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**DEPARTMENT OF DEFENSE
HANDBOOK**

DOD PRODUCED CD-ROM PRODUCTS



This handbook is for guidance only. Do not cite this document as a requirement.

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FOREWARD

1. This handbook is approved for use by all Departments and Agencies of the Department of Defense (DOD).
2. This handbook is for guidance only. This handbook cannot be cited as a requirement. If it is, the contractor does not have to comply.
3. The production and use of Compact Disc-Read Only Memory (CD-ROM) have significantly different considerations than of paper products. This handbook serves to provide guidance to Department of Defense agencies on the use of Compact Disc (CD) technology as the recommended method for physical distribution of information within DOD. This document is the basis for addressing current/future CD-ROM issues/concerns and will be revised as guidelines and new standards mature.
4. The International Organization for Standardization (ISO) CD-ROM standards, ISO 9660 and ISO 10149, have been widely accepted for sharing large amounts of information across all computing platforms. ISO 9660 standardizes how CD-ROM sectors are organized into logical records, then grouped into files, directories and volumes. ISO 10149 addresses the physical format of CD-ROM. With the acceptance of the two ISO standards, the use of CD-ROM to store and disseminate information has become a reality, and has been implemented throughout DOD as a means of reducing paper/microform/magnetic media distribution and attendant costs. However, the producers of CD-ROM determine what user interfaces, application platform support, and utility of the information are provided. Ultimately, end users must deal with CD-ROM products containing different access/retrieval capabilities. Standards and guidelines lighten the burden on the end user, standardize production procedures, and streamline migration from paper/microform/magnetic media products to CD-ROM media products.
5. All DOD components/activities should evaluate the use of ISO 9660 compliant CD-ROM for the distribution of information.
6. All DOD components/activities producing CD-ROM products for use within DOD should adhere to the standards and general guidelines provided in this handbook.
7. Handbook objectives:
 - a. Encourage a common migration path to CD-ROM.
 - b. Compile adopted standards for the use of CD-ROM.
 - c. Provide general guidance to CD-ROM producers/users.
 - d. Establish a DOD forum for discussions of CD-ROM issues/standards, their use by DOD publishers, their impact on DOD end users, and their impact/use in the CD-ROM industry as a whole.
 - e. Provide a central DOD library/catalog of CD-ROM titles and their contents where applicable to DOD components/activities.
8. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: DISA/JIEO Center for Standards, 10701 Parkridge Boulevard, ATTN: Mr. James Barnette, Reston, VA 20191-4357, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

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1. SCOPE

1.1 Scope. This document was prepared by the Defense Information Systems Agency (DISA), in cooperation with the services and other activities within the Department of Defense (DOD). The goal of this document is to provide information and guidelines to support the creation and interoperability of Compact Disc-Read Only Memory (CD-ROM) development and use within DOD. This document specifies core compact disc fundamentals for the DOD community. It is strongly recommended all DOD components comply with the fundamentals established within this document. Specialized functions within DOD may require expanded internal guidance to meet their own mission needs. All other Governmental entities are invited to use this document.

This document is for guidance only. This document cannot be cited as a requirement. If it is, the contractor does not have to comply.

2. APPLICABLE DOCUMENTS

2.1 Government documents. The following government documents form a part of this handbook to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the latest issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplements thereto. DOD activities may request copies of Government documents from: Defense Automated Printing Services (DAPS), ATTN: Standardization Documents Order Desk, 700 Robbins Avenue, 4D, Philadelphia, PA 19111-5094. FAX orders: (215) 697-1462. Include a point of contact, shipping address, telephone and fax numbers, title of publication, and quantity of copies. (See also Internet URL: <http://www.dodssp.daps.mil>).

a. FIPS PUB 1-2 - *Code for Information Interchange, Its Representations, Subsets, and Extensions, (American Standard Code for Information Interchange [ASCII])*.

b. MIL-PRF-28000A (for CALS) - *Digital Representation for Communication of Product Data: IGES (Initial Graphics Exchange Specification) Application Subsets and IGES Application Protocols*.
NOTE: DRAFT MIL-PRF-28000B, dated 6 June 1997, has been distributed for coordination.

c. MIL-PRF-28001C (for CALS) - *Markup Requirement and Generic Style Specification for Exchange of Text and its Presentation, 2 May 1997 (Standard Generalized Markup Language [SGML]). ISO Standard 8879:1986 Information Processing Text and Office Systems; Standard Generalized Markup Language (SGML)*.

d. MIL-PRF-28002B (for CALS) - *Requirements for Raster Graphics Representation in Binary Format (Group 4 Raster Scanned Images)*. NOTE: DRAFT MIL-PRF-28002C, dated 6 June 1997, has been distributed for coordination.

e. MIL-PRF-28003A (for CALS) - *Digital Representation for Communication of Illustration Data: CGM (Computer Graphics Metafile) Applications Profile*.

f. TRADOC Pam 350-70-2, Training MULTIMEDIA COURSEWARE DEVELOPMENT GUIDE, 22 April 1996.

g. Automated Document Conversion Master Plan, April 1995, Office of the Assistant Secretary of Defense Command, Control, Communications, and Intelligence/Information Management), Version 1.0.

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- h. DOD Directive 5200.1-R, *Information Security Program*, January 1997, The Assistant Secretary of Defense for Command, Control, Communications, and Intelligence.
- i. DOD Directive 5230.24, *Distribution Statements on Technical Documents*, March 18, 1987.
- j. Defense Information Systems Agency, Joint Interoperability and Engineering Organization (DISA/JIEO) Report 8300, "Department of Defense Minimum Desktop Personal Computer Configuration," August 1, 1997.
- k. Department of Defense, Information Technology Standards Guidance (ITSG), Version 3.1., 7 April 1997. Copy may be obtained electronically via the Internet at URL: <http://www-itsg.itsi.disa.mil/>.
- l. Department of Defense Technical Architecture Framework for Information Management, Volume 7, Adopted Information Technology Standards (DOD TAFIM AITS), Version 3.0, 30 April 1996. Copy may be obtained electronically via the Internet at URL: <http://www.itsi.disa.mil/>.
- m. Department of Defense Joint Technical Architecture (JTA), Version 1.0, 22 August 1996 (Version 2.0 is under development). Copy may be obtained electronically via the Internet at URL: <http://www-jta.itsi.disa.mil/>.
- n. DOD Personal Computer Policy Implementation Plan, FY1995-FY2000, 7 April 1995. Copy may be obtained at URL: <http://www.dtic.dla.mil/c3i/pcpp.html>.
- o. U.S. Department of Commerce, SIGCAT/SIGCLASS Specification for Encrypted CD-ROM, SecureCD, April 21, 1993.

(Unless otherwise indicated, copies of the above documents are available from DISA/JIEO Center for Standards, ATTN: Mr. James Barnette, 10701 Parkridge Blvd., Reston, VA 22191-4357.)

2.2 Non-Government publications. The following non-government documents form a part of this handbook to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the latest issue of the DODISS, and supplements thereto. ISO/IEC standards may be obtained from ANSI (American National Standards Institute), 1430 Broadway, New York, NY 10018; Phone (212) 642-4900.

- a. ISO/IEC/ANSI/NISO 9660:1988 - *Volume and File Structure of CD-ROM for Information Interchange*.
- b. ISO/IEC 10149: 1995 - *Information technology - Data interchange on read-only 120 mm optical data disks (CD-ROM)*.
- c. ISO/IEC 11172:1993, Information technology - *Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s - Part 2: Video, Part 3: Audio (MPEG-1)*.
- d. ISO/IEC 11544:1993, *Coded representation of picture and audio information - Progressive bi-level image compression*. Originally developed by the Joint Bi-level Imaging Experts Group (JBIG) as an improved fax standard follow-on to ITU (CCITT) Group 3 and Group 4 facsimile, JBIG provides for a progressive mode compression/decompression which allows an image to be transmitted with quality

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improving as more data is transmitted. It is useful for bitonal and dithered images with low bit-depth (up to 4-bit) grayscale.

e. ISO/IEC 13346:1995 - *Volume and File Structure for Write-Once and Rewritable Media Using Non-Sequential Recording (NSR) for Information Interchange*. Copies of the equivalent standard from ECMA (ECMA 167-1992) may be ordered, free of charge, from the Internet at URL: <http://www.helpdesk@ecma.ch>.

f. ISO/IEC 13490:1996, *Volume and File Structure of read-only and write-once compact disc media for information interchange—Part 1: General; Part 2: Volume and file structure*. Copies of the equivalent standard from ECMA (ECMA 168-1994) may be ordered, free of charge, from the Internet at URL: <http://www.helpdesk@ecma.ch>.

g. ISO/IEC 13818-2:1996, *Information technology - Generic coding of moving pictures and associated audio information: Video (MPEG-2)*.

h. ISO/IEC DIS 12024, *Electronic imaging - Verification of the information stored on CD media*. Under development.

i. ISO/IEC DIS 15485 - *Information technology - Data interchange on 120mm optical disk cartridges using phase change PD format - Capacity: 650 Mbytes per cartridge*. Under development at ISO. Copies of the equivalent standard from ECMA (ECMA 240-1996) may be ordered, free of charge, from the Internet at URL: <http://www.helpdesk@ecma.ch>.

j. DISC Manufacturing Incorporated's documents dated 6 February 1992: *Integrating Mixed-Mode CD-ROM; An Overview to Multimedia CD-ROM Production; and Compact Disc Terminology*.

k. Pahwa, Ash, *The CD-Recordable Bible: An Essential Guide For Any Business*, Eight Bit Books, 462 Danbury Road, Wilton, CT 06897-2126, 1994. Copies may be obtained from Eight Bit Books.

l. Nadeau, Michael, *Byte Guide to CD-ROM*. Copies may be obtained from Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710.

m. Parker, Dana J., and Starrett, Robert A., *CD-ROM Professional's CD-Recordable Handbook, The Complete Guide to Practical Desktop CD Recording*, A CyberAge Book, 1996. Copies may be obtained from Pemberton Press.

n. Internet - Additional information on CD may be obtained by browsing the following Websites: SIGCAT (Special Interest Group on CD Applications and Technology), IMA (Interactive Multimedia Association), NewMedia Magazine.

(Unless otherwise indicated, copies of the above documents are available from DISA/JIEO Center for Standards, ATTN: Mr. James Barnette, 10701 Parkridge Blvd, Reston, VA 22191-4357.)

2.3 Order of precedence. The text of this handbook is not intended to take precedence over references cited herein, or supersede applicable laws and regulations unless a specific exemption has been obtained.

MIL-HDBK-9660B**3. DEFINITIONS**

3.1 Acronyms and Abbreviations. Acronyms and abbreviations related to this handbook are defined below.

ADC	-	Automated Document Conversion
AIMS	-	Adopted Information Technology Standards
ANSI	-	American National Standards Institute
ASCII	-	American Standard Code for Information Interchange
ASMO	-	Advanced Storage Magneto-Optical (120mm)
CAD	-	Computer-Aided Design
CAM	-	Computer Aided Manufacturing
CALS	-	Continuous Acquisition and Life Cycle Support. (Also: JCALS-Joint Computer-Aided Acquisition and Logistic Support)
CCITT	-	Comite Consultatif International de Telegraphique et Telephonique (International Telegraph and Telephone Consultative Committee (See ITU).
CD	-	Compact Disc
CD-I	-	Compact Disc - Interactive
CD-R	-	Compact Disc - Recordable
CD-R2	-	CD-Recordable media compatible with both CD and DVD players.
CD-ROM	-	Compact Disc - Read Only Memory
CD-RW	-	Compact Disc - Rewritable (formerly known as CD-Erasable (CD-E))
CD-V	-	Compact Disc - Video, aka Video-CD
CGM	-	Computer Graphics Metafile
CIA	-	Central Intelligence Agency
CIPS	-	Combined Intelligence Publishing Service
COMSEC		Communications Security
DBMS	-	Data Base Management System
DEC	-	Digital Equipment Corporation

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DEXA	-	DODIIS Executive Agent
DIA	-	Defense Intelligence Agency
DIS	-	Draft International Standards
DISA	-	Defense Information Systems Agency (DOD)
DOD	-	Department of Defense
DOS	-	Disk Operating System
DPI	-	Dots Per Inch
DVD	-	Digital Video Disc or Digital Versatile Disc, also known simply as DVD
DVD-RAM	-	DVD - Rewritable
DVD-R	-	DVD - Recordable
DVD-ROM	-	DVD - Read Only
ECC	-	Error Correction Code
ECMA	-	European Computer Manufacturers Association
EDC	-	Error Detection Code
EGA	-	Enhanced Graphics Adapter
EIDE	-	Enhanced Integrated Drive Electronics
FIPS	-	Federal Information Processing Standard (NIST)
FOUO	-	For Official Use Only
FPS	-	Frames Per Second
GSA	-	General Service Administration
HTML	-	Hypertext Markup Language
IDE	-	Integrated Drive Electronics
IEC	-	International Electrotechnical Commission IGES-Initial Graphics Exchange Specification
ISO	-	International Organization for Standardization

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ITSG	-	Information Technology Standards Guidance
ITSI BBS	-	Information Technology Standards Integrated Bulletin Board System
ITU	-	International Telecommunications Union (Formerly CCITT)
JIEO	-	Joint Interoperability Engineering Organization
JPEG	-	Joint Photographic Experts Group
JTA	-	Joint Technical Architecture
KB	-	Kilobyte (1,000 bytes)
KHz	-	Kilohertz (1,000 hertz)
MB	-	Megabyte (1,000,000 bytes)
MHz	-	Megahertz (1,000,000 hertz)
MIDI	-	Musical Instrument Digital Interface. An interface standard for music synthesis.
MIL-	-	Military
MPC	-	Multimedia Personal Computer
MPEG	-	Motion Pictures Expert Group
MSCDEX	-	Microsoft CD-ROM extensions
MSEC	-	Millisecond
NISO	-	National Information Standards Organization
NIST	-	National Institute of Standards and Technology
NSA	-	National Security Agency
OADR	-	Origination Agency Determination Required
ODC	-	Optical Disk Cartridge
OPC	-	Optimum write Power Calibration (used by CD-R recorders)
OSTA	-	Optical Storage Technology Association
PCMCIA	-	Personal Computer Memory Card International Association
PCX	-	PC Paintbrush (a graphics file format)

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PDF	-	Portable Document Format
PIXEL	-	Picture Element
QA	-	Quality Assurance
QC	-	Quality Control
PCR	-	Phase Change Rewritable/Rewritability
PD	-	Phase Change Dual Technology
RTF	-	Rich Text Format (a standard database file format)
SBU	-	Sensitive But Unclassified
SCI	-	Sensitive Compartmented Information
SGML	-	Standard Generalized Markup Language
SIGCAT	-	Special Interest Group on CD-ROM Applications & Technology
SIGCLASS	-	Special Interest Group on Classified Applications (a subgroup of SIGCAT)
SSP	-	Secure Storage Processor
TAFIM	-	Technical Architecture Framework for Information Management
TSC	-	Top Secret Code (words)
TIFF	-	Tagged Image File Format
UDF	-	Universal Disk Format
UIC	-	Unit Identification Code

3.2 Definitions. The definitions used in this handbook are defined as follows:

a. ANSI (American National Standards Institute) - ANSI is responsible for developing and approving industry-wide consensus-based standards for the United States. ANSI is a member of the International Organization for Standardization (ISO). Address: 1430 Broadway, New York, NY 10018; Phone (212) 642-4900.

b. ASMO - Advanced Storage Magneto-Optical. A consortia of nine companies working on a 120mm single sided optical disc (MO7) with a capacity of 6-7 GB. This new media type may compete with DVD-Rewritable (DVD-RAM) and 130mm (5-1/2-inch) magneto-optic rewritable optical disks.

c. Authoring/Retrieval Software - Although in some situations these can represent totally

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different software applications, for the most part authoring and retrieval software can be viewed as a pair. They represent the mechanism for preparing information to write to CD-ROMs and for retrieving information from CD-ROMs. Advanced data management schemes and database search engines have been developed and marketed as Authoring/Retrieval software. Authoring software may be referred to as putting the pieces of a product together into one cohesive, integrated application (to include creating and loading the index database, creating reports and the user interface, and testing the system), but this is generally only one piece of the functionality. The actual process of accessing the information efficiently during retrieval, interactivity, or playback, is the other piece of authoring software functionality. All authoring software can handle ISO 9660, but may be platform (MS-DOS, Macintosh, Unix, OS/2, etc.) specific.

d. Blue Book - Specifications for Enhanced CD, aka CD Plus, aka CD Extra. The Blue Book format places audio tracks in the first CD session, followed by data in the second session. Enhanced CDs can be played by an ordinary CD-A or CD-ROM player and can include full lyric and linear notes, photos, music videos and more.

e. Compact Disc-Audio (CD-A) or Compact Disc-Digital Audio (CD-DA) - A Compact Disc for storing audio. The physical standards for CD-A were defined by Sony and Philips in 1980 and published in a red binder called the Red Book standards for audio. CD-quality audio is played at 44,100 samples per second, 16 bits and stereo. To play CD-quality audio on a computer, the minimum transfer rate must be 176 KBps.

f. Compact Disc-Interactive (CD-i) - A Compact Disc format containing data, still and full motion video, audio, and animated graphics. CD-i discs require unique CD-i players and are incompatible with a CD-ROM drive. The specifications for CD-i are defined in the Green Book.

g. CD-i Bridge Disc - CD-ROM XA discs which have been recorded to conform with the CD-i operating system and will therefore play on CD-i drives.

h. Compact Disc-Read Only Memory/Extended Architecture (CD-ROM/XA) - XA defines a new form of the Yellow Book CD-ROM format, Mode-2 data tracks, which utilizes some filler space in the sector header to allow specifications of data types by sector. The XA format allows producers to interleave audio, video, text, and other computer data within the same physical track on a CD-ROM. Until recently, special hardware was required to read CD-ROM/XAs but there are now software solutions available. Yellow Book XA specifications may be obtained from ANSI - see ANSI definition.

i. Compact Disc-Recordable (CD-R) - A CD format allowing local recording to the disc. The specifications for CD-R are defined in the Orange Book. Part 1 of the Orange Book standard pertains to Compact Disc-Magneto Optical (CD-MO), which divides a disc into two parts - the inner tracks are used as compact discs (i.e., pre-embossed read-only) and the outer tracks may be written to, erased and rewritten. Part 2 of the Orange Book standard pertains to Compact Disc-Write Once (CD-WO), or CD-R. The CD-WO specifications cover single- and multi- session writing to a compact disc. As the name implies, CD-WO discs may be written to, but not erased.

j. Compact Disc-Recordable 2 (CD-R2) - CD-Recordable media compatible with both CD and DVD players. DVD players containing two laser read heads will not require special CD-R2 media.

k. Compact Disc-Read Only Memory (CD-ROM) - An optical storage, read-only, compact disc format used to hold various types of information, such as computer data, audio, video, or animation. CD-ROMs can hold in excess of 600 MB representing over 200,000 pages of ASCII text, 20,000 medium

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resolution graphic images (at an estimated per image size of 33 Kilobytes), or 63 minutes of 44.1 KHz 16-bit stereo sound without compression. Different information types may also be combined on the same disc. The specifications for CD-ROM are defined in the Yellow Book which may be obtained from ANSI (see ANSI definition).

l. Compiled By - Preparation of multiple source information by an Activity or other entity responsible for data assembly.

m. Contributed By - Activity responsible for the original information.

n. Data Transfer Rate (DTR) - the amount of data that can be transferred over a period of time (usually given in bits per second). Specifications should list both burst DTRs (usually the fastest rate) and sustained (more important when transferring big files like images and in multimedia applications).

Transfer rate = # revolutions/sec x # bytes/sector x # sectors/track x 8 bits

DTR specifications only measure the data transfer speed from drive memory to host computer memory. Real drive performance is impacted by other things such as host processor, host operating system, drive software and drive mechanics.

o. Data Preparer - A person or other entity which controls the processing of the data to be recorded on a volume group.

p. DOD-produced - Compact discs produced by or under the authority of any DOD Activity.

q. DVD - aka Digital Video Disc, Digital Versatile Disc, or simply DVD. A family of high capacity 120mm optical disc types, first introduced by the interactive game and motion picture industries. DVD-Video, the first commercially available product, uses linear recording, and stores MPEG-2 encoded video, and audio encoded in six-channel Dolby Digital (AC-3) or MPEG-2 audio (popular in Europe). The DVD-Video specification (Book B) allows for capacities of: 4.7 GB (single-layer), 8.5 GB (dual-layer), 9.4 GB (double-sided) and 17 GB (dual layer, double-sided). It is backward-compatible with CD-A discs. The DVD-Audio specification (Book C) will provide higher fidelity than CD-A. Specifications have also been finalized by the DVD Forum (version 0.9) for DVD-Recordable (DVD-R, Book D, capacity of 3.9 GB, single-sided) and DVD-Rewritable (DVD-RAM, Book E, capacity of 2.6 GB, single-sided).

The **DVD-ROM** specifications (Book A, read-only), allow for the same capacities as DVD-Video, supports UDF, and is backward-compatible with CD-A and CD-ROM. A DVD-ROM disc is capable of playing MPEG 2 and Dolby Digital sound but does not require it. A DVD-ROM system can play linear DVD-Video movies if it comes with an MPEG 2/Dolby Digital decoder card, decryption hardware and software, software for demultiplexing the bit stream, and software for decoding subpicture and control-stream data.

r. Green Book - The Compact Disc-interactive (CD-i) specifications. This book specifies the sector and track layout and synchronization of video, audio, and data for a CD-i application. This document may be obtained from American CD-i Association, 11111 Santa Monica Blvd., Los Angeles, CA 90025; phone (310) 444-6619.

s. Handling caveats - Warnings or cautions on how the information should be handled or used.

t. HTML - HyperText Markup Language (Version 2.0) - a simple data format used to create

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hypertext documents that are portable from one platform to another. HTML documents are SGML documents with generic semantics appropriate for representing information from a wide range of domains. HTML has been in use by the World-Wide Web (WWW) since 1990.

u. Hybrid Disc - A multi-platform disc that combines more than one directory/file structure, typically ISO 9660 for the PC and HFS for the Macintosh. A shared hybrid disc has data that is used in common.

v. Incremental Recording (see also Packet Writing) - refers to writing to multiple data streams (packets) within a track, separated by gaps. Packets within a track can be either fixed-length or variable length. The access time of a packet-written disc is usually greater than that of a disc written by other modes. UDF will help improve the performance of packet-written discs while maintaining some backward compatibility with ISO 9660.

w. ISO/IEC 13346:1995 - Volume and File structure for Write-Once and Rewritable Media Using Non-Sequential Recording (NSR) for Information Interchange. (ECMA 167-1992). Defines the international file system format established for non-sequential recording of information on optical media. Prior to NSR, every write-once implementation used some form of proprietary format. NSR also supports mass storage devices such as jukeboxes. ISO 9660 is a file system standard for read-only. NSR provides the ability to both read and write information among different operating systems. UDF is a subset of ISO/IEC 13346.

x. ISO/IEC 9660:1988 - The international standard which defines the file structure for putting computer files on compact discs. ISO 9660 is a subset of the Yellow Book specification. This standard may be obtained from ANSI - see ANSI definition.

y. ISO/IEC 13490:1996 - (ECMA 168-1992), *Volume and File Structure of read-only and write-once compact disc media for information interchange—Part 1: General; Part 2: Volume and file structure.* The international standard which defines the logical structure of information on a CD-WO disc (Orange Book Part II). It allows for files to be written at any time. A Table of Contents does not need to be written up front but can be added incrementally using packet writing. The standard includes directory information required to support Unix and Windows NT, and is compatible with ISO 10646 (a standard supporting all the character sets in the world). It is not compatible with ISO 9660; however, it is possible to write a "conformant disc" containing both sets of volume and file structures.

z. ITSI BBS - Information Technology Standards Integrated Bulletin Board System. An official Government bulletin board for use in the development and distribution of DOD information technology standards and related information. For information call the ITSI Help Desk at (703) 735-8338, DSN: 653-8338.

aa. Lead-in/Lead-out - A *lead-in* is a track written for CD drives to recognize the beginning of the logical volume; i.e., where the Table of Contents (TOC) is written. A *lead-out* designates the end of a logical volume (end of disc or session). Original CDs and early CD-Rs allowed only one session - the beginning and end of a session were marked by a set of lead-in and lead-out blocks.

bb. MPC (Multimedia Personal Computer) - The specifications defining the minimum computer system functionality for MPC compliance. These specifications serve as a guide to consumers purchasing multimedia PCs, upgrade kits and components. The MPC Working Group Executive Board has adopted MPC3 (Release 1.3). The MPC3 Specification is not a recommendation for any particular system configuration and does not replace the MPC1 and MPC2 specifications; rather, it defines an

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updated platform suitable for delivering enhanced multimedia functionality (e.g., includes MPEG video).

cc. MPEG - A compression standard for full motion, full screen, digital video, designed to deliver 30fps over such limited bandwidth transmissions as CD-ROM applications running on a PC. ISO/IEC 11172:1993 describes the standards for MPEG-1, ISO/IEC 13818:1996 describes the standards for MPEG-2. One minute of MPEG-1 video requires 9 MB of storage space. The MPEG-2 algorithm applies to a higher bit rate and a higher quality than MPEG-1 and is designed for high-bandwidth transmissions such as satellite-based broadcasting. MPEG-2 requires at least a 4X speed CD drive.

dd. Multiread - The ability of a device (to include DVD-ROM players) to read all CD-A, CD-ROM, CD-R, and CD-RW media. The draft implementation guide (version 0.71) defines the full system environment (hardware and firmware requirements) for developing Multiread compatible devices. Multiread is used to switch a disc from the packet written UDF format to and from the ISO 9660 format. It also includes defect management to ensure data can be read after long periods of time.

ee. Multisession - True Orange Book allows for incremental writing of each track on a disc separately and writing individual tracks in multiple sessions. Each session is like a mini-disc because each contains a lead-in, tracks, and a lead-out. Multisession-capable playback devices view multisession discs as one "logical" volume when mounted by the computer's operating system, ignoring all but the last directory. The most popular use of multisession is Photo-CD (Mode 2, Form 1, of the CD-ROM XA format).

ff. Orange Book - This book provides specifications describing the physical attributes associated with CD-Recordables (CD-R). It is divided into two parts: one for CD-MO (Magneto-Optical, rewritable) and one for CD-WO (Write Once). CD-WO identifies track-at-once and incremental writing, using either fixed- or variable-length packets.

gg. Packet Writing (see also Incremental Recording) - Packet writing refers to recording incrementally within a track with multiple data streams (packets), each separated by gaps. A packet-written disc cannot be read by a standard CD-ROM drive until the open track is closed and a session created with lead-in and lead-out blocks. When done, an ISO 9660 file system is created to map the directory to the packets on the disc.

hh. PD - Phase Change Dual Technology - Combines the benefits of high-capacity phase change rewritable (PCR) optical storage (650 MB capacity) with the advantages of high-speed, high performance CD-ROMs (4X speed) in a single drive. Reference ISO/IEC DIS 15485, *120mm ODC Using Phase Change PD form*.

ii. Phase Change Rewritable/Rewritability (PCR) - A technique for writing, reading, and direct overwriting to optical discs by changing the molecular structure of the metallic recording layer between crystalline (highly reflective) and amorphous (low reflective) states when pulsed by a laser.

jj. Photo-CD - A proprietary multisession storage format by Kodak & Philips, originally designed to display up to one hundred 35mm slides (estimated at 6 MB each) on a television using a Kodak Digital Science Photo-CD player (which also plays audio CDs), Philips CD-i player, Panasonic/3DO R.E.A.L. player or, in the near future, a Sega Saturn player. Photo-CD discs can also be played on a computer on a multisession CD-ROM XA drive equipped with Photo-CD access software, Apple Computer's QuickTime extension, the IRIX operating system from Silicon Graphics, or Sun Microsystems' Solaris. IBM's OS/2 Warp platform can also read and write Photo CD discs, and IBM supports Photo-CD technology in its AIX operating system (which runs on RISC System/6000 workstations) through

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Ultimedia Services, an optional package of multimedia tools. Photo-CDs use some of the Green Book specifications, but are recorded under the Orange Book, Part II, which defines CD-WO appendable media.

kk. Pixel - Short for Picture Element, the smallest addressable element of a computer graphic display area into which a document is divided for scanning purposes.

ll. Premastering Software - Software used to prepare information for the proper format to be physically recorded on a CD. The three essential functions of premastering software are: to convert the file structures into the standardized file format of ISO 9660 and create a disc image on a computer's hard disk, simulate the disc image as a CD-ROM, and send the CD-ROM image to the CD recorder. It may also be able to image the CD-ROM "on-the-fly" while sending it to the recorder; however, using this eliminates the ability to simulate the CD on the hard disk.

mm. Producing Organization - The name of the Government organization with overall responsibility for the product.

nn. Red Book - This book specifies the sector and track structure and layout for an audio compact disc. The CD industry started when Philips and Sony introduced the Compact Disc Digital Audio (CD-DA or CD-A) standard. Virtually all music CDs conform to this standard.

oo. SCI - Sensitive Compartmented Information. Information and material that requires special controls for restricted handling within compartmented intelligence systems and for which compartmentation is established. See DOD Directive 5200.1-R, Information Security Program.

pp. SCSI - Small Computer Systems Interface is an interface specification for connecting multiple peripheral equipment to computers. It is utilized on most Unix & Macintosh platforms and is readily available on PC based platforms and CD devices.

qq. SCSI-2 - Defines the actual SCSI connection, termination, and data transmission in more detail than the original SCSI specification. Several multi-platform computer peripherals including CD-ROM drives, CD-Recordable drives, and image scanners use SCSI-2 interfaces.

rr. TAFIM - Technical Architecture Framework for Information Management. A DOD publication which provides guidance for the evolution of the DOD technical infrastructure. It consists of eight volumes, providing services, standards, design concepts, components, and configurations that can be used to guide the development of technical architectures that meet specific mission requirements.

ss. Track-At-Once - A form of incremental writing, most used by CD recorders today. The data or audio tracks are written first, then the lead-in, followed by the lead-out. Updates are possible, and tracks of data may be recorded one at a time, or as multiple tracks in one uninterrupted stream (limit of 99 tracks), but the disk cannot be read by a standard CD-ROM drive (that cannot find data on a partially filled disk) until it has been "finalized." Finalizing means writing the lead-out and the Table of Contents (TOC) on the disk. No updates may be added after a disk has been finalized. After finalization, the disc essentially contains one session. When the laser turns off between writes, a "link block" is written of about 600 KB (therefore, if you use all 99 tracks, about 60 MB of disc space is wasted). A link block is nothing more than a null sector where the drive stopped writing and where it will start again when another track is written. Such blocks present no problems to CD-ROM or CD-A players, which ignore them. However, if used as a master CD, sometimes the link blocks show up as "E32" uncorrectable errors to the sophisticated mastering machines at replication factories.

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tt. UDF - Universal Disk Format - UDF serves as the link between the underlying physical tracks and logical sectors to the top-level application. It was developed by OSTA as a practical subset of ISO/IEC 13346 that would be easier to market, yet still address how information is to be interchanged between different operating systems. CD-UDF defines the logical file format specification for packet writing on CD-R media. The DVD file structure is included in UDF.

uu. User - (ISO 9660) A person or other entity (for example, an application program) that causes the invocation of the services provided by an implementation.

vv. Volume - (ISO 9660) A dismountable CD-ROM.

ww. White Book - Specifications for how CD-i data is recorded on CD-ROM XA discs. The White Book is the basis for Compact Disc-Video (CD-V), which uses the Motion Pictures Experts Group (MPEG) video compression encoding and decoding.

xx. Yellow Book - Compact Disc-Read Only Memory (CD-ROM) specifications. The Yellow Book, the second phase of the CD industry introduced by Philips and Sony, describes the physical attributes for CD-ROM and CD-ROM XA (Extended Architecture). It expands on the Red Book specifications to include two new types of tracks: Mode-1 for text and computer data, and Mode-2 for compressed audio and video/picture data.

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4. COMPACT DISC FUNDAMENTALS

4.1 General. This section provides fundamental information that should be used by all DOD compact disc users and producers.

4.2 Physical Properties. ISO/IEC 10149:1989 Information Technology - *Data Interchange on Read-only 120mm Optical Discs*, is the standard for DOD-produced CD-ROM discs. This standard defines physical track shape, track pitch, and data structure as well as disc size (120 millimeters or 4.72 inches).

4.3 Disc Labeling. The following paragraphs provide disc labeling instructions for both classified and unclassified DOD-produced compact discs destined for distribution as a final product. Unless specified as "optional" all items should be present on any DOD-produced CD. All information on the label should also be unclassified. See FIGURE 1 for a sample classified label and FIGURE 2 for a sample unclassified label. See 5.2.2 for the proper marking of CD containers, paper enclosures, and liners.

a. Data Classification: **NOTE**: If an unclassified CD-ROM is inserted in a classified information system, the unclassified CD-ROM assumes the classification of the information system. Upon removal of the CD-ROM, it is labeled to reflect the classification of the information system.

(1) Security classification: For discs containing classified information. The classification marking to use is the highest of any information contained on the disc. Position the classification marking at the top of the disc label, in 18 point bold type with a Sans Serif typeface. All other markings on the label should have a smaller point size than the classification marking.

(2) Other Protective Markings: For discs containing protected information, such as For Official Use Only (FOUO). Use at least 12 point bold type with a Sans Serif typeface.

b. Handling Caveats: For discs containing any information with handling caveats.

(1) For discs containing information requiring control numbers (e.g., TOP SECRET (TS), NATO SECRET, TOP SECRET CODE WORD (TSC), etc.), place the handling caveat marking and control number (*Example*: TS-xxxx/yr or TSC-xxxx/yr) directly below the data classification marking.

(2) For discs containing information covered by Public law 93-579 "The Privacy Act of 1974," the handling caveat phrase "Privacy Act Data, Sec. 552a, Title 5, U.S.C." is placed directly below the data classification marking.

(3) Prominently display access or use constraints, such as "copyright," "proprietary," or "limited distribution" on the label.

c. Classification Color Rings: For discs containing classified information. Place a 1/4 inch wide color ring along the outside perimeter of the disc label. The following list provides the ring color for the corresponding classifications.

- | | |
|------------------|---------------------------------------|
| (1) Yellow | (Sensitive Compartmented Information) |
| (2) Orange | (Top Secret) |
| (3) Red | (Secret) |
| (4) Blue | (Confidential) |

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d. Producing Organization's Name: All discs.

e. Classification Authority: For classified discs.

f. Declassification Date: If applicable.

g. Producer and/or Product Seals/Logos: Optional.

h. ISO 9660/Compact Disc Data Storage Logos: Optional; however, placing the ISO 9660 logo on a disc indicates to the user that the disc is ISO 9660 compliant. It also quickly identifies the disc as a CD-Audio, CD-ROM, CD-i, etc., without having to insert it into a drive.

i. Title of Production or Disc Set, including any disc set numbering schemes, such as 1 of 3: All discs. Include any prefacing number or title, such as Technical Order (TO), Technical Manual (TM), Department of Defense Directive (DODD), etc.

NOTE: Include markings on classified discs to show that the title is unclassified information (U).

j. Date Produced: All discs.

k. Platforms Supported: If applicable (*Examples*: DOS, Windows, Unix (specify), Macintosh, DEC, etc.).

l. Supplemental Data Formats Used: When using any extended or supplemental data formats (*Examples*: XA, MPC, MPC2, MPC3).

m. Edition: Edition, version, revision, change number or identification. Optional.

n. Volume Identification: All discs. This should be identical to the eleven characters of the Volume Identifier (first eleven characters of the ISO 9660 Volume Identifier (32 characters available)) written in the header of the disc. Use only upper-case letters, 0-9, and the underscore for Volume Identifications. One way to accommodate the requirements for unique volume identification for discs in CD-ROM jukeboxes, towers, and network systems is to use the producing organization's Unit Identification Code (UIC) as the first six characters; the producing organization should then manage/ensure disc uniqueness using the next five characters of the Volume Identifier.

o. Identification Number for Disc (serial/copy #): To be used for accounting of top secret or code word discs, optional for other discs.

(1) For top secret or code word disc accountability, each producer should assign a unique serial number to each title or production release. Additionally, each disc should contain a copy number unique to the serial number.

(2) For accountability of other discs: As needed. Identification Numbers can be used to provide accountability for every disc produced.

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4.3.1 CD-Recordables. Items in 4.3 also apply to CD-Recordable discs. If used, adhesive labels should be frangible (tears if you try to remove it). CD-Recordable adhesive labels need to be thin enough to not interfere with the CD-ROM drive and be able to withstand humidity and heat in typical user environments. CD-Recordable label printers need to have permanent, smear-proof inks. Refer to 6.3 for general information concerning CD-Recordable labeling options.

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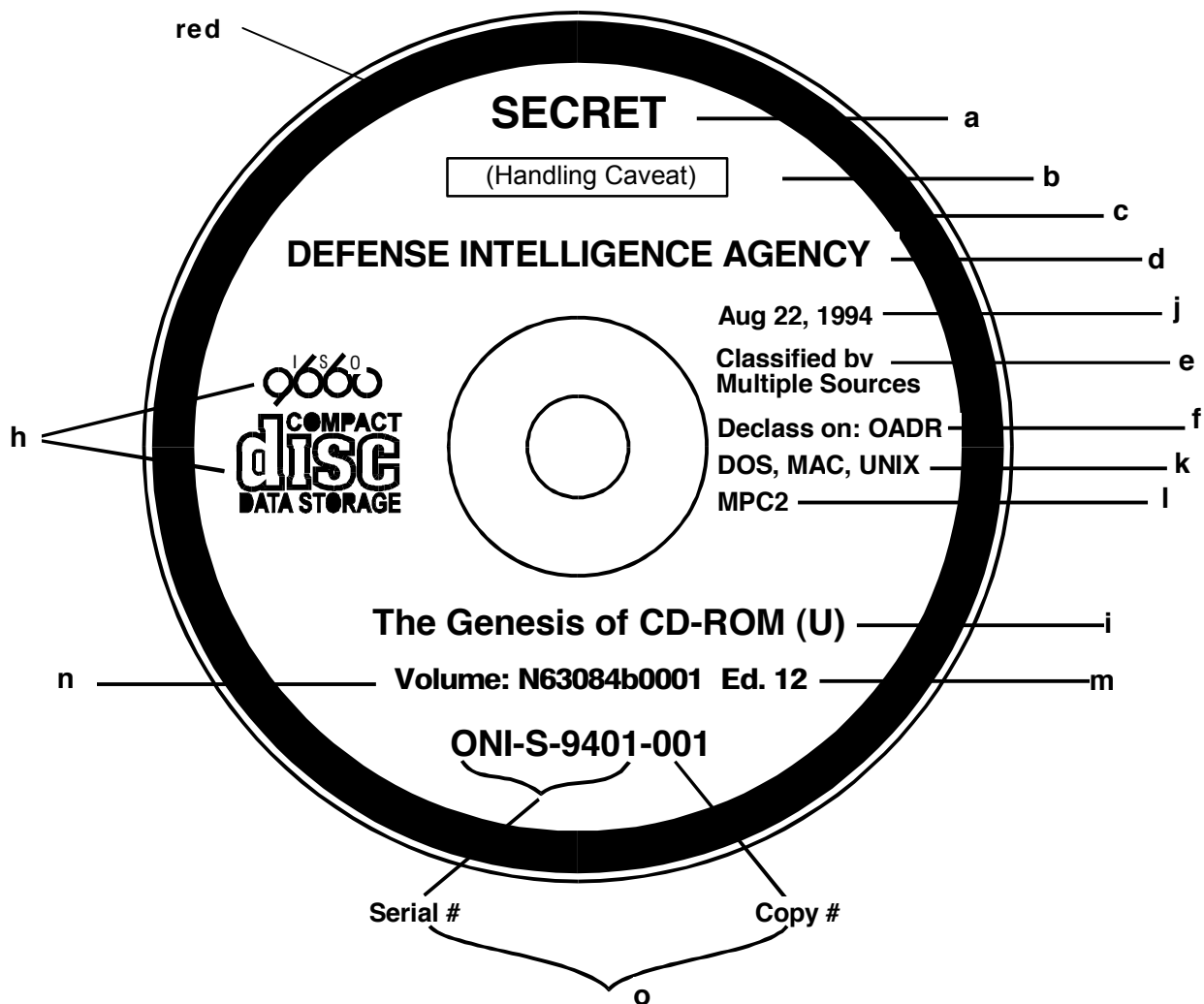


FIGURE 1. Sample CLASSIFIED Label

NOTES: Letters correspond to paragraphs in 4.3. This is an example only. Note the locations for the classified ring, disc classification, and handling caveats. Components/agencies may tailor the rest of the label layout.

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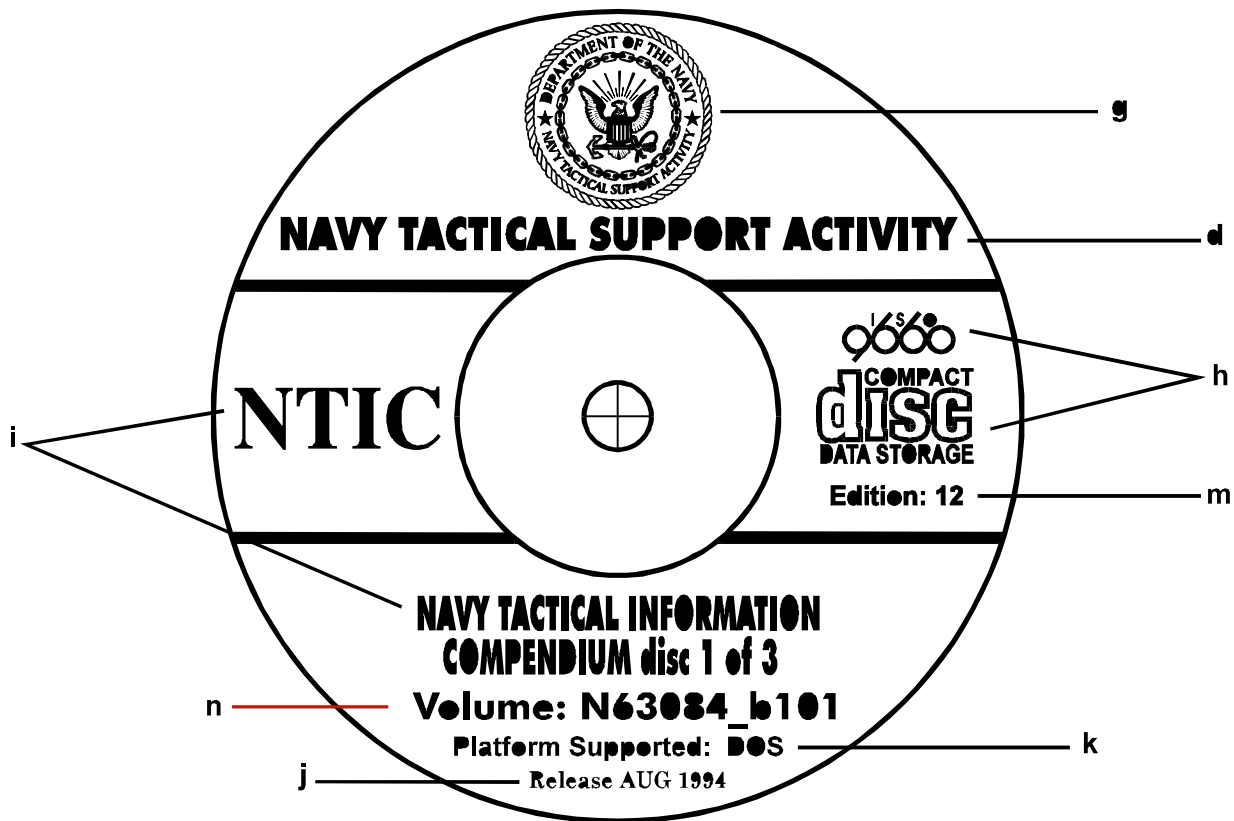


FIGURE 2. Sample UNCLASSIFIED Label

NOTES: Letters correspond to paragraphs in 4.3. This is an example only. Components/agencies may tailor the rest of the label layout.

MIL-HDBK-9660B**4.4 Disc Contents.**

4.4.1 Volume and File Structure. ISO 9660:1988, *Information Processing - Volume and File Structure of CD-ROM for Information Interchange*, is the volume and file structure for DOD-produced CD-ROMs.

4.4.2 Internal CONTENT.TXT File. For every DOD-produced CD-ROM disc, include a flat ASCII file titled "CONTENT.TXT" in the top level (root) directory with the following format and information:

a. Eighty or less characters per line, with a hard return (ASCII Carriage Return - Line Feed combination CRLF) at the end of each line. Use descriptors (such as "**TITLE:**") to introduce each new information block in all capital letters, beginning in column one of the line. Use upper and lower case for associated data.

b. Following is the proper structure for the CONTENT.TXT file. Descriptor headings that should appear in the CONTENT.TXT file are shown in bold type. For consistency, use all the descriptors, although the associated information is optional. To improve readability, if a descriptor requires more than one line, indent all lines after the first by eight spaces

TITLE:

State verbatim the name by which the disc is known, including any disc set numbering schemes, such as 1 of 3. Do not include any superfluous descriptions or qualifiers. More than one title may be needed if the CD contains more than one distinct product or contains sets of information (See **DOCUMENT IDENTIFICATION:**).

EDITION:

The edition, version, revision, change number or identification of the title.

VOLUME IDENTIFICATION:

This should be identical to the eleven characters of the Volume Identifier (first eleven characters of the ISO 9660 Volume Identifier (32 characters available)) written in the header of the disc. Use only upper-case letters, 0-9, and the underscore for Volume Identifications. One way to accommodate the requirements for unique volume identification for discs in CD-ROM jukeboxes, towers, and network systems is to use the producing organization's Unit Identification Code (UIC) as the first six characters; the producing organization should then manage/ensure disc uniqueness using the next five characters of the Volume Identifier.

ORIGINATOR:

The name of an organization(s) or individual(s) that developed the information (see definition of contributed by). If the names of editors or compilers are provided, follow each name by "(ed.)" or "(comp.)," respectively.

CD PUBLICATION DATE:

The date when the disc was published or otherwise made available for release.

SECURITY CLASSIFICATION:

Name of the security restrictions on the disc. Use the highest classification of any information on the disc.

MIL-HDBK-9660B**CLASSIFICATION AUTHORITY/SECURITY CLASSIFICATION SYSTEM:**

Name of the classification system. State/reference the actual classification authority or "Multiple Sources" if appropriate. Use "N/A" for unclassified discs.

SECURITY HANDLING DESCRIPTION:

Additional information about the restrictions on handling the disc.

DECLASSIFICATION DATE:

Provide the date the disc becomes declassified. This is either the last declassification date of any material on the disc, or Originating Agency Determination Required (OADR) if appropriate. Use "N/A" for unclassified discs.

TIME PERIOD OF CONTENT:

Time period(s) for which the data on the disc is valid. For calendar date, use year as YYYY (and optionally month and year as MMM YYYY, or day, month and year as DD MMM YYYY). For time of day, use hour as H: or HH: (and optionally hour and minute as H:MM or HH:MM, or hour, minute and second as H:MM:SS or HH:MM:SS). Identify AM or PM following the time.

Select one of the following methods:

(1) Single Date/Time: means of encoding a single date and time when there is no expiration date for the entire CD contents.

Example:

TIME PERIOD OF CONTENT:

BEGINNING DATE: 1997 (or JUN 1997, or 2 JUN 1997)
BEGINNING TIME: 2:00 PM (or 2:43 PM, or 2:43:23 PM)

(2) Multiple Dates/Times: means of encoding multiple individual dates and times when there is more than one "product" or "sets of information" on the CD with different beginning dates/times, but no expirations.

Example:

TIME PERIOD OF CONTENT:

DATA DESCRIPTION: The Genesis of CD-ROM (U)
BEGINNING DATE: 1997 (or JUN 1997, or 2 JUN 1997)
BEGINNING TIME: 2:00 PM (or 2:43 PM, or 2:43:23 PM)

DATA DESCRIPTION: Navy Tactical Information Compendium
BEGINNING DATE: 1996 (or AUG 1996, or 9 AUG 1996)
BEGINNING TIME: 9:00 AM (or 9:15 AM, or 9:15:46 AM)

(3) Range of Dates/Times: means of encoding a range of dates and times using BEGINNING and ENDING DATES/TIMES if there is an expiration date of the entire CD contents, or there are different expirations for each "product" or "sets of information" on the CD.

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Example using BEGINNING and ENDING DATES/TIMES for entire CD:

TIME PERIOD OF CONTENT:

BEGINNING DATE: 1997 (or JUN 1997, or 2 JUN 1997)
BEGINNING TIME: 2:00 PM (or 2:43 PM, or 2:43:23 PM)
ENDING DATE: 2002 (or JUN 2002, or 2 JUN 2002)
ENDING TIME: 2:00 PM (or 2:43 PM, or 2:43:23 PM)

Example using BEGINNING and ENDING DATES/TIMES for different products/sets of information:

TIME PERIOD OF CONTENT:

DATA DESCRIPTION: The Genesis of CD-ROM (U)
BEGINNING DATE: 1997 (or JUN 1997, or 2 JUN 1997)
BEGINNING TIME: 2:00 PM (or 2:43 PM, or 2:43:23 PM)
ENDING DATE: 2000 (or JUN 2000, or 2 JUN 2000)
ENDING TIME: 8:00 AM (or 8:15 AM, or 8:15:05 AM)

DATA DESCRIPTION: Navy Tactical Information Compendium
BEGINNING DATE: 1996 (or AUG 1996, or 9 AUG 1996)
BEGINNING TIME: 9:00 AM (or 9:15 AM, or 9:15:46 AM)
ENDING DATE: 2000 (or SEP 2000, or 21 SEP 2000)
ENDING TIME: 9:00 AM (or 9:15 AM, or 9:15:46 AM)

OPERATING ENVIRONMENT/NATIVE DATA SET ENVIRONMENT:

State the minimum DOS version, Microsoft Windows version, Unix version, Macintosh version, etc., that is required to operate this disc. In addition, state any other hardware/software requirements.

ACCESS CONSTRAINTS:

Restrictions and legal prerequisites for accessing the data. These include any access constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations on obtaining the data.

USE CONSTRAINTS:

Restrictions and legal prerequisites for using the data after access is granted. These include any use constraints applied to assure the protection of privacy or intellectual property, and any special restrictions or limitations on obtaining the data.

ABSTRACT:

A brief narrative summary describing the CD and its purpose. More than one abstract may be needed if the CD contains more than one distinct product or contains sets of information.

ORDERING INSTRUCTIONS:

State specifically how to request copies of the CD.

FEES:

The fees/terms for receiving the disc.

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POINT OF CONTACT:

Contact information for an individual and organization that is knowledgeable about the data on the disc.

CONTACT NAME:

CONTACT ORGANIZATION:

CONTACT ADDRESS:

CONTACT VOICE TELEPHONE:

CONTACT FACSIMILE TELEPHONE:

CONTACT E-MAIL/INTERNET ADDRESS:

MAINTENANCE AND UPDATE FREQUENCY:

State plans for product enhancements, schedule of updates, termination of product support or any other related information.

ORIGINATOR COMMENTS:

Provide any comments desired by the originator of the CD or products on the CD.

DOCUMENT IDENTIFICATION:

List the number, title, date, and originator of each document or product found on the disc. (This and the following DOCUMENT ABSTRACT field can be repeating pairs).

DOCUMENT ABSTRACT:

Provide a brief narrative describing each document or product on the disc. (This field and the DOCUMENT IDENTIFICATION field can be repeating pairs for every document/product found on the disc).

END OF CONTENT.TXT FILE:

c. Forward an unclassified version of each CONTENT.TXT file (in the format specified above) to DISA electronically or on a 3.5", 1.44 MB, IBM PC compatible floppy disk. DISA will not accept classified CONTENT.TXT files. The appropriate EMAIL/INTERNET address is: barnettj@ncr.disa.mil. The appropriate mailing address is: DISA/JIEO Center for Standards, ATTN: JEBEB (Mr. James Barnette), 10701 Parkridge Blvd, Reston, VA 22191-4357. These CONTENT.TXT files are used to maintain a database of all DOD CD products. For information on how to access the database call the ITSI BBS Help Desk at (703) 735-8338, DSN: 653-8338.

4.5 Compact Disc Security.

4.5.1 Classified Disc Labeling, Color, and Serialization Marking. Refer to 4.3 for labeling instructions and FIGURE 1 for a sample of the proper format for a classified label.

4.5.2 Output Classification Screen/Printer. Classification marking information should be provided/attached to relevant information to allow the retrieval engine to display the highest classification of any information on the display at that time. In addition, mark all paragraphs/subsections contained within a classified document/database on CD-ROM with the appropriate classification in accordance with security regulations.

MIL-HDBK-9660B**5. COMPACT DISC GUIDELINES****5.1 Software Guidelines.**

5.1.1 Licensing Issues. A major concern in the production and dissemination of CD-ROM discs is software licensing restrictions and costs for the selected authoring/retrieval package. A search and retrieval engine can be used to support those CD-ROMs containing extensive text. This is required to facilitate rapid searches through volumes of information.

Authoring software is normally packaged/priced separately from retrieval software, but is specifically designated for a single retrieval engine. Each operating platform supported by the disc may require separate viewers, authoring software, or both.

Most authoring/retrieval engines can be purchased in a variety of ways. The following list defines many of the more popular licensing schemes. If the vendor does not currently offer the particular scheme best suited for your needs/budget, they often will develop new pricing/licensing to obtain your business.

a. Site License: A one-time cost includes all future titles, replicated copies and users. A separate fee or royalty is not required for each user receiving a CD-ROM disc. *Example:* A site license for authoring and retrieval software may cost \$50,000, with no additional charges. This method is usually the most cost-effective if a single package can address all of your CD-ROM publishing needs.

b. Per Title License: A one-time cost and a fixed royalty for each new title produced. A producer pays a fixed fee, and an additional fee each time a new title is produced. *Example:* Purchasing price is \$20,000, each new title costs \$10,000.

c. Per Product License: A one time cost per CD-ROM product regardless of the number of discs replicated or the number of releases. This type of license is usually associated with a unique customer base/type (distribution list) but can grow/shrink as required.

d. Free Runtime Licensing: A one time cost is paid for the authoring software and there are no costs associated with distributing the retrieval engine.

e. Per User or Replicate Licensing: A one-time cost is paid for the authoring software and a fee for each user or each disc replicated/distributed must be paid. *Example:* A producer pays \$20,000 for authoring software, then \$10 for each user or each disc disseminated. This is the favored approach of vendors but can often be the most costly for producers.

Any combination of the above schemes can also be negotiated. Before any purchase, investigate the number of titles, copies, updates, and users affected by the license(s).

5.1.2 Authoring/Retrieval Software Selection One of the most important decisions to be made when developing a CD-ROM product is the authoring package/retrieval engine used. There are a large number of government and commercially developed packages available. Any product having a significant amount of text should have a full text retrieval package.

There are several packages available that enable producers to easily convert existing paper products to CD-ROM, but they also require more time and effort on the part of the end user to obtain/access required information.

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Although the catalyst for producing CD-ROM products is often cost effective for the producer, end user acceptance/utilization must be given the highest priority when selecting a package. If the end user does not accept, or cannot effectively utilize, the CD-ROM product, then either the paper product must continue to be produced or the end user no longer has access to the information.

CD-ROM developers/producers should get their prospective end users involved early in the development cycle. If users feel they have contributed to the development of the product and in the selection of the retrieval engine, they will be more likely to accept the product and continue to work with the producers to perfect the product.

Approaches/methods for developing standards governing the selection and use of authoring/retrieval engines include:

- a. Selecting a single engine or a small set of engines for use;
- b. Compiling a list of minimum capabilities required of any authoring/retrieval system used;
- c. Adopting a data exchange standard. This approach uses a client-server architecture with a standard messaging format so any compliant user interface can query and obtain data from any other compliant server database (*Example*: a command could use its own retrieval engine on any CD-ROM disc complying with the standard);
- d. Standardizing on the actual stored data format with like data being represented consistently (*Examples*: WordPerfect format, SGML, PDF, RTF);
- e. De facto standardizing by limiting the number of organizations allowed to produce CD-ROM titles;
- f. Letting CD-ROM use grow on its own.

5.2 Production Guidelines (Recommendations).

5.2.1 Disc Packaging and Mailing. There are several options available for packaging a CD-ROM disc for distribution. A choice must be made on both the actual disc container and the packaging/ mailing container.

Some of the most popular disc containers include: jewel cases, tyvex sleeves, paper sleeves, disc caddies, and multi-disc trays. Paper/tyvex sleeves are the lowest cost containers and are often provided free with the purchase of replicated discs. Jewel cases generally cost 20 to 30 cents each and are fragile, but provide a good mechanism for marking the packaged disc with needed information (such as title, classification, date). Disc caddies and multi-disc trays can cost up to a few dollars each.

Some of the most popular packaging/ mailing containers include: cardboard disc mailers, padded disc mailers, padded envelopes, bubble wrap within an envelope, and envelopes by themselves. Cardboard disc mailers and padded disc mailers usually come with a self adhesive securing strip, saving some packaging time and effort, but they only provide slightly better protection than regular envelopes and can cost 45 to 60 cents each. Bubble wrap and padded envelopes provide good protection for discs (especially when jewel cases are used), but they can cost over a dollar apiece.

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5.2.2 CD Containers, Enclosures, and Liners. CD containers, such as plastic jewel cases or cardboard cases, can provide information on the side ribs as well as the front and back covers. Note that marking the CD container, enclosure, or liner does not take the place of the disc labeling instructions listed in 4.3. Repeat any disc labeling information obscured by the use of a container, enclosure or liner.

For classified discs, place a 1/4 inch border of the appropriate color on both the front and back covers as well as a 1/4 inch color square on the top and bottom on each side rib. Stamp/mark the front and back covers of the container, enclosure or liner with the same classification as that of the disc (which will be the highest classification of any information contained on the disc).

5.2.3 Decision to Produce CD-ROM. The production of a CD-ROM can be a lengthy process. Proper planning is a must for proper production and the right decisions made during the planning stage can make or break the success of the project. The following points should be considered before initiating a CD-ROM project:

- a. Decide whether the project is a money making venture or an internal vehicle for boosting efficiency and reducing costs. Have a realistic idea of direct and associated costs and desired results.
- b. Evaluate what, how, and to whom information is to be disseminated. Benefits to the customer/user must be considered in addition to benefits to the producer. Figure out the perishability of the information to be put on the CD-ROM. Ease of retrieval of CD-ROM versus other media, weight/volume trade-offs, urgency of dissemination, and timeliness all need to be integral variables in determining the best approach. Be flexible.
- c. Determine if data used must be integrated, cleaned up, or reformatted. Consider the time, effort, and cost for any needed digital conversion. Formulate all costs and time involved in this effort.
- d. Determine hardware requirements. Evaluate any hardware constraints bearing on the success of the project. Give consideration to producing and using the CD-ROM across hardware/operating platforms (*Examples*: DOS, Windows, Unix, Macintosh, DEC). Consider this for the production environment as well as the user environment.
- e. Evaluate user acceptance of this type of information. This is the most important step for ensuring a valuable product is developed. Get users involved early in the development cycle.
- f. Determine what production and user software may be required. Is the software available? If not, is there an efficient approach to get what is needed? Look carefully at user fees and licenses.
- g. Evaluate the need for data encryption, serialization, or copyrights. Follow established procedures. Check for any special requirements or restrictions regarding the mention or use of freeware and trademarks in your CD product(s). Consult with your legal office before including copyrighted or non-freeware/shareware material copyrighted by non-government organizations on your CDs.
- h. Evaluate and readjust the project production and distribution time frame as often as needed. Make sure all steps in the production, replication, and distribution process are considered.
- i. Determine the impact of final packaging. The variety and availability of materials, such as use of color, number of discs per package, or method of distribution, all affect costs and efficiency.
- j. Evaluate the need for, and method of, providing training. Determine options and time needed.

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k. Plan for the impact on maintaining and updating data. Determine the process needed to update. Evaluate redistribution approaches.

l. Evaluate any similar products. Determine any advantages and disadvantages.

m. Develop an investment strategy based upon a cost and benefit analysis, comparing CD-ROM dissemination of information with the use of paper medium for distribution.

5.2.3.1 Commercial CD-ROM Replication Versus Local Production Break-Even Analysis Tool.

When many copies of a CD-ROM are to be produced, one decision to be made is whether to produce CD-ROMs locally (in-house) using one-off machines or to contract the job to a CD-ROM replication company. If time is critical, local one-off production may be the only satisfactory alternative (although one-day turnaround can be obtained from a production vendor). If there is time to have a company replicate the CD-ROM, however, the prime consideration becomes cost. The following tool is provided to identify the crossover point (number of CD-ROMs) at which it becomes less expensive to use a CD-ROM replication company. If a CD-ROM production run is below the crossover point, it costs less to produce them locally; if higher than the crossover point, it costs less to have them produced by a CD-ROM replication company. For the purpose of this equation/example, it is assumed that the producer currently has the capability in-house to produce.

The price charged by a CD-ROM replication company is divided into two categories: fixed price and variable price. The fixed price is the same regardless of how many CDs are produced. The variable price is equal to the number of CD-ROMs produced times the total "per CD-ROM" price. The CD-ROM replication company may identify just the total fixed price and the total "per CD-ROM" price or it may itemize the prices. If itemized, you will need to identify fixed prices and the "per CD-ROM" prices. The fixed price is the total of the fixed price components for a production run. The "per CD-ROM" price is the composite of the "per CD-ROM" price components.

Many replication companies have block rates; for example, one rate for up to 2,000 CD-ROM discs and another rate for 2,000-5,000 which permits greater volume discounts. This analysis will need to be accomplished for each block.

The following equations are used to determine the CD-ROM break-even number. If the planned production run is larger than the break-even number, the production can be contracted to a CD-ROM replication company. If it is less, the CD-ROMs can be produced locally as one-offs.

$$\text{Break-even \#} = FcC / (ADo - Pdc)$$

$$\text{Break-even \#} = ((1 + S) \times FcC) / (ADo - ((1 + S) \times Pdc)) \text{ (when a surcharge is applied)}$$

FcC - Fixed charges, Commercial: This is the total of one-time fixed costs charged by the CD-ROM replication company. Fixed costs include the substantial "start up" costs associated with developing a CD-ROM template (glass master and metal press). It may also include a single charge for etching sequential numbers (serialization) on every disc.

Pdc - Per Disc Charge, Commercial: This is the CD-ROM replication company charge for each CD-ROM produced. It may be provided as a total or may be calculated by adding the following together:

- Charge per disc
- Charge for serialization per disc (may be fixed)
- Charge for printing each included booklet

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- Charge per package/container (may be included in disc charge)
- Charge to produce/install liner (may be included in disc charge)
- Charge for mailing each CD-ROM back to the publisher

S - Surcharge: This is the total of surcharges (a percentage of the total commercial charges) levied by contract middlemen; for instance, the Government Printing Office or the Defense Automated Printing Service. Some contracting vehicles will not require a surcharge.

ADo - Average Disc Cost, one-offs: This is the only cost relevant to producing CD-ROMs locally. It is the cost incurred by you, the producer, for each one-off produced. It is the sum of the following:

- Cost per CD-ROM one-off blank (the primary cost consideration)
- Cost per package/container
- Cost per label materials
- Cost per liner materials
- Cost per booklet materials
- Average manpower cost per disc to write to the one-off, make the labels, liner, and booklet and assemble each package.

Example:

Fixed Charges, Commercial = \$2,500.00

Per Disc Charges, Commercial = \$3.00

Surcharge = 10%

Average Disc Cost, One-off = \$16.00

Break-even # = $((1 + .1) \times \$2,500) / (\$16 - ((1 + .10) \times \$3)) = 216.6$

Therefore, if you need 217 or more copies, you should contract out to a replication company. If you need less than 217 copies, you should produce the discs in-house.

5.2.4 Quality Assurance Guidelines for CD-ROM Producers. To ensure CD-ROMs produced by DOD adhere to minimum quality assurance/quality control (QA/QC) guidelines, check the following items before final production:

a. Review the CONTENT.TXT file to ensure its information conforms with the physical label, documentation, and the actual content of the disc. The CONTENT.TXT file can be created early in the CD-ROM product development cycle. It can then be printed and used to ensure all of the documents/databases are actually on the appropriate discs.

b. Review all external document/database references (hyper-links) to ensure they are present and properly named. Missing images or improperly named images/directories are the most frequent errors found on CD-ROM products. If possible, develop a standard naming convention for images. For example, place all images for a particular document in a unique directory or folder. Then a scheme like CCFFSSS.TIF could be used to represent each image where CC = chapter number, FFF = figure number, and SSS = sheet number. This allows a top level QA check to ensure there is an actual file corresponding to each required image. Ultimately, going through the List Of Illustrations inside the retrieval engine and pulling up each image is the only way to absolutely ensure each image is appropriately named and not corrupted.

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c. Review the documents/databases placed on a release and derive a consistent tagging scheme to be applied throughout. Document this tagging scheme and provide rules for various situations. Then have one phase of your QA/QC process be a tag/format proof of the documents. Have the various personnel responsible for tagging distribute the proofing evenly among themselves. This will allow them to resolve tagging conflicts and ensure their tagging is consistent with their peers.

d. Scan all information (files) for viruses before submission for replication or release of the CD, and before using for the first time.

e. Finally, someone who is not involved with the release should provide the final QA/QC check by actually using the production one-off. Have the individual work with only the documentation and CONTENT.TXT file provided to ensure the information can be installed, run, and effectively accessed. If they get stuck or confused about anything make corrections - it will pay off in less required end user support in the future.

5.2.5 Data Encryption. If the producer of a classified CD-ROM product requires the disc to be handled, shipped, and stored as if it were unclassified, then NSA Approved encryption is required. A NSA Approved encrypted disc can be handled and stored without regard to its data classification. Use of a NSA Approved media encryption/decryption system will permit users to accrue benefits by preventing unauthorized access to any level of classified data written to the CD-ROM discs.

Contact NSA (V-group) for additional information on NSA Approved encryption/decryption methods. Refer to 6.2 for more information on encryption.

5.2.6 Data Exchange/File Format. CD-ROM has the capacity to store a large amount of information and it is important to use established standards. Be careful not to get locked into a proprietary solution. Standards are listed in the DOD TAFIM AITS (see 2. APPLICABLE DOCUMENTS).

The following are established exchange standards used by the DOD for CALS (Continuous Acquisition and Life Cycle Support) and Automated Document Conversion (ADC):

a. *Code for Information Interchange, Its Representations, Subsets, and Extensions, (American Standard Code for Information Interchange [ASCII] (FIPS PUB 1-2))* is the standard for the exchange of textual data including any structured arrangement of character-oriented records, files, or indices.

b. *Markup Requirement and Generic Style Specification for Electronic Printed Output and Exchange of Text (Standard Generalized Markup Language [SGML])*, which adopts ISO 8879:1986 (MIL-PRF-28001C for CALS), is the standard for the exchange of textually-oriented data.

c. *Requirements for Raster Graphics Representation in Binary Format (Group 4 Raster Scanned Images)* (MIL-PRF-28002B for CALS) is the scanning standard for exchange of data in raster file format. NOTE: DRAFT MIL-PRF-28002C, dated 6 June 1997, has been distributed for coordination.

d. *Digital Representation for Communication of Product Data: IGES (Initial Graphics Exchange Specification) Application Subsets and IGES Application Protocols* (MIL-PRF-28000A for CALS) is the standard for the exchange of 3-D data in vector file format, particularly for documents prepared in CAD/CAM. NOTE: DRAFT MIL-PRF-28000B, dated 6 June 1997, has been distributed for coordination.

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e. *Digital Representation for Communication of Illustration Data: CGM (Computer Graphics Metafile) Applications Profile* (MIL-PRF-28003A for CALS), is the standard for exchange of 2-D data in vector file format for documents not prepared in CAD/CAM.

IGES, CGM, TIFF, and PCX are file formats for graphics files that systems with imaging interfaces can generally read and print. TIFF files are popular, but file header schemes vary and the result can be a specific type of TIFF file.

Some of the major wordprocessing, desktop publishing, and document retrieval software companies have announced support for SGML, but it has not yet become a fully implemented industry text and document markup standard.

HTML is a markup language used to create hypertext documents for the World-Wide Web (WWW).

RTF is another markup language gaining popularity, especially in the Microsoft Windows programming/document processing environment.

Adobe's Portable Document Format (PDF) is beginning to gather support in the commercial sector, but is currently oriented towards document format/layout vice structure/content.

Regardless of the format you choose, it is important to be consistent. Consistency will significantly reduce manual effort required to implement future system enhancements/data conversions.

5.2.6.1 Compression/Decompression. Scanned (bitmapped/raster) images, motion video, animation, and sound generally must be compressed to reduce the amount of required disc storage space. Several compression/decompression algorithms and schemes are available enabling producers to maximize the amount of information provided on their discs. Compressed files are also smaller to transfer, which improves computer performance.

By using standard compression/decompression schemes instead of proprietary, information can be more easily transferred/converted to other applications/formats.

The following are established standards used by the DOD for CALS (Continuous Acquisition and Life Cycle Support) and Automated Document Conversion (ADC):

a. ITU (formerly CCITT) Recommendation T.6:1988, Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus (Group 4) - used to encode/decode (compress/decompress) binary raster graphics (black and white bitmapped images) as defined in FIPS PUB 150 - Telecommunications: Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus.

b. JPEG (Joint Photographic Experts Group). ISO 10918-1:1994, Digital compression and coding of continuous-tone still images: Requirements and guidelines. Used for encoding/decoding (compressing/decompressing) of still-frame, continuous-tone, gray scale images that are eight or more bits per pixel, and color images that are sixteen or more bits per pixel. JPEG consists of a family of "lossy" image compression processes; i.e., some data is lost during the processing. A JPEG toolkit allows the user to choose how much loss an application can tolerate. JPEG also provides an extension for true "lossless" compression.

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Compressed information must be decompressed by the end-user workstation/system before it is usable. Scanned images should be viewed on high resolution monitors which can display at 150 to 240 dots per inch (dpi). Standard VGA monitors display at less than 100 dpi and images often need to be "zoomed out" to be legible. Scanning images at less than 300 dpi may display on a monitor nicely, take less storage space, and take less time to transfer and print, but a significant amount of the original image detail is lost. Standard laser printers can print scanned images at a resolution of 300 dpi or greater.

5.3 End-User Guidelines.

5.3.1 Minimum End-User System to be Supported. Minimum system requirements are to be used by DOD CD-ROM producers as a baseline equipment suite to design their products. In other words, producers can assume DOD personnel will at least have access to one of the minimum system platforms described below. If producers know their users/customers have a higher level system, then they can design to the higher level. End-users looking to procure new systems or upgrade existing systems can refer to 6.1.

5.3.1.1 Minimum Computer Specifications.

DOS Environment: 80286 processor, 2 MB RAM, 20 MB hard disk (must have 10 MB free space), EGA graphics adapter, EGA color monitor, MS DOS 5.0, Microsoft CD-ROM extensions (MSCDEX) version 2.2.

Unix Environment: Tac-3 with runtime HP-UX, or SPARCstation 2 workstation with 40 MHz SPARC floating-point processor; 14-inch monochrome monitor; 64 KB write-through cache; 32 MB RAM; 424 MB SCSI hard drive; SUN 4.1.2.

Macintosh Environment: 68030 processor with 2 MB of RAM and 20 MB hard drive running Macintosh System 6 or 7.

5.3.1.2 Minimum CD-ROM Drive Specifications. All Environments: 2X CD-ROM drive, ISO 9660 compatible, with appropriate driver software and interface card/cabling for the computer system being used. Typical average access times for these drives range from 200-400 milliseconds (msec) and throughput/data transfer rate is approximately 300 KBps (Kilobytes per second).

5.3.2 Handling, Storage, and Cleaning of CDs. To ensure continued usefulness of a CD, do not write on, touch, or scratch the recording surface. The CD should be handled by the edges or the center hole only and should not be bent or exposed to excessive sun or heat. Store CDs in the provided container when not in use. Clean dust from the recorded side with a clean soft dry cloth, wiping in a straight motion from the disc hub to the outer edge; do not wipe in a circular motion. Liquid cleaners are available to clean other than dust from the recording surface.

5.3.3 CD-ROM Destruction and General Recycling. This paragraph covers destruction of CDs containing classified information (without 5.2.5 encryption) or Sensitive But Unclassified (SBU) information (i.e., Distribution Restricted and For Official Use Only (FOUO)), and general recycling.

Currently there is no standard for the destruction of CD-ROMs containing classified and SBU information. Work is being done to approve a method to grind the CD-ROM surface, thus destroying the information recorded on the disc. Acceptable methods include incineration under controlled conditions, and shipping of old CD-ROMs to a central facility for destruction. Special care needs to be taken when incinerating CD-ROMs to ensure that the space is well ventilated since fumes in high concentration can

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be toxic.

CD DESTRUCTION (CLASSIFIED and certain SBU) AT NSA:

Government agencies may ship classified and certain SBU CDs to the National Security Agency (NSA) for destruction.

NOTE: SBU CDs that are acceptable to NSA are all Distribution Restricted CDs, but only FOUO CDs that are intelligence or defense related.

For: **TOP SECRET** and **CODE WORD:**

By Defense Courier Service, to:

449563-BA20
Film Destruction Facility

NOTE: DO NOT USE Defense Courier Service for COMSEC (Communications Security). Follow COMSEC custodian security procedures and address/send to the COMSEC account as follows:

DIRNSA
ATTN: S714, Account 889999
Fort George G. Meade, MD 20755-6000

For: **SECRET** and **CONFIDENTIAL** (by REGISTERED MAIL, double wrapped (brown paper)), and for **SBU** (by FIRST CLASS MAIL, single wrapped (brown paper)) (includes all Distribution Restricted and FOUO CDs that are intelligence or defense related)

to: Director, National Security Agency
9800 Savage Road
ATTN: CMC-S714, Suite 6890
Fort George G. Meade, MD 20755-6000

Refer to DOD Directive 5200.1-R, *Information Security Program*, for any special marking and/or wrapping requirements. Leave CDs whole, do NOT cut or break into pieces. Scratching both sides of the disc with a sharp object such as a nail is not required when shipping to NSA, but recommended. Ship only discs, remove from jewel cases, tyvex sleeves, paper sleeves, disc caddies, multi-disc trays, liners, mailers, etc. Packages cannot exceed 18 inches in height, width, or length. Maximum allowable weight per package is 40 pounds. Do not ship more than ten packages at a time.

For classified packages (optional for SBU), enclose a self addressed return envelope and the documentation/destruction form with receipt. On the form, enter the total number of CDs in the package or include a complete itemized listing.

For more information, call (301) 688-7215, DSN: 644-7215. Use a secure line or a STU III for overseas calls.

MIL-HDBK-9660BCD RECYCLING:

NOTE: Providing this information does not constitute DOD's endorsement

General recycling should be considered for unclassified CDs and SBU CDs that cannot be sent to NSA. If there is no local recycling effort, a commercial facility may be used (such as NeSar Systems, 420 Ashwood Road, Darlington, PA 16115-9325. Telephone: (412) 827-8172. If the CDs contain sensitive information not open to the general public, scratch the surface of each side of the disc with a nail or screwdriver prior to shipment. Ship disks whole, do NOT cut or break into pieces. There is no minimum or maximum shipment size, nor does packaging have to be removed. There is currently no charge to the organization except shipping.

6. GENERAL INFORMATION

6.1 Recommended End-User System. The following system specifications should be considered minimum requirements for end users when procuring new systems or upgrading existing systems. They can be used by CD-ROM producers as the baseline minimum system requirements starting in calendar year 1998.

6.1.1 Computer Specifications. For recommended computer specifications, refer to JIEO Report 8300, August 1, 1997, "Department of Defense Minimum Desktop Personal Computer Configuration."

6.1.2 CD-ROM Specifications. All Environments: 4X (or faster) CD-ROM drive, ISO 9660 compatible, with appropriate driver software and an interface card/cabling for the computer system being used. Average access time will be no greater than 300 msec and throughput/data transfer rate 600 KBps or greater.

6.1.3 Sound Specifications. All Environments (for multimedia applications): 16-bit (8-bit is more portable but will not have professional quality sound) sound card capable of audio playback at 44.1 KHz stereo with optional wave table support, and audio speakers or earphones. For IBM compatible computers running DOS or Windows, use MPC2 or MPC3 capability. A multimedia-ready sound board should also offer a MIDI interface.

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6.2 Encryption. A lower cost companion product to the SSP3110 (Secure Storage Processor) NSA Approved Type I encryption/decryption system is the Secure Retrieval Processor (SRP), a computer card for decrypting SSP-encrypted media.

A PCMCIA technology encrypt/decrypt system is also being developed for Type II encryption/decryption, with a probable Type I compatibility in the future.

6.3 CD-Recordable Labeling Options. The following options are available for labeling CD-Rs:

a. In-house Color Printing. For production of CD-ROMs using CD-Recordable equipment, purchase blank labels (currently two to a sheet), graphics software, and a color printer to print the labels in-house as needed.

b. Off-set Color Printing. For production of CD-ROMs using CD-Recordable equipment, purchase blank labels and have color ring/generic information printed by an off-set printing facility. Then, as required for specific titles, print additional information with a standard office printer.

c. Disc Printer. Purchase a CD-Recordable disc printer, blank discs compatible with that disc printer, the appropriate graphics software, and print directly on the discs.

d. Silk Screen Labels. Design a label which complies with the labeling instructions in 4.3, purchase custom CD-Recordable discs from a mastering facility, and request the facility silk screen your label design on the CD-Recordable discs. This solution is considered the best if more than 100 discs are required and if time permits.

7. NOTES

7.1 Intended Use The purpose of this handbook is to provide a common format for DOD CD-ROM producers and users. The ultimate goal is to ensure the interoperability of CD-ROM products throughout DOD.

7.2 Subject Term (Key Word) Listing.

Authoring
 CALS
 CD-ROM
 Classified
 Compression
 CONTENT.TXT
 Data Exchange
 Destruction
 Encryption
 File format
 File structure
 Green Book
 ISO
 Label
 Licensing
 Orange Book
 Packaging and Mailing

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Red Book
Replication
Retrieval
Security
SGML
TAFIM
Volume Identifier
Yellow Book

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

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APPENDIX A

ADDITIONAL INFORMATION USEFUL FOR CD PRODUCERS AND USERS

A.1 SCOPE

A.1.1 Scope. This appendix adds some additional information that may be useful for producers and users of CDs. This appendix is for guidance only.

A.2 APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

A.3 DEFINITIONS

The definitions in section 3 of this handbook apply to this appendix.

A.4 GENERAL INFORMATION

A.4.1 General. Compact Disc (CD) was the first commercial success using laser technology for digital recording (Video Laserdisks came first but used analog recording). Almost all computers shipped today are equipped with CD drives.

A standard CD physically consists of a thin reflective layer (usually aluminum), on top of a polycarbonate substrate, covered by a protective overcoat. It is 4.72 inches in diameter (120 mm) and is single-sided.

CLV (Constant Linear Velocity) recording is used to maximize data density throughout the disc. To keep the data passing under the read head at the same rate, the disc rotates faster towards the inside of the disc and slower towards the outside. The first single-speed CD drives (1X) had a rotation speed of 539 rpm (revolutions per minute) on the inner tracks and 210 rpm towards the outer tracks. These changes in disc rotation slow access time and lower data transfer speeds. Single-speed drives transferred data at 153.6 KBps (kilobytes per second).

Data transfer speeds and access time can be improved by spinning the disc faster. Double-speed drives (2X) transfer at 300 KBps, triple-speed (3X) at 450 KBps and quad-speed (4X) at 600 KBps. Multimedia applications demand at least a 2X transfer rate, most are optimized for 4X. Expect a 1.2 MBps rate for an 8X (spinning as fast as 4,000 rpm) and 1.5 MBps for a 10X. 12X, 16X, and higher drives are already available. However, access times remain somewhere between 150-250 msec (milliseconds), still far slower than magnetic hard drives.

CAV (Constant Angular Velocity) is a newer recording technique that rotates the disc at a constant speed. The number of bits in each track is the same, but density varies because inner tracks have smaller circumferences. This method wastes disc space, but allows for much higher spin rate speeds. Some drive manufacturers use a combination CLV/CAV for optimal performance and reliability. A 12X *basic spin rate* (i.e., the maximum mechanical rotation at the inner tracks) drive at full CAV provides effective speeds of up to 30X.

CD drives can be internal (installed into a drive bay in the computer's chassis), or external (has its own power supply). The interface for connecting the CD drives to the computer can be SCSI, SCSI-2, IDE, EIDE, or proprietary. NOTE: SCSI or SCSI-2 interface is used for CD recorders.

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A.4.2 CD Standards. All CD “standards” (are actually specifications which define the Physical Level: Media and Device) are proprietary to Philips and Sony Corporations. Only licensed manufacturers of CD players and discs or holders of Information Agreements may purchase the specifications. The standards are bound in different colored books:

RED BOOK	(1980)	- CD-DA or CD-A
YELLOW BOOK	(1983)	- CD-ROM
	(1989)	- CD-ROM-XA
ORANGE BOOK	(1990)	- CD-R; CD-WO
	(1994)	- CD-RW
GREEN BOOK	(1986)	- CD-I
WHITE BOOK	(1986)	- Video-CD
BLUE BOOK		- Enhanced CD, aka CD Plus, aka CD Extra

A.4.2.1 The Red Book. The first CD specification/standard developed jointly by Philips and Sony Corporations was the Red Book. Written specifically for the audio/music industry, the CD-DA (Compact Disc-Digital Audio, or simply CD-A) was designed as read-only (or rather “listen” only). For mass distribution/sale, a master disc was created first and copies were inexpensively replicated by a manufacturing facility. The Red Book is the common thread that exists in all CD discs.

A Red Book CD can contain up to ninety-nine tracks which are arranged one after the other in a spiral leading out from the innermost part of the disc near the center hole disc hub. The Red Book describes what the pits and lands are that make up the information, their arrangement, the speed at which they are read, the error correction, and the sector size.

A sector, or block, is the smallest addressable unit of information on a CD. A block consists of 98 frames. One frame equals 24 bytes. One block, therefore, contains 2,352 bytes.

The location of an address on a Red Book CD is based on time; i.e., minute:second:sector/block. Most audio CDs use a 60-minute spiral (270,000 sectors), although 74 minutes are possible (333,000 sectors) if the difficult outer 5mm of recordable area on the disc is used. A 60 minute audio disc (without extra error correction) can hold 601 MB of user data (630 MB maximum) and a 74 minute disc, 742 MB of user data (777 MB maximum). Interestingly, the 74 minute maximum playing time was based on the exact length of Herbert von Karajan's recording of Beethoven's Ninth Symphony

A.4.2.2 The Yellow Book. The Yellow Book, also by Philips and Sony, extended the Red Book to add the additional error correction code (ECC) necessary for storing computer data and text on a CD. The basic Yellow Book architecture breaks data into two types:

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CD-ROM Mode 1 - Standard CD-ROM, for text and computer data, includes layered ECC (2,048 bytes of user data, 280 bytes of ECC per sector). The standard capacity used for CD-ROM with ECC is 650 MB (681,984,000 bytes).

12	Sync
4	Header (MM:SS:BB Mode=1) - describes sector's location and what mode it is recorded in.
2048	User Data
8	Error Detection Codes
272	Error Correction Codes
8	Blank
2352	Total

CD-ROM Mode 2 - For audio and voice data, has no extra error correction (2,336 bytes of user data), used mainly in CD-i and CD-ROM XA.

12	Sync
4	Header (MM:SS:BB Mode=2) - describes sector's location and what mode it is recorded in.
2336	User Data
2352	Total

Any given track on a Yellow Book CD-ROM must be designated as either Mode 1 or Mode 2. The first track on a standard CD-ROM will always be recorded in Mode 1. If the disc also contains Red Book audio tracks recorded in Mode 2, it is called a "**mixed mode**" disc (mixed mode allows for one track of CD-ROM followed by tracks of CD-A).

A.4.2.2.1 ISO/IEC 9660. The Yellow Book did not provide a directory structure which would allow different retrieval programs to read data regardless of the host computer or operating system. Therefore, a group of major vendors (Apple, DEC, Hitachi, LaserData, Microsoft, 3M, Philips, Reference Technology, Sony, TMS, VideoTools, and Xebec) met to define the **High Sierra File format (HSF)** standard, completed in May 1986. The HSF, named for the Del Webb High Sierra Hotel and Casino in Lake Tahoe, NV, where the group met, was the beginning of what is now known as ISO/IEC 9660. Discs formatted under the HSF standard are rare today, but those that still exist are not compatible with today's ISO 9660.

A.4.2.2.2 Limits to ISO/IEC 9660: Competing companies agreed by consensus to develop a standard file structure which eventually culminated into ISO/IEC 9660. Since its publication it has been extremely useful for standardizing the storage of computer-based information on a compact disc. However, its roots lie in the commercial audio industry, designed to be read-only, from start to finish, or at least one track/song at a time. Since that time technology and demands have changed tremendously.

1. In Level 1 of ISO 9660, file names are limited to eight characters plus a three character extension. In addition, file names must be all capital letters, and are limited to A-Z, 0-9, and the underscore. No special characters are allowed. In Level 3, the maximum file name is 31 characters. At the end of the file name, the version number (e.g., ;1) of the file is also added. Levels 2 and 3 are not available to all systems, specifically MS-DOS PCs. To accommodate non-English languages, a supplementary volume descriptor (SVD) must be used, support for SVD is not common in the U.S.

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2. Directory names are limited to eight characters with no extension.
3. Hierarchical file structure is limited to eight levels. It cannot support symbolic links.
4. Special file types that Unix applications require to run cannot be translated into ISO 9660.
5. ISO 9660 was specified for Read Only. It does not support incremental write and other CD-R features.
6. Original CDs allowed only one session - the beginning and end of a session were marked by a set of lead-in and lead-out blocks. CD-ROM players built before about 1991 were not designed to read past the lead out.
7. The volume descriptor, which contains information about the contents of the disc, is located at sector 16 of the first track. The location of all files and directories on the disc must be included in the path and directory tables in sector 16 in order to be accessible. This makes it impossible to append information to a writable disc recorded in ISO 9660.
8. ISO 9660 is inadequate for CD-RW (rewritable) and DVD (Digital Video/Versatile Disc) discs.

A.5. CD-R (COMPACT DISC-RECORDABLE)

A.5.1 General. CD-R's widespread popularity deserves additional discussion. CD-Rs are used as backup storage for local and/or network hard drives, large graphic files and/or video clips, or to create full blown multimedia productions. Virtually anyone with a CD recorder and some software can create compact discs at their desktop. Most recorders can write CDs conforming to any of the "colored books."

A.5.2. CD-R Format and Physical Layout. A CD-R disc is physically identical to the Red Book, its capacity is listed in terms of time. Logically (file structure), a CD-R conforms to ISO 9660, but there are some differences between a CD-R and a prerecorded CD-ROM. Both have a polycarbonate substrate layer and a protective lacquer coating. However, a conventional CD-ROM's pits and lands (indicating information) are stamped onto an aluminum layer and covered with a plastic coating during the injection molding process of factory replication. A blank CD-R is prestamped with a single continuous spiral groove but it does not contain pits.

Gold or silver is used for the reflective layer in a CD-R instead of the standard aluminum found in CD-ROM and CD-A due to the improved environmental stability of these materials compared with aluminum. The CD-R reflective layer is placed on top of an organic dye polymer to form a hybrid laser-writable surface. When the dye polymer on a CD-R is heated by the laser during the write phase, a physical change occurs which will exhibit the same optical characteristics as a molded pit on a CD-ROM.

Until recently there were only two types of dyes used for CD-R - **cyanine** (pale-green tinge) and **phthalocyanine** (yellow). A recent third is metal-chelate dyes comprising azo compounds (very deep blue). The life expectancy of a CD-R under normal office conditions depends on the type of dye used. Phthalocyanine is considered to be the most stable over time (shelf life 100-300 years). Cyanine ranges from 10-100 years and has a greater tolerance for variations in laser power. However, all organic dyes used in CD-R media are susceptible to degradation by prolonged exposure to ultraviolet light. Azos are

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also not recommended for 4X and 6X (900 KB per second) recording speeds.

A.5.3 Writing to CD-R. CD recording is not a simple task to master. CD-R systems are finicky. CD-R media may be in any of four states:

Blank unrecorded (pre-grooved and time-stamped)
Partially recorded
Finalized or Recorded
Multisession

NOTE: Some older CD hardware/software cannot successfully read multisession CDs. Unless the producer has determined that all users of the CD product can read multisession discs, it is recommended CDs be produced as single session.

CD-R recorders perform an optimum write power calibration (OPC) when the disc is first spun up. This calibration is monitored and controlled in a feedback loop during recording using a running OPC strategy.

Every time a CD-R writes something, it makes a "track." A track can be a song, data file(s), video sequence(s), etc., and must be at least 4 seconds in length, which equates to roughly 700 KB (each second equals 75 blocks, each block equals 2,352 bytes). The "writing mode" is determined by three things:

1. The write modes supported by the CD-R drive.
2. The write modes supported by the premastering software.
3. The writing mode desired by the user.

A.5.3.1 Tips for writing to CD-R.

1. Use a double speed (2X) CD-R drive (300 KB per second) for recording. This offers the best combination of fast and reliable writing.
2. Buy CD-R media that goes with the recorder.
3. Get a CD-R drive with a large data buffer so if the data flow is interrupted during recording the session will not be interrupted.
4. The PC should be at least a 486DX2/66 or equivalent with 8 MB or more of RAM and a hard drive large enough to accommodate DOS, Windows, and the CD-R application (e.g., a quick SCSI hard drive with a throughput of at least 1 MBps). Rule of thumb: Use the fastest computer with the most RAM you can find/afford.
5. Unless the CD-R unit comes with its own hard drive, use a second hard drive (or a partition of a hard drive) for the source material with at least 1 GB in capacity, a seek time of 12 ms or less, a sustained system transfer rate twice that required by the speed of the CD-R, and one that does not perform **thermal recalibration** (t-cal) over long periods, such as AV-rated (Audio-Visual) SCSI hard drives.

Thermal Recalibration (t-cal) - T-cal is a process that some hard drives use to periodically check and adjust head tracking to compensate for changes in temperature. When writing large amounts of information, the hard drive pauses to

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realign the heads due to physical changes in the drive platters caused by heat expansion. During t-cal, all drive activity stops and the drive does a series of seeks. If this happens while a CD-R is being written, the disc is ruined. Some software utilities can turn t-cal off on some drives.

T-cal has become less of a problem as newer CD-R devices have larger buffers.

6. Buy the mastering software designed to go with the recorder being purchased. Mastering software converts files to the desired format (CD-A, ISO 9660 CD-ROM, etc.) and creates an image of the compact disc which is to be written. Make sure the software purchased supports the format(s) wanted.

7. Make a physical ISO image (a bit-for-bit copy of the finished CD) on a hard drive before writing rather than a virtual one (virtual requires the hard drive to not only maintain a sufficient transfer rate, but to spend time seeking files that may be on different parts of the hard disk).

8. Disable screen savers. Screen savers can interrupt the flow of data and trash the disc. Close any competing applications.

A.5.3.2 Problems with Writing to CD-R.

1. Bugs in the CD-R products themselves (not so much a problem today).
2. Finding enough conventional memory (some CD-R programs require a minimum amount of 450 KB).

3. **Buffer Underrun Errors** - Buffer underruns are the number one cause for creating "coffee coasters" out of blank CD-Rs. These are errors that occur when the data rate falls below the minimum during a write operation. Buffer underruns can be caused by the cache buffer not being kept full, if t-cal occurs, by screen savers, background applications, and by network activity. Packet writing curtails the occurrence of buffer underruns when recording, files to be written are grouped into packets, with each packet equal to or smaller than the recorder's buffer.

A.5.4 Final word on CD-R. Complaints continue that CD-R discs simply cannot be read. CD-R products appeared in the marketplace before the Orange Book standard was finalized. This allowed for many vendor interpretations of the CD-WO specifications. The Orange Book Part II defines the medium only, not the drives used to record it or play it. Therefore, a CD-WO drive using CD-R media not specifically designed for it may or may not be able to read the disc or append to it. This problem will continue until older model devices and early software versions have been replaced or upgraded.

A.6. CD-RW (COMPACT DISC-REWRITABLE)

Compact Disc-Rewritable (CD-RW) discs support the CD-UDF file format and have a capacity of 650 MB. An estimated 1,000 direct overwrites are possible, using phase change rewritability (PCR). Part 3 of the Orange Book specifications (released in 1994) pertains to CD-RW. CD-RW drives can read CD-ROMs, read and write CD-Rs, and read/write/overwrite CD-RWs. However, due to the medium's lower reflectivity, a disc created on a CD-RW drive can only be played on CD-RW drives, new generation CD-ROM drives, or on DVD-ROM drives. CD-RW drives cost around \$1,000, with speeds beginning at 6X. Media costs average \$20-\$25. Due to the random overwrite function, ISO 9660 is inadequate for CD-RW.

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A.7. CD TESTING

Prior to CD-R, testing was only an issue for large disc manufacturing facilities which understood the difficult testing process and could afford the expensive equipment. Testing without special equipment is usually done by “playing” the disc; however, this does not provide a true indication of reliability since in essence you are also testing the player and the computer. A specification for jitter (a measure of the standard deviation of pit length within a window of tolerance) did not exist prior to CD-R because factory replication was performed under optimal conditions and equipment. Since in CD-R the recording layer is not altered by burning a physical hole, a test suite for jitter has since been added to the Red Book Specification.

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CONCLUDING MATERIAL

Custodians:

DISA - DC
Army - AC
Navy - NM
Air Force - 02
DLA - DH
NIMA - MP

Preparing activity:

DISA - DC
(Project IPSC 0347)

Review activities:

OSD - DO, IQ, IR
DISA - DC1, DC5, DC7
Army - AM, TM1, TM3, SC2, SC3
Navy - AS, CG, CH, EC, MC, NC, ND, OM, TD
Air Force - 13, 16, 17, 19, 29, 33, 90, 93
MISC. - DI, NS, OST, US

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DEPARTMENT OF DEFENSE HANDBOOK DOD PRODUCED CD-ROM PRODUCTS

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

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c. ADDRESS (Include Zip Code)

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(If applicable)

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