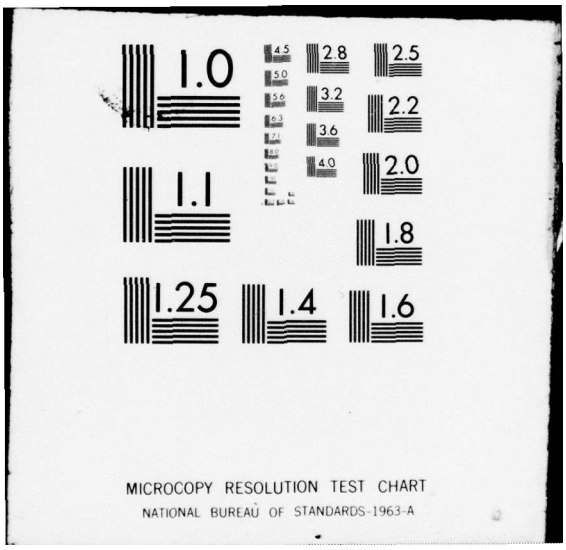
AD-A071 001 HARRY DIAMOND LABS ADELPHI MD F/G 5/2
GUIDES FOR ERADCOM FORMAL REPORTS.(U)
MAR 79 B S COLLIER, E E JONES
UNCLASSIFIED HDL-ESP-79-1 NL

1 OF 2
AD
A071001


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
7.1
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ESP-79-1

March 1979

LEVEL II

12

Guides for ERADCOM Formal Reports

Co-authors: Barbara S. Collier and E. Ellen Jones

U.S. Army Electronics Research
and Development Command
Adelphi, MD 20783

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of manufacturers' or trade names does not constitute an official indorsement or approval of the use thereof.

Destroy this report when it is no longer needed. Do not return it to the originator.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

AD A071001

(14) HDL-

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: ESP-79-1
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): (6) Guides for ERADCOM Formal Reports
5. TYPE OF REPORT & PERIOD COVERED: (9) Special Publication
6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s): (10) Co-authors: Barbara S. Collier and E. Ellen Jones
8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS: Harry Diamond Laboratories, 2800 Powder Mill Road, Adelphi, MD 20783
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: (11)

11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Electronics Research and Development Command, Adelphi, MD 20783
12. REPORT DATE: March 1979
13. NUMBER OF PAGES: 115

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): (12) 114 p.
15. SECURITY CLASS. (of this report): UNCLASSIFIED
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

HDL Project: 012C31
DRCMS Code: 36AA.8000

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Technical report	Grammar	Style manual
Technical writing	Language usage	Report organization
Technical editing	Writing style	Report production

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A stylebook has been produced to assist authors, editors, and production personnel in the preparation of scientific and technical reports. Thus, guidelines are directed specifically to the different groups who write, edit, type, lay out copy, and prepare reports for the printer.

The report consists of two main parts. Part I (which will interest production personnel) describes and illustrates mechanical aspects of report preparation, such as format, treatment of tables and figures, pagination, classification markings, and proper referencing. Part II

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

163050

1/3

(which will be most helpful to authors and editors) addresses standards of style, grammar, and usage. Also included is an Annotated Bibliography, which lists many of the most easily obtainable and well-known references for grammar, correct usage, and technical writing.

Some of the information included was summarized from the applicable Army regulations that govern the preparation of scientific and technical reports; other information was adapted from established editorial policies that have been adopted or approved by activities of the Electronics Research and Development Command (ERADCOM). Although these guidelines were compiled primarily for the ERADCOM activities, they are applicable to the production of any formal scientific and technical reports that are issued by or for the Department of Defense.

Foreword

As various elements of DARCOM were reorganized into the Electronics Research and Development Command (ERADCOM), it was realized that standards for style and format would have to be set for formal ERADCOM reports.

Thus, this manual was compiled, in an effort to provide a consistent format for formal reports; information was drawn from style manuals, instructions, and pamphlets from various elements of ERADCOM. Certain standards of style, format, mechanics, and organization are recommended, many of which are expansions of the requirements given by MIL-STD-847A. Although these guidelines were compiled primarily for the ERADCOM activities, they are applicable to the production of any formal scientific and technical reports that are issued by or for the Department of Defense.

Many people were involved in the production of this manual. We appreciate the assistance of our colleagues throughout ERADCOM: Ann Applegate (ETDL), Royal Burkhardt (SWL), Carl Hundley (OMEW), Donna O'Brien (Technical Support Directorate), Marie Richardson (ASL), Anita Schwartz (EWL), and Jeff Slusher (NV&EOL).

Our coworkers at Harry Diamond Laboratories, the CM/CCM Office, and ERADCOM Headquarters have also been sources of support and encouragement in offering constructive criticism and helpful suggestions. Those who volunteered their time and comments were Vondell Carter, William Isler, Fred King, Nelda and James McNeil, Joseph Michalowicz, James Penar, John Scales, Dale Schallhorn, Frank Tevelow, Della Whittaker, and Peter Winokur. We especially appreciate the advice and guidance of the Chief of the Technical and Visual Information Office, John P. Carrier, and the Chief of the Technical Reports Branch, Ruth E. Savage, without whose ideas this manual could not have been published.

CONTENTS

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

FIGURES

FIGURES (cont'd)

TABLES

INTRODUCTION

These guidelines, compiled under the authorization and direction of the Electronics Research and Development Command (ERADCOM), are intended to help achieve a reasonable degree of consistency in the style and format of formal reports issued by ERADCOM activities. Although many of the elements of format and style described are expansions of the requirements outlined in MIL-STD-847A, this manual is not intended to replace any Army regulation that governs the preparation of scientific and technical reports issued by or for the Department of Defense. Instead, it should be used as an ERADCOM stylebook, or as a standardization device to achieve uniformity in format and ease of readability in the formal reports disseminated externally by the Command activities. It is not a rigid directive.

This manual is divided into two sections, since the information is directed toward distinct groups: production personnel, authors, and editors. Although all groups involved in any stage of report production should be aware of the overall content of this manual, those responsible for the direct production of reports (typing, layout, preparing for printing) will be most interested in Part I—The Physical Report. Authors and editors will want to pay close attention to Part II—The Contents of the Report.

Part I. The Physical Report

1. RULES AND POLICIES

Both the content and the form of formal reports are governed partially by regulation[1] and partially by good editorial policy. Requirements and recommendations concerning the elements of a

[1] *MIL-STD-847A, Format Requirements for Scientific and Technical Reports Prepared by or for the Department of Defense (31 January 1973).*

report are described in section 1; those concerning format are presented in section 2. All such policies and guidelines, however, depend on an editorial review for implementation (see Part II).

1.1 **General Policies**

1.1.1 *Use of Metric Units*

Current military policy encourages the conversion to the metric system from English units of measure;[2] the editorial review should ensure that this policy is followed. Scientific reports usually use metric units; however, some subjects seem to require the use of English units. If there is some overriding reason why English units should be retained (for example, a survey of a building might refer to layout distances in feet to conform with available engineering drawings of the building), some mention should be made of this reason, and a conversion factor given, so that the units can be easily converted if necessary (see app A). Further, if the common name of an item refers to an English unit of measure (such as 5-in. pipe, inchworm, etc), it is unnecessary to convert to metric units since the measurement is a designation and not an exact measure. Thus, the editor must exercise judgement in applying this and other policies (such as those given in this manual).

1.1.2 *Treatment of Acronyms, Abbreviations, and Symbols*

Most acronyms should be spelled out when first mentioned, and referred to by the acronym afterwards. For example,

> The complementary metal-oxide semiconductor (CMOS) device was chosen for use. CMOS technology is . . . .

---

[2] *Use of the Metric System of Measurement, Department of Defense Directive 4120.18 (10 December 1976).*

Sometimes the editor or author may prefer to put the spelled-out version within parentheses, such as when the acronym is more familiar than the full version. Some words that were originally acronyms are no longer acronyms, such as radar and sonar; others approach word status, but have not yet achieved it. It is tempting to leave the acronym undefined in such cases, but unless the word is in a dictionary, so that readers can look it up if need be, it is better to spell it out the first time.

Once an acronym is introduced, it should be used throughout; it is confusing if the full term is used in some places and the acronym in others. Some readers may get the impression that two different things are being discussed.

Uncommon abbreviations and symbols should also be defined when first introduced in the text. If these are numerous, their definitions may be listed at the end of the report for the convenience of the reader. A list of common technical abbreviations used by ERADCOM is included in appendix B to this manual.

1.2 **Components of Reports**

1.2.1 *Cover*

The covers of ERADCOM reports should be basically similar to those illustrated in figure 1. However, if the cover format is varied, the type of information illustrated (including the official Command name and logo) must appear on the front cover of all formal reports distributed externally by the activities. Each activity under ERADCOM is free to continue its present numbering system.

Publication dates should be realistic: the report dates that are established should allow for processing and printing.

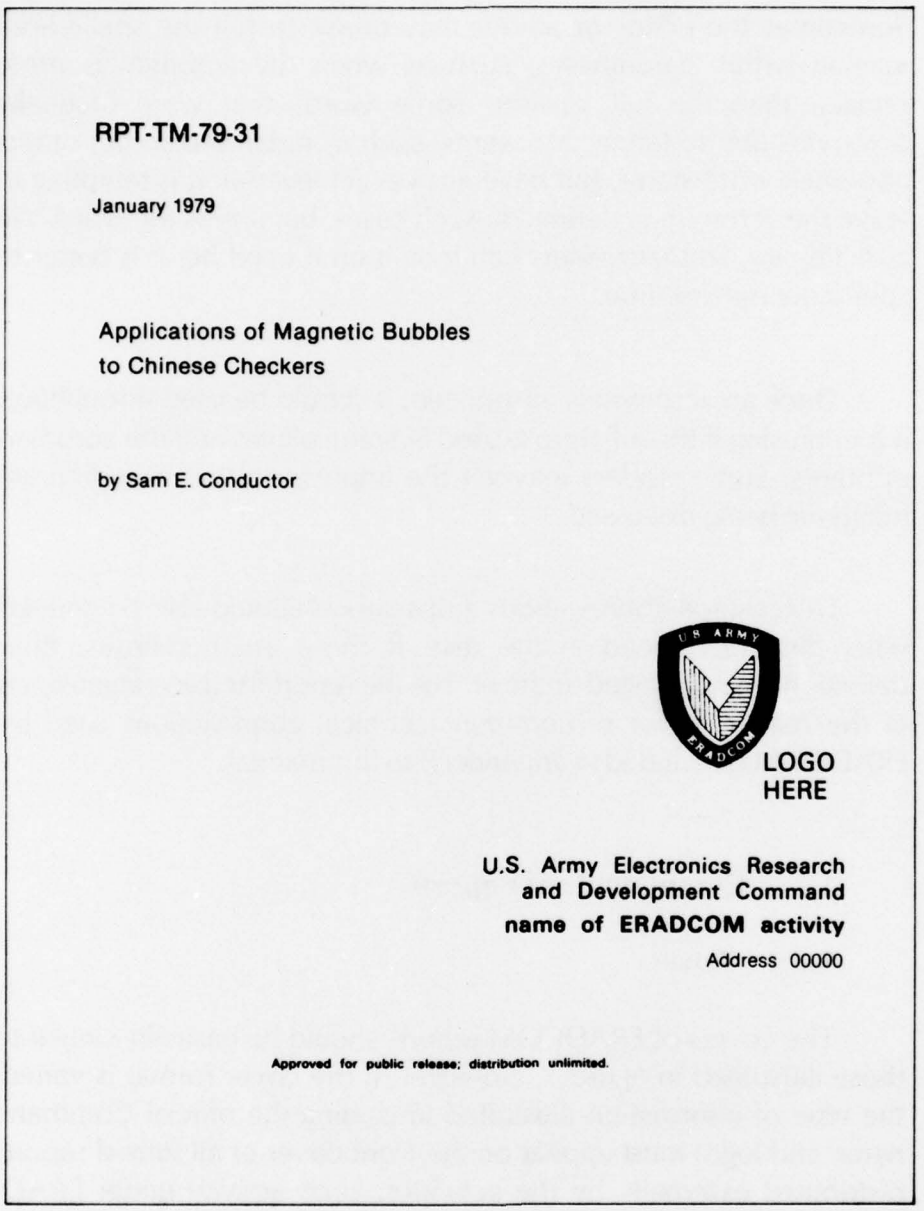


Figure 1. Sample cover formats for various types of reports: unclassified technical memorandum.

RPT-CR-79-30

January 1979

Getting to Know Your XM-1 Tank

by Millie Joule

Prepared by

XYZ Corporation
101 31st Street
Phloxville, MA 11223

Under contract

AB-123-456

LOGO
HERE

U.S. Army Electronics Research
and Development Command
name of ERADCOM activity
Address 00000

Approved for public release; distribution unlimited.

Figure 1. Sample cover formats for various types of reports (cont'd): unclassified contractor report.

SECRET

RPT-TR-1234

January 1979

Nuclear Devices in the Home (U)

by Nan O'Henry

LOGO
HERE

Classified by Home CG, 1 November 1977
Declassify on 31 December 1993

NATIONAL SECURITY INFORMATION
Unauthorized disclosure subject to criminal sanctions

U.S. Army Electronics Research
and Development Command
name of ERADCOM activity
Address 00000

SECRET

Figure 1. Sample cover formats for various types of reports (cont'd): classified technical report.

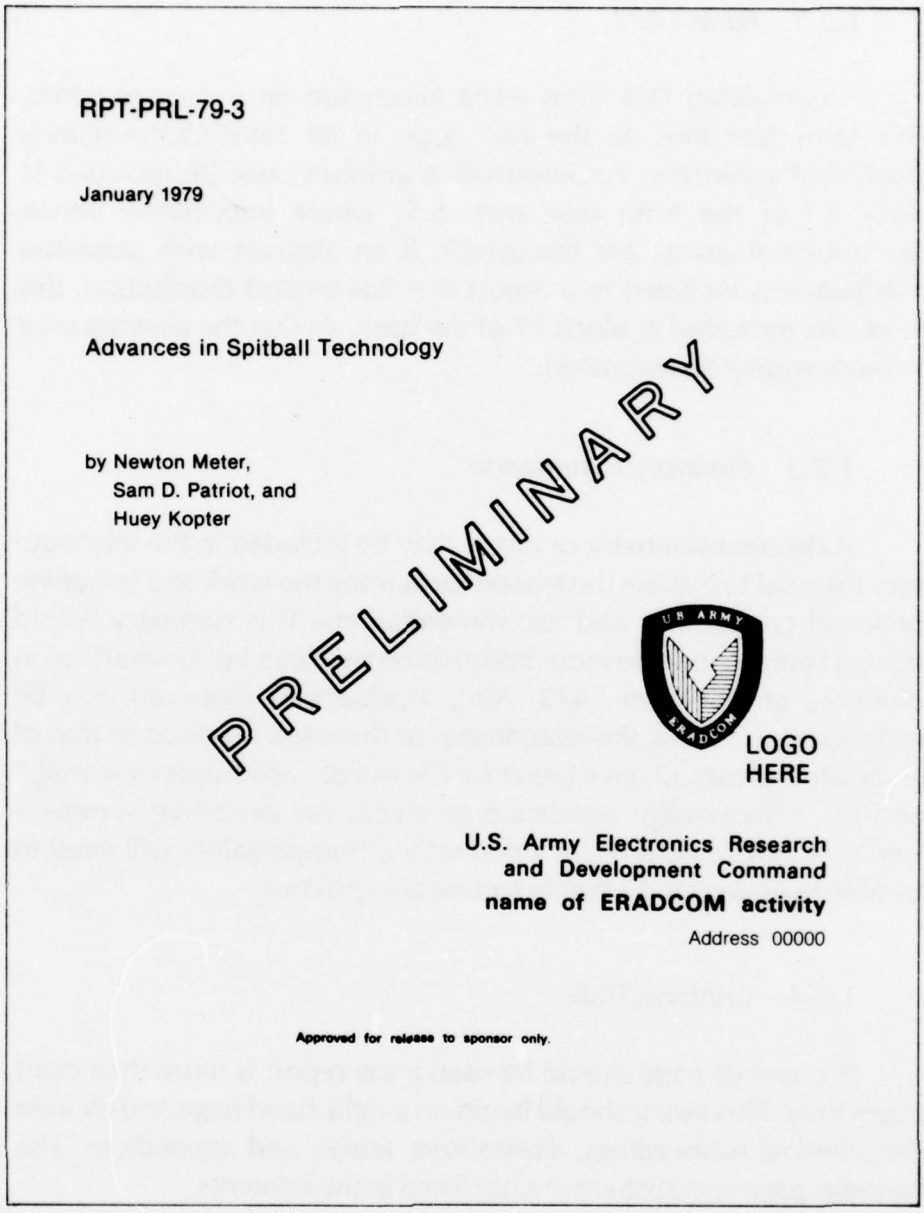


Figure 1. Sample cover formats for various types of reports (cont'd): unclassified preliminary report.

1.2.2 *Form 1473*

A completed DD Form 1473 (illustrated on p 1) is required. This form functions as the title page in all ERADCOM reports distributed externally. An informative abstract must be included in block 20 of the form (see sect. 6.3, where informative versus descriptive abstracts are discussed). If an abstract with unlimited distribution is included in a report that has limited distribution, this should be indicated in block 17 of the form, so that the abstract may be more widely disseminated.

1.2.3 *Prefatory Information*

A detailed summary or digest may be included in the introductory material to explain the reason for starting the work and to outline principal conclusions and recommendations. This summary would be used only to include more information than can be summarized in block 20 of DD Form 1473. Also, a preface or foreword may be included to (1) show the relationship of the work reported to that of associated efforts, (2) give credit for the use of copyrighted material,* and (3) acknowledge assistance received. An executive summary (see sect. 6.4) should be included only if nonspecialists will need to be able to understand a highly technical exposition.

1.2.4 *Contents Page*

A contents page should be used if the report is more than eight pages long. This listing should begin on a right-hand page and include the principal subheadings, illustrations, tables, and appendices. The contents page and abstract are not listed in the contents.

**Copyrighted material may be used in ERADCOM reports only with written consent of the copyright owner or upon approval of the Judge Advocate General or his designee.*

1.2.5 *Text of Formal Reports*

The first section in the body of the report should orient the reader. No matter what it is labelled, this section (which should begin on a right-hand page) must provide background information to prepare the reader to follow the exposition and to understand the point of the report, the work objectives, and so on. Succeeding sections may describe work procedures, apparatus involved, tests performed, results achieved, and related matters as appropriate. The final sections usually present conclusions, recommendations, and plans, if applicable. (See sect. 6 for further discussion.)

The illustrative materials (figures and tables) presented in the main text must be called out in the body of the report, and numbered consecutively in the order in which they appear. The figures or tables should appear as soon as possible after the citations (see sect. 2.4). The appendices should also be cited in order in the body of the report and identified by letter—*appendix A, appendix B,* and so on. Even if only one appendix is needed, it is referred to as *appendix A*.

1.2.6 *Literature References and Bibliographies*

To aid the reader who uses microform,* literature references should be completely written out in footnotes on each page where literature is cited.[1] If there are five or more references, they may be listed at the end of the body of the report as "Literature Cited." Superscript numerals and symbols are preferred for citations and footnotes. Literature references should be numbered sequentially in the order that they are first referred to in the text. Once a reference is numbered, it retains the same number throughout the body of the report. Literature references should include only published work, as this is the only type of literature available to the reader. Other types

---

[1] *MIL-STD-847A, Format Requirements for Scientific and Technical Reports Prepared by or for the Department of Defense (31 January 1973).*

**Copy that has been much reduced in size, e.g., microfilm.*

of footnotes should be marked with symbols. If more than one note falls on one page, the symbols used should follow this sequence: asterisk (*), dagger (†), double dagger (‡), section mark (§), and parallel (‖).[3] Literature references cited in an appendix should be numbered independently of those in the main body or in other appendices and be treated in the same way: that is, footnoted on each page where cited, listed at the end of the appendix if desired, and so on.

It is advisable to avoid having more than six footnotes on one page; a page that is half filled with footnotes looks unattractive and cluttered. Editors should check documents that appear to be excessively footnoted to make sure that each citation is sufficiently explained, so that its relevance is obvious, and also that the material referenced really needs to be cited.

Sometimes, excessive footnoting can be avoided if references can be grouped in an annotated bibliography and referred to by topic. This technique is often possible in the introduction of a report, where the author wants to give as much background as possible.

The "Literature Cited" section lists references by the numbers used in text citations. (See the Literature Cited section in this manual, p 92.) Other bibliographic entries not cited in the text are listed as supplementary information under the heading "Selected Bibliography" at the end of the body of the report.[1] These unnumbered entries should be alphabetized by the first author's last name, or, for an annotated bibliography, arranged by subject and alphabetized within the subject groups. (See the Annotated Bibliography of this manual.)

---

[1] *MIL-STD-847A, Format Requirements for Scientific and Technical Reports Prepared by or for the Department of Defense (31 January 1973).*

[3] *U.S. Government Printing Office Style Manual, Washington, DC (1973), 228.*

1.2.7 *Glossary of Terms*

Unusual terms should be defined either in the text or as footnotes the first time they are used. When many such terms are used, they may be alphabetized with their definitions in a glossary at the end of the main body.[1]

1.2.8 *Distribution*

The report distribution should be listed at the end of the report, beginning on a right-hand page.

All reports issued for external use must be sent to the Defense Documentation Center (DDC), Alexandria, VA. DDC requires 12 copies of reports with unlimited distribution and 2 copies of reports with limited distribution, to be used for secondary distribution. Only by special permission are documents exempted from DDC distribution.

Mailing address: Administrator
Defense Documentation Center
ATTN DDC-TCA
Cameron Station, Building 5
Alexandria, VA 22314

2. PHYSICAL SPECIFICATIONS AND FORMAT

2.1 **Line Spacing**

Usually, the text should be typed in single spacing for printing. Where superscripts and subscripts are used frequently, the text may be typed in 1½ spacing.

---

[1] *MIL-STD-847A, Format Requirements for Scientific and Technical Reports Prepared by or for the Department of Defense (31 January 1973).*

2.2 Copy Image

The preferred page size for formal reports is 8 by 10½ in.* The image area for the text, illustrations, and tables should not exceed 6 by 8 in., including figure and table titles. A 1-in. margin (minimum) must be allowed on all sides. Foldout copy is permitted only for diagrams that are illegible if reduced to 6 by 8 in. When a foldout cannot be avoided, however, it should begin on a right-hand page. The back of the foldout is almost invariably blank and should be treated as any other blank page. (It is sometimes possible to divide a large illustration so that it will appear on facing pages.)

2.3 Subject Headings and Designations

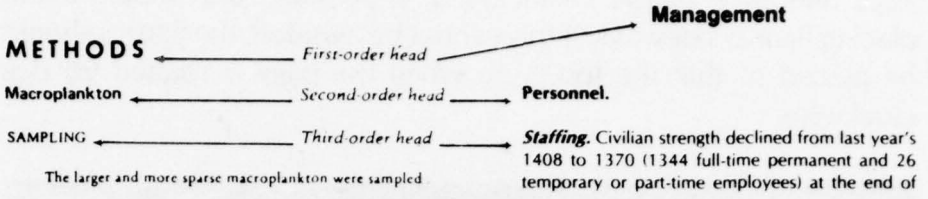
When needed for clarification, numerical designations should be used with subject headings as illustrated in this manual. Run-in headings (as used in sect. 2.8) are preferred to four- and five-digit breakdowns.

Various styles may be used to distinguish different levels of headings and subheadings. All that is necessary is that headings stand out so that their relative importance is apparent. Typewritten documents obviously have fewer options for setting off headings than do typeset documents, which may make use of different font sizes, different typefaces, bold and italic styles, and so on. Even typewritten documents, however, can make clear distinctions by the combined use of indentations, underlinings, and capital letters, as shown in figure 2.

2.4 Illustrative Material

All illustrations should be interspersed throughout the text, in the sections in which they are cited. If, however, the text is extremely short and the illustrations numerous, the illustrations may be placed

A paper size of 8½ by 11 in. may be used, but is not preferred.




```
1.  MAIN HEADING

    Note that the main heading is all caps.

    1.1  First-Order Heading

         Observe how the indentations line up.

    1.1.1  Second-Order Heading

           Again the indentations line up.

           Run-in heading.--Using run-in headings
avoids the use of ridiculously long strings of
numbers in subsections.
```

Figure 2. Samples of headings.

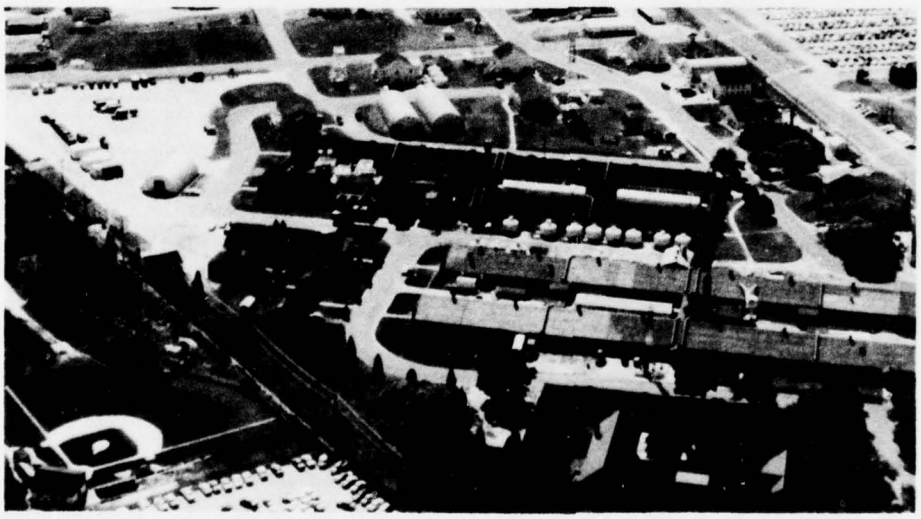
after the text. This unusual placement of figures should be explained in the Foreword to the report or in a footnote where the first figure is cited. The most numerous type of illustrations (whether tables or figures) should be placed last.

2.4.1 *Figures*

Figure titles are lowercase (except for acronyms, proper names, and beginning letters of titles) as shown in figure 3. Figures are numbered in order of appearance, in Arabic numerals. A figure should be placed as near as possible to its first mention in the text, after it is cited. If the figure cannot fall in the section where cited, a

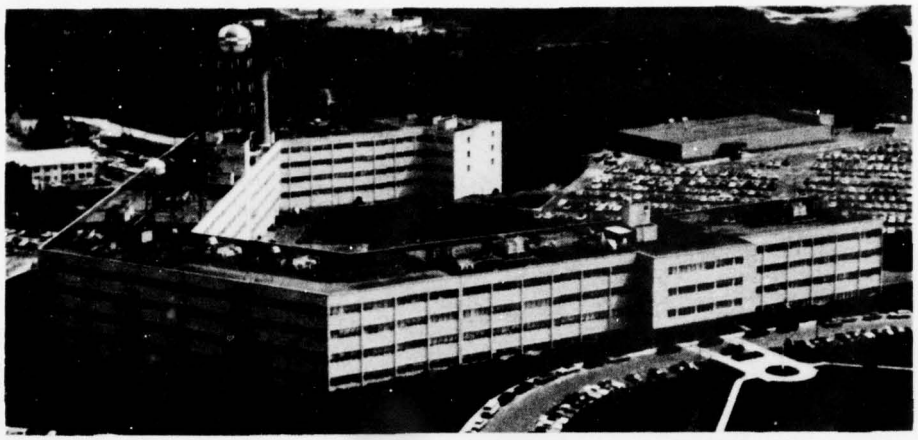
page reference should be included. If possible, one should avoid placing figures sideways. If this cannot be avoided, the figures should be placed so that the top is up when the page is rotated 90 deg clockwise.

(a)



(b)

Figure 3. Some ERADCOM elements: (a) Ft Belvoir, VA, and (b) Ft Monmouth, Evans, NJ.



(c)

(d)

Figure 3. Some ERADCOM elements (cont'd): (c) Ft Monmouth, NJ, and (d) Vint Hill Farms Station, VA.

2.4.2 *Tables*

Table titles should be fully capitalized, as illustrated in table 1. Arabic numerals are used to number tables, although Roman numerals may be used if there are fewer than 20 tables in a report.

TABLE 1. EDITING AND PROOFREADING MARKS*

Edited copy	Correction indicated	Corrected copy
Now is the time for	Delete	Now is the time for
Now is the time for	Insert from above	Now is the time for
Now is time for	Insert from below	Now is the time for
R & D effort	Close up	R&D effort
The problems	Close up and delete	The problems
Propulsion System	Center	Propulsion System
Propulsion System	Move to left	Propulsion System
Propulsion System	Move to right	Propulsion System
Propulsion System	Indent	Propulsion System
1+1 = 2	Insert spaces	1 + 1 = 2
technical Reports	Use lowercase	technical reports
WASHINGTON, DC	Initial caps only	Washington, DC
Finish the job	Use period	Finish the job.
e = mc2	Make superscript	$e = mc^2$
A1 = πr_1^2	Make subscript	$A_1 = \pi r_1^2$
agarts Program	Use capital letters	AGARTS Program
Roust Jab/Rocking Chair	Use all caps	ROUST JAB/ ROCKING CHAIR
Orbtal	Transpose letters	Orbital

Adapted from OMEW Report Style Manual, Electronic Warfare Laboratory, Office of Missile Electronic Warfare, White Sands Missile Range, NM (1978).

TABLE 1 (Cont'd). EDITING AND PROOFREADING MARKS*

Edited copy	Correction indicated	Corrected copy
The change plane is	Transpose words	The plane change is
Use (9) bolts	Spell out	Use nine bolts
Use ~~twelve~~ 12 bolts	Use Arabic numerals	Use 12 bolts
The TEMPS was (STET)	Use original wording (literally, "let it stand")	The TEMPS was
Vdd	Move up	Vdd
H20	Move down	H_2O
AN/GRC . . . AN/VRC . . .	Align vertically	AN/GRC . . . AN/VRC . . .
The 4- and 5-μm band	Align horizontally	The 4- and 5-μm band

**Adapted from OMEW Report Style Manual, Electronic Warfare Laboratory, Office of Missile Electronic Warfare, White Sands Missile Range, NM (1978).*

2.5 **Equations**

Equation symbols should be identified when first used to simplify reading from any type of microform; they may also be listed separately. Opening and closing parentheses, brackets, and braces should extend as far as the highest and lowest expressions that they enclose, as illustrated in figure 4.

Within the text, fractions should be typed on one line. The numerator should be separated from the denominator with a diagonal slash, such as *2/5* or *[H(w)]/M.* When a complex equation consists of multilevel (built-up) fractions, one can separate the equation from the text and use a horizontal line, as in the following example:

$$\frac{x^3 - y^6}{3}$$

Equations should be centered, with adequate spacing above and below the equation: it is usual to use three carriage returns with typed equations, but the right amount of leading (space between lines) in photocomposed copy will vary according to the document. Arithmetical operation symbols ($+, -, \pm, <, >$, and $=$) that are not in superscripts or subscripts should be lined up with the horizontal fraction line. One space should be allowed before and after arithmetical operation symbols and trigonometric functions (for example, $aBc^2 - de^5$, *sin x, cos w, y tan z*).

If an equation must be broken because of its length, it is best to break it at the $=$ ($\geq, \sim, \neq$, etc); the next best place is at a $+$ or $-$. The least desirable place is at a $\times$. The arithmetic sign at the break is carried over to the following line.

An equation should never be broken after a trigonometric function (between *sin* and *x,* for example, in *sin x*). It is best to avoid breaking an expression within parentheses or brackets. In case of difficulties, the author should be consulted about the most mathematically sensible place to break an equation.

Equation (1) is therefore written in the following compact form:

$$+ \sum_{m,n} C^{*}_{mn} \begin{Bmatrix} \bar{M}_{eo}\left[k_g(c-z)\right] \bar{M}'_{eo}\left[k_g z'\right] & - \bar{N}_{oe}\left[k_g(c-z)\right] \bar{N}'_{oe}\left[k_g z'\right] \\ \bar{M}_{eo}\left[k_g z\right] \bar{M}'_{eo}\left[k_g(c-z')\right] & - \bar{N}_{oe}\left[k_g z\right] \bar{N}'_{oe}\left[k_g(c-z')\right] \end{Bmatrix}_{z \gtrless z'} \tag{1}$$

where

$$C^{*}_{mn} = \frac{2(2-\delta_o)}{abk_c^2 k_g \sin k_g c}.$$

Figure 4. Example of equation format. *(From Chen-To Tai, Different Representations of Dyadic Green's Functions for a Rectangular Cavity, Harry Diamond Laboratories TR-1724 (December 1975).)*

2.6 Appendices

Each appendix should begin on a right-hand page. Appendix pages are numbered as a continuing part of the main body of the report and should not be renumbered from 1. The letter designation of each appendix must be used with the numerical designations of figures, tables, and equations of that appendix (such as figure A-1, table A-2, equation (A-3), and so on). The letter designation should not, however, be used with page numbers or footnotes.

2.7 Pagination

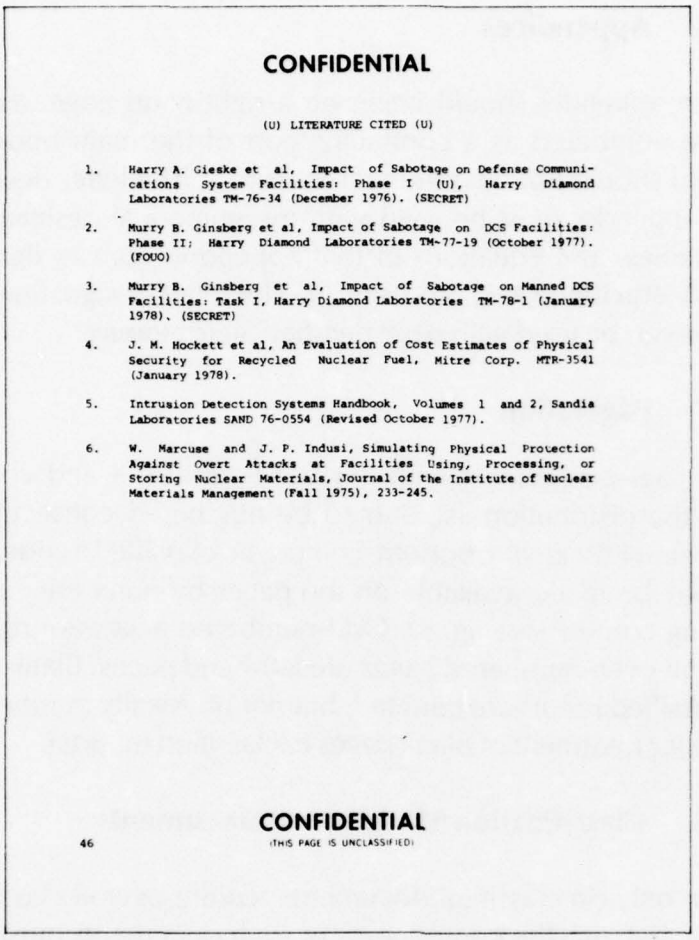
All pages, beginning with the DD Form 1473 and continuing through the distribution list, should be numbered consecutively in Arabic numerals at the bottom center. In classified reports, more space may be made available on the pages by numbering pages in alternating corners (see fig. 5). Odd-numbered pages are right-hand pages, and even-numbered pages are left-hand pages. Blank pages in an unclassified report are counted, but not physically numbered (see sect. 2.8 for treatment of blank pages in classified reports).

2.8 Classification Markings on Documents

Not only do classified documents require overall classification markings, but also the components of such documents must receive individual classification markings.[4]

Overall and Page Markings.—The overall classification of a document should be conspicuously marked or stamped at the top and bottom on the outside front cover and back cover. Each inside page of a document should be conspicuously marked or stamped at the top and bottom with the highest classification of information appearing on that page. Figure 6 shows how a blank page is marked

[4] *DoD Information Security Program Regulation, DoD 5200.1-R (November 1973).*



CONFIDENTIAL

(U) LITERATURE CITED (U)

1. Harry A. Gieske et al, Impact of Sabotage on Defense Communications System Facilities: Phase I (U), Harry Diamond Laboratories TM-76-34 (December 1976). (SECRET)

2. Murry B. Ginsberg et al, Impact of Sabotage on DCS Facilities: Phase II; Harry Diamond Laboratories TM-77-19 (October 1977). (FOUO)

3. Murry B. Ginsberg et al, Impact of Sabotage on Manned DCS Facilities: Task I, Harry Diamond Laboratories TM-78-1 (January 1978). (SECRET)

4. J. M. Hockett et al, An Evaluation of Cost Estimates of Physical Security for Recycled Nuclear Fuel, Mitre Corp. MTR-3541 (January 1978).

5. Intrusion Detection Systems Handbook, Volumes 1 and 2, Sandia Laboratories SAND 76-0554 (Revised October 1977).

6. W. Marcuse and J. P. Indusi, Simulating Physical Protection Against Overt Attacks at Facilities Using, Processing, or Storing Nuclear Materials, Journal of the Institute of Nuclear Materials Management (Fall 1975), 233-245.

CONFIDENTIAL

46 (THIS PAGE IS UNCLASSIFIED)

Figure 5 (U). *Sample of marking of unclassified page when classified material is on reverse page (U).*

in a classified report, in which all pages have to be physically numbered. Figure 5 illustrates the marking of an unclassified page when the reverse side is confidential.

Paragraph Markings.—Each section, part, paragraph, or subparagraph should be marked to show the level of classification. This marking should precede the section, part, or paragraph, as illustrated in figure 7. Main headings that have subsections should be marked

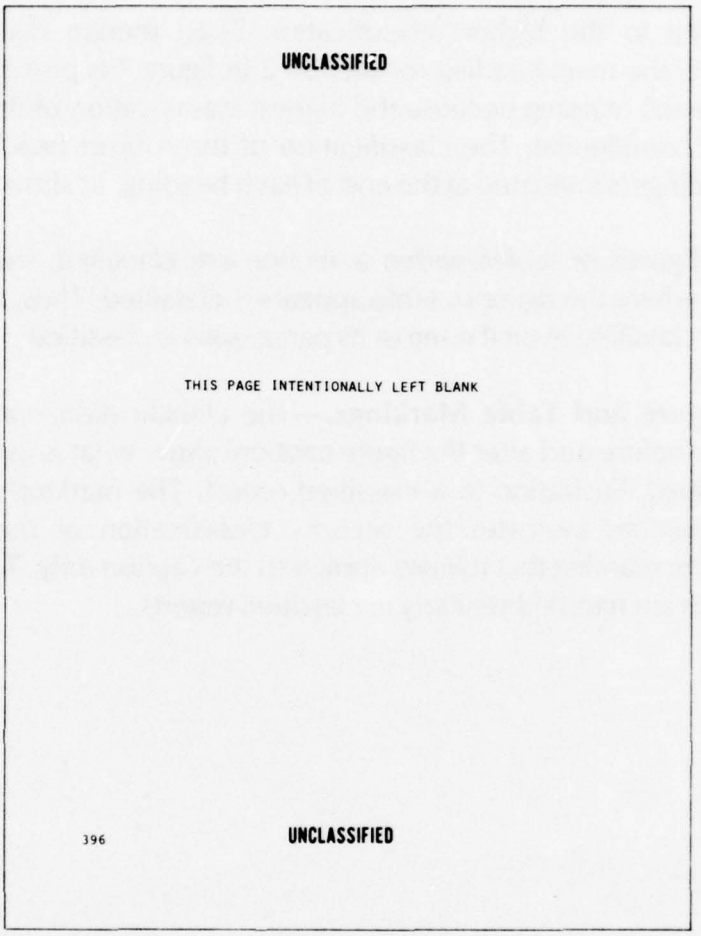


Figure 6. Sample of blank-page marking used in classified reports.

2. (C) SAMPLE OF CLASSIFICATION MARKINGS (U)

(U) Now is the time for all good men to watch the quick brown fox jump over the lazy dog.

2.1 (C) First-Order Heading with M- (U)

(C) She sells seashells SAMPLE ONLY UNCLASSIFIED shore when she is too busy to come to the aid

2.1.1 (U) Second-Order Head. -th Markings (U)

(U) This experiment attempted to determine how many cans a cannibal could nibble, if a cannibal can nibble cans.

Figure 7. Paragraph marking in classified reports.

according to the highest classification listed therein (fig. 7). For example, the main heading for section 2 in figure 7 is preceded by a confidential marking because the highest classification of its subsections is confidential. The classification of the subject headings and subheadings is indicated at the end of each heading, as shown.

If figures or tables within a section are classified, the overall section where the figure or table appears is classified. Thus, a section may be classified even if none of its paragraphs is classified.

Figure and Table Markings.—The classification markings in figure 8 (before and after the figure caption) show what is used for an unclassified illustration in a classified report. The marking after the figure number indicates the security classification of the overall figure; the marking that follows applies to the caption only. Table-title markings are handled similarly in classified reports.

(a)

(b)

Figure 8 (U). More ERADCOM elements: (a) Adelphi, MD, and (b) White Sands, NM (U).

Part II. The Contents of the Report

3. THE AUTHOR

3.1 **Getting Started**

Over and over, editors hear this familiar authors' lament: "I don't have time to write," or "I hate to do it," or "I can't get started." Although editors might never persuade authors to enjoy writing, editors can help authors to get started and can provide advice and encouragement along the way. If authors and editors talk over a proposed report before it is written, the report will flow more easily and quickly, without the chaos that results from a haphazard approach. This section contains the sort of advice an editor can give an author in the first stages of report writing.

3.2 **Preparing the Outline**

The route you take has fewer detours with a planned outline. Most technical reports are complex enough that they must be outlined before a draft is begun or disaster follows. The following checklist is suggested for authors forming an outline.

- List your tentative main headings.

- Gather the necessary information from laboratory notebooks, test reports, and other sources: the history or origin of the project, detailed comments, design calculations, records, charts, sketches, and sudden relevant thoughts. You must be able to recon-

struct the events as they progressed. Add names of management people and dates of planning sessions that began your participation in the project. Describe the project plan and specific information about its purpose. Keep up a list of people who worked with the project, their titles, and their positions. List all equipment ordered, the manufacturers' nomenclatures, models, serial numbers, costs, special features, and operating and service instructions. Not all this information will necessarily be included in the final report, but you will find it useful to have all the relevant information handy; the names of people who might be able to supply missing information might prove especially useful.

- On proposed illustrations, write descriptions, numbers, dates, and identifying remarks as tentative figure captions. List all formulas and mathematical expressions, with a list of symbols and their meanings. In tables and graphs, indicate the curves by exact data or approximate curves drawn through many test points. To avoid later confusion, code mark each photograph on both its back and its envelope (use a label, or write lightly in pencil on the back of the photo, in a lower corner).

- Collect descriptions of experiments from your laboratory notebook. With them, you can reconstruct experiments in their historical order and thereby chronicle your efforts.

- List all data or information that you got from other sources: authors, titles, publishers, publication dates, report numbers if applicable, and page numbers. List all expenses in both formal expense accounts of purchase orders and small out-of-pocket shopping orders. Being careful at the beginning of your data collection saves hours later when the source may not be easy to find.

- Jot down facts on cards, one topic to a card. Analyze the facts to determine their significance, and decide what you will use. Cards may be shuffled and reshuffled until you decide the best order to present the facts.

• Fit your cards to your tentative outline, or modify your outline to reflect the organization of your cards. Decide what facts you still need, and get them. Readjust your main headings, and add subheadings from your fact cards. Add these headings to your cards. Decide where you will use figures and tables.

Many people find it unnecessary or uncongenial to prepare a formal outline. To organize your thinking, if you are a determined nonoutliner, you might try asking yourself the following questions in sequence.

(1) What was the problem?
(the answer to this corresponds to the introduction and background)

(2) What was done to meet the problem?
(methods, procedures)

(3) What was learned in what was done?
(results)

(4) What was the significance of what was learned?
(conclusion)

(5) What does all this suggest we do or not do in the future?
(recommendations)

3.3 **Writing the Report**

Begin writing in conversational (slang, spoken, informal) English, as if you were explaining the topic of your report to another person. It is easier to formalize informal writing than to unwind the vagaries of complex writing. Remember, however, that although you are using simple words and constructions, you must "fill in the blanks" of your report. Do not assume that your reader knows anything about the particular project you are describing. Decide

what audience you are writing for and structure the presentation accordingly—that is, the more general the audience, the less specific the knowledge that can be assumed.

Although your outline will probably change after you begin writing, it will provide you with a starting point, serve as a general framework, and keep you thinking and writing along logical lines. If you have trouble getting started, postpone work on the opening section and start writing any section that you feel ready to write. Do not worry if the first few things you write have to be thrown out; it is important to get the process going. Try not to edit very much as you write: get your thoughts on paper as quickly as possible, and polish at your leisure, preferably after a day or so has passed.

It is often useful to postpone writing the introduction and conclusions until after the other sections are written. In this way, you can help assure that both introduction and conclusions reflect what you have actually written (see sect. 6 for a discussion of organization).

3.4 **Unofficial Peer Review**

Let a peer read your draft and comment on it for improvement. The harder it is for your peer to understand your point, the more you must revise. From comments on the paper, you can tell whether your message was caught or missed. If it was missed, then you must revise further to assure more understanding by your intended readership.

It is also sometimes a good idea to try out your report on a "naive" reader—that is, one who is unfamiliar with your subject. Such a reader may help you to find gaps in your logic or exposition that should be filled in for clarity.

3.5 **Revision**

After allowing time for the report to "cool," and gathering comments from other people, reread your report; try not to edit on

this reading. It is better to get an overall impression on this reading, and not get bogged down in revisions. Make notes in the margin wherever something strikes you as awkward, illogical, unclear, or otherwise in need of revision. In reading, try to take your material as literally as possible; do not allow yourself to simply "get the idea." If you find you have to reread anything, mark it for revision (your readers will probably have the same problem). After reading the report all the way through, you can go back and revise the passages you marked. Repeat this process until you are satisfied.

4. THE EDITOR

4.1 **Necessity for Editorial Review**

The only effective way to assure that standards for reports are followed is to provide for an editorial review of all formal reports. Authors and typists, no matter how competent in their own fields, cannot be expected to produce reports according to particular editorial standards. The efficient editor (through training, natural talent, or both) is a master at fussing over the English language; the editor should also be sensitive to consistency in format, abbreviations, and other details. The author or the technical reviewer verifies technical accuracy; the efficient editor ensures that the material is presented clearly and concisely. Thus, whether a manuscript is produced by in-house writers or by contractors, it should be edited by people familiar with the types of regulations and recommended practices given in this manual. Therefore, contract monitors should be reminded that if a formal contractor report is required, the contract should include provisions (and funding) for a preliminary draft, to allow for editorial changes and for final printing.

Time commitments occasionally make it desirable for a report to be sent out (to a sponsor, for example) in less time than is reasonable to produce an edited, polished report. In such situations, a "preliminary" draft can be prepared for limited distribution, with a disclaimer attached, explaining that the document is preliminary

only, has not been editorially reviewed, and will be replaced by a formal report. In this way, the demands of timeliness and high quality can both be met.

4.2 Editorial Review as Part of Production

A thorough editorial review can simplify the process of producing a technical report. At the best of times this process is long and complex, as shown in the flow chart given in figure 9 (pp 40 to 45). All the steps shown in this flow chart may not apply to all publications offices (some offices do not have access to word–processing equipment, approval procedures differ from place to place, and so on); however, the flow chart does represent the types of processes that a report must go through. Because these processes are so complex, it is especially important that the initial editorial review be as comprehensive as possible, and that the editor and author both agree on the final form of the report; starting off with a carefully assembled manuscript can help prevent needless repetition of complex steps.

4.3 Primary Editorial Concerns

The editorial review is thus the first step on the road to a finished report. The editor must assure that specific rules and policies[1] are followed concerning the components of a report (see Part I); however, the technical editor's first concern is to help an author produce an excellent report. This concern requires the editor to attend both to many small details (requiring copy editing) and to various larger considerations (requiring content editing or rewriting). Many editors perform both kinds of editing at once, although, in some organizations, these functions are divided between two groups: copy editors and content editors. However, the distinction between the two groups—and the two functions—is fuzzy, varying from organization to organization. All editors need to be aware of the

[1] *MIL-STD-847A, Format Requirements for Scientific and Technical Reports Prepared by or for the Department of Defense (31 January 1973).*

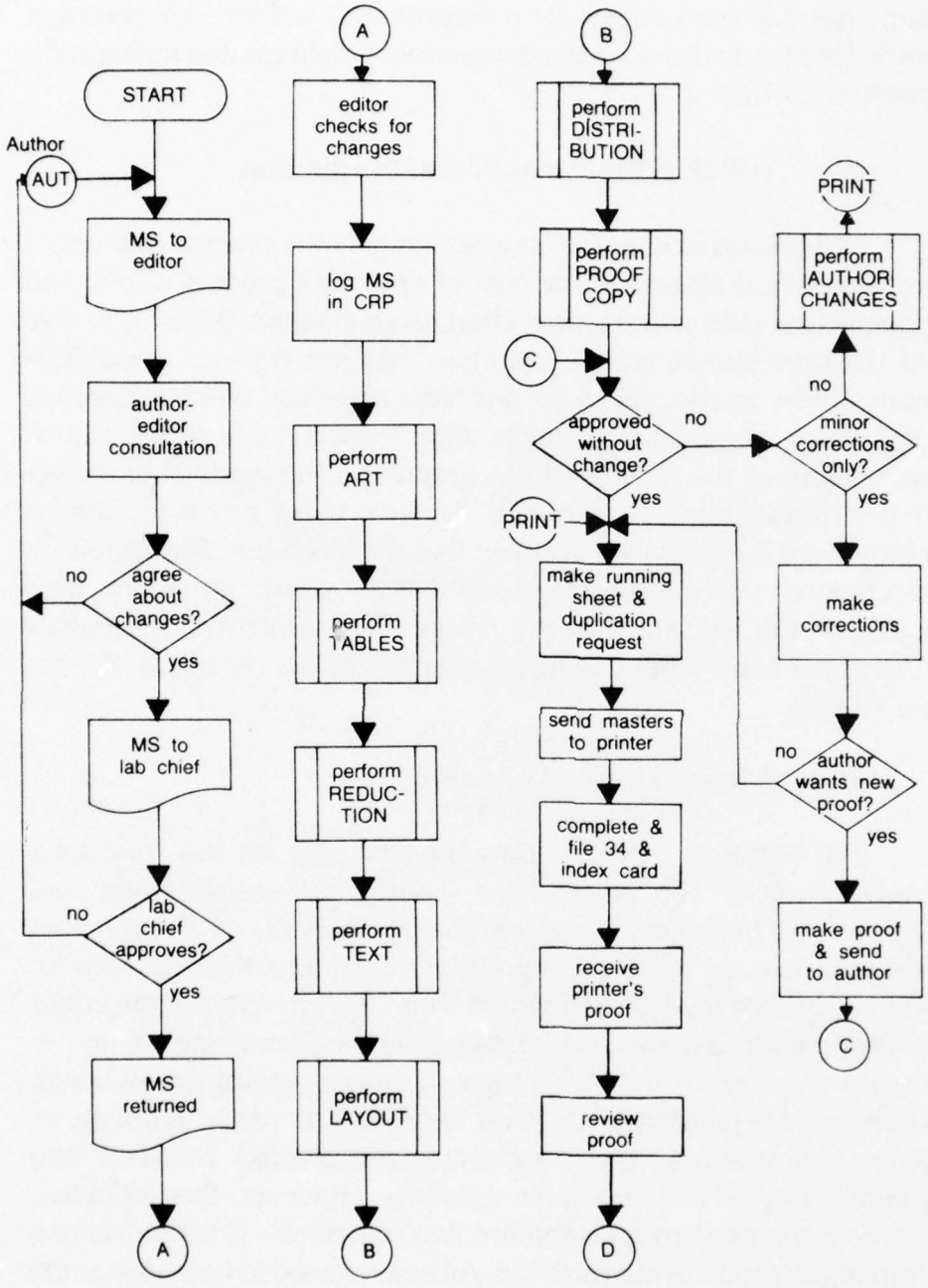


Figure 9. Steps in report production: main routine.

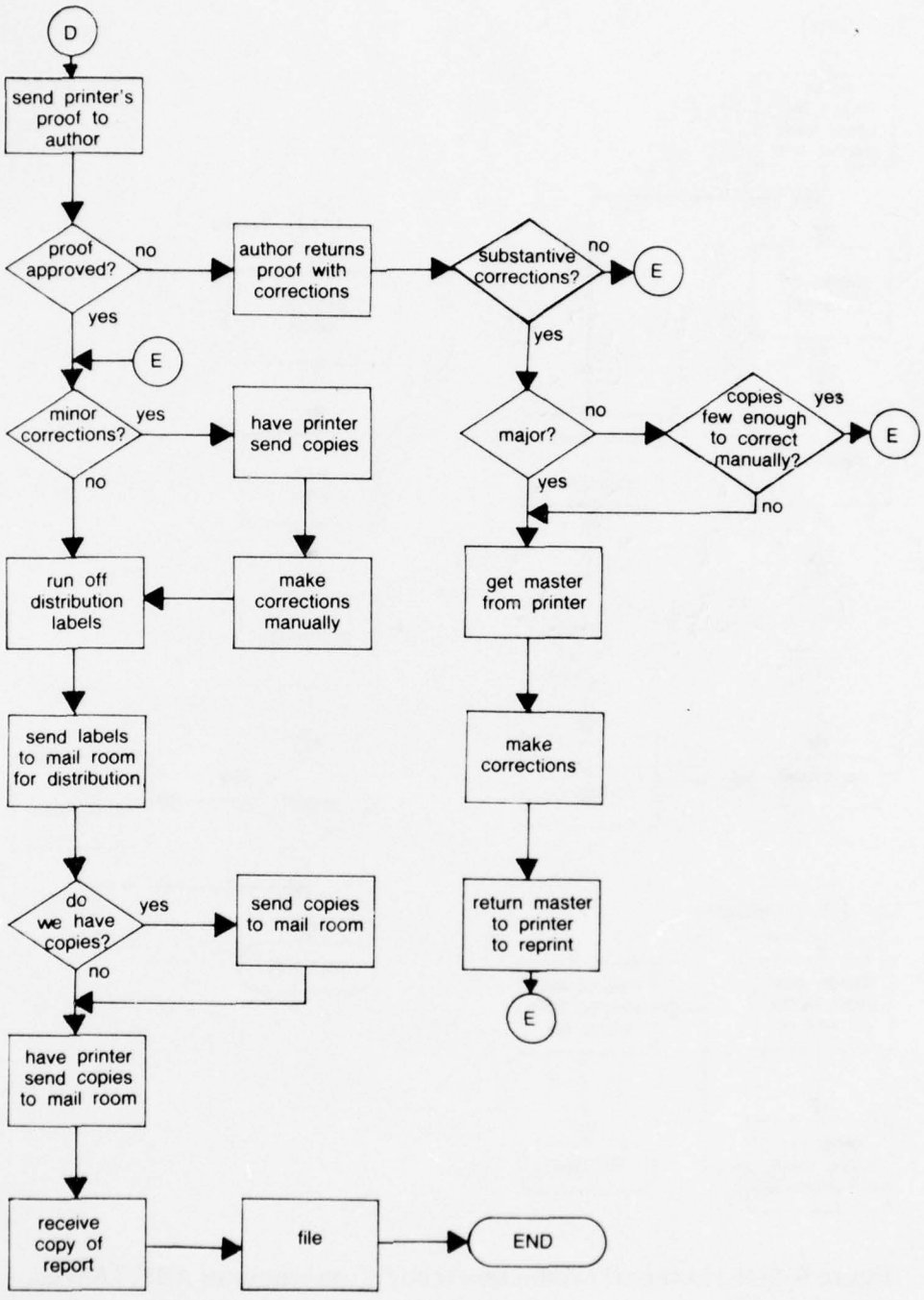


Figure 9. Steps in report production: main routine (cont'd).

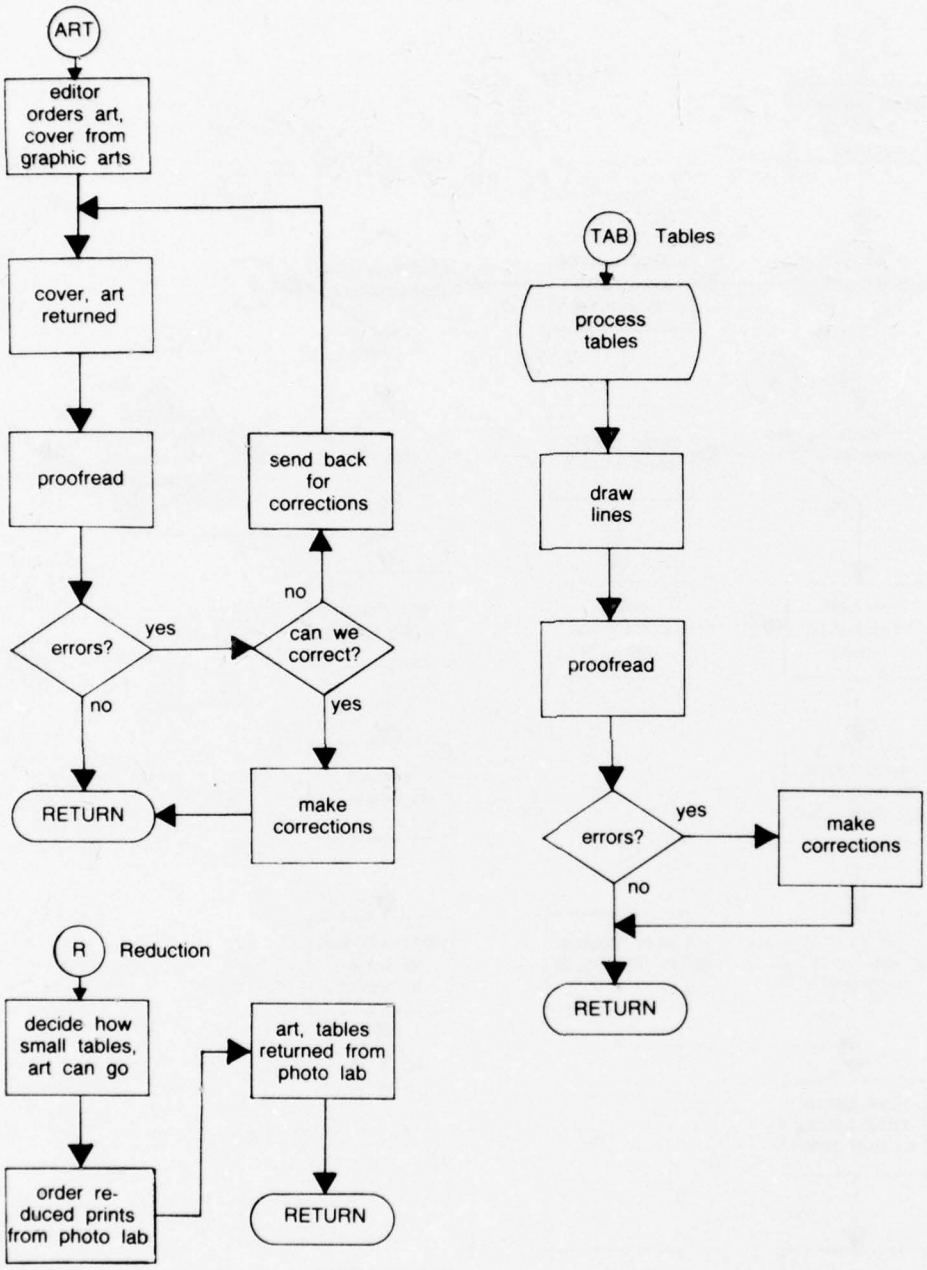


Figure 9. Steps in report production (cont'd): subroutines ART, TABLES, and REDUCTION.

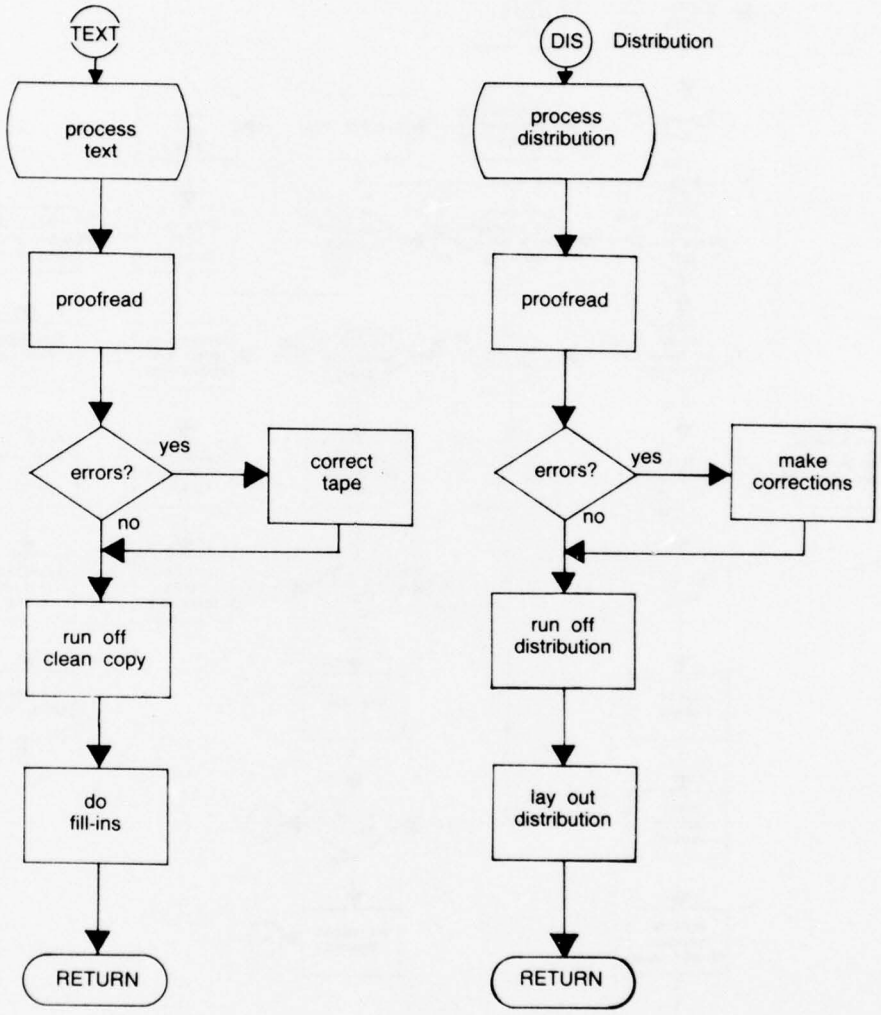


Figure 9. Steps in report production (cont'd): subroutines TEXT and DISTRIBUTION.

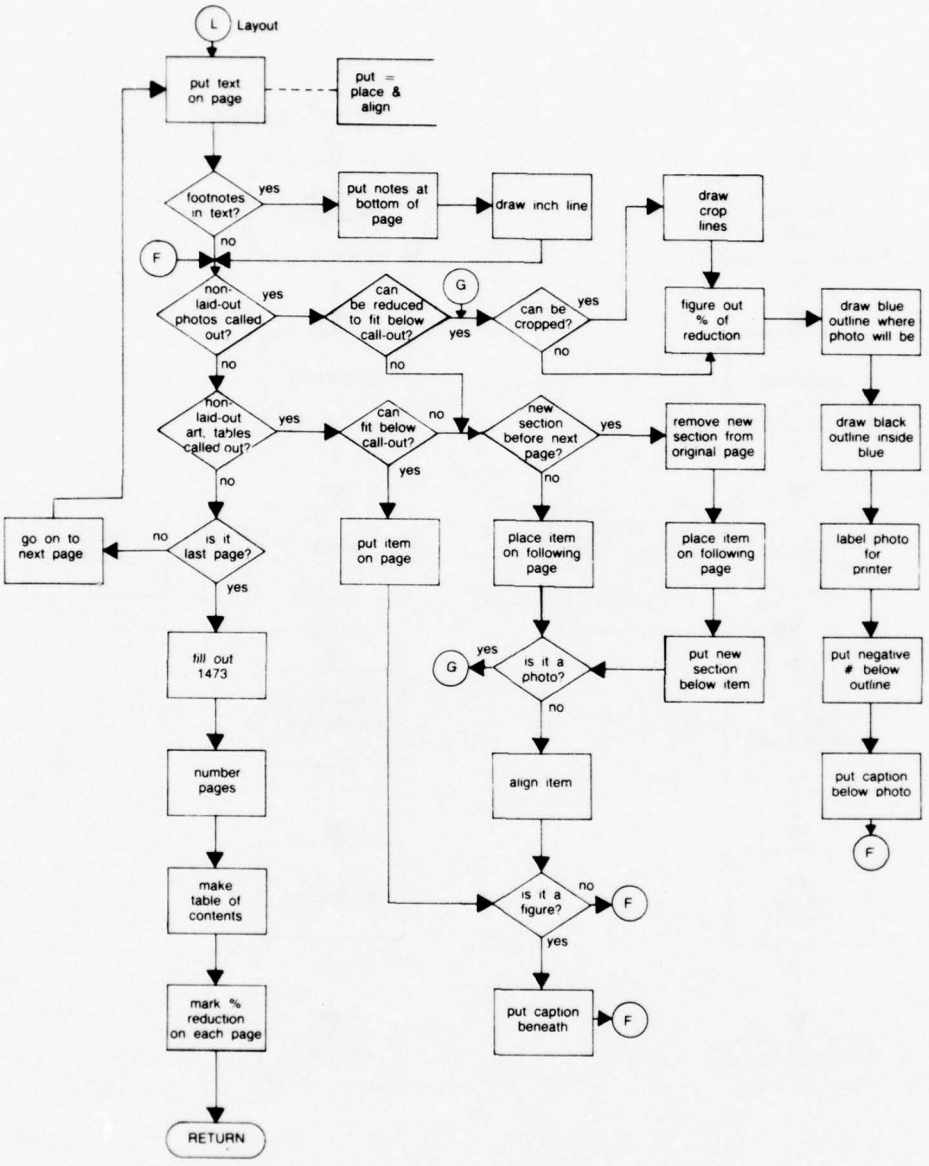


Figure 9. Steps in report production (cont'd): subroutine LAYOUT.

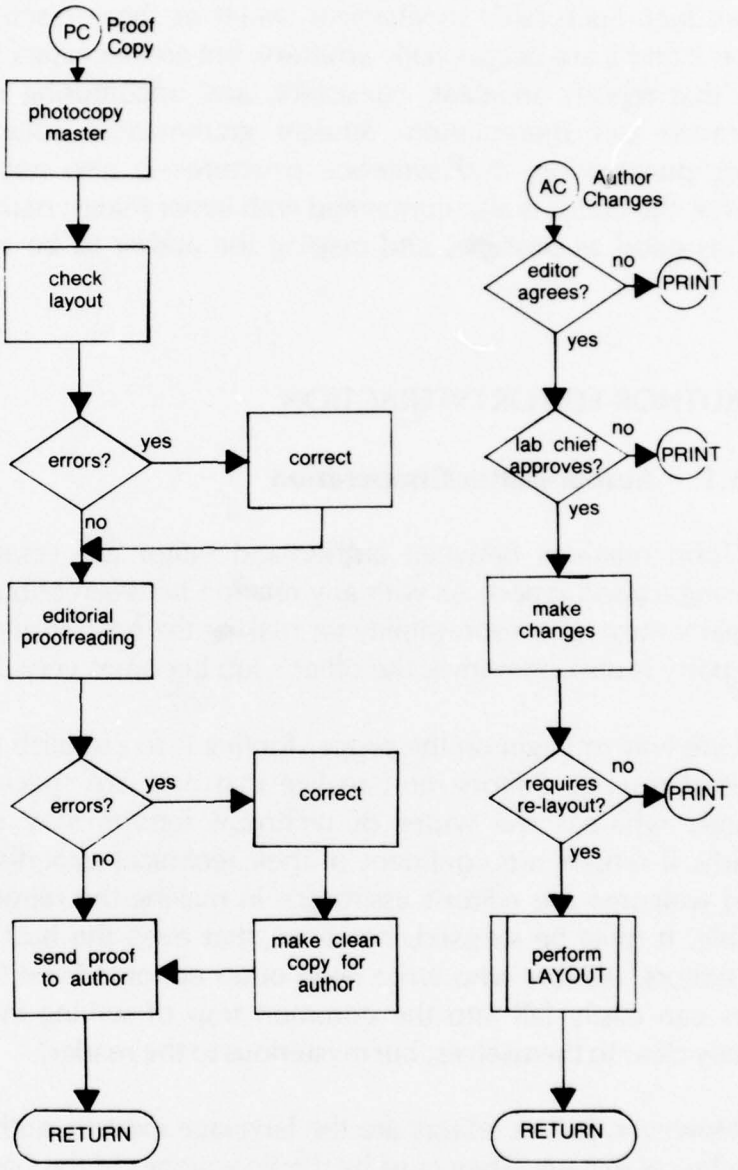


Figure 9. Steps in report production (cont'd): subroutines PROOF COPY and AUTHOR CHANGES.

elements of both types of editing, since both are important for the final product. Such fairly mechanical details as those discussed in sections 2 and 3 are occasionally arbitrary, but are necessary to help assure that reports are neat, consistent, and unconfusing in their appearance and presentation. Straight grammatical editing—for spelling, punctuation, and sentence structure—is also necessary. However, the editor is also concerned with larger things: making the report as good as possible, and helping the author to be a better writer.

5. AUTHOR-EDITOR INTERACTION

5.1 **Author-Editor Cooperation**

Good relations between author and editor are essential to producing a good report. As with any relation between two people, each party must take responsibility for making the relationship work. If one party is uncooperative, the other's job becomes very difficult.

One way to begin on the proper footing is to establish feelings of mutual respect. Editors must realize that they are specialists in language, whereas the writer of technical reports may not be. Similarly, if writers are confident of their technical expertise, they should welcome the editor's assistance in making the report more readable. It must be stressed, however, that even the best writers need editors. (Editors who write need other editors.) Even the best writers can easily fall into the common trap of writing in a way perfectly clear to themselves, but mysterious to the reader.

However, just as editors are the language experts, authors are the technical experts. They must be the final judges of the content of their reports, assuring completeness, accuracy, and relevance. An editor may always suggest changes, but the author must take the final reponsibility for technical content. For both parties to attain their goal—an excellent report—good relations are essential.

The first step toward good author-editor relations is the face-to-face conference. In some elements of ERADCOM, this might not be possible; whenever it is, editors should make every effort to talk to the author in person, so that authors do not feel that some faceless, heartless creature has rampaged through their manuscripts. The editor should have a list of questions or problems that have been noted in the report, and the author should be given an opportunity to bring up any objections at conference time. It is important for both parties to keep in mind that the editor is not an adversary, but a helper—someone who is sincerely interested in making the report more readable.

The relationship between editor and author is much like that between defense attorney and client. The attorney's job is to present the client's case in the best possible light. The editor's job is to present the author's material in the clearest possible way. The writer, in turn, must give the editor all the information and cooperation necessary to meet their mutual goal. Neither should attempt to "snow" the other with the technical jargon of their respective specialties.

The editor who is without specific technical knowledge should be wary of arbitrary changes in language that might change technical meaning. One can often make a lovely sentence out of an awkward one by repositioning clauses and phrases; when this is done, however, technical meaning might be changed. The editor should make certain, by question marks or lists of questions with page numbers, that the author sees every major change. Likewise, the author must read both the edited manuscript and any proof copies with great care, to make sure errors do not creep in. It is especially important for the author to check all numbers, whether statistics, references to figures and tables, or footnotes. Tedious though it may be, this task is vital, and this is the time for changes, not later (see sect. 5.2).

One technique editors can use to prevent authors from being discouraged by the mere appearance of the manuscript is to avoid

the red pencil. A manuscript covered with red marks not only reminds people unpleasantly of grade school, but also can look as if World War III has broken out on the manuscript. Blue or ordinary pencil is a better choice. It is usually a good idea to mention that many of the marks are formatting instructions to production people, and are thus not substantive changes.

A word of caution to the editor: do not become so enthusiastic in the rewriting and reworking of a report that you forget the author. Both author and editor should remember whose name will be printed on the cover of the report, and act accordingly.

5.2 Author Alterations—Changes to Final Proof Copy

Editors should emphasize that the time for authors to make final "rewrite" changes in their manuscripts is at the author-editor conference (or before). In fact, after the conference, it is a good idea for the author to take the manuscript back for a day or two and read it over. This is the time for the author to give the proposed manuscript to peers and naive readers for unofficial review (see sect. 3.4).

Unfortunately, many authors do not understand the publication process; thus, they wait until they receive the author's proof copy to make substantive changes. The author receiving a proof copy is expected to check technical data, correct minor errors, and approve the report for printing, but not to rewrite. All levels of publication personnel will emphasize that this is not the time for substantive changes. When the authors receive their proofs, pages have been laid out to proper depth for printing, and tables and line drawings have been photographically reduced; changing these items is a time-consuming and expensive process. The author should understand the repercussions that can occur from seemingly innocent changes, shown in the following three examples.

- *Alteration*: The author adds 10 lines to a section on page 9 of a 50-page report to better explain the failure of one experiment compared with the success of two similar experiments.

Repercussion: Forty pages of camera-ready copy have to be laid out again. This may sound simple; however, it is comparable to laying out a report from the beginning. Text, equations, tables, footnotes, and illustrations must be picked up and moved. Finish lines for the tables must be redrawn; inch lines for footnotes must be redrawn; pages must be repaginated; the contents page is then incorrect and must be done over—all this on top of moving each page of text.

- *Alteration*: The author adds three footnotes (after number 5) to a literature study that has 45 literature references.

Repercussion: This copy had been proofread twice before the author saw it. Now the copy preparer must locate every footnote each time it is cited and change every number after reference 5 both in the text and at the bottom of the page. The Literature Cited page has to be typed (or set) and laid out again. Pages that were the correct depth now have extra footnotes cited, and paragraphs must be crowded together or laid out on subsequent pages, forcing repagination of the contents page, etc, as in the first example.

- *Alteration*: The author decides to add blocks to a flow chart and to add schematic symbols to a circuit diagram; each illustration had been reduced for printing.

Repercussion: Original art work has to be resubmitted to graphic arts personnel. If the art work had been contracted, it must be sent back to the contractor for alteration, at additional cost and, usually, a time lag of weeks. Then, when the art is returned from the contractor (if it is correct and does not have to go back to the contractor again), the copy preparer must again send the art to be photographically reduced.

Publications personnel are eager to help the author produce an attractive, technically accurate report. However, the task of keeping up production is hindered if a report must be reworked after it has been prepared for the printer. The process is time-consuming and expensive, as well as demoralizing to production personnel, who have to delay work on other reports.

6. ORGANIZATION

Important though format and grammatical correctness are, clarity of exposition is the most important aspect of a technical report. In a well-organized report, the information is presented in the order in which it can best be grasped by the reader.

The importance of letting the reader know what the writer is talking about cannot be overemphasized. Although particularly important in the introduction to a report, this principle applies throughout any piece of expository writing. One of the editor's most important functions is to let authors know when they are "writing to themselves": that is, explaining things so that only they, or someone else who already knows all about the specific topic, can understand what is going on. This pitfall is difficult to avoid since most normal speech is in what some sociologists of language call *restricted code*—a way of speaking that takes advantage of shared knowledge by leaving out (very efficiently) much detail, context, and explanation. In writing, however, an *elaborated code* is required—one that provides context, explains what is meant by certain terms, gives background, and so on. The difficulty each author faces is to decide how much elaboration is required by the audience. In speech, this is a relatively easy problem to solve; many cues are available to speakers to tell them that their listeners are not following them, from a wrinkled brow to actual questions. A writer, on the other hand, has to imagine a listener, try to guess where confusion might arise, and forestall it by providing the necessary elaboration in advance.

Editors can improve the overall clarity of the material by restructuring a report if they notice, for example, that a needed explanation is provided after it would have been useful, that a section of a report suddenly makes previous mysterious sections understandable, that a point is made at the end that sheds new light on the beginning, and so on. These are signs of either minor or major problems in organization. Some such problems can be avoided if the report follows the traditional report structure outlined in sections 6.3 through 6.8.

One principle that should always be kept in mind is that the whole (overview) should be presented before the parts (details). That is, the overall picture of whatever is to be described should be given before any details are mentioned (whether at the report, the section, or the paragraph level). The general point of the argument, the function of the equipment, the purpose of the experiment—these should be primary. Putting the whole before the parts prepares the reader for the details that follow.

6.1 **Determining the Thesis**

The abstract and the title together should allow a reader to determine the thesis of a report. Writers should determine their theses before they begin to write; determining the thesis is to a report what formulating a hypothesis is to an experiment. As a hypothesis channels the course of an experiment, a thesis guides the development of a report; even if the thesis is changed in the course of writing, it is a necessary starting point for the writer.

If a report has no obvious thesis, it will not hang together, no matter what the writer does in revising or the editor does in editing. If a report's thesis is obvious, and is reflected in the title and abstract, this is a great boon to the readers, who can immediately tell whether the report deals with a subject that interests them.

6.2 **Title**

A concise report that is enhanced by its clear language and logical presentation must not be draped in the fussy ruffles of an overly complicated title. Just as a person is first judged superficially, so a report is first judged by its title. On first meeting a sloppy person with black under the fingernails, you might get a negative impression before you find out that the other person reads a lot, is kind to his family, has a great sense of humor, and rebuilds cars in his spare time.

In the same way, if you are looking for reports about radiation hardening of fiber-optic systems and you come across a reference with this title,

> A Radiation Hardened 400 MHz Bandwidth Linear Response Fiber Optic Transmission System,

you might stalk out of the library in disgust, muttering about noun modifier increase phenomenon (see sect. 8.2.5).

The editor realizes, of course, that nouns in titles must be modified and qualified for the title to be precise. However, there are discreet ways of changing titles around so that they are easier to read and sometimes livelier, if not more fascinating. Notice how the above title can be changed.

> ***Revision:*** A Radiation-Hardened Fiber-Optic Transmission System Having a 400-MHz Bandwidth and Linear Response

Titles, like sentences, can be made more lively and more readable by changing noun forms to verbs.

- Design Practices for High-Altitude Electromagnetic Pulse (HEMP) Protection—Intrasite Cabling

  Revision: Design Practices for Protecting Intrasite Cabling against High-Altitude Electromagnetic Pulse (HEMP)

There is another totally different titling problem: authors want to describe the entire report in the title.* Try to imagine the editorial comments provoked by the following title.

- The EMP Vulnerability Assessment of the 10-kW (Design Model SF-10-MD); 5-kW, 60-Hz, AC (DoD Model MEP-017A); 5-kW, 400-Hz, AC (DoD Model MEP-022A); 3-kW, 60-Hz, AC (DoD Model MEP-016A); 3-kW, 400-Hz, AC (DoD Model MEP-021A); 3-kW, 38-V, DC (DoD Model MEP-026A) Generator Sets

  Revision: The EMP Vulnerability Assessment of Several Generator Sets

The most important thing about a title, however, is that it reflect accurately what the report is about. Such titles as

A Way to Improve Laser Operation

tell a reader nothing about the type of improvement concerned. Even worse is a title like

Laser Operation

which tells us only that the report has something to do with laser operation. A better title would be

Crystal Cleaning: A Way to Improve Laser Operation

Thus, a good title should be readable and concise, and should reflect the content of the report.

**Some titles could serve as abstracts if a word or two were added about "recommendations."*

6.3 **Abstract**

Abstracts can be descriptive, informative, or a combination of both.

A descriptive abstract tells what a report is about in a sort of prose table of contents, as shown in the following example:

> A simple method of building close-packed molecular and crystal models is described. It has proved its pedagogic value, as well as its many advantages to the research worker. Two diagrams and four photographs are included. The method was evolved in the author's laboratory.

The informative abstract transmits the most important methods, results, and conclusions of the text. This type is more valuable than the descriptive and is often preferred:

> Close-packed molecular and crystal models can be built easily and inexpensively when balls of various materials are dipped into latex of 60-percent concentration. Desired colors can be obtained when the balls are dipped into a quick-drying water-insoluble paint before the latex is applied. Only slight pressure is needed to stick the balls together to form a model. They can be separated by jerking.

Often, however, reports are too long and involved to be suitable for an informative abstract. For such reports, a combination abstract, like the following, may be best.

> The XYZ Laboratory has developed an electronic dust-attractor. Volumes up to 3 m^3 can be kept dust-free by the attractor, which works by suction through a fine filter. Details of design and operation are discussed and engineering drawings are provided. The attractor could have industrial, medical, and domestic applications, some of which are discussed.

This kind of abstract combines the hard information of the informative abstract with the "list of ingredients" approach of the descriptive abstract.

In any case, the abstract should be understandable without reference to the text. If a report is difficult to abstract, it may be a sign that the report has no clear focus or thesis. For ERADCOM reports, informative or combination abstracts are preferred.

6.4 **Introduction**

A good beginning serves as a springboard into the subject. Even if the first section is not labelled "Introduction," introductory material should appear early in the text. Introductory information

orients the reader with historical background and then describes the present problem,

states the purpose of the study,

defines the scope, limitations, and qualifications of the study,

describes the methods used, and

includes definitions of terms or symbols used often in the report.

The introduction should be tailored to the needs of the audience. The more general the audience, the more information is needed in the introduction. Even the specialist audience, however, needs orientation on the particular aspect of the specialty that the report deals with.

Sometimes, besides an introduction, a report may require an executive summary; an author may wish to include an executive summary if the report is destined for two distinct types of audience.

That is, part of the audience may only be interested in the general procedure and the conclusions, whereas another part of the audience requires greater detail. An executive summary should therefore be a streamlined version of the report, omitting details but including important arguments and conclusions. It should be considered to be a separate part of the report, rather like an appendix (except that it comes at the beginning); thus, terms should be defined, background given, and so on, both in the executive summary and in the full report. The full report will still require an introduction, therefore. Both the report and the executive summary should be able to stand alone.

6.5 **Main Body**

The main body includes those parts of the document that fall between the introduction and the conclusions and usually includes such topics as the following:

equipment,

experimental methods,

theoretical considerations,

predictions and observations,

advantages and disadvantages of equipment and methods,

detailed or summarized data, and

evaluation of the results.

The main body should reflect the purpose stated in the introduction. The sequence should be arranged in the most logical way from the reader's standpoint, with appropriate headings and subheadings to alert the reader to the structure of the report. To avoid needlessly distracting the reader, extensive detailed data can be organized into tables, and illustrations can be used to save words and to clarify the material presented.

6.6 Conclusions

The conclusions can be placed at the beginning, at the end, or in both places, depending on the report. If conclusions are at the beginning, only the actual conclusions should be given; that is, the supporting evidence should not be explained yet. If conclusions come at the end, each conclusion should be tied to its supporting evidence, to avoid the charge of "begging the question." Of course, all conclusions should follow from the facts presented in the main body, and should be consistent with the ideas given in the introduction. New information that has not appeared in the main body should not be brought into the conclusions. If recommendations are given with the conclusions, the section should be labelled "Conclusions and Recommendations."

6.7 Recommendations

The recommendations section describes the actions that the author believes should be taken as a result of the conclusions drawn from the facts presented. Although it is sometimes desirable to present conclusions and recommendations together, these should always be distinguished from each other. If a particular recommendation follows from a particular conclusion or conclusions, these should be tied together. As with conclusions, it is important that no new information be given with the recommendations, and that all statements follow logically from the exposition in the main body of the report.

6.8 Appendices

Appendices are useful for providing supplementary material not essential to the body of the report, such as lengthy interpretations or proofs of mathematical or physical theories, computer printouts, specifications, procedures, or policies. The appendix provides a place to unload details that are of secondary importance to the main presentation, but that are still necessary for the record. Using

appendices for this purpose avoids burying important ideas under a mass of detail.

It is important to refer to the appendices where they are relevant in the body of the report so that readers may look up the information if they wish.

7. COHERENCE AND CONSISTENCY

In a coherent and consistent report, the exposition is presented so that the reader can see the point of each section and its relevance to the whole.

Coherence is desirable at all levels of a report. Individual sentences, paragraphs, subsections, sections, chapters, and the report as a whole can all be judged as coherent or incoherent. Webster's[5] defines "to *cohere*" as "to be logically or aesthetically *consistent.*" Often, writers use "coherence" to describe this unified quality at the higher levels of report organization, and "consistency" to describe uniformity at the lower levels of word choice, sentence structure, and so on. However, the two concepts are closely related; thus, they are treated together here.

7.1 **The Unified Whole**: Guiding the Reader

Coherence at the higher levels is closely related to organization: arranging the parts of the exposition in the order easiest for the reader to follow may be half the battle in getting a coherent report. However, it is important not only to present things in the right order, but also to make it clear *why* they are presented in that order: in other words, how each concept or point relates to the argument as a whole. It is not enough to explain a point and then give an example illustrating the point; the writer must also make it clear which specific point the example illustrates and how. Writers cannot assume that

---

[5] *Webster's Third New International Dictionary of the English Language, G. and C. Merriam Company, Springfield, MA (1961).*

their audience will see as clearly as they do how a certain example proves a point; such things must be stated explicitly. It is not uncommon for a reader to draw from an example a conclusion totally unlike the one the writer had intended. This can be avoided if the writer ties examples closely to the arguments they support.

Similarly, sections of an exposition should be tied into the overall point or theme of the report. Even if a report or sections of a report are mainly descriptive, it is important to make it clear to the reader how the individual parts of the description fit into the whole. Without signposts to show the way, the reader may get lost trying to struggle through amorphous masses of detail. Often, such "shaping" of descriptive detail can be done by explicit subject headings, such as

2. Parts of the Gizmo
    2.1 Power Supply
        2.1.1 Thingumajig
        2.1.2 Whatsit
        2.1.3 Whozis
    2.2 Direction-Finding Equipment
        2.2.1 Thing 1
        2.2.2 Thing 2

and so on. It would also be useful to explain why the gizmo is being described, and how the description is expected to benefit the reader. Not only is such an explanation useful for the reader, it can also help the writer to decide how much description is really needed.

Generally, therefore, it is important to let the reader in on what the author is doing. However, the writer should not constantly indulge in empty preambles such as

This section describes how the gizmo works.

The writer's motto should be "Don't say what you're *going* to say; say it." It should be possible to let the reader know that a section

describes the gizmo's workings without such empty preambles; for example, the section could be called *Workings of the Gizmo.* Or, rather than saying,

> This section describes the importance of efficient mosquito capture,

a topic sentence can be used, like

> Efficient mosquito capture is essential to the smooth operation of the mosquito vasectomy program.

This gives the reader not only the topic of the paragraph or section, but also some content; it is not an entirely empty sentence.

A rather simple and obvious way of keeping the reader informed of the author's drift is to include appropriate transitions, whether single words or whole paragraphs. Single words or phrases can efficiently orient the reader to the point of a paragraph. *In addition, also, moreover,* and *further,* for example, flag a paragraph as additional support for a previous point. *However, but, on the other hand, in contrast,* and *nevertheless* indicate a contrast. *Therefore, for that reason, thus, hence, consequently,* and *as a result* show that some conclusion is being drawn or result being pointed out.

Sometimes a single word is not enough, however. If it is not obvious how the addition, contrast, conclusion, or whatever follows from the preceding point, a sentence or paragraph is necessary to explain how the two points are linked. In such circumstances, a one-word transition begs the question. (Many readers are immediately suspicious of such introducers as *Clearly, ...* Even more suspect is a *therefore* for which there is no obvious basis.)

The discovery of logical flaws is another benefit of paying close attention to the transitions and connective material in a report. These logical flaws may be either errors of omission (leaving out intervening

steps in an argument, thus leaving the argument incomplete and unconvincing) or errors of commission (conclusions not actually justified by the premises). Although the second type is ultimately more serious, both types of flaws, if detected by readers, can undercut the whole purpose of a report.

In summary, the writer's job is not only to set down facts and arguments relating to a topic, but also to guide the reader through these facts and arguments. A reader is by definition less familiar with the author's topic than the author is (or should be), and thus requires explicit explanations to understand the author's point. The editor's job is to be a responsive reader, to let the author know when the report successfully conveys what the author wants it to convey, and to pinpoint the problems that prevent such success.

7.2 **The Uniform Parts**: Avoiding Confusion

Consistency at the lower levels adds to the coherence of the report as a whole by removing confusing variation in the details of the report. Variation in itself is not bad; in some areas, such as rhythm, sentence length, and sentence beginnings (see sect. 8.1), variation is even necessary, to prevent readers from dozing off while reading. However, in certain technical areas, consistency should be more highly prized than variation.

7.2.1 *Consistent Terms*

Just as spelling, punctuation, and the physical organization of a report (indentations, treatment of subject headings, footnotes, captions, etc) should be consistent, so should technical terms be used consistently, to avoid confusion. Some things may have many possible names, various designation numbers, and so on; the first time such a thing is mentioned in a report, it is just as well to identify it completely, mentioning all the names (parenthetically, if need be), and then to choose one term to use throughout the rest of the report; for example,

. . . including the BC/DEF-123 safety and arming device (S&A). The S&A uses . . .
[referred to thereafter as S&A]

or

The ABC Corp. Model 567 carburetor (fuel-injection device) was chosen. The 567 carburetor features . . .
[referred to thereafter as 567 carburetor].

The same sort of thing goes for verbs: if an action or process can be described by various verbs, this can be acknowledged, but only one verb should be chosen to be used commonly in the report.

7.2.2 *Parallel Structure*

Another way to clarify and simplify through consistency is to use parallel structure. Where there are two items of the same type in a sentence or paragraph, the structure of the items should be as similar as possible. For example, conjoined items (linked by *and*) should be of the same type. Two or more adverbs, two or more prepositional phrases, two or more clauses, two or more nouns—any of these may be conjoined. It is not good practice, however, to conjoin unlike parts of speech. Thus, if an adverb is linked by *and* to a prepositional phrase in a sentence (e.g., *quickly and with ease*), the phrase should be changed to another adverb, *quickly and easily.*

Also, items in a list should all have the same structure. For example,

We resolved

(1) To go to the beach.	(marked infinitive)
(2) play in the sand.	(unmarked infinitive)
(3) swimming.	(gerund)
(4) sunbathing.	(gerund)
(5) Sand castles.	(noun)

should become

We resolved to
(1) go to the beach,
(2) play in the sand,
(3) go swimming, (all infinitives)
(4) sunbathe, and
(5) make sand castles.

Similarly for parallel style, a sequence of like actions can be conjoined. Thus, instead of

The experimenter measured the height of the antenna and the amount of current. Then the field was measured.

we have

The experimenter measured the height of the antenna, the amount of current, and then the field.

It is important to be careful with *either . . . or*:

. . . until she either comes home or she phones
(subject *either* verb *or* subject verb)

should become

. . . until she either comes home or phones
(subject *either* verb *or* verb)

or

. . . until either she comes home or she phones
(*either* subject verb *or* subject verb)

In other words, both items following *either* and *or* should have the same structure. In simple sentences, like the example above, the

differing structure is not a bar to understanding (even though, strictly speaking, it is still wrong). However, in complex sentences, confusion can result. In the following example, the problem is compounded by the presence of a second *or*, not part of the *either . . . or* construction.

> However, if this is the case, the transistor is either damaged by EMP or by lightning, or the transistor survives.

A less confusing structure is

> However, if this is the case, either the transistor is damaged by EMP or lightning, or the transistor survives.

8. READABILITY

In a readable report, the author's words do not interfere with the reader's understanding of the material. Readability is a quality easy to recognize but difficult to define. Many factors contribute to the readability (or lack of it) of a piece of prose. These factors operate at many levels, of which we distinguish three here:

(1) unobtrusiveness of general style,
(2) clarity of sentence structure, and
(3) careful choice of words.

8.1 **Unobtrusive Style**

In technical writing, it is important that the code (or language) used should not distract from the content. (In poetry, in contrast, the code and content are both important.) Thus, in technical writing, the general style of writing should be as unobtrusive as possible. This does not mean that technical writing should be colorless; it does mean that the style should be as understandable and as unboring as possible. Confusion and boredom are both prime distractors from content.

One source of boredom and confusion is overly long sentences. For college-trained readers, writers should aim for an average sentence length of 25 words. The longer the sentence, the lower the readability.

It is, indeed, important to modify and qualify statements to prevent misinterpretation; however, if the sentence is too long, the reader might forget by the end what the beginning said and misinterpret anyway. Therefore, to avoid inaccuracy while keeping the reader's interest, writers should state at least some qualifications in separate sentences. However, merely repunctuating a long sentence into two or three sentences can produce choppy, disconnected thought fragments. Transition words or phrases should be used so that the sentences flow one from another.

The following sentence (before editing) has about 90 words:

- Since the user frequently has an absolute upper bound on the computer memory available but not on the execution time available, it was decided to conserve storage needed by extended precision numbers by packing digits into the whole integer word (i.e., using a scaling modulus S > N) and having the multiply routine unpack the fraction words of the two input operands into shorter fraction elements having scaling modulus N, and then repack the product fraction, of scaling modulus N, back into the result fraction elements having scaling modulus S.

This paragraph is easier to read:

- The user freqently has an absolute upper bound on the available computer memory, but not on the execution time. Thus, it was decided to conserve storage (needed by extended precision numbers) by packing digits into the whole integer word (i.e., using a scaling modulus S > N). Also, the multiply routine was designed to unpack the fraction words of the two input operands into shorter fraction elements having scaling modulus N;

the routine then repacked the product fraction of scaling modulus N back into the result fraction elements having scaling modulus S.

Although overly long sentences are undesirable, a whole series of sentences of the same length tends to be boring. This is especially true if, as often happens, each sentence begins with the same word or construction. With a series of sentences beginning subject-verb, subject-verb, subject-verb, a paragraph sounds like drum music: the subject did this; the subject did that; the subject did the other.

Writers can vary the beginnings of their sentences by moving a modifier from within the sentence to the beginning:

The user frequently must

becomes

Frequently, the user must . . . .

Also, part of a compound predicate can be changed into a participial phrase:

Hansen used the method of Joyner and obtained similar results

becomes

Using the method of Joyner, Hansen obtained similar results.

Such revisions can often help to put ideas in perspective. That is, important ideas can be expressed in main clauses, and less important ideas put into subordinate clauses (see sect. 8.2.3). Thus, such revisions not only avoid boring the reader with repetitive sentence beginnings, but also help the exposition.

Similarly, sentences all of one length should be avoided. Readers will be annoyed if they must stop and start, stop and start, stop and start, as in the following.

> Some spare parts are stored on site. All others must be brought in from the U.S. This site has an unarmed guard. In addition, there is a guard who patrols the site at night.

The revised version reads much more easily.

> Some spare parts are stored on site, but others must be brought in from the U.S. In addition to the unarmed gate guard on this site, an armed guard patrols at night.

8.2 **Sentence Structure**

Aside from the overall consideration of style just discussed, certain facets of the structure of individual sentences contribute to readability, some of which are discussed here.

8.2.1 *Active versus Passive Voice*

English grammar has two voices of the verb—active and passive. A verb in the active voice is the normal, simple type of verb: *he ran, he catches fish.* Any sentence with an object of the verb can be made passive: the object becomes the subject, the auxiliary verb *to be* is inserted before the main verb, and sometimes the original subject is retained in a *by* phrase. Thus, *he catches fish* becomes *fish are caught (by him). He insulted me* becomes *I was insulted (by him).* Usually, in scientific writing, the *by* phrase is left out, since the whole point of using the passive is to emphasize the action and downplay the person who did it. In fact, some science writers have actually prohibited the use of personal pronouns, thus forcing themselves into heavy use of the passive. However, modern science writers do not prohibit the use of personal pronouns, and in fact encourage the active voice, because it is usually easier to understand than the passive.

Some examples of passive sentences should make this analysis clear.

- This method allows the sample to self-align and compensate for variations in sample thickness.

The subject (*method*) is doing something (*allows*) to the object (*sample*), so the verb is active.

- One control sample and one irradiated sample were received by this Facility.

The subjects (*sample and . . . sample*) are being acted upon (*were received*) by the object (*Facility*) of the preposition (*by*), so the verb is passive.

- Each sample was secured with adequate pressure at a gage length of 2 in.

Nobody is mentioned as doing anything, but something is getting done, so the verb is passive.

A third type of verb is neither active nor passive: the "linking" or "equational" verb, sometimes called the copula. The verb *to be* is a copula, as are *seem* and *appear.*

I am not a crook.
A verb is a part of speech.
You seem unhappy.
The circuit appeared undamaged.

8.2.2 *Splitting Grammatical Constructions*

Certain types of grammatical constructions are closely tied together. For example, the subject and verb of a sentence are in a close grammatical relationship. Similarly, modifiers and what they modify are closely tied. Such structures should not be split so widely apart that continuity is lost.

Thus, the subject should be near the verb, so that the reader does not forget what is being talked about. For example, a sentence with a split like

> Such factors as the sites' location, terrain, perimeter, guard force, and component susceptibilities are addressed . . .

may make the reader forget what was stated (the purpose). A more readable sentence is

> Site factors that are addressed include location, terrain, perimeter, guard force, and component susceptibilities.

Sometimes a sentence becomes so complex that the subject, modified by too many phrases, which in turn are modified by clauses, to which information is added in a parenthetical expression (such as a reference number or name and date because the author wants to document his statements), gets separated from its verb. (!) Not only do the readers forget what the subject is, but so does the author. As a result, an author sometimes makes the verb agree with the noun closest to it, and sometimes the verb is pluralized when it should be singular.

To help assure that the subject agrees with the verb, the two should be kept close to each other; sometimes the sentence can be cut into two sentences, so that one can more easily keep the subject and verb together.

For example, the error in

> A diagram of the various connectors to be found between the gimmix and the seven whatsits are presented . . .

is avoided by moving the verb close to the subject, as in

> A diagram is presented of the various connectors . . . .

A modifying phrase should be near the noun or verb that it modifies. The following sentence might give the impression that an upset occurred from visual observation.

> This staggering of the dropoffs along with a simultaneous initiation of new calls effectively masks that an upset occurred from visual observation.

Revised, the sentence makes more sense:

> . . . effectively masks from visual observation that an upset occurred.

Marked infinitives (with *to*) may be split, but large splits should be avoided: "to easily convince," but not "to more easily and perhaps even more effectively convince." (An unmarked infinitive would be, "He helped *convince* the jury I was innocent." The unmarked infinitive *convince* lacks the word *to*.)

8.2.3 *Subordinating Subordinate Ideas*

Just as a painter or photographer consigns unimportant details to the background of a picture, so a writer can put secondary thoughts into subordinate structures. For example, conjoining two main clauses by *and* implies that both clauses are equals. However, in sentences like

> The circuit was repaired and its operation was found to have improved,

the two ideas may not be equals. A better structure might be

> After the circuit was repaired, its operation was found to have improved.

Similarly, putting an important idea in a subordinate clause can be a mistake (although not a disastrous one) since a reader might be led to believe that the idea is less important than it really is.

8.2.4 *Run of Prepositional Phrases*

Using up to three prepositional phrases in a row is all right stylistically. However, a sentence with five or six prepositional phrases in a row can be hard to follow; the number of phrases should be reduced by cutting out unnecessary words or by moving some of the phrases elsewhere in the sentence. The following sentence appears to have a series of phrases tagged on to each other:

> More realistic testing should include the synchronized firing of a radiating antenna such as TEMPS and the necessary number /of cable drivers/ /in the simulation/ /of the effects/ /of EMP/ /on the switch/ /through the access cables./

As indicated, six phrases are in a row. This revision is more readable:

> For more realistic testing, the firing of a radiating antenna such as TEMPS should be synchronized with the necessary number of cable drivers, to simulate the way that EMP affects the switch through the access cables.

Here, verbs separate the phrases for readability and carry some of the meaning for strength.

8.2.5 *Noun Modifier Increase Phenomenon*

It often requires considerable mental agility to sort out and understand a noun phrase in which the head noun is preceded by multiple nouns playing the role of adjectives. The best way to transform the idea into good English is to rewrite the sentence with some modifiers after the noun. For example,

> the pulse timing circuit breakdown test set schematic diagram

has eight modifiers before the noun *diagram.* The reader must work through those eight modifiers before finding out what is being described. It is easier to read

> the schematic diagram of a test set for pulse timing circuit breakdown.

8.2.6 *Pronoun Reference*

Refer clearly to the immediately preceding stated referent of *this, which, that,* and *it.* Otherwise, the pronoun's referent could be ambiguous or vague and might cause misunderstanding. Substitute a noun for the pronoun or add a noun after *this* or *which.* The following examples have faulty reference and are revised to be clear:

- Attached is the gimmix of an engine that we built at our Apex facility, which has been tested and accepted.

What has been tested—the facility, the engine, or the gimmix?

> ***Revision:*** . . .Apex facility. This gimmix has been . . . .

- The measuring apparatus can introduce changes in the local fields that affect the measurement results.

What affects the results—the fields, the changes, or the apparatus?

> ***Revision:*** . . .introduce local-field changes that . . . .

- The conclusion is that a signal was coupled onto the circuit by the probe, which changed the contents for a memory location leading to a switch malfunction.

What changed the contents—the probe, circuit, signal, or conclusion?

> ***Revision:*** . . .probe. The coupling changed . . . .

8.2.7 *Possessive Inanimate Objects*

Unlike traditional grammarians, modern grammarians do not forbid the possessive case for inanimate objects (for example, *the building's exterior*). However, if this trick is overdone throughout a report, the reader will stumble over unfamiliar constructions such as *the cable's end, the antenna's yoke, the report's author.* In the vernacular, we would say, *the end of the cable, the yoke of the antenna, the author of the report.*

8.3 **Word Choice**

Although the word level is the least general level considered here, word choice is nevertheless an important factor in readability.

8.3.1 *Strong Verbs*

Some technical authors routinely use nondescriptive verbs, especially linking verbs and *make.* Frequently, where authors could use strong verbs, they instead change them into nouns and add *were done* or *were made.* Thus, instead of the straightforward *The frequency was measured,* the result is *Measurements of the frequency were done/made.* As a result, their writing is wordy and dull. Nouns and adjectives can often be changed to descriptive verbs, as in the examples in table 2.

An example of strengthening the verb in a sentence is

- A series of interlocks would have to have been bypassed with consequent violation of proper personnel safety considerations.

Revision: Bypassing a series of interlocks would have endangered personnel.

A related problem is circumlocution: that is, saying things indirectly and weakly, rather than directly and vigorously, as in the expressions of table 3.

TABLE 2. EXAMPLES FOR STRENGTHENING VERBS

Verb plus noun or adjective	Descriptive verb
causes damage to	damages
comes into conflict	conflicts
conducts a study	studies
gives an indication of	indicates
gives consideration to	considers
gives thanks to	thanks
has an effect on	affects
has the ability to	can
has the need for	needs
is capable of	can
is dependent	depends
is different	differs
is of the opinion	believes
makes an adjustment in	adjusts
makes an attempt	attempts
makes an investigation	investigates
makes mention of	mentions
provides amplification	amplifies

8.3.2 *Plain Words*

Most scientific reports are complicated enough without the unnecessary addition of words of many syllables. If readers get bogged down in the Introduction to a report, they may quit reading before they find out what it has to offer. Instead of unusual, fancy words, plain words should be used whenever possible. Fancy words tend to have come from French or Latin; plain words tend to have come from Anglo-Saxon. Latinized vocabulary tends to be "elevated," in contrast with Anglo-Saxon words that have similar meaning and are shorter and more common. In the following sentence, the

TABLE 3. EXAMPLES OF INDIRECT VERSUS DIRECT EXPRESSIONS

Indirect expression	Direct expression
It appears that the synthetic material is better. . .	The synthetic material appears to be better . . .
It is essential that the requirements of all the control systems with which the switch may be used be taken into consideration.	The requirements must be considered for all the control systems with which the switch may be used.
One point of interest worth noting is that . . .	Interestingly, . . .

italicized Latin-based words could be replaced by more common Anglo-Saxon forms:

> It would have been *difficult* to *accomplish* a *similar objective* with the older *methods.*
>
> It would have been hard to do the same thing the old way.

Nevertheless, it is no solution to mechanically delete all Latin-based words and substitute Anglo-Saxon words of one or two syllables. After all, there are no exact synonyms; one of the riches of the English language is its many alternative words, drawn from many sources, that express shades of meaning. However, in technical writing, authors often choose the longer word simply because it sounds "formal" (in fact, it sounds ponderous). It is the rare technical

author who chooses an elegant word because a plain word lacks some subtle shade of meaning. Technical writing is not poetry, relying on the connotations and forms of words for its impact. Usually, a shorter word expresses the meaning just as well as its elegant counterpart (see table 4).

TABLE 4. PLAIN AND FANCY WORDS

Anglo-Saxon	Latin
do	accomplish
next to	adjacent* (to)
about	approximately
on, about	concerning
thus, hence	consequently
showed	demonstrated
made, built	fabricated
next, after	following
often	frequently
showed	indicated
site, place	location
later, then	subsequently
enough	sufficient
use	utilize

**nongeometric sense*

8.3.3 *Needless Words*

Wordiness requires readers to translate long-winded expressions back into the simple meanings hidden within. For example, some words are used unnecessarily as sentence fillers: *means, manner, reference, standpoint, connection, purpose,* and *nature.*

For example,

The pressure is varied *by mechanical means*

can be rewritten as

The pressure is varied *mechanically*.

Needless words can be avoided if we eliminate words that contribute no meaning whatever, as in the following examples:

- Only seals *which are of the hermetic type give complete protection.*

  Revision: Only hermetic seals protect completely.

- A crystal rectifier was connected across the field *to reduce the magnitude of the voltage.*

Revision: A crystal rectifier was connected across the field to reduce the voltage.

One should also avoid roundabout expressions that use several words to express an idea that can be expressed in fewer words (table 5) or in one word, as in the following examples:

- *Leaving out of consideration* the size . . .

  Revision: Disregarding the size . . .

- *Despite the fact that the fuze . . .*

  Revision: Although the fuze . . .

8.3.4 *Information Overload*

Technical writing is verbose in some areas, yet concise in others. Use of the passive voice, noun phrases instead of descriptive verbs, and tremendous numbers of qualifiers and modifiers leads to wordiness. On the other hand, the Germanic fashion of making

TABLE 5. ROUNDABOUT AND CONCISE EXPRESSIONS

Roundabout phrasing	Concise phrasing
abovementioned	this ____, these ____
along the lines of	like
at such time	when
despite the fact that	though
due to the fact that	because
for the purpose of	for, to
for the reason that	since
in a careful manner/fashion	carefully
in accordance with	by
in the event that	if
in the case of	if
in the near future	soon
in the vicinity of	near
in view of the foregoing	therefore
of a confidential nature	confidential
on a frequent basis	frequently
on the order of	about
on the basis of	by, from
owing to the fact that	since, because
prior to	before
subsequent to	after

enormous compound nouns and noun phrases (noun modifier increase phenomenon) is one symptom of a type of concise, scientific shorthand, developed by specialists for communicating with other specialists (the same material aimed at nonspecialists would require more words). Scientists often try to pack all the technical detail they possibly can into one or two sentences, to get it out of the way and to be "brief." Unfortunately, readers find such masses of compressed

detail very difficult to follow. Neither of these two opposing tendencies, toward wordiness and toward shorthand, aids readability.

Overloaded shorthand requires readers to reread passages to break them down into their component meanings. A sentence that is packed with too much technical detail is not a sentence that can be easily understood. (The example sentence on p 65 is an excellent specimen of an overpacked sentence.)

Robert Rathbone, in his book *Communicating Technical Information,*[6] gives a nice example of a sentence overloaded with numerical information:

> Experiments showed that the camera had an error of 2 percent of the sampling rate (60 Hz) for a 500-W 13-by-23 degree sealed-beam tungsten-lamp target at 3000 ft.
>
> ***Revision:*** Experiments showed that the camera had an error rate of 2 percent of the 60-Hz sampling rate. The target was a 500-W, 13-by-23 degree, sealed-beam tungsten lamp, located 3000 ft from the camera.

8.3.5 *Redundancy versus Completeness*

"Redundancy" means saying the same thing twice, perhaps with different wording. Sometimes the repetition is effective but often it is accidental and wordy. Redundancy should be avoided for conciseness, as in the following examples:

Redundant	Concise
dc current	dc
for measurement reasons	for measurement
for the purpose of measurement	for measuring *or* to measure
for a long period of time	for a long time

[6] *Robert R. Rathbone, Communicating Technical Information, Addison-Wesley Publishing Company, Reading, MA (1972), p 66.*

Although it is a good idea to eliminate words that do not contribute to the meaning or the clarity of the message, writers should avoid writing in telegraphic style. They should not omit articles, prepositions, verbs, pronouns, or conjunctions necessary to the grammar of their sentences. These words should be retained, because they help the reader to understand the message clearly and easily. Consider the following examples:

Telegraphic	Complete
the laser can operate fundamental mode	the laser can operate in the fundamental mode
this type problem	this type of problem

8.3.6 *Precision*

It is easy to choose the wrong spelling for a homophone—a word that sounds like another, but is spelled differently (*there/their, whose/who's, principle/principal, its/it's,* etc). Writers and editors should be on guard against these errors.

Other common errors are equally easy to make. The following lists some commonly misused words and guidance for their use.

---

ability versus **capacity:** able to perform versus able to hold (*The tank could move at 10 mi/hr,* not *The tank had the capacity to move . . .*).

affect, **effect:** In technical contexts, *affect* is usually a verb (*the circuit was affected by the temperature*) and *effect* is usually a noun (*the effect was disastrous*). *Affect* as a noun is a psychological term meaning, roughly, "subjective emotion" (*negative affect is often associated with physical trauma*). *Effect* as a verb means "to bring about" (*a change was effected when the temperature was lowered*).

anticipate: to take up, use, introduce, or experience beforehand. Synonyms are *forestall, prevent, foresee, divine.* In no sense is it a synonym for either *believe* or *expect.*

He anticipated arrest by leaving the country.

We expect (*not* anticipate) that the program will be enlarged.

We believe (*not* anticipate) that the program will end in FY78.

all of: *of* is not used with nouns in formal writing.

Colloquial: *All of the fuzes were inert.*
Improved: *All the fuzes were inert.*

However, *of* is used with pronouns: *All of them have lice.*

case: cliche catchall; for other than legal, medical, or grammatical cases, substitute

often *or* frequently	*for*	in many cases
sometimes *or* occasionally	*for*	in some cases
usually	*for*	in most cases
if	*for*	in case
as is true	*for*	as in the case
each time	*for*	in each case
sometimes	*for*	in other cases
it is true	*for*	such is the case
here	*for*	in this case
for	*for*	in the case of
anyhow, anywhere	*for*	in any case
always	*for*	in all cases

comprise, compose, consist: *Comprised of* cannot be substituted for *composed of,* since *comprise* means include or

embrace and does not take *of.* Webster's Dictionary of Synonyms[7] gives an example of correct use:

The district comprises three counties and part of a fourth.

Resist the temptation to write "The district is comprised of . . .," since the whole comprises the parts and not the reverse. Many consider

The district *is made up of, consists of,* or *is formed by*

plainer language, and thus more desirable, than *comprises.*

data: plural noun.

due to: Formal English frowns on the use of *due to* or *caused by* except when the phrase refers definitely to a substantive (any word or group of words used as a noun). Careful writers prefer *because of, on account of,* or *owing to* in adverbial constructions.

Informal—He was tardy due to an accident. (*due to* modifies the verb)

Formal—He was tardy because of (on account of) an accident.

Formal—His tardiness was due to an accident. (*due to* modifies *tardiness*)

Therefore, if it is correctly used, *due to* can never begin a sentence, as shown by the following examples.

The accident was due to slippery streets.

He saw an accident due to slippery streets.

(?)Due to slippery streets, he saw an accident.

The accident due to slippery streets was thought to be due to driver error.

(?)Due to slippery streets, the accident was thought to be due to driver error.

---

[7]*Webster's New Dictionary of Synonyms, G. and C. Merriam Company, Springfield, MA (1973).*

etc: means *and so on*. Use only with a list, but do not let the reader supply his own wrong list; it is better to use *for example* or *such as*.

imply, infer: These words are often misused. Strictly, *to imply* means to express indirectly; speakers or writers *imply* something by what they do or say. *To infer* means to induce, to surmise, to guess; listeners or readers *infer* something from what they experience.

> The director implied that the interview was closed by rising from his chair.
>
> The engineer inferred from the director's action that the interview was closed.

it is (see also **there is**): expletive filler words beginning a sentence—usually wordiness; omit *it is* when possible.

percent: use *percent* with a numeral in the text; use *%* with a numeral in a table or figure.

percentage: use without a numeral.

principle, principal: *-ple* is the noun, meaning "a general truth." *-pal* as an adjective means "primary," and as a noun refers to someone or something of paramount importance.

that: in formal writing, introduces a restrictive modifier (no comma). See section 9.2.1 for a discussion of restrictive and nonrestrictive clauses.

there is: expletive filler words beginning a sentence—often wordiness; omit *there is* when possible.

which: in formal writing, introduces a nonrestrictive modifier (*which* is preceded by a comma).

while: ambiguous—could mean "time during" or "contrast"; for contrast, use *whereas* or *although*.

---

9. SOME GRAMMAR NOTES

Some of the more prevalent errors of grammar and punctuation are mentioned in this section, although we refer you to books of grammar and style for more complete information.*

9.1 **Dangling Modifiers**

It is easy to explain what a dangling modifier is in everyday English; in technical writing it is not so obviously ridiculous. Notice the following examples:

> *Having taken* some refreshments, the corpse was put in the hearse.
>
> *To grow* fine sweet peas, strings should support the plants.
>
> The plumber was murdered *using* a wrench.
>
> The ingredients were placed in the test enclosure before *starting* the experiment.

In these examples the guilty words appear to modify nouns that they could not possibly modify (e.g., *ingredients, corpse*), and the results are ludicrous as well as inaccurate. The sentences are easily fixed, as

> After taking some refreshments, we placed the corpse in the hearse.

**Much of the information in section 9 was adapted from the OMEW Report Style Manual, Electronic Warfare Laboratory, Office of Missile Electronic Warfare, White Sands Missile Range, NM (1978).*

To grow fine sweet peas, you must support the plants with strings.

She used a wrench to murder the plumber.

Or, if you must write in the passive voice:

A wrench was used to murder the plumber.

The experiment was started after the ingredients were placed in the test enclosure.

A specific type of dangling modifier bears mentioning—the prepositional phrase, as

In 1990, we estimate production will reach 70 million tons.

The phrase *In 1990* appears to modify *estimate,* but it cannot, at least not until we reach 1990. The error is simple enough to repair, as

We estimate that production will reach 70 million tons by 1990

or

In 1990, we estimate, production will reach 70 million tons.

9.2 **Punctuation**

Good punctuation is essential in the clear transmission of information. Properly used, it leads your readers through your writing, helping them to properly separate or relate your ideas. Through good punctuation, your writing has more meaning, as do spoken words when delivered with good voice inflection.

Even the smoothest style can be ruined if punctuation is used improperly. Good punctuation makes sentence structure clear and,

consequently, more understandable. A good writing handbook can be consulted for use of punctuation. Some excellent writing references are listed in the Annotated Bibliography at the end of this report. The U.S. Government Printing Office (GPO) Style Manual[3] is a standard authority for Government publications. A word of warning: if one comprehensive style manual is chosen, such as the GPO Style Manual, one should avoid simultaneously using a similar reference, such as the Chicago Style Manual[8] (although this is an excellent reference). These two, and others, differ in choices of standard abbreviations, compound words, etc, many of which are arbitrary anyway.

This manual covers only the most frequent applications of the punctuation marks most often used in ERADCOM reports, other than the use of simple periods. Note: The GPO Style Manual is the authority on which the punctuation rules in this section are based, and it is recommended that you use the same reference for punctuation rules not given here.

9.2.1 *Commas*

The most common uses of commas in technical writing are

- To separate a series of coordinate qualifying words—*short, swift strokes.*
- To separate an introductory modifying phrase and the subject modified—*Beset by problems, the study was rescheduled.*
- To precede or enclose Jr., Sr., Ph.D., the word "incorporated" as part of a company name within a sentence, and elements of addresses in text—*Henry Smith, Jr., chairman; Walter Brown, Ph.D.; Washington, DC.*

---

[3] *U.S. Government Printing Office Style Manual, Washington, DC (1973).*
[8] *A Manual of Style, 12th edition, The University of Chicago Press, Chicago (1972).*

- To set off parenthetical words, phrases, or clauses—

  Mr. Jefferson, Secretary of State, favored the location.

  It must be remembered, however, that there was no guarantee.

  It is obvious, therefore, that commas are necessary.

  The atom bomb, which was developed at the Manhattan project, was first used in World War II.

  Their high morale might, we suggest, have been responsible.

  The information is found in section 8, third paragraph, of this report.

- To set off words or phrases in apposition or contrast—

  Ms. Kegley, the mathematician, was very cooperative.

  Senator Cranston, Democrat of California, also voted in favor of the amendment.

  The butcher, not the baker, was the candlestick-maker's friend.

- After each member within a series of three or more words or phrases, letters, or figures used with *and, or,* or *nor—red, white, and blue; a, b, or c; neither temperature, altitude, nor entry angle.*

- Before a conjunction in a compound sentence with an independent clause—

  The skin parted, and the propellant escaped.

  The missile was highly accurate, and the target disintegrated.

- Between the title of a person and the name of an organization, when *of* or *of the* is omitted—*Chief, Divison of Finance; chairman, Committee on Appropriations; president, General Dynamics Corporation.*

- To separate thousands, millions, etc, in numbers of five or more digits—*49,000; 320,251; 5,635,452.*

To avoid ambiguity, commas should be used around subordinate qualifiers (nonrestrictive clauses and phrases). In this way, the distinction between nonrestrictive and restrictive clauses can be made overt. A nonrestrictive clause or phrase adds information about a word already defined. It is parenthetical; that is, it can be omitted without changing the meaning of the main clause. A restrictive clause or phrase limits or defines the main clause and cannot be omitted. Consider the following simple examples:

(a) Our newest boat, *which is painted red and white,* has sprung a leak.

(Nonrestrictive clause: the *which* clause adds information about a boat already identified; the clause is parenthetical and not essential to the main clause, *our newest boat has sprung a leak.*)

(b) A boat *that leaks* is of little use.

(Restrictive clause: the clause *that leaks* is essential to the meaning of the main clause.)

(c) Our newest boat, *painted red and white,* has sprung a leak.

(Nonrestrictive phrase: the phrase *painted red and white* adds information, but is not essential for identification of the boat.)

(d) A boat *full of holes* is of little use.

(Restrictive phrase: *full of holes* is essential to the meaning of the sentence.)

9.2.2 *Dashes*

The most common uses of dashes in technical writing are

- To replace commas or parentheses if their use imparts the meaning better—*These are shore deposits—gravel, sand, and clay.*

- Before a final clause that summarizes a series of ideas—*High-quality design, close-tolerance machining, meticulous assembly—these are the cornerstones of reliability.*

9.2.3 *Hyphens*

The most common uses of hyphens in technical writing are

- To connect the elements of certain compound words—*cross-pollinate, e-beam, inch-pound.*

- To promote the readability and understandability of text by making the relationship of related words apparent; e.g., unit modifiers—*voltage-activated rectifier, 2- or 3-s bursts, prime-rated equipment, low-level energy, crooked-necked projection.*

- In unit modifiers having a numerical value as their first element and an abbreviation or symbol as the second element, even if the second element consists of one letter—*3-s interval, 3-A input, 10-mph zone, 8-rpm motor.*

A hyphen is never used after a word ending in *ly—electrically heated device.*

Avoid using a hyphen to indicate the inclusion of values between an initial and terminal value, such as *2-6 V.* Use *2 to 6 V.*

9.2.4 *Semicolons*

The most common uses of semicolons in technical writing are

- To separate clauses that contain commas—*Some of the ERADCOM elements are White Sands Missile Range, White Sands, NM; Harry Diamond Laboratories, Adelphi, MD; and the Electronic Technology and Devices Laboratory, Ft Monmouth, NJ.*

- To link main clauses not joined by conjunctions—

  When drawing circuit diagrams, use a technical pen; you must be very accurate.

  Some dogs are large; furthermore, some are very fierce.

  Technical writing is demanding; one must be clear, concise, and consistent.

  Knitted wire mesh is made of many interlocked loop-shaped springs; it combines springiness with flexibility and cohesion.

The semicolon is often misused. Semicolons cannot be used to link sentence fragments except in the listing usage shown above. Only the colon can be used with fragments.

9.2.5 *Colons*

The colon is used primarily as an introducer. The colon is used

- To introduce a series—*The flag had three colors: red, white, and blue.*

- To introduce a clause or phrase that explains, illustrates, amplifies, or restates the previous clause—

  In the hedge we found an enormous gap: a hole, in fact.

  The flaw was obvious: the car had no wheels.

  We had only one defense: to run away.

  The man was a villain: he stole from widows and orphans.

The last example can be used to show the difference in meaning between the colon and the semicolon. In the sentence as written, the colon means "Attention reader: here comes the explanation of what I just said." A semicolon in place of the colon would mean something slightly different: "Here we have something related to what I just said." Thus, the stealing from widows and orphans might be only one aspect of the man's villainy, if introduced by a semicolon; on the other hand, the stealing is the characteristic that makes the author call the man a villain, if it is introduced by a colon.

10. REFERENCES FOR GRAMMAR, STYLE, AND USAGE

Consult your favorite standard sources for spelling, punctuation, and word choice. The writing, editing, and publications offices of ERADCOM's activities use, among others, the references listed in the Annotated Bibliography.

In using references, it is wise to remember that most general rules have exceptions, and one should feel free to use common sense in unusual situations, even if it means "breaking a rule."

11. CONCLUDING REMARKS

For various reasons, this publication is intended to offer guidance only, not to lay down the law. For example, many points of

style and policy are open to debate and differing interpretations. Many, also, are matters of taste. We expect, therefore, that some of the ideas included may provoke argument; some important points have also, no doubt, been omitted. If readers feel that important items have been left out or glossed over, or that certain statements are wrong or misleading, we encourage them to inform us. Thus, if a revised edition of these guides is produced, it will be more perfect than the present one.

LITERATURE CITED

1. MIL-STD-847A, Format Requirements for Scientific and Technical Reports Prepared by or for the Department of Defense (31 January 1973).

2. Use of the Metric System of Measurement, Department of Defense Directive 4120.18 (10 December 1976).

3. U.S. Government Printing Office Style Manual, revised, U.S. Government Printing Office, Washington, DC (1973).

4. DoD Information Security Program Regulation, Department of Defense 5200.1-R (November 1973).

5. Webster's Third New International Dictionary of the English Language, G. and C. Merriam Company, Springfield, MA (1961).

6. Robert R. Rathbone, Communicating Technical Information, Addison-Wesley Publishing Company, Reading, MA (1972).

7. Webster's New Dictionary of Synonyms, edited by G. and C. Merriam Company, Springfield, MA (1973).

8. A Manual of Style, 12th edition, The University of Chicago Press, Chicago (1972).

ANNOTATED BIBLIOGRAPHY

General References

Peter Mark Roget, Thesaurus of English Words and Phrases, Grossett and Dunlap, New York (1960).

Webster's New Collegiate Dictionary (desk version), G. and C. Merriam Company, Springfield, MA (1976).

Webster's Third New International Dictionary of the English Language, G. and C. Merriam Company, Springfield, MA (1964).

Word Division, Supplement to GPO Style Manual, 7th edition, U.S. Government Printing Office, Washington, DC (1970).

Grammar Books

Eugene Ehrlich and Daniel Murphy, Schaum's Outline of English Grammar, McGraw-Hill Book Company, New York (1976).

John C. Hodges and Mary E. Whitten, Harbrace College Handbook, 8th edition, Harcourt Brace, New York (1977).

Writing and Usage Workbooks

Roy. H. Copperud, A Dictionary of Usage and Style, Hawthorn Books, Inc., New York (1964).

George W. Feinstein, Programed Writing Skills, Prentice-Hall, Inc., Englewood Cliffs, NJ (1976).

Marilyn B. Gilbert, Clear Writing, John Wiley and Sons, Inc., New York (1972).

David Lambuth et al, The Golden Book on Writing, The Viking Press, New York (1964).

Kate L. Turabian, A Manual for Writers of Term Papers, Theses, and Dissertations, 4th ed., The University of Chicago Press, Chicago (1973).

Technical Writing Textbooks

Donald H. Menzel, Howard Mumford Jones, and Lyle G. Boyd, Writing a Technical Paper, McGraw-Hill Book Company, New York (1961).

H. J. Tichy, Effective Writing for Engineers, Managers, Scientists, John Wiley and Sons, Inc., New York (1967).

Joseph N. Ulman, Jr., and Jay R. Gould, Technical Reporting, 3rd ed., Holt, Rinehart and Winston, Inc., New York (1972).

Fun Reading

Paul W. Merrill, The Principles of Poor Writing, The Scientific Monthly (January 1947).

APPENDIX A.—TABLES FOR CONVERTING ENGLISH TO METRIC UNITS

Because current Army policy encourages the use of metric units of measurement in place of or as well as English units, editors may find it necessary to perform some conversions. The conversion tables presented are excerpted from the OMEW Report Style Manual, Electronic Warfare Laboratory, Office of Missile Electronic Warfare, White Sands Missile Range, NM (1978).

Length			**Mass**		
1 in.	=	2.54 cm	1 oz (avdp)	=	28.35 g
1 ft	=	30.48 cm	1 lb (avdp)	=	0.4536 kg
1 yd	=	0.9144 m	1 ton (2000 lb)	=	0.9072 t
1 mi (statute)	=	1.609 km			
1 nmi	=	1.852 km	**Density**		
1 Å	=	0.1 nm	1 lb/ft^3	=	16.02 kg/m^3
			Force[b]		
Area			1 oz-force	=	0.2780 N
1 $in.^2$	=	6.452 cm^2	1 lb-force	=	4.448 N
1 ft^2	=	0.0929 m^2	1 kg-force	=	9.807 N
1 yd^2	=	0.8361 m^2	1 dyne	=	10^{-5} N
1 mi^2 (statute)	=	2.590 km^2	**Work, energy-power**		
			1 ft-lb-force	=	1.356 J
Volume			1 Btu	=	1055.0 J
1 $in.^3$	=	16.39 cm^3	1 hp (elec)	=	746.0 W
1 ft^3	=	0.0283 m^3	1 ft-lb-force/s	=	1.356 W
1 yd^3	=	0.7646 m^3	1 Btu/hr	=	0.2931 W
Speed			**Pressure**[c]		
1 ft/min	=	5.080 mm/s	1 lb-force/$in.^2$	=	6.895 kPa
1 mi/hr (statute)	=	0.4470 m/s	1 lb-force/ft^2	=	47.88 Pa
			1 kg-force/m^2	=	9.807 Pa
1 knot	=	0.5144 m/s	1 mbar	=	100.0 Pa
Light[a]			**Temperature**		
1 fc	=	10.76 lux	°F = 9/5°C + 32°		
1 fL	=	3.426 cd/m^2	°C = 5/9(°F − 32°)		

[a] *fc—footcandle* *lx—lux* [b] *N—Newton*
fL—footlambert *cd—candela* [c] *Pa—pascal*

APPENDIX B.—COMMON TECHNICAL ABBREVIATIONS

The following list of technical abbreviations was compiled by the Harry Diamond Laboratories (HDL) Technical Reports Branch for use within HDL. It is offered as an example of one approach to the problem of standardizing abbreviations. Another approach is to choose a particular source and declare its usage the standard. Often, however, a single source may not include all items that are needed. A secondary source (or various sources, in order of priority) can then be used for those items only. Thus, if writers cannot find what is needed in the primary source, they can refer to the next, and then the next, if necessary. In this way, debate within an organization, with people citing contradictory sources, can be avoided.

Word	Abbreviation
absolute	abs
alternating current	ac
altitude	alt
ambient	amb
American wire gauge	AWG
ampere	A
ampere–hour	A hr
amplitude modulation	AM
angstrom	Å
approximate	approx
arc tangent	arctan
ARC cotangent	arcot
atmosphere	atm
atmosphere, standard	A_S
atomic mass units	amu
atomic percent	at.%
atomic units	a.u.
atomic weight	at. wt
automatic frequency control	AFC
automatic gain control	AGC
automatic volume control	avc
average	av
avoirdupois	avdp
beat–frequency oscillator	BFO
billion electron volts	GeV
Bohr magneton	μ_B
boiling point	bp
brake horsepower	bhp
Brinell hardness number	Bhn
British thermal unit	Btu
calorie	cal
candlepower	cp
cathode–ray oscilloscope	CRO
cathode–ray tube	CRT
centi (= 10^{-2})	c
centimeter	cm
center of mass	c.m.
centimeter–gram–second	cgs
chemical	chem
chemically pure	cp
circa	ca
circular	circ
circular error probable	CEP
circular mil	cmil
coefficient	coeff
cologarithm	colog
computer output microfilm	COM
constant	const

AD-A071 001 HARRY DIAMOND LABS ADELPHI MD F/G 5/2
GUIDES FOR ERADCOM FORMAL REPORTS.(U)
MAR 79 B S COLLIER, E E JONES
UNCLASSIFIED HDL-ESP-79-1 NL

2 OF 2
AD
A071001

END
DATE
FILMED
8-79
DDC

APPENDIX B

Word	Abbreviation
contact potential difference	cpd
continuous wave	cw
cosecant	csc
cosine	cos
cotangent	cot
coulomb	C
cubic centimeter	cm^3
curie	Ci
cycles per second	Hz
deca (= 10^1)	da
deci (= 10^{-1})	d
decibel	dB
decibel referred to 1 mW	dBm
decibel referred to 1 W	dBW
decibel referred to 1 V	dBV
degree (angular)	deg
degrees Celsius/centigrade	°C, C
degrees Fahrenheit	°F, F
degrees Kelvin; kelvin	K
diameter	diam
direct current	dc
disintegrations per second	dis/s
double–pole, double–throw	dpdt
double–pole, single–throw	dpst
efficiency	eff
electromagnetic units	emu
electromotive force	emf
electron spin resonance	ESR
electron volt	eV
electrostatic units	esu
electron units	e.u.
entropy unit	eu
equation	(eq)
equivalent weight	equiv wt
error function	erf
error function, complement of	erfc
experimental	exptl
exponential	exp
face–centered cubic	fcc
farad	F

Word	Abbreviation
femto (= 10^{-15})	f
femtometer	fm
fermi	F
figure	(fig.)
foot	ft
foot–candle	fc
foot–pound	ft–lb
foot per second	ft/s
frequency modulation	FM
gallon	gal.
giga (= 10^9)	G
giga–electron volt	GeV
gilbert	Gi
gram	g
gravity	g
ground	gnd
hecto (= 10^2)	h
henry	H
hertz	Hz
high frequency	hf
horsepower	hp
hour	hr
hyperbolic cosecant	csch
hyperbolic cosine	cosh
hyperbolic cotangent	coth
hyperbolic secant	sech
hyperbolic sine	sinh
hyperbolic tangent	tanh
inch	in.
infrared	IR
inside diameter	i.d.
integrated circuit	IC
intermediate frequency	I.F.
joule	J
kayser	K
kelvin	K
kilo (= 10^3)	k
kilogram–meter	kg–m
kilovolt–ampere	kVA
kilowatt–hour	kWh
kinetic energy	KE

Word	Abbreviation
latitude	lat
limit	lim
linear foot	lin ft
logarithm (common)	log
logarithm, natural (Napierian—base$_e$)	ln
longitude	long.
longitudinal acoustic	LA
longitudinal optic	LO
low frequency	lf
lumens	lm
lux	lx
magnetomotive force	mmf
maxwell	Mx
mean effective pressure	mep
mean horizontal candlepower	mhcp
medium frequency	mf
mega (= 10^6)	M
megavolt	MV
melting point	mp
meter	m
meter–kilogram–second	mks
metric ton	t
micro (= 10^{-6})	μ
microampere	μA
milli (= 10^{-3})	m
milliampere	mA
million electron volts	MeV
minute	min
modulator–demodulator	modem
molar mass	*M*
mole	mol
molecular weight	mol wt
multiplex, multiplexer	MUX
nano (= 10^{-9})	n
nanosecond	ns
negative–positive–negative	npn
newton	N
nuclear magnetic resonance	NMR
nuclear magneton	μ_N

Word	Abbreviation
number	No.
oersted	Oe
ohm	Ω
ounce	oz
outside diameter	o.d.
page	p
pages	pp
parts per million	ppm
pascal (= N/m^2)	Pa
peak inverse voltage	PIV
peak–to–peak	p–p
per	/
pico (= 10^{-12})	p
picofarad	pF
poise	P
positive–negative–positive	pnp
pound	lb
pound–force per square inch	$lb/in.^2$
pressure–volume–temperature	PVT
probable error	pe
probability	prob
pulse per second	pps
pulse repetition frequency	PRF
radian	rad
radiation absorbed dose	rad
radio frequency	rf
receiver	rcvr
reciprocal ohm	mho
revolutions per minute	rpm
roentgen	R
root mean square	rms
rydberg	Ry
secant	sec
second	s
section	(sect.)
sensitivity	sens
silicon controlled rectifier	SCR
sine	sin
single–pole, double–throw	spdt

APPENDIX B

Word	Abbreviation
single–pole, single–throw	spst
specific gravity	sp gr
specific heat	sp ht
specific volume	sp vol
standard	std
standard deviation	SD
standard temperature and pressure	STP
standing wave ratio	SWR
steradian	sr
tangent	tan
temperature	temp
tera (= 10^{12})	T
terahertz	THz
tesla (Wb/m^2)	T
torr	Torr
transverse acoustic	TA
transverse optic	TO
ultrahigh frequency	uhf
ultraviolet	uv
vacuum tube voltmeter	VTVM
vapor pressure	vp
variable–frequency oscillator	VFO
versed sine	vers
versus	vs*
very high frequency	vhf
very low frequency	vlf
vestigial sideband	vsb
volt	V
voltampere	VA
voltampere, reactive	var
volume	vol
watt	W
weber	Wb
weight	wt
weight percent	wt%

*In illustrations only

Index

A

Index

B

C

Index

Index

D

E

F

G

Index

H

I

L

M

N

O

Index

P

Index

R

S

T

U

Index

V

W

☆ U. S. GOVERNMENT PRINTING OFFICE : 1979 O - 291-280