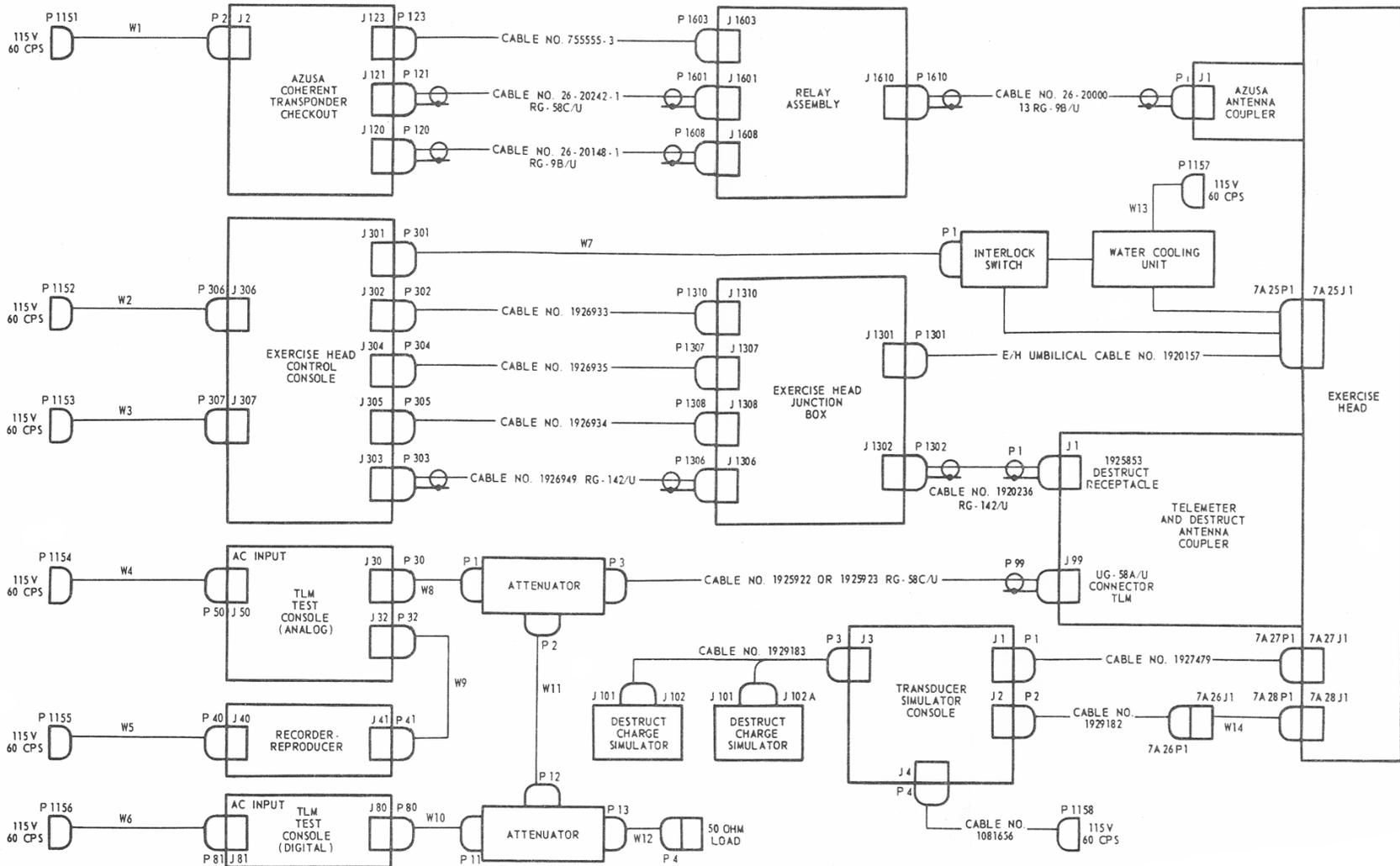
FIGURE 35. Timing circuits diagram.



90

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

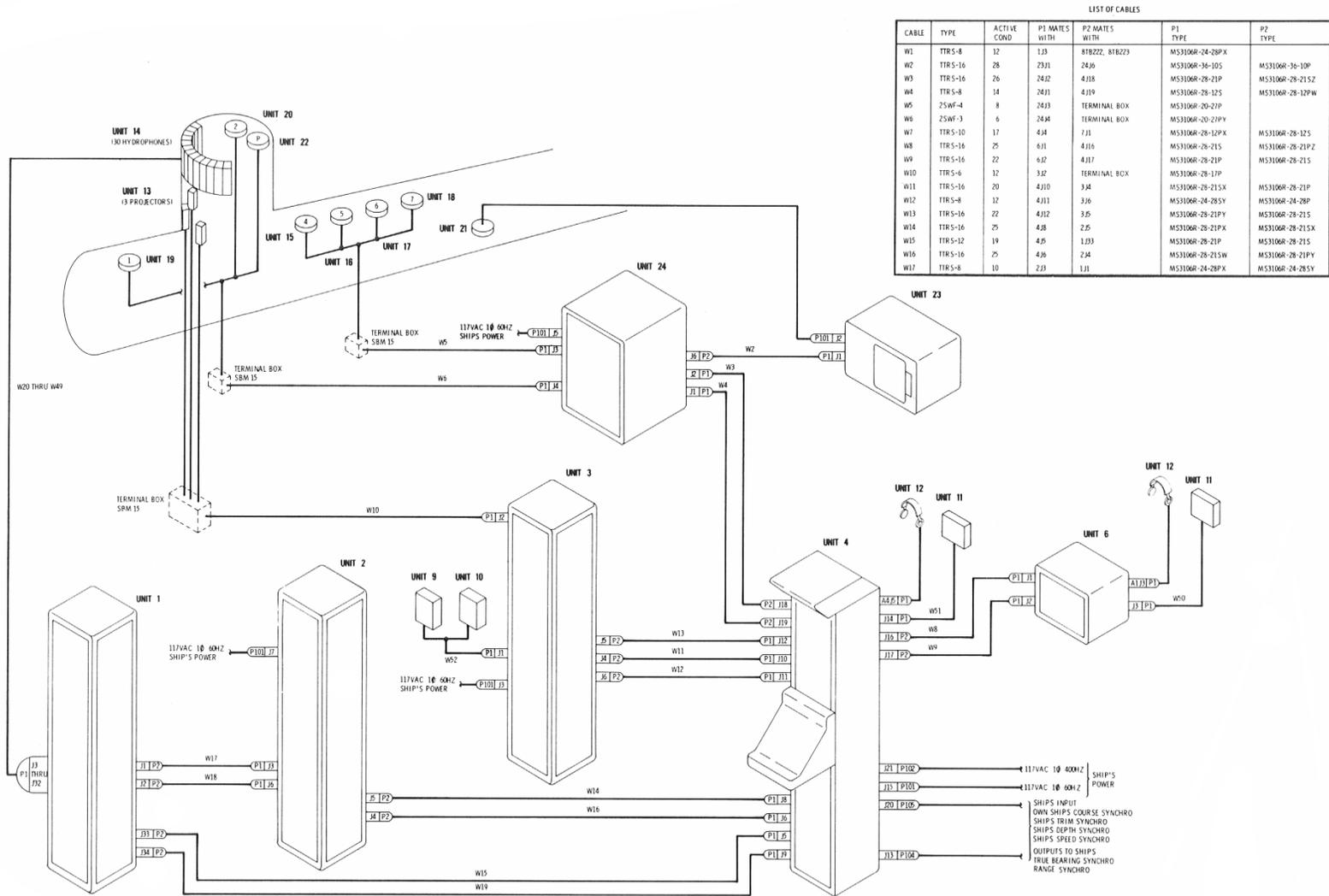
FIGURE 36. Piping diagram.



MIL-DTL-24784D(NAVY)

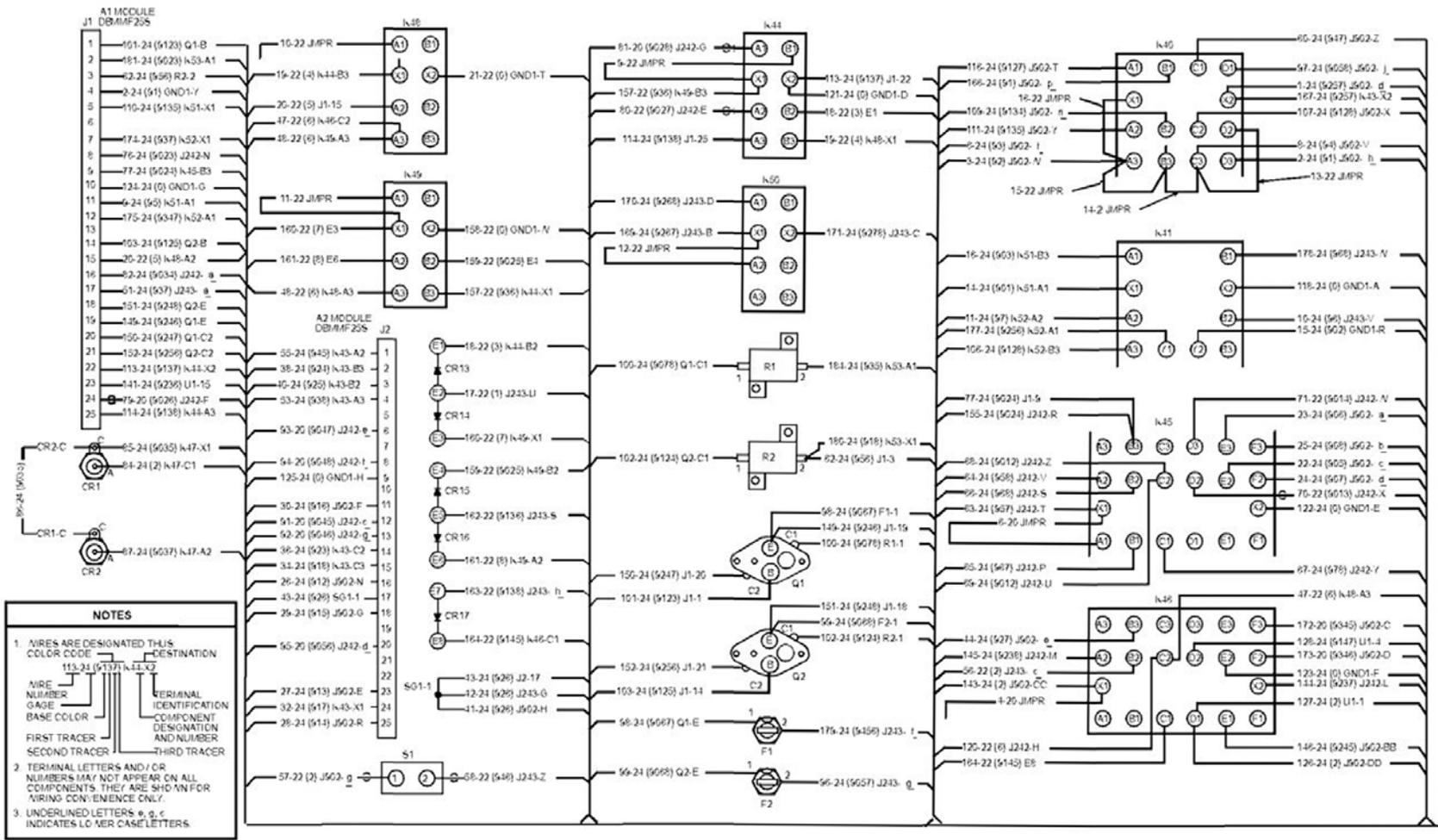
NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 37. Interconnection diagram, typical.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

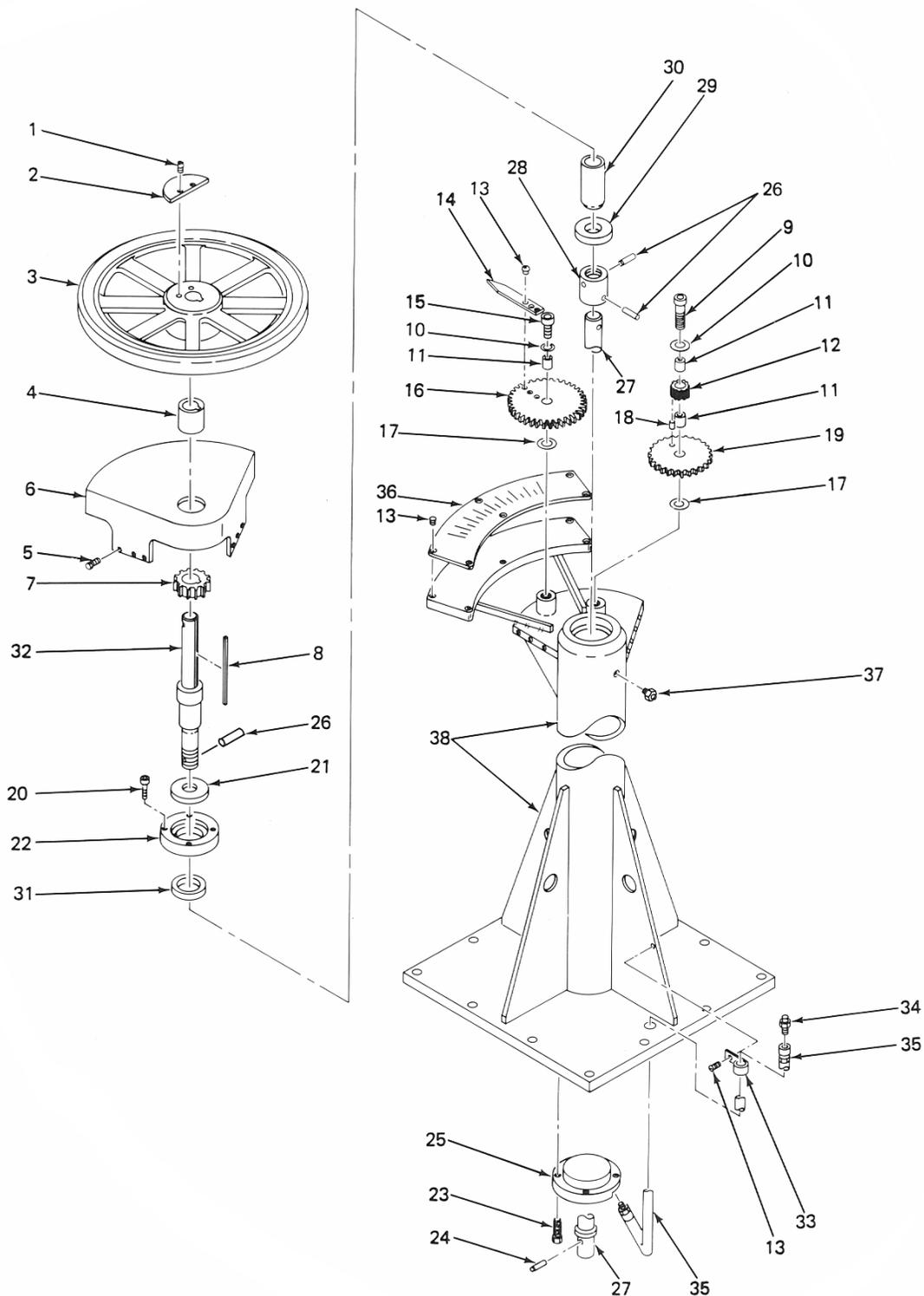
FIGURE 38. Interconnecting cable run/piping diagram.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 39. Wiring diagram.

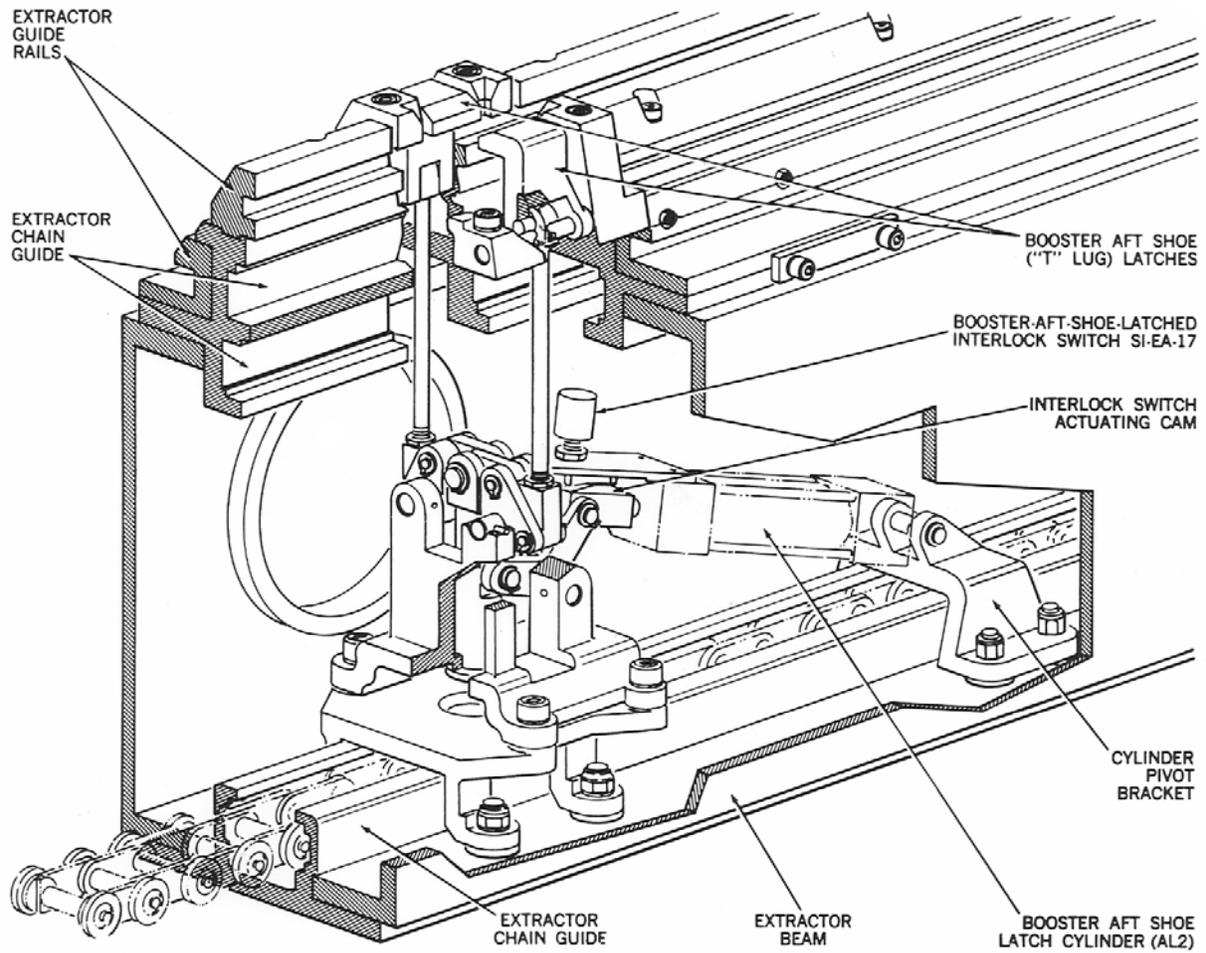
MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 40. Exploded view.

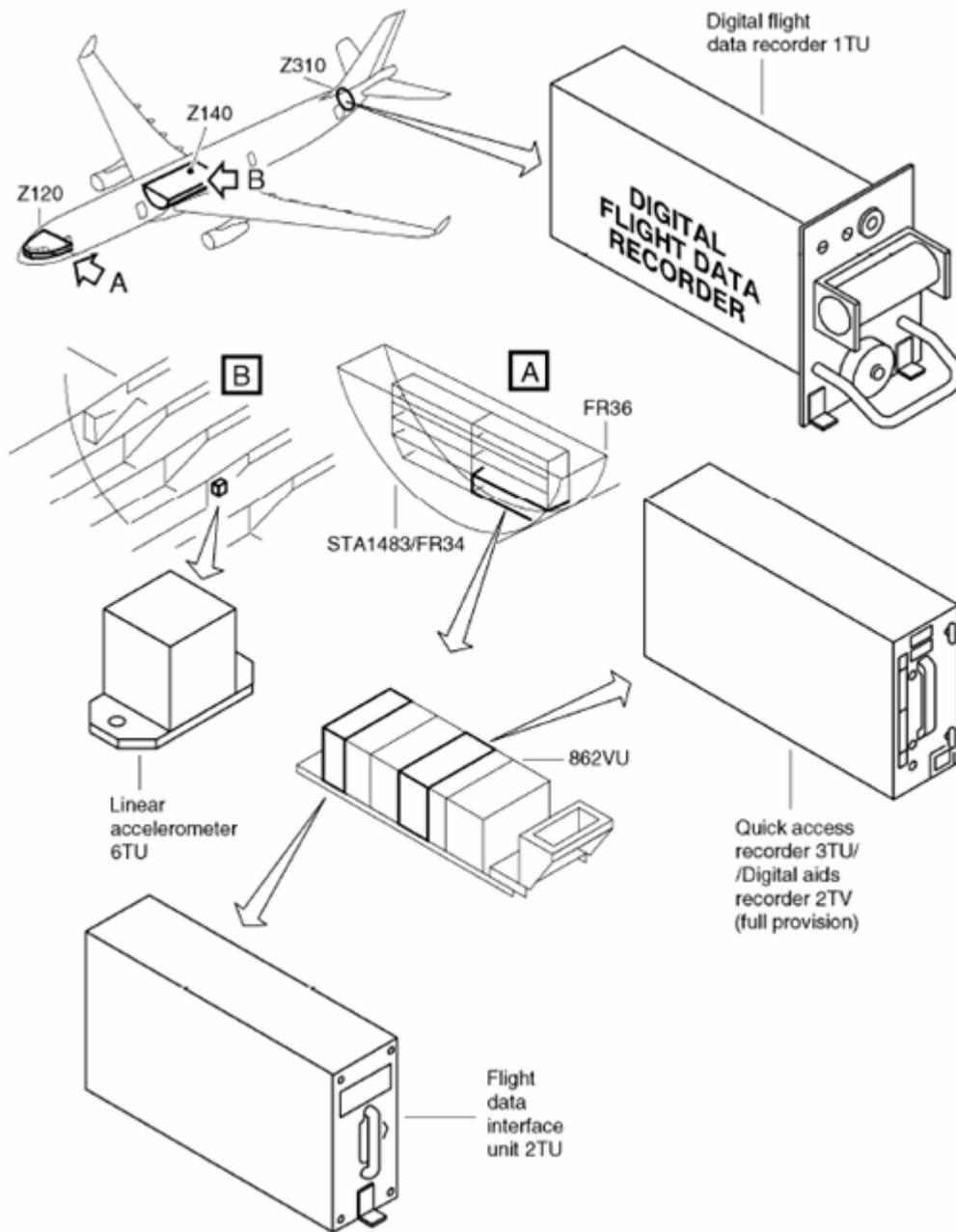
## MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 41. Sectional view.

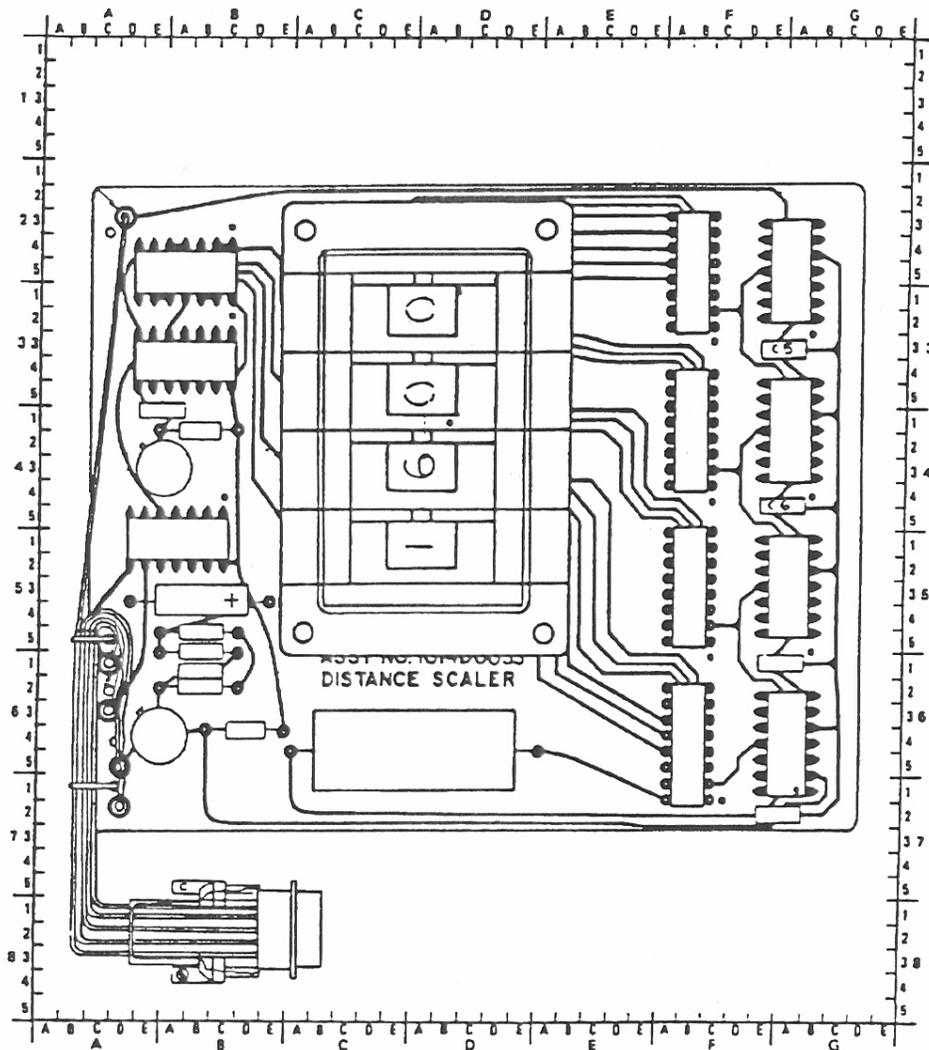
MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 42. Location drawing.

MIL-DTL-24784D(NAVY)

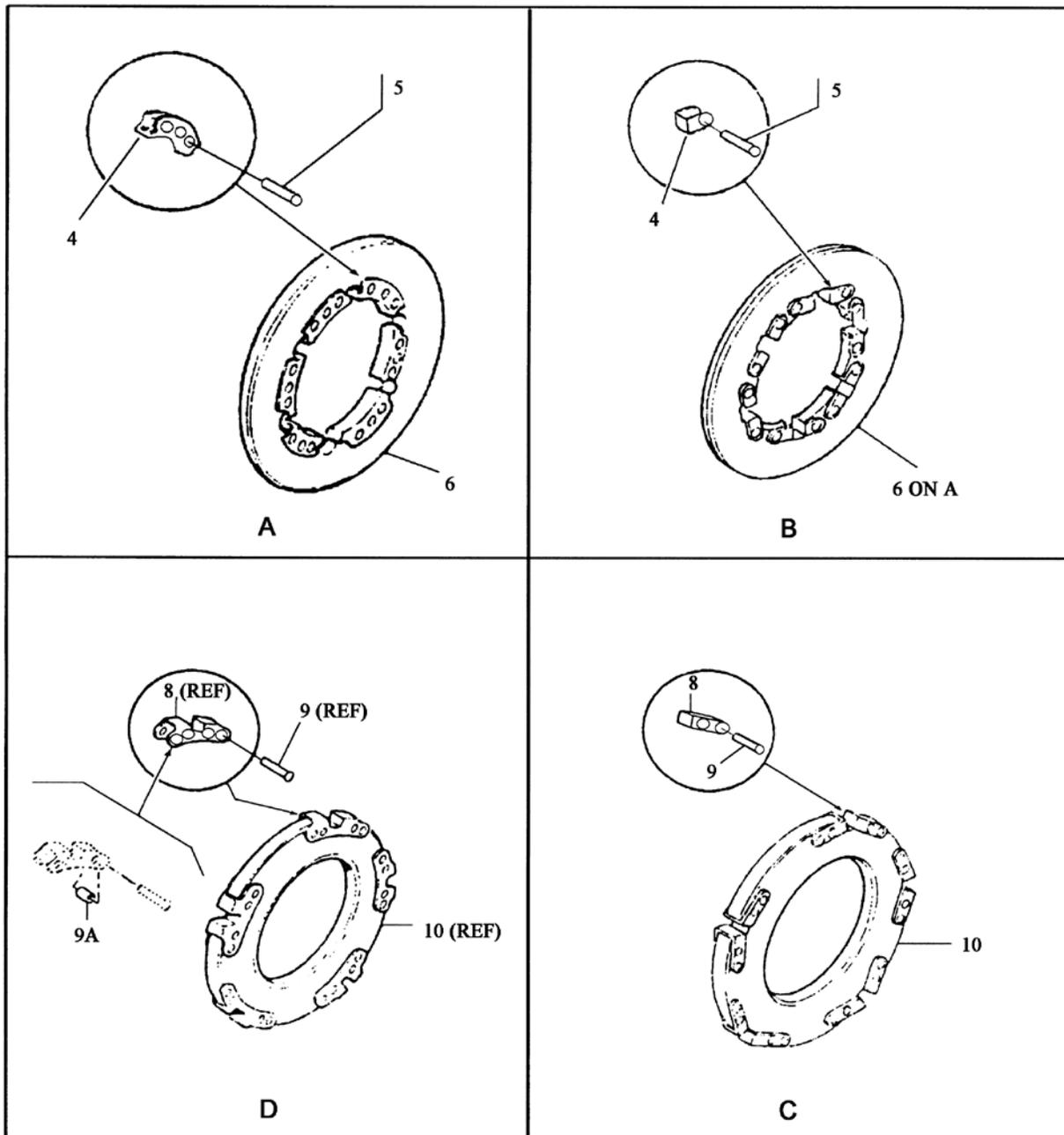


REF DESIG	LOCATING COORD	NAME AND DESCRIPTION
C1	B.B/5.2	CAPACITOR: 15 uf, 20%, 20V, MIL TYPE M39003/01-2050
C2	D.A/6.4	CAPACITOR: 0.1 uf, 10%, 50V, MIL TYPE CH09A1RA1D4K
C3	B.B/6.1	CAPACITOR: 0.01 uf, 20%, 200V, MIL TYPE CK06CW103M
C4	A.E/4.1	SAME AS C3
C5	F.E/3.3	SAME AS C3
C6	F.E/4.2	SAME AS C3
C7	F.E/6.1	SAME AS C3
C8	F.E/7.2	SAME AS C3
E1	A.C/2.3	TERMINAL: MIL TYPE 55155
E2	A.C/6.1	SAME AS E1
E3	A.C/6.3	SAME AS E1
E4	A.D/6.5	SAME AS E1
E5	A.D/7.2	SAME AS E1
P4	B.E/3.2	CONNECTOR: MIL TYPE M53106A14S-6P
Q1	A.E/5.4	TRANSISTOR: MIL TYPE JAN2N2222
Q2	A.E/4.3	SAME AS Q1

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 43. Printed circuit board, typical.

MIL-DTL-24784D(NAVY)



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE 44. Multisection illustration.

## MIL-DTL-24784D(NAVY)

990033 R: 153 G: 000 B: 051	FF3366 R: 255 G: 051 B: 102	CC0033 R: 204 G: 000 B: 051	FF0033 R: 255 G: 000 B: 051	FF9999 R: 255 G: 153 B: 153	CC3366 R: 204 G: 051 B: 102	FFCCFF R: 255 G: 204 B: 255	CC6699 R: 204 G: 051 B: 153	993366 R: 153 G: 051 B: 102	660033 R: 102 G: 000 B: 051	CC3399 R: 204 G: 051 B: 153	FF99CC R: 255 G: 153 B: 204	FF66CC R: 255 G: 102 B: 204	FF99FF R: 255 G: 153 B: 255	FF6699 R: 255 G: 102 B: 153	CC0066 R: 204 G: 000 B: 102
FF0066 R: 255 G: 000 B: 102	FF3399 R: 255 G: 051 B: 153	FF0099 R: 255 G: 000 B: 153	FF33CC R: 255 G: 051 B: 204	FF00CC R: 255 G: 000 B: 204	FF66FF R: 255 G: 102 B: 255	FF33FF R: 255 G: 051 B: 255	FF00FF R: 255 G: 000 B: 255	CC0099 R: 204 G: 000 B: 153	990066 R: 153 G: 000 B: 102	CC66CC R: 204 G: 102 B: 204	CC33CC R: 204 G: 051 B: 204	CC99FF R: 204 G: 153 B: 255	CC66FF R: 204 G: 102 B: 255	CC33FF R: 204 G: 051 B: 255	993399 R: 153 G: 051 B: 153
CC00CC R: 204 G: 000 B: 204	CC00FF R: 204 G: 255 B: 255	9900CC R: 153 G: 000 B: 204	990099 R: 153 G: 000 B: 153	CC99CC R: 204 G: 153 B: 204	996699 R: 153 G: 102 B: 153	663366 R: 153 G: 051 B: 102	660099 R: 102 G: 000 B: 153	9933CC R: 153 G: 051 B: 204	660066 R: 102 G: 000 B: 102	9900FF R: 153 G: 000 B: 255	9933FF R: 153 G: 051 B: 255	9966CC R: 153 G: 102 B: 204	330033 R: 051 G: 000 B: 051	663399 R: 102 G: 051 B: 153	6633CC R: 102 G: 051 B: 204
6600CC R: 102 G: 000 B: 204	9966FF R: 153 G: 102 B: 255	330066 R: 051 G: 000 B: 102	6600FF R: 102 G: 000 B: 255	6633FF R: 102 G: 051 B: 255	CCCCFF R: 204 G: 204 B: 255	9999FF R: 153 G: 153 B: 255	9999CC R: 153 G: 153 B: 204	6666CC R: 102 G: 102 B: 204	6666FF R: 102 G: 102 B: 255	666699 R: 102 G: 102 B: 153	333366 R: 051 G: 051 B: 204	333399 R: 051 G: 051 B: 153	330099 R: 051 G: 000 B: 153	3300CC R: 051 G: 000 B: 204	3300FF R: 051 G: 000 B: 255
3333FF R: 051 G: 051 B: 255	3333CC R: 051 G: 051 B: 204	0066FF R: 000 G: 102 B: 255	0033FF R: 000 G: 051 B: 255	3366FF R: 051 G: 102 B: 255	3366CC R: 051 G: 102 B: 204	000066 R: 000 G: 000 B: 102	000033 R: 000 G: 000 B: 051	0000FF R: 000 G: 000 B: 255	000099 R: 000 G: 000 B: 153	0033CC R: 000 G: 051 B: 204	0000CC R: 000 G: 000 B: 204	336699 R: 051 G: 102 B: 153	0066CC R: 000 G: 102 B: 204	99CCFF R: 153 G: 204 B: 255	6699FF R: 102 G: 153 B: 255
003366 R: 102 G: 051 B: 102	6699CC R: 102 G: 153 B: 204	006699 R: 000 G: 102 B: 153	3399CC R: 051 G: 153 B: 204	0099CC R: 000 G: 153 B: 204	66CCFF R: 102 G: 204 B: 255	3399FF R: 051 G: 153 B: 255	003399 R: 000 G: 051 B: 153	0099FF R: 000 G: 153 B: 255	33CCFF R: 051 G: 204 B: 255	00CCFF R: 000 G: 204 B: 255	99FFFF R: 153 G: 255 B: 255	66FFFF R: 102 G: 255 B: 255	33FFFF R: 051 G: 255 B: 255	00FFFF R: 000 G: 255 B: 255	00CCCC R: 000 G: 204 B: 204
009999 R: 000 G: 153 B: 153	669999 R: 102 G: 153 B: 153	99CCCC R: 153 G: 204 B: 204	CCFFFF R: 204 G: 255 B: 255	33CCCC R: 051 G: 204 B: 204	66CCCC R: 102 G: 204 B: 204	339999 R: 051 G: 153 B: 153	336666 R: 051 G: 102 B: 102	006666 R: 000 G: 102 B: 102	003333 R: 000 G: 051 B: 051	00FFCC R: 000 G: 255 B: 204	33FFCC R: 051 G: 255 B: 204	33CC99 R: 051 G: 204 B: 153	00CC99 R: 000 G: 204 B: 153	66FFCC R: 102 G: 255 B: 204	99FFCC R: 153 G: 255 B: 204
00FF99 R: 000 G: 255 B: 153	339966 R: 051 G: 153 B: 102	006633 R: 000 G: 102 B: 051	336633 R: 051 G: 102 B: 051	669966 R: 102 G: 153 B: 102	66CC66 R: 102 G: 204 B: 102	99FF99 R: 153 G: 255 B: 153	66FF66 R: 102 G: 255 B: 102	339933 R: 051 G: 153 B: 051	99CC99 R: 153 G: 204 B: 153	66FF99 R: 102 G: 255 B: 153	33FF99 R: 051 G: 255 B: 153	33CC66 R: 051 G: 204 B: 102	00CC66 R: 000 G: 204 B: 102	66CC99 R: 102 G: 255 B: 153	009966 R: 000 G: 153 B: 102
009933 R: 000 G: 153 B: 051	33FF66 R: 051 G: 255 B: 102	00FF66 R: 000 G: 255 B: 102	CCFFCC R: 204 G: 255 B: 204	CCFF99 R: 204 G: 255 B: 153	99FF66 R: 153 G: 255 B: 102	99FF33 R: 153 G: 255 B: 051	00FF33 R: 000 G: 255 B: 051	33FF33 R: 051 G: 255 B: 051	00CC33 R: 000 G: 204 B: 051	33CC33 R: 051 G: 204 B: 051	66FF33 R: 102 G: 255 B: 051	00FF00 R: 000 G: 255 B: 000	66CC33 R: 102 G: 204 B: 051	006600 R: 000 G: 102 B: 000	003300 R: 000 G: 051 B: 000
009900 R: 000 G: 153 B: 000	33FF00 R: 051 G: 255 B: 000	66FF00 R: 102 G: 255 B: 000	99FF00 R: 153 G: 255 B: 000	66CC00 R: 102 G: 204 B: 000	00CC00 R: 000 G: 204 B: 000	33CC00 R: 051 G: 204 B: 000	339900 R: 051 G: 153 B: 000	99CC66 R: 153 G: 204 B: 102	669933 R: 102 G: 153 B: 051	99CC33 R: 153 G: 204 B: 051	336600 R: 051 G: 102 B: 000	669900 R: 102 G: 153 B: 000	99CC00 R: 153 G: 204 B: 000	CCFF66 R: 204 G: 255 B: 102	CCFF33 R: 204 G: 255 B: 051
CCFF00 R: 204 G: 255 B: 000	999900 R: 153 G: 153 B: 000	CCCC00 R: 204 G: 204 B: 000	CCCC33 R: 204 G: 204 B: 051	333300 R: 051 G: 051 B: 000	666600 R: 102 G: 102 B: 000	999933 R: 153 G: 153 B: 051	CCCC66 R: 204 G: 204 B: 102	666633 R: 102 G: 102 B: 051	999966 R: 153 G: 153 B: 102	CCCC99 R: 204 G: 204 B: 153	FFFFCC R: 255 G: 255 B: 204	FFFF99 R: 255 G: 255 B: 153	FFFF66 R: 255 G: 255 B: 102	FFFF33 R: 255 G: 255 B: 051	FFFF00 R: 255 G: 255 B: 000
FFCC00 R: 255 G: 204 B: 000	FFCC66 R: 255 G: 204 B: 102	FFCC33 R: 255 G: 204 B: 051	CC9933 R: 204 G: 153 B: 051	996600 R: 153 G: 102 B: 000	CC9900 R: 204 G: 153 B: 000	FF9900 R: 255 G: 153 B: 000	CC6600 R: 204 G: 102 B: 000	993300 R: 153 G: 051 B: 000	CC6633 R: 204 G: 102 B: 051	663300 R: 102 G: 051 B: 000	FF9966 R: 255 G: 153 B: 102	FF6633 R: 255 G: 102 B: 051	FF9933 R: 255 G: 153 B: 051	FF6600 R: 255 G: 102 B: 000	CC3300 R: 204 G: 051 B: 000
996633 R: 153 G: 102 B: 051	330000 R: 051 G: 000 B: 000	663333 R: 102 G: 051 B: 051	996666 R: 153 G: 102 B: 102	CC9999 R: 204 G: 153 B: 153	993333 R: 153 G: 051 B: 051	CC6666 R: 204 G: 102 B: 102	FFCCCC R: 255 G: 204 B: 204	FF3333 R: 255 G: 051 B: 051	CC3333 R: 204 G: 051 B: 051	FF6666 R: 255 G: 102 B: 102	660000 R: 102 G: 000 B: 000	990000 R: 153 G: 000 B: 000	CC0000 R: 204 G: 000 B: 000	FF0000 R: 255 G: 000 B: 000	FF3300 R: 255 G: 051 B: 000
CC9966 R: 204 G: 153 B: 102	FFCC99 R: 255 G: 204 B: 153	FFFFFF R: 255 G: 255 B: 255	CCCCCC R: 204 G: 204 B: 204	999999 R: 153 G: 153 B: 153	666666 R: 102 G: 102 B: 102	333333 R: 051 G: 051 B: 051	000000 R: 000 G: 000 B: 000								

FIGURE 45. Web-safe color palette.

MIL-DTL-24784D(NAVY)  
APPENDIX ASPECIFIC DEVELOPMENT REQUIREMENTS FOR  
PAGE-BASED CHAPTER-FORMAT TECHNICAL MANUALS

## A.1 SCOPE

A.1.1 Scope. This appendix establishes the style, format, front matter, other supporting requirements, and products for page-based chapter-format technical manuals (TMs). This appendix is a mandatory part of this specification. The information contained herein is intended for compliance.

## A.2 DEVELOPMENT OF PAGE-BASED CHAPTER-FORMAT TECHNICAL MANUALS

A.2.1 General. The following are unique requirements applicable to chapter-format TMs developed in accordance with MIL-DTL-24784/7, /10, /11, /22, and /23.

A.2.2 Development products.

A.2.2.1 Book plan. When specified by the acquiring activity (see 6.2), a book plan shall be developed for each TM. Format and content requirements of the TM book plan shall be as specified (see 6.2). The TM book plan contains a detailed overview of the proposed scope of the manual, including identifying major paragraphs, tables, and illustrations planned for the manual in compliance with this document. The TM book plan shall be submitted to the acquiring activity for acceptance prior to development of the RDC or PTM.

A.2.2.1.1 Model manual. When specified by the acquiring activity (see 6.2) or approved by the Government, an existing manual covering similar system/equipment may be used, marked up, and submitted to satisfy the requirements of the book plan. The text from the model manual may be used verbatim with changes to cover the equipment differences and to correct inconsistencies, unclear wording, or obvious editorial or typographical errors. For all new manuals, the format and requirements in this specification shall apply. All inconsistencies, unclear wording, or errors noted in the model manual shall be identified to the Government. All deviations from the model manual shall be approved by the Government.

A.2.3 Divisions and arrangement.

A.2.3.1 TM divisions. TMs shall be divided into volumes, parts, chapters, sections, paragraphs, and procedures as appropriate. There shall be at least two of each subdivision used, except in paragraphs. That is, where there is a Volume 1, Part 1, Chapter 1, or Section I, there shall be a Volume 2, Part 2, Chapter 2, or Section II. All volumes, parts, chapters, and sections shall be titled. Breakout shall be planned to subordinate that which should be subordinated.

A.2.3.1.1 Volumes. When the manual exceeds 1,500 printed pages (750 sheets), it shall be divided into separately bound segments (volumes). Each volume is essentially an independent manual and shall include applicable front and rear matter. Volumes shall be separated by complete chapters, where possible. Each volume shall be identified by a unique TMIN, title, and subtitle that describe the contents.

A.2.3.1.2 Parts. When necessary, each volume of a manual may be formatted into two or more separate parts according to required subject matter. Each part shall be identified by both its volume number and part number and have a unique TMIN assigned as provided by the Government.

A.2.3.1.3 Chapters. The manual shall be divided into chapters to provide a logical work sequence arrangement. Chapters shall start on a right-hand page.

A.2.3.1.4 Sections. When multiple coverage in chapters of manuals for compound items is approved by the Government, a chapter sectioning technique may be employed.

A.2.3.2 TM arrangement. Each manual shall be arranged according to the following standardized format:

- a. Front matter.
- b. Technical content.
- c. Rear matter.

MIL-DTL-24784D(NAVY)  
APPENDIX A

A.2.3.2.1 Front matter. Material preceding the first chapter shall consist of the following, as applicable, in the order specified:

- a. Cover/title page.
- b. Record of revisions.
- c. Foreword.
- d. Table of Contents.
- e. List of Tables.
- f. List of Illustrations.
- g. Safety summary.
- h. Frontispiece.

A.2.3.2.1.1 Cover/title page. See 3.6 for general requirements applicable to all TM types. The bar code and human readable NSN shall be displayed on the cover/title page.

A.2.3.2.1.2 Record of revisions. A record of revisions shall be provided. The record shall include revision number, date, and a title or description of the revision(s) (see [figure A-1](#)).

A.2.3.2.1.3 Foreword. A foreword containing the purpose and scope of the manual plus any other information required by the technical content specification sheet shall be provided. The foreword shall identify and define abbreviations and nonstandard symbols, including any icons used in the manual if not explained elsewhere. When more than 20 abbreviations or symbols require definition, a glossary shall be used to identify and define the abbreviations and symbols used in the manual (see A.2.3.2.3.2). The first volume of a manual shall contain general information and reporting requirements regarding all volumes and specific information applicable to Volume 1, as required. The first volume of a manual shall include the technical assistance and deficiency reporting information on [figure 1](#) (verbatim).

A.2.3.2.1.4 Table of Contents. A Table of Contents listing front matter, parts, chapters, sections, and paragraphs in the same order and with the exact titles used in the text, with page number, shall be placed at the beginning of each publication (see [figure A-2](#)). The security classification, if any, of titles, shall be indicated. Each manual or volume in a set of manuals shall contain its own Table of Contents. Layout shall be in accordance with [figure A-2](#), except that a double column format shall be used when the manual is prepared in double column.

A.2.3.2.1.5 List of Tables. Manuals containing tables (including charts assigned table numbers) shall have a List of Tables showing the table number, title, and page number of each table. The security classification, if any, of table titles shall be indicated. Layout shall be in accordance with [figure A-3](#), except that a double column format shall be used when the manual is prepared in double column. Each manual or volume in a set of manuals shall contain its own List of Tables. When both are brief, the List of Illustrations and List of Tables may be included on the same page.

A.2.3.2.1.6 List of Illustrations. Manuals containing illustrations (including charts and graphs assigned figure numbers) shall have a List of Illustrations showing the figure number, title, and page number of each figure. This list shall include foldout pages, schematics, and so forth. The security classification, if any, of illustration titles shall be indicated. Layout shall be in accordance with [figure A-3](#), except that a double column format shall be used when the manual is prepared in double column. Each manual or volume in a set of manuals shall contain its own List of Illustrations.

A.2.3.2.1.7 Safety summary. All TMs containing dangers, warnings, or cautions shall include a safety summary in accordance with 3.7.5.10. [Figure A-4](#) is a sample of the format and content. See 3.7.5 through 3.7.5.11 for additional safety and health requirements.

A.2.3.2.1.8 Frontispiece. A frontispiece shall illustrate the system, equipment, or repairable item covered in the manual. It shall be placed preceding Chapter 1 (see 3.7.8.2.1).

A.2.3.2.2 Technical content. See MIL-DTL-24784/7, /10, /11, /22, and /23 for technical content data requirements.

MIL-DTL-24784D(NAVY)  
APPENDIX A

A.2.3.2.3 Rear matter. Rear matter shall consist of the following, in the order specified:

- a. Appendices (when applicable).
- b. Glossaries (when applicable).
- c. TMDER form.
- d. Back cover.
- e. Backbone (when applicable).

A.2.3.2.3.1 Appendices. When specified by the acquiring activity (see 6.2), appendices shall be used to separate relatively bulky information from the body of the manual when such separation will increase the clarity of the overall manual. Appendices shall be titled "APPENDIX A", "APPENDIX B", etc. Each appendix shall contain a statement delineating its purpose and application. Appendices shall immediately follow the last chapter of the manual. Appendices shall begin on a right-hand page. Pages, paragraphs, illustrations, and tables for appendices shall be numbered. Each manual or volume in a set of manuals shall contain its own appendices.

A.2.3.2.3.2 Glossaries. Glossaries shall be used in TMs only when the terms (acronyms/abbreviations, symbols) are not defined in the text; in the Navy, DoD, or standard dictionary; or contained in the manual's foreword. Each manual or volume in a set of manuals shall contain its own glossary.

A.2.3.2.3.3 TMDER. The TMDER Form NAVSEA 4160/1 shall be included at the back of the manual. The TMDER is a user activity TM comment sheet and shall be used to provide feedback on corrections and suggested improvements to the methods and procedures specified by a TM.

A.2.3.2.3.4 Back cover and backbone. Manuals shall have an outside back cover and contain the information indicated by [figure A-5](#). The overall classification of the manual shall be shown on the back cover. When specified by the acquiring activity (see 6.2), a backbone shall be prepared and contain the information indicated by [figure A-5](#). The overall classification of the manual shall be shown on the backbone.

#### A.2.4 Style and format.

A.2.4.1 Page size, reproduction area, and margins. Manuals shall be prepared in 8½- by 11-inch size with a maximum reproduction area of 7¼ by 10 inches. The binding edge margin shall not be less than 1 inch and the outside edge margin not less than ¼ inch.

A.2.4.2 Column format. Preferred text format for 8½- by 11-inch manuals is single column (maximum 7¼ inches wide), although double column can be used (see 6.2). If double column is used, the columns shall be separated by a ¼-inch gutter.

A.2.4.3 Text placement. Full justification shall be used for all lines of text displayed as sentences or paragraphs. Text shall not be wrapped around an illustration.

A.2.4.4 Type style, capitalization, and vertical spacing. Text, titles, headings, numbers, and callouts may be in sans-serif or serif font. Font style, size, and capitalization shall be as identified on [figure A-6](#). Layout shall conserve space without lessening usability or clarity of material. Blank pages and spaces shall be avoided whenever possible. Leading (see 6.4.10) and vertical spacing as indicated by [figure A-6](#) shall be used for best legibility and conservation of space. Text shall be single spaced (double spaced between procedural text). Double spacing of text within a paragraph, or similar wastefulness, is unacceptable. Layout practices shall not result in:

- a. The first line of a paragraph being at the bottom of a page or column.
- b. The last line of a paragraph being at the top of a new page.
- c. A sidehead falling on the last line of a page or column.
- d. Dangers, warnings, cautions, and notes being divided so that first lines or group of icons appear on one page and remaining lines or group of icons on another (first lines or group of icons) may appear in the left column with remaining lines in the right column on the same page.

MIL-DTL-24784D(NAVY)  
APPENDIX A

e. Dangers, warnings, cautions, and notes being separated from the paragraph that they apply to (dangers, warnings, cautions, and notes may appear in the left column with applicable paragraphs in the right column on the same page).

f. Undesirable location of an illustration or table.

A.2.4.5 Margin data. Margin data (generally the running heads and feet) shall be placed outside that portion of the page used for narrative text, full-page tabular data, or full-page illustrations, but within the reproduction area dimensions of the page.

A.2.4.5.1 Running heads and feet. Complete running heads and feet shall be included on all pages except cover/title page, back cover, TMDER form, or pages otherwise blank. Blank pages that back up classified pages shall be marked with the security classification of the backed up page.

A.2.4.5.1.1 Running heads.

A.2.4.5.1.1.1 Security classification. The security classification of classified manuals shall be marked at the top center of each page, including unclassified pages, in bold face type in accordance with DoDI 5200.01. For foldouts, the security classification shall be marked between the TMIN and the left margin of the page, in bold face type and repeated continuously with 4 inches of space between each marking, aligned with the classification markings used in the running foot.

A.2.4.5.1.1.2 TMIN. The Government-assigned TMIN shall be in bold face type and located at the outer/right margin (right justified) for an odd-numbered right-hand page and at the inner/left margin (left justified) for an even-numbered left-hand page. For a foldout page, the number shall be located at the outer/right margin (right justified). When all the information for a manual is placed horizontally on all pages and all pages are arranged head to foot, the TMIN shall be placed in the upper right corner of all pages. If the manual will be jointly used, only the acquiring activity's TMIN shall be used on the interior pages of the manual.

A.2.4.5.1.2 Running feet.

A.2.4.5.1.2.1 Page number. Page numbers shall be located at the outer/right margin (right justified) for an odd-numbered right-hand page, and at the inner/left margin (left justified) for an even-numbered left-hand page. The page number for a foldout page shall be placed at the lower outer edge ending at the outside margin so that the number shall be visible when the printed page is folded.

A.2.4.5.1.2.2 Security classification. The security classification of classified manuals shall be marked at the bottom center of each page, including unclassified pages, in bold face type in accordance with DoDI 5200.01. For foldouts, the security classification shall be marked at the bottom of the page in bold face type, ¾ inch from the right-hand edge and repeated continuously to the left with four inches of space between each marking, aligned with the classification markings used in the running head.

A.2.4.5.1.2.3 Foldout figure number and title. The figure number and title for the illustration on a foldout page shall be placed below the figure, in the lower outer corner, justified with the right margin so that the number shall be visible when the printed page is folded.

A.2.4.6 Paragraphs. Paragraphs and subparagraphs may have titles. The title shall end with a period. There shall be no more than five levels of paragraphs used. Paragraph and subparagraph titles shall be formatted as follows:

- a. Primary (first level) paragraph titles shall be bold, all capital letters, and stand alone. The paragraph text shall begin two line spaces down and be indented approximately ½ inch from the left margin.
- b. Second level paragraph titles shall be regular type, all capital letters, with the paragraph text run-in.
- c. Third, fourth, and fifth level paragraph titles shall be regular type; the first letter of the first word and of each principle word shall be capitalized, and the paragraph text is run-in.

MIL-DTL-24784D(NAVY)  
APPENDIX A

A.2.4.7 Procedural steps. Procedural steps shall not have titles. Procedural steps are placed immediately after paragraph or subparagraph titles, or, if applicable, after a small paragraph that introduces the procedural steps. Procedural steps may be divided into no more than four levels. Procedural steps and substeps shall be formatted as follows:

- a. Procedural steps in a paragraph structure begin two lines below the preceding text. Text begins approximately two spaces after the step letter/number or period following the letter/number (when applicable). All text is blocked.
- b. First level procedural steps begin at the left margin.
- c. Each level of substep begins two lines below the preceding step and is aligned under the first word of the previous level procedural step.

A.2.5 References.

A.2.5.1 Textual references. References to another TM or volume of the same TM shall conform to the following:

- a. When referring to the entire content of another TM or volume, present the reference as the TMIN and TM title. Subsequent references may truncate the reference to the TMIN only when it causes no reader confusion.
- b. When referring to specific content within another TM or volume, the reference should be specific enough to direct the reader to the desired location. Present the reference in the following manner, as applicable: TMIN; TM title; volume; part; chapter; section; and paragraph, table, or figure number. Subsequent references may truncate the reference to the TMIN and the specific location (e.g., SE555-AB-MMO-020 Table 2-1) when it causes no reader confusion.
- c. References to material within the same TM shall conform to the following:
  - (1) Create links within paragraphs, steps, and tables to internal references.
  - (2) Refer to paragraphs by paragraph number (e.g., paragraph 2-4.1). Reference to a subordinate paragraph within the same primary paragraph may be presented as “above” or “below”.
  - (3) Refer to procedural steps by step number (e.g., step 3, or step 1[a]).
  - (4) Refer to tables by table number (e.g., Table 6-1).
  - (5) Footnotes are not allowed within text; use notes when applicable.
- d. References to figures shall conform to the following requirements:
  - (1) Refer to figures by figure number (e.g., Figure 2-1), including sheet number for multi-sheet figures (e.g., Figure 6-3, Sheet 3).
  - (2) Refer to a section of a multi-section figure by section letter and figure number (e.g., A, Figure 3-2).
  - (3) Refer to callouts (e.g., index number, reference designation) on a figure by callout first, followed by the figure number (e.g., [3, Figure 2-6] or [S1, Figure 3-6]). However, when multiple references in a paragraph refer to the same figure, only the first reference need indicate the figure number. Additional references need indicate only the callout number until the sequence is broken by a reference to a different figure number. If the sequence is unbroken for procedures requiring two or more pages, the figure number shall be repeated on each succeeding page.
  - (4) Reference to a zone on a figure shall be by zone number first then zone letter to avoid possible confusion with reference designations.
  - (5) Refer to parts on figures by enough of their reference designation to identify the item (e.g., Resistor A6R11).

A.2.5.2 Post-maintenance action referencing. When required, the last step of a procedure shall reference any post-maintenance actions necessary to ensure the initial procedure has been successfully completed. The reference shall be to the procedure title.

MIL-DTL-24784D(NAVY)  
APPENDIX AA.2.6 Use of terminology, nomenclature, numbers, and equations.

A.2.6.1 Abbreviations and acronyms. Use of abbreviations and acronyms shall be held to a minimum and each shall be spelled out the first time it appears in each chapter, section, or part and where confusion may exist or usability shall be enhanced.

A.2.7 Tabular material.

A.2.7.1 Table titles. Tables shall be assigned table titles. The title shall follow two spaces after the word "Table" and the table number and shall be centered above the table. The first letter of the first word and of each principal word shall be capitalized. Full-page tables, placed sideways on a page, shall be turned 90 degrees counterclockwise. The table number and title for a turned table shall also be turned 90 degrees counterclockwise to stay centered above the table. Table titles shall begin with an identifying name when applicable (e.g., "Table 3-1. Guidance System Test Points"). The title shall be short, not exceeding two lines, and describe the contents or purpose of the table. Tables applicable to one Service, in a manual that will be used by more than one Service, shall be identified (e.g., "Table 2-3 (Navy Only). Fuel Indicator Correction Factors").

A.2.7.2 Continued table material. When a table is continued on a following page, the table number and title shall be repeated above the table, followed by a dash and the word "Continued". Table column head titles shall also be repeated. The above information shall not be repeated on a following page when the page is a foot page of a head-to-foot tabular arrangement.

A.2.7.3 Footnotes in tables. Footnotes shall be placed immediately below the table in which they are referenced. A 1-inch horizontal rule shall be placed flush left below the table and the footnote placed under the rule. Footnotes at the end of the table shall begin two lines below the closing rule of the table. All lines of footnotes shall be aligned with the left margin of the table. If a table is continued onto other pages, all footnotes shall be placed at the end of the table and the header note "See footnotes at end of table" shall be placed immediately following the table title block or directory note.

A.2.8 Numbering.

A.2.8.1 Cover and title pages. The cover and title page shall not be numbered.

A.2.8.2 Front matter. Front matter pages shall be numbered as follows:

a. The Record of Revisions page shall be numbered "RECORD OF REVISIONS-1/(RECORD OF REVISIONS-2 Blank)". When applicable, the word "Blank" shall be omitted.

b. The Table of Contents, List of Tables, List of Illustrations, Safety Summary, and frontispiece (as applicable) pages shall be consecutively numbered in lower case Roman numerals (i, ii, iii, etc.).

c. The Foreword page shall be numbered "FOREWORD-1/(FOREWORD-2 Blank)". When applicable, the word "Blank" shall be omitted.

A.2.8.3 Volumes. When used, volumes shall be numbered consecutively in Arabic numerals. Two or more volumes shall be identified sequentially by volume numbers and subtitles indicative of volume content and have a unique TMIN assigned as provided by the Government.

A.2.8.4 Parts. Each part shall be numbered consecutively in Arabic numerals. Each part shall be identified by both its volume and part number and have a unique TMIN assigned as provided by the Government.

A.2.8.5 Chapters. Arabic numerals shall be used to number chapters consecutively throughout all volumes of the publication. Chapters shall begin on a right-hand page.

A.2.8.6 Sections. Roman numerals shall be used to number sections consecutively within each chapter.

A.2.8.7 Paragraphs. Paragraphs shall be numbered consecutively within the chapter using the decimal numbering method. All paragraph numbers shall be preceded by the chapter number and a dash (-). For example, the first primary paragraph of Chapter 3 shall be 3-1, the second primary paragraph shall be 3-2, and so forth. The second level paragraph of Chapter 3 shall be numbered 3-1.1, the third level paragraph shall be numbered 3-1.1.1, the fourth level paragraph shall be numbered 3-1.1.1.1, and the fifth level paragraph shall be numbered 3-1.1.1.1.1.

MIL-DTL-24784D(NAVY)  
APPENDIX A

A.2.8.8 Procedural steps. Procedural steps and sub-steps shall be numbered as follows:

- a. First level - consecutively with lower case letters followed by a period.
- b. Second level - consecutively with Arabic numerals enclosed in parenthesis.
- c. Third level - consecutively with lower case letters enclosed in parenthesis.
- d. Fourth level - consecutively with Arabic numerals followed by a period.

A.2.8.9 Sequential lists. Sequential list items shall be numbered as follows:

- a. First level - consecutively with lower case letters followed by a period.
- b. Second level - consecutively with Arabic numerals enclosed in parenthesis.
- c. Third level - consecutively with lower case letters enclosed in parenthesis.
- d. Fourth level - consecutively with Arabic numerals followed by a period.
- e. Fifth level - consecutively with lower case Roman numerals followed by a period.

A.2.8.10 Pages, tables, and illustrations. Pages, tables, and illustrations shall be numbered consecutively within each chapter. Even numbers shall be assigned to left-hand pages and odd numbers to right-hand pages. Manuals divided into chapters, and in turn into sections, shall contain consecutively numbered pages, tables, and illustrations for the entire chapter. Page, table, and illustration numbers shall consist of two part Arabic numerals separated by a hyphen. The first part shall be the chapter number with the second part being the order within the chapter. See below for examples:

<u>Number</u>	<u>Meaning</u>
2-17	Chapter 2, page 17
Table 2-17. (Title)	Chapter 2, table 17
Figure 2-17. (Title)	Chapter 2, figure 17
Figure 2-17. (Title) (Sheet 1 of 3)	Chapter 2, figure 17 is a multi-sheet (3 total) illustration. Remaining sheets shall be numbered in consecutive order; (Sheet 2 of 3), (Sheet 3 of 3), and so forth.

A.2.8.11 Blank pages. Blank pages shall be assigned page numbers. The page number and the word “blank” shall appear in parentheses on the preceding page, following the preceding page number. For example, “1-9/(1-10 Blank)”. In a classified TM, the statement “THIS PAGE IS UNCLASSIFIED” shall be included, centered on the blank page.

A.2.8.12 Foldout figure numbers. The figure numbers for illustrations on a foldout shall follow normal figure numbering sequence.

A.2.8.13 Foldout page numbers. The page numbers for foldout pages shall follow normal page numbering sequence. The reverse side of foldout pages shall be blank. Each foldout page number shall include a blank page notation (for example “2-21/(2-22 Blank)”).

A.2.8.14 Footnotes. Footnotes to tables shall be numbered using consecutive Arabic superior numbers beginning with “1”. Footnote numbers and text shall be separated by two spaces. The numbering system shall be per table.

A.2.8.15 Glossary pages. The page numbers for an independent glossary shall be consecutively numbered in Arabic numerals with the word “GLOSSARY” preceding the page number. For example, “GLOSSARY-1”.

MIL-DTL-24784D(NAVY)  
APPENDIX A

A.2.8.16 Appendices. Pages, paragraphs, illustrations, and tables within appendices shall be consecutively numbered in Arabic numerals preceded by the capital letter of the appendix. For example:

<u>Number</u>	<u>Meaning</u>
A-17	Appendix A, page 17
Figure B-17	Appendix B, figure 17
Table C-17	Appendix C, table 17

A.2.9 Graphics.

A.2.9.1 Graphic types and development techniques.

A.2.9.1.1 Operational and procedural step illustrations. Illustrations depicting operations or procedures may be included as necessary. Operational ([figure A-7](#)) or procedural ([figure A-8](#)) illustrations shall have one or more text steps with each illustrated step. It is not necessary to illustrate each step of a maintenance procedure, such as the removal of screws with an ordinary screwdriver, lifting off a cover after the screws have been removed, and so forth. Procedural illustrations shall supplement the text by clarifying procedures that are of a special nature or are not obvious. The text step shall be as close to the illustrated step as possible. Steps shall be identified in the order in which they are to be accomplished. Alternate types of operational and procedural step illustrations are acceptable.

A.2.9.1.2 Fault logic diagrams. (**Electronic Equipment TRSs only**.) Fault logic diagrams shall be based on a fault indication observed during troubleshooting. The diagrams shall comprise a branching series of questions pertaining to fault isolation. Each question shall pertain to a further observation or measurement and shall result in a “yes” or “no” answer, thereby progressively narrowing the possible functional area of the fault. Tolerance values shall be presented in those instances where a definitive “yes” or “no” is not obtained. This progression and elimination shall isolate the functional area of the equipment containing the fault and then refer the user to the portion of the manual containing that information needed to complete the fault isolation and repair. Each diagram shall include or make reference to information necessary to establish the test or operating conditions required for starting the fault isolation procedure. Only three types of blocks shall be used. Shaded blocks (right and bottom border lines weighted) shall contain questions that may be answered from observation, without changing test setup and without special equipment. Single-line blocks shall contain questions requiring measurement by special setup of external test equipment. Double-line boxes (conclusion boxes) shall list the functional area within an equipment that is the probable source of malfunction and shall reference a procedure or another diagram for further isolation or correction of a fault (see [figure A-9](#)).

A.2.9.1.3 Flowcharts. (**Electronic Equipment TRSs only**.) The flowchart shall be developed using the following procedure and symbology.

- a. General flow: The general flow of the flowchart shall be top-to-bottom and left-to-right. A portion of the flow may be contrary to the general flow if no intermediate blocks are involved (see [figure A-10](#)).
- b. Terminal blocks: These blocks are used to show the starting and ending points of a flow (see [figure A-11](#)). START blocks shall have a vertical exiting line. EXIT and COMPLETE blocks shall have vertical or horizontal entry lines. The EXIT block shall be accompanied by text explaining the reason for the EXIT.
- c. Annotation or comment blocks: These blocks are used to provide additional descriptive clarification, comments, or explanatory notes (see [figure A-12](#)). The dashed line is connected to the dashed outline of the symbol corresponding to the data contained inside. This block is inserted with the dashed line intersecting flowchart flow at the point appropriate to the content of the block.
- d. Process blocks: These blocks define an operation to be performed (see [figure A-13](#)). These blocks shall have only one entry line and one exiting line. Entry lines and exiting lines shall be vertical or horizontal; however, entry lines shall not enter the bottom of a process block and exiting lines shall not leave the top of a process block (see [figure A-10](#)). Process blocks shall not be used in place of decision blocks.

MIL-DTL-24784D(NAVY)  
APPENDIX A

e. Decision blocks: These blocks are used to provide two or more paths resulting from specific condition related decisions (see [figure A-14](#)). Decision blocks where the exiting line choice is dependent on a “yes” or “no” decision shall normally have only two exiting lines. These blocks may have more than two exiting lines if each path is clearly defined by the decision required to select that path. There shall be only one entry line (either from the top or at the side) to a decision block. Entry and exiting lines shall not occupy the same side of a decision block. Exiting lines shall not occupy the top of a decision block. Exiting lines shall be labeled by decision criteria. Do not include question marks in decision blocks.

f. On-page connectors: These connectors shall be used to join two ends of a line when it is inconvenient to draw a single continuous line between two points on a single sheet (see [figure A-15](#)). These connectors shall be shown by a circle enclosing a capital letter. The letter used in the on-drawing connectors shall start with “A” and proceed alphabetically on each figure. The same letter shall be used in the starting and ending connectors at both ends of an implied line of communication. The same letter shall be used in multiple starting connectors when their respective ending connectors are the same point. Connectors shall have exiting or entry lines consisting of vectored arrows that indicate that the connector is used as a starting or ending connector. A single arrowhead with multiple entry lines may be used when required to ensure clarity (see [figure A-16](#)). The exiting from a starting connector and the entry line to an ending connector shall show the direction of the corresponding connector and path of the implied line between.

g. Off-page connectors: These connectors shall be used to show flow continuity between sheets of the same figure or of different figures. These connectors shall be shown by an irregular pentagon enclosing a number and a capital letter (see [figure A-17](#)). The number contained by the off-page connector shall indicate the destination sheet (for the output connector) and the origin sheet (for the input connector). The letters used in off-page connectors shall start with “A” and proceed alphabetically in each figure, using the same letter in the output and input connectors at each end of an implied line continuation. The same letter shall be used in multiple output connectors when their respective input connectors are the same point. The entry line to an output off-page connector shall enter the side of the connector opposite the point. The exiting line from an input off-page connector shall leave from the point of the connector. When off-page connectors are used to show flow continuity between figures, the figure number or title (as applicable) of the corresponding connector location shall be shown outside each off-page connector symbol (see [figure A-18](#)). If more than one of the output connectors is located on another figure, two or more input connectors shall be placed at the entry point so that figure number or title (as applicable) of all output connectors are shown (see [figure A-18](#)).

h. Arrowheads: Arrowheads shall be used to indicate the direction of flow. All block or connector entry lines shall have arrowheads. Arrowheads shall be used at all line intersections to clearly show direction of flow (see [figure A-19](#)).

i. Line intersections: Lines shall not cross except when an intersection is intended. On-drawing connectors shall be employed to prevent line crossings where intersections are not intended (see [figure A-19](#)).

#### A.2.9.2 General graphic requirements.

A.2.9.2.1 Illustration titles. Illustrations shall be assigned figure titles. The title shall follow two spaces after the word “Figure” and the figure number and be centered below the figure. The first letter of the first word and each principal word shall be capitalized. Full-page illustrations, placed sideways on a page, shall be turned 90 degrees counterclockwise. The figure number and title for a turned illustration shall also be turned to appear below the illustration. For foldouts, place the word “Figure” and the figure number and title in the lower outer corner of the page so that the number is visible when the printed page is folded. Figure titles shall begin with an identifying name when applicable (e.g., “Figure 3-1. Guidance System Gyroscope Assembly”). The title shall be short and describe the contents or purpose of the illustration. Illustrations applicable to one Service, in a manual that will be used by more than one Service, shall be identified (e.g., “Figure 2-3 (Navy Only). Fuel Indicator”).

A.2.9.2.2 Illustration placement. Each illustration shall be included as part of a paragraph or follow as closely as possible to its first reference in the narrative text.

MIL-DTL-24784D(NAVY)  
APPENDIX A

A.2.9.2.3 Foldout pages. When usability is not affected, multi-sheet illustrations shall be used in lieu of foldouts. Foldup-foldout pages shall not be used. When authorized by the acquiring activity (see 6.2), foldout pages may be prepared and shall meet the following requirements:

- a. Maximum page size for foldouts is 26 by 11 inches. Printable area is 24¾ by 10 inches.
- b. All foldout pages shall be prepared for printing on one side only.
- c. Foldout pages shall not be spliced.
- d. When specified by the acquiring activity (see 6.2), foldout pages may be interspersed within text pages or fall at the end of the chapter.

A.2.10 Style, format, and content for revisions. The revised TM shall be in accordance with the style, format, content, and arrangement of the existing manual. All pages, paragraphs, subparagraphs, procedural steps, list items, illustrations (including index numbers used within an illustration), and tables shall be renumbered, as necessary, to eliminate all number suffixes and to establish correct sequence. All previous revision indicators shall be eliminated. The revised TM shall include the following as applicable:

- a. A revised title page and, when required, a front cover, back cover, and backbone.
- b. New or revised front matter, including the Record of Revisions.
- c. New or revised text, illustrations, tables, glossaries, and appendices.

A.2.10.1 Display of new or changed material. After all previous revision indicators have been eliminated, new or changed material shall be identified/displayed as follows:

- a. Changes to text and tables shall be indicated by a vertical line (change bar) in the margin extending the entire area of the material affected (outer margin for double column material, margin opposite binding edge for single column material) (see [figure A-20](#)).
- b. The change bar is not required for changed or added front matter material (except for the Table of Contents); the replacement or addition of complete chapters or sections; or for the correction of minor inaccuracies, such as spelling, punctuation, relocation of material, and renumbering, unless such correction changes the meaning of the information.
- c. Change marks shall be applied to the complete danger, warning, caution, or note and not to the individual words or paragraphs it contains.
- d. Additions or changes to line drawings, charts, illustrations, graphs, diagrams, and schematics shall be indicated by screens (shading), screened (shaded) boxes, or miniature pointing hands to highlight updated areas (see [figure A-20](#)). Extensively changed presentations shall be indicated by a screen border around the affected area. For minor changes not suited to shading or screening, a miniature pointing hand shall be used.

A.2.10.2 Record of Revisions. A Record of Revisions shall be provided. The record shall include revision number, date, and a title or description of the revision(s) (see [figure A-1](#)).

MIL-DTL-24784D(NAVY)  
APPENDIX A

## RECORD OF REVISIONS

REVISION NO.	DATE	TITLE OR BRIEF DESCRIPTION/PREPARING ACTIVITY
0	31 AUG 2009	THIS NEW ISSUE SUPERSEDES 0383-LP-009-3000 AND DOCUMENTS SCD-72596 WHICH CONTINUES AER 01-01-301 ON THE REMAINDER OF THE AIRCRAFT ELEVATOR DOORS.

RECORD OF REVISIONS-1 / (RECORD OF REVISIONS-2 Blank)

FIGURE A-1. Example record of revisions.

MIL-DTL-24784D(NAVY)  
APPENDIX A

Chapter/Paragraph	Page
<b>1 GENERAL INFORMATION AND SAFETY PRECAUTIONS . . . . .</b>	<b>1-1</b>
1-1 SAFETY PRECAUTIONS. . . . .	1-1
1-2 INTRODUCTION. . . . .	1-1
1-2.1 Purpose. . . . .	1-1
1-2.2 Scope. . . . .	1-1
1-2.3 Applicability. . . . .	1-1
1-2.4 Interface. . . . .	1-1
1-3 EQUIPMENT DESCRIPTION. . . . .	1-2
1-3.1 Equipment Capabilities. . . . .	1-2
1-3.2 Equipment Limitations. . . . .	1-2
1-3.3 Equipment Interfaces. . . . .	1-2
1-3.4 Physical Arrangement. . . . .	1-2
1-4 EQUIPMENT ILLUSTRATIONS. . . . .	1-2
1-5 EQUIPMENT REFERENCE DATA. . . . .	1-4
1-6 EQUIPMENT, ACCESSORIES, AND DOCUMENTS SUPPLIED. . . . .	1-4
1-7 EQUIPMENT, ACCESSORIES, AND DOCUMENTS NOT SUPPLIED. . . . .	1-4
<b>2 OPERATION . . . . .</b>	<b>2-1</b>
2-1 INTRODUCTION. . . . .	2-1
2-1.1 General Description. . . . .	2-1
2-1.2 Operator Responsibilities. . . . .	2-1
2-2 CONTROLS AND INDICATORS. . . . .	2-1
2-2.1 Control Panel. . . . .	2-1
2-3 OPERATING PROCEDURES. . . . .	2-3
2-3.1 Preliminary Procedures. . . . .	2-4
2-3.2 Detailed Checks and Procedures. . . . .	2-4

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE A-2. Example Table of Contents (chapter-format TMs).

MIL-DTL-24784D(NAVY)  
APPENDIX A

**LIST OF ILLUSTRATIONS**

Figure	Title	Page
1-1	HPRO General Assembly . . . . .	1-3
2-1	Control Panel (Left) and Gauge/Transmitter Panel (Right) . . . . .	2-3
2-2	Ro Unit Log Sheet . . . . .	2-9
2-3	Piping and Instrument Diagram, 627-D-11422 (Sheet 1 of 2) . . . . .	2-11
2-4	Flow Diagram, 627-D-11422 . . . . .	2-15
3-1	Osmosis Process . . . . .	3-2
3-2	RO Membrane (Sheet 1 of 2) . . . . .	3-2
3-3	PLC . . . . .	3-4

**LIST OF TABLES**

Table	Title	Page
1-1	Reference Data . . . . .	1-4
1-2	Equipment, Accessories, and Documents Supplied . . . . .	1-4
1-3	Equipment, Accessories, and Documents Not Supplied . . . . .	1-4
2-1	Control Panel Controls and Indicators . . . . .	2-2
2-2	Valve Positions at Start-up . . . . .	2-4
3-1	Variables Affecting Performance . . . . .	3-3
3-2	Alarm Summary . . . . .	3-8
4-1	Membrane Cleaning . . . . .	4-2

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE A-3. Example List of Illustrations and List of Tables (chapter-format TMs).

MIL-DTL-24784D(NAVY)  
APPENDIX A

**SAFETY SUMMARY**

**GENERAL SAFETY PRECAUTIONS**

The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this manual. These are recommended precautions that personnel must understand and apply during all phases of operation. Should situations arise that are not covered in these safety precautions, the Commanding Officer or other authority will issue orders as necessary to cover the situation.

**KEEP AWAY FROM LIVE CIRCUITS**

Operational and maintenance personnel must observe all safety regulations. Do not replace components or make adjustments inside equipment with the power turned on. Under certain conditions, dangerous potentials may exist even after power is removed due to charges retained by internal capacitors. To avoid bodily injury, always remove power and discharge a circuit by grounding before touching it.

**DO NOT SERVICE OR ADJUST ALONE**

Under no circumstances should any person reach inside any cabinet for the purpose of servicing or adjusting the equipment except in the presence of someone who is capable of rendering first aid. Whenever the nature of the operation permits, keep one hand away from equipment to reduce the hazard of current flowing through the body.

**FIRST AID**

An injury, no matter how slight, shall never go unattended. Always obtain first aid or medical attention immediately, and file an injury report in accordance with OPNAVINST 5102.1 series, subj: Mishap Investigation and Reporting.

**RESUSCITATION**

Personnel working with or near high voltage shall be familiar with approved methods of resuscitation. Should someone be injured and stop breathing, begin resuscitation immediately. A delay could cost the victim's life. Resuscitation procedures shall be posted in all electrically hazardous areas.

**DANGER, WARNING, AND CAUTION STATEMENTS**

Dangers, warnings, and cautions appear throughout this manual. It is important that the significance of each be thoroughly understood by personnel using this manual. Definitions are as follows:



**DANGER** is used to highlight a statement or some other notification about an operating or maintenance procedure, practice, or condition, that if not strictly observed will result in death or serious injury, or threatens the primary mission of the ship.



**WARNING** is used to highlight a statement or some other notification about an operating or maintenance procedure, practice, or condition, that if not strictly observed could result in death, injury, or long-term health hazards.



**CAUTION** is used to highlight a statement or some other notification about an operating or maintenance procedure, practice, or condition, that if not strictly observed could result in damage to or destruction of equipment, or loss of mission effectiveness.

FIGURE A-4. Example safety summary.

MIL-DTL-24784D(NAVY)  
APPENDIX A

The following dangers, warnings, and cautions appear in the text of this manual, and are repeated here for emphasis.



115v present on synchro when radar is in the off mode. (Page 6-2)



Dangerous voltages are present at the terminals of the isolation transformers. Use caution when connecting and disconnecting the multimeter. Open the 115 vac or 440 vac Radar Set Bulkhead Switch, as applicable, before changing connections in the following steps. (Page 6-45, page 6-54, page 6-110)



Ensure that adjustment screw is not grounded with screwdriver. (Page 6-37, page 6-66)



Motor unit weight is approximately 170 pounds. Utilize appropriate lift-rigging and support devices to avoid injury to personnel. (Page 6-33)



Use care when disconnecting rigid coax so as not to bend or damage assembly. (Page 6-55, page 6-69, page 8-3)



Ensure power is OFF before removing P13 to prevent damage to equipment. (Page 3-4, page 3-20, page 6-22, page 6-33)



Loosen both ends of rigid coax before trying to move. (Page 6-23)

FIGURE A-4. Example safety summary – Continued.

MIL-DTL-24784D(NAVY)  
APPENDIX A

**WARNINGS APPLICABLE TO HAZARDOUS MATERIALS**

Warnings for hazardous materials listed in this manual are designed to warn personnel of hazards associated with such items when they come in contact with them by actual use. Additional information related to hazardous materials is provided in OPNAVINST 5100.23, Navy Occupational Safety and Health (NAVOSH) Program Manual, NAVSUPINST 5100.27, Navy Hazardous Material Control Program, and the DoD 6050.5, Hazardous Materials Information System (HMIS) series publications. For each hazardous material used within the Navy, a Material Safety Data Sheet (MSDS) must be provided and available for review by users. Consult your local safety and health staff concerning any questions regarding hazardous materials, MSDSs, personal protective equipment requirements, and appropriate handling and emergency procedures and disposal guidance.

Symbols are used within the manual to provide quick recognition of the hazard by the user. The following provides an explanation of the hazard symbols and gives the complete warnings for hazardous material used in this manual.

**EXPLANATION OF HAZARDOUS MATERIALS SYMBOLS**



**CHEMICAL** – drops of liquid on hand shows that the material will cause burns or irritation to human skin or tissue.



**FIRE** - flame shows that a material may ignite and cause burns.



**EYE PROTECTION** - person with goggles shows that the material will injure the eyes.



**VAPOR** - human figure in a cloud shows that material vapors present a danger to life or health.

**HAZARDOUS MATERIALS WARNINGS**

In the text of the manual, the caption **WARNING** is not used for hazardous material warnings; hazards are cited with appropriate icon(s), and the nomenclature of the hazardous material that relates to the complete warning identified below. Users of hazardous materials shall refer to these complete warnings.



**Acrylic Lacquer, MIL-L-81352**

Acrylic lacquer, MIL-L-81352, is toxic, flammable, and highly irritating to the eyes. Protection: chemical splash proof goggles, gloves, and good ventilation. Keep container closed; keep sparks, flames, and heat away. Keep lacquer off skin, eyes, and clothes. Do not breathe vapors.



**Drycleaning Solvent, P-D-680**

Drycleaning solvent, P-D-680, Type II, is toxic and combustible. Protection: chemical splash proof goggles, gloves, and forced ventilation (or respirator). Keep container closed; keep sparks, flames, and heat away. Keep solvent off skin, eyes, and clothes. Do not breathe vapors.

FIGURE A-4. Example safety summary – Continued.

MIL-DTL-24784D(NAVY)  
APPENDIX A

**SECURITY CLASSIFICATION**<sup>24</sup>  
**TM IDENTIFICATION NUMBER**<sup>24</sup>

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**SECURITY CLASSIFICATION**<sup>24</sup>

NOTE: Numbers in small type indicate minimum type point size.

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE A-5. Example back cover.

MIL-DTL-24784D(NAVY)  
APPENDIX A

**S9310-XX-MMA-010 GENERATOR SET, 350 KW, DIESEL**<sup>18</sup>

**For manuals 1 – 2 inches  
thick**

**SECURITY CLASSIFICATION**  
**S9310-XX-MMA-010 GENERATOR SET 350 KW,**  
**MODEL P1-350 D18M, DIESEL**<sup>18</sup>

**For manuals thicker than 2  
inches**

NOTE: Numbers in small type indicate the preferable type point size. Type size may be adjusted when necessary to fit contents on the backbone.

FIGURE A-5. Example back cover – Continued.

MIL-DTL-24784D(NAVY)  
APPENDIX A

Use	Type Style/Size	Capitalization	Leading	Vertical Spacing
Publication Number	Bold 11	Upper case	--	36-points from top of page
Page Number	Bold 11	--	--	36-points from bottom of page
Security Classification	Bold 14	Upper case	--	36-points from top and bottom of page
Part Number, Chapter Number and Title, Record of Revisions Heading, Appendix Heading and Number, and Glossary Heading and Number	Bold 11	Upper case	0	48-points below publication number; 18-points above text, table, or illustration
Section Number and Title	Bold 11	Upper case	0	28-points below publication number; 24-points below chapter title; 18-points above text, table, or illustration
Headings for Table of Contents, List of Illustrations, List of Tables, Foreword, and Safety Summary	Bold 11	Upper case	--	48-points below publication number; 18-points above text
Text	Regular 11	Upper and lower case	1	18-points below publication number, chapter/section title; 12-points above/below table or illustration; 6-points above page number; 12-points above/below Danger, Warning, Caution, and Note signal word panels
Emphasis	Italic Bold 11	Upper and lower case	1	--
Paragraph Number and Title:			2	
Primary	Bold 11	Upper case		18-points below publication number, chapter/section title; 12-points above/below text, table or illustration; 12-points above/below Danger, Warning, Caution, and Note signal word panels
Second Level	Regular 11	Upper case		
Third, Fourth, and Fifth-Level	Regular 11	Initial cap for first letter of first word and each principle word		
Procedural Step Letter/Number	Regular 11	--	2	12-points above/below text, table or illustration; 12-points above/below Danger, Warning, Caution, and Note signal word panels

FIGURE A-6. Style, capitalization, leading, and vertical spacing (chapter-format TMs).

MIL-DTL-24784D(NAVY)  
APPENDIX A

Use	Type Style/Size	Capitalization	Leading	Vertical Spacing
Lists:				
Definition List Header	Bold 11	Initial cap	2	12-points above/below text, table or illustration; 12-points above/below Danger, Warning, Caution, and Note signal word panels
Sequential List Number and Title	Bold 11	Upper and lower case		
Figure (the word), Figure Number, and Figure Title	Regular 11	Upper case for first letter of each principle word	2	18-points below illustration and 6-points above page number
Legend on Artwork	Regular 8	Upper case	1	As required
Table (the word) and Table Number	Bold 11	Upper case for first letter of each principle word	2	11-points above table
Table Title	Regular 11	Upper case for first letter of each principle word	1	11-points above table
Table Column Heads	Bold 11	Upper case for first letter of each principle word	1	--
Table Text	Regular 11	Upper and lower case	2	--
Rules	$\frac{3}{4}$ point width	--	--	--
Table Footnotes	Regular 11	Upper and lower case	1	11-points below the 1-inch horizontal rule
<b>NOTE 1:</b> Information within this table does not apply to the cover/title page, back cover, or backbone.				
<b>NOTE 2:</b> Unless otherwise indicated, all type sizes may be plus-or-minus one point. Slight variations in spacing and leading are permitted.				

FIGURE A-6. Style, capitalization, leading, and vertical spacing (chapter-format TMs) – Continued.

MIL-DTL-24784D(NAVY)  
APPENDIX A

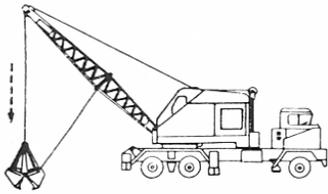
Use	Type Style	Capitalization	Leading	Vertical Spacing
Parts List, Numerical Index and Reference Designation Index Column Heads	Serif 10	Upper Case	1	—
Maintenance Parts List Text	San Serif 8 or 10	Upper and Lower Case	1	—
Numerical Index and Reference Designation Index Text	San Serif 8 or 10	Upper and Lower Case	1	—
All type sizes may be plus-or-minus one point. Slight variations in spacing and leading are permitted.				
<b>IT IS NOT THE INTENT OF THIS SPECIFICATION TO SPECIFY THE METHODS OR COMPOSING EQUIPMENT TO BE USED, BUT ONLY TO SPECIFY REQUIRED RESULTS</b>				

FIGURE A-6. Style, capitalization, leading, and vertical spacing (chapter-format TMs) – Continued.

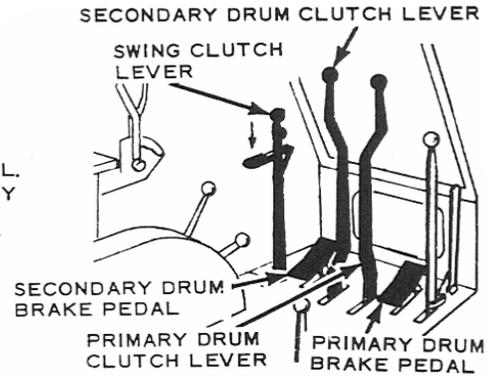
MIL-DTL-24784D(NAVY)  
APPENDIX A

### FILLING THE CLAMSHELL

PULL BACK ON THE DRUM CLUTCH LEVERS UNTIL THE CLAMSHELL BUCKET IS HIGH ENOUGH TO CLEAR THE MATERIAL BEING MOVED, THEN PUSH THE DRUM CLUTCH LEVERS TO NEUTRAL POSITION, APPLYING BOTH BRAKE PEDALS. SWING CLAMSHELL OVER MATERIAL.

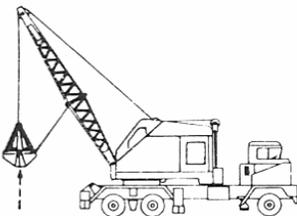


RELEASE THE SECONDARY DRUM BRAKE PEDAL TO OPEN CLAMSHELL BUCKET, THEN RELEASE PRIMARY DRUM BRAKE PEDAL TO LOWER CLAMSHELL BUCKET ONTO MATERIAL.

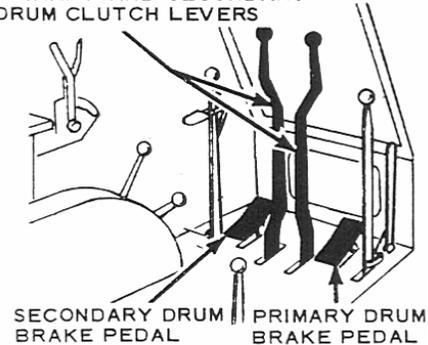


### CLOSING AND HOISTING

TO CLOSE THE CLAMSHELL BUCKET PULL BACK ON THE SECONDARY DRUM CLUTCH LEVER. HOLD THE LEVER UNTIL THE BUCKET IS FILLED WITH MATERIAL AND CLOSED. WHEN THE BUCKET IS CLOSED, RELEASE THE PRIMARY DRUM BRAKE PEDAL AND PULL THE PRIMARY DRUM CLUTCH LEVER BACK. HOLD BOTH LEVERS BACK UNTIL THE LOAD HAS REACHED THE DESIRED HEIGHT. RETURN BOTH DRUM CLUTCH LEVERS TO NEUTRAL AND AT THE SAME TIME APPLY BOTH DRUM BRAKE PEDALS.

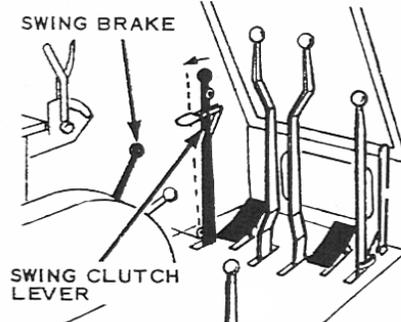


### PRIMARY AND SECONDARY DRUM CLUTCH LEVERS



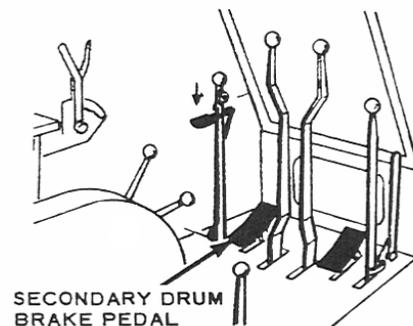
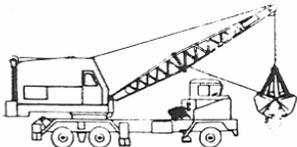
### SWINGING

PUSH THE SWING CLUTCH LEVER FORWARD TO SWING THE CRANE TO THE LEFT. PULL IT TO THE REAR TO GO TO THE RIGHT. SWING SLOWLY AND EVENLY TO AVOID BUCKET WHIPPING. WHEN HANDLING FINE MATERIALS KEEP LOAD ON SECONDARY LINE BUT COORDINATE PRIMARY DRUM TO AVOID EXCESSIVE SLACK IN PRIMARY LINE.



### DUMPING

TO DUMP THE BUCKET, RELEASE THE SECONDARY DRUM BRAKE PEDAL.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE A-7. Example operational illustrations.

MIL-DTL-24784D(NAVY)  
APPENDIX A

INSTALLATION CYCLE  
DOUBLE ACTION INSTALLION  
(5/32 and 3/16 diameter only)



**Step 1.** During initial part of driving operation, the sleeve is squeezed between head of pin and nose of rivet tool.



**Step 2.** Head of pin upsets sleeve to form a strong, bulbed head on blind side.



**Step 3.** When blind head has been formed, the tool automatically forces locking collar into conical space between recesses in head and locking groove in pin. This locks parts together permanently.



**Step 4.** Pin is broken off in tension at breakneck groove, substantially flush with head of sleeve. There is no projecting pin left to be cut off in a separate operation.

INSTALLATION CYCLE  
SINGLE ACTION INSTALLATION



**Step 1.** During initial part of driving operation, the sleeve is squeezed between head of pin and nose of rivet tool.



**Step 2.** Head of pin upsets sleeve to form a strong, bulbed head on blind side.



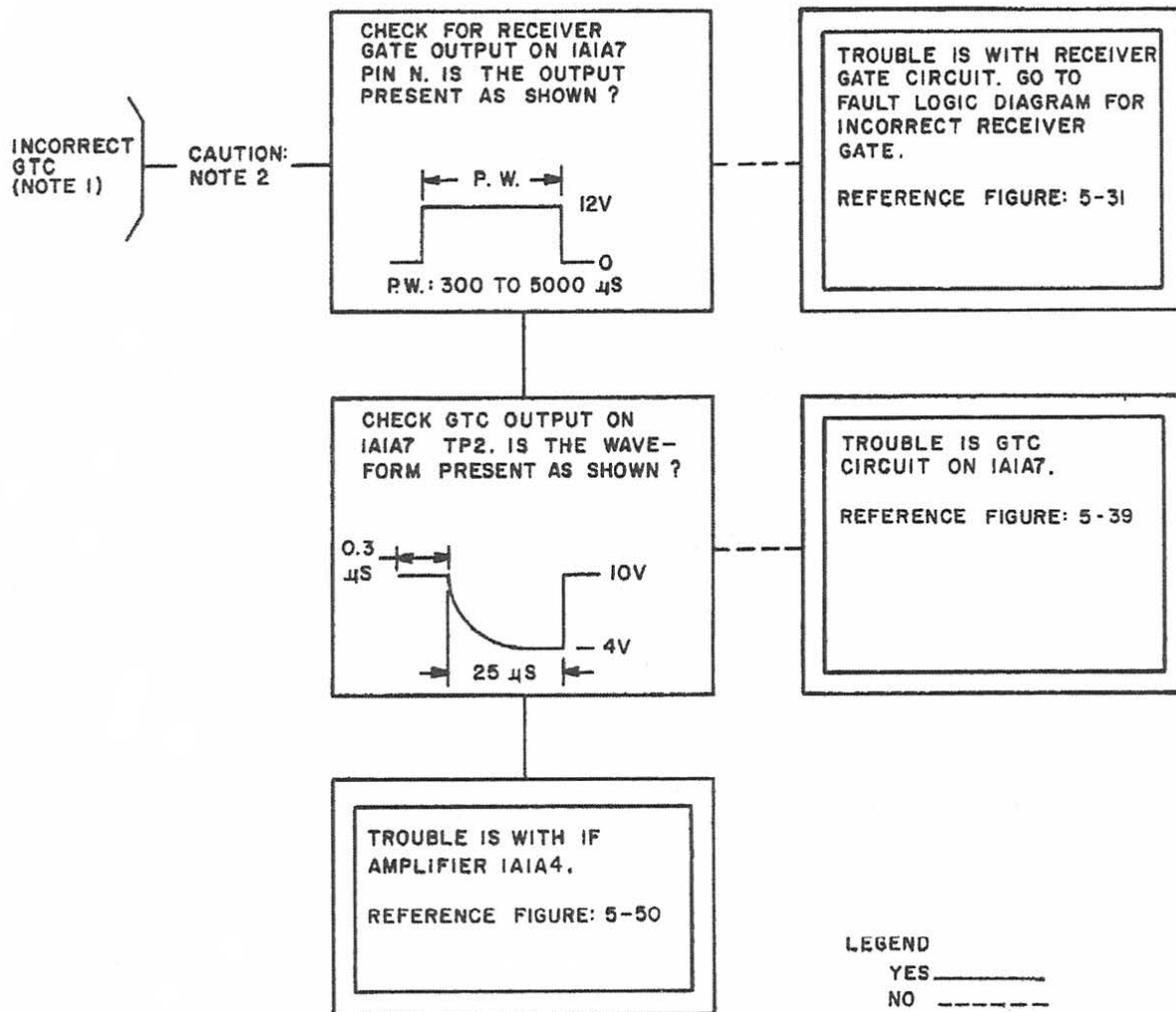
**Step 3.** When blind head has been formed, the tool automatically forces locking collar (at pintail end of sleeve) into conical space between recess in head and locking groove in pin. This locks parts together permanently.



**Step 4.** Pin is broken off in tension at breakneck grooves, substantially flush with head of sleeve. There is no projecting pin left to be cut off in a separate operation.

**NOTE:** Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE A-8. Example procedural illustrations.

MIL-DTL-24784D(NAVY)  
APPENDIX A

## NOTES:

## 1. SYSTEM SETUP

AN/UPX-27 NORMAL OPERATING SINGLE CONDITIONS, CHALLENGE ANY MODE, EITHER LOCALLY OR REMOTELY. TERMINATE ALL MEASURED VIDEO OUTPUT CONNECTORS ON THE INTERROGATOR SET WITH 75 OHMS, EXCEPT SUPP OUT (WHICH IS TO BE TERMINATED WITH 100 OHMS).

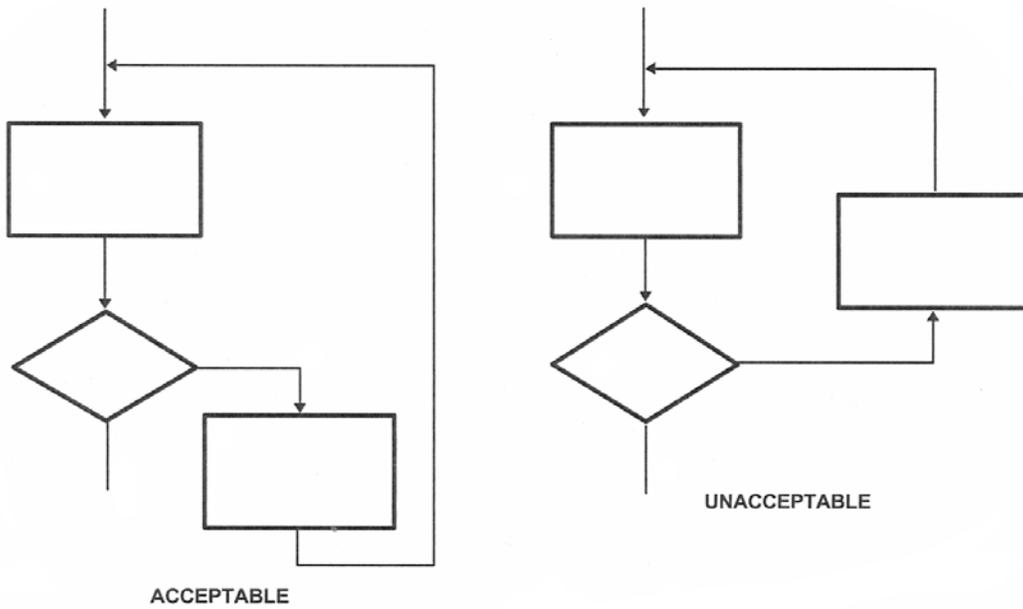
## 2. CAUTION:

DO NOT ENERGIZE EQUIPMENT UNLESS EITHER AN IFF ANTENNA OR SUITABLE DUMMY LOAD IS CONNECTED TO ANTENNA JACK ON FRONT PANEL.

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

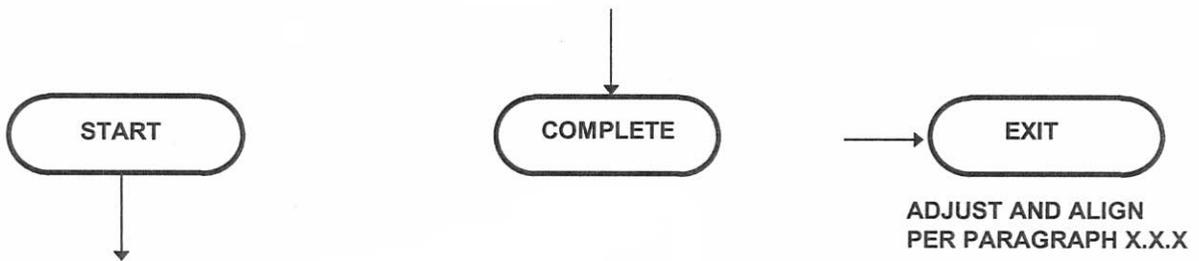
FIGURE A-9. Fault logic diagram (sample).

MIL-DTL-24784D(NAVY)  
APPENDIX A



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE A-10. General flow.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

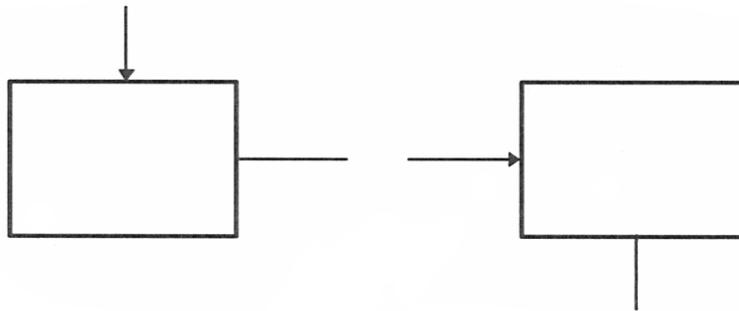
FIGURE A-11. Terminal blocks.

MIL-DTL-24784D(NAVY)  
APPENDIX A



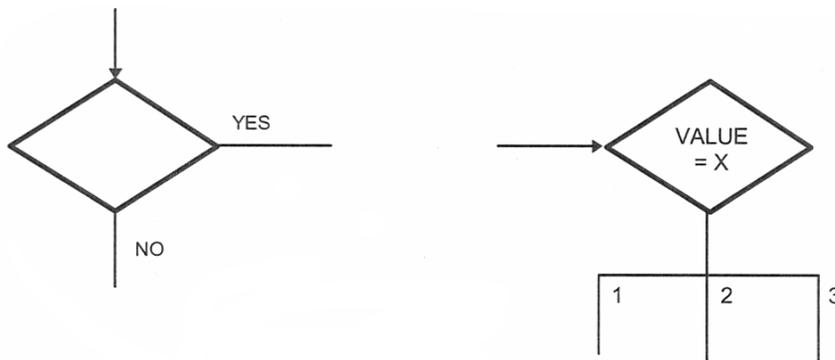
NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE A-12. Annotation/comment block.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

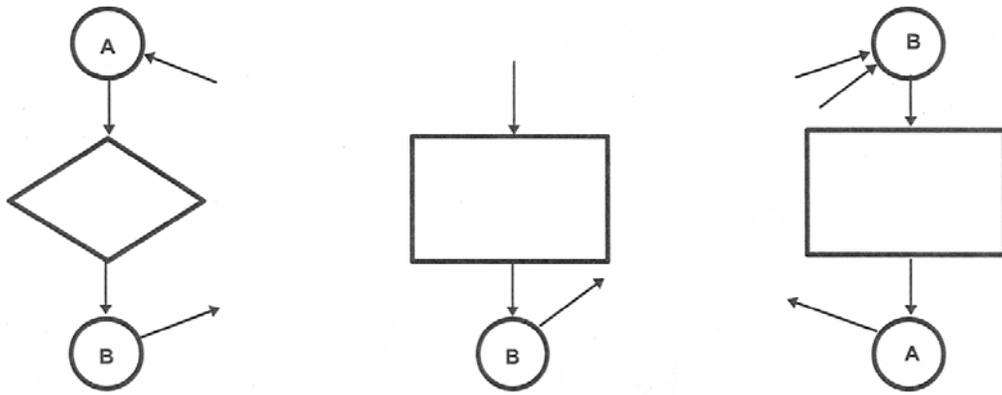
FIGURE A-13. Process blocks.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

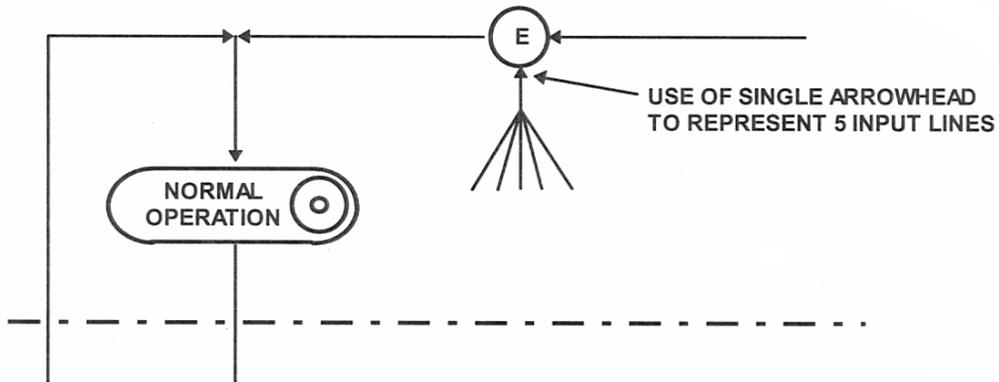
FIGURE A-14. Decision blocks.

MIL-DTL-24784D(NAVY)  
APPENDIX A



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

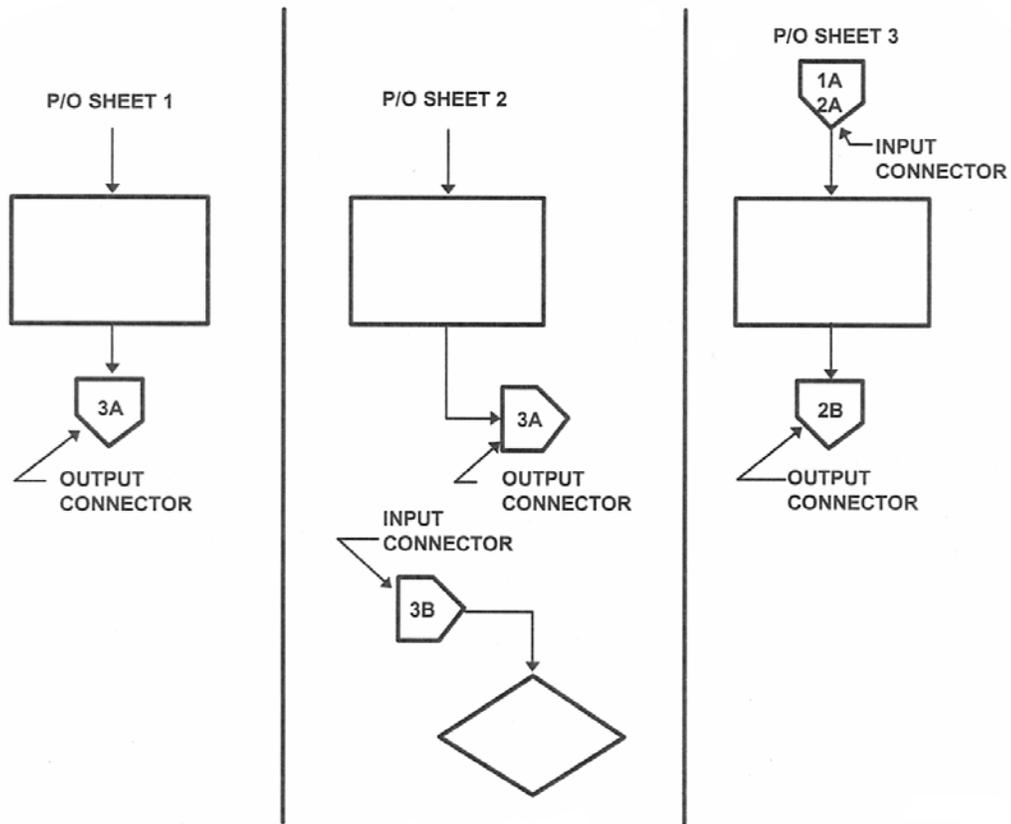
FIGURE A-15. On-page connectors.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE A-16. Multiple on-page connector variant.

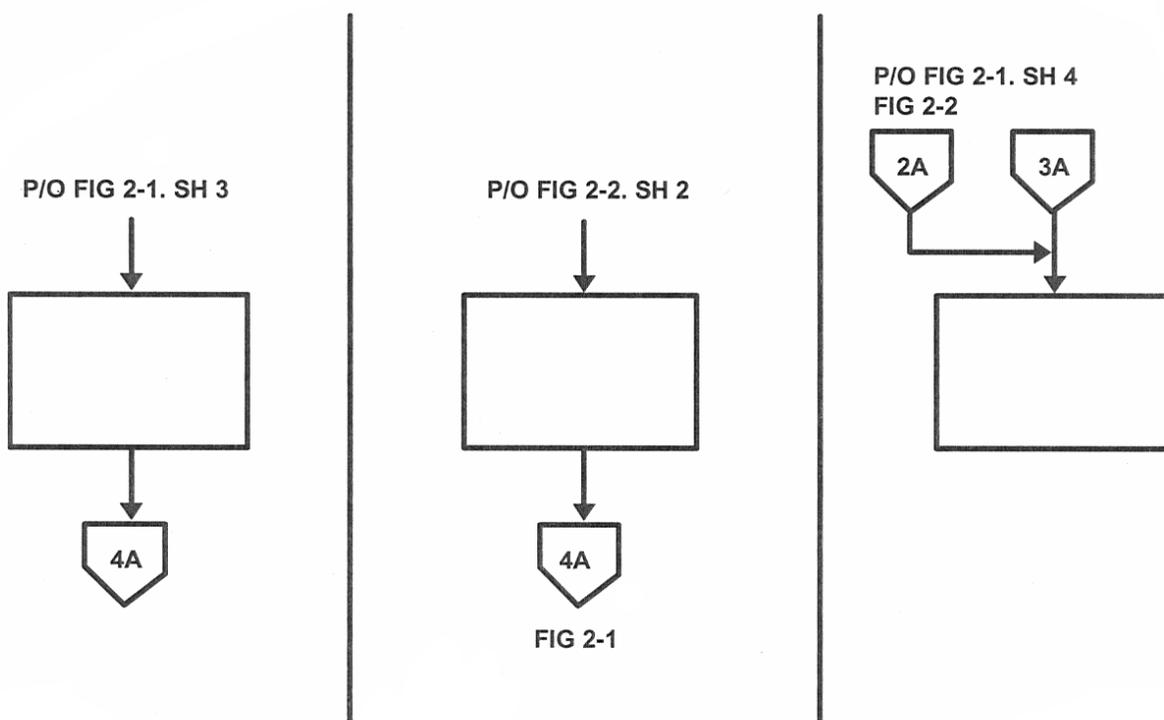
MIL-DTL-24784D(NAVY)  
APPENDIX A



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

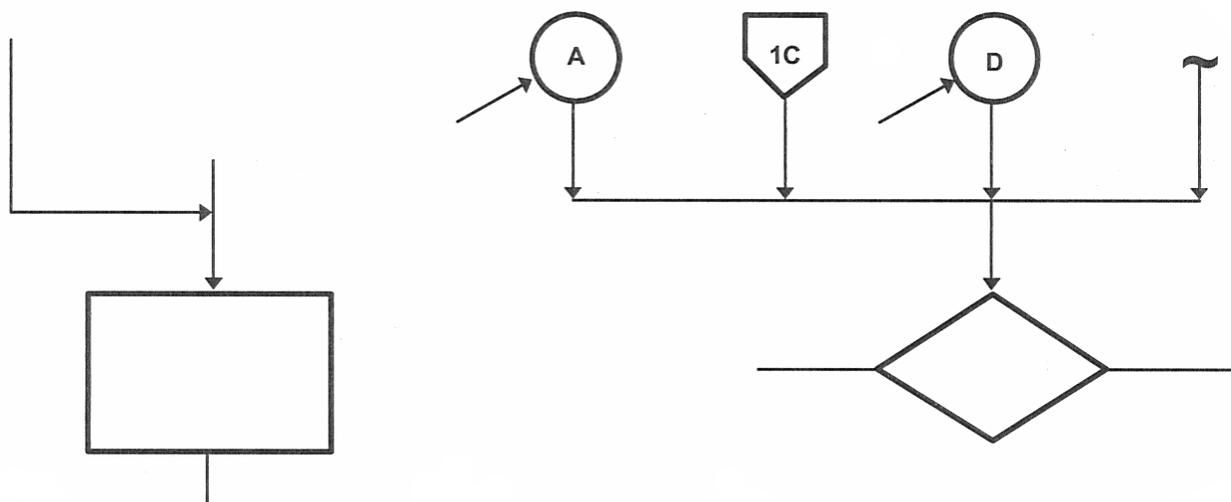
FIGURE A-17. Off-page connectors.

MIL-DTL-24784D(NAVY)  
APPENDIX A



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

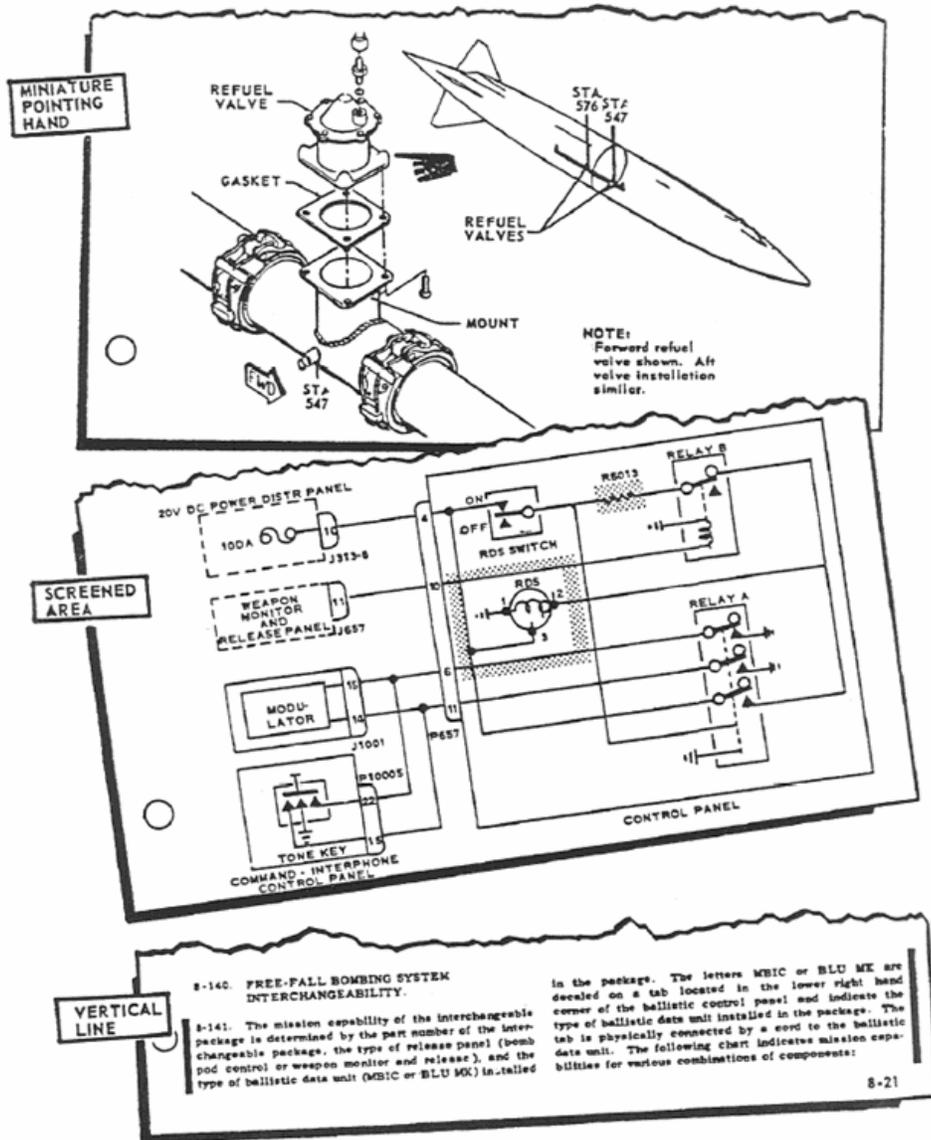
FIGURE A-18. Use of multiple input off-page connectors.



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE A-19. Line intersections.

MIL-DTL-24784D(NAVY)  
APPENDIX A



NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE A-20. Example revision indicators.

MIL-DTL-24784D(NAVY)  
APPENDIX BSPECIFIC DEVELOPMENT REQUIREMENTS FOR PAGE-BASED MODULAR-FORMAT TECHNICAL  
MANUALS

## B.1 SCOPE

B.1.1 Scope. This appendix establishes the style, format, front matter, other supporting requirements, and products for page-based modular-format technical manuals (TMs). This appendix is a mandatory part of this specification. The information contained herein is intended for compliance.

## B.2 DEVELOPMENT OF PAGE-BASED MODULAR-FORMAT TECHNICAL MANUALS

B.2.1 General. The following are unique requirements applicable to page-based modular-format TMs developed in accordance with MIL-DTL-24784/22 and /23.

B.2.2 Development products.

B.2.2.1 Book plan. When specified by the acquiring activity (see 6.2), a book plan shall be developed for each TM. Format and content requirements of the TM book plan shall be as specified (see 6.2). The TM book plan contains a detailed overview of the proposed scope of the manual, including identifying major paragraphs, tables, and illustrations planned for the manual in compliance with this document. The book plan shall be submitted to the acquiring activity for acceptance prior to development of the RDC or the PTM.

B.2.2.1.1 Model manual. When specified by the acquiring activity (see 6.2) or approved by the Government, an existing manual covering similar system/equipment in a modular-format shall be used, marked up, and submitted to satisfy the requirements of the book plan. The text from the model manual shall be used verbatim with changes to cover the equipment differences and to correct inconsistencies, unclear wording, or obvious editorial or typographical errors. For all new manuals, the format requirements in this specification shall apply. All inconsistencies, unclear wording, or errors noted in the model manual shall be identified to the Government. All deviations from the model manual shall be approved by the Government.

B.2.3 Divisions and arrangement.

B.2.3.1 TM divisions. Modular-format TMs shall be divided into volumes, modules, paragraphs, tasks, and subtasks (procedures), as appropriate. Where there is a Volume 1, there shall be a Volume 2. All volumes and modules shall be titled. Breakout shall be planned to subordinate that which should be subordinated.

B.2.3.1.1 Volumes. When a publication exceeds 1,500 printed pages (750 sheets), the manual shall be divided into volumes (separately bound segments). Each volume is essentially an independent manual and shall include applicable front and rear matter. Volumes shall be separated by complete modules where possible. Each volume shall be identified by a unique TMIN, title, and subtitles that describe the contents.

B.2.3.1.2 Modules. Modules are used to logically divide all data required for a certain function (for example, descriptive information, operator's instructions, maintenance, IPB data, and troubleshooting). Each module shall consist of a title, initial setup information (when required), supporting information, and technical content as described in MIL-DTL-24784/22 and /23. These data types can be further divided into sub-modules, paragraphs, tasks, and subtasks (procedures).

B.2.3.2 TM arrangement. Each manual shall be arranged according to the following standardized format:

- a. Front matter.
- b. Technical content modules.
- c. Rear matter.

B.2.3.2.1 Front matter. Material preceding the first technical content module shall consist of the following, as applicable, in the order specified:

- a. Cover/title page.
- b. Revision summary.
- c. Table of Contents.

MIL-DTL-24784D(NAVY)  
APPENDIX B

- d. List of Illustrations.
- e. List of Tables.

B.2.3.2.1.1 Cover/title page. See 3.6 for general requirements applicable to all TM types. The bar code and human readable NSN shall be displayed on the cover/title page.

B.2.3.2.1.2 Revision summary. When a revision to a TM is issued, a revision summary shall be provided. The revision summary shall contain a list of modules by title that have been revised and for each module listed, a brief description of the major changes. The titles of revised modules shall be linked to the module containing the revised information. As applicable, the revision summary shall also describe the method(s) used to identify new and changed material in the manual (i.e., font color change for text, miniature pointing hands within illustrations, etc.).

B.2.3.2.1.3 Table of Contents. A Table of Contents listing front matter, the technical content modules and associated paragraphs, and rear matter in the same order and with the exact titles, with the module number and page number, shall be placed at the beginning of each publication (see [figure B-1](#)). The security classification, if any, of titles shall be indicated. The Table of Contents shall be in “traditional” order (for example, in the order of occurrence). In publications containing alphabetical indexes, only primary and first subordinate paragraphs shall be listed in the Table of Contents. There shall be no Table of Contents preceding individual modules.

B.2.3.2.1.4 List of Illustrations. Publications containing graphics (including illustrations, drawings, charts, and graphs) with assigned figure numbers shall have a List of Illustrations showing the figure number, title, module number, and page number of each figure. This list shall include foldout pages. The security classification, if any, of illustration titles shall be indicated. Layout shall be in accordance with [figure B-2](#).

B.2.3.2.1.5 List of Tables. Publications containing tables (including charts with assigned table numbers) shall have a List of Tables showing the table number, title, module number, and page number of each table. The security classification, if any, of table titles shall be indicated. Layout shall be in accordance with [figure B-2](#). When both are brief, the List of Illustrations and List of Tables may be included on the same page.

B.2.3.2.2 Technical content. See MIL-DTL-24784/22 and /23 for technical content data requirements.

B.2.3.2.2.1 Module title block. All modules shall have and begin with a title block. The module title block (see [figure B-3](#)) shall contain the following data:

- a. Maintenance levels: The maintenance level(s) shall be stated, for example: “ORGANIZATIONAL MAINTENANCE”.
- b. Module title: The title shall describe the general subject or maintenance task and follow the maintenance level, for example: “REPAIR”. For the troubleshooting module, the specific symptom or malfunction may be used when necessary in lieu of a general subject or maintenance task title.
- c. End item nomenclature: The end item nomenclature, such as the system, subsystem, or equipment (including AN type designation), shall follow the module general title. When applicable, the model(s) and part number(s) shall be placed below the nomenclature. When the module covers more than one model or part number, all models or part numbers shall be listed.
- d. Effectivity: If applicable, effectivity shall be included in the title block.
- e. Supplement notice: If applicable, a cross-reference notice to supplements shall be included, for example: “This module is incomplete without module 042 00 contained in confidential supplement, SE105-XX-XXX-010.”
- f. The technical content for the module shall begin immediately after the title block’s content (below the bottom horizontal line).

B.2.3.2.3 Rear matter. Rear matter shall consist of the following, as applicable, in the order specified:

- a. Acronyms and abbreviations list.
- b. Alphabetical index.
- c. Numerical index of part numbers (see 3.6.5 of MIL-DTL-24784/23).
- d. Reference designation index (see 3.6.6 of MIL-DTL-24784/23).
- e. TMDER form.

MIL-DTL-24784D(NAVY)  
APPENDIX B

- f. Back cover.
- g. Backbone.

B.2.3.2.3.1 Acronyms and abbreviations list. A consolidated list shall be prepared to identify and define all abbreviations, acronyms, and uncommon terms used in the TM. The list shall be treated as a module and precede the alphabetical index, if any.

B.2.3.2.3.2 Alphabetical index. When specified by the acquiring activity (see 6.2), an alphabetical index shall be developed (see [figure B-4](#)). The alphabetical index shall begin on a right-hand page and shall be located at the end of the publication but be located before foldout page(s). The primary purpose of this index is to provide access to the technical content modules contained in the manual and further to the primary technical content information contained within each module. The alphabetical index shall list each nomenclature referenced in a publication. Each unique nomenclature shall have indented, subordinate entries that link to the module or the primary technical content applicable to that index.

B.2.3.2.3.3 TMDER. The TMDER Form NAVSEA 4160/1 shall be included at the back of each NAVSEA TM. The TMDER is a user activity TM comment sheet and shall be used to provide feedback on corrections and suggested improvements to the methods and procedures specified by a TM.

B.2.3.2.3.4 Back cover and backbone. Manuals shall have an outside back cover and contain the information indicated by [figure A-5](#). The overall classification of the manual shall be shown on the back cover when the manual itself is classified. When specified by the acquiring activity (see 6.2), a backbone shall be prepared and contain the information indicated by [figure A-5](#). The overall classification of the manual shall be shown on the backbone when the manual itself is classified.

#### B.2.4 Style and format.

B.2.4.1 Page size, reproduction area, and margins. Manuals shall be prepared in 8½- by 11-inch size with a maximum reproduction area of 7¼ by 10 inches. The binding edge margin shall not be less than 1 inch and the outside edge margin not less than ¼ inch.

B.2.4.2 Column format. Text format shall be single column (page-wide).

B.2.4.3 Text placement. Left justification shall be used for all lines of text displayed as sentences or paragraphs. Text shall not be wrapped around an illustration.

B.2.4.4 Type style, capitalization, leading, and vertical spacing. All text, titles, headings, numbers, and callouts shall be sans-serif font. Font style, size, and capitalization shall be as identified in [figure B-5](#). Layout shall conserve space without lessening usability or clarity of material. Blank pages and spaces shall be avoided whenever possible. Leading and vertical spacing as indicated by [figure B-5](#) shall be used for best legibility and conservation of space. Narrative text shall be single spaced (double spaced between procedural text). Double spacing of text within a paragraph, or similar wastefulness, is unacceptable. Layout practices shall not result in:

- a. The first line of a paragraph being at the bottom of a page.
- b. The last line of a paragraph being at the top of a new page.
- c. A paragraph title falling on the last line of a page.
- d. Dangers, warnings, cautions, and notes being divided so that first lines or group of icons appear on one page and remaining lines or group of icons on another.
- e. Dangers, warnings, cautions, and notes being separated from the paragraph that they apply to.
- f. Undesirable location of an illustration or table.

B.2.4.5 Margin data. Margin data (the running heads and feet) shall be placed outside that portion of the page used for the module title block, narrative text, full-page tabular data, or full-page illustrations, but within the reproduction area dimensions of the page.

MIL-DTL-24784D(NAVY)  
APPENDIX B

B.2.4.5.1 Running heads and feet. Complete running heads and feet shall be included on all pages except cover/title pages, back cover, TMDER form, or pages otherwise blank within an unclassified manual. Blank pages that back up classified pages shall be marked with the security classification of the backed up page.

B.2.4.5.1.1 Running heads.

B.2.4.5.1.1.1 Security classification. The security classification of classified manuals shall be placed at the top center of each page, including unclassified pages, in bold face type in accordance with DoDI 5200.01. For foldouts, the security classification shall be placed between the TMIN and the module number, in bold face type, and be repeated continuously approximately every 4 inches.

B.2.4.5.1.1.2 TMIN. The TMIN, as assigned by the Government, shall be in bold face type at the extreme upper left corner of the reproducible area and outer segment (page unit) of each foldout page. If the manual will be jointly used, only the acquiring activity's TMIN shall be used on the interior pages of the manual.

B.2.4.5.1.1.3 Module number. The module number shall be placed on each page of the module in the extreme upper right corner of the reproduction area.

B.2.4.5.1.2 Running feet.

B.2.4.5.1.2.1 Page number. Page numbers shall be located at the lower outer edge ending at the outside margin and shall be in bold face type. Even numbers shall be assigned to left-hand pages and odd numbers to right-hand pages. For a foldout page, the page number shall be placed in the running foot area of the page, directly under the figure number and title, and shall be aligned with the right margin, so that the number is visible when the printed page is folded.

B.2.4.5.1.2.2 Security classification. The security classification of classified manuals shall be placed at the bottom center of each page, including unclassified pages, in bold face type in accordance with DoDI 5200.01/DoDM 5200.01. For foldouts, the security classification shall be marked at the bottom of the page in bold face type,  $\frac{3}{4}$  inch from the right-hand edge and repeated continuously to the left with 4 inches of space between each marking, aligned with the classification markings used in the running head.

B.2.4.5.1.2.3 Foldout figure number and title. The figure number and title for the illustration on a foldout page shall be placed below the figure, in the lower outer corner, justified with the right margin, so that the number is visible when the printed page is folded.

B.2.4.6 Paragraph titles. Paragraphs and subparagraphs within a module may have titles that describe that paragraph's contents. The title shall begin at the left margin and end with a period. There shall be no more than five levels of paragraphs used. Paragraph and subparagraph titles shall be formatted as follows:

- a. Primary (first level) titles shall be bold, all capital letters, and stand alone. Paragraph text begins flush left.
- b. Second level titles shall be bold, all capital letters, with the paragraph text run-in.
- c. Third level titles shall be bold, the first letter of the first word and of each principal word capitalized, with the paragraph text run-in.
- d. Fourth level titles shall be regular type, the first letter of the first word and of each principal word capitalized, with the paragraph text run-in.
- e. Fifth level titles shall be italic, the first letter of the first word and of each principal word capitalized, with the paragraph text run-in.

B.2.4.7 Procedural steps. Procedural steps shall not have titles. Procedural steps are placed immediately after paragraph or subparagraph titles or, if applicable, after a small paragraph that introduces the procedural steps. Procedural steps may be divided into no more than four levels. Single substeps may be used, but a minimum of two is recommended. Procedural steps and sub-steps shall be formatted as follows:

- a. Procedural steps in a paragraph structure begin two lines below the preceding text. Text begins approximately two spaces after the period following the step number/letter. All text is blocked.
- b. First level procedural steps begin at the left margin.

MIL-DTL-24784D(NAVY)  
APPENDIX B

c. Each level of substep begins two lines below the preceding step and is aligned under the first word of the previous level step.

### B.2.5 References.

B.2.5.1 Textual references. References to another TM or volume of the same TM shall conform to the following:

a. When referring to the entire content of another TM or volume, present the reference as: TMIN, TM title. Subsequent references may truncate the reference to the TMIN only when it causes no reader confusion.

b. When referring to specific content within another TM or volume, the reference should be specific enough to direct the reader to the desired location. Present the reference in the following manner, as applicable: TMIN, TM title, volume, module, and paragraph, table, or figure number and title. Subsequent references may truncate the reference to the TMIN and the specific location (e.g., SE555-AB-MMO-020, module 006 00, Table 2) when it causes no reader confusion.

c. References to material within the same TM shall conform to the following:

(1) Create links within paragraphs, steps, and tables to internal references.

(2) Refer to paragraphs by paragraph number and title (e.g., 3.3 TASK DESCRIPTION). Reference to a subordinate paragraph within the same primary paragraph may be presented as “above” or “below”.

(3) Refer to procedural steps by step number (e.g., step 3).

(4) Refer to tables by table number (e.g., Table 6).

(5) When reference is made to data within another module, it shall be by module number and title and paragraph, table, or figure number and title.

(6) Footnotes are not allowed within text; use notes when applicable.

d. References to figures shall conform to the following requirements:

(1) Refer to figures by figure number (e.g., Figure 2), including sheet number for multi-sheet figures (e.g., Figure 6 [Sheet 3 of 10]).

(2) Refer to a section of a multi-section figure by section letter and figure number (e.g., A, Figure 3).

(3) Refer to callouts (e.g., index number, reference designation) on a figure by callout first, followed by the figure number (e.g., [3, Figure 2] or [S1, Figure 3]). However, when multiple references in a paragraph refer to the same figure, only the first reference need indicate the figure number. Additional references need indicate only the callout number until the sequence is broken by a reference to a different figure number. If the sequence is unbroken for procedures requiring two or more pages, the figure number shall be repeated on each succeeding page.

(4) Reference to a zone on a figure shall be by zone number first then zone letter to avoid possible confusion with reference designations.

(5) Refer to parts on figures by enough of their reference designation to identify the item (e.g., Resistor A6R11).

B.2.5.2 Frequently used maintenance tasks. Frequently used maintenance tasks, such as applying external electrical or hydraulic power, shall be prepared once as a common maintenance task and linked as a common step in all other maintenance tasks requiring the need for external electrical or hydraulic power. It is not necessary to link supporting graphics to common steps with linked tasks.

B.2.5.3 Tasks performed by other work centers. Procedures that require performance of tasks by technical personnel other than those normally assigned to the subject task shall be referenced in the introductory information for the module and in the text. For example, if the primary task is removal of a component of the piping system that is inaccessible without removal of a component of the sewage ejection/holding system, a preparatory step of the procedure shall be, “Remove CHT pump (NAVSEA 0905-LP-092-4060).”

B.2.5.4 Post maintenance action referencing. When required, the last step of a procedure shall reference any post maintenance actions necessary to ensure the initial procedure has been successfully completed. The reference shall be to the associated module number and procedure title.

MIL-DTL-24784D(NAVY)  
APPENDIX BB.2.6 Use of terminology, nomenclature, numbers, and equations.

B.2.6.1 Abbreviations and acronyms. Use of abbreviations and acronyms shall be held to a minimum and each shall be spelled out the first time it appears in each module and where confusion may exist or usability will be enhanced. An excellent rule to follow is “when in doubt, spell it out”.

B.2.7 Tabular material. Tabular information shall be displayed as cells of textual information or a graphic. Textual elements within tables shall conform to the requirements herein for textual information. Graphical elements within a table shall conform to the requirements herein for graphical information.

B.2.7.1 Table format. Three categories of tables are allowed in a TM: CALS tables, simple tables, and standardized information tables. Refer to the appropriate Tagging and Authoring Guidelines for specific tagging and authoring guidance for all tables.

B.2.7.1.1 CALS tables and simple tables. CALS tables and simple tables shall conform to the following:

- a. Tables shall have column headers and, if applicable, row headers. Include the units of measure in row or column headings if the entries are in measurable quantities. If several different units are used in the same rows or columns, place the units of measurement next to each entry.
- b. Borders for table headers shall be the same size as the rest of the table. Borders for table cells shall be single or double lines. Small tabular text may have no borders.
- c. Entries within tables shall be single spaced. Insert a dash (-) to indicate an entry that is intentionally left blank.
- d. Align related entries in different columns. Align alphabetic or alphanumeric data flush left. Align column entries containing numerical data as follows:
  - (1) Decimal numbers on the decimal point.
  - (2) Scientific notation on the multiplication symbol.
  - (3) All other numerical data flush right.

B.2.7.1.2 Standardized information tables. Standardized information tables provide a method to ensure consistent presentation to the end-user for common information. MIL-DTL-24784/22 specifies which tables are standard information tables. There shall be no deviations to the number of columns or the column head titles established in the standard.

B.2.7.2 Table titles. Tables shall be assigned table titles. The title shall follow two spaces after the word “Table” and the table number and shall be centered above the applicable table. The first letter of the first word and of each principal word shall be capitalized. Full-page tables, placed sideways on a page, shall be turned 90 degrees counterclockwise. The table number and title for a turned table shall also be turned 90 degrees counterclockwise to stay centered above the table. Table titles shall begin with an identifying name when applicable (e.g., “Table 3. Guidance System Test Points”). The title shall be short and describe the contents or purpose of the table. Tables applicable to one Service, in a manual that will be used by more than one Service, shall be identified (e.g., “Table 2 (Navy Only). Fuel Indicator Correction Factors”).

B.2.7.3 Continued table material. When a table is continued on a following page, the table number and title shall be repeated above the table on all following pages of the table, followed by a dash and the word “Continued”. Table head titles shall also be repeated. The above information shall not be repeated on a following page when the page is a foot page of a head to foot tabular arrangement. When a table entry is continued, the entry or its identifying number or letter from the first column shall be repeated in the first column followed by a dash and the abbreviation “Cont”.

B.2.7.4 Footnotes in tables. Footnotes shall be placed immediately below the table in which they are referenced. A 1-inch horizontal rule shall be placed flush left below the table and the footnote placed under the rule. Footnotes at the end of the table shall begin two lines below the closing rule of the table. All lines of footnotes shall be aligned with the left margin of the table. If a table is continued onto other pages, all footnotes shall be placed at the end of the table and the header note “See footnotes at end of table” shall be placed immediately following the table title block.

MIL-DTL-24784D(NAVY)  
APPENDIX BB.2.8 Numbering.

B.2.8.1 Cover and title pages. The cover and title page shall not be numbered.

B.2.8.2 Front matter. Lower case Roman numerals (in sequence i, ii, iii, and so forth) shall be used in numbering front matter pages (Table of Contents, Revision Summary, List of Illustrations, and List of Tables).

B.2.8.3 Volumes. Volumes shall be identified sequentially by a unique TMIN as provided by the Government, and include subtitles indicative of volume content.

B.2.8.4 Module number. Each module shall be assigned a permanent number. The module number shall be considered permanent upon distribution of the basic issue of the manual and shall not change. Module numbers may be changed only when a complete revision to a manual is authorized by the acquiring activity. The module number shall be placed on each page of the module in the extreme upper right corner of the reproduction area.

B.2.8.5 Paragraphs. Paragraphs contained within a module shall be numbered consecutively in Arabic numerals separated with a period (.). For example, the first primary paragraph within a module shall be numbered 1, the first second-level paragraph below it shall be numbered 1.1, the first third-level paragraph below that shall be numbered 1.1.1, the next second-level paragraph shall be numbered 1.2, and the second primary paragraph within the module shall be numbered 2.

B.2.8.6 Procedural steps. When necessary, procedural steps may be divided into no more than four levels. Single substeps may be used, but a minimum of two is recommended. Procedural steps shall be numbered as follows:

- a. First level - consecutively with Arabic numerals, followed by a period.
- b. Second level - consecutively with lower case letters followed by a period.
- c. Third level - consecutively with Arabic numerals enclosed in parenthesis.
- d. Fourth level - consecutively with lower case letters enclosed in parenthesis.

B.2.8.7 Sequential lists. Sequential list items shall be numbered as follows:

- a. First level - consecutively with lower case letters followed by a period.
- b. Second level - consecutively with Arabic numerals enclosed in parenthesis.
- c. Third level - consecutively with lower case letters enclosed in parenthesis.
- d. Fourth level - consecutively with Arabic numerals followed by a period.
- e. Fifth level - consecutively with lower case Roman numerals followed by a period.

B.2.8.8 Pages, tables, and illustrations. The pages of each module shall be numbered consecutively in Arabic numerals beginning with the number 1. Tables and figures within a module shall be numbered consecutively in Arabic numerals beginning with the number 1.

B.2.8.9 Blank pages. Blank pages shall be assigned a page number, but the page number and the word "blank" shall appear in parentheses on the preceding page following the preceding page number (for example, "15/(16 blank)"). For classified manuals, the statement "THIS PAGE IS UNCLASSIFIED", shall be included, centered on the blank page.

B.2.8.10 Foldout figure numbers. Foldout figures shall be numbered in the same manner as a standard size illustration/figure. Numbers shall start with the next number after the last standard size illustration figure number in the module.

B.2.8.11 Foldout page numbers. The page numbers for foldout pages shall follow normal page numbering sequence. The first foldout page of a module shall be assigned the next number after the last standard size text or illustration page number of the module. The reverse side of foldout pages shall be blank. Each foldout page number shall include a blank page notation (for example, "27/(28 blank)").

MIL-DTL-24784D(NAVY)  
APPENDIX B

B.2.8.12 Footnotes. Footnotes may be used within tables. Footnotes shall be numbered using consecutive Arabic superior numbers beginning with “1”. Footnote numbers and text shall be separated by two spaces. The numbering system shall be per table, as applicable.

B.2.9 Graphics.

B.2.9.1 General graphic requirements. See 3.7.8.3 for additional general graphic requirements.

B.2.9.1.1 Illustration titles. Illustrations shall be assigned figure titles. The title shall follow two spaces after the word “Figure” and the figure number, and be centered below the figure. The first letter of the first word and of each principal word shall be capitalized. Full-page illustrations, placed sideways on a page, shall be turned 90 degrees counterclockwise. The figure number and title for a turned illustration shall also be turned to appear below the illustration. For foldouts, place the word “Figure” and the figure number and title in the lower outer corner of the page so that the number is visible when the printed page is folded. Figure titles shall begin with an identifying name when applicable (e.g., “Figure 3. Guidance System Gyroscope Assembly”). The title shall be short and describe the contents or purpose of the illustration. Illustrations applicable to one Service, in a manual that will be used by more than one Service, shall be identified (e.g., “Figure 2 (Navy Only). Fuel Indicator”).

B.2.9.1.2 Illustration placement. Each illustration shall be included as part of a paragraph or follow as closely as possible to its first reference in the narrative text or be placed at the end of the module. Use of foldout illustrations is discouraged. However, when an illustration does require a foldout sheet, such as for a large schematic diagram, it shall be located at the end of the module.

B.2.9.1.3 Legends. Legends shall not be used in an Illustrated Parts Breakdown illustration. Legends shall be included on, adjacent to, or facing the artwork. When index numbers are used, a legend consisting of their numerical listing and their identification shall be included.

B.2.9.1.4 Foldout pages. When usability is not affected, multi-sheet illustrations shall be in lieu of foldouts. Foldup-foldout pages shall not be used. If approved by the acquiring activity (see 6.2), foldout pages may be prepared and shall meet the following requirements:

- a. Maximum page size for the foldout shall be 26 by 11 inches. Printable area is 24¾ by 10 inches.
- b. All foldout pages shall be prepared for printing on one side only.
- c. Foldout pages shall not be spliced.
- d. Foldout pages shall fall at the end of modules.

B.2.10 Style, format, and content for revisions. The revised TM shall be in accordance with the style, format, content, and arrangement of the existing manual. All pages, paragraphs, subparagraphs, procedural steps, list items, illustrations (including index numbers used within an illustration), and tables shall be renumbered, as necessary, to eliminate all number suffixes and to establish correct sequence. All previous revision indicators shall be eliminated. The revised TM shall include the following as applicable:

- a. A revised title page and, when required, a front cover, back cover, and backbone.
- b. New or revised front matter, including a revision summary.
- c. New or revised text, illustrations, tables, and indices.
- d. Current instructions for contacting Distance Support and for reporting TM deficiencies and suggested improvements, including the current TMDER Form NAVSEA 4160/1. The text in [figure 1](#) shall be included (verbatim).

MIL-DTL-24784D(NAVY)  
APPENDIX B

B.2.10.1 Display of new or changed material. Unless otherwise specified by the acquiring activity (see 6.2), new or changed material will be displayed to the end user as normal text without revision indicators (no differentiation in font style or color for text and no shading or pointing hands on drawings and illustrations). When specified by the acquiring activity (see 6.2), after all previous revision indicators have been eliminated, new or changed material shall be identified/displayed as follows:

a. New or changed text within the main body of the TM shall be displayed in green italic font. The green italic font style is not required for changed or added front matter, replacement or addition of a complete module, or for the correction of minor inaccuracies, such as spelling, punctuation, relocation of material, and renumbering, unless such correction changes the meaning of the information.

b. Change marks shall be applied to the complete danger, warning, caution, or note and not to individual words or paragraphs it contains.

c. Additions or changes to line drawings, charts, illustrations, graphs, diagrams, and schematics shall be indicated by screens (shading), screened (shaded) boxes, or miniature pointing hands to highlight updated areas (see [figure B-6](#)). Extensively changed presentations shall be indicated by a screen border around the affected area. For minor changes not suited to shading or screening, a miniature pointing hand shall be used.

B.2.10.2 Revision summary. A revision summary shall include a listing of the modules by title that have been revised and, for each module listed, a brief description of the major changes. The titles of revised modules shall be linked to the module containing the revised information. As applicable, the revision summary shall also describe the method(s) used to identify new and changed material in the manual (i.e., font color change for text, miniature pointing hands within illustrations, etc.).

MIL-DTL-24784D(NAVY)  
APPENDIX B

TABLE OF CONTENTS

<u>Title</u>	<u>IP/Page Number</u>
<b>Front Matter</b>	
LIST OF EFFECTIVE INFORMATION PACKAGES/PAGES .....	i
REVISION SUMMARY .....	iii
LIST OF ILLUSTRATIONS .....	v
LIST OF TABLES .....	vi
<b>General</b>	
GENERAL INTRODUCTION .....	001 00/1
MODEL DIFFERENCES .....	002 00/1
<b>Supporting</b>	
SAFETY PRECAUTIONS .....	003 00/1
REFERENCE PUBLICATIONS .....	004 00/1
EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED .....	005 00/1
<b>Descriptive</b>	
OPERATOR'S CONSOLE PHYSICAL ARRANGEMENT .....	006 00/1
POWER SUPPLY COMPONENTS .....	006 00/3
AC Power Requirements .....	006 00/4
DC Power Requirements .....	006 00/5
COOLING SYSTEM COMPONENTS .....	006 00/5
HSI COMPONENTS .....	006 00/8
MAINTENANCE CONSOLE PHYSICAL ARRANGEMENT .....	007 00/1
SYSTEM DESCRIPTION .....	008 00/1
SYSTEM/EQUIPMENT CHARACTERISTICS/CAPABILITIES .....	009 00/1
<b>Hull, Mechanical, and Electrical System Functional Description</b>	
INTRODUCTION .....	010 00/1
SIMPLIFIED FUNCTIONAL DESCRIPTION .....	011 00/1
POWER SUPPLY .....	011 00/2
COOLING SYSTEM .....	011 00/4
HSI SYSTEM .....	011 00/5
DETAILED FUNCTIONAL DESCRIPTION .....	012 00/1
<b>Rear Matter</b>	
ABBREVIATIONS AND ACRONYMS .....	013 00/1
ALPHABETICAL INDEX .....	014 00/1
PART NUMBER INDEX .....	015 00/1
REFERENCE DESIGNATION INDEX .....	016 00/1
TMDER	

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE B-1. Example Table of Contents (modular-format TMs).

MIL-DTL-24784D(NAVY)  
APPENDIX B

## LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Title</u>	<u>IP/Page Number</u>
1	UYQ-XX Console .....	001 00/2
1	Equipment Cabinet .....	006 00/7
2	Power Control Panel .....	006 00/13
1	Basic Fault Isolation Flowchart .....	019 00/3
2	Radar Test Pattern .....	019 00/16
3	Over-Temperature Fault Isolation Flowchart .....	019 00/17
4	Battery Backup Fault Isolation Flowchart .....	019 00/19

## LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>IP/Page Number</u>
1	Power Control Panel Controls and Indicators.....	006 00/9
1	Pixel Data Format.....	009 00/9
2	Radar Signals.....	009 00/18
3	Analog Video Inputs.....	009 00/22
4	Base Address Switch Settings .....	009 00/25
1	Console Switch Settings .....	017 00/5
2	Console Door Safety Latch.....	017 00/12

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE B-2. Example List of Illustrations and List of Tables (modular-format TMs).



MIL-DTL-24784D(NAVY)  
APPENDIX B

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(U) ALPHAINDEXIP  
BUNN-O-MATIC COFFEE BREWERS

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<u>Title</u>	<u>IP/Page Number</u>
<b>BUNN-O-MATIC AUTOMATIC COFFEE BREWERS</b>	
ADDITIONAL INFO TITLE.....	001 00/5
ALERTINFOR TITLE.....	001 00/3
EFFECTIVITIES.....	001 00/1
END ITEM DESCRIPTION.....	001 00/1
ESDINFO TITLE.....	001 00/3
GENERALINTROIP.....	001 00/1
NUCLEAR REQUIREMENTS.....	001 00/2
PURPOSE.....	001 00/1
TMDER INSTRUCTIONS.....	001 00/1
VOLUME INFORMATION.....	001 00/5
WARRANTY.....	001 00/5
<b>BUNN-O-MATIC COFFEE BREWERS</b>	
ALIGNMENTSYNOPSIS TITLE.....	042 00/1
INTRODUCTIONIP.....	041 00/1
MAMS IP.....	067 00/1
OPERATIONAL CHECKOUT TROUBLESHOOTING IP.....	062 00/1
OPERATIONAL CHECKOUT TROUBLESHOOTING IP (TEST PROCEDURE).....	063 00/1
OPERATIONALCHECKOUTIP.....	064 00/1
OPERATIONALCHECKOUTIP.....	065 00/1
PROCEDURESYNOPSISIP.....	042 00/1
SECOND TITLEDPARA.....	041 00/1
SERVICE.....	059 00/1
SERVICE.....	067 00/1
SERVICE 1.....	041 00/1
TESTPROCEDURE TITLE.....	063 00/1
TESTPROCEDURE TITLE.....	063 00/1
TROUBLESHOOTING REFERENCE IP.....	059 00/1
<b>G1000</b>	
ACTIVESYSTEMTESTINFO TITLE.....	052 00/1
ACTIVESYSTEMTESTIP.....	052 00/1
ADDITIONALFUNCDESCIP.....	092 00/1
ADDITIONALSYSIP.....	087 00/1
ADJUST TITLE.....	045 00/4
ADJUSTALIGN TITLE.....	045 00/3
AEGISCOMBATSYSIP.....	074 00/1
ANTISUBWARFARESYSIP.....	079 00/1
CALIBRATE TITLE.....	045 00/4
CHECKOUT TITLE.....	045 00/4
CLEANING.....	043 00/12
CLEANING.....	044 00/6
CLEANING TITLE.....	045 00/4
COMBATDIRSYSIP.....	076 00/1

NOTE: Sample arrangement only. Size and legibility requirements do not necessarily conform to minimum specification requirements.

FIGURE B-4. Example of an alphabetical index information package.

MIL-DTL-24784D(NAVY)  
APPENDIX B

Use	Type Style/Size	Capitalization	Leading	Vertical Spacing
Publication Number	Bold 10	Upper case	--	36-points from top of page
Information Package Number	Bold 10	Upper case	--	36-points from top of page
Page Number	Bold 10	--	--	36-points from bottom of page
Security Classification	Bold 14	Upper case	--	36-points from top and bottom of page
Headings for: List of Effective Information Packages/Pages, Table of Contents, List of Illustrations, List of Tables	Bold 14	Upper case	--	48-points below publication number; 18-points above text
Information Package Title Block	Bold 14	Upper case	--	48-points below publication number; 18-points above text
Text	Regular 10	Upper and lower case	1	18-points below publication number or IP title block; 12-points above/below table or illustration; 6-points above page number; 12-points above/below Danger, Warning, Caution, and Note signal word panels
Emphasis	Italic Bold 10	Upper and lower case	1	--
Paragraph Number and Title:			2	18-points below publication number or IP title block; 12-points above/below text, table or illustration; 12-points above/below Danger, Warning, Caution, and Note signal word panels
Primary	Bold 10	Upper case		
Second-Level	Bold 10	Upper case		
Third-Level	Bold 10	Initial cap for first letter of first word and each principle word		
Fourth-Level	Regular 10	Initial cap for first letter of first word and each principle word		
Fifth-Level	Regular 10 (for number); Italic 10 for title)	Initial cap for first letter of first word and each principle word		

FIGURE B-5. Style, capitalization, leading, and vertical spacing (modular-format TMs).

MIL-DTL-24784D(NAVY)  
APPENDIX B

Use	Type Style/Size	Capitalization	Leading	Vertical Spacing
Procedural Step Number	Regular 10	--	2	12-points above/below text, table or illustration; 12-points above/below Danger, Warning, Caution, and Note signal word panels
Lists: Definition List Header	Bold 10	Initial cap	2	12-points above/below text, table or illustration; 12-points above/below Danger, Warning, Caution, and Note signal word panels
Sequential List Number and Title	Bold 10	Upper and lower case		
Figure (the word), Figure Number, and Title	Bold 10	Upper case for first letter of each principle word	2	18-points below illustration and 6-points above page number
Legend Text	Regular 8	Upper case for first letter of first word	1	28-points above illustration
Legend on Artwork	Regular 8	Upper case	1	As required
Table (the word), Table Number, and Title	Bold 10	Upper case for first letter of each principle word	2	18-points above table
Table Column Heads	Bold 10	Upper case for first letter of each principle word	1	--
Table Text	Regular 10	Upper and lower case	2	--
Rules	¾ point width	--	--	--
Table Footnotes	Regular 8	Upper and lower case	1	11-points below the 1-inch horizontal rule
GAPL Text	Regular 8 or 10	Upper and lower case	1	--
<p><b>NOTE 1:</b> Information within this table does not apply to text on the cover/title page, back cover, or backbone.</p> <p><b>NOTE 2:</b> Unless otherwise indicated, all type sizes may be plus-or-minus one point. Slight variations in spacing and leading are permitted.</p>				

FIGURE B-5. Style, capitalization, leading, and vertical spacing (modular-format TMs) – Continued.

MIL-DTL-24784D(NAVY)  
APPENDIX B

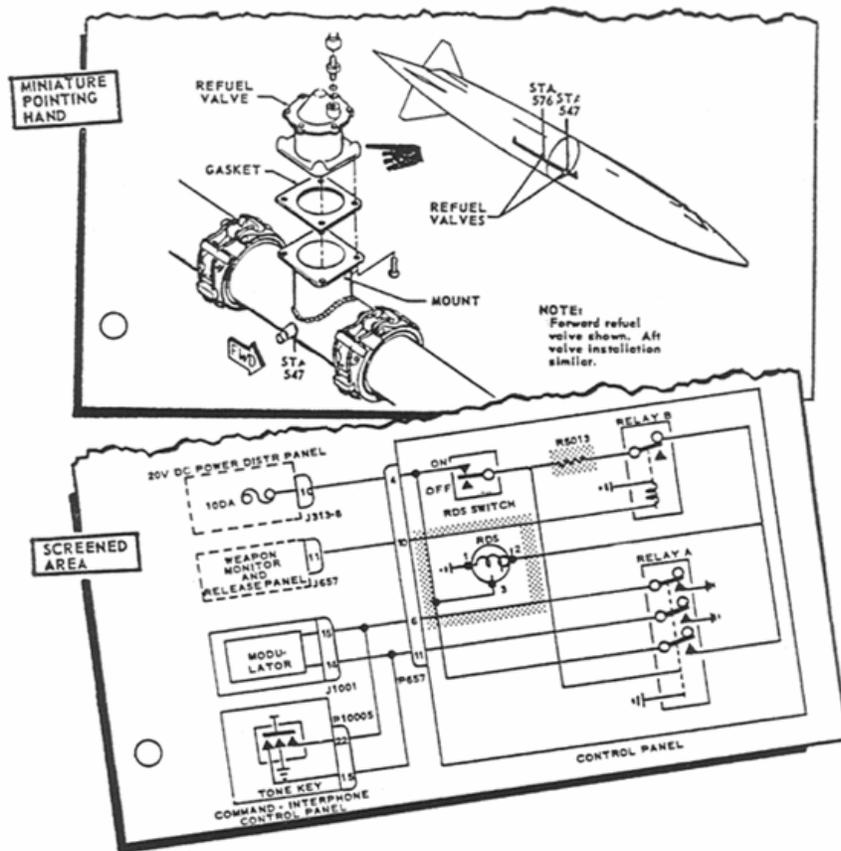


FIGURE B-6. Example revision indicators (modular-format TMs).

MIL-DTL-24784D(NAVY)  
APPENDIX CSPECIFIC DEVELOPMENT REQUIREMENTS FOR MODULAR-FORMAT INTERACTIVE ELECTRONIC  
TECHNICAL MANUALS

## C.1 SCOPE

C.1.1 Scope. This appendix establishes the style, format, front matter, other supporting requirements, and products for modular-format interactive electronic technical manuals (IETMs). This appendix is a mandatory part of this specification. The information contained herein is intended for compliance.

## C.2. DEVELOPMENT OF MODULAR-FORMAT INTERACTIVE ELECTRONIC TECHNICAL MANUALS

C.2.1 General. The following are unique requirements applicable to modular-format IETMs developed in accordance with MIL-DTL-24784/22 and /23.

C.2.2 Development products.

C.2.2.1 IETM content plan. When specified by the acquiring activity (see 6.2), an IETM content plan shall be developed for each IETM. Format and content requirements of the content plan shall be as specified (see 6.2). The IETM content plan contains a detailed overview of the proposed scope of the IETM, including identifying major paragraphs, tables, and illustrations planned for the IETM in compliance with this document. The plan also contains an explanation of the preparing activity's implementation of functionality requirements and graphical user interface features for the IETM. The IETM content plan shall be submitted to the acquiring activity for review and acceptance prior to development of the IETM RDC or preliminary IETM.

C.2.2.1.1 Model manual. When specified by the acquiring activity (see 6.2) or approved by the Government, an existing manual or IETM covering similar system/equipment may be used, marked up, and submitted to satisfy the requirements of the IETM content plan. The text from the model manual may be used verbatim with changes to cover the equipment differences and to correct inconsistencies, unclear wording, or obvious editorial or typographical errors. For all new manuals, the format requirements in this specification shall apply. All inconsistencies, unclear wording, or errors noted in the model manual shall be identified to the Government. All deviations from the model manual shall be approved by the Government.

C.2.3 Divisions and arrangement.

C.2.3.1 IETM divisions. Modular-format IETMs shall be divided into modules, paragraphs, tasks, and subtasks (procedures), as appropriate.

C.2.3.1.1 Modules. Modules are used to logically divide all data required for a certain function (for example, descriptive information, operator's instructions, maintenance, IPB data, and troubleshooting). Each module shall consist of a title, initial setup information (when required), supporting information, and technical content as described in MIL-DTL-24784/22 and /23. These data types can be further divided into paragraphs, tasks, and subtasks (procedures).

C.2.3.2 IETM arrangement. The arrangement and order of presentation of content is based on the DTD or Schema and how the modules are placed in the authored XML. Each modular-format IETM shall include front matter and technical content.

C.2.3.2.1 Front matter. Front matter shall consist of the following items as applicable. Front matter items shall be made accessible to the user at all times. Access to and location of the content on the display screen is largely predetermined by the NAVSEA-approved IETM Publisher/Viewer.

- a. Title page.
- b. Revision summary.
- c. Acronyms and abbreviations list.
- d. General information module data (see 3.7 of MIL-DTL-24784/22).
- e. Supporting information module data (see 3.8 of MIL-DTL-24784/22).
- f. Numerical index of part numbers and reference designation index (see MIL-DTL-24784/23).

MIL-DTL-24784D(NAVY)  
APPENDIX C

C.2.3.2.1.1 Title page. See 3.6 for general requirements. The title page shall be the first information to appear in the main content area of the display when the IETM is launched. The formatting and display of information on the title page/screen is controlled by the NAVSEA-approved IETM Publisher/Viewer.

C.2.3.2.1.2 Revision summary. When a revision to an IETM is issued, a revision summary shall be provided. The revision summary shall contain a list of modules by title that have been revised and for each module listed, a brief description of the major changes. The titles of revised modules listed in the revision summary shall be linked to the module containing the revised information. As applicable, the revision summary shall also describe the method used to identify new and changed material in the manual (i.e., font color change for text, miniature pointing hands within illustrations, etc.).

C.2.3.2.1.3 Acronyms and abbreviations list. A consolidated list shall be prepared to identify and define all abbreviations, acronyms, and uncommon terms used in the IETM. Unless otherwise specified by the acquiring activity (see 6.2), hot spots shall be used to link all abbreviations, acronyms, and uncommon terms to the consolidated listing.

C.2.3.2.1.4 Table of contents. A list of front matter items and technical content modules shall be generated and displayed in the Table of Contents. The Table of Contents shall be made accessible to the user at all times. When “Table of Contents” is selected, the front matter and technical content items shall be listed for subsequent selection by the user. The Table of Contents shall be in “traditional” order, based on the order of occurrence within the IETM, and with the exact titles used in the text. Access to and display of the Table of Contents are controlled by the NAVSEA-approved IETM Publisher/Viewer.

C.2.3.2.1.5 List of Illustrations and multimedia. IETMs containing figures (graphics, illustrations, drawings, and photos) shall include a List of Illustrations and multimedia by title. Access to and display of the List of Illustrations are controlled by the NAVSEA-approved IETM Publisher/Viewer.

C.2.3.2.1.6 List of Tables. IETMs containing tables shall include a List of Tables by table title. Access to and display of the List of Tables are controlled by the NAVSEA-approved IETM Publisher/Viewer.

C.2.3.2.1.7 “How to use this IETM” information. When applicable, helpful information for the end user specific to the particular IETM may be included. Information may include:

- a. Information to familiarize the user with the format and special or unusual features or functions of the IETM. Include an explanation of important features of the organization and content and any peculiarities in the basic structure of the IETM.
- b. An explanation of the icons and buttons used in the IETM.
- c. An explanation on how to identify hot spots and how they are used and activated.
- d. If over-sized supporting schematic and wiring diagrams have been authorized and developed, a reference to the supplement they are contained in by TMIN.
- e. As applicable, an explanation on how and where parts information is available in the modules, how the parts information is accessed, and, if applicable, how the parts can be ordered.
- f. An explanation on how troubleshooting data is presented in the IETM and, if applicable, an explanation on how failure symptom indexes and malfunction codes correspond to maintenance operational checks and troubleshooting procedures for individual systems and components.
- g. When a standard form is used in the process of performing a task, provide instructions on how these forms are accessed, used, and filled out.
- h. “How to use” information shall not repeat instructions given within the modules.

C.2.3.2.2 Technical content. See MIL-DTL-24784/22 and /23 for technical content data requirements.

MIL-DTL-24784D(NAVY)  
APPENDIX C

C.2.4 Style and format. The IETM shall be authored for publishing and display using the NAVSEA-approved IETM Publisher/Viewer. Unless otherwise specified herein, the IETM user interface, functionality, and much of the display, presentation, and formatting of the IETM's content are provided within, controlled by, or auto-generated through publish scripts for use by the NAVSEA-approved IETM Publisher/Viewer. The "NAVSEA Interactive Electronic Technical Manual (IETM) Viewer Software Performance Requirements" document provides information to IETM developers on what to expect in the NAVSEA-approved Viewer and can be obtained from the technical reports section of the Navy XML/SGML Repository (<http://www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Carderock/Resources/Technical-Information-Systems/IETMs/TechReps/>).

C.2.4.1 IETM display screen layout. The NAVSEA-approved Viewer screen layout consists of an outer shell and an inner shell.

a. The outer shell is the application/browser window and includes the IETM title bar. The title bar is the only area within the outer shell that shall be populated by the IETM developer. The title bar shall display the TMIN and the overall classification, when applicable, for the IETM being displayed. If the IETM is to be jointly used, only the acquiring activity's TMIN shall appear in the title bar.

b. The inner shell is the portion of the screen within the browser shell, provided as the client application display area and is the only portion of the screen area under the IETM content developer's control. Unless otherwise specified herein, selectable functions and menu items and their labels are supplied by the NAVSEA-approved IETM Publisher/Viewer.

C.2.4.2 Paragraph titles. Paragraphs and subparagraphs may have titles that describe that paragraph's contents. There shall be no more than five levels of paragraphs used. Bolding, line spacing, indenture, and blocking of paragraph text are controlled by the NAVSEA-approved IETM Publisher/Viewer. Paragraph titles shall begin at the left margin and shall be formatted as follows:

a. Primary (first level) titles shall be bold, all capital letters, and stand alone. The paragraph text will appear as block text.

b. Second level titles shall be bold, all capital letters, with the paragraph text run-in. The paragraph text will appear as block text.

c. Third level titles shall be bold, the first letter of the first word and of each principal word capitalized, and stand alone. The paragraph text will appear as block text.

d. Fourth level titles shall be regular type, the first letter of the first word and of each principal word capitalized, with the paragraph text run-in. The paragraph text will appear as block text.

e. Fifth level titles shall be italic, the first letter of the first word and of each principal word capitalized, with the paragraph text run-in. The paragraph text will appear as block text.

C.2.4.3 Procedural steps. Procedural steps shall not have titles. Procedural steps may be divided into no more than four levels. Single substeps may be used, but a minimum of two is recommended. Text will be block indented under the first word of the step. Formatting of procedural steps and substeps are controlled by the NAVSEA-approved IETM Publisher/Viewer.

## C.2.5 References.

C.2.5.1 Textual references. References to another TM shall conform to the following:

a. When referring to the entire content of another TM, present the reference as: TMIN and TM title. Subsequent references may truncate the reference to the TMIN only when it causes no reader confusion.

b. When referring to specific content within another TM, the reference should be specific enough to direct the reader to the desired location. Present the reference in the following manner, as applicable: TMIN, TM title, module title, paragraph title, and table or figure number and title. Subsequent references may truncate the reference to the TMIN and the specific location (e.g., SE555-AB-MMO-020, module 006 00, Table 2) when it causes no reader confusion.

c. References to material within the same TM shall conform to the following:

(1) Refer to paragraphs by paragraph title (e.g., TASK DESCRIPTION). Reference to a subordinate paragraph within the same primary paragraph may be presented as "above" or "below".

MIL-DTL-24784D(NAVY)  
APPENDIX C

- (2) Refer to procedural steps by the word “step” and the step number (e.g., step 3).
  - (3) Refer to tables by the word “Table” and the table number (e.g., Table 6).
  - (4) When reference is made to data within another module, it shall be by module title and paragraph title, table or figure number and title, as applicable.
  - (5) Footnotes are not allowed within text; use notes when applicable.
- d. References to figures within the same module shall conform to the following requirements:
- (1) Refer to figures by the word “Figure” and the figure number (e.g., Figure 2), including sheet number for multi-sheet figures (e.g., Figure 6 [Sheet 3 of 10]).
  - (2) Refer to a section of a multi-section figure by section letter and figure number (e.g., A, Figure 3).
  - (3) Refer to callouts (e.g., index number, reference designation) on a figure by callout first, followed by the figure number (e.g., [3, Figure 2] or [S1, Figure 3]).
  - (4) Reference to a zone on a figure shall be by zone number first then zone letter to avoid possible confusion with reference designations.
  - (5) Refer to parts on figures by enough of their reference designation to identify the item (e.g., Resistor A6R11).

C.2.5.2 Frequently used maintenance tasks. Frequently used maintenance tasks, such as applying external electrical or hydraulic power, shall be prepared once as a common maintenance task and linked as a common step in all other maintenance tasks requiring the need of external electrical or hydraulic power.

C.2.5.3 Tasks performed by other work centers. Procedures that require performance of tasks by technical personnel other than those normally assigned to the subject task shall be referenced in the introductory information for the module and in the text. For example, if the primary task is removal of a component of the piping system that is inaccessible without removal of a component of the sewage ejection/holding system, a preparatory step of the procedure shall be “Remove CHT pump (NAVSEA 0905-LP-092-4060).”

C.2.5.4 Post maintenance action referencing. When required, the last step of a procedure shall reference any post maintenance actions necessary to ensure the initial procedure has been successfully completed. The reference shall be to the associated module title and procedure title. For example, the last step would read “Perform Maintenance IP SERVICE HYDRAULIC SYSTEM.”

C.2.5.5 Maintenance procedure leading to IPB information. When an IPB is developed, hot spots shall be used for individual parts called out on supporting maintenance graphics to link the user to the applicable IPB information.

C.2.6 Use of terminology, nomenclature, numbers, and equations.

C.2.6.1 Abbreviations and acronyms. Abbreviations, acronyms, and unusual terms may be used in any text, when applicable. It is not necessary to spell out the words completely after the first use of an acronym or abbreviation. Unless otherwise specified by the acquiring activity (see 6.2), hot spots shall be used to link all abbreviations, acronyms, and uncommon terms to the complete explanation and listing of abbreviations, acronyms, and uncommon terms (see C.2.3.2.1.3).

C.2.7 Tabular material. Tabular information shall be displayed as cells of textual information or a graphic. Textual elements within tables shall conform to the requirements herein for textual information. Graphical elements within a table shall conform to the requirements herein for graphical information.

C.2.7.1 Table format. Three categories of tables are allowed in a TM: CALS tables, simple tables, and standardized information tables. Refer to the appropriate Tagging and Authoring Guidelines for specific tagging and authoring guidance for all tables.

C.2.7.1.1 CALS tables and simple tables. CALS tables and simple tables shall conform to the following:

- a. Tables shall have column headers and, if applicable, row headers. Include the units of measurement in row or column headings if the entries are in measurable quantities. If several different units are used in the same rows or columns, place the units of measurement next to each entry.

MIL-DTL-24784D(NAVY)  
APPENDIX C

- b. Borders for table headers shall be the same size as the rest of the table. Borders for table cells shall be single or double lines. Small tabular text may have no borders.
- c. Entries within tables shall be single spaced. Insert a dash (-) to indicate an entry that is intentionally left blank.
- d. Align related entries in different columns. Align alphabetic or alphanumeric data flush left. Align column entries containing numerical data as follows:
  - (1) Decimal numbers on the decimal point.
  - (2) Scientific notation on the multiplication symbol.
  - (3) All other numerical data flush right.

C.2.7.1.2 Standardized information tables. Standardized information tables provide a method to ensure consistent presentation to the end-user for common information. MIL-DTL-24784/22 specifies which tables are standardized information tables. There shall be no deviations to the number of columns or the column head titles established in the standard.

C.2.7.2 Table titles. Tables shall be assigned table titles. The first letter of the first word and of each principal word shall be capitalized. Table titles shall begin with an identifying name when applicable (e.g., “Table 3. Guidance System Test Points”). The title shall be short, not exceeding two lines, and describe the contents or purpose of the table. Tables applicable to one Service, in a manual that will be used by more than one Service, shall be identified (e.g., “Table 2 (Navy Only). Fuel Indicator Correction Factors”). The table title shall be placed two spaces after the table number and be centered above the table. The format and placement of table titles are controlled by the NAVSEA-approved IETM Publisher/Viewer.

C.2.7.3 Footnotes in tables. Footnotes may be used in tables. Footnote callouts within tables shall link to the footnote data. The footnote marker shall be a numerical value, consecutive Arabic superior numbers beginning with “1”. Format and placement of footnotes is controlled by the NAVSEA-approved IETM Publisher/Viewer.

## C.2.8 Numbering.

C.2.8.1 Paragraphs. Paragraphs within a module shall be unnumbered.

C.2.8.2 Procedural steps. Numbering of procedural steps and substeps are controlled by the NAVSEA-approved IETM Publisher/Viewer. Procedural steps and sub-steps shall be numbered as follows:

- a. First level - consecutively with Arabic numerals.
- b. Second level - consecutively with lower case letters.
- c. Third level - consecutively with Arabic numerals enclosed in parenthesis.
- d. Fourth level - consecutively with lower case letters enclosed in parenthesis.

C.2.8.3 Sequential lists. The numbering for sequential lists is formatted by the NAVSEA-approved IETM Publisher/Viewer. Sequential list items shall be numbered as follows:

- a. First level - consecutively with lower case letters followed by a period.
- b. Second level - consecutively with Arabic numerals enclosed in parenthesis.
- c. Third level - consecutively with lower case letters enclosed in parenthesis.
- d. Fourth level - consecutively with Arabic numerals followed by a period.
- e. Fifth level - consecutively with lower case Roman numerals followed by a period.

C.2.8.4 Tables, illustrations, and multimedia. Tables, figures, and multimedia within a module shall be numbered consecutively in Arabic numerals generated by the NAVSEA-approved IETM Publisher/Viewer. The placement of the number is also controlled by the NAVSEA-approved IETM Publisher/Viewer. Figure numbers shall be included on all illustrations except inline graphics (example equation). The table, figure, or multimedia number shall not be an integral part of the table, figure, or multimedia. The number and title shall be separated from the table, figure, or multimedia so the text can have the capability of being searched.

MIL-DTL-24784D(NAVY)  
APPENDIX C

C.2.9 Multimedia. Multimedia includes graphics (e.g., illustrations, drawings, diagrams, photographs), audio, video, animation, and three-dimensional (3D) modeling. The textual information for procedures, instructions, or steps shall not be replaced by multimedia. Multimedia objects and their presentation are used in support of technical textual data and shall be considered secondary to the technical information. General and specific requirements for the development of graphics are as specified in this document. See 3.7.8.7 for multimedia file format requirements.

C.2.9.1 Multimedia presentation. When specified by and approved by the acquiring activity (see 6.2), audio, video, animation, and 3D modeling may be included in the IETM. Audio, video, animation, and 3D modeling techniques shall only be used when it results in enhancing the presentation of the information or makes the procedures more effective. Audio, video clips, and animations shall not be played automatically but shall be manually started by the end user of the IETM by pressing “Play” on a Navy authorized media player. The end user shall be made aware when audible warnings are contained within the IETM.

C.2.9.1.1 Audio. Developers shall use best commercial practices when implementing audio. Recent audio compression algorithms allow for acceptable audio quality using much smaller file sizes. The decision as to which compression format to use shall be based on obtaining acceptable audio quality with the smallest possible file size. Audio shall not be provided for classified information. Audio portions of multimedia shall not contain classified information.

C.2.9.1.2 Video. Developers shall use best commercial practices when implementing video. Recent streaming video and video compression algorithms allow for acceptable video quality by using much smaller file sizes. Streaming video formats are preferred.

C.2.9.1.3 Animation. Developers shall use best commercial practices when implementing animation. The decision as to which compression format to use shall be based on obtaining acceptable quality with minimized file size. Streaming formats are preferred.

C.2.9.1.4 3D modeling. Developers shall use best commercial practices when implementing 3D modeling. 3D data shall be generated and produced from original validated engineering models. Removed parts shall remain in view and be parked in a removed area or bench location to complete the maintenance sequence. Animated removal or tool actions shall be realistically performed as viewed by the end user. For animated actions that would represent a danger or hazard to the end user, warnings and cautions shall appear.

C.2.9.2 Figure titles. Figures shall be assigned figure titles. The first letter of the first word and of each principal word shall be capitalized. Figure titles shall begin with an identifying name when applicable (e.g., “Figure 3. Guidance System Gyroscope Assembly”). The title shall be short and describe the contents or purpose of the illustration. Illustrations applicable to one Service, in a manual that will be used by more than one service, shall be identified (e.g., “Figure 2 (Navy Only). Fuel Indicator”). The placement of the figure title is controlled by the NAVSEA-approved IETM Publisher/Viewer.

C.2.9.3 Oversized illustrations. When usability is not affected, multi-sheet illustrations shall be used in lieu of oversized illustrations. Special attention shall be given to the Fleet, overhaul, and training community’s need to have certain long-line diagrams (oversized schematics, timing circuit diagrams, test setup diagrams, wiring diagrams, etc.) delivered as a separately packaged hardcopy supplement or re-authored to be easily viewed on screen and printed.

C.2.9.3.1 Supplements. When specified and approved by the acquiring activity (see 6.2), a supplement containing the oversized illustrations shall be developed. The supplement shall be prepared for publishing and distribution as an iPDF in accordance with ISO 32000-1. The supplement shall conform to the appropriate Tagging and Authoring Guidelines (including page headers/footers, bookmarks, security). For end-use purposes, the following additional requirements for the supplement apply:

a. Include a front cover/title page with a unique Government-assigned TMIN for the supplement (see [figure 2](#)), a Table of Contents, List of Illustrations, List of Tables (as applicable), general introduction information, the technical assistance and deficiency reporting information, the TMDER form, and a back cover and backbone (see [figure A-5](#)).

b. Maximum page size is 26 by 11 inches; printable area is 24¾ by 10 inches. Oversized pages shall be prepared for printing on one side only and shall not be spliced.

MIL-DTL-24784D(NAVY)  
APPENDIX C

C.2.9.4 Illustration placement. Each illustration shall be included as part of a paragraph or follow as closely as possible to its first reference in the narrative text or be placed at the end of the module.

C.2.10 Style, format, and content for revisions. The revised IETM shall be in accordance with the style, format, content, and arrangement of the existing IETM. Procedural steps, list items, figures (including index numbers used within an illustration), and tables shall be renumbered, as necessary, to eliminate all number suffixes and to establish correct sequence. All previous revision indicators shall be eliminated. The revised TM shall include the following as applicable:

- a. A revised title page/screen.
- b. A revision summary.
- c. New or revised text, illustrations, tables, and information packages.
- d. Current instructions for contacting Distance Support and for reporting TM deficiencies and suggested improvements, including the current TMDER Form NAVSEA 4160/1. The text in [figure 1](#) shall be included (verbatim).

C.2.10.1 Display of new or changed material. When specified by the acquiring activity (see 6.2), after all previous revision indicators have been eliminated, new or changed material shall be identified. The NAVSEA-approved Publisher/Viewer shall provide the user the option to view change markings. The default shall be set to off so that change markings are not displayed unless requested. When the user requests to view change markings, they shall be displayed as follows:

- a. New or changed text within the main body of the TM shall be displayed in green italic font. The green italic font style is not required for changed or added front matter, replacement or addition of a complete information package, or for the correction of minor inaccuracies, such as spelling, punctuation, relocation of material, and renumbering, unless such correction changes the meaning of the information.
- b. Change marks shall be applied to the complete danger, warning, caution, or note and not to the individual words or paragraphs it contains.
- c. Additions or changes to line drawings, charts, illustrations, graphs, diagrams, and schematics shall be indicated by screens (shading), screened (shaded) boxes, or miniature pointing hands to highlight updated areas (see [figure B-6](#)). Extensively changed presentations shall be indicated by a screen border around the affected area. For minor changes not suited to shading or screening, a miniature pointing hand shall be used.

C.2.10.2 Revision summary. A revision summary shall include a listing of the modules by title that have been revised and, for each module listed, a brief description of the major changes. The titles of revised modules shall be linked to the module containing the revised information. As applicable, the revision summary shall also describe the method(s) used to identify new and changed material in the manual (i.e., font color change for text, miniature pointing hands within illustrations, etc.). The revision summary is generated by the NAVSEA-approved IETM Publisher/Viewer.

MIL-DTL-24784D(NAVY)

CONCLUDING MATERIAL

Custodian:  
Navy – SH

Preparing activity:  
Navy – SH  
(Project TMSS-2017-003)

Review activity:  
Navy – EC

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.dla.mil>.