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**Digital Mapping, Charting, and Geodesy
Analysis Program (DMAP)
Technical Review of
Tactical Oceanographic Data Level 4 (TOD4)
Associated Performance Specifications,
MIL-PRF-89049/14 (15 March 2001)**

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14. ABSTRACT Tactical Oceanographic Data Level 4 (TOD4) is intended to be a digital replacement for the Hull Integrity Test Sites (HITS) Chart. TOD4 is in the Standard Vector Product Format (VPF) and is designed to be used in conjunction with Digital Nautical Chart (DNC) and TOD2 for complete navigation information. The intended use is to supplement the electronic chart display systems with detailed classified depth and other information to permit the safe surface and underwater navigation and operation of submarines and their escorts during submarine hull integrity tests. The TOD4 is intended for use by military branches of the government.					
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Contents

1.0	Background	1
2.0	Discussion	1
2.1	Previous Review	1
2.2	Environmental Factors	2
2.3	Latitude/Longitude Floating Point Representation	2
2.4	Symbology Issues	3
2.5	Collision and Duplication of Features	3
2.6	TOD4 Coverage Compared to DNC and Other TOD Products	3
3.0	Features and Attributes	4
4.0	Editorial Notes	8
5.0	Summary/Conclusions/Recommendations	8
6.0	Acknowledgments	6
	Appendix A. Samples of HITS Chart Graphics	10

**Tactical Oceanographic Data Level 4 (TOD4)
Associated Performance Specification, MIL-PRF-89049/14
(15 March 2001)**

1.0 Background

Tactical Oceanographic Data Level 4 (TOD4) is intended to be a digital replacement for the Hull Integrity Test Sites (HITS) Chart. TOD4 is in the Standard Vector Product Format (VPF) and is designed to be used in conjunction with Digital Nautical Chart (DNC) and TOD2 for complete navigation information.

The intended use is to supplement the electronic chart display systems with detailed classified depth and other information to permit the safe surface and underwater navigation and operation of submarines and their escorts during submarine hull integrity tests. The TOD4 is intended for use by military branches of the government.¹

2.0 Discussion

Two directions were taken to approach this review. First was to review the comments made in the last review (May 2000) and also to investigate an actual HITS chart. A meeting was held with Naval Oceanographic Office personnel (Ocean Products Department, Code N9, Margaret Schexnayder and Bruce Rumish) who were able to show us two HITS charts and gave us an unclassified copy of the original 1978 product specification for HITS charts as well as valuable information regarding the charts.

2.1 Previous Review

TOD4 was last reviewed in May 2000 with the following findings and recommendations:

- Four new feature codes and eight new attributes were identified.
 - These are further discussed in Section 3.0 of this current review.
 - A further look at a standard HITS chart versus the performance specification is also included in this review.
- DMAP found the coding of Hull Integrity Test Site Core Site or Grab Site was misclassified.
 - The code has been changed from BG050 to BF012.

¹ National Imagery and Mapping Agency, MIL-PRF-89049/14 (15 March 2001) *Associated Performance Specification Tactical Ocean Data – Level 4 (TOD4), Section 6.1.*
Manuscript approved June 5, 2002.

- Still under consideration are the symbology issues.

2.2 Environmental Factors

A review of the original HITS chart performance specification (1st Edition, October 1978) placed considerable emphasis on environmental information contained in the test area. This information was considered important for test operations or search and recovery should the need arise. Some of the environmental factors contained on HITS charts are:

- Water clarity at depths
- Sound velocity profile
- Currents at depths
- Bottom sediments and associated bearing capacity
- Magnetics
- Limited climatology and expected sea states

Samples of these environmental factors are shown in Appendix A. It should be further noted that **the majority of the environmental data is displayed on HITS charts in the margin as graphics.** VPF is a poor choice of data format for the encoding and subsequent display of this type of information. **In short, it is almost impossible to do with any measure of effectiveness.**

Section 3.11.5.2.1 of the Performance Specification states that the information originally contained on the HITS chart margin would be included by means of “notes related attribute table.” While some of the margin data can be effectively handled in this manner it is doubtful that the graphic elements can be given adequate textual description.

The current TOD4 specification fails to identify these factors. Perhaps operational methods have evolved since the original 1978 specification. However, **it should be verified that this information is readily available from alternative sources for all parties interested in the HITS areas.** In the case of accident or equipment failure, time will be of great importance. This places increased emphasis on having all pertinent data quickly available. **If this proves not to be the case, then DMAP recommends that this product specification be modified prior to acceptance to address the noted lack of environmental data.**

2.3 Latitude/Longitude Floating Point Representation

Calculations were conducted to estimate the possible effects on positional accuracy resulting from the use of single precision 32-bit floating point representation. A worse case scenario produced a quantization resolution of a little over 11 meters. At the scale of the chart this should be adequate. However, in consideration of the geographical extent of a HITS and the smaller number of cartographic elements compared to other VPF products (like DNC), adequate storage should be available on a single CD to permit the use of double precision floating points for the storage of positional information.

2.4 Symbology Issues

While the definitions of feature and attribute codes are essential, symbology has become increasingly important. This is especially true with the advent of GeoSym and Mil-Spec 2525, Common Warfighting Symbology. Both these symbol sets are increasingly used within the Department of Defense and thus it is important to choose symbology for “new” features that communicate effectively and do not conflict with existing symbology. However, it is unlikely that the “2525” symbols will be used contemporaneously with HITS. Additionally, some consideration should also be given to the techniques used by various display systems so as to avoid conflicts in methodology.

2.5 Collision and Duplication of Features

The TOD4 Product Specification states in Section 3.5.a:

“TOD4 is based on the feature content of hardcopy Hull Integrity Test Site (HITS) Charts produced by NIMA. It will, however, contain only the information that is not covered by the Digital Nautical Chart (DNC) and by the Tactical Ocean Data Level 2 (TOD2). The TOD4 must be used in conjunction with the appropriate DNC and TOD library coverages in the same area to ensure complete coverage for surface and subsurface navigation.”²

Consequently, TOD2 and DNC must be compared against TOD4 to ensure that no feature duplication is present. While this may be possible at the time of the TOD4 production, subsequent editions of TOD2 or DNC covering this common geographic region may contain new features not present in earlier editions. The presence of these features could lead to duplication.

Some GIS/display packages, when dealing with duplicate feature, may produce unpredictable results when the feature area is subjected to a geographical query. However, some duplication of features may be unavoidable in which case the software system that is working with the data will need to resolve this conflict.

2.6 TOD4 Coverage Compared to DNC and Other TOD Products

A comparison was made to the DNC specification for the features and attributes. Both the TOD4 coverages (earth cover and hydrography) are included in DNC, TOD1 and TOD2. It was noted, however, that the coverage of BD180 Wreck, was in earth cover in TOD4, in hydrography and/or obstructions in DNC, and in non-submarine contacts in TOD1 and TOD2. The following chart summarizes:

² Ibid., Section 3.5.

		BD180 Wreck			
	DNC	TOD4	TOD1	TOD2	
Product Coverage:	hyd	ecr	nsc	nsc	
	obs				

This is not necessarily a concern, unless affected by the proposed Combined VPF product.

3.0 Features and Attributes

As identified in an earlier DMAP review of TOD 4 (May 2000), there were four new feature codes developed to define Hull Integrity Test Site (HITS) that were not included in the DIGEST FACC, Edition 2.0a, February 1999. These features are still not included in the latest version, Edition 2.1, September 2000.

BF012	HITS Core Site or Grab Site
FC178	HIT Area
FC179	Side Scan Sonar Coverage
FC180	HITS Bottom Feature

Also identified in the earlier review, several new attributes were divided into two areas for Hull Integrity Test Site features and text features.

Hull Integrity Test Site (FC178)		Text (ZD040)	
htb	Hull Integrity Test Site – changes in bottom topography	Clr	Color of text
htc	Hull Integrity Test Site Characteristics (BE020, FC180)	Fon	Type of font
htd	Hull Integrity Test Site Direction of slope of test site	Size	Font size
hte	Date/Dates of Hull Integrity Test Site	Sty	Style of Text
htg	Hull Integrity Test Site Slope Gradient		
hth	Maximum height of obstacles in a Hull Integrity Test Site		
hts	Hull Integrity Test Site – Special Features		
htz	Hull Integrity Test Site Test Zone		

Separate Note: It was noted the attribute code for “font size” within ZD040 has four characters instead of the usual three. This is inconsistent with DIGEST.

Due to the short timeframe allowed for the prior review in May 2000, a more extensive look at the attribute values was not done. For this current review DMAP looked at the TOD4 attribute values as compared to the FACC available values and found, as expected, that not all defined FACC attributes were used when defining an existing feature. For example, the following table shows the available FACC attributes versus those anticipated for TOD4. However, those attributes shown in italics are suggested for inclusion in TOD4. The table also shows unit of measure differences such as meters vs. numeric.

Feature	Description	FACC Attribute Value Codes	TOD4 Attribute Value Codes
acc	Accuracy Category	0 Unknown 1 Accurate 2 Approximate 3 Doubtful 5 Disputed 6 Undisputed 7 Precise 8 Abrogated 997 Unpopulated 998 Not Applicable 999 Other	000 Unknown 001 Accurate 002 Approximate 003 Doubtful 997 Unpopulated 998 Not Applicable 999 Other
coe	Certainty of Existence	0 Unknown 1 Definite 2 Doubtful 3 Reported 997 Unpopulated 998 Not Applicable 999 Other	000 Unknown 001 Definite 002 Doubtful 003 Reported 997 Unpopulated 998 Not Applicable 999 Other
crv	Depth Curve or Contour Value	Metres	Numeric
cvh	Depth Curve or Contour Value High	Metres	Numeric
cvl	Depth Curve or Contour Value Low	Metres	Numeric
hdp	Hydrographic Depth	Metres	Numeric
hgt	Height above surface level	Metres	Numeric
hqc	Hypsography Portrayal Category	0 Unknown 1 Index 2 Intermediate 3 Supplementary (1/2) 4 Form Lines 5 Depression Index 6 Depression Intermediate 7 Approximate Index 8 Mound Index 9 Mound Intermediate 12 Intermediate Approximate 13 Supplementary Approximate 14 Supplementary (1/4) 15 Depression Approximate 16 Auxiliary 18 Intermediate Depression Approximate 19 Carrying Contour 20 Supplemental Depression 23 Supplemental Depression Approximate 98 Transition or erroneous 99 Connector 997 Unpopulated 998 Not Applicable 999 Other	000 Unknown 001 Index 002 Intermediate 003 Supplementary (1/2) 014 Supplementary (1/4) 997 Unpopulated 998 Not Applicable 999 Other

Feature	Description	FACC Attribute Value Codes	TOD4 Attribute Value Codes
snd	Sounding category	0 Unknown 1 Drying Heights 2 No bottom found 3 -7 Intentional blank values 8 Out of position 9 Slant 10 Ordinary 11 Not Regularly Maintained 12 Depth Known 13 Normal 14 Hairline 90 Adequately sounded 91 No bottom found at depth shown 92 Depth unknown 93 Doubtful sounding 94 Unreliable sounding 95 Least depth known 96 Least depth unknown 97 Value reported (not surveyed) 98 Value reported (not confirmed) 99 Maintained depth 997 Unpopulated 998 Not applicable 999 Other	<i>000 Unknown</i> <i>002 No bottom found</i> <i>009 Slant</i> <i>010 Ordinary</i> <i>997 Unpopulated</i> <i>998 Not Applicable</i> <i>999 Other</i>
sou	Exposition of sounding	0 Undefined 1 Within the range of depth ... 2 Shallower than the range of depth ... 3 Deeper than the range of depth... 997 Unpopulated 998 Not applicable 999 Other	<i>000 Undefined</i> <i>001 Within the range ...</i> <i>002 Shallower than the range ...</i> <i>003 Deeper than the range ...</i> <i>997 Unpopulated</i> <i>998 Not Applicable</i> <i>999 Other</i>
svc	Sounding velocity	0 Unknown 1 Echo Sounder calibrated at 4800 ft/sec Uncorrected 2 Echo Sounder calibrated at 1500 m/sec Uncorrected 3 Mathews Tables Corrected 4 Sound Velocity Meter Corrected 5 Corrected by other means of calibration 997 Unpopulated 998 Not Applicable 999 Other	<i>000 Unknown</i> <i>001 Echo Sounder calibrated at 4800 ft/sec Uncorrected</i> <i>002 Echo Sounder calibrated at 1500 m/sec Uncorrected</i> <i>005 Corrected by other means of calibration</i> <i>997 Unpopulated</i> <i>998 Not Applicable</i> <i>999 Other</i>
vca	Void Collection Attribute	0 Unknown 1 Data not requested by user 2 Area too rough to collect 3 No available imagery 4 Different height threshold within data block 5 Low data collection criteria 6 No available map source 7 No suitable imagery 8 Data not required 997 Unpopulated	<i>000 Unknown</i> <i>002 Area too rough to collect</i> <i>003 No available imagery</i> <i>006 No available map source</i> <i>007 No suitable imagery</i> <i>997 Unpopulated</i> <i>998 Not Applicable</i> <i>999 Other</i>

Feature	Description	FACC Attribute Value Codes	TOD4 Attribute Value Codes
		998 Not Applicable 999 Other	
vct	Void collection type	0 Unknown 1 Relief 2 Intentional blank values 997 Unpopulated 998 Not Applicable 999 Other	000 Unknown 001 Relief <i>997 Unpopulated</i> <i>998 Not Applicable</i> <i>999 Other</i>
wkt	Wreck type	0 Unknown 1 Anomalies 2 Aircraft 3 Auxiliary 4 Battleship 5 Barge 6 Buoy 7 Caisson 8 Aircraft Carrier 9 Cargo 10 Subchaser 11 Coaster 12 Cruiser 13 Ship debris 14 Destroyer ... 15 Dredge 16 Drill vessel or rig 17 Explosives 18 Fishing Vessel 19 Fishing Reef 20 Ferry 21 Frigate 22 Gunboat 23 Hospital ship 24 Hydrographic survey, air cushion, hydrofoil 25 Junk 26 Lash vessel 27 Landing craft, infantry 28 Gas carrier, natural petroleum 29 Landing Ship, infantry 30 Landing Ship, tank 31 Lightship 32 Minesweeper, minelayer 33 Net tender 34 Bulk carrier 35 Obstruction 36 Passenger cargo 37 Patrol boat 38 Pinnacle rock 39 Roll on – roll off 40 Sailing ship 41 Sea bee, lash barge 42 Submarine float 43 Submarine 44 Survey vessel	<i>000 Unknown</i> 035 Obstruction 998 Not Applicable <i>997 Unpopulated</i> <i>998 Not Applicable</i> <i>999 Other</i>

Feature	Description	FACC Attribute Value Codes	TOD4 Attribute Value Codes
		45 Tanker 46 Tender, submarine, airplane, oil rig 47 Target 48 Torpedo boat 49 Transport 50 Tug 51 Trawler 52 Very large container 53 Well head 54 Yacht 997 Unpopulated 998 Not applicable 999 Other	

4.0 Editorial Notes

The following editorial notes were found in the specification and are suggested for change:

Location	Comment
pg 3	3.2.1 and 3.2.2 remove extra period after "accuracy"
pg 11	3.11.5.2.1, reference made to MIL-PRF-89049A, section 3.16.4.3.1 not found; did find MIL-PRF-89049 (General Specification for VPF), section 3.16.4.2.1.1.
pg 13	Add period after Web Sites (next to last sentence)
pg 17	A.2 – add spaces before and after (TOD2) in second line

5.0 Conclusions and Recommendations

TOD4 as specified is adequate to contain the information content of the HITS chart within the test area proper. However, the specification fails to deal adequately with the graphic information included on HITS chart margins.

DMAP makes the following recommendations:

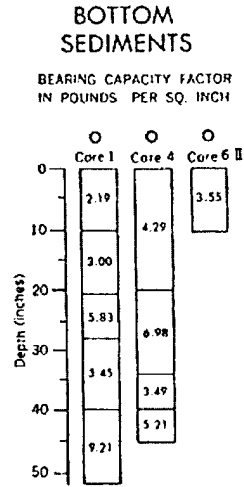
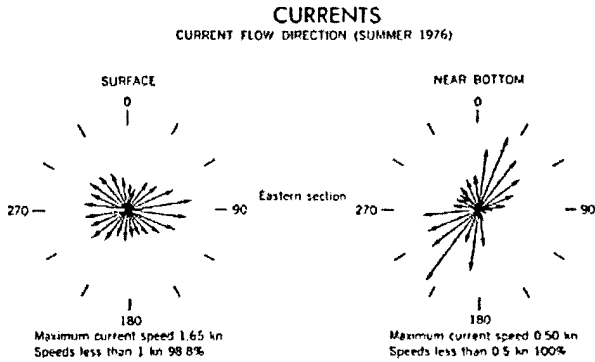
- Address the lack of effective techniques to convey data now in HITS chart margins that may be essential for the effective conduct of rescue operations. Ensure environmental factors shown in chart margins are accessible in some form or that the TOD4 product specification be modified prior to acceptance.
- Conduct discussions and planning to identify symbology to support the new features and attributes added by this product consistent with GeoSym symbology.
- Develop plans or methods to assure that DNC and other VPF products do not duplicate features in the HITS area during production.

- Ensure new features and attributes identified in TOD4 are submitted for formal acceptance and inclusion into the DIGEST FACC.
- Consider addition of other attributes as discussed to enhance attribute values.
- Consider the use of double precision floating point representation for positional information.
- Check on differences of the units of measurements between FACC and TOD4 (meters vs. numeric).

6.0 Acknowledgments

The Oceanographer of the Navy (N096) funded this effort to evaluate the Tactical Oceanographic Data Level 4 (TOD4) Associated Product Specification, MIL-PRF-89049/14 (15 March 2001) under the direction of LCDR Karen Ruppe. This evaluation, funded under Program Element 0603704N, is a part of the Naval Digital Mapping, Charting, and Geodesy Analysis Program (DMAP) long-term focus of enhancing the Navy's use and development of digital MC&G technologies. DMAP greatly appreciates the ongoing efforts of Dr. Edward Mozley, SPAWAR Program Manager.

Appendix A. Samples of HITS Chart Graphics



The sediment bearing capacity needed to support a 688-class submarine is 8.07 pst.

The composition of the bottom sediments is as follows: gravel, 0.2%; silt, 25.6%; clay, 33.2%; and sand, 41.0%

WEATHER

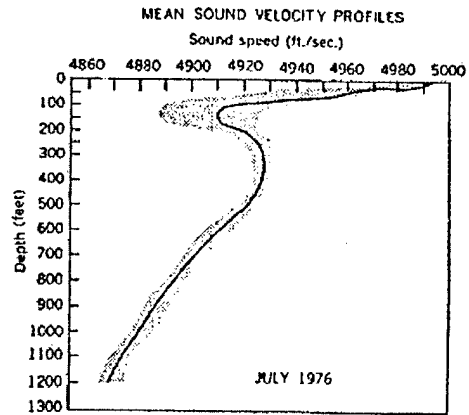
PERCENT FREQUENCY OF OCCURRENCE OF WIND-SPEED AND VISIBILITY WITH PREDOMINANT WIND DIRECTION, BY MONTH

	Windspeed Less than 22 kn	Windspeed 22-33 kn	Predominant Wind Direction	Visibility Less Than 5 Miles
Jan	72.0	22.4	NW	16.6
Feb	74.8	20.4	NW	19.1
Mar	78.8	17.2	W	18.3
Apr	86.9	11.3	W	22.6
May	93.6	5.8	SW	29.3
Jun	95.8	4.0	SW	38.8
Jul	97.2	2.6	SW	35.8
Aug	96.2	3.5	SW	26.7
Sep	92.2	6.8	SW	18.2
Oct	84.9	13.1	W	12.1
Nov	79.0	17.4	W	10.4
Dec	70.6	23.4	NW	10.5

Fog occurs 13.3% of the time per year with 27% occurrence during May-July.

Windspeed and visibility data from Summary of Synoptic Meteorological Observations (SSMO), North American Coastal Marine Areas, Volume 2, published by the Director of Naval Oceanography and Meteorology.

SOUND VELOCITY



Nine vertical profiles (surface to near bottom) of sound velocity measurements were taken in July and November 1976. The bounds of the shadow area in both graphs represent the variation over the area. The curve inside the shadow area represents an average of the measured values.

In the summer the mixed layer extended to 300 feet, which caused a sound duct to exist at 150 feet. This duct would inhibit surface-to-bottom communication. In November the sound velocity profile should not hinder surface-to-bottom communication.