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MIL-PRF-28002C
30 SEPTEMBER 1997

SUPERSEDING
MIL-PRF-28002B
AMENDMENT 1
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PERFORMANCE SPECIFICATION

RASTER GRAPHICS REPRESENTATION IN BINARY FORMAT, REQUIREMENTS FOR

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

1. SCOPE

1.1 Scope. This specification identifies the requirements to be met when raster data represented in digital, binary format are delivered to the Government.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: ATTN CALS Digital Standards Office, DISA Center for Standards, Code JIEO/JEBEB, 10701 Parkridge Blvd, Reston VA 20191-4357, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1.2 Classification. The digital representation of raster data is classified as the following four types:

Type 1 – Untiled Raster Data (see 3.2).

Type 2 – Tiled/Untiled Raster Data. The detail requirements for the Type 2 format have been removed from this specification. Implementation of the Type 2 format, also known as Office Document Architecture (ODA) Raster Document Application Profile (DAP), may be accomplished in accordance with the requirements of Federal Information Processing Standards (FIPS) Publication 194, ODA Raster DAP. FIPS PUB 194 is explicitly incorporated into this specification by reference to define the Type 2 Raster Data file format.

Type 3 – Tiled/Untiled Raster Data, Navy Image File Format (NIFF) (see appendix A).

Type 4 – Tiled Raster Data, Joint Engineering Data Management Information and Control System (JEDMICS) C4 (see appendix B).

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2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

FEDERAL INFORMATION PROCESSING STANDARDS

FIPS PUB 150	–	Telecommunications: Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus.
FIPS PUB 194	–	Open Document Architecture (ODA) Raster Document Application Profile (DAP)

(Copies of the FIPS are available to Department of Defense (DoD) activities from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia PA 19111-5094. Others must request copies of FIPS from the National Technical Information Service, 5285 Port Royal Road, Springfield VA 22161-2171.) Electronic copies of the FIPS publications can be obtained via the following WWW URL: `http://www.itl.nist.gov/div897/pubs/`

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1840	–	Automated Interchange of Technical Information

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia PA 19111-5094.) Electronic copies of the CALS core standardization documents can be obtained via the following WWW URL: `http://www-cals.itsi.disa.mil/`

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

OTHER GOVERNMENT DOCUMENTS

SPAWAR-S-903 – Space and Naval Warfare Systems Command Miscellaneous Specification for Navy Implementation for Raster Scanning (NIRS)

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia PA 19111-5094.) Electronic copies of the Space and Naval Warfare Systems Command (SPAWAR) publications can be obtained via the following WWW URL:
`http://www.spawar.navy.mil/spawar/welcome.page/`

2.3 Non-Government publications. The following document forms a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE / ASSOCIATION FOR INFORMATION AND IMAGE MANAGEMENT (ANSI/AIIM) STANDARDS

ANSI/AIIM MS44 – Standard for Information and Image Management – Recommended Practice for Quality Control of Image Scanners.

(Application for copies should be addressed to the Association for Information and Image Management, 1100 Wayne Avenue, Suite 1100, Silver Spring, MD 20910.) Electronic copies of the ANSI/AIIM publications can be obtained via the following WWW URL:
`http://www.ansi.org/`

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. REQUIREMENTS

3.1 General requirements. The requirements contained herein apply to all raster data types. All digital raster data complying with this specification shall be bitonal. Those requirements for specific raster data types are as follows:

a. Type 1 – Untiled Raster Data (see 3.2).

b. Type 2 – Tiled/Untiled Raster Data, ODA Raster DAP (see 3.3).

c. Type 3 – Tiled/Untiled Raster Data, NIFF (see appendix A).

d. Type 4 – Tiled Raster Data, JEDMICS C4 (see appendix B).

3.1.1 Raster data compression. Raster data binary format consists of Group 4 encoding as defined in Consultative Committee for International Telegraphy and Telephony (CCITT) Recommendation T.6 from FIPS PUB 150. CCITT Recommendation T.6 and International Telecommunications Union Telecommunication Standardization Sector (ITU-T) Recommendation T.6 are equivalent. The ITU-T renamed the recommendation to agree with its sponsorship. This specification exclusively requires ITU-T Recommendation T.6 (Group 4) compression. ITU-T Recommendation T.4 (Group 3) compression is specifically not supported. Also not supported are the uncompressed escape option and variations to the T.6 algorithm identified in FIPS PUB 150.

3.1.2 Raster image orientation. The values for pel path direction and line progression direction shall reflect the proper viewing orientation of each encoded image in degrees. The permissible values for the pel path direction shall be "0", "90", "180", or "270". The permissible values for the line progression direction shall be "90" or "270" (see 6.4.6). The contractor shall perform rotation where necessary to achieve proper viewing orientation as specified in the contract or other form of agreement (see 6.2).

3.1.3 Raster image size and pel count. The raster image size and pel count for standard page formats used in technical documents and large format drawings are described in table I and table II. The pel count shall be documented in each Type 1, Type 3, or Type 4 raster data file. The pel count shall specify the number of pels contained in a line in the pel path direction; the number of lines contained in the line progression direction; and, the values for the number of pels per line. The number of lines and image size shall be in accordance with table I or table II, or as specified in the contract or other form of agreement (see 6.4.2).

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TABLE I. North American drawing sizes.

Drawing Size	Maximum W-by-L (inches)	Pels Per Line	Number of Lines
A	8.5-by-11	1704	2200
B	11-by-17	2200	3400
C	17-by-22	3400	4400
D	22-by-34	4400	6800
E	34-by-44	6800	8800
F	28-by-40	5600	8000
G	11-by-90	2200	18000
H	28-by-143	5600	28600
J	34-by-176	6800	35200
K	40-by-143	8000	28600
Legal	8.5-by-14	1704	2800

TABLE II. Metric drawing sizes.

Drawing Size	Maximum W-by-L (mm)	Pels Per Line	Number of Lines
A4	210-by-297	1656	2344
A3	297-by-420	2344	3312
A2	420-by-594	3312	4680
A1	594-by-841	4680	6624
A0	841-by-1189	6624	9368

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3.1.4 Raster image pel density. Unless otherwise specified in the contract or other form of agreement, the pel density for raster images within technical documentation shall be 300 pels per inch, and the pel density for raster images representing large format engineering drawings shall be 200 pels per inch (see 6.2, 6.4.2, and 6.4.7). Pel density shall be used to describe the number of samples per unit distance taken to create the raster image.

3.1.5 Byte (octet) boundaries. An encoding program exporting documents from a system for interchange shall produce documents with a pel path dimension and a line count dimension which are multiples of eight pels. If specified in the contract or other form of agreement, decoding systems may be required to import documents which have arbitrary dimensions from other, non-MIL-PRF-28002 compliant systems.

3.1.6 Definitions of one and zero in bitmap data. A bitmap image shall represent the information in a document by a bit value of one (1) and the background by a bit value of zero (0) (see 6.4.8).

3.1.7 Bit ordering. The bit ordering of Most Significant Bit (MSB) to Least Significant Bit (LSB), the "down" ordering, shall be used for both compressed and bitmap data (see 6.4.5).

3.1.8 Tiled raster data; Type 2, Type 3, and Type 4. Requirements contained herein apply only to the tiled raster data types, and specifically excludes Type 1 raster data.

3.1.8.1 Tiles per image. The number of tiles in the pel path direction shall equal the number of pels contained in a line in the pel path direction, divided by 512. The number of tiles in the line progression direction shall equal the number of lines contained in the line progression direction, divided by 512. Fractional size tiles (runt tiles) shall not be generated. When a fractional tile exists, in either direction, boundary tiles containing fractional portions of the image area shall be padded with zero (0) bits (background bits) to the full tile size of 512-by-512 pels, and the tile count shall be increased to the next higher whole number.

3.1.8.2 Null tiles. Null tiles consisting of either all one (1) bits or all zero (0) bits are permitted when they exist within the data area. Null tiles are not permitted beyond the data area of the image.

3.1.9 First article. When specified in the contract or other form of agreement, a sample system and set of raster data files shall be subjected to first article inspection in accordance with 4.2 (see 6.2.1).

3.1.10 Conformance inspection. When specified in the contract or other form of agreement, raster data files shall be subjected to conformance inspection in accordance with 4.3 (see 6.2).

3.2 Specific requirements for Type 1 raster binary data. Type 1 raster data shall be encoded using ITU-T Recommendation T.6 from FIPS PUB 150. The first byte of the first encoded line

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shall begin in the first byte of the first block following the raster data file header block. Type 1 raster binary data shall be contained in data blocks that follow the data file header block. Each succeeding encoded line shall immediately follow the preceding encoded line, with no separation or padding between lines and blocks. Binary zeroes (0) shall be used to pad to the byte boundary for any incomplete (partial) bytes. Unused bytes in the last data block of the file shall be padded with binary zeroes (0).

3.2.1 Raster data file header block. A Type 1 raster data file shall begin with a 2048-byte data block containing identifying header records. This data block shall be present in all data interchanges regardless of the physical media or transfer mechanism used (see 6.5). Raster data file header records shall be formatted in accordance with the MIL-STD-1840 transfer unit data file header record format. Header records shall be fixed length records of 128 bytes each. Each record has a dedicated use, and each record is required. All header record data shall be in American Standard Code for Information Interchange (ASCII) character format. Each record shall have a record identifier string from table III as the first characters in the record. The last two characters in the identifier string shall be the ASCII colon character followed by the ASCII space character (": "). The ASCII comma character and the ASCII space character (", "), shall be used for the data field delimiter between field values. The first space after a comma is not significant as data. Subsequent spaces are part of the data. Raster data file header records shall always occur in the order in which they are presented in table III.

3.2.1.1 rorient: header record. The raster image orientation header record consists of two values identifying the direction of the pel path and line progression directions in degrees of the image in the raster data file. The permissible values for the pel path direction shall be "0", "90", "180", or "270". The permissible values for the line progression direction shall be "90" or "270" (see 6.4.6). The rorient: header record shall be formatted in accordance with table III. The values for pel path direction and line progression direction shall reflect the proper viewing orientation of each encoded image. The contractor shall be required to perform rotation where necessary to achieve proper viewing orientation as specified in the contract or other form of agreement (see 6.2).

3.2.1.2 rpelcnt: header record. The raster image pel count header record consists of two values identifying the pels per line and the number of lines of the image in the raster data file. The rpelcnt: header record shall be formatted in accordance with table III. If a standard image size is specified in the contract or other form of agreement, the value for the number of pels per line and the number of lines shall be in accordance with table I or table II (see 6.4.2).

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TABLE III. Type 1 raster data file header records.

RECORD ID	RECORD NAME	DESCRIPTION
rorient:	Raster image orientation	Two, right-justified, three-character strings separated by the ASCII comma character and the ASCII space character (", "), specifying respectively the direction of the progression of successive pels along a line relative to the horizontal, and the direction of the progression of successive lines relative to the pel path. If the value is fewer than three characters, the string shall be padded with the ASCII space character (" "). If more than one value is applicable to the data file, the ASCII character string "MIXED" shall be used. Permissible and default pel path and line direction values are listed in 3.2.1.1. Example: rorient: 270, 90
rpelcnt:	Raster image pel count	Two, right-justified, six character strings separated by the ASCII comma character and the ASCII space character (", "), specifying respectively the integer count of pels contained per line in the pel path direction, and the integer count of lines contained in the line progression direction. If the value is fewer than six characters, the string shall be padded with the ASCII space character (" "). If more than one value is applicable to the data file, the ASCII character string "MIXED" shall be used. Example: rpelcnt: 4400, 6800
rdensity:	Raster image density	One, right-justified, four character string, representing the numerical value of the raster image density. If the value is fewer than four characters, the string shall be padded with the ASCII space character (" "). If more than one value is applicable to the data file, the ASCII character string "MIXED" shall be used. Permissible and default image density values are listed in 3.1.4. Example: rdensity: 200
NOTES: The example values in this table represent a "D" size engineering drawing scanned from the left-hand edge at 200 pels per inch, and stored as a Type 1 raster data file.		

3.2.1.3 rdensity: header record. The raster image pel density header record consists of one value identifying the number of pels per unit of distance of the image in the raster data file. The rdensity: header record shall be formatted in accordance with table III.

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3.3 Specific requirements for Type 2 raster binary data. The detailed requirements for the Type 2 format have been deleted from this performance specification, and can be found in FIPS PUB 194. The Type 2 format, also known as the ODA Raster DAP, FIPS PUB 194, should not be used to acquire new digital raster data for DoD use. If Type 2 is used, it should be limited to special cases when its implementation is specifically required by the contract or other form of agreement (see 6.3.2.2).

3.4 Specific requirements for Type 3 untiled/tiled raster binary data. Type 3 raster data shall contain a mix of untiled and tiled images. The requirements contained herein shall pertain to both text and graphical data. Raster files of technical data having paper dimensions of 8.5-by-11 inches or smaller shall be produced as untiled raster images. Raster files of technical data having page dimensions greater than 8.5-by-11 inches shall be produced as tiled raster images. If Type 3 raster data is to be specifically limited to only tiled or only untiled data, Type 3 tiled raster data or Type 3 untiled raster data shall be specified in the contract or other form of agreement (see 6.2 and 6.3.2.3). The requirements for Type 3 raster data binary headers appear in appendix A.

3.4.1 Tile size. Type 3 raster data shall be square tiles consisting of 512-by-512 pels per tile.

3.5 Specific requirements for Type 4 tiled raster binary data. The Type 4 tiled raster format is designed for data which is acquired for storage in a JEDMICS data repository. The requirements for Type 4 tiled raster binary data appear in appendix B.

3.6 Data content notation declaration. The Standard Generalized Markup Language (SGML) data content notation below shall be used in DoD document type declarations when raster files in accordance with this specification are referenced or included in SGML document instances. Note that these SGML declarations are case-sensitive.

a. For Type 1:

```
<!NOTATION raster1 PUBLIC "-//USA-DOD//NOTATION MIL-PRF-28002C Type 1//EN">
```

b. For Type 2:

```
<!NOTATION raster2 PUBLIC "-//USA-DOD//NOTATION MIL-PRF-28002C Type 2//EN">
```

c. For Type 3:

```
<!NOTATION raster3 PUBLIC "-//USA-DOD//NOTATION MIL-PRF-28002C Type 3//EN">
```

d. For Type 4:

```
<!NOTATION raster4 PUBLIC "-//USA-DOD//NOTATION MIL-PRF-28002C Type 4//EN">
```

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4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.2 First article inspection. First article inspection shall be the inspection of the first article (see 6.2.1) raster data file deliverable, as defined by the contract or other form of agreement, for its compliance with this specification. First article inspection shall also include the requirements of the conformance inspection (see 4.3) for verification of the raster image quality. All first article inspections shall be performed on a contract specified system or on a system equal to the destination system that will eventually receive and store the raster data files being delivered under the contract. If the contract does not specify a system, all first article inspections shall be performed on an alternative system known to rigorously exercise all requirements and attributes of this specification. The use of the same system for encoding and decoding of raster image files is prohibited. First article inspection shall assure the quality of the encoded raster image files in accordance with this specification, independent of the systems used for the encoding and decoding the raster data. Raster data files selected for the first article inspection shall be selected to rigorously exercise all attributes, values, and options in accordance with this specification, and the complexity of the required deliverables as specified in the contract. Insofar as possible, inspection and analysis procedures shall be automated with appropriate computer programs that report analysis and inspection results. The Government may require the inclusion of Government-furnished or contract-specified test charts or images with diverse image content.

4.3 Conformance inspection. Conformance inspection shall be the inspection on the raster data deliverable to assure conformance of the raster image to the requirements established by this specification and the contract or other form of agreement. Inspection processes shall include, but not be limited to, visual inspection of the raster data. Raster images shall be visually inspected and compared to the original image to ensure the legibility of text; that lines are discernible and unbroken; and that text, lines, and patterns appear sharp, without fuzziness, smearing, or other indications of lack of focus. The visual inspection shall also compare the reproduced image to the original for the determination that the registration, linearity, alignment, coverage aspect ratio, and scale are identical to the original within the limits of this specification or the contract. Visual inspection shall be performed by either the printing of a paper copy or by the electronic display on a reference image system in accordance with the first article inspection (see 4.2). Additionally, a visual inspection shall verify that the pel path and line progression direction values correctly describe the viewing orientation of the image. The Government may require the inclusion of Government-furnished or contract-specified test charts or images with diverse image content.

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Such additional images, when included for conformance inspection, shall contain images covering the range of complexity equal to the contract deliverable.

4.3.1 Data sampling. Unless otherwise specified in the contract or other form of agreement, data sampling is prohibited. When less than 100 percent inspection is performed, the digital data sample shall contain raster data representing all levels of complexity of the required deliverables as specified in the contract or other form of agreement.

4.3.2 Raster image scanning. The quality of a scanned raster image depends upon the capabilities of the scanner and the quality control procedures used to maintain the highest quality output of the scanner. When specified by contract, ANSI/AIIM MS44 shall be used to verify the performance of the scanner in obtaining the highest quality output.

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5. PACKAGING

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

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6. NOTES

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

6.1 Intended use. This specification is intended to be used by contracting agencies of the DoD in the procurement of raster data and raster data applications. The specification presents raster data requirements which are applicable to the interchange of raster encoded technical document pages, foldout illustrations, and large format engineering drawings.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of the specification.

b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2).

c. Packaging requirements (see 5.1). Typically, magnetic tapes and disk cartridges should be packaged in accordance with MIL-STD-2073-1, Procedures for Development and Application of Packaging Requirements, level C for domestic shipment and level A for international shipment, using containers in accordance with PPP-B-636, Boxes, Shipping, Fiberboard, and cushion/dunnage material in accordance with PPP-C-1842, Cushioning Material, Plastic, Open Cell (for Packaging Purpose).

d. Proper viewing orientation (see 3.1.2).

e. The raster image pel density (see 3.1.4).

f. Image sizes, including overscanning (see 3.1.3 and 6.4.2).

g. First article inspection (see 4.2)

h. Conformance inspection (see 4.3)

6.2.1 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item should be a pre-production sample, a first article sample, a first production item, a sample selected from the first production items, or a standard production item from the contractor's current inventory, and the number of items to be tested. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive

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the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation. The contract must specify a reference system for first article test (see 4.2).

6.2.2 Data acceptance. This specification does not address data acceptance at the content level. When data acceptance of raster data is required, the contract should define the acceptance requirements, require data acceptance procedure(s), and specify who, where, and by whom the data acceptance procedures will be implemented.

6.3 Tailoring guidance. To ensure proper application of this specification, invitations for bids, requests for proposals, and contractual statements of work should tailor the requirements in sections 3 and 4 of this specification to exclude any unnecessary requirements and to stipulate project-specific details. Detailed communications and agreements between the preparer and receiver will ensure that all delivered raster data meets the contract and customer requirements.

6.3.1 Contract data. When this specification is invoked by contract or other form of agreement, the term "data requirements" will only apply to contract data called out in the Contract Data Requirements List (CDRL). Each item in the CDRL will be annotated on the respective DD Form 1423 to indicate that MIL-PRF-28002 specifies the proper format for delivery. The content of the information to be delivered is defined by the Data Item Description (DID) referenced by the CDRL.

6.3.2 Notes to Contracting Officers. The following guidance will assist users of this specification in understanding the strengths and applicabilities of the Type 1, Type 2, Type 3, and Type 4 raster tile formats. Tiled representations are best applied in systems handling large format drawings or illustrations typically associated with engineering design. The subdivision of a drawing into tiles permits use of only those portions of an image required at a given time by the application. This can result in reduced requirements for workstation memory and workstation display area. In addition, tiling permits compression and decompression activities to be performed in parallel upon the drawing tiles. A tiled format should be selected whenever the project involves conversion of large quantities of paper/film documents to raster format, particularly where there are multi-page/frame documents with large format pages or where there are multiple page documents with multi-page sizes.

6.3.2.1 Intended use of Type 1 raster binary data. Type 1 raster data, a simple one-page-per-file format, should be used when the graphics are included in other compound documents. For example, Type 1 raster data files are often used as illustrations in tagged SGML documents such as technical manuals.

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6.3.2.2 Intended use of Type 2 raster binary data. Although Type 2 is not recommended for new Government procurement due to limited support, the Type 2 format allows multi-page documents with multiple page sizes and orientations and tiled images for faster access to portions of large format pages. Type 2 may be used when:

a. There are large existing collections of Type 2 raster file formats.

b. Sending and receiving entities can handle the Type 2 tiled format either as their native format or via conversion to local tiled formats. This is especially true if the conversion between Type 2 and local tiled formats usually only rewraps the file headers and does not involve decompression and recompression of the image.

6.3.2.3 Intended use of Type 3 raster binary data. Type 3 raster, the NIFF, is intended to be a mix of untiled and tiled images based on the size of the individual image. Type 3 raster data allows multi-page documents with multiple page sizes and orientations and tiled images for faster access to portions of large format pages. If raster images formatted to Type 3 are to be restricted to only tiled or only untiled raster data, these files should be acquired as "Type 3 tiled" or "Type 3 untiled," whichever is intended. Type 3 raster data should be used when:

a. Requirements are intended to be used in procuring data for systems that need the flexibility to use tiled or a mixture of tiled and untiled raster data representations.

b. Untiled raster data are required since the images are too small to require tiling (for example, A-size or smaller).

6.3.2.4 Intended use of Type 4 raster binary data. Type 4 raster data, the JEDMICS C4 format, should be used when the destination system is a JEDMICS repository.

6.4 Data requirements.

6.4.1 File size and efficiency considerations. Files containing large format drawings or illustrations in raster data form are relatively large. After ITU-T Group 4 compression, E-sized drawings will have a file size of approximately one-half of a megabyte for a moderately detailed drawing.

6.4.2 Image sizes for drawings. The drawing sizes A through K, and metric drawing sizes A4 through A0, in accordance with ANSI Y14.1, American National Standard, Drawing Sheet Size and Format, are summarized in table I and table II. These tables show the nominal number of pels per line and the nominal number of lines. The table values are for the default pel density of 200 pels per inch for a large format image size. The numbers listed in the tables are minimal, sufficient only to provide for byte alignment of the pels at the end of each bitmap line. 200 pels per line and 200 lines of total overscan would provide a recommended nominal one inch overscan without loss

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of byte alignment. This is not shown added into the numbers in table I and table II, but is consistent with industry practice. Particular requirements associated with overscanning should be identified and specified in the contract document to allow extra white space at the margins, if needed. Overscanning is a function of capturing raster images from hard-copy documents in a production environment and may vary from system to system. A typical by-product of overscanning is image noise which may significantly enlarge the resulting image file. The amount of overscan and the cost of trimming the edges of a scanned image during the verification process should be evaluated (on an application basis) to determine the overall impact on an individual application. The quantity and quality of the overscan around the edges of an image may add significantly to the amount of data being stored. Demonstrations have shown a significant reduction in image size can be gained by simply cropping the image during the verification process. The cost benefits of 100 percent verification and the cost of processing and storing larger images should be evaluated for the various applications using MIL-PRF-28002 data.

6.4.3 Generation of raster data by scanning. Raster data for either technical publication or product definition materials may be generated by scanning source document sheets or pages in accordance with this specification. Scanning is performed in a line-by-line sequence from left to right, beginning at the leading edge of a page as it is fed into the scanner, and at a standard pel spacing selected to preserve the smallest detail (minimum line pair spacing) represented in the source material. Note that the image orientation may be such that the top of the image does not correspond to the leading edge of the scanned page. This scan-produced raster data is initially stored in intermediate, digital form as a binary bitmap such that respective ones and zeros reflect the black and white physical picture elements of the scanned image. In this intermediate or expanded form, raster scan data may be processed for enhancement or editing, or directly reproduced by an appropriate display or printing device. The relationship between the orientation of scanning and the orientation of image display must be accurately specified in the raster data presentation attributes. The relationship between the pel path and line progression attributes for typical images are shown on figure 1 for portrait pages and on figure 2 for landscape pages. The orientation of the scanned image must be provided in the orientation parameter such that a receiving system may render the image as the author had intended (in proper orientation for viewing).

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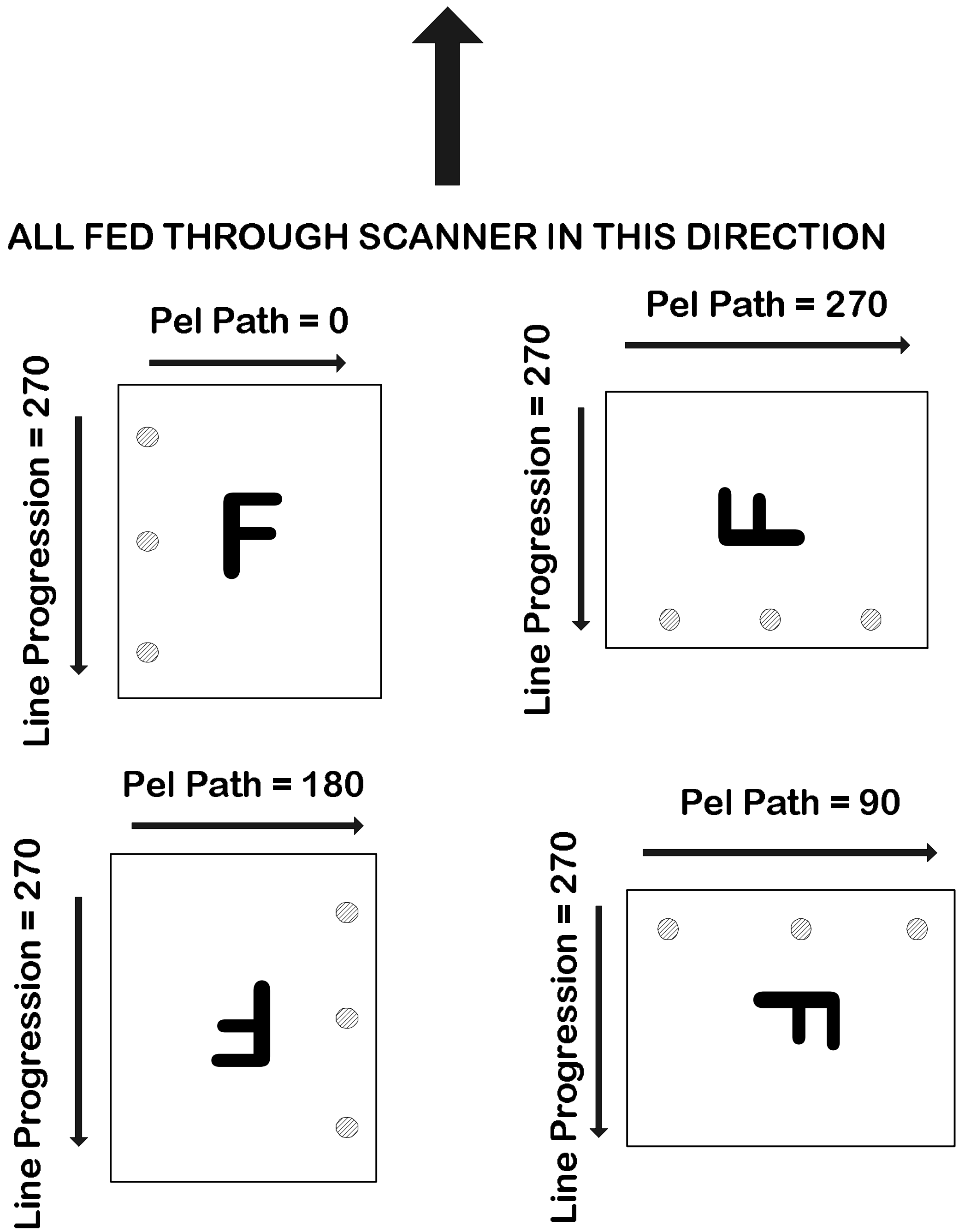

NOTES:

1. The pel path direction is measured in degrees counterclockwise from the positive horizontal axis (east). The pel path value represents the number of degrees the image would have to be rotated counterclockwise in order to display the image with proper viewing orientation.

2. The line progression direction is measured in degrees counterclockwise from the pel path direction.

FIGURE 1. Position of pels, portrait document.

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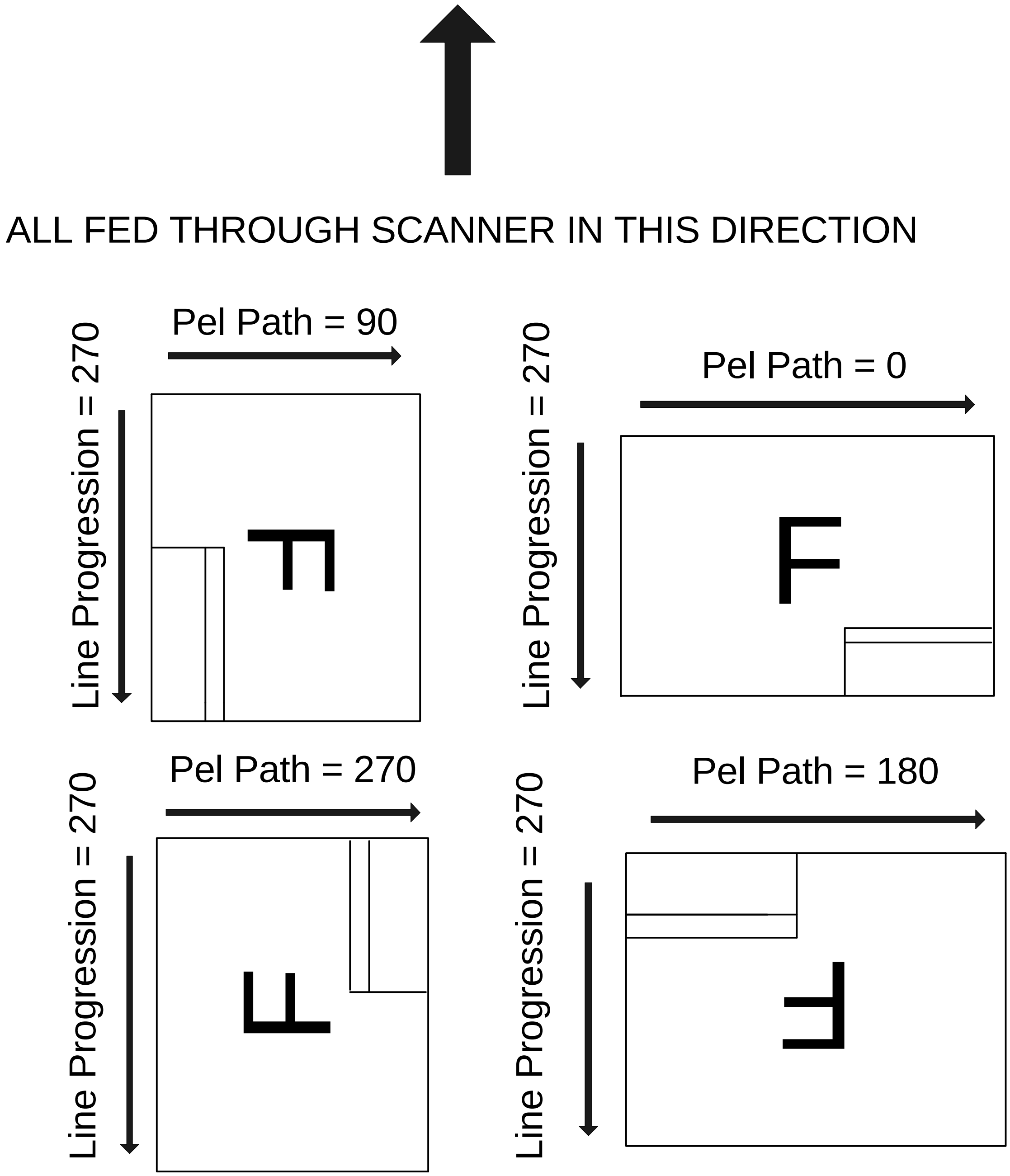

NOTES:

1. The pel path direction is measured in degrees counterclockwise from the positive horizontal axis (east). The pel path value represents the number of degrees the image would have to be rotated counterclockwise in order to display the image with proper viewing orientation.

2. The line progression direction is measured in degrees counterclockwise from the pel path direction.

FIGURE 2. Position of pels, landscape document.

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6.4.4 Additional data processing conditions. This specification defines the data formats required to describe pages or sheets of raster data. Issues related to database management, such as document information, aperture card Hollerith code, document and page relationships, sheets, revisions, and multiple aperture card frames are not considered in this specification. If such data is required as a deliverable, the procurement contract should specify the content and format of such data in accordance with MIL-STD-1840.

6.4.5 Note on bit ordering. While this specification calls for the bit ordering of MSB to LSB, the "down" direction, for both compressed and bitmap data, the proper ordering of bits within bytes (octets) is a subject of industry-wide dispute. The traditional method in facsimile equipment for compressed data is to pack code bits into bytes in "up" fashion, LSB to MSB. The most widespread method used in sending bitmapped (uncompressed) data to computer display adapters is with a "down" ordering (MSB to LSB).

6.4.6 Notes regarding orientation. The raster image orientation is stipulated in the file by two attributes, pel path and line progression. The values for these attributes reflect the proper viewing orientation of the image. These two attributes determine how the application will extract pels from the bitmap array and deposit these pels on the page when rendering the image. Raster image orientation is dependent on the orientation of the scanned medium relative to the scanning mechanism. For typical technical documentation, the pel path direction is 0 degrees and the line progression direction is 270 degrees. The relationship of pel path to line progression directions for a typical piece of portrait technical documentation is depicted on figure 1. For typical large format documents, the pel path direction is 90 degrees and the line progression direction is 270 degrees. The relationship of pel path to line progression directions for a typical landscape large format document is depicted on figure 2. On figures 1 and 2, four pages are shown. Each has been fed through a scanner in the direction shown by the large arrow. Immediately after scanning and before the verification/visual inspection step, the proper viewing orientation would not be known to the system; each would be identified (some incorrectly) as having a pel path direction of 0 degrees and a line progression direction of 270 degrees. After the visual inspection step, each would have been correctly identified with the values shown on figure 1 placed into their files. Printers and other peripherals may require images to have data presented to them in other than proper viewing orientation. This is a system-dependent requirement and does not have any impact on the interchange file contents. Note that four other orientations are possible which are the mirror images (around one axis) of the four shown. These could result from scanning an aperture card, paper sepia, or transparency from the wrong side, either inadvertently or to achieve better image quality.

6.4.7 Note regarding raster image pel density. Typical pel density values on some systems might include 100, 200, 240, 300, 400, 600, and 1200 pels per inch. Support for some of these pel densities may be desirable for interchange of data with non-military systems.

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6.4.8 Note regarding one (1) and zero (0) in bitmap data. Raster data represents each pel in the source document by a 0 or a 1. A 1 is an information pel. The information pels in an image are those which make it differ from a blank image (see 3.1.6).

6.4.9 Notes on scanning quality. Data encoded according to this specification may come from a scanning process, an image conversion process, or an electronic creation/modification process. Scan quality relates to the scanning process (though the same analysis may be performed on converted images where the results of the analysis would have little bearing on the conversion process and more on the production process of the original image). The scanning process renders an image of a document as a set of data elements. Typically, scanning quality is enhanced by a control step that enables a workstation operator to improve the quality of the image before final raster data file creation. Scanning devices and the processes associated with scanning require regular inspection procedures to ensure high-quality operation of the scanner hardware and appropriate performance of scanner and image quality control personnel. Such inspections are critical in an operating environment where actual raster data file usage may occur many years after scanning. Some of the factors involved in raster scanning quality are described in 6.4.9.1 - 6.4.9.16. Determination of factors 6.4.9.1 - 6.4.9.3, 6.4.9.5 - 6.4.9.7 and 6.4.9.9 - 6.4.9.16 requires reference to the original document. Factors 6.4.9.4 and 6.4.9.8 may be determined after the original document is no longer available.

6.4.9.1 Aliasing. Aliasing is a group of image defects generally caused by elements of the scanned image being smaller than or not registered with the picture element created by the scanner. An aliasing effect occurs when stair-stepping or jaggedness is introduced in a feature. Aliasing can affect the image quality, readability, and accuracy of the raster image.

6.4.9.2 Alignment. Most engineering drawings have many straight line segments aligned with the length and width of the page. If the scanned image axes are correctly aligned with scanner axes, each line segment in the set is contained in a pel row or column, and the line image appears straight and sharp. If the scanned image is slightly misaligned (or skewed), each line segment from the set is stair-stepped in its representation. In addition to affecting the appearance of the image, misalignment reduces the effectiveness of compression routines.

6.4.9.3 Aspect ratio. Aspect ratio refers to the scale in the vertical dimension as compared to the horizontal dimension. Unless otherwise specified, the aspect ratio of scanned images is usually unity (1). That is, the number of pels required to represent one inch of the drawing horizontally usually is equal to the number of pels required to represent one inch of the drawing vertically. In measuring the aspect ratio, if linear scales are not present in both dimensions on the drawing itself, the original drawing dimensions must be known, or measurements must be taken from it. Aspect ratio is calculated from the formula:

$$AR = \frac{Pv \ X \ Lh}{Ph \ X \ Lv}$$

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where:

AR is the dimensionless aspect ratio.
Pv is the number of pels in the vertical dimension.
Lh is the represented length in the horizontal dimension.
Ph is the number of pels in the horizontal dimension.
Lv is the represented length in the vertical dimension.

6.4.9.4 Cleanness. Cleanness is the relative freedom from random flecks or amorphous dirt spots in the image representation. In addition to detracting from clarity in representing objects, flecks, and spots in an image can also severely diminish the degree of compression achievable. If dirt appears in the image area to the extent that the image is obliterated, obscured or defaced, then a major defect exists. The presence of dirt without obliterating, obscuring, or defacing the image constitutes a minor defect. Dirtiness can be measured as the dimensionless ratio of the number of wrong pel values to the total number of pels in a specified region of the image.

6.4.9.5 Continuity. Continuity is the ability of the imaging system to maintain the complete image without adding breaks to lines.

6.4.9.6 Contrast. While contrast in a raster image is normally concerned with treatment of grayscale and texture in the image, the treatment of lines, texture, and textual characters is also affected by contrast. In binary raster data, intensity-level contrast is not at issue. In this context, contrast is established in the scanning process itself, and is dependent on the scanning resolution, the sharpness of the image and the threshold level at which a pel is digitized. If contrast is too high, characters may be filled in, pattern-density shading may result in solid regions of set pels, and double lines may be merged. If contrast is too low, fine lines and pattern-density shading may be lost completely.

6.4.9.7 Coverage. Coverage is the portion of the desired region of the original drawing included in the raster image. A coverage of 100% ensures no data are lost. Determination of coverage by reference to the original drawing is particularly important for those engineering drawings or technical documents that do not have borders.

6.4.9.8 Evaluation of the scanning process. Evaluation of the scanning process can be achieved quantitatively at the point of acceptance by measuring all factors in a known standard test pattern scanned with each batch of drawings submitted for acceptance. At that time, application of factors 6.4.9.1 - 6.4.9.7 and 6.4.9.9 - 6.4.9.15 should form a basis for acceptance or rejection of the material.

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6.4.9.9 Focus. Focus affects the sharpness of a raster image. Diminished focus is characterized by a shallow pel density gradient in one or both dimensions. The result is a fuzzy appearance, and reduced susceptibility of the image to optical character recognition or edge-detection algorithm treatment.

6.4.9.10 Linearity. The number of raster image pels required to represent a unit of vertical or horizontal length in the original drawing should ideally be a constant at every point in the image, making the pel-length relationship linear. If the relationship is non-linear in either the horizontal or vertical direction, diagonal line segments will appear to be curved or wavy, and the image cannot be used for measurement purposes.

6.4.9.11 Orthogonality. While most systems are designed so that the two independent scanning dimensions are mutually orthogonal, alignment errors can occur in the scanning process, causing a deviation from orthogonality. This causes rectangles to appear as parallelograms. Orthogonality deviation is the number of degrees by which the angle between the two dimensions differs from 90 degrees.

6.4.9.12 Pel density. Pel density of the scanned raster image is normally expressed in image pels per original-drawing inch. Generally speaking, image quality improves with pel density. In the case of images scanned from 35-mm aperture card images, there is a practical limit to the effect of increased pel density on image quality, namely the resolution of the film image. Attempts to represent highly textured drawings with insufficient pel density may result in distortions such as Moiré patterns.

6.4.9.13 Readability. Readability is a subjective decision made as to whether an image can be read. The sizes of features on the original document affect the readability of the image, as do many other factors including the person reading them. Even though it is a subjective evaluation, readability is a useful indication of the quality of the image produced by the system.

6.4.9.14 Registration. Registration is a measure of the positioning of the raster image in the desired image medium area. Registration is the distance in pel rows or pel columns of the imaged area from the corresponding edges in the raster image. If the image is badly registered, excessive borders may appear or some coverage may be lost. Registration may be a problem when converting nonstandard raster formats to standard ones. Raster Types 1, 3, and 4 assume that the image content begins at the upper left hand corner of raster images. Some nonstandard formats record the coordinates of the image content at an offset from the upper left hand corner of the raster image. When such a file is converted to Types 1, 3, or 4, the conversion software should copy only a rectangle that contains the image content, and not the entire raster image area with its surrounding white space.

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6.4.9.15 Resolution. The resolution which an imaging system can reproduce determines the minimum feature size which is recognizable. Due to the linear pickup devices and the non-symmetrical responses of the electronics of many scanners, it is desirable to measure horizontal, vertical, and diagonal resolution as well as black on white and white on black resolution.

6.4.9.16 Scale. The scale (or magnification) of the raster image should accurately and consistently portray the size of the original drawing. The capability of the imaging system to accurately reproduce a scanned image can be measured. Horizontal and vertical scale accuracy can vary independently. It is also useful to determine the black and white scale ratio, which is used to determine whether lines are thickened or thinned by the digitization process.

6.5 Note on Type 1 raster data file header block. Type 1 raster data files can not be rendered on receiving systems unless the following information is contained within the MIL-STD-1840 raster header block.

a. Raster image orientation, the rorient: header record.

b. Raster image pel count, the rpelcnt: header record.

c. Raster image pel density, the rdensity: header record.

6.6 Type 3 raster data presentation and content attributes. The Navy SPAWAR Technical Manual SPAWAR-S-903, dated 1 August 1990, contains the NIFF, Version 1, as its appendix A. The NIFF appendix presents the specific limits and defaults for the document architecture and the content attributes used to interchange Type 3 raster data. The focal point for NIFF is:

Space and Naval Warfare Systems Command
2451 Crystal Drive
ATTN Code 05L2C
Arlington VA 22245-5200

Electronic copies of the SPAWAR publications can be obtained via the following WWW URL:
`http://www.spawar.navy.mil/spawar/welcome.page/`

6.7 Joint Engineering Data Management Information and Control System (JEDMICS) C4 raster subtype. JEDMICS C4 is a Government-owned raster format for the storage of images in the JEDMICS system. The C4 format is documented herein as a publicly available specification. Additionally, the JEDMICS Program Management Office (PMO) is preparing the detailed documentation of C4, and is developing implementation guidance. The JEDMICS PMO focal point for further details on the implementation of the C4 format is:

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Code PML 590 JEDMICS PMO
Building 9
Naval Supply Systems Command
PO Box 2050
Mechanicsburg PA 17055-0791

Electronic copies of the JEDMICS publications can be obtained via the following WWW URL:
`http://jrts.jedmics.navy.mil`

6.8 Raster data file size minimization. Raster data compression does not always produce the smallest file size. Raster data files compressed in accordance with 3.1 may produce raster files which are larger than their uncompressed version (negative compression). When this occurs, the raster file may be left in its uncompressed form.

6.8.1 Tile size minimization. When individual tiles have negative compression they may be left in their uncompressed form. This will then produce the smallest possible file.

6.9 CALS raster Multipurpose Internet Mail Extensions (MIME) types. The following file name extensions are recommended to identify the individual CALS raster MIME types:

a. `.CAL` – MIL-PRF-28002B raster, CALS Type 1 (Legacy format with attached MIL-STD-1840 header. This file name extension should only be used to read or describe older CALS raster files which are stored with their entire MIL-STD-1840 header records intact, see 3.2.).

b. `.CT1` – MIL-PRF-28002C raster, CALS Type 1 (simplified format with the embedded raster data header records rorient: , rpelcnt: , and rdensity: . All new Type 1 raster data files should comply with this clarified format, see 3.2.).

c. `.CT2` – MIL-PRF-28002C raster, CALS Type 2 (ODA raster DAP format, see 3.3).

d. `.CT3` or `.NIF` – MIL-PRF-28002C raster, CALS Type 3 (NIFF format, see 3.4).

e. `.CT4` or `.C4` – MIL-PRF-28002C raster, CALS Type 4 (JEDMICS C4 format, see 3.5).

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6.10 Definitions.

6.10.1 Abbreviations and acronyms. The abbreviations and acronyms used in this specification are defined as follows:

a. AIIM – Association for Information and Image Management

b. ANSI – American National Standards Institute

c. ASCII – American Standard Code for Information Interchange

d. C4 – Short name for JEDMICS C4 Raster format (not an acronym)

e. CALS – Continuous Acquisition and Life-Cycle Support

f. CCITT – Consultative Committee for International Telegraphy and Telephony (now the International Telecommunications Union Telecommunication Standardization Sector, ITU-T)

g. CCW – Counterclockwise

h. CDRL – Contract Data Requirements List

i. DAP – Document Application Profile

j. DID – Data Item Description

k. DISA – Defense Information Systems Agency

l. DoD – Department of Defense

m. DoDISS – Department of Defense Index of Specifications and Standards

n. FIPS – Federal Information Processing Standards

o. IFD – Image File Directory

p. ITU-T – International Telecommunications Union Telecommunication Standardization Sector

q. JEDMICS – Joint Engineering Data Management Information and Control System

r. LSB – Least Significant Bit or Least Significant Byte

s. MIME – Multipurpose Internet Mail Extensions

t. MSB – Most Significant Bit or Most Significant Byte

u. NAVSUP – Naval Supply Systems Command

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v.	NIFF	–	Navy Image File Format
w.	NIRS	–	Navy Implementation for Raster Scanning
x.	ODA	–	Office Document Architecture
y.	PMO	–	Program Management Office
z.	SGML	–	Standard Generalized Markup Language
aa.	SPAWAR	–	Space and Naval Warfare Systems Command
ab.	URL	–	Universal Resource Locator
ac.	WWW	–	World Wide Web

6.10.2 Attribute. An element of a constituent of a document that has a name and a value and that expresses a characteristic of this constituent or a relationship with one or more constituents.

6.10.3 Bit ordering. The ordering of bits within bytes. MSB to LSB is considered the "down" direction. LSB to MSB is considered the "up" direction. Both types of bit ordering may be used in imaging systems. The most widespread method used in sending bitmapped (uncompressed) data to computer display adapters is with a "down" ordering (MSB to LSB).

6.10.4 Bitmap. A two-dimensional or three-dimensional data field representing a pel array.

6.10.5 Block. A contiguous group of data.

6.10.6 Byte boundary. A position in a binary data stream where, if the stream were packed into bytes (octets), an integer number of completely filled bytes would result.

6.10.7 Byte ordering. "Little-endian" byte ordering arranges the bytes from LSB to MSB, while "big-endian" byte ordering arranges the bytes from MSB to LSB. Within MIL-PRF-28002 both big-endian and little-endian byte orderings are utilized. Byte ordering should not be confused with bit ordering. Byte ordering does not have any effect on the bit ordering. In MIL-PRF-28002 all bit orderings are given in big-endian (MSB to LSB).

6.10.8 Compression. An operation performed on raster image data to remove redundant information and thus reduce the stored or interchanged size.

6.10.9 Decoding. The process of deriving a bitmap from an octet string by translating any compression algorithm used to create the octet string.

6.10.10 Decoding system. A program that reads and interprets a file of the specified type, which may not have been produced locally.

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6.10.11 Encoding. The process of deriving compressed data from a bitmap by applying a compression algorithm to the bitmap.

6.10.12 Encoding system. A program which produces or outputs for export a file of the specified type.

6.10.13 Header. Control or attribute information that is prefixed to a block of user data.

6.10.14 Line progression. The direction of progression of successive lines of pels in an image.

6.10.15 Null tiles. Image tiles containing either all foreground (1) or all background (0) pels. Null tiles therefore contain no image information, but merely take up data file space.

6.10.16 Octet. A subdivision of bits numbered from 8 to 1, where bit 8 is the MSB and bit 1 is the LSB. (Also known as a byte.)

6.10.17 Page. A type of layout object or layout object class that corresponds to a rectangular area used as a reference area for presenting the content of the document.

6.10.18 Pel (picture element). The smallest graphic element that can be individually addressed within a picture. Synonymous with pixel.

6.10.19 Pel array. A two-dimensional array of pels used to represent a pictorial image.

6.10.20 Pel density. The number of pels per unit distance in a raster image.

6.10.21 Pel path. The direction of progression of successive pels along a line in an image.

6.10.22 Pel spacing. The distance between any two successive pels along a scan line of an image. It is the inverse of such often used terms as pel density, transmission density, or resolution.

6.10.23 Raster. A matrix, constructed of orthogonally positioned rows and columns of discrete data points. The binary value of each data point indicates the presence or absence of a pictorial (visual) artifact.

6.10.24 Raster data. The electronic data processing medium used to depict any arbitrary assemblage of text characters, graphical figures, or pictorial images with a pel array. This is the entire data file.

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6.11 Note on document fonts. As part of the CALS initiative to introduce the use of digital technology into the process of reviewing and coordinating standards, this revision of the standard has been reformatted for improved readability as both a paper and an electronic document. The body text of this document uses the same font as the previous revision, but slightly enlarged to give an improved on-screen appearance when displayed by a computer. The tables and figures now use a sans-serif font for a cleaner appearance and to be distinguished easily from the body text. URLs, computer code entries, values, and listings are shown in a `non-proportional typewriter font` so that they may be identified easily and with minimal confusion. When such values are quoted (" "), this denotes ASCII values.

6.12 Subject term (key word) listing.

CALS
Conversion
Digital
Image
Image compression
JEDMICS
MIL-STD-1840
NIFF
ODA
Scanning

6.13 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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NIFF, VERSION 1

A.1 SCOPE

A.1.1 Scope. The appendix details the binary header requirements for NIFF raster image files. This appendix is a mandatory part of the specification when Type 3 raster data files are ordered. The information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

(This section is not applicable to this appendix.)

A.3 PROCEDURE

A.3.1 Requirements. A NIFF raster image will be used for the raster data contained within an MIL-PRF-28002 Type 3 raster data file, and will consist of a binary header and an Image File Directory (IFD). The binary header will contain only fixed position, byte ordered data, and the IFDs will contain tagged information about the images, and pointers to each raster data section of the file. In NIFF, individual fields are identified with a unique tag. A NIFF file begins with an 8-byte "image file binary header" that points to one or more IFDs.

A.3.2 Image File Directory (IFD). The IFDs contain information about the images, as well as pointers to the actual image data. Each file shall contain one complete IFD with all required tags, but each successive IFD requires only those tags which have different values corresponding to the next data area(s). Additional IFDs should be used only when the parameters that describe the data change. Only those tags whose values relate the data parameters need be used. Additional IFDs are not required for the change of the compression value of a tiled image. If some tiles are compressed and some are in uncompressed (bitmapped) form, the NavyCompression tag value will point to the compression values to be used with each tile, as do the DataOffset and DataByteCounts tags. All tags shall be entered into the IFD in numerical sequence.

A.3.3 Binary header and Image File Directory (IFD) structure. Default values can be assumed and the tag use in the IFD is optional. Table A-I contains the binary header and IFD structures to be used. All hexadecimal values are given in Intel (little-endian) byte order (see A.3.4.1) except for numbers appearing within the offset column.

A.3.4 Binary header content. The binary header is a group of elements describing the overall contents of the image data. These elements do not have any coded tags and will only contain a single value (see tables A-III, A-IV, A-V, and A-VI).

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TABLE A-I. Binary header and IFD structure.

TAG NAME	*FIELD TAG	FIELD TYPE	LENGTH
Binary header			
ByteOrder		Short	N.A.
Name		Short	N.A.
IFDPointer		Long	N.A.
Image File Directory (IFD)			
IFDTags (value = number of tags)		Short	N.A.
SubfileType	254	Long	1
PelPathLength	256	Long	1
LineProgressionLength	257	Long	1
BitsPerSample	258	Short	1
PhotometricInterpretation	262	Short	1
DataOffset	273	Long	1 or **n
SamplesPerPixel	277	Short	1
DataByteCounts	279	Long	1 or **n
PelPathResolution	282	Rational	1
LineProgressionResolution	283	Rational	1
ResolutionUnit	296	Short	1
ColumnsPerPelPath	322	Long	1
RowsPerLineProgression	323	Long	1
Rotation	33465	Short	1
NavyCompression	33466	Short	1 or **n
TileIndex	33467	Short	1 or **n
NextIFD		Long	N.A.

NOTE:
1. Empty fields in this table are intentionally left blank.
2. Field Tag numbers are given in this table in decimal form (base 10).
**n = number of tiles.

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A.3.4.1 ByteOrder. A 16-bit (2-byte) unsigned integer specifying that the byte order within the file binary header is always from LSB to MSB, for both 16-bit and 32-bit integers. This byte ordering is true for all Type 3 raster data. The following is the byte order for these two bytes:

Bytes 0-1
Value:
Byte 0 = "I" (49h)
Byte 1 = "I" (49h)

NOTE: This indicates Intel (little-endian) order.

A.3.4.2 Name. The tag Name shall consist of a 2-byte field containing the ASCII value 'N1" (4E31h). This value indicates that this is the NIFF version 1. The following is the byte order for these two bytes.

Bytes 2-3
Value:
Byte 2 = "N" (4Eh)
Byte 3 = "1" (31h)

A.3.4.3 IFDPointer. The IFDpointer is a 32-bit (4-byte) unsigned integer indicating the offset to the first IFD from the beginning of the NIFF file. This pointer shall follow the Intel byte order in accordance with A.3.4.1.

Bytes 4-7
Value: offset to the first IFD

A.3.5 Image File Directory (IFD) content. The IFD is a tag structure directory required for every data area within the raster data file. All tags will start on a word boundary, thus requiring 12 bytes for each tag line. Each tag entry will be as follows:

Bytes 0-1 contain the tag for the field

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Bytes 2-3 contain the field type:

1 = Byte: 8-bit bytes
2 = ASCII: 8-bit ASCII codes
3 = Short: 16-bit (2-byte) unsigned integers
4 = Long: 32-bit (4-byte) unsigned integers
5 = Rational: 2 longs, the first is the numerator of a fraction, the second is the denominator of the fraction.

Bytes 4-7 contain the length of the information pointed to by the tag. The units of the length are the field type of the tag. (This can also be considered as the number of values contained in the field, with each value containing the number of bytes indicated by the file type.) If the length is greater than 1, the value will contain a pointer to the data (see below for explanation of value.)

Bytes 8-11 contain the value or field data. The value can be either a pointer (offset) to where the actual tag data is located, or it can be the actual tag data itself. The value is expected to begin on a word boundary; the corresponding value offset will thus be an even number.

A.3.6 Image File Directory (IFD) tag definitions.

A.3.6.1 IFDTags. IFDTags are a 16-bit (2-byte) unsigned integer indicating the number of tags used in this IFD (count does not include "IFDTags" nor "NextIFD".) This is the number of tags from the following list, the number of 12 byte fields.

A.3.6.2 SubfileType.

Tag = 254 (FE00h)

Type = 4 (0400h)

Length = 1 (01000000h)

Value

bit 2^0 = 1 if the image is a supporting image and not the primary image in this NIFF file; else the bit is 0.
bit 2^1 = 1 if the image is a tiled image; else the bit is 0.

Default Value = 0

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A.3.6.3 PelPathLength. For an untiled image, this is the total number of pels in the pel path direction of an image and must be evenly divisible by 8. For a tiled image, this will be the total number of pels in the pel path direction of the untiled image and will not include any padding pels used to eliminate runt tiles. The number of tiles in the pel path direction can be calculated by dividing this value by 512 and rounding any remainder to the next higher value.

Tag = 256 (0001h)

Type = 4 (0400h)

Length = 1 (01000000h)

Default Value = No default value.

A.3.6.4 LineProgressionLength. For an untiled image, this is the total number of pels in the line progression direction of an image and must be evenly divisible by 8. For a tiled image, this will be the total number of pels in the line progression direction of the untiled image and will not include any padding pels used to eliminate runt tiles. The number of tiles in the pel path direction can be calculated by dividing this value by 512 and rounding any remainder to the next higher value.

Tag = 257 (0101h)

Type = 4 (0400h)

Length = 1 (01000000h)

Default Value = No default value.

A.3.6.5 BitsPerSample. The number of bits per sample. For this version of NIFF this value will always be 1 (01000000h).

Tag = 258 (0201h)

Type = 3 (0300h)

Length = SamplesPerPixel, 1 (01000000h) for this version of NIFF.

Default Value = 1

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A.3.6.6 PhotometricInterpretation. Only one value is supported for this element at this time, but it is presented for future use.

Tag = 262 (0601h)

Type = 3 (0300h)

Length = 1 (01000000h)

Value = 0
Bi-level; 0 is imaged as white (background).

Default Value = No default value.

A.3.6.7 DataOffset. This is the offset to the beginning of the data area from the beginning of the NIFF file.

Tag = 273 (1101h)

Type = 4 (0400h)

Length = Number of images in the data area.
For a tiled image, length = the number of tiles
For an untiled image, length = 1 (01000000h)

Default Value = No default value.

A.3.6.8 SamplesPerPixel. The number of samples per pel. For this version of NIFF this value will always be 1 (01000000h).

Tag = 277 (1501h)

Type = 3 (0300h)

Length = 1 (01000000h)

Default Value = 1

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A.3.6.9 DataByteCounts. This is the number of bytes in this data area or bytes per image. For a compressed image this is the number of compressed bytes.

Tag = 279 (1701h)

Type = 4 (0400h)

Length = Number of images in the data area.
For a tiled image, length = the number of tiles
For an untiled image, length = 1 (01000000h)

Default Value = No default value.

A.3.6.10 PelPathResolution. This is the number of pixels per ResolutionUnit in the pel path direction.

Tag = 282 (1A01h)

Type = 5 (0500h)

Length = 1 (01000000h)

Default Value = No default value.

A.3.6.11 LineProgressionResolution. This is the number of pixels per ResolutionUnit in the line progression direction.

Tag = 283 (1B01h)

Type = 5 (0500h)

Length = 1 (01000000h)

Default Value = No default value.

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A.3.6.12 ResolutionUnit. To be used with PelPathResolution and LineProgressionResolution.

Tag = 296 (2801h)

Type = 3 (0300h)

Length = 1 (01000000h)

Value
1 = No absolute unit of measurement.
2 = Inch
3 = Centimeter

Default Value = 2

A.3.6.13 ColumnsPerPelPath. The number of pels in the pel path direction. For an untiled image, this is the number of pels for a single row in the pel path direction and will be equal to the PelPathLength. For a tiled image, this is the number of pels for a single row in the pel path direction and will be equal to 512.

Tag = 322 (4201h)

Type = 4 (0400h)

Length = 1 (01000000h)

Default Value = No default value.

A.3.6.14 RowsPerLineProgression. The number of pels in the line progression direction. For an untiled image, this is the number of pels for a single column in the line progression direction and will be equal to the LineProgressionLength. For a tiled image, this is the number of pels for a single column in the line progression direction and will be equal to 512.

Tag = 323 (4301h)

Type = 4 (0400h)

Length = 1 (01000000h)

Default Value = No default value.

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A.3.6.15 Rotation. The value indicates the "Angle of Rotation for Display" of the image contained in this data area. There will only be one value for either a tiled or an untiled image. For a tiled image this will be the rotation of the complete image, not of the individual tiles. A fixed coordinate system is defined for an image orientation having the 0° position to the right with the angle of rotation in the counterclockwise (CCW) direction. All images will be oriented on this coordinate system with the short dimension edge parallel to the horizontal axis (0° or 180°). All 8.5-by-11 inch images will be oriented with the top of the image pointing in the 90° direction. The top of the image is defined, relative to a standard page of textual data, as that short dimension edge parallel to the first line of text. The top of the image for a landscape page is defined as the upper, short dimension edge when the page is bound on its long dimension edge. Oversize pages, those pages greater than 8.5-by-11 inches, will be oriented on the coordinate system with a short dimension edge pointing in the 90° direction. For images which are normally viewed with the long dimension of the image in the horizontal, the viewing direction will point in the 180° direction of the coordinate system. For images which are normally viewed with the short dimension of the image in the horizontal, the viewing direction will point in the 270° direction of the coordinate system. The "Angle of Rotation for Display" is defined as the CCW rotation of the image, on this coordinate system, for normal display of the content data. The pel path and line progression for all pages will be 0° and 270° respectively. The "Angle of Rotation for Display" of a portrait page will be 0°, and for a right-hand or recto landscape page it will be 270°.

Tag = 33465 (B982h)

Type = 3 (0300h)

Length = 1 (01000000h)

Value
- 0 = 0°
- 1 = 90°
- 2 = 180°
- 3 = 270°

Default Value = 0

A.3.6.16 NavyCompression. For tiled images there shall be a compression value for each tile.

Tag = 33466 (BA82h)

Type = 3 (0300h)

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Length = 1 (01000000h) for an untiled image, and for a tiled image when all of the tiles have the same NavyCompression value.

Length = Number of tiles in the data area when all of the tiles in the data area do not have the same NavyCompression value.

Value

1 = uncompressed or bitmapped data area. Bits will be packed into bytes as tightly as possible, with no unused bits. All bit rows in the pel path direction shall be padded with zero (0) bits such that the number of bits per row will be evenly divisible by 8. The padded bits shall either be inserted or can be obtained by overscan.

4 = Facsimile-compatible ITU-T Group 4 compression in accordance with FIPS PUB 150 for Group 4 Facsimile Apparatus, Recommendation T.6.

Default Value = 4 This default value assumes length = 1 (01000000h).

A.3.6.17 TileIndex. For an untiled image the value will be zero (0). For tiled images the value will be the sequence number of the tile. Tiles will be numbered in sequence starting with a sequence number of zero (0) for the first tile in the first tile path. The numbering sequence is always from the first tile in the tile path, progressing in the tile path direction then in the tile line progression direction. Tiles can be placed in any order in the file. The TileIndex values shall be in the same sequence as the tiles within the file.

Tag = 33467 (BB82h)

Type = 3 (0300h)

Length = 1 (01000000h) for an untiled image.

Length = Number of tiles in the data area for a tiled image.

Default Value = 0 (00000000h), a single value of 0 implies an untiled image.

A.3.6.18 NextIFD. NextIFD is a 32-bit (4-byte) unsigned integer indicating the offset to the next IFDTags element from the beginning of the NIFF file. This value is 00000000h when this is the last IFD in the NIFF file.

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APPENDIX A

TABLE A-II. NIFF tag definitions.

TAG NAME	*FIELD TAG	FIELD TYPE	LENGTH		VALUE	DEFAULT
			T	UT		
SubfileType	254	Long	1	1	bit 0 = 0, untiled image bit 0 = 1, supporting image bit 1 = 1, tiled image	0
PelPathLength	256	Long	1	1	T = total pels of untiled image UT = total pels, divisible by 8	N.A.
LineProgressionLength	257	Long	1	1	T = total pels of untiled image UT = total pels, divisible by 8	N.A.
BitsPerSample	258	Short	1	1	bits per sample	1
PhotometricInterpretation	262	Short	1	1	0	N.A.
DataOffset	273	Long	*	1	offset to data area	N.A.
SamplesPerPixel	277	Short	1	1	samples per pel	1
DataByteCounts	279	Long	*	1	bytes per image in data area	N.A.
PelPathResolution	282	Rational	1	1	resolution value	N.A.
LineProgressionResolution	283	Rational	1	1	resolution value	N.A.
ResolutionUnit	296	Short	1	1	1 = no absolute unit 2 = inch 3 = centimeter	2
ColumnsPerPelPath	322	Long	1	1	T = 512, UT = PelPathLength	N.A.
RowsPerLineProgression	323	Long	1	1	T = 512, UT = LineProgressionLength	N.A.
Rotation	33465	Short	1	1	0 = 0° 1 = 90° 2 = 180° 3 = 270°	0
NavyCompression	33466	Short	n	1	1 = uncompressed 4 = ITU-T Group 4	4
TileIndex	33467	Short	*	1	tile index/sequence number	0

T = Tiled image
UT = Untiled image
n = 1 or number of tiles in image data area (see definition)
* = Number of tiles in image data area
NOTE: Field Tag numbers are given in this table in decimal form (base 10).

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TABLE A-III. Example 1, NIFF tagged, 8.5"-by-11" untiled page, uncompressed.

TAG NAME	OFFSET	DATA (Intel)			
LEADER					
ByteOrder	0000h	4949			
Name	0002h	4E31			
IFDPointer	0004h	08000000			
Image File Directory (IFD)					
TAG NAME	**OFFSET**	**TAG**	**TYPE**	**LENGTH**	**VALUE**
IFDTags (value = number of tags)	0008h	1000			
SubfileType	000Ah	FE00	0400	01000000	00000000
PelPathLength	0016h	0001	0400	01000000	F8090000
LineProgressionLength	0022h	0101	0400	01000000	E80C0000
BitsPerSample	002Eh	0201	0300	01000000	01000000
PhotometricInterpretation	003Ah	0601	0300	01000000	00000000
DataOffset	0046h	1101	0400	01000000	DE000000
SamplesPerPixel	0052h	1501	0300	01000000	01000000
DataByteCounts	005Eh	1701	0400	01000000	A3020200
PelPathResolution	006Ah	1A01	0500	01000000	CE000000
LineProgressionResolution	0076h	1B01	0500	01000000	D6000000
ResolutionUnit	0082h	2801	0300	01000000	02000000
ColumnsPerPelPath	008Eh	4201	0400	01000000	F8090000
RowsPerLineProgression	009Ah	4301	0400	01000000	E80C0000
Rotation	00A6h	B982	0300	01000000	00000000
NavyCompression	00B2h	BA82	0300	01000000	01000000
TileIndex	00BEh	BB82	0300	01000000	00000000
NextIFD	00CAh	00000000 (end IFD marker)			
Fields pointed to by the tags					
PelPathResolution	00CEh	2C010000 01000000			
LineProgressionResolution	00D6h	2C010000 01000000			
Image Data					
	00DEh	Beginning of the actual data			

NOTE: The data column is the actual data to the offset. The tag, type, length, and value columns separate the data for clarity in this example.

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TABLE A-IV. Example 2, NIFF default tagged, 8.5"-by-11" untiled page, uncompressed.

TAG NAME	OFFSET	DATA			
LEADER					
ByteOrder	0000h	4949			
Name	0002h	4E31			
IFDPointer	0004h	08000000			
Image File Directory (IFD)					
TAG NAME	**OFFSET**	**TAG**	**TYPE**	**LENGTH**	**VALUE**
IFDTags (value = number of tags)	0008h	0A00			
PelPathLength	000Ah	0001	0400	01000000	F8090000
LineProgressionLength	0016h	0101	0400	01000000	E80C0000
PhotometricInterpretation	0022h	0601	0300	01000000	00000000
DataOffset	002Eh	1101	0400	01000000	96000000
DataByteCounts	003Ah	1701	0400	01000000	A3020200
PelPathResolution	0046h	1A01	0500	01000000	86000000
LineProgressionResolution	0052h	1B01	0500	01000000	8E000000
ColumnsPerPelPath	005Eh	4201	0400	01000000	F8090000
RowsPerLineProgression	006Ah	4301	0400	01000000	E80C0000
NavyCompression	0076h	BA82	0300	01000000	01000000
NextIFD	0082h	00000000 (end IFD marker)			
Fields pointed to by the tags					
PelPathResolution	0086h	2C010000 01000000			
LineProgressionResolution	008Eh	2C010000 01000000			
Image Data					
	0096h	Beginning of the actual data			
NOTE: The data column is the actual data at the offset. The tag, type, length, and value columns separate the data for clarity in this example.					

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TABLE A-V. Example 3, NIFF tagged, 11"-by-14" tiled page, uncompressed.

TAG NAME	OFFSET	DATA			
LEADER					
ByteOrder	0000h	4949			
Name	0002h	4E31			
IFDPointer	0004h	08000000			
Image File Directory (IFD)					
TAG NAME	**OFFSET**	**TAG**	**TYPE**	**LENGTH**	**VALUE**
IFDTags (value = number of tags)	0008h	1000			
SubfileType	000Ah	FE00	0400	01000000	02000000
PelPathLength	0016h	0001	0400	01000000	E80C0000
LineProgressionLength	0022h	0101	0400	01000000	68100000
BitsPerSample	002Eh	0201	0300	01000000	01000000
PhotometricInterpretation	003Ah	0601	0300	01000000	00000000
DataOffset	0046h	1101	0400	01000000	5C010000
SamplesPerPixel	0052h	1501	0300	01000000	01000000
DataByteCounts	005Eh	1701	0400	3F000000	58020000
PelPathResolution	006Ah	1A01	0500	01000000	CE000000
LineProgressionResolution	0076h	1B01	0500	01000000	D6000000
ResolutionUnit	0082h	2801	0300	01000000	02000000
ColumnsPerPelPath	008Eh	4201	0400	01000000	00020000
RowsPerLineProgression	009Ah	4301	0400	01000000	00020000
Rotation	00A6h	B982	0300	01000000	01000000
NavyCompression	00B2h	BA82	0300	01000000	01000000
TileIndex	00BEh	BB82	0300	3F000000	DE000000
NextIFD	00CAh	00000000 (end IFD marker)			
Fields pointed to by the tags					
PelPathResolution	00CEh	2C010000 01000000			
LineProgressionResolution	00D6h	2C010000 01000000			
TileIndex	00DEh	0000 0100 0300 0400 0200 58 more 2-byte values give the tile order			
DataOffset	015Ch	63 4-byte values pointing to each tile data area			
DataByteCounts	0258h	63 4-byte values pointing to each tile data area			
Image Data					
	0354h	Beginning of the actual data, 63 data areas, one for each tile as pointed to by the DataOffset values			
NOTE: The data column is the actual data at the offset. The tag, type, length, and value columns separate the data for clarity in this example.					

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TABLE A-VI. Example 4, NIFF tagged, 11"-by-14" tiled page, compressed.

TAG NAME	OFFSET	DATA			
LEADER					
ByteOrder	0000h	4949			
Name	0002h	4E31			
IFDPointer	0004h	08000000			
Image File Directory (IFD)					
TAG NAME	**OFFSET**	**TAG**	**TYPE**	**LENGTH**	**VALUE**
IFDTags (value = number of tags)	0008h	1000			
SubfileType	000Ah	FE00	0400	01000000	02000000
PelPathLength	0016h	0001	0400	01000000	E80C0000
LineProgressionLength	0022h	0101	0400	01000000	68100000
BitsPerSample	002Eh	0201	0300	01000000	01000000
PhotometricInterpretation	003Ah	0601	0300	01000000	00000000
DataOffset	0046h	1101	0400	3F000000	5C010000
SamplesPerPixel	0052h	1501	0300	01000000	01000000
DataByteCounts	005Eh	1701	0400	3F000000	58020000
PelPathResolution	006Ah	1A01	0500	01000000	CE000000
LineProgressionResolution	0076h	1B01	0500	01000000	D6000000
ResolutionUnit	0082h	2801	0300	01000000	02000000
ColumnsPerPelPath	008Eh	4201	0400	01000000	00020000
RowsPerPelPath	009Ah	4301	0400	01000000	00020000
Rotation	00A6h	B982	0300	01000000	01000000
NavyCompression	00B2h	BA82	0300	3F000000	54030000
TileIndex	00BEh	BB82	0300	3F000000	DE000000
NextIFD	00CAh	CE040000			

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TABLE A-VI. Example 4, NIFF tagged, 11"-by-14" tiled page, compressed - Continued.

TAG NAME	OFFSET	DATA
Fields pointed to by the tags		
PelPathResolution	00CEh	2C010000 01000000
LineProgressionResolution	00D6h	2C010000 01000000
TileIndex	00DEh	0000 0200 0010 0300 0500 0400; 57 more 2-byte values giving the tile order
DataOffset	015Ch	9C090000 62 more 4-byte values pointing to each tile data area
DataByteCounts	0258h	330B0000 330B0000 330B0000 00100000 00100000 58 more 4-byte values
NavyCompression	0354h	0400 0400 0400 0100 0100 58 more 2-byte values of 0400
Image File Directory (IFD) for expanded view		
IFDTags	04CEh	1200 (The remaining IFD for the expanded view)
First Image Data	099Ch	Data area for 63 tiles, one for each tile as pointed to by the DataOffset values
NOTE: The data column is the actual data at the offset. The tag, type, length, and value columns separate the data for clarity of this example.		

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APPENDIX B

JEDMICS C4 FORMAT

B.1 SCOPE

B.1.1 Scope. This appendix details the format requirements for JEDMICS C4 raster image files. This appendix is a mandatory part of this specification when Type 4 raster data files are ordered. The information contained herein is intended for compliance.

B.2 APPLICABLE DOCUMENTS

(This section is not applicable to this appendix.)

B.3 PROCEDURE

B.3.1 Requirements. The JEDMICS C4 compressed raster image file consists of the following components, in order:

a. C4 header.

b. C4 tile index, on entry for each 512-by-512 pixel tile in the image.

c. Compressed image data, a sequence of compressed tiles.

d. Preview tile index, one entry for each 512-by-512 pixel tile in the preview.

e. Preview compressed image data, a sequence of compressed tiles.

B.3.2 Formats. In the following file component description, numeric fields are in one of two formats.

B.3.2.1 Numeric fields. Numeric fields marked "(Intel)" in the tables are in Intel (little-endian) byte order.

B.3.2.2 Other fields. All other numeric fields are in Motorola (big-endian) byte order.

B.3.3 C4 header. Table B-I describes the header fields used in the C4 format.

B.3.4 C4 tile index entry. Table B-II describes the tile index entries used in the C4 format.

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TABLE B-I. C4 header field definitions.

Field	Size	Offset	Description
index offset	4 byte	0 bytes	Offset to the tile indices (Intel)
lines high	2 byte	4 bytes	Height of image in pixels (Intel)
bytes wide	2 byte	6 bytes	Width of image in bytes (Intel)
data offset	4 byte	8 bytes	Offset to compressed tiles
n tiles	1 byte	12 bytes	Value is hexadecimal number of 512-by-512 pixel tiles in image. If the number of tiles is greater than 252, the value is 00h. Otherwise, the value is hexadecimal number of tiles
reserved	1 byte	13 bytes	Reserved (00h filled by default)
preview index	4 byte	14 bytes	Height of preview tile index (Intel)
preview height	2 byte	18 bytes	Height of preview in bytes (Intel)
preview width	2 byte	20 bytes	Width of preview in bytes (Intel)
preview data	4 byte	22 bytes	Offset to compressed preview tiles
preview n tiles	1 byte	26 bytes	Hexadecimal number of 512-by-512 pixel tiles in preview. If the number of preview tiles is greater than 252, then value is 00h. Otherwise the value is hexadecimal number of preview tiles
reserved	1 byte	27 bytes	Reserved (00h filled by default)
file type	2 byte	28 bytes	Value is 0001h
QAflag	4 byte	30 bytes	Result of Quality Assurance (QA) analysis
reserved	2 byte	34 bytes	Reserved (0000h filled by default)
format	1 byte	36 bytes	Data format code: If the number of tiles is greater than 252, then the value is 06h, otherwise the value is 04h
index spacing	1 byte	37 bytes	Value is 00h
dpi	2 byte	38 bytes	Resolution (value is 0000h, indicates 200 dpi) (Intel)
pixel polarity	1 byte	40 bytes	Value is 00h
hollerith	80 byte	41 bytes	Hollerith data if from scanned aperture cards; otherwise all bytes are 00h
reserved	7 byte	121 bytes	Reserved all bytes are 00h

NOTES:
1. Numeric fields marked "(Intel)" are in Intel (little-endian) byte order.
2. All other numeric fields are in Motorola (big-endian) byte order.

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TABLE B-II. C4 tile index entries.

Field	Size	Offset	Description
tile number	1 byte	0 bytes	Zero-based offset of tile in image. If the number of tiles is greater than 252 then value is 00h else value is zero-based tile number
neg comp	1 byte	1 byte	If negative compression then value is 80h else value is 00h
data size	2 byte	2 bytes	Size of compressed tile in bytes (Intel)
NOTE: Here, offset is the offset with the tile index entry, not the overall files.			

B.3.5 Compressed image data. ITU-T Group 4 compressed tiles following the order of the indices (see 3.1.1).

B.3.6 Preview tile index. Same as C4 tile index entry.

B.3.7 Preview compressed image data. ITU-T Group 4 compressed tiles following the order of the preview indices (see 3.8.2).

B.3.8 Tile indexing. Each tile index structure contains a "tile number" field that identifies the position of that tile in the logical image. If the number of tiles in the image (or preview) exceeds 252, the tile number fields are set to `00h` and the tile index is in row-major order. Otherwise, the tile number field is set to the zero-based offset of the corresponding tile in the logical image. Tile number `0` indicates the tile in the upper left-hand corner of the image. Tile numbers proceed across the image in row-major order. In this case, the order of the index structure may or may not be in row-major order.

B.3.8.1 Negative compression. The negative compression flag in the tile index structure indicates an occurrence of the case where compression of the given tile would have resulted in larger data size that the original tile. In this event, the tile is not compressed and the negative compression flag is set. The data size in this case will be `32768`.

B.3.8.2 Preview. The "preview" is produced by applying a scaling algorithm to the full image and compressing. The goal of the scaling algorithm is to reduce the image to a preview that fits onto a screen of 1024-by-1536 pixels, (six (6) tiles, 2-by-3), the scaling factor thus varies with image size.

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B.3.8.3 Scaling Algorithm. The scaling algorithm preserves the quality of the original image. For a scaling factor of n, the original image can be logically divided into regions of n pixels square. The preview consists of one pixel for each scaled region. In the preview, a given pixel is set if any pixel in the corresponding region is set.

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Preparing Activity:
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Review activities:
OSD – DO, IR, SE
Army – AC, AC1, AC2, AL, AT, MI, PT, TM1, TM3
Navy – AS, CG, CH, EC, MC, ND, NM, TD
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DIA – DI
NSA – NS
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4. NATURE OF CHANGE ***(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)***

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