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**Digital Mapping, Charting, and Geodesy
Analysis Program (DMAP)
Technical Review of
Tactical Ocean Data (TOD) Levels 0, 1, 2**

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14. ABSTRACT Technical reviews of the Tactical Ocean Data Levels 0, 1, and 2 Performance Specifications were performed by the Digital Mapping, Charting, and Geodesy Analysis Program (DMAP). Background, discussion, recommendations, and conclusions are presented for each review.					
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Technical Review of Tactical Ocean Data (TOD) Levels 0, 1, 2

1.0 Background

The Tactical Ocean Data (TOD) is a vector-based digital product that portrays seafloor configuration, particularly in areas deeper than 183 meters (100 fathoms) in a format suitable for computerized subsurface navigation. It is intended for use in conjunction with the Digital Nautical Chart (DNC) for complete navigation information. The TOD also functions as a general-purpose global database designed to support Geographic Information System (GIS) applications. This review encompasses specifications for TOD Levels 0, 1, and 2, each of which provides descriptions of the content, accuracy, data format, and design of the respective level of TOD database. In addition, TOD portrays strategic information to support naval operations. Since the TOD is a multi-level product designed to always be used in conjunction with the DNC, the main emphasis of this review is threefold, including: 1) determining if each of the TOD levels are sufficient to be used with DNC alone as an integrated product; 2) determining if the different TOD levels can complement each other in a manner that allows the user to easily transition from one level to the next; and finally 3) identifying if these products work well with other standard and non-standard spatial data products.

The following table shows the differences among TOD Levels 0, 1, and 2.

1.1 Table 1. TOD Intended Uses

Level	Intended Use & Data Sources	Use and # of Charts
TOD0	Limited distribution information portraying Naval Operating Areas, Ranges, and Exercise Areas for use with DNC and GIS applications	Least complex of TOD Products. OP areas and Exercise Charts (55 charts)
TOD1	Detailed classified depth information to permit the safe underwater navigation of submarines. Hydrographic sources are: BNPC, TOD2, DNC, Track data and US Navy quality surveys.	Bottom Contour Chart >200 m (452 charts)
TOD2	Detailed classified depth information to permit the safe underwater navigation of submarines. Hydrographic source is NAVOCEANO Ocean Survey Program data.	Bathymetric Navigation Planning Chart >200 m (657 charts)

2.0 Reviews

The following sections review each of the TOD from different aspects including editorial notes, differences in coverage names, and their comparison with Digital Nautical Chart libraries and F_Codes. Each of the items listed in the following tables also contain a reference as to how

critical the recommendation is in relation to the finalization of its respective TOD Specification. This is in response to NIMA Memorandum Serial U-002-02/PST of 20 May 2002, which states that changes should be denoted, as either *essential* or *suggested*.

Table 2. Editorial Notes for TOD0, 1, and 2

Item#	Necessity	Page	Section	Comment
1	Suggested	1	1.1	Underline Scope to be consistent
2	Essential	2	2.3	TOD0, 1, 2 and VPF 2407 all state their documents take precedence. Is that possible?
3	Suggested	2	2.3	Add period after 2.3 Order of precedence
4	Suggested	2	3.3.1	Remove extra space before WGS84
5	Suggested	9 (TOD0 only)	Table 6	Align column headings under Feature Classes
6	Suggested	11, 13 (or 14)	3.16.2.2.a 6.8	“NIMA Customer Help Desk” or as renamed in the FFD Spec, 6.9, “NIMA Operational Desk”
7	Suggested	11 (TOD0 only)	4.3.2	Indent alpha tabs a – c
8	Essential	12	6.5	Changes are to be marked by vertical lines; no lines were indicated in this revision
9	Suggested	15	B.3.1	Underline General to be consistent
10	Suggested	17	Table B – 3	Remove page break so Table is below header
11	Suggested	31	Table B – 13	Remove page break so Table continues
12	Suggested	36f	Appendix B	Align tabs on F_Code columns
13	Suggested	43	C.3	Heading should be all caps to be consistent

2.1 Expanded Comments

The following section presents expanded comments to any items in Section 2.1 marked essential and needing further explanation.

2.1.1 Item 2: Document Precedence

Consideration must be given as to what happens when these products are used in unison? This may require that the specification indicate that the highest resolution data would take precedence. Therefore, if there were differences between two or more data elements, the specification for the data entity from the higher resolution product, as defined in the DQ layer, would be given precedence over other data.

2.1.2 Item 8: Changes To Be Marked by Vertical Lines

Previous versions of the Specifications used vertical lines to denote changes. This version does not use this editorial technique. It is understood that since this review represents a near final evaluation, the use of change tracking may have been eliminated. However it would still be beneficial to the review process to note changes so as to facilitate a more expeditious review cycle.

2.1.3 Identifying the Need for Addressing Differences in Coverage Names Between TOD, DNC and VPF General Specifications

The coding of coverage names and attributes is a significant part of the design of geospatial data products. The use of consistently uniform nomenclature for coverage names and attribute values insures that GIS software can manipulate this data with the least amount of need for data deconfliction operations. It also eliminates user confusion in determining whether libraries, coverages and attributes with similar names are also related in data content. The following table reflects some potential inconsistencies in the names of Data Libraries and Coverage Names within the TOD products in relation to the VPF General Specification used by other DoD Standard Products. Further examination is advised to ensure full compatibility between these products. Since each of the TOD products will potentially be used in conjunction with other VPF products, consideration should also be given as to whether the VPF General Specification should serve as a guideline for naming both Libraries and Coverage Names. However, in the case of the Hydrography Data Library, it is noted that the TOD products often offer a more intuitive name for the feature (i.e., HYD for Hydrography in TOD and OEN in VPF).

Table 3.1 Differences in Coverage Names

Necessity	Data Libraries	Coverage Names			
		TOD 0	TOD 1 & TOD 2	DNC	VPF General Spec
None	Aeronautical	AER	--	--	AER
Essential	Data Quality	DQ	DQ	DQY	DQ
None	Earth Cover	ECR	ECR	ECR	--
Essential	Maritime	MAR	--	LIM	MLT, OEN
Essential	Hydrography	--	HYD	HYD	OEN
Essential	Non-submarine Contacts	--	NSC	OBS	OEN
Essential	Survey Information	--	SUR	--	OEN

2.2 Table 4. Comparisons between TOD and DNC Libraries and F_Codes

The following table offers more specific examples of differences in attribute feature codes contained within TOD products in relation to the DNC data product. The table indicates whether each FACC is present in the TOD and DNC products, and it attempts to identify whether F_Code or FACC attributes are different within these products. Careful consideration should be given as to whether these differences will have significant effects on using these products in an integrated GIS manner.

TOD Libraries	Coverage Name	F Code	FACC	TOD0	TOD1	TOD2	DNC & FACC note	DNC Library
Aeronautical	AER	ACC	GA035, GA055	x			x (GA035)	Cultural
		CHL		x				
		LFA		x				
		MAG		x				
		MCA		x			x (GA035)	Cultural
		NAM		x			x (GA035)	Cultural
		NST		x			x (GA035)	Cultural
		ORC		x				
		WPR		x				
		AUA	GA005, GA015	x				
		AUL		x				
		AUR		x				
		ICL		x				
		NAM		x				
		SUA		x				
Earth Cover	ECR		ZD040	x	x	x	x	Earth Cover
Maritime	MAR	COE	BG010, ZB035	x				
		CRN		x				
		CRX		x				
		CUR		x				
		DOF		x				
		HS1		x				
		HS2		x				
		NAM		x				
		STA		x				
		MBL	FC021, FC101, FC102	x			x (FC021 only)	Limit Boundaries
		COD	FC031, FC036, FC170	x			x (FC021, FC031, FC036)	Limit Boundaries
		MAC		x			x (FC021, FC031, FC036)	Limit Boundaries
		NAM		x			x (FC021, FC036)	Limit Boundaries

TOD Libraries	Coverage Name	F Code	FACC	TOD0	TOD1	TOD2	DNC & FACC note (FC021, FC036)	DNC Library
		TXT		x				Limit Boundaries
Hydrography	HYD	ACC	BE020		x	x	x	Hydrography
		CDV			x	x		
		COE			x	x		
		HDP				x	x	Hydrography
		SND			x	x	x	Hydrography
		SOU			x	x		
		SVC			x	x	x	Hydrography
		ACC	BE015		x	x		
		CRV			x	x		
		HQC			x	x		
		ACC			x	x		
		CVH			x	x		
		CVL			x	x		
Non-submarine Contacts	NSC	ACC	BD005, BD180		x	x	x (BD180)	Obstructions
		CDV			x	x		
		COE			x	x		
		EXS			x	x	x (BD180)	Obstructions
		HDP			x	x	x (BD180)	Obstructions
		NA4			x	x		
		NAM			x	x	x (BD180)	Obstructions
		PEV			x	x		
		RAG			x	x		
		SFC			x	x	x (BD180)	Obstructions
		TNG			x	x		
		TXT			x	x		
		WKT			x	x		
		WSR			x	x		
	SUR		BE040		x	x		
			BE030		x	x		

2.3 TOD Level 0 Review – Standalone Use With DNC Only

The general purpose of the TOD Level 0, as stated in the Associated Performance Specification, is to serve as a vector-based digital product that portrays Naval Operating Areas (OPAREAS), Ranges, and Naval Exercise Areas (NAVEX) in a format suitable for computerized navigation. The TOD0 is designed to stand alone as a global database for GIS applications. Although, since its absolute horizontal accuracy is stated as being 250 meters circular error at 90% probability, it should not be used to support any GIS operations that require zooming beyond a comparable level. When translated to a representative fraction (RF) scale, (e.g., a 1:250,000 scale WVS product has an absolute horizontal accuracy of 100m, the formula $x/250m = 250000/100m$ produces $x=625,000$) it appears that zoom levels of 1:625,000 or smaller would be adequate to support most GIS operations using TOD0. This scale would correspond to that of the GENERAL use library of the Digital Nautical Chart (DNC). Since it also states that only territorial limits of three and twelve nautical miles would be collected, this scale could adequately distinguish these limits from other prominent features such as shorelines.

It is noted that the scale above is computed based on the given absolute horizontal accuracy of 250m. The TOD0 specification does not note a scale factor based upon a latitude of true scale and/or prime meridian, but rather it states that “the compilation scale will vary based on the scale of the hardcopy charts”. Most GIS users may not be familiar with methods for calculating true scale and therefore NIMA should consider denoting an optimum representative scale for use of the TOD0 product in a GIS. For example, the World Vector Shoreline is designated as a 3 Arc Second or 1:250,000-scale product. Most users familiar with using GIS know not to exceed a zoom scale of 1:250,000 when using the WVS product. Providing a comparable RF scale for the TOD0 product would help the user better understand the limits by which the TOD should be used for feature extraction.

Section 3.5 of the TOD0 Associated Performance Specification states that “TOD0 must be used in conjunction with the appropriate DNC library coverage”. Therefore, TOD0 should not be considered adequate to support its use as a standalone product. Each of the TOD Specifications describes TOD as a “general purpose global database designed to support Geographic Information System (GIS) applications”. NIMA may also wish to clarify whether this definition still requires the use of DNC in conjunction with TOD, or if it could be used in GIS as a standalone product when not intended for navigation purposes. When used in conjunction with DNC and other Standard DoD Products, TOD seems to be sufficient for providing OPAREA, Ranges and NAVEX data features.

2.4 TOD Level 0 Review – Associated Use With Other TOD

Since the TOD0 Specification is designed to convey OPAREAS, Ranges and NAVEX, which represent boundaries of varying general scale, TOD0 data is the least complex of the TOD products and thus represents the smallest scale and accuracy of any of the TOD products. This should allow its data to be more easily integrated with any of the more complex data sets available in other TOD. However, the use of this data should always be consistent with the minimum and maximum bounds of the original data used to build the TOD0. The TOD0 Specification denotes that “the compilation scale will vary based

on the scale of hardcopy charts which vary depending on latitude and chart coverage”. Since Section 3.14.1 designates that the OPAREA Charts, Range Charts and NAVEX Charts are generally used to provide the fundamental source data sets, the TODO should not be used to support navigation at scales larger than these source data scales. Again, based upon scale calculations provided in the Section 2.4, this would equate to approximately 1:625,000.

2.5 TOD Level 0 Review – Associated Use With Other Standard/Non-Standard Products

The TODO Specification notes that the product “is designed to be used in conjunction with the Digital Nautical Chart (DNC) for complete navigation information”. However, with absolute horizontal accuracy reported as 250m with 90% circular error, one would suspect that this is not sufficient for navigation based on International Hydrographic Organization standards. Since TODO does not contain hydrographic data values, (i.e., soundings or depth contours) this should not be a problem for its use in navigation issues. *However, it might be noted that users should be made aware that the OPAREAS, Ranges and NAVEX boundaries represented are general boundaries and may not represent specific boundary positions when used in conjunction with much higher resolution navigation products.*

2.6 Review of Designated Changes to TODO Specification

The following comments are offered in reference to the changes to TODO Specification, 1st Edition, that were designated in the cover letter of instruction (re: NIMA Memorandum U-002-02/PST).

- 2.6.1** Minor corrections to VPF tables and adjustment of field lengths – *No additional comment is offered.*
- 2.6.2** Removed caveat on DQ layer geometry – *No additional comment is offered.*
- 2.6.3** Clarified requirement for depth contours and index contours – *Since changes were not indicated with vertical lines (see comments Section 2.1.2), the author is uncertain as to the change made. The Specification states the intended purpose of TODO is to convey OPAREAS, Ranges, and NAVEX boundaries. Therefore, no depth contours or index contours would be expected to be stored in TODO.*
- 2.6.4** Modified Information booklet to reflect migration from NAVINFONET...-*No additional comment is offered.*
- 2.6.5** Added symbol.rat table...- *No additional comment is offered.*
- 2.6.6** Corrected typographical errors...-*No additional comment is offered.*
- 2.6.7** Added Maritime Floating Point VDT... - *No additional comment is offered.*

2.7 TOD Level 1 Review – Standalone Use With DNC Only

The general purpose of the TOD Level 1, as stated in the Associated Performance Specification, is to serve as “a vector-based digital product that portrays seafloor configuration, particularly in areas deeper than 200 meters, and Non-submarine Contacts data in a format suitable for computerized subsurface navigation”. Like TOD0, the Level 1 TOD design supports its use only in conjunction with DNC for complete navigation information. It should, therefore, not be used as a standalone product. However, since the product contains “only the information that is not covered by the DNC”, any soundings and bathymetric information retrieved from the TOD1 should be of an accuracy level that is comparable to the accuracy of the DNC product with which it is being used. This once again presents some concern since the absolute horizontal accuracy stated for TOD1 is the same as TOD0, (i.e., 250 meters circular at 90 percent probability). *This might suggest that data features extracted from the TOD1 should only be used in conjunction with DNC GENERAL and APPROACH level products, since these are the only ones that report accuracies not exceeding the TOD1 horizontal accuracy. The danger in using TOD1 with higher resolution DNC would be that the user assumes the data to be equal in its accuracy relevant to the DNC data.*

2.8 TOD Level 1 Review – Associated Use With Other TOD

The use of TOD1 data with TOD0 data should not pose any inherent difficulties relevant to feature placement since both products have equal horizontal scale accuracy levels. The Specification does note that the Absolute Vertical Accuracy levels of these products may differ. However, since TOD0 contains no sounding/bathymetric data, any integration of TOD0 OPAREAS, Ranges and NAVEX boundaries in conjunction with soundings from TOD1 should not pose a problem. Also TOD1 and TOD2 reference the same vertical and horizontal datum, therefore no problems are anticipated in using these products in a integrated manner.

2.9 TOD Level 1 Review – Associated Use With Other Standard/Non-Standard Products

Again, TOD1 design supports its use in conjunction with DNC. Given the references to its horizontal and vertical accuracy levels, it is again recommended that care be given to consider scale and accuracy when integrating TOD1 and DNC along with any other standard or non-standard DoD data. *The author fails to understand how any other product of greater scale and accuracy could be used without the potential for abusing the intended accuracy of the TOD1 product.*

2.10 Review of Designated Changes to TOD1 Specification

The following comments are offered in reference to the changes to TOD1 Specification, 1st Edition, which were designated in the cover letter of instruction (re: NIMA Memorandum U-002-02/PST).

- 2.10.1 Minor corrections to VPF tables... - *No additional comment offered.*
- 2.10.2 Removed caveat on DQ layer geometry – *No additional comment offered.*
- 2.10.3 Clarified requirement for depth contours and index contours – *No additional comment offered.*
- 2.10.4 Modified Information booklet to reflect migration from NAVINFONET... - *No additional comment offered.*
- 2.10.5 Added symbol.rat... - *No additional comment offered.*
- 2.10.6 Corrected typographical errors...-*No additional comment offered.*
- 2.10.7 Added Maritime Floating Point VDT... - *No additional comment offered.*
- 2.10.8 Added attributes RAG and NA4... - *No additional comment offered.*

2.11 TOD Level 2 Review – Standalone Use With DNC Only

The general purpose of the TOD Level 2, as stated in the Associated Performance Specification, is to serve as a vector-based digital product that portrays seafloor configuration, particularly in areas deeper than 200 meters. Like previous TOD products, Level 2 also recognizes a horizontal accuracy of 250 meters and a vertical accuracy at or better than the sounding datum. Therefore, no problems are anticipated when extracting these features at scales appropriate to the original chart data. TOD2, like other TOD design, also supports its use in conjunction with DNC. Therefore any extraction of soundings from TOD2 should also be done at DNC scales that are comparable to the original chart scales of the data being extracted. This again equates to either the DNC GENERAL or COASTAL level charts. Since TOD2 states that it is designed for areas deeper than 200 meters, (i.e., potentially steep areas) it is anticipated that data requests for depth curves with small contour intervals (i.e., 10-20 meters) could generate values that exceed the horizontal accuracy of 250m with circular error of 90%. ***Again, although TOD2 usage is intended to accompany DNC, the user's request for data that is not contained within the DNC holds a great potential for the TOD2 data being used at scales that inappropriately exceed its accuracy levels.***

2.12 TOD Level 2 Review – Associated Use With Other TOD

The use of TOD2 data with TOD1 data should not pose any inherent difficulties relevant to feature placement since both products have equal horizontal and vertical accuracy levels. Once again, since TOD0 contains no sounding/bathymetric data, any integration of TOD0 OPAREAS, Ranges and NAVEX boundaries in conjunction with soundings or bathymetry from TOD2 should not pose a problem at small scales (i.e., 1:625,000). However, at larger scales, TOD2 feature placement must take president over any TOD0 or TOD1 features. Also TOD1 and TOD2 reference the same vertical and horizontal datum, therefore no problems are anticipated in using these products in an integrated manner.

2.13 TOD Level 2 Review – Associated Use With Other Standard/Non-Standard Products

Similar to TOD1, TOD2 design supports its use in conjunction with DNC. Given the references to its horizontal and vertical accuracy levels, it is once again recommended that care be given to consider scale and accuracy when integrating TOD2 and DNC along with any other standard or non-standard DoD data. *It should be recommended that only products with equal scale to the appropriate DNC product be used in conjunction with the TOD2 product.*

2.14 Review of Designated Changes to TOD2 Specification

The following comments are offered in reference to the changes to TOD2 Specification, 1st Edition, that were designated in the cover letter of instruction (re: NIMA Memorandum U-002-02/PST).

- 2.14.1 Minor corrections to VPF tables... - *No additional comment offered.*
- 2.14.2 Removed caveat on DQ layer geometry – *No additional comment offered.*
- 2.14.3 Clarified requirement for depth contours and index contours – *No additional comment offered.*
- 2.14.4 Modified Information booklet to reflect migration from NAVINFONET... - *No additional comment offered.*
- 2.14.5 Added symbol.rat... - *No additional comment offered.*
- 2.14.6 Corrected typographical errors...- *No additional comment offered.*
- 2.14.7 Added Maritime Floating Point VDT... - *No additional comment offered.*
- 2.14.8 Added attributes RAG and NA4... - *No additional comment offered.*

3.0 Conclusions

The changes made to the Associated Performance Specifications for TOD0, TOD1 and TOD2 seem to adequately reflect previous concerns about data content, geometry and minor grammatical errors reported in review of the first edition of the specification MIL-PRF-89049/10. This review raises some question concerning the intended user's perception of the accuracy of the TOD products. In specific, the fact that all three product specifications reference Absolute Horizontal Accuracy of the same value, (i.e., 250 meters circular error at 90% probability) would imply that TOD1 and TOD2 are not capable of representing larger scale data than TOD0. However, the base products used to develop these TOD products (i.e., BNPC, track data and other survey data) are of significantly higher resolution than the data presented in TOD0 (i.e., OPAREAS, Ranges & NAVEX boundaries). More clarification is needed in the Specifications to indicate to the user the appropriate scales at which each TOD product should be utilized. This is especially significant when TOD products are used for navigation purposes.

4.0 Recommendations

NRL recommends that a formal request be made to NIMA to clarify each of the TOD Specifications in the area of 'Scales of Intended Usage'. We recommend that the most appropriate scales for using each TOD product be determined based on the compilation methods and base charts from which each product is derived. These values should be reported to the user in the product specification and in the Data Quality fields of the TOD data. The values should report an optimum representative scale (i.e., 1:625,000) at which each product should be utilized.

NRL also recommends that further attention be given to examining the nomenclature used for Data Libraries, Coverage Names and feature attribute values. Table 2 of this review indicates some differences that could cause potential problems in using the TOD products in conjunction with other standard DoD products.

5.0 Acknowledgments

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