NOTICE OF CHANGE

NOT MEASUREMENT SENSITIVE

MIL-STD-188-199
NOTICE 1
27 June 1996

DEPARTMENT OF DEFENSE INTERFACE STANDARD

VECTOR QUANTIZATION DECOMPRESSION
FOR THE NATIONAL IMAGERY TRANSMISSION FORMAT STANDARD

TO ALL HOLDERS OF MIL-STD-188-199:

1. THE FOLLOWING PAGES OF MIL-STD-188-199 HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
cover	27 June 1996	cover	27 June 1994
ii	27 June 1996	ii	27 June 1994
iii	27 June 1996	iii	27 June 1994
iv	27 June 1996	iv	27 June 1994
1	27 June 1996	1	27 June 1994
2	27 June 1996	2	reprinted without change
3	27 June 1996	3	27 June 1994
4	27 June 1996	4	27 June 1994
5	27 June 1996	5	27 June 1994
6	27 June 1996	6	reprinted without change
11	27 June 1996	11	27 June 1994
12	27 June 1996	12	27 June 1994
15	27 June 1996	15	27 June 1994
16	27 June 1996	16	reprinted without change
17	27 June 1996	17	27 June 1994

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NEW PAGE	DATE	SUPERSEDED PAGE	DATE
18	27 June 1996	18	reprinted without change
29	27 June 1996	29	27 June 1994
30	27 June 1996	30	reprinted without change
DD1426	27 June 1996	DD1426	27 June 1994

2. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

3. Holders of MIL-STD-188-199 will verify that page changes and additions indicated above have been entered. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the military standard is completely revised or canceled.

Custodians:
Army - SC
Navy - EC
Air Force - 90
Misc - NS

Preparing Activity:
CIO - CI
(Project TCSS-199001)

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NOTE: The cover page of this standard has been changed for administrative reasons. There are no other changes to this document.

MIL-STD-188-199
27 June 1994

DEPARTMENT OF DEFENSE INTERFACE STANDARD

VECTOR QUANTIZATION DECOMPRESSION FOR THE NATIONAL IMAGERY TRANSMISSION FORMAT STANDARD

AMSC N/A **AREA TCSS**

Supersedes cover of MIL-STD-188-199.

FOREWORD

1. This standard is approved for use by all Departments and Agencies of the Department of Defense (DOD).

2. The National Imagery Transmission Format Standard (NITFS) is the standard for formatting digital imagery and imagery-related products and exchanging them among members of the Intelligence Community (IC) as defined by Executive Order 12333, the DOD and other departments and agencies of the United States Government, as governed by Memoranda of Agreement (MOA) with those departments and agencies.

3. This standard was developed using currently available technical information.

4. The DOD and members of the IC are committed to interoperability of systems used for formatting, transmitting, receiving, and processing imagery and imagery-related information. This standard describes the Vector Quantization (VQ) decompression algorithm for the National Imagery Transmission Format (NITF) file format and establishes its application within the NITFS.

5. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Central Imagery Office, STSD/ISD, 14675 Lee Road, Chantilly, VA 22021, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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PARAGRAPH PAGE

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1. SCOPE

1.1 Scope. This standard establishes the requirements to be met by NITFS compliant systems when image data are decompressed using the VQ compression algorithm. This allows NITFS-compliant systems to accept and decompress data that are compressed using a VQ compression scheme. This standard describes the VQ compression in the general requirements section, but does not fully describe the steps for compression. The steps involved in decompressing images compressed with VQ are fully described by this standard.

1.2 Content. This standard provides technical detail of the NITFS VQ decompression algorithm, designated by the code C4 or M4 in the image compression field of the image subheader in a NITF file.

1.3 Applicability. This standard is applicable to the IC and the DOD. It is mandatory for all Secondary Imagery Dissemination Systems (SIDS) in accordance with the memorandum by the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence ASD(C^3I) Subject: National Imagery Transmission Format Standard (NITFS), 12 August 1991. This directive shall be implemented in accordance with the MIL-STD-2500A, JIEO Circular 9008, and MIL-HDBK-1300A. New digital imagery equipment and systems, those undergoing major modification, or those capable of rehabilitation shall conform to this standard.

1.4 Tailoring task, method, or requirement specifications. The compliance requirements for implementation of this decompression algorithm are defined in JIEO Circular 9008.

1.5 Types of operation. This standard establishes the requirements for the communication or interchange of image data in VQ compressed form. Each type of operation defined by this standard consists of two parts:

a. The compressed data interchange format (which defines the image data field of the NITF file format).

b. The decoder.

Two types of operations are specified by the acquisition authority:

a. Type 1 - Eight-bit monochrome sample compression

b. Type 2 - 24-bit color sample compression

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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4 and 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional informaton 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, 4 and 5 of this standard, 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 issue 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.

STANDARDS

MILITARY

MIL-STD-2500A	-	National Imagery Transmission Format (Version 2.0) for the National Imagery Transmission Format Standard.

HANDBOOK

MILITARY

MIL-HDBK-1300A	-	National Imagery Transmission Format Standard (NITFS).

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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. Unless otherwise specified, the issues are those cited in the solicitation.

DISA/JIEO Circular 9008	-	NITFS Certification Test and Evaluation Program Plan.
ESC-TR-93-314	-	Analysis of Compression Techniques for Common Mapping Standard Data, Markuson, N.J., July 1994.

(Copies of DISA/JIEO Circular 9008 may be obtained from Defense Information Systems Agency, Joint Interoperability Test Command (JITC), Building 57305, Fort Huachuca, AZ 85613-7020. Copies of the ESC Technical Report (TR) can be obtained from USAF/AFMC/ESC/YVD, 5 Eglin Street, Hanscom AFB, MA 01731-2124.)

Supersedes page 3 of MIL-STD-188-199.

2.3 Non-Government publications The following document(s) form 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.

Abut, Huseyin (Ed.), Vector Quantization, IEEE Press, New York, NY, 1990

(Application for copies should be addressed to IEEE Customer Service, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.)

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. DEFINITIONS

3.1 Acronyms used in this standard. The following definitions are applicable for the purpose of this standard. In addition, terms used in this standard and defined in the FED-STD-1037B shall use the FED-STD-1037B definition unless noted.

a.	ADRG	ARC Digitized Raster Graphics
b.	AFMC	Air Force Materiel Command
c.	ARC	Equal Arc Second Raster Chart/Map
d.	ASCII	American Standard Code for Information Interchange
e.	ASD(C^3I)	Assistant Secretary of Defense for Command, Control, Communication, and Intelligence
f.	BWC	BandWidth Compression
g.	CFS	Center for Standards
h.	CLEVEL	Compliance Level
i.	COMRAT	Compression Ratio
j.	DISA	Defense Information Systems Agency
k.	DOD	Department of Defense
l.	DODISS	Department of Defense Index of Specifications and Standards
m.	ESC	Electronic Systems Center
n.	IC	(1) Intelligence Community (2) Image Compression
o.	JIEO	Joint Interoperability and Engineering Organization
p.	JITC	Joint Interoperability Test Command
q.	LUT	Lookup Table
r.	M	Monochromatic
s.	MOA	Memoranda of Agreement

t.	NBPC	Number of Blocks Per Column
u.	NBPR	Number of Blocks Per Row
v.	NITF	National Imagery Transmission Format
w.	NITFS	National Imagery Transmission Format Standard
x.	NPPBH	Number of Pixels Per Block Horizontal
y.	NPPBV	Number of Pixels Per Block Vertical
z.	NTB	National Imagery Transmission Format Standard Technical Board
aa.	PVTYPE	Pixel Value Type
ab.	RGB	Red, Green, Blue
ac.	SIDS	Secondary Imagery Dissemination Systems
ad.	TR	Technical Report
ae.	VQ	Vector Quantization

3.2 Definition of terms. The definitions used in this document are defined as follows:

a. Band - For the purpose of MIL-STD-188-199, a two-dimensional array of pixels that comprise a monochromatic image or one of multiple arrays that comprise a multidimensional image, such as multispectral image.

b. Big Endian - For the purpose of MIL-STD-188-199, an ordering of bytes within a file such that the most significant byte is recorded and read first, and successive bytes are recorded and read in order of decreasing significance.

c. Byte - For purpose of MIL-STD-188-199, a byte is a sequence of eight binary digits, usually treated as a unit.

d. C4 - The NITF American Standard Code for Information Interchange (ASCII) code used to indicate the VQ compression algorithm.

e. code_size - The size of each image code in bytes.

f. Codebook - An array of values used to represent rectangular blocks or kernels of the image data.

g. Columns - Pixels per line in an image band.

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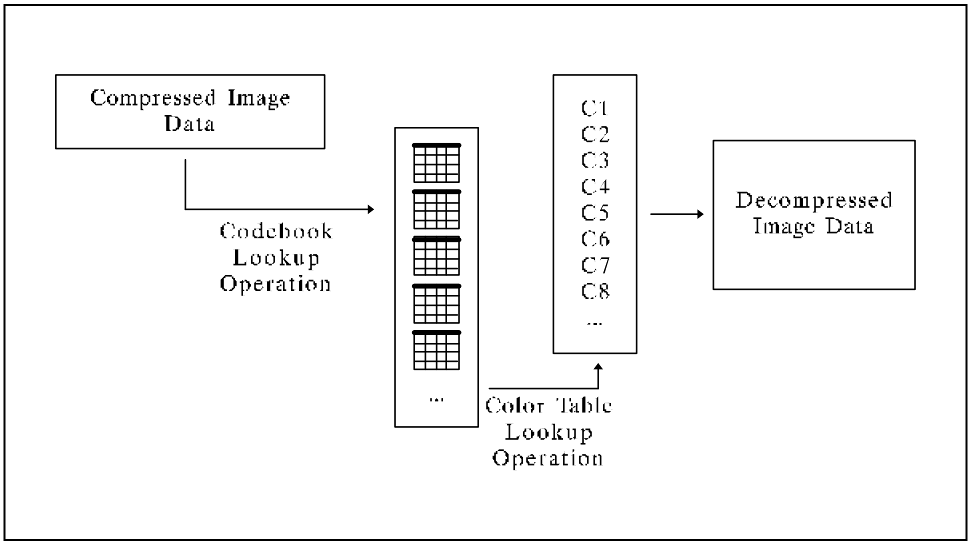

FIGURE ***3.*** Decompression process flow**.**

This specification does not limit the implementation of VQ within NITF in terms of the types and sizes of color lookup tables allowed. However, current implementation of VQ within NITF uses 8-bit RGB with LUT, or monochrome with or without LUT and many of the examples and figures in this document are specific to this implementation. Other organizations of VQ within NITF may be implemented in the future. VQ decompression detailed requirements are found in paragraph 5.2.

4.5 Compression ratio. The amount of compression provided by the VQ compression process is dependent on the size of the v x h kernel used for compression, and the number of entries in the color table and codebook. These values are given, for each image, in the VQ header section for the NITF image. A formula to determine the theoretical compression ratio provided by the VQ process (which is independent of the size of the input image and includes color compression) is as follows:

$$\text{Theoretical Compression Ratio} = \frac{\text{vsize x idepth}}{\text{code\_size x odepth}} \quad (1)$$

In the above equation, *vsize* is the size of the compression kernel in pixels (v x h), idepth is the size in bytes of each individual pixel for the input image For example, if the original image is an RGB Equal Arc Second Raster Chart Map (ARC) Digitized Raster Graphics ADRG. The parameter code_size is the size of each image code in bytes; odepth is the size of the color for the output pixels in bytes. For example, if the output of the decompression process is an image with a 256-entry (one-byte) LUT, odepth would be 1. Normally there is a significant difference between the theoretical compression ratio and the actual compression ratio. This difference is due to the fact that the compression codebook and color table add to the size of the compressed image. Overhead information, including the codebook and color table must be included to determine the actual compression ratio provided by the compression technique. The actual compression ratio for NITF VQ images can be calculated as follows, with isize equal to the size of the input image in pixels:

$$\text{Actual Compression Ratio} = \frac{\text{isize x idepth}}{[(\text{size / vsize}) \text{ x code\_size + Overhead}]} \quad (2)$$

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The following example shows the theoretical and actual compression ratios for a digitized 24-bit (3byte) RGB map image with size 1536 x 1536 pixels, kernel size of 4 x 4, codebook length of 4096 bytes with a 12 bit (1.5 byte) code_size, with 3K bytes for miscellaneous overhead, which includes an 8-bit (1-byte) color table that is 1K in size.

$$\text{Theoretical Compression Ratio} = \frac{16 \times 3}{1.5 \times 1} = 32 : 1 \qquad (3)$$

$$\text{Actual Compression Ratio} = \frac{2{,}359{,}296 \times 3}{(2{,}359{,}296/16) \times 1.5 + 68608} = 24.42 : 1 \qquad (4)$$

The overhead in this example is equal to the size of the codebook (4096 entries x 16 pixels per entry), plus the size of the color lookup table and other NITF overhead which total approximately three kilobytes, for a total overhead of 68,608 bytes. Additional information regarding the compression of data is provided in section 5 of this document.

Supersedes page 12 of MIL-STD-188-199.

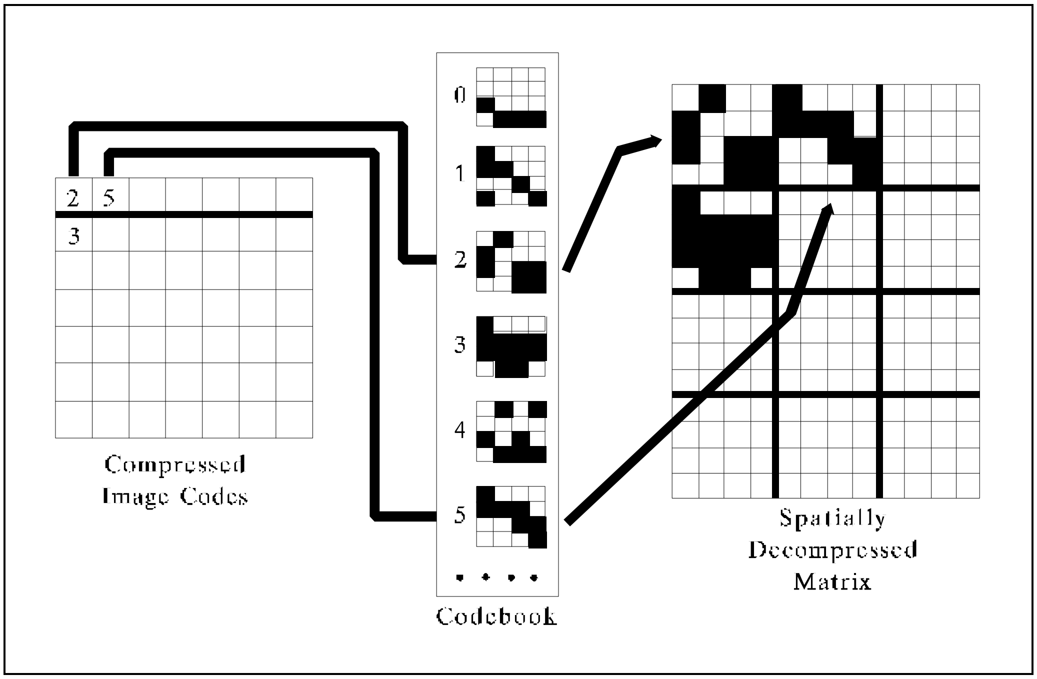

FIGURE 5. Spatial decompression.

5.2.2 Color decompression. As described in section 4.4, this specification does not limit the implementation of VQ within NITF in terms of the types and sizes of color lookup tables allowed. However, current implementation of VQ within NITF has a limited scope and uses 8-bit RGB with LUT, or monochrome with or without LUT. Many of the examples and figures in this document are specific to this implementation. Other organizations of VQ within NITF may be implemented in the future.

a. The output from the spatial decompression process described in paragraph 5.2.1 is an array consisting of values that represent either (1) monochromatic (grayscale) values for an image that is not color compressed or (2) indices to the LUT in the NITF image subheader (see figure 2) if the image requires the use of a LUT. The final decompression step for color compressed images shall transform the indices into their corresponding pixel values by using the LUT values. Figure 6 shows an example LUT operation involving the use of a mapped color, or RGB LUT.

Supersedes page 15 of MIL-STD-188-199.

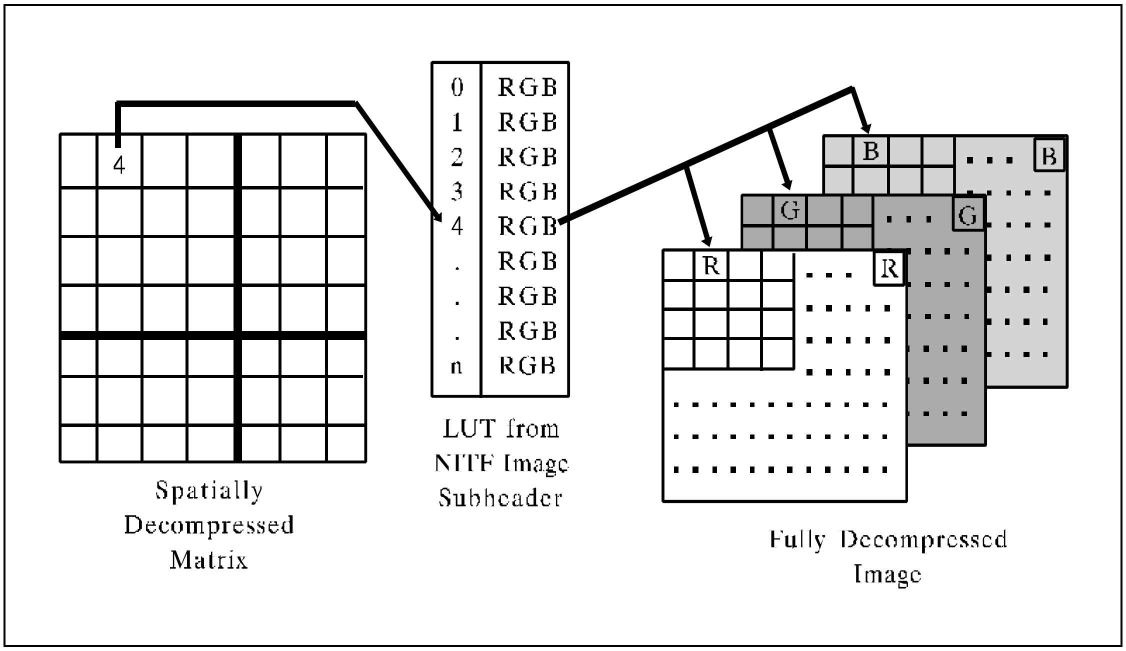

FIGURE 6. Color decompression.

5.2.3 Data elements compression ratios, and several. The NITF VQ format allows for many possible organizations of the compression codebooks and color tables. The NITF VQ file contains the information that the user needs in order to understand the organization of the data and to decompress the data for display. The following sections describe the fields in the NITF VQ file that shall be used to determine the VQ organization of a particular file. The various sections described in 5.2.3.1 through 5.2.3.4 identify various levels of organizations within the NITF VQ image data section and are shown on figure 7 beginning and ending with a square bracket, for example, [compression section]. The notation used for the VQ fields is given in Appendix A.

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```
{1}
[nitf image data]
    {2}
    <blocked image data offset>,uint:4(0, 1)
    [mask subsection] (0, 1)
        {3}
        [mask subheader]
        [block mask table] (0,1)
        [transparency mask table] (0, 1)
    {2}
    [VQ Header]
        {3}
         image display parameter sub-header]
            {4}
            <number of image rows>,uint:4
            <number of image codes per row>,uint:4
            <image code bit length>,unint:1
        {3}
        [compression section]
            {4}
            [compression section subheader]
                {5}
                <compression algorithm id>,uint:2
                <number of compression lookup offset records>,uint:2
                <number of compression parameter offset records>,uint:2
            {4}
            [compression lookup subsection]
                {5}
                <compression lookup offset table offset>,uint:4
                <compression lookup table offset record length>,uint:2
                [compression lookup offset table]
                    {6}
                    [compression lookup offset record] (1, ... many)
                        {7}
                        <compression lookup table id>,uint:2
                        <number of compression lookup records>,uint:4
                        <number of values per compression lookup record>,uint:2
                        <compression lookup value bit length>,uint:2
                        <compression lookup table offset>,uint:4
                {5}
                [compression lookup table] (1, ... many)
                    {6}
                    [compression lookup record] (1, ... many)
                        {7}
                        /compression lookup value/,bits:var (1, .. many)
    {2}
    [compressed image data]
        {3}
        [spectral group] (1, ... many)
            {4}
            [subframe table] (1, ... many)
                {5}
                [spectral band table] (1, ... many)
                    (6}
                    [image row] (1, ... many)
                         {7}
                         [spectral band line] (1, ... many)
                             {8}
                             /image code/,bits:var (1, ... many)
```

FIGURE 7. Structure of the NITF image data section.

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5.2.3.1 Compression ratio. The Compression Ratio (COMRAT) field shall be present in all NITF VQ files and shall contain a value given in the form n.nn representing the average number of bits-per-pixel for the image after compression (See MIL-STD-2500). In the example given in section 4.5, the value for COMRAT would be the idepth (bytes) x 8 (bits/byte) = 24 bits, divided by the theoretical compression ratio (32), yielding a bpp of 0.75. Although other NITF compression algorithms may need this value to properly decompress the NITF image, this entry in a VQ compressed file is purely informational and is not used in the decompression process.

5.2.3.2 Masked vs. unmasked images. In VQ images, the Image Compression (IC) field shall contain the value C4 if the image is not masked or M4 if the image is masked. MIL-STD-2500 contains an explanation of masking as it relates to VQ images.

5.2.3.3 Codebook organization The compression section within the NITF VQ image data section (shown as image data on figure 2) defines the organization of the VQ codebook. The user of the VQ data will need to understand how many compression codes are present in the codebook, the size of each v x h kernel and how the data that make up the kernels are organized. The number of entries in the codebook is represented by the <number of compression lookup records>. For example, if the <number of compression lookup records> equals 4096, then there are a total of 4096 v x h kernels represented in the codebook.

a. To determine how many pixels make up each compression kernel, the <number of image rows> and <number of image codes per row> are used, along with the number of pixels per block vertical (NPPBV) and the number of pixels per block horizontal (NPPBH) in the NITF image subheader. For example, as 256 x 256 blocked image with 128 rows of compressed image data, and 128 compressed image codes per row would have a kernel size of v = (256/128) = 2 by h = (256/128) = 2. The following equation is used to determine the size of the compression kernel in pixels:

$$v = \frac{\text{NPPBV}}{\text{<number of image rows>}} \qquad h = \frac{\text{NPPBH}}{\text{<number of image codes per row>}} \qquad (5)$$

kernel size = v rows x h columns

b. The <number of compression lookup offset records> within the structure (see figure 7) shall equal 1 if the data is organized such that all the /compression lookup value/s for each kernel are grouped together. In this case, if the kernel size is 4 x 4, then the 16 /compression lookup values/ that make up each kernel are grouped sequentially, starting with the first /compression lookup value/ in the first kernel and proceeding in a row major fashion, through the last /compression lookup value/ in the last kernel.

c. If the <number of compression lookup offset records> is greater than 1, then the data for each kernel is organized into tables. Tyically, values for each row of the kernel. The <number of compression lookup records> and the <number of values per compression lookup record> can be used to determine the structure of the codebook when the <number of compression lookup tables> is greater than 1. For example, in the case above where the kernels are 4 x 4 in size, if the <number of compression lookup tables> equals 4, then the 16 pixels that make up the kernel are divided into four tables, each of which represents the /compression lookup values/ for one row of the kernel. In this scenario, the <number of values per compression lookup record> would also be equal to 4. The 16 element kernel is effectively split into 4 tables, one representing

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CONCLUDING MATERIAL

Custodians:

Army - SC
Navy - EC
Air Force - 90
Misc - NS

Preparing activity:
Misc - CI

Agent:
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(Project TCSS-1990)

Review activities:

OASD - SO, DO, HP, IR, IQ
Army - AM, AR, MI, TM, MD,
CE, IE, ET, AC, PT, CR2
DLA - DH
Misc - NS, MP, DI, NA, DC1, DC7
Navy - NC, MC, OM, TD, CG
Air Force - 93, 33, 21, 29, 02, 13, 7

Civil agency coordinating activities:

USDA - AFS, APS
DOC - NIST
DOE
EPA
GPO
HHS - NIH
DOI - BLM, GES
DOT - CGCT
NCS, OST

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1,2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER **MIL-STD-188-199**	2. DOCUMENT DATE (YYMMDD) **940627**

3. DOCUMENT TITLE
VECTOR QUANTIZATION DECOMPRESSION FOR THE NITFS

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

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) AUTOVON *(If applicable)*	7. DATE SUBMITTED *(YYMMDD)*

8. PREPARING ACTIVITY **CENTRAL IMAGERY OFFICE (CIO)**

a. NAME **STSD/ISD**	b. TELEPHONE *(Include Area Code)* (1) Commercial (2) AUTOVON
c. ADDRESS *(Include Zip Code)* **14675 Lee Road** **Chantilly, VA 22021**	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340

DD Form 1426, OCT 89 *Previous editions are obsolete.* 198/290