NAVAL AVIATION SYSTEMS TEAM

Mapping, Charting, & Geodesy Handbook

For the digitally perplexed
the cartographically disoriented
and the geospatially doomed
custom tailored for self resuscitation
in the privacy of your own cubicle

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Introduction

This handbook is for all members of the Naval Aviation Systems Team (TEAM). It is your initial reference for information about Mapping, Charting, and Geodesy (MC&G) support from the Defense Mapping Agency (DMA).

This handbook will:

clarify MC&G **relevance** to TEAM systems development and your job,

guide you in acquiring a necessary basic **competence** in MC&G,

explain the process for you to **get** DMA MC&G **data and services**, and

point you to **help** on MC&G within the TEAM, DMA, and elsewhere.

You don't have to read the whole thing front to back right away, if ever. We organized it for browsing. For more details on a particular topic see the

Where to find it:

box at the end of each section.

We recognize that you are important and busy. So we included Executive Gouge that distills the essence of the handbook to one page. If you read the Executive Gouge on the next page and intuitively grasp the fundamental implications of each nugget of truth...well, you need read no more! Furthermore, you are designated a Geospatial Information Prophet and authorized to grant audiences with those of dimmer wattage than yourself, and to reveal to DMA the next crisis area that needs to be mapped which is, of course, where our next war will be. If anyone needs to know, they do.

One other thing. When we generally speak of warfighters, we are not talking just about the shooters. We mean all of you on the TEAM: developers, planners, everybody. We know your support is integral to their success.

After initial hard copy distribution, this handbook will be on the NAVAIR Headquarters Network (NHN) and updated by your MC&G Team in Air-526.

If you now are beginning to wonder:

"Why is MC&G so important to the TEAM anyway?"

–please read on!

EXECUTIVE GOUGE

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Section I

DO YOU NEED MC&G SUPPORT FOR YOUR TEAM ACTIVITY?

Everyone on the TEAM has questions, problems, and issues; this is the nature of systems development. The common backdrop supporting Department of Defense (DoD) weapons systems and their development is MC&G spatially referenced data. So the $64 question is this: "Is my problem, issue, or question related to MC&G?" If your weapons system needs reference or positioning information, it uses geospatial information and you need to know about MC&G. Your system won't work without it. The newest weapons systems require *digital* geospatial information in increasing amounts, quicker, and on varying media for successful mission operations. So what is this thing called *geospatial information*?

1. **GEOSPATIAL INFORMATION.** Geospatial information is dimensional data referenced to the earth and its environment. Map makers give the information its meaning through formal representations that describe distances, direction, size, and relative position. Spatial objects, which vary in location or time, are either picture elements (pixels), points, lines, or areas (sometimes called polygons). Cartographers measure, encode with coordinates, and further defined these objects with other attributes and values, then store them in raster or vector data models for the warfighter's later use. This information can be printed or displayed as text, imagery, or accurate models of the real world. For maximum value to the warfighter, geospatial information should be worldwide, highly accurate, continuously updated, electronically delivered, and referenced in space in a universally usable way.

These ideas compose a new notional concept from DMA called Global Geospatial Information and Services (GGIS). GGIS is the future of MC&G. GGIS data will be used and exchanged anytime, anywhere for measuring, mapping, monitoring, modeling and simulation, mission rehearsal, evaluating the battle space, and for other new applications yet to be discovered. It will take many years, significant resources, and unprecedented cooperation throughout DoD to achieve the ultimate potential that an infrastructure of geospatial information promises. To be successful, GGIS must meet the *needs of informed customers like you*, rather than MC&G data providers like DMA.

2. **DMA.** DMA, established in 1972 from existing Service MC&G assets, provides MC&G combat support to the warfighters. DMA is a joint DoD agency under the direction and control of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD C^3I). The DMA Director, a flag officer, reports to the Chairman, Joint Chiefs of Staff (JCS) for operational matters. DMA also speaks for DoD on international MC&G issues.

DMA employs approximately 7,700 civilians and about 275 military personnel representing all Services. Professional specialties include cartography, geodesy, geology, astronomy, oceanography, remote sensing, photogrammetry, optics, computer science, and engineering. The DMA FY93 budget was $763 million, less than a day's worth of the DoD budget.

DMA is the sole DoD provider of MC&G support to joint warfighter operations; for example, combat, search and rescue, peacekeeping, evacuations, humanitarian efforts, counter drug operations, disaster relief, crisis, surveillance, deterrence, planning, training, special operations, and, of course, systems development.

Many DoD elements, including the development community, are not fully knowledgeable of the wide range of MC&G products and services available to them from DMA without cost. DMA makes over 230 MC&G product lines including 70 digital ones. More are on the way.

Advances in technology and warfighter expectations require DMA MC&G products and services of improved accuracy and currency, increased information content, covering more diverse areas of the world with faster delivery. These higher expectations are especially challenging in the present DoD budget reduction that has significantly impacted DMA.

3. **INTEROPERABILITY.** Joint Pub 1-02 says: "Interoperability is the ability of systems, units or forces to provide services to, and to accept services from, other systems, units or forces, and to use the exchanged services to operate effectively together." Talk about a classic understatement with leading implications!

DMA's goal for systems development is straightforward – joint MC&G interoperability in the battle space!

4. **MEMORANDUM OF UNDERSTANDING.** In June of 1993, the Director of DMA and the Commander of Naval Air Systems Command signed a Memorandum of Understanding establishing a DMA liaison position at NAVAIR. There is an urgent need to develop and identify MC&G requirements as early as possible in the system development cycle. The costs to be avoided are significant. The DMALO assists the TEAM in *early identification* of MC&G requirements for sensor systems, targeting systems, autonomous weapons, aircraft avionics, modeling and simulations, mission planning, and mission rehearsal systems from conceptual design through advanced development. The DMALO works closely with the TEAM to address their MC&G needs in system development documents

such as MNSs, ORDs, RFIs, RFPs, and COEAs. The DMA Liaison Officer (DMALO) also facilitates the exchange of MC&G policy and procedural issues such as planning, programming, budgeting, and management of requirements. While the DMALO represents the Director of DMA, the position is not another required layer of coordination. The liaison emphasis is on encouraging direct contact between the TEAM members and DMA action officers and simultaneous communication with the Meteorological/Oceanographic (METOC) Officer in NAVAIR to ensure proper coordination of MC&G requirements.

Where to find it:

✈ For more information on GGIS read **Strategic Direction for the Defense Mapping Agency: A Vision for the 21st Century** and **The Global Geospatial Information and Services Initiative** available from Air-526 at (703) 604-3380 ext 8118 [DSN 664]. ✈ A copy of the **Memorandum of Understanding** is available from Air-526 at (703) 604-3380 ext 8118 [DSN 664].

Section II

MC&G REQUIREMENTS IN TEAM SYSTEMS DEVELOPMENT

1. **TWO KINDS OF REQUIREMENTS.** There are two kinds of MC&G requirements: developmental requirements and operational requirements. They are different. Developmental requirements come from the service development commands such as NAVAIR. The usual MC&G outcomes are DMA test data sets, product prototypes, and hardware and software related to the development. On the other hand, operational requirements come from the Services, Unified Commands, and the JCS, not from the developers. These are also called "area" requirements because they identify where map coverage is needed for operational use. These go through a priority process so that DMA produces the most important areas first. System developers must take the initiative and talk to the warfighters and their MC&G support staffs early and often in the development process. If not, a system can deploy for which NO operational MC&G coverage exists. Believe it or not, this has already happened with embarrassing and costly consequences! There is no substitute for clear teamwork in MC&G.

2. **SOME BASIC CONSIDERATIONS.** DMA and the TEAM learned from painful experience the following MC&G *articles of faith* that apply to system development.

Article A. The **earlier** you involve MC&G in **development** the better for everyone. It saves big bucks. Be clear about when you need MC&G support in the development cycle.

Article B. Know, in **warfighter** terms, the **intended use(s)** of MC&G data. Nothing is more important! It drives the accuracy and every other characteristic of the product. Here are some examples of intended use:

Precise Target Coordinates
Strike Warfare
Mission Planning
Mission Rehearsal
Command, Control, and Communications
Intelligence
Antisubmarine Warfare
Electronic Warfare
Assault Operations
Special Operations
Mine Warfare

Amphibious Operations
Fleet Support
Construction
Antisurface Warfare
Anti-Air Warfare
Shared situational awareness
Rapid synchronization of joint forces
Interoperable real time information exchange
Visualization of entire battle space
Location reporting

System developers need to identify which uses will require additional applications software either furnished by DMA or developed by others.

Article C. What is the MC&G positional **accuracy required** by the warfighter? Express it in absolute and relative terms (feet or meters) at some probability level (typically 50 or 90%) for vertical and horizontal dimensions, or spherically. [See Section VII for more on this subject.]

Article D. What MC&G **information density and data coverage** does the warfighter need for expected areas of operation? This may seem relatively unimportant during development but it directly influences such variables as data storage capacity, processing speed, and selection of the storage medium. It requires close coordination among developers, operational planners, and those determining area requirements. This information drives DMA's production schedule to meet Fleet needs.

Article E. Choose the appropriate MC&G **digital data structure** (raster, vector, matrix, imagery, text). Most warfighters find data structures uninteresting; however, system developers need a basic familiarity to make intelligent decisions on implementation. Each structure has inherent advantages and disadvantages.

The raster structure has a simple format of rows and columns of pixels each having a row and column location that is geospatially referenced. All feature content within the pixel is condensed to a single value. There are several algorithms to choose the single value. This single value generalizes reality, but simplifies the data format, saving time and storage. Excessive magnification of a displayed raster file degrades the visual fidelity and does not improve the accuracy of the content.

In contrast to the single pixel value of raster features, vector features are described objectively and subjectively in great detail. The vector structure is more flexible because at any magnification it preserves feature content and retains maximum digitized positional accuracy. Vector is not a simple data structure; it requires sophisticated data manipulation software and significant storage typically resulting in slower times for data access and display.

The matrix (also called gridded) structure is a kind of raster that needs no condensing algorithm since the original source information is a single value. A good example is a data file of terrain elevations where each elevation is the pixel content.

Digital imagery is also a kind of raster that has richer information content by far. The richness of content is proportional to the size of the pixels.

The digital text structure includes text-based embedded objects (such as graphics) as well as the usual keyboard data (such as narrative descriptions).

Article F. Eliminate or minimize **pre-processing** of standard DMA MC&G data before warfighter use. In the past, DoD expended resources on proprietary contractor software that transformed standard DMA data for unique hardware. Such costly reformatting, data compression, and similar data manipulation are no longer affordable. Whenever possible, design the system to use standard DMA data. Early coordination with DMA will make integration easier.

Article G. Clearly identify each **functional capability**. Here are some examples:

Declutter logical groups of information (roads, for example)
Use the data for graphic display
Zoom, scan, roam, and rotate the display
Use the data internally for computations
Annotate new local information by the warfighter
Delete or change information
Load, change, access, and transfer the data base
Generate profiles
Handle data updates from DMA

Requirement for any transformation or other pre-processing of DMA data before use by the warfighter
Requirement for these capabilities to be interoperable with other systems for joint Navy or DoD operations
Switch from one coordinate reference system to another
Transform datums and projections
Customize symbology
Measure distances, coordinates, elevations, and areas
Output to hard copy
Search by names and other attributes
Capability to perform lossy or lossless compression of spatial or color data
Adjust MC&G display for varying glare, ambient brightness, and shadows
Accurately correlate aircraft position with MC&G data position

What are the associated performance characteristics for each capability? How easy to use? How fast? Do these capabilities require unique software tools and applications that are not available from DMA?

Article H. How will **updates** (additions, deletions, corrections) to the MC&G data be managed?

Article I. What storage **medium** does the warfighter need? A CD-ROM has the storage capacity of about 600 MB or 22 square feet of paper maps. This equals about four 1:250,000 maps or 10,000 square nautical miles. A CD can also hold more than 200 1° cells of DTED (280 million elevations) covering 440,000 square nautical miles. For comparison, this much data would require between 10 and 20 half-inch nine-track Computer Compatible Tapes (CCT) recorded at 6,250 CPI. Other storage possibilities include write once read many (WORM) optical discs, 8 mm digital cassettes, erasable optical discs, and video discs.

Article J. Build in a capacity for **growth** where it makes sense. The potential applications for MC&G data are still not fully known.

3. **THE ROLE OF CNO (N096).** The Oceanographer of the Navy, CNO (N096), is responsible for all Navy MC&G matters (which includes Marine Corps aviation through the NAVAIR link) including validation and submission of Navy MC&G requirements to DMA. You probably are asking yourself: Why the Oceanographer of the Navy? Navy's contribution to MC&G source information originated with the collection of bathymetry data, and N096 still owns the ships that collect this data.

When the Fleet needs MC&G support, TEAM developers determine whether an adequate product already exists. If not, they work with DMA to develop a new or modified product. They submit this requirement by letter through N096 to DMA.

4. **THE ROLE OF CNMOC.** The Commander, Naval Meteorology Oceanography Command integrates fleet and development requirements into the integrated survey plan. This five year survey plan dictates the employment of the Oceanographic Fleet that is under the direction of the Naval Oceanographic Office. The Oceanographic Fleet collects oceanographic information such as bathymetry, gravity, acoustic measurements, and non-acoustic parameters.

5. **THE ROLE OF NRL.** The Naval Research Laboratory, located at Stennis Space Center, has the Navy expertise for MC&G research and development. NRL produced CAC used by the F/A-18 and AV-8B aircraft. They also provide technical evaluation of all new DMA products for the Navy and Marine Corps. NRL has a wealth of experience in digital moving maps, digital data bases, compression of scanned map data, digital map image enhancement, color palette optimization, and software development for map stations and mission planning systems. Any TEAM program can work with them directly.

6. **EVALUATING DMA PROTOTYPES.** The TEAM, a big user of DMA products, greatly influences new product development. If you want to evaluate a prototype, contact the TEAM METOC Officer to get on the master list of prototype evaluators. Anyone on the TEAM can evaluate a prototype including your contractors. (Contractors must confirm their compliance with any release restrictions.) If you evaluate a prototype you also participate in technical exchange meetings and respond to questionnaires. Please keep in mind that due to the nature of prototyping minor changes can occur from the final prototype to the first production copy.

Data formats impact speed of retrieval. PLAN AHEAD so the Statement of Work covers prototype evaluation.

7. **WHEN YOUR CONTRACTOR WANTS MC&G DATA.** DMA digital data bases are defense information and an increasingly valuable national resource. All provided DMA data is government furnished information (GFI) under the DoD Federal Acquisition Regulations (DFARS). DMA Instruction 8660.10, "Procedures for Request, Release, Handling, and Distribution of Defense Mapping Agency Mapping, Charting and Geodesy Digital Products," provides some measure of protection by limiting access. It contains an extract from the DFARS about the limitations on distribution outside DoD. TEAM members need to know that recipients of DMA digital data are responsible for protecting this information against misuse or loss. Contractors can't duplicate, retain, or reuse the MC&G data. They must return it to the Government or destroy it upon completion of the contract.

Contractors submit requests for standard DMA products through their TEAM sponsor and the NAVAIR MC&G Team to N096. Release of MC&G data for system demonstrations is generally permissible if it remains under Government control at all times.

8. **MC&G AND FOREIGN MILITARY SALES.** Foreign access to DMA products and services is subject to security directives, international agreements, copyrights, and other release factors. DMAI 8660.10 states that DMA is not responsible for providing digital MC&G products for weapons systems sold to foreign governments.

Existing bilateral agreements between DMA and a particular country may already allow FMS release. To avoid delays and potential embarrassment for DoD, the TEAM must coordinate with DMA before making any commitments to release MC&G products to FMS customers. DMA handles each case separately. The Director of DMA is the sole release authority for DMA produced MC&G products, not TEAM developers or contractors.

Here are some examples of recent DMA FMS guidance:

> Unclassified products not otherwise restricted such as GNC, JNC, ONC, TPC, WVS, and DCW are releasable to FMS customers.
>
> DTED of a specific country may be released under the terms of a DMA Digital Agreement with that country.
>
> ADRG of GNC, JNC, and ONC products is releasable worldwide unless the ADRG contains foreign produced maps. In this case, release is subject to approval by the foreign co-producer.

ADRG of JOG and TLM is releasable if DMA has an existing bilateral agreement with the FMS customer and no other restrictions apply.

DAFIF is also releasable, but since it is updated every 28 days, the recipient will need to maintain a current data base.

Where to find it:

✈ Refer all FMS requests directly to the International Operations Directorate at Headquarters, DMA 285-9417 [DSN 356] or call your MC&G Team in Air-526 at (703) 604-3380 ext 8102 or 8118 [DSN 664, For a copy of **DMAI 8660.10** write DMA, Attn: AMO, Stop D-2, 4600 Sangamore Rd., Bethesda MD 20816 or call (301) 227-2026 DSN [287] or fax (301) 227-2359 DSN [287].

Section III

BUILDING YOUR MC&G LIBRARY

1. DOD DOCUMENTS.

DMA. DoD Directive 5105.40, "Defense Mapping Agency," established DMA, its mission, authority, responsibilities, and relationships. It also directs the use of DMA standard products except as authorized by ASD (C^3I).

MOP 31. Chairman Joint Chiefs of Staff Memorandum of Policy 31 (CJCS MOP 31), "Submitting and Assigning Priorities to Requirements for Mapping, Charting, and Geodesy Support," is the CJCS statement of policy for submitting and prioritizing MC&G operational requirements. DMA maintains the approved consolidated data base of DoD MC&G production priorities.

2. MILITARY SPECIFICATIONS AND STANDARDS.

National strategic objectives for joint and combined operations require interoperability of MC&G data, applications, and equipment. Interoperability of MC&G digital data and software assures consistent accuracy, data structure, feature coding, coordinate reference systems, datums, and spatial resolution. Interoperability allows exchange of MC&G information among warfighters, planners, and developers regardless of Service. It demands rigorous development and enforcement of DoD standards for geospatial data exchange and exploitation.

Military Specifications. DMA Instruction 8130.1, "Department of Defense Military Specifications for Mapping, Charting, and Geodesy Technology," defines the format and content of MC&G MIL-SPECS. Developers reviewing specifications may find this useful.

MC&G Glossary. MIL-HDBK-850, "Glossary of Mapping, Charting, and Geodetic Terms," is a valuable reference for developers unfamiliar with MC&G terminology and their meanings.

Standardization Report. DMA publishes a Standardization Report to relay the status of MC&G related MIL-SPECS, MIL-STDS, and MIL-HDBKS available and in work.

3. DMA DOCUMENTS.

The following DMA publications directly apply to weapons system development:

Strategic Direction. "Strategic Direction for the Defense Mapping Agency: A Vision for the 21st Century," published in February 1994, is a policy document

for the near-term and long-range future. The implications for advanced weapons system development are worth knowing.

GGIS. The best reference on GGIS to date is the professional paper, "The Global Geospatial Information and Services Initiative," written by Roberta Lenczowski of DMA and published in the 1994 IMAGE VII Proceedings. All TEAM system developers and their contractors need to understand the notional concepts behind this vital part of the evolving National Spatial Data Infrastructure (NSDI). GGIS will be the DoD worldwide spatial reference for interoperability.

Continuous Improvement. "DMA Plan For Continuous Improvement: Creativity, Excellence, and Teamwork," Version 2, implements the DMA strategic direction using a Total Quality (TQ) approach. It nicely compliments the TEAM vision.

TEAM MC&G Plan. "Naval Aviation Systems Team Mapping, Charting, and Geodesy Plan," is the action plan for your MC&G Team in Air-526. It was distributed to the TEAM in March 1994 accompanied by an Air-05 policy letter.

Data Transformation. DMA Instruction 8130.4, "Defense Mapping Agency Provision of Mapping, Charting and Geodesy Transformation Services," concerns the prior processing of standard DMA digital products and services before use by warfighters. It also defines "transformation," and implements related ASD(C^3I) policy.

Requesting MC&G Products and Prototypes. DMA Instruction 8660.10, "Procedures for Request, Release, Handling, and Distribution of Defense Mapping Agency Mapping, Charting and Geodesy Digital Products," covers requests for existing products including prototypes. It includes DMA Form 8660-6, "DMA Digital Product Request," used to order DMA digital products. The TEAM must comply with OPNAVINST 3140.55, "Submission of Requirements for Mapping, Charting, and Geodesy Products and Services," as well.

Requesting New Products. DMA Instruction 8052.1, "Validation of Requirements for New or Modified Non-Crisis Mapping, Charting and Geodesy Digital Products and Services," covers how to develop a Statement of Requirements for unanticipated but necessary near-term MC&G products.

Unique Service Requirements. DMA Instruction 5000.56, "Programming Unique Mapping, Charting and Geodesy Requirements for Developing Systems," implements DoD policy on interoperability and prescribes procedures for reimbursing DMA to satisfy an emerging system requirement when it is unique to

one Service. It also states that the ORD is the authoritative source document for MC&G developmental requirements.

Commercial Satellite Imagery. DMA Handbook 8290.2, "Handbook for Ordering Commercial Land Remote Sensing Satellite Data by the Department of Defense," tells you how to place orders with DMA for unclassified photographic and digital imagery from systems such as Landsat and SPOT.

List of DMA Products. DMA List 805-1A, "DMA List of Products and Services" is a basic reference for identifying (but not ordering) products and services available through DMA including some under development. It contains detailed descriptions and other useful summary information. Highly recommended.

Modernized Production System. "The DMA Modernized Production System Operations Concept Summary," written in 1988, explains integration of this new digital system into existing DMA analog production processes to significantly improve DMA mission capability. The $2.8 billion MPS contains over seven million lines of software code. It represents the leading edge of complex MC&G technology in the world.

Geodesy. DMA Technical Report 80-003, "Geodesy For the Layman," presents the basics of geodesy in elementary form – elementary being a relative term. TEAM members interested in target location error, precise coordinates, or datums need this enduring classic.

WGS 84. DMA Technical Report 8350.2, "Department of Defense World Geodetic System 1984: Its Definition and Relationships With Local Geodetic Systems," 2nd Edition, defines the DMA geometric, geodetic, and gravitational models of the earth. The International Civil Aviation Organization and the International Hydrographic Organization use WGS 84 as their global reference system. Included with the report is an MS-DOS diskette containing Mapping Datum Transformation (MADTRAN) software for coordinate conversion and datum transformation of 115 datums to or from WGS 84. Input and output are in geodetic, UTM, or MGRS coordinates. MADTRAN is easy to use and comes with instructions and internally documented source code. A classified supplement to this technical report is available.

Coordinate Selection Guide. The DIA/DMA Coordinates Working Group produced this poster in 1988. Although somewhat dated by the absence of GPS information, it is still a clear, concise, and valuable reference on the comparative accuracy of target coordinate sources. Every PEO and PMA should have a copy.

Digitizing The Future. This is an executive level document developed by DMA in direct partnership with warfighters, contractors, and other Federal agencies. It describes DMA standard digital products and data bases, prototype products, software, and special related subjects such as digital data structures. Very popular and highly recommended.

The DMA MCGrapher. This quarterly DMA newsletter, mostly about the status of new products, is free and available to anyone, including contractors.

4. OTHER SOURCES.

"Your Target Is...". This 1991 unclassified 20 minute video, a cooperative effort between DMA and DIA, is a logical companion to the Coordinate Selection Guide poster. It is available from DIA in VHS and 3/4 inch U-matic formats.

"Impact of GPS and Targeting Errors on GPS Equipped Attack Weapons". This technical, but unclassified, 16 minute video is a product of the Naval Air Warfare Center dated July 1993. It is available from them in VHS format only and includes a 31 page reference handout.

"On a True Course". The Defense Mapping School produced this unclassified 15 minute VHS video in November 1993. It describes the training available from DMS and shows some clear interoperable examples of MC&G applications.

5. **DMA CATALOGS.** The DMA Catalog contains the stock numbers you need to order products. It is organized in seven separate parts and is notoriously hard to use. DMA has a major fix underway. If you need help in the meantime, call your MC&G Team in Air-526 or call DMA Customer Assistance at 1-800-826-0342 [DSN 287-2495].

Part 1, Aerospace Products, Volume I, Aeronautical Charts, Flight Information Publications and Related Products (#CATP1V01)
Semiannual Bulletin Digest for Aeronautical Products (#CATP1UBD)
Part 1, Aerospace Products, Volume II, Weather Plotting Charts (#CATP1V02)
Part 2, Hydrographic Products, Volume I, Nautical Charts and Publications (#CATP2V01U)
Semiannual Bulletin Digest for Hydrographic Products (#CATP2V01UBD)
Part 2, Hydrographic Products, Volume II, Classified Nautical Charts and Publications (SECRET) (#CATP2V02C)
Semiannual Bulletin Digest for Classified Nautical Charts and Publications (CONFIDENTIAL) (#CATP2V02CBD)

Part 3, Topographic Products, Volume I, All Scales (#CATP3V01U)

Semiannual Bulletin Digest for Topographic Products (#CATP3V01UBD)

Part 3, Topographic Products, Volume II, Classified Topographic Maps And Related Products (SECRET) (#CATP3V02C)

Semiannual Bulletin Digest for Classified Topographic Maps And Related Products (CONFIDENTIAL) (#CATP3V02CBD)

Part 4, Target Material Products, Volume I, Air Target Materials Charts (CONFIDENTIAL) (#CATP4V01)

Part 4, Target Material Products, Volume III, Point Positioning Data Bases (SECRET) (#CATP4V03)

Part 5, Submarine Navigational Products, Volume I, SSBN Navigational Material - Atlantic (CONFIDENTIAL) (#CATP5V01)

Part 5, Submarine Navigational Products, Volume II, SSBN Navigational Material - Mediterranean (CONFIDENTIAL) (#CATP502)

Part 5, Submarine Navigational Products, Volume III, SSBN Navigational Material - Pacific (CONFIDENTIAL) (#CATP5V03)

Part 6, Special Purpose Products, Volume IV, Operation Restore Hope Catalog (#CATP6V04)

Part 6, Special Purpose Products, Volume V, Operation Provide Promise Catalog (#CATP6V05)

Part 7, Digital Data Products, Volume I, Terrain, Feature and World Vector Shoreline Data (#CATP7V01)

Part 7, Digital Data Products, Volume II, Probabilistic Vertical Obstruction Data (SECRET) (#CATP7V02)

Part 7, Digital Data Products, Volume III, ARC Digitized Raster Graphics (#CATP7V03)

DMA Exchange Catalog (no catalog number, order from DMA)

Consolidated Air Target Materials Notices/Target Materials Bulletin, Volume I (SECRET) (no catalog number, order from DMA)

Consolidated Air Target Materials Notices/Target Materials Bulletin, Volume II (SECRET) (no catalog number, order from DMA)

Gridded Photo (GP) Listing (SECRET) (no catalog number, order from DMA)

Terrain Contour Matching Matrix/Map Catalog (no catalog number, order from DMA)

DMA Chart Updating Manual (#CATP1CHUM)

DMA Chart Updating Manual Supplement (#CATP1CHUMSUP)

6. **DMA SOFTWARE.** DMA produces general purpose utility software to standardize the examination of MC&G digital data. This software will not perform analytical applications unique to NAVAIR needs.

MUSE. Mapping, Charting, and Geodesy Utility Software Environment (MUSE) is DMA's initial effort, with the help of NRL and Naval Command Control and Ocean Surveillance Center, to develop standard software to exploit DMA raster and vector digital products across different hardware platforms and operating systems. MUSE will run on Macintosh, MS-DOS, Windows, and Sun UNIX. The included source code allows the user to tailor MUSE to other operating systems. Basic exploitation includes the capability to import, display, annotate, and generate simultaneous overlays of products such as DTED, DNC, CIB, DAFIF, and WVS. MUSE includes a user manual and sample data sets (ADRG, CAC, CADRG, ADRI, DTED, DBDB, DCW). Other applications in MUSE: line of sight analysis, 3-D perspective scene analysis, and MADTRAN for large files of multiple coordinates and datums. MUSE comes on CD-ROM.

VPFVIEW. VPFVIEW will access any present or future DMA MC&G data base implemented in Vector Product Format. You can select data for display by region, feature, or group of related features. You don't have to load or convert the data: simply read it directly from the media (CD-ROM, hard drive, diskette). It is not a Geographic Information System (GIS), so it has no analytical capability other than viewing sets of features. Display and text can be sent to a printer or plotter. VPFVIEW supports MS-DOS, PC-DOS, and Sun UNIX operating systems and contains executable and source code as well as a user manual.

Where to find it:

✈ For a current copy of the DMA **Standardization Report** call DMA(TIJ), (703) 285-9238 [DSN 356]; however, they don't distribute the actual standards. ✈ For individual copies of **standards** contact TeleSpecs at the Defense Printing Service at (215) 697-2667 [DSN 442]. For automatic distribution of selected new and revised standards contact Naval Publications and Forms Directorate, Attn: Standardization Document Order Desk, 700 Robbins Avenue, Bldg. 4D, Philadelphia PA 19111. ✈ Also order **MIL-HDBK-850 Glossary of MC&G Terms** from TeleSpecs. ✈ Order parts of the **DMA Catalog** from DMA using the appropriate stock number. ✈ Order **Coordinate Selection Guide** from DMA using stock number #DIAXXCOORDGRAPH. ✈ Get a copy of the videotape **Your Target Is...** from your local audio visual service (ask for PIN# 505318) or call Capt Hodge at DIA, (202) 373-8406 [DSN 243]. ✈ Get a copy of the videotape **Impact of GPS and Targeting Errors on GPS Equipped Attack Weapons** from Mark Wonnacott at NAWC Weapons Division, Attn: Code C-2876, 1 Administration Circle, China Lake CA 93555, (619) 939-1089 [DSN 437]. ✈ Order the tech manual on **DoD WGS 84** (which includes MADTRAN) from DMA using #DMATR83502WGS84; to separately order **MADTRAN** (MS-DOS only) ask for #MADTRANIBMPC: Specify Version 4.0 because previous versions are still in circulation. ✈ Get the **DMA List of Products and Services** from DMA(PRB) at (703) 285-9260 [DSN 356]. Ask for DMAL 805-1A. ✈ Order **Digitizing The Future, 4th Edition** from DMA with stock number #DDIPDIGITALPAC. ✈ Order **Geodesy For the Layman** from Defense Technical Information Center, Attn: BCR, Bldg. 5, Cameron Station, Alexandria VA 22304 or call (703) 274-7633 ext 9307 [DSN 284] and ask for #DMATR80-003. ✈ **The DMA MCGrapher** is available from DMA(PRW). Call Maj Spence at (703) 285-9110 [DSN 356] to get on the mailing list. ✈ The latest version of **VPFVIEW** is available on a prototype CD-ROM "VPF Data Sampler" from DMA(PRW) at (703) 285-9319 [DSN 356]. ✈ Order **MUSE** from DMA using stock number #MUSXXSOFTWARE001. ✈ Requests copies of **DMA Instructions, Lists, and Handbooks** from DMA, Attn: AMO, Stop D-2, 4600 Sangamore Rd., Bethesda MD 20816 or call (301) 227-2026 DSN [287] or fax (301) 227-2359 DSN [287]. ✈ For copies of the **Strategic Direction, Plan For Continuous Improvement, Modernized Production System, TEAM MC&G Plan, The Global Geospatial Information and Services Initiative, and other source documents** contact Mr. Harden or LCDR Willis in Air-526 at (703) 604-3380 ext 8118 [DSN 664].

Section IV

HOW TO GET MC&G TRAINING

1. **OFF SITE.** The Defense Mapping School (DMS) resides at Ft. Belvoir, 15 miles south of Washington, DC. DMS develops all its training literature and helps the Services develop MC&G related doctrine, training materials and courses. DMS is academically accredited. DMS deploys Mobile Training Teams (MTT) to deliver standard and tailored MC&G training in the field. In FY94, DMS traveled to 34 locations and delivered seven different courses to 2,000 students.

2. **ON SITE.** DMS offers the following courses at Ft. Belvoir:

MC&G Staff Officer Course (a one week basic course);

MC&G for the Warrior (one or two days depending on customer needs);

Geographic Information Systems (two weeks of theory and hands on);

Introduction to Remotely Sensed Imagery (two weeks);

Introduction to Remotely Sensed Imagery and Geographic Information Systems (a one week course combing RSI and GIS);

Global Positioning System for the Warrior (a one day look at military applications and examples, including a discussion of future GPS capabilities);

and other formal training customized to your needs.

Whenever you need it, the MC&G Team in Air-526 lectures on a myriad of MC&G subjects at your routine staff meetings, technical meetings, and training sessions. They also arrange for DMA subject matter experts to lecture, too.

Where to find it:
✈ For the latest **course descriptions and schedules**, contact the MC&G Team or call the DMS Registrar, Ms. Keleher, at (703) 805-3213 [DSN 655]. ✈ Submit **MC&G training applications** to the Director, DMS, 5825 21st St., Suite 106, Ft. Belvoir, VA 22060.

Section V

DEMONSTRATIONS OF DMA PRODUCTS AND CAPABILITIES

1. **AT THE DMA HYDROGRAPHIC/TOPOGRAPHIC CENTER.** DMAHTC routinely hosts warfighters, developers, and senior DoD officials for custom briefings and tours of their production facility in Bethesda, Maryland. This includes traditional nautical charting processes and digital production.

2. **AT THE DMA COMBAT SUPPORT CENTER.** DMACSC is the ordering and distribution part of DMA. They offer a half day tour and briefing on their key processes: requisition processing, issuance and shipping, customer assistance, inventory management, receipt and storage. They also discuss the improvements under way to make it easier to get DMA products. Very informative and well done.

3. **AT THE DMA WARRIOR SUPPORT CENTER.** The purpose of the Warrior Support Center is to orient DoD warfighters to new and emerging MC&G products and services. Their joint officer staff regularly demonstrates the latest MC&G capabilities in their facility at Headquarters, DMA. WSC also conducts MC&G development and prototyping.

4. **ON SITE DEPLOYMENT.** The Warrior Support Center also deploys their demonstrations of DMA digital products to field activities and, in some cases, will leave sample products with you. This is a highly recommended way for TEAM field activities to stay current with MC&G digital developments.

5. **ON YOUR DESKTOP.** If you have a 386 or greater PC and a CD-ROM reader you can view many DMA digital products in your office. For example Digital Chart of the World is available complete with software to run on a PC. Prototypes and sample CD-ROMs come with VPFVIEW for displaying the data, but analytical software is usually not included.

Where to find it:

✈ For arranging **briefings and demonstrations** call on your MC&G Team in Air-526 at (703) 604-3380 ext 8102 or 8118 [DSN 664]. This is their job. They may know of one already scheduled and you can tag along. ✈ Call LTC Bothe at DMA (703) 285-9260 [DSN 356] if you need to know the current schedule of **demonstrations at WSC.** ✈ Call the MC&G Team for **desktop demos** of the latest digital products and prototypes. They can show demos in Air-526 or perhaps where you work.

Section VI

HOW TO GET DMA PRODUCTS

DMA stocks over 185 million copies of 66,000 different products and maintains over 16,000 subscription accounts. In addition, warfighters, system developers, and contractors submit about 12,000 separate orders per month. DMA satisfies customer requests with no transportation assets of its own and must depend on external carriers to ship your order.

1. **BASIC INFORMATION.** You need a DoD Activity Address Code (DoDAAC) to routinely order MC&G products or subscribe to products on automatic distribution. (The DoDAAC is keyed to the official clear text address of a DoD activity.) You also need to know with some precision what product you want (its DMA stock number), if it's available, how many of them you need, and by when. Finally, you need to know the priority.

DoDAAC. Navy DoDAACs start with either an N, V, or R followed by the 5 digit Unit Identification Code (UIC). Commands use the UIC to handle all incoming requisitions, bills, and supplies. The TEAM DoDAAC account number is N00019. Don't use this command number to order DMA products.

Administrative DoDAAC Account for MC&G. DMA products requisitioned by the TEAM are free; therefore, use an administrative DoDAAC account to order MC&G products. The administrative DoDAAC account number for the MC&G Team is N76000. All products ordered under N76000 will be delivered to Air-526. If you need your own administrative DoDAAC account for local delivery, you must request it in writing to the Defense Finance and Accounting Service.

Temporary DoDAAC Account. Temporary accounts are no longer authorized. TEAM DoDAAC accounts that begin with T were deleted.

Priority. DMA is changing and improving the priority system at customer request. TEAM members should ignore the priority instructions in the DMA Catalogs and use priority 09 when ordering. DMA is now filling 96% of all orders within 48 hours.

Automatic Distribution. You can set up a subscription on your account if you want to receive predetermined quantities of new or revised products automatically. This is most frequently done for Flight Information Publications (FLIPs), some of which are revised every 28 days. Submit your request for automatic distribution through the MC&G Team to DMA.

Then What Happens? After receipt, DMA will either ship your order, put all or part of it on backorder, or reject your order. It could be rejected because of a releaseability restriction on a product, a product quantity limit that temporarily applies in a crisis area of the world, or because of incorrect information (such as the wrong stock number, account number, or invalid address).

Returning Stuff. Before sending anything back, call DMA Customer Assistance. It's usually not economical to return it. Dispose of products according to your local security and salvage directives.

2. **ROUTINE ORDERING.** You can use DMA GETAMAP software to submit orders if you have an MS-DOS machine. GETAMAP allows you to submit orders via E-Mail, modem, message, or correspondence. It originated in 1987 and now 60% of all orders use it. GETAMAP gives you an easy step by step ordering method that reduces time and delay. It has some idiosyncrasies and doesn't work with all products. In addition, TEAM orders for digital products must follow OPNAVINST 3140.55. Your MC&G Team can advise you.

Via E-Mail. You can use DMA GETAMAP software to submit orders via electronic file transfer. Complete instructions are contained in the software. You also need a modem and DAMES, the DAASC (DoD Automatic Addressing System Center) Automated Message Exchange System that uses the Defense Automatic Addressing System (DAAS). The advantage of DAAS is that it tracks the customer when deployed even if the requisition was submitted before deployment. You can use DAMES to transmit orders for MC&G products 24 hours a day, seven days a week. It's great for TEAM activities without AUTODIN or Defense Data Network (DDN) capability. It is user friendly, menu driven, and free to the TEAM and its contractors. You will need to complete their questionnaire and registration form to get properly loaded in the DAASC data base. You will also need a dedicated telephone circuit.

Via Modem. Use GETAMAP to create the order file .ORD and then use any standard communication package to transmit. The settings for the modem are 1200 baud, Parity - None, 8 bit, 1 stop.

Via AUTODIN. The AUTODIN message is another way to order MC&G products. You can use GETAMAP to create the .ORD file and then import it into Message Text Format (MTF). You can also use GETAMAP to create a Military Standard Requisitioning and Issue Procedure (MILSTRIP). This is useful if the requester address and the supplementary ("ship to") address are different; however, it is not necessary to send the message in MILSTRIP format.

Message Address

DMACSC WASHINGTON DC//CCOR//

Via Correspondence. DMA also handles about 125 pieces of routine correspondence each month, so you may also send a normal letter through channels specifying the products you want by stock number, how many, the priority, and when needed. They also accept DMA Form 8660-6, "DMA Digital Product Request," and facsimile transmissions. Or use GETAMAP to create the .ORD file. Copy the order file to a 5 1/4 inch, double sided, double density, 360 KB floppy diskette, put your account number on the floppy, and mail it to DMACSC. They will return it to you.

Correspondence Address

DMA Combat Support Center
Attn: CCOR, Stop D-16
6001 MacArthur Blvd.
Bethesda, MD 20816

fax
(301) 227-2498
DSN 287-2498

3. NOT SO ROUTINE ORDERING.

Crisis. In a crisis, the usual rules go out the window. DMA products and services are no good unless the warfighter gets exactly what is needed on time, every time. If necessary, DMA will Federal Express your order.

Local Foot Power. Are you located in the Washington, DC metro area? Are you *desperate* for *small* quantities of *paper* products? Does your desperation surface only between 0730 and 1600, Monday through Friday? If so, you have another choice:

① Call the DMA Pentagon Office at (703) 695-7907 [DSN 225] and see if they have it.

② Fax them your shopping list of DMA stock numbers and quantities at (703) 695-4846 [DSN 224]. (They need a little time to pull the order from the shelves.)

③ Head on down to the Pentagon, Room BG720. You must have a military identification card or a National Capitol Region badge to pick up your order. A contractor can't pick it up for you. By the way, the folks there are understandably concerned if you fax an order in desperation and then don't show. Call back and cancel if your urgency subsides. The DMA Pentagon Office is small and has limited stock. They simply are not resourced for routine, over-the-counter requests or significant quantities.

4. **VOICE CUSTOMER ASSISTANCE.** From experience, it is just too error prone to order products via DMA Customer Assistance. But they *will* help you prepare your order. They handle over 2,500 routine and *emergency* requests for assistance every month by telephone. When calling after DMA business hours, don't hang up; they have voice mail and will return your call within 24 hours.

DMA Customer Assistance

toll-free 1-800-826-0342
commercial (301) 227-2495
DSN 287-2495

If you know what you want, but can't find a stock number, call them. They are experts on the latest ordering short cuts. They will also research the status of your order and reinitiate shipment of missing items if necessary. For technical questions beyond their expertise, they will refer you to the appropriate DMA subject matter specialist who, by the way, may be on your Air-526 MC&G Team.

Where to find it:

✈ The **DMA Pentagon Office** is hard to find in a hurry. From Metro Pentagon exit, enter concourse and turn right. Take ramp up (corridor 10) to first floor. At main corridor (A Ring) turn right and take down ramp (corridor 7) through loading area to end of corridor. On your left take stairwell 74 down as far as you can go. Turn right, then immediately left. The Army Operations Center will be on your right. Continue and turn right at the first corridor. At end of corridor, turn right. DMA is at the end of this corridor on left. ✈ To establish an **administrative DODAAC account**, write to Defense Finance and Accounting Service, Attn: AABB, 1420 East 9th St., Cleveland OH 44199, explaining your need. Your account must be activated in DAAS with notification to DMA before DMA can send you stuff. For more information talk to Mr. Edsall, the DFAS Navy Service Point, at (216) 522-5908 [DSN 580]. ✈ Order **DAMES** from DAASC Information Center, Gentile Station, 1080 Franklin St., Dayton OH 45444 or call (513) 296-5914 [DSN 986]. ✈ Order **GETAMAP** from DMA or contact the MC&G Team in Air-526 at (703) 604-3379 ext 8118 [DSN 664]. They may have some copies of the current version. ✈ To establish **automatic distribution** send your justification through the NAVAIR MC&G Team to DMA, Attn: PRA, 8613 Lee Highway, Fairfax VA 22031. To verify the products you expect to get on automatic distribution call DMA Customer Assistance, 1-800-826-0342, and ask for the R05 report for your DoDAAC. ✈ **DMA Form 8660-6** is found in Part 7, Vol I of the DMA Catalog and in OPNAVINST 3140.55.

Section VII

A BIT ABOUT DMA PRODUCT ACCURACY AND SUCH

1. **SOME HISTORY.** MC&G is becoming increasingly critical to advanced weapons system development. Ironically, accuracy improvements in weapons systems created new, unanticipated MC&G problems.

After a 1993 deployment, a Carrier Air Wing cruise debriefing (eventually given to CNO) cited the following map and targeting problems: "90% of world not mapped," "GPS target coordinates as much as 6 kilometers in error," and "maps were dated 1943 with 1991 overprinted information." During operations, the warfighters did not seek assistance from DMA. It turns out that the shooters were given target coordinates from the principal intelligence organization for the theater without the understanding of this section of the MC&G Handbook. If you think this was an isolated incident, it wasn't. This happens too often and it's happening more frequently. And it's not a problem unique to the Navy.

In Operation Desert Storm, B-52s missed targets because they initialized their INS at Diego Garcia on a different datum from the one used to reference the target location. The datum shift exactly equaled the miss direction and distance. To add further confusion, there were 11 different datums covering the theater of operations.

In Lebanon, naval gunfire from the USS New Jersey was based on WGS 72 coordinates while Marines ashore used European Datum coordinates!

Potential disaster lurks in the use of mixed coordinates and datums!

2. **THE SHAPE OF OUR MOTHER.** MC&G concerns three different surfaces of the earth: the actual physical or natural surface traditionally mapped for warfighters; a smooth mathematically defined surface called the ellipsoid; and the decidedly unsmooth equipotential surface of constant gravitational pull known as the geoid. These surfaces are not the same. They have *different* coordinates for the *same* place! Does this have anything to do with TEAM systems development? You bet it does!

For one thing, determining accurate elevation is now more important than ever for successful weapons delivery. Warfighters use height information in several varieties: barometric altitude (referenced to atmospheric pressure); MSL elevation, AGL elevation, radar altitude, contour values and spot elevations (all related to the mapped surface); geoid height (related to the bumpy, undulating

physical model of the world's gravity); and the ellipsoid height (based on the smooth geometric model of earth). All of these elevations have different inherent accuracies. Precise height information is derived from a complicated set of assumptions and standards which developers and warfighters need to understand.

Consider good old Mean Sea Level (MSL) and the new kid on the block, GPS. Traditionally, MSL has been the zero point for our vertical datum. It's called *mean* sea level because it is based on the average rise and fall of tides over about 18.6 years of measuring (the length of the sun and moon cycles that influence tides). The tide gauges were referenced to the local vertical datum. In the past MSL was good enough, but scientists now know that MSL (the surface of the sea) is not level everywhere. The water conforms to the equipotential surface of constant gravity – the geoid, our gravity model of the earth. Better height measurements from satellite radar altimetry using the Earth's center of mass as the point of origin verified that MSL is a poor approximation of the geoid surface for the current needs of DoD. Contrary to common sense, water does *not* seek its own level, globally speaking, because of major variations in gravity around the world. Typically, GPS receivers display elevation data referenced to the ellipsoid, not the geoid. So, you could find yourself floating on the sea at a location in a geoid valley beneath the smooth surface of the ellipsoid model, and your GPS receiver will say the sea level is *minus* some number of meters, and it will be correct!

In some places, the ocean surface is 100 meters lower than elsewhere!

3. **PROJECTIONS AND SCALES.** Conversion from the curved, three-dimensional globe to the flatlands of paper is accomplished through projections – similar to projecting light from a three-dimensional object onto a two-dimensional surface. All projections optimize some aspect of mapped information at the expense of other information. No projection can show true directions, true distances, true areas, and true shapes simultaneously. For example, the gnomonic projection (the oldest of them all) optimizes great circle information as straight lines while compromising shape and positional accuracy.

Scale varies to some degree from place to place on all maps, with the variation depending on the projection used. Scale is often crucial to a product's usefulness for a warfighter's given purpose. It is the size ratio of what is seen in the flatlands of maps compared to actual size in the real world. Scale is expressed as a fraction. Therefore, a 1:250,000 scale chart means that the ratio of map measures to measures in the real world is one to 250,000. This translates to 1 inch (or other unit) on the map equaling 250,000 inches (or other unit) in the real

world. The smaller the scale (1:1,000,000 is smaller than 1:250,000) the larger the area in the real world that is represented by the corresponding area on the chart. Small scale = large area and large scale = small area.

The DMA accuracy for paper charts meets the National Map Accuracy Standard, originally based on human limitations in manually plotting added information on charts. For charts at 1:20,000 and smaller scales, 90% of all well-defined features (those not subject to generalization or displacement) are within 1 mm of their actual location. Note that this accuracy depends on the scale of the product. For example, a 1 mm plotting error on a 1:250,000 Joint Operations Graphic (JOG) is 250,000 mm or 250 meters on the ground. In other words, the ubiquitous .5 mm government mechanical pencil line is 125 meters wide!

In addition, the scale of a paper map forces cartographers to generalize and even move selected information on the map to preserve clarity. The inaccuracies associated with map generalization and displacement are no longer acceptable for new weapons systems.

For digital displays of MC&G data, the same rules about projections and scales apply. The scale of the display is deceptive because it varies as the operator zooms in and out. The system may or may not tell the operator as the scale factor changes. Raster data is scanned from existing maps so it preserves the original scale and projection limitations as you zoom in and out.

When vector data is displayed, traditional projection problems for the warfighter are minimized. The data displayed at the moment uses a projection optimized for the location in view rather than using a constant projection required for an entire map sheet. The positional accuracy of the displayed data is consistent and will not vary by location to the degree it would on a map. The digital data will always appear seamless along the display edges. The age old problem of trying to exactly match map sheets together is gone with a digital display.

4. **COORDINATE REFERENCE SYSTEMS.** Coordinate reference systems are a shorthand means of communicating locations on the earth's surface. The most familiar coordinate reference system is latitude, longitude, and elevation. Others include the Universal Transverse Mercator (UTM) and Universal Polar Stereographic (UPS) grid systems which are two-dimensional. Simply put, these are grids placed on maps which allow a location to be identified without the lengthy description of degrees, minutes, and seconds of latitude and longitude. The Military Grid Reference System (MGRS) is based on 100,000 meter grid squares.

5. **MEASURES OF ACCURACY.** The accuracy measures provided with MC&G paper products or digital data define the warrior's envelope of reliable use. MC&G data cannot be any more accurate than its original source, and sources vary in accuracy. In addition, each step in the process can introduce errors due to limitations of the production hardware and software, human factors, and the inherent characteristics of the product itself (such as the size and scale of the chart or the specification accuracy for digital data). These typically manifest themselves as errors in position or elevation.

> Some position coordinates and elevations are more accurate than others!

Statistical techniques are used to measure and identify these errors. These measures convey a confidence level to the warrior for the probable accuracy of a DMA product. Accuracy tells the warrior how close the measurement is to a known higher standard assumed to be the truth, such as the WGS 84 system. Depending on the product's intended use, MC&G product accuracies are usually expressed in terms of absolute or relative accuracy, or both. *Absolute accuracy* tells how close each feature or data point is to the specified higher standard. *Relative accuracy* tells how close the measured distance or elevation is between two features or data points within the standard. MC&G position accuracy is traditionally measured in feet or meters of Linear Error (LE) for heights, and feet or meters of Circular Error (CE) for horizontal position, both at 90% probability.

GPS, JDAM, JSOW, and Tomahawk all use circular measures of absolute and relative accuracy at 50% probability that reflect the intended uses of these systems. The 50 percent Circular Error Probable (CEP) figure is the radius of a circle around the target within which 50% of the weapons are expected to fall. The remaining 50% fall outside the CEP. The Spherical Error Probable (SEP) is a three-dimensional combination of horizontal and vertical errors at 50% probability.

Target Location Error (TLE) is the difference between the actual location of the target and the expected location. Understanding and predicting TLE is particularly crucial to autonomous weapons development because of low CEP objectives.

DMA product accuracy objectives are stated in the specification; however, individual products produced in accordance with the specification will vary in accuracy.

Because of the way DMA processes source information, the location, elevation, and accuracy of each digital data point is independent of any other data point. This means that increasing the density of data points in the data base *will not* improve the accuracy of positional information in the data base.

Nor can you create greater accuracy by expanding the display scale of digital MC&G data captured at another scale. Magnifying a raster data file on the screen does not add accuracy or information content although feature detail may be easier to distinguish. After compression, a digital raster file cannot be restored to its original accuracy or content. For example, data from a 24 bit file of up to 16 million colors scanned at 100 microns, compressed to an 8 bit file of just 256 colors, yields new pixels now degraded to 200 microns.

6. **PSEUDO ACCURACY.** A related problem arises from our unquestioning assumptions about high technology. DoD plans to buy up to 95,000 Precise Lightweight Geopositional Receivers (PLGR) at $1,300 each for a diversity of applications. PLGR is hand held and weighs 2.75 pounds. It has the capability to display coordinates in whole degrees, whole minutes, and seconds to two decimal places. Trigonometry tells us that .01 arc seconds of latitude is equal to about *31 centimeters* on the earth. This display precision has mislead warfighters about digital data accuracy. If you are using WVS for example, remember that it has a specification accuracy no better than 500 meters or *50,000 centimeters* no matter what the displayed precision of the coordinates suggests!

> Use of the most powerful hardware and software in the world to exploit MC&G data will not improve the original accuracy of that data, and can make it worse!

7. **DATUMS.** In the past warfighters didn't worry much about datums. Older datums were acceptably accurate only within a particular local geographic region, like Europe or North America, because of the earth's imperfect shape. Now DoD weapons systems need precise, highly accurate datums and the equally accurate coordinates that come from them. An in-depth understanding of datums is essential. A lack of understanding could easily cause mission failure!

A datum is a math model of the Earth's shape used as a basic reference to calculate position coordinates, heights, distances, and to make maps. The datum is the origin or point of reference.

> The only way you can know the datum of a paper map is by a careful reading of the margin information!

The only way you can know the datum of digital data is by a careful reading of the header information!

The only way you can know the unspecified datum of coordinates given to you is to ask!

There are currently over 100 different datums in existence worldwide. Consider them all "apples and oranges." Always talk about the same datum when communicating. Precise target locations depend on it.

8. **WGS 84.** The single datum preferred by DoD today and used most is the World Geodetic System 1984 (WGS 84). (WGS 84 replaces its predecessor systems WGS 59, WGS 60, WGS 66, and WGS 72.) WGS 84 is a unified earth-centered model of the globe based on improved geometric, geodetic, and gravity information. It is intended to support the widest possible range of applications. WGS 84 provides a means to relate positions on those other datums to a single interoperable standard. Some older datums have lost their accuracy, some because earthquakes have physically moved permanent survey marks that were at one time precisely known locations! DMA continues to update the constants needed to transform between one datum and another and to derive new constants when necessary. Excluding the datums already tied to WGS 84, several hundred other obscure ones exist that don't have transformation constants.

Poorly known coordinates from another datum when converted to WGS 84 coordinates are still poorly known!

A major problem is that some deployed weapons systems have been hard wired to specific or non-standard datums less accurate than WGS 84. For example, the B-1B is hard wired to WGS 72. Early models of the F-15 were referenced to North American Datum 1927. Early models of the F-16 were referenced to the European Datum (their expected area of operation). The UH-60 and the AH-64 are referenced to six ellipsoids and not to WGS at all. Unfortunately, this is not explained to the aviators in their flight manuals and there are no plans to retrofit.

In Korea, the current local datum is the "Tokyo Datum." The datum shift to WGS 84 in this area averages about 750 meters!

Different datums will give different coordinates for the same target!

There are still many existing DMA paper products in distribution (mostly reprints and maps made by foreign countries) that are not on WGS 84.

9. **DATUM AND GRID CONVERSION.** Errors are induced every time you transform from one datum or grid to another, even if using DMA-approved MADTRAN software. The WGS 84 technical report is the authoritative source for these transformation constants.

> The minimum degradation of position using WGS 84 transformation constants is two meters for each transformation.

10. **THE GLOBAL POSITIONING SYSTEM.** Any DoD weapons system using GPS, or being developed to use GPS, will require MC&G combat support from DMA, directly or indirectly. Why? Because GPS is the DoD standard navigation system that provides a common, highly precise spatial reference to warfighters continuously in real time anywhere in the world. And GPS is referenced to WGS 84. GPS supplies three-dimensional position, velocity, and time information in all weather conditions.

GPS has profound applications for weapons guidance, bomb on coordinates, enroute navigation, mission planning, target acquisition, command and control, Unmanned Aerial Vehicle (UAV) operations, search and rescue, photo reconnaissance, range instrumentation, and precise target locations.

GPS accuracy is usually better than maps by several orders of magnitude. The difference increases as map scale decreases. However, this is not to say that since warfighters now have GPS, they don't need maps!

> If you have GPS, you still need MC&G products and services for referencing and positioning.

GPS provides two different levels of accuracy. With Precise Positioning Service, full accuracy is 10 meters CEP (50%) or 16 meters SEP (50%). This signal is encrypted to limit access to DoD. (Note that this equates to an accuracy of no better than .005 arc seconds on a PLGR display.)

With Standard Positioning Service, the accuracy is 40 meters CEP (50%). This signal is primarily for the civil community and can be downgraded in a crisis. (Note that this equates to an accuracy of no better than .02 arc seconds on a PLGR display.)

GPS *receivers* give warfighters the option to output elevations and coordinates on many grids and datums, including WGS 84. Just because they are "coordinates from GPS" do *not* assume they necessarily meet the GPS accuracy.

> Accuracy depends on the original source of the coordinates, not the display device!

GPS is planned for most of the Naval aviation fleet: EA-6B, SH-60D, SH-60F, C/KC-130, E-2C, E-6A, ES-3A, CH-53E, MH-53E, P-3C, EP-3, VH-60, and JPATS. The Miniature Airborne GPS Receiver (MAGR) will be installed in the AV-8B, F-14A/B, F-14D, F/A-18A/B, F/A-18C/D, F/A-18E/F, S-3B, and V-22A. The Embedded GPS Receiver (EGR) goes in the AH-1W.

The Standoff Land Attack Missile (SLAM) and Tomahawk Land Attack Missile (TLAM) will have integrated GPS receivers. The Tomahawk Baseline Improvement Program (TBIP) will use a seeker and GPS. It will not need Digital Scene Mapping and Correlation (DSMAC) or Terrain Contour Matching (TERCOM).

JDAM will be a launch and leave autonomous weapon with a terminal seeker and EGR coupled to an Inertial Measurement Unit (IMU). JSOW will combine GPS with INS.

Aviators on the TEAM will be interested in the Combat Survivor Evader Locator (CSEL) being developed. CSEL is a GPS receiver mated to a non-voice satellite communications radio that reports your position automatically to SAR units when you are down behind enemy lines. There will be no need for visual searching or voice communications that can be monitored by the enemy. CSEL will make "Beam me up, Scotty" pretty much a reality for those warfighters with an unequal number of takeoffs and landings.

11. **PRECISE TARGET COORDINATE SOURCES.** Not too long ago, maps were the basic frames of reference for position. There was nothing better. Now, maps and their raster derivatives are *unsuitable* for targeting! Does this mean give maps the heave ho? No. Just use them differently as the frame of reference for the more accurate GPS position.

> DON'T DEGRADE THE DELIVERY ACCURACY OF YOUR WEAPONS SYSTEM BY USING COORDINATES THAT ARE LESS ACCURATE THAN YOUR SYSTEM PERMITS!

Reliable target coordinates come only from a limited number of classified sources:

DMA Points Program. DMA accepts requests for precise positions via secure phone, secure fax, or classified message – usually with two hour (or better) turnaround in a crisis.

APPS. Navy users can derive their own precise positions using the Analytical Point Positioning System (APPS) and hard copy PPDB imagery, even when deployed afloat. APPS requires a skilled operator. Digital PPDBs will begin to replace the hard copy in FY95. The Navy system to use DPPDB will be the Digital Image Workstation (DIWS).

When working with coordinates, receiving coordinates, or passing coordinates, always know the SOURCE of the coordinates and the DATUM!

WGIS Retrieval. The World Geodetic Information System (WGIS) is a PC software application developed by DMAAC and available to you. It allows you to retrieve previously mensurated precise positions from two classified data bases of published aim points. They are the World Aim Point Catalog (WAPC) and the North American Aim Point Catalog (NAPC). Additional aim points can be added to these data bases by warfighters. WGIS will also list the GNC, JNC, ONC, TPC, and JOG charts covering your aim points and all aim points in these data bases along your specified flight path or geographic area.

BC = CMF
Bad Coordinates equal Combat Mission Failure

Where to find it:
✈ Order **DoD WGS 84** from DMA and ask for #DMATR83502WGS84. Remember it includes MADTRAN. ✈ Order **Coordinate Selection Guide** from DMA using stock number #DIAXXCOORDGRAPH. ✈ Order **Geodesy For the Layman** from Defense Technical Information Center, Attn: BCR, Bldg. 5, Cameron Station, Alexandria VA 22304 or call (703) 274-7633 ext 9307 [DSN 284] and ask for #DMATR80-003. ✈ To get WGIS talk to Mr. Wiley at DMAAC, (314) 263-4133 [DSN 693] or write to DMAAC, Attn: SDF, 3200 S. Second St., St. Louis MO 63118.

Section VIII

KEEPING UP WITH MC&G PROGRESS

1. SOURCES OF INFORMATION.

Your MC&G Team in Air-526. Routinely contact your DMA Liaison and METOC Officer. We are there to assist you. We know about the latest MC&G developments.

MC&G Conference. This annual DoD MC&G conference is a forum for the principal MC&G officers from the Unified Commands, Services, and certain Federal agencies. They address MC&G issues, problems, and activities of mutual interest. The conference report summarizes presentations, discussions, new action items, and status of previous action items. "Report of the Eighteenth Annual Department of Defense Mapping, Charting, and Geodesy Conference," 19-20 October 1993, is a record of the last annual Conference. The main conference is in the fall (usually at Ft. Belvoir), with a smaller one in the spring (usually at Headquarters, DMA). It's the one place to go to find out all the latest stuff DMA is doing for the warfighter. Conference attendance is by invitation only. If you need to attend as a non-voting observer see your DMA Liaison Officer. Conference reports are limited distribution, so contact your MC&G Team if you want to see them.

2. **A PEEK AT THE FUTURE.** The future of MC&G is GGIS, plain and simple. DMA customers of GGIS – the warfighters of the future – will have unprecedented access to digital information that describes the earth in such detail that they will be able to acquire equally unprecedented knowledge of battle spaces, any time, anywhere. GGIS is the natural consequence of an explosion of commercial digital technology, new customer expectations, fiscal constraints, and revolutionary MC&G technical development at DMA.

Many new DMA initiatives are in the works that are important to system developers.

New Military Standards. DMA is developing a Vector Product Format Standard, a Raster Product Format Standard, and a Text Product Format Standard.

- Vector Product Format Development Program. VPF will provide a family of thematically organized digital data bases of low, medium, and high resolution. They will include such things as hydrography, shorelines, elevation, vegetation data, lines of transportation, aeronautical information, names data, and

viewing software. The data format will be standardized for digitizing conventions, tiling, feature attribution, and feature coding. The standard medium will be CD-ROM. These data bases will support GIS analysis for command, control, and intelligence as well as terrain analysis, mission planning and rehearsal, and simulation and modeling. VPF is already in MIL-STD form.

• Raster Product Format Development Program. RPF will provide a family of digital products in a standardized format to support spatial referencing and background displays. Key considerations will be storage format, digitizing conventions, tiling schemes, spatial accuracy, and speed of display. Raster products will be made from existing paper products and digital imagery. RPF data files will be fully compliant with the National Imagery Transmission Format (NITF) standard.

• Text Product Format Development Program. This will be modeled after the Continuous Acquisition and Life Cycle Support (CALS)/Standard Graphics Markup Language (SGML) industry standard. Text applications of interest to NAVAIR developers include a Digital Gazetteer and Digital CHUM for distribution electronically and via CD-ROM.

• Improved Vertical Datum. The geoid heights in WGS 84 have a one sigma error range of ±2 to ±6 meters. DMA is working to define a new world height vertical reference standard to be used in DoD systems development.

Here are samples of DMA MC&G products and services that system developers can expect to work with in the future.

• CADRG. Compressed ARC Digitized Raster Graphic is a compressed and reduced version of ADRG in the RPF. The ADRG is filtered and down sampled prior to compression. The resulting pixel spacing is 150 microns (169 DPI) as opposed to the 100 microns (254 DPI) of ADRG. The data is then compressed using a Vector Quantization (VQ) technique. The final step in the production of CADRG is to reduce the 24-bit RGB color of the ADRG (16.7 million possible combinations) to an 8-bit indexed RGB color table (216 colors). Each step in the process causes some data loss so that the original data cannot be recovered exactly from the compressed product. The resulting CADRG data file has a 55:1 compression ratio. CADRG has been adopted DoD wide for mission planning and cockpit displays. Production began in January 1994 and worldwide coverage is expected to be completed by the end of FY95.

• CIB. Controlled Image Base is a seamless, compressed broad area image product in Raster Product Format made from SPOT source. Mission planning and C^3I systems will use CIB. The VQ compression technique used for

CIB is identical to that used in CADRG. Unlike CADRG, CIB is not spatially reduced, and no color reduction is necessary because the image is monochromatic. The only losses incurred in the compression process are the result of VQ. The resulting compression ratio is approximately 8:1. The CIB prototype is expected to be approved in mid 1994. Worldwide coverage is a goal, but limited source availability and the extensive volume of imagery data make 100 percent coverage unlikely.

• DCW. Digital Chart of the World was published in 1992 as the proof of concept for VPF. Although technically VPF compliant, the DCW format differs in several ways from the current VPF. DCW will be replaced by VMap Level 0 in 1995.

• DNC. Digital Nautical Chart is a VPF compliant product containing the significant maritime features found on paper nautical charts. DNC production began in 1993 and worldwide coverage is expected in 1997.

• ITD. Interim Terrain Data is a vector product designed for Army and Marine Corps terrain analysts. It incorporates all of the information found in hard copy Tactical and Planning Terrain Analysis Databases including slope, vegetation, surface material, drainage, transportation, and obstacle data. DTED Level 1 coverage in included with the data base. Originally in Standard Linear Format, existing ITD is being converted to VPF and will be used as the basis for Digital Terrain Analysis Data (DTAD) production.

• TTD. Tactical Terrain Data is a new composite product combining DTED Level 2 with DTAD and DNC.

• VMap 0. The data in Vector Smart Map Level 0 is similar to the content found on 1:1,000,000 scale charts. Aeronautical information is not included in this product.

• VMap 1. The data in Vector Smart Map Level 1 is similar to the content found on 1:250,000 scale Joint Operations Graphics. Aeronautical information is not included. Production will begin in 1994.

• VMap 2. The data in Vector Smart Map Level 2 is similar to the content found on 1:50,000 scale Topographic Line Maps. Production will begin in 1995.

• UVMap. The Urban Vector Smart Map content is similar to the information found on DMA City Graphics. The intelligence community will fund production to begin in 1994.

• AID. Aeronautical Information Data is a VPF product which provides information similar to that found in the aeronautical overprint on paper charts and in Vertical Obstruction Data. This product supplements VMap Level 0 and VMap Level 1 products since they don't contain aeronautical information. A draft specification and sample data set have been released to customers for comment.

• DFLIP. Digital FLIP research is underway to define a suitable format. It could be TPF or VPF or possibly a hybrid which contains elements of two or all three of DMA's standard formats. DFLIP product research should be completed in summer 1994 followed by a draft product specification and prototype.

• DG. Digital Gazetteer contains information about the location and names of features and places. It will be in VPF on CD-ROM and will include DIGIGAZVIEW utility software. A draft specification and prototype data are being evaluated. A new prototype will be available in summer 1994 followed by initial production in early FY95.

• DPPDB. Digital Point Positioning Database is a classified data base of high resolution digital stereo image pairs for accurate geopositioning of targets. This will replace the existing film based PPDB.

• ECHUM. This Electronic Chart Updating Manual is a digital text file listing updates to DMA charts. This data will be accessed from DMA by modem. ECHUM will test a new methodology to automatically update CADRG.

• New DMA Catalogs. DMA is developing a modernized catalog system in soft copy and hard copy versions that will provide a better portrayal of available products, include simple ordering procedures, contain up-to-date product description information, and allow for remote access. It will be available in both classified and unclassified versions. A prototype is scheduled for late FY94 followed by production in December 1995.

Precise Positioning Initiative. GPS guided weapons, JDAM, JSOW, and Tomahawk (Block III, IV) will need enhanced positioning support. DMA has established near and long term accuracy enhancement objectives that will allow aircraft and weapons to navigate more accurately than currently possible. The near term objective will be reached in October 1995 and the long term objective will probably be realized in 1999-2000. DPPDB will take advantage of these accuracy improvements.

Remote Replication. DMA is developing a crisis operations capability for customers to use DMA digital data to print locally, on demand, a limited number of lithographic quality paper products using electrostatic printers. Current goals are 12-80 copies per hour at $5-10 per copy depending on size. The expected hardware configuration is not suitable for shipboard use.

MC&G Distribution. DMA is integrating MC&G product distribution into the Defense Logistics Standards System to fully utilize its information and transportation assets. DMA stock numbers will be converted to National Stock Numbers (NSNs). This will make it much easier for everyone to get DMA products. Testing will begin in late September 1994.

New Training Products. Defense Mapping School will produce a brochure and a video to help educate and explain problems associated with datums as well as a reference work on GPS modeled after the classic "Geodesy For the Layman." In addition, DMS is actively looking into interactive multimedia training and distance learning applications. At the request of warfighters they plan to offer a Coordinate Workshop to examine actual DoD targeting problems.

GGIS. DMA is leading the transition from MC&G products and services to a new paradigm called Global Geospatial Information and Services. DMA is going from a product factory to a library of information about the earth. GGIS will collect, map, and distribute global geospatial information, and related services, and deliver them on line from an electronic gateway with bulletin board access. The information will be accurate, precise, current, and referenced to WGS 84 in a coherent structure that is part of the NSDI. The Defense Information Systems Agency (DISA) manages the DoD data communications networks. GGIS will assure the interoperability of joint systems, reduce the cost of unique MC&G solutions, and intimately involve the customer in its development.

GPS. A report on implementing Differential GPS (DGPS) will be published in late FY94. COMSAT (Commercial Satellite) Augmented GPS (CAG) is under consideration for dual use, military and civilian. CAG will add GPS to commercial satellites in geosynchronous orbit to improve availability and vertical accuracy. CAG will be available for all users with an accuracy of 3-5 meters SEP, almost ILS Category 1 precision.

Unified Grid System. The DIA/DMA Coordinates Working Group is considering a Unified Grid System which will resolve interoperability problems in the battle space caused by the current Military Grid Reference System (MGRS).

Toolkit Standardization Software. The Defense Information Systems Agency (DISA) and DMA are coordinating development of new DoD analytical software tools standardized for interoperability and general purpose utility software.

Product Evaluation Handbook. This DMA publication will improve the formal process DMA uses to evaluate MC&G products for routine updating. The evaluation process is essentially a life cycle maintenance concept based on the intended uses of the products. DMA uses two criteria: the positional accuracy of the current product and the currency of product content. This publication tells system developers how often DMA plans to produce new editions of products and which existing MC&G products will not be maintained. Expect availability of this handbook in early FY95.

Customer Measures. DMACSC is leading a customer satisfaction measurement and modeling team to develop better external indicators of DMA performance.

Where to find it:
✈ The **MC&G conference reports** are available from your MC&G Team at (703) 604-3380 ext 8102. ✈ The **data structure standards** are available from TeleSpecs at the Defense Printing Service, (215) 697-1187 [DSN 442]. ✈ For information on **MC&G developmental products** contact Mr. Harden or LCDR Willis in Air-526 at (703) 604-3380 ext 8118 [DSN 664].

Section IX

MEASURING DMA COMBAT SUPPORT PERFORMANCE

1. **THE NEED.** Budget realities are driving all of us interested in MC&G to be more effective and to work together at unprecedented levels of complexity within a more interoperable infrastructure. In turn, DMA needs to know from TEAM customers, in practical ways, how well they are performing and how they can specifically improve. DMA improvement eventually translates into lower unit cost, broader geographical coverage, and more accurate MC&G data for the warfighter.

2. **QUALITY FEEDBACK.** Quality is what the customer says it is. To DMA quality is fitness for use; i. e., the degree to which MC&G products and services meet the needs and exceed the expectations of warfighters. Experts tell us that, regardless of the product or service, you can describe fitness for use with three basic measures: quantity, quality, and timeliness.

We all know that things left to themselves don't get right. Until a problem is acknowledged, there is no need for a solution. We can't improve something until we know it needs fixing. It's not always obvious, so how do you know when there is a problem?

> A problem exists *anytime* there is a difference between what IS and what OUGHT TO BE.

The most important part of every DMA production process is feedback from customers. For you – oh, busy and important warfighter and system developer – this is an easy thing to delegate to others, or defer indefinitely. After all, isn't it commonly known that DMA products are the best available, they are free, and DMA has no competition? So, why not take them for granted?

> When was the last time you washed a rental car?

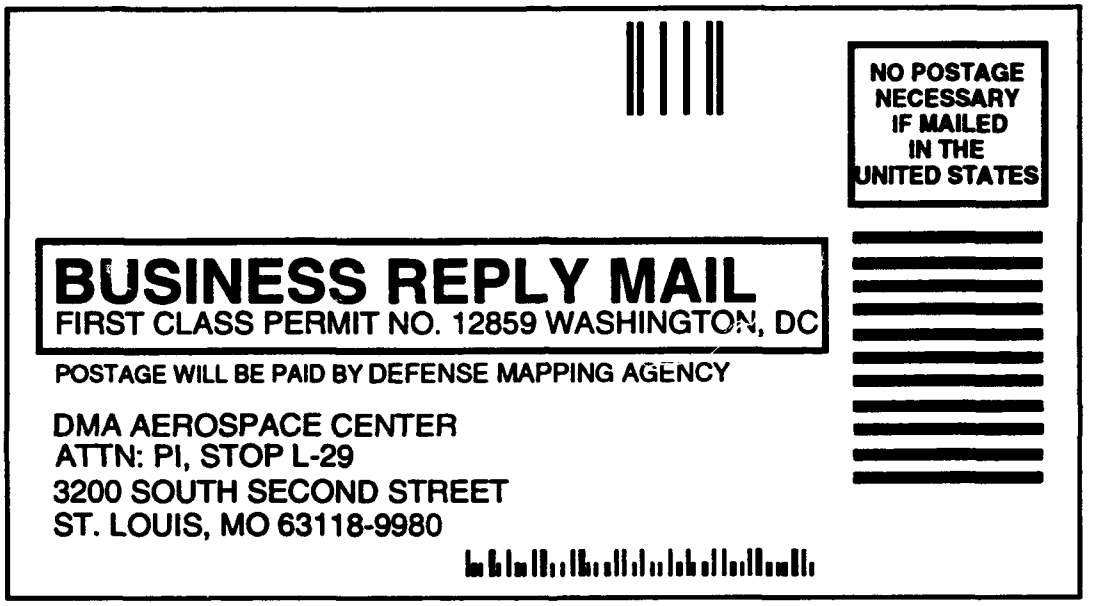
Why bother with talking to DMA? Why not just grab a map and go? The answer is because MC&G products are critical to your mission success and your personal safety. You and DMA can't wait until something goes wrong. The name of the MC&G quality game is PREVENTION.

DMA wants to hear from any customers by any means on any topics related to MC&G. In particular, they need to know how MC&G products and services

perform in actual operational use – the ultimate reality check. (This also applies to prototypes during development.)

All DMA paper products have a note in the margin asking for additions, corrections, comments or questions along with a return address. Historically, very few customers respond to this note, if they notice it at all.

So DMA developed the Quality Feedback Card (QFC). DMA Form 8560-1 is a prepaid business reply postcard that gives warfighters a quicker and easier way to tell DMA about the fitness for use of *any* MC&G product or service.

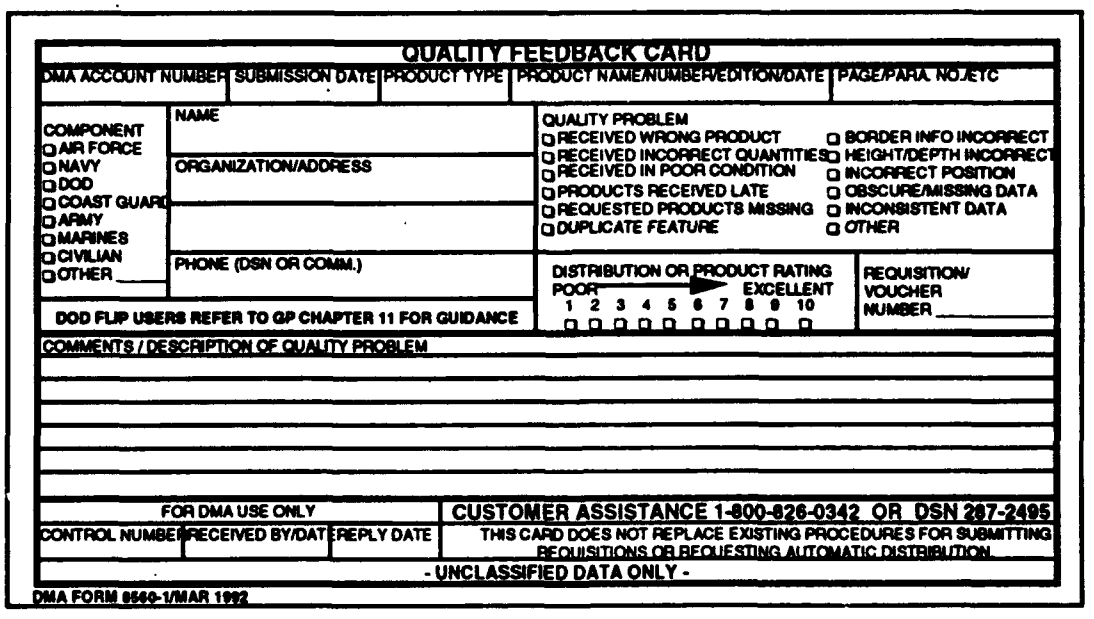


NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 12859 WASHINGTON, DC

POSTAGE WILL BE PAID BY DEFENSE MAPPING AGENCY

DMA AEROSPACE CENTER
ATTN: PI, STOP L-29
3200 SOUTH SECOND STREET
ST. LOUIS, MO 63118-9980



QUALITY FEEDBACK CARD

DMA ACCOUNT NUMBER	SUBMISSION DATE	PRODUCT TYPE	PRODUCT NAME/NUMBER/EDITION/DATE	PAGE/PARA. NO./ETC

COMPONENT
☐ AIR FORCE
☐ NAVY
☐ DOD
☐ COAST GUARD
☐ ARMY
☐ MARINES
☐ CIVILIAN
☐ OTHER ____

NAME

ORGANIZATION/ADDRESS

PHONE (DSN OR COMM.)

QUALITY PROBLEM
☐ RECEIVED WRONG PRODUCT
☐ RECEIVED INCORRECT QUANTITIES
☐ RECEIVED IN POOR CONDITION
☐ PRODUCTS RECEIVED LATE
☐ REQUESTED PRODUCTS MISSING
☐ DUPLICATE FEATURE
☐ BORDER INFO INCORRECT
☐ HEIGHT/DEPTH INCORRECT
☐ INCORRECT POSITION
☐ OBSCURE/MISSING DATA
☐ INCONSISTENT DATA
☐ OTHER

DISTRIBUTION OR PRODUCT RATING
POOR → EXCELLENT
1 2 3 4 5 6 7 8 9 10
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

REQUISITION/ VOUCHER NUMBER ____

DOD FLIP USERS REFER TO GP CHAPTER 11 FOR GUIDANCE

COMMENTS / DESCRIPTION OF QUALITY PROBLEM

FOR DMA USE ONLY			CUSTOMER ASSISTANCE 1-800-826-0342 OR DSN 287-2495
CONTROL NUMBER	RECEIVED BY/DATE	REPLY DATE	THIS CARD DOES NOT REPLACE EXISTING PROCEDURES FOR SUBMITTING REQUISITIONS OR REQUESTING AUTOMATIC DISTRIBUTION

- UNCLASSIFIED DATA ONLY -

DMA FORM 8560-1/MAR 1992

DMA believes that DMA responsiveness to customer expectations directly relates to customer confidence in MC&G products and services. Every card submitted gets a DMA reply. DMA collects and analyzes QFC data to measure satisfaction and dissatisfaction with MC&G product and service performance and to make subsequent process improvements.

Experts say that about 80% of all product innovations are initiated by customers. DMA simply has no substitute for the unique input of warfighters and developers like you. Use whatever method is easiest for you (QFC, telephone, visit with the DMA Liaison Officer, etc.) so long as you DO IT!

> Just thinking about improving DMA products and services has the same result as not thinking about it.

3. **JOINT TEAMS.** Both DMA and the TEAM are committed to Total Quality Leadership as their primary means for doing better with fewer resources. It makes good strategic sense to each organization. Both have a successful track record with internal TQ team efforts. The next logical step is a team of map makers and system developers working together for mutual benefit. Your MC&G Team wants to nominate an appropriate pilot project and they want some proposals from you. To get you going, consider the following question.

> What is impossible to do today, but if it could be done by the TEAM and DMA, would fundamentally improve your operations?

The MC&G Team in Air-526 wants to hear from you.

Where to find it:

✈ QFCs are available in tear out form in DMA Catalogs, FLIPs, and the CHUM. They are also blown in loosely in all map shipments.

ACKNOWLEDGMENTS

This handbook owes its inspiration to the original MC&G Handbook put together by the DMA Liaison Officer to Air Force Material Command, Gary Hacker, and the MC&G Officer, Maj Mike Papirtis, USAF. We plagiarized without remorse from their handbook and elsewhere, and when we thought it would help TEAM readers, made improvements along the way.

We would like to thank Mr. Tom Klocek of MITRE for material taken from his paper MAPS: Myth and Reality presented at the Automated Mission Planning Conference in March 1994.

Ms. Bobbie Lenczowski, the champion of GGIS, USAF Capt Wes Baker, from DMS, Dr. Bill Wooden, the DMA Headquarters GPS guru, and Ms. Cindy Burns of DMACSC took the time for careful review of early drafts and we appreciate their improvements. LCDR Karl Dinkler at DMA provided a much needed customer preview of the penultimate version.

However, any and all the errors belong to us.

So, how did we do? Does this handbook add any value to your work? Do you think it was worth the effort? Can you make it better?

Send those comments, questions, and improvements to:

LCDR Zdenka S. Willis Air-5260W williszs@AM@NTRPRS
Williszs.NTRPRS@NAVAIR.Navy.mil

or

John H. Harden, Jr. Air-5260W1 hardenjh@AM@NTRPRS
Hardenjh.NTRPRS@NAVAIR.Navy.mil

In return, we'll send you a durable 2-inch DMA color seal (while our supply lasts). It shows your commitment to DoD interoperability and looks neat on planners and notebooks!

Appendix A

KEY MC&G PLAYERS

Name	Address	Phone	Remarks
LCDR Zdenka S. Willis	Commander Naval Air Systems Command (Code Air-5260W) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5526	703-604-3380 ext 8118 fax 604-4179 [DSN 664]	TEAM METOC Officer
Mr. Jay Harden	Commander Naval Air Systems Command (Code Air-5260W1) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5526	703-604-3380 ext 8102 fax 604-4179 [DSN 664]	DMA Liaison to TEAM
CDR Mike Hacunda Ms. Mary Clawson	Office of the Oceanographer, N096 3450 Massachusetts Avenue, NW Washington DC 20392-5421	202-653-1610 [DSN 294]	CNO sponsor
Mr. Steve Hall	Office of the Oceanographer CNO N961CD (Steve Hall) 3450 Massachusetts Avenue, NW Washington DC 20392-5421	202-653-1610 [DSN 294]	DMA Liaison to Navy
Ms. Beverly Mitchell	Space and Naval Warfare Systems Command (Code 30D) 2451 Crystal Drive Arlington VA 22245	703-602-8381 [DSN 332]	DMA Liaison to SPAWAR
Mr. Kurt Savoie	Marine Corps Intelligence Activity Attn: DMAL MCIA-13 2033 Barnett Avenue Quantico VA 22134-5011	703-640-4525 fax 640-2026 [DSN 278]	DMA Liaison to USMC
Maj Bobby Mosley	Marine Corps Intelligence Activity Attn: DMAL MCIA-13 2033 Barnett Avenue Quantico VA 22134-5011	703-640-4525 fax 640-2026 [DSN 278]	Marine Corps MC&G Officer
Mr. Bill McMahon	U.S.Army Corps of Engineers Topographic Engineering Center Attn: CETEC-PD-D 7701 Telegraph Road Alexandria VA 22315	703-355-2804 [DSN 345]	DMA Liaison to TEC
Mr. John Arensberg	Electronic Systems Center Attn: DMAL 5 Eglin Street Hanscom AFB MA 01731-2123	617-377-8368 [DSN 478]	DMA Liaison to ESC
Mr. Gary Hacker	Headquarters, Air Force Material Command Attn: IND 4225 Logistics Avenue, Suite 11 Wright Patterson AFB OH 45433	513-257-5047 [DSN 787]	DMA Liaison to AFMC
Mr. Steve Wallach	Defense Mapping Agency Attn: PRW, Stop A-13 8613 Lee Highway Fairfax VA 22031	703-285-9228 [DSN 356]	Advanced Weapons and Systems Division
CDR Fred Gay	Defense Mapping Agency Attn: PRA, Stop A-13 8613 Lee Highway Fairfax VA 22031	703-285-9340 [DSN 356]	Aerospace Warfare Division

QMCS John Gray	Pentagon Office DMA Combat Support Center Pentagon Room BG720 Washington DC 20301-7000	703-695-7907 [DSN 225]	DMA Pentagon Office
Ms. Lynn Keleher	Defense Mapping School 5825 21st Street Suite 106 Ft. Belvoir VA 22060	703-805-3213 [DSN 655]	DMS Registrar
Mr. Kevin Shaw Ms. Maura Lohrenz	Naval Research Laboratory Mapping, Charting, and Geodesy Branch (Code 7441) Stennis Space Center MS 39529-5004	601-688-4611 [DSN 485]	Navy lab
Mr. Mark Wonnacott Ms. Janis Lindgren	Naval Air Warfare Center Weapons Division (Code C-2876) 1 Administration Circle China Lake CA 93555-6001	619-939-1089 [DSN 437]	Weapons Division
LCDR John Scanlan	JAST Program Office (Code JAST-RQN1) 1215 Jefferson Davis Highway, Suite 800 Arlington VA 22202-3251	703-602-7390 ext 6650 [DSN 664]	Joint Advanced Strike Technology
LCDR Randy Mahr	Commander Naval Air Systems Command (Code PMA-201E3) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5201	703-604-2410 ext 2492 [DSN 664]	Conventional Strike Weapons
Ms. Phyllis Corley	Commander Naval Air Systems Command (Code PMA-2053B2) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5205	703-604-2245 ext 3072 [DSN 664]	Aviation Training Systems TOP SCENE
Mr. Fred Salvesen	Commander Naval Air Systems Command (Code PMA-209I) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5209	703-604-2500 ext 8860 [DSN 664]	Common Avionics
MAJ Al Womble	Commander Naval Air Systems Command (Code PMA-233D) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5233	703-604-1450 ext 8446 [DSN 664]	Tactical Aircraft Mission Planning System
LCDR Matt Scassero	Commander Naval Air Systems Command (Code PMA-23441) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5234	703-604-2540 ext 4832 [DSN 664]	A-6/EA-6
Ms. Laurie Godschall	Commander Naval Air Systems Command (Code PMA-257) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5257	703-604-4000 ext 2956 [DSN 664]	AV Weapon Systems (Harrier)
LCDR Jeff Sherman	Commander Naval Air Systems Command (Code PMA-2613) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5261	703-604-2480 ext 7053 [DSN 664]	H-53 and Executive Transport Helicopters

CDR Dave Culbertson	Commander Naval Air Systems Command (Code PMA-265) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5265	703-604-6240 ext 2830 [DSN 664]	F/A-18
LCDR Scott Bruce	Commander Naval Air Systems Command (Code PMA-275) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5275	703-604-4000 ext 2928 [DSN 664]	V-22A Osprey
Ms. Wanda Green	Commander Naval Air Systems Command (Code PMA-276) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5276	703-604-4000 ext 2951 [DSN 664]	AH-1
Mr. Dave Maddox	Commander Naval Air Systems Command (Code PMA-278) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5278	703-604-4567 [DSN 664]	Joint Advanced Weapons Countermeasures
Mr. Paul Coakley	Commander Naval Air Systems Command (Code PMA-28135) Naval Air Systems Command Headquarters 1421 Jefferson Davis Highway Arlington VA 22243-5281	703-604-1706 [DSN 664]	Cruise Missile Command and Control System
CDR Paul Mallon	Program Executive Officer Tactical Aircraft Program (Code APEO(T)OPS1) 1421 Jefferson Davis Highway Arlington VA 22243-5010	703-604-2446 ext 8513 [DSN 664]	PEO(T)
Mr. John Misenheimer	Commander Space and Naval Warfare Systems Command (Code PMW/PMA-167) 2451 Crystal Drive Arlington VA 22245-5200	703-604-5191 [DSN 664]	Navigation Systems

Appendix B

MATRIX OF TEAM CUSTOMERS AND DMA PRODUCTS

TEAM	Acronym	Program	Product(s)	Milestone	Status	Remarks
PEO(JAST)	JAST	Joint Advanced Strike Technology	DTED			Joint (USN lead)
PMA-201	JSOW	Joint Standoff Weapon Baseline	DTED Points DPPDB	2	ORD	Joint GPS
PMA-201	JDAM	Joint Direct Attack Munitions	Points DPPDB	1	ORD	Joint (USN lead) GPS
PMA-205		Aviation Training Systems				
PMA-205	TOP SCENE	Tactical Operational Preview Scene	DTED PPDB			
PMA-209	TAMM	Tactical Aircraft Moving Map	CADRG CIB DTED		MNS draft	
PMA-231	ATDS	E-2 Aircraft Tactical Display System	DTED DCW			GPS
PMA-233	TAMPS	Tactical Aircraft Mission Planning System	CADRG DTED1 WVS DAFIF ADRG ADRI CIB DNC DCW	NA	ORD draft	TMTK
PMA-233	COMPASS	Joint Integrated Mission Planning Capability	CADRG DTED1 WVS DAFIF ADRG ADRI CIB DNC DCW		MNS draft	Joint (USN lead) TMTK
PMA-234	TEAMS	Tactical EA-6B Mission Support System	DTED1 ADRG DAFIF	1		GPS
PMA-248	JTCTS	Joint Tactical Combat Training System		1	ORD	Joint GPS
PMA-257		AV-8B Targeting System	CAC		MNS	GPS
PMA-261	CH-53	CH-53 Midlife Upgrade	Points		ORD	GPS

TEAM	Acronym	Program	Product(s)	Milestone	Status	Remarks
PMA-265		Low Altitude Terrain Following/Terrain Clearance Navigation Capability for F/A-18	DTED1 CAC		MNS draft	
PMA-265	F/A-18E/F	F/A-18E/F	CIB CAC	NA	ORD	M2:FY96Q2 GPS/INS or MAGR
PMA-273	JPATS	Joint Primary Aircraft Training System	DTED1	1	ORD	Joint (USAF lead) GPS
PMA-273	T45TS	T-45 Training System				GINA
PMA-275	V-22A	V-22A Osprey	DTED1 CADRG CIB	1		M2:FY94Q4
PMA-276	AH-1W	AH-1W Midlife Upgrade	CADRG CIB	NA	ORD	EGR
PMA-278	TSSAM	Tri-Service Standoff Attack Missile	DPPDB Points			
PMA-280	TBIP	Tomahawk Weapon System Baseline Improvement Program	TERCOM Points	2	ORD	GPS
PMA-281	JSIPS	Joint Service Imagery Processing System	DTED1 WMED DPPDB ADRG CADRG	2	ORD draft	Joint (USAF lead)
PMA-281	MDS/MDDS	Mission Display System/Mission Data Distribution System	VOD ADRG WVS			TMPCU
PMA-281	TDDS	Tactical Data Distribution System	VOD			APPS
PMA-281	DIWS DIWS-A	Digital Image Workstation Suite (Afloat)	DPPDB TERCOM			TMPCU APPS
PMA-281	TSCM	Tomahawk Strike Coordination Module	ADRG WVS			
PMA-281	TPS TPS-A	Tomahawk Land Attack Missile Planning System (Afloat)	DTED VOD WVS TERCOM			TMPCU APPS
PMA-290	P-3 GPS	P-3 Global Positioning System	Points	3		datums, coordinate systems, accuracies
PMA-299	VH-60N	VH-60N Midlife Upgrade	DAFIF		ORD	GPS
PMW/ PWA-159	JTIDS	Joint Tactical Information Distribution System		2		

TEAM	Acronym	Program	Product(s)	Milestone	Status	Remarks
PMW/ PWA-167	PLGR	Precise Lightweight Geopositional Receiver	Points	3		GPS, datums, coordinate systems, accuracies
PMW/ PWA-167	CSEL	Combat Survivor Evader Locator	Points	1		GPS datums, coordinate systems, accuracies
PMW/ PWA-167	GPS	Global Positioning System	Points	3		
PMW/ PWA-167	MAGR	Miniature Airborne Global Positioning System	Points	3		

Appendix C

USEFUL STATISTICS ABOUT SELECTED DMA PRODUCTS

Standard Products

[Some statistics are representative values for purposes of comparison.]

Product	GNC	JNC	ONC	TPC	Coastal Chart	JOG-A	*TLM*
Output unit	chart	chart	chart	chart	chart	chart	*chart*
Medium	paper	paper	paper	paper	paper	paper	*paper*
Scale	1:5M	1:2M	1:1M	1:500K	1:300K	1:250K	*1:50K* (7)
Digital storage (1)	NA	NA	NA	NA	NA	NA	*NA*
Data density	NA	NA	NA	NA	NA	NA	*NA*
One inch =	416,667 feet	166,667 feet	83,333 feet	41,667 feet	25,000 feet	20,883 feet	*4,167 feet*
Average size in x in	42 x 57	42 x 57	42 x 57	42 x 57	24 x 35	22 x 29	*22 x 29*
Average size nm x nm	2,400 x 3,650	960 x 1,460	480 x 730	240 x 340	121 x 177	60 x 90	*15 x 15*
Average snm	876,000	1.4M	350,400	81,600	21,417	5,400	*190*
Equivalent # 1:50K TLM	*44,800*	*7,168*	*1,792*	*448*	*93*	*32*	*1*
Print quantity	40,000	17,000	50,000	50,000	1,500	16,000	*5,900*
Labor cost new product	NA	NA	1,500 hours	1,999 hours	1,450 hours	1,800 hours	*850 hours*
Labor cost (revision)	876 hours	619 hours	512 hours	476 hours	NA	771 hours	*450 hours*
Calendar days new product	NA	NA	502	436	436	591	*476*
Calendar days (revision)	255	240	245	259	NA	519	*257*
Abs Horiz Accuracy	32,805 feet	13,123 feet	6,561 feet	3,280 feet	.5 meters	125 meters	*50 meters*
Abs Vertical Accuracy	NA	1,000 feet	500 feet	250 feet	.3 meters	25-100 meters	*10-40 meters*
Rel Horiz Accuracy	8,333 feet	3,333 feet	1,667 feet	833 feet	NA	NA	*NA*
Rel Vertical Accuracy	NA	1,000 feet	500 feet	250 feet	NA	NA	*NA*
Required earth coverage (2)	100% (4)	100% (5)	100% (6)	76%	27%	22%	*3%*
Available earth coverage (3)	100%	100%	100%	61%	26%	17%	*2%*

(1) Maps to digital vary with the data structure (1 ONC ≈ 7 MB vector or ≈ 320 MB raster).
(2) The percent of the total earth's surface (148,705 ksnm) the warfighter needs mapped.
(3) The percent of the total earth's surface (148,705 ksnm) currently available to the warfighter.
(4) 27 charts cover the total earth's surface.
(5) 122 charts cover the total earth's surface.
(6) 270 charts cover the total earth's surface.
(7) Also available at 1:100,000 (statistics are for 1:50,000).

Product	Combat Chart	City Graphic	DTED Level 1	DTED Level 2	DFAD Level 1 E2	VOD	ITD
Output unit	chart	chart	1° cell	15' cell	1° cell	1° cell	15' cell
Medium	paper	paper	CD-ROM	9 track CCT	9 track CCT	9 track CCT	9 track CCT
Scale	1:50K	1:12.5K (1)	1:250K (equiv)	1:50K (equiv)	1:250K (equiv)	1:250K (equiv)	1:50K (equiv)
Digital storage	NA	NA	2.9 MB	27 MB	12 MB		6 MB (4)
Data density	NA	NA	403 pts/snm	3620 pts/snm	1.5 features/snm		varies (5)
One inch =	4,167 feet	1,042 feet	varies (2)	varies (2)	varies (2)	varies (2)	4,167 feet
Average size in x in	33 x 45	34 x 44	NA	NA	NA	NA	22 x 29
Average size nm x nm	27 x 32	12 x 7	37 x 60		37 x 60	37 x 60	15 x 13
Average snm	864	89	2,220	555	2,220	2,220	190
Equivalent # 1:50K TLM	*4*	*<1*	*16*	*4*	*16*	*16*	*1*
Print quantity	3,100	2,500	NA	NA	NA	NA	NA
Labor cost new product	934 hours	1,171 hours	700 hours	550 hours	1,143 hours	492 hours	1,725 hours
Labor cost (revision)	NA	800 hours	NA	NA	NA	NA	NA
Calendar days new product	321	613	235	371	200	154	344
Calendar days (revision)	NA	369	NA	NA	NA	NA	NA
Abs Horiz Accuracy	50-100 meters	25 meters	50 meters	50 meters	130 meters	classified	50 meters
Abs Vertical Accuracy	0-100 meters	10 meters	30 meters	30 meters	10 meters	NA	10-40 meters
Rel Horiz Accuracy	NA	NA	NA	NA	NA	NA	NA
Rel Vertical Accuracy	NA	NA	NA	NA	NA	NA	NA
Required earth coverage	.22%	.14%	27% (3)		13%		
Available earth coverage	.22%	.08%	17%		4%		

(1) Also available at 1:25,000.
(2) Depending on display.
(3) This is 100% of the earth's land mass, or about 19,000 1° cells worldwide.
(4) This includes the entire ITD data set.
(5) Same as TTADB and PTADB.

Product	TERCOM Landfall	TERCOM Enroute	TERCOM Terminal	PPDB Film	Gridded Photo	APG	Points
Output unit	cell	cell	cell	film pairs floppy disk	photo	cell	coordinate pair
Medium	9 track CCT	9 track CCT	9 track CCT	hard copy software package	photo	photo	text
Scale	classified	classified	classified	1:110,000 (1)	1:6,000	1:15,000	NA
Digital storage	98 MB	48 MB	39 MB	NA	NA	NA	NA
Data density				NA	NA	NA	NA
One inch =	classified	classified	classified	9,167 feet	500 feet	1,250 feet	NA
Average size in x in	classified	classified	classified	8.5 x 11	20 x 24	5 x 5	NA
Average size nm x nm	classified	classified	classified	60 x 60	2 x 2		NA
Average snm	classified	classified	classified	30,000	4	1.25	NA
Equivalent # 1:50K TLM	*classified*	*classified*	*classified*	*5*	*<1*	*<1*	*NA*
Print quantity	NA	NA	NA	25	15	6	NA
Labor cost new product	525 hours	198 hours	160 hours	275 hours	60 hours	16 hours	455
Labor cost (revision)	NA	NA	NA	NA	NA	NA	NA
Calendar days new product	477	249	214	NA	90	60	10
Calendar days (revision)	NA	NA	NA	NA	NA	NA	NA
Abs Horiz Accuracy	classified	classified	classified	classified	classified	classified	classified
Abs Vertical Accuracy	classified	classified	classified	classified	classified	classified	classified
Rel Horiz Accuracy	classified	classified	classified	classified	classified	classified	classified
Rel Vertical Accuracy	classified	classified	classified	classified	classified	classified	classified
Required earth coverage				14%			classified
Available earth coverage				5%			classified

(1) Also available at 1:80,000 and 1:300,000.

Product	FLIP (1)	DAFIF (1)	ADRG (2)	DCW (3)	DNC	WVS	WMED
Output unit	text graphics	text records		4 CD-ROM (4)		5° x 5° tile set	WAG cell
Medium	hard copy	9 track CCT	CD-ROM	CD-ROM	CD-ROM	CD-ROM	9 track CCT
Scale	varies	NA	varies (6)	1:1M (equiv)	1:50K - 1:500K (equiv)	1:250K (equiv) various (7)	
Digital storage	NA	<5 MB	400 MB	1,700 MB		106 MB (1:250K)	
Data density	NA	NA	varies	varies	varies	12 pts/nm	
One inch =	NA	NA	varies (5)		varies (6)	varies	
Average size in x in	varies	NA	NA		varies (6)		
Average size nm x nm	varies	NA	varies (6)		varies (6)	varies	12 x 18
Average snm	NA	NA	varies (6)		varies (6)		
Equivalent # 1:50K TLM	*NA*	*NA*	*varies (6)*		varies (6)		
Print quantity		NA	NA	NA	NA	NA	NA
Labor cost new product			52 hours			NA	
Labor cost (revision)	NA		NA			NA	
Calendar days new product			30			NA	
Calendar days (revision)	NA		NA			NA	
Abs Horiz Accuracy	varies	NA	varies (6)	6,700 feet	varies (6)	500 meters	NA
Abs Vertical Accuracy	varies	NA	varies (6)	2,000 feet	varies (6)	NA	varies
Rel Horiz Accuracy	varies	NA	varies (6)		varies (6)	NA	NA
Rel Vertical Accuracy	varies	NA	varies (6)		varies (6)	NA	NA
Required earth coverage						100% of shorelines	
Available earth coverage						100% of shorelines	

(1) Updated every 28 days.
(2) ADRG is transformed by NRL into CAC to support the AV-8B and F/A-18.
(3) DCW is the first DMA product to support GIS and comes with VPFVIEW software.
(4) Four CD-ROMs cover the world.
(5) Depending on display.
(6) See original paper product.
(7) Additional scales available are 1:1M, 1:3M, 1:12M, 1:40M, 1:120M.

Developmental Products

Product	CADRG	CIB	VMAP Level 0	VMAP Level 1	VMAP Level 2	Digital PPDB
Output unit	1° cell	1° cell	4 CD-ROM (1)	1° tile	15' tile	1° ZDR
Medium	CD-ROM	CD-ROM	CD-ROM	CD-ROM	CD-ROM	8mm tape cartridge
Scale	varies	1:75,000	1:1M (equiv)	1:250K (equiv)	1:50K-1:100K (equiv)	1:110,000
Digital storage	289 MB	13 GB	1.7 GB (2)			28 GB (3)
Data density	169 pixels/inch		varies	varies	varies	
One inch =	varies					NA
Average size in x in	NA	NA	NA			NA
Average size nm x nm	varies	60 x 60				60 x 60
Average snm	varies	3,600				3,600
Equivalent # 1:50K TLM	*varies*					*5*
Print quantity	NA	NA	NA	NA	NA	TBD
Labor cost new product		TBD				60 hours
Labor cost (revision)	NA	TBD				NA
Calendar days new product		TBD				TBD
Calendar days (revision)	NA	TBD				NA
Abs Horiz Accuracy	varies	<61 meters	6,700 feet	125-500 meters	50-200 meters	classified
Abs Vertical Accuracy	varies	NA	2,000 feet	.5-2 contours	.5-2 contours	classified
Rel Horiz Accuracy	varies	<61 meters	NA	NA	NA	classified
Rel Vertical Accuracy	varies	NA	NA	NA	NA	classified
Required earth coverage			100 %			10%
Available earth coverage			0			0
IOC	Apr 94					Apr 96

(1) Four CD-ROMs cover the world.
(2) For the 4 CD-ROMs of 273 vectorized ONCs worldwide.
(3) Equals 4.5 GB compressed.

PAPER CHART SCALES & EQUIVALENTS (1)

	MILES PER INCH		INCHES PER MILE		
SCALE	NAUTICAL	STATUTE	NAUTICAL	STATUTE	FEET PER INCH
1:50,000	0.69	0.79	1.46	1.27	4,166.67
1:250,000	3.43	3.95	0.29	0.25	20,833.33
1:500,000	6.86	7.89	0.15	0.13	41,666.67
1:1,000,000	13.72	15.78	0.07	0.06	83,333.33
1:2,000,000	27.43	31.57	0.04	0.03	166,666.67
1:3,000,000	41.15	47.35	0.02	0.02	250,000.00
1:5,000,000	68.58	78.91	0.01	0.01	416,666.67

(1) A 1:500,000 digitally scanned paper chart, when zoomed in, is magnified and no longer displayed at 1:500,000 scale even though the information content remains unchanged!

PAPER CHART LINE WEIGHTS

SCALE	WIDTH OF PENCIL	GROUND DISTANCE	
1:50,000	0.5 mm	2,500 mm	25 meters
1:250,000	0.5 mm	12,500 mm	125 meters
1:500,000	0.5 mm	25,000 mm	250 meters
1:1,000,000	0.5 mm	50,000 mm	500 meters
1:2,000,000	0.5 mm	100,000 mm	1000 meters
1:3,000,000	0.5 mm	150,000 mm	1500 meters
1:5,000,000	0.5 mm	250,000 mm	2500 meters

While the math in this table seems obvious, the inference is not. A road on a levee that is also the shoreline for a section of river all appear in the same physical space when seen from directly overhead. (Cartographers call this the planimetric or plan view, as opposed to a perspective view.) With faithful positioning at 1:250,000 scale, the road, levee, and shore would all be mapped on top of one another and be indistinguishable. For a line weight on the map of .5 mm, no objects at this scale can be shown with closer spacing than 125 meters. To make the product useful for the warfighter, map makers displace these features from their true position and may generalize their shape so they appear visually distinct and clear. Displacement and generalization, often not obvious to the warfighter, play havoc with precise feature positions taken from maps. Paper charts can be your worst enemy for determining coordinates such as target locations – don't do it!

THE WATER AND LAND MASSES OF THE EARTH

TOTAL WATER	103,833 KSNM	69.8 %
ASIA	14,548 KSNM	9.8 %
AUSTRALIA	2,237 KSNM	1.5 %
GREENLAND	633 KSNM	.4 %
AFRICA	8,829 KSNM	5.9 %
ANTARCTICA	4,525 KSNM	3.0 %
NORTH AMERICA	7,059 KSNM	4.7 %
SOUTH AMERICA	5,191 KSNM	3.5 %
EUROPE	804 KSNM	.5 %
OTHER	1,046 KSNM	.7 %
TOTAL LAND	44,872 KSNM	30. %
WORLD TOTAL	**148,705 KSNM**	**100.0 %**

THE COASTLINES OF THE COUNTRIES

There are about 174,055 nautical miles of coastline worldwide.

Appendix D

THOSE INEVITABLE ACRONYMS

AAFIF	Automated Air Facilities Information File
ADRG	ARC Digitized Raster Graphic
ADRI	ARC Digitized Raster Imagery
AFMC	Air Force Material Command
AGL	Above Ground Level
AID	Aeronautical Information Data
Air-05	Assistant Commander for Systems and Engineering
Air-526	Weapons Analysis Division
AMO	Administrative Operations Division
APG	Aim Point Graphic
APPS	Analytical Point Positioning System
ARC	Equal Arc Second Raster Chart/Map
ASD C^3I	Assistant Secretary of Defense for Command, Control, Communications, and Intelligence
ATDS	Aircraft Tactical Display System
AUTODIN	Automatic Digital Network
AV	Assault Vertical
CAC	Compressed Aeronautical Chart
CADRG	Compressed ARC Digitized Raster Graphic
CADRI	Compressed ARC Digitized Raster Imagery
CAG	COMSAT Augmented GPS
CALS	Continuous Acquisition and Life Cycle Support
CCT	Computer Compatible Tape
CDR	Commander
CD-ROM	Compact Disc - Read Only Memory
CE	Circular Error
CEP	Circular Error Probable
CHUM	Chart Updating Manual
CIB	Controlled Image Base
CINC	Commander-In-Chief
CJCS	Chairman, Joint Chiefs of Staff
CNO	Chief of Naval Operations
CNMOC	Commander, Naval Meteorology and Oceanography Command
COEA	Cost and Operational Effectiveness Analysis
COMPASS	Common Operational Mission Planning And Support Strategy
COMSAT	Commercial Satellite
CPI	Characters Per Inch
CSEL	Combat Survivor Evader Locator
DAAS	Defense Automatic Addressing System
DAASC	DoD Automatic Addressing System Center
DAFIF	Digital Aeronautical Flight Information File
DAMES	DAASC Automatic Message Exchange System
DBDB	Digital Bathymetric Data Base
DC	District of Columbia
DCHUM	Digital Chart Updating Manual
DCW	Digital Chart of the World
DDN	Defense Data Network
DFAD1	Digital Feature Analysis Data, Level 1
DFAD2	Digital Feature Analysis Data, Level 2
DFARS	Department of Defense Federal Acquisition Regulations
DFAS	Defense Finance and Accounting Service
DFLIP	Digital Flight Information Publication

DG	Digital Gazetteer
DGPS	Differential Global Positioning System
DIA	Defense Intelligence Agency
DISA	Defense Information Systems Agency
DIWS-A	Digital Image Workstation (Afloat)
DMA	Defense Mapping Agency
DMAAC	Defense Mapping Agency Aerospace Center
DMACSC	Defense Mapping Agency Combat Support Center
DMAHTC	Defense Mapping Agency Hydrographic/Topographic Center
DMAI	Defense Mapping Agency Instruction
DMAL	Defense Mapping Agency List
DMALO	Defense Mapping Agency Liaison Officer
DMS	Defense Mapping School
DNC	Digital Nautical Chart
DoD	Department of Defense
DoDAAC	Department of Defense Activity Address Code
DPI	Dots Per Inch
DPPDB	Digital Point Positioning Data Base
DSMAC	Digital Scene Matching And Correlation
DSN	Defense Switched Network
DTAD	Digital Terrain Analysis Data
DTED1	Digital Terrain Elevation Data, Level 1
DTED2	Digital Terrain Elevation Data, Level 2
ECHUM	Electronic Chart Updating Manual
EGR	Embedded GPS Receiver
ESC	Electronic Systems Center
FLIP	Flight Information Publication
FMS	Foreign Military Sales
FY	Fiscal Year
GB	Gigabyte
GFI	Government Furnished Information
GGIS	Global Geospatial Information and Services
GINA	GPS/INS Navigation Assembly
GIS	Geographic Information System
GNC	Global Navigation Chart
GPS	Global Positioning System
HE	Horizontal Error
ILS	Instrument Landing System
IMU	Inertial Measuring Unit
INS	Inertial Navigation System
IOC	Initial Operational Capability
IRS	Internal Revenue Service
ITD	Interim Terrain Data
JAST	Joint Advanced Strike Technology
JCS	Joint Chiefs of Staff
JDAM	Joint Direct Attack Munition
JNC	Jet Navigation Chart
JOG-A	Joint Operations Graphic - Air
JPATS	Joint Primary Aircraft Training System
JSIPS	Joint Service Imagery Processing System
JSOW	Joint Standoff Weapon
JTCTS	Joint Tactical Combat Training System

JTIDS	Joint Tactical Information Distribution System
K	Thousand
KB	Kilobyte
KSNM	Thousand Square Nautical Miles
LCDR	Lieutenant Commander
LE	Linear Error
M	Million
MADTRAN	Mapping Datum Transformation
MAGR	Miniature Airborne GPS Receiver
MB	Megabyte
MC&G	Mapping, Charting, and Geodesy
MDDS	Mission Data Distribution System
MDS	Mission Display System
METOC	Meteorological/Oceanographic
MGRS	Military Grid Reference System
MIL-HDBK	Military Handbook
MIL-SPEC	Military Specification
MIL-STD	Military Standard
MILSTRIP	Military Standard Requisitioning and Issue Procedures
mm	millimeter
MNS	Mission Needs Statement
MOP	Memorandum Of Policy
MPS	Modernized Production System
MS-DOS	Microsoft Disk Operating System
MSL	Mean Sea Level
MTF	Message Text Format
MTT	Mobile Training Team
MUSE	Mapping, Charting, and Geodesy Utility Software Environment
N096	Oceanographer of the Navy
NA	Not Applicable or Not Available
NAPC	North American Aim Point Catalog
NAVAIR	Naval Air Systems Command
NHN	NAVAIR Headquarters Network
NITF	National Imagery Transmission Format
NRL	Naval Research Laboratory
NSDI	National Spatial Data Infrastructure
NSN	National Stock Number
OCR	Optical Character Reader
ONC	Operational Navigation Chart
OPNAVINST	Office of the Chief of Naval Operations
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
PC	Personal Computer
PEO	Program Executive Officer
PEO(A)	Program Executive Officer for Anti-Submarine Warfare, Assault & Special Missions
PEO(CU)	Program Executive Officer for Cruise Missiles & Unmanned Aerial Vehicles
PEO(JAST)	Program Executive Officer for Joint Advanced Strike Technology
PEO(T)	Program Executive Officer for Tactical Aircraft
PGM	Precision Guided Munition
pixel	picture element
PLGR	Precise Lightweight Geopositional Receiver
PMA	Program Management Air

PMA(F)	Program Management Air (Field)
PMA-201	Conventional Strike Weapons Program Office
PMA-205	Aviation Training Systems Program Office
PMA-209	Common Avionics Program Office
PMA-231	E-2 Aircraft Tactical Display System Program Office
PMA-233	Tactical Aircraft Mission Planning System Program Office
PMA-234	A-6/EA-6 Program Office
PMA-248	Tactical Training Ranges Program Office
PMA-257	Attack Vertical Weapon Systems Program Office
PMA-261	H-53 and Executive Transport Helicopters Program Office
PMA-263	Navy Unmanned Aerial Vehicles Program Office
PMA-265	F/A-18 Program Office
PMA-273	T-45 Training System Program Office
PMA-275	V-22A Osprey Program Office
PMA-276	AH-1 Program Office
PMA-278	Tri-Service Standoff Attack Missile Program Office
PMA-280	Tomahawk All-Up-Round Program Office
PMA-281	Cruise Missile Command and Control System Program Office
PMA-282	Cruise Missile Weapon Systems Program Office
PMA-290	Maritime Surveillance Aircraft Program Office
PMA-299	Multi-Mission Helicopters Program Office
PMW	Program Management Warfare
PMW/PMA-159	Advanced Tactical Data Link Systems Program Office
PMW/PMA-167	Navigation Systems Program Office
PQL	Partial Quality Leadership
PRA	Aerospace Warfare Division
PRB	Land and Naval Warfare Division
PRW	Advanced Weapons and Systems Division
PTADB	Planning Terrain Analysis Data Base
QFC	Quality Feedback Card
QMCS	Senior Chief Quartermaster
RFI	Request For Information
RFP	Request For Proposal
RGB	Red Green Blue
RPF	Raster Product Format
RSI	Remotely Sensed Imagery
SAR	Search And Rescue
SEP	Spherical Error Probable
SGML	Standard Graphics Markup Language
SLAM	Standoff Land Attack Missile
SNM	Square Nautical Mile
SPAWAR	Space and Naval Warfare Systems Command
SPOT	Système Probatoire d'Observation de la Terre
SSBN	Subsurface Ship Ballistic Nuclear
TAMM	Tactical Aircraft Moving Map
TAMPS	Tactical Aircraft Mission Planning System
TBD	To Be Determined
TBIP	Tomahawk Baseline Improvement Program
TDDS	Tactical Data Distribution System
TEAM	The Naval Aviation Systems Team
TEAMS	Tactical EA-6B Mission Support System
TEC	Topographic Engineering Center
TERCOM	Terrain Contour Matching
TIJ	Joint MC&G Interoperability Division

TLAM	Tomahawk Land Attack Missile
TLE	Target Location Error
TLM	Topographic Line Map
TMPCU	Theater Mission Planning Center Upgrade
TMTK	Tactical Map Tool Kit
TOP SCENE	Tactical Operational Preview Scene
TPC	Tactical Pilotage Chart
TPF	Text Product Format
TPS-A	TLAM Planning System (Afloat)
TQ	Total Quality
TQL	Total Quality Leadership
TSSAM	Tri-Service Standoff Attack Missile
TTADB	Tactical Terrain Analysis Data Base
TTD	Tactical Terrain Data
UAV	Unmanned Aerial Vehicle
UB	Unified Build
UIC	Unit Identification Code
UPS	Universal Polar Stereographic
US	United States
USA	United States Army
USAF	United States Air Force
USMC	United States Marine Corps
USN	United States Navy
USS	United States Ship
UTM	Universal Transverse Mercator
VHS	Video Home System
VOD	Vertical Obstruction Data
VPF	Vector Product Format
VQ	Vector Quantization
WAG	World Aeronautical Grid
WAPC	World Aim Point Catalog
WGIS	World Geodetic Information System
WGS	World Geodetic System
WMED	World Mean Elevation Data
WORM	Write Once Read Many
WSC	Warrior Support Center
WVS	World Vector Shoreline
ZDR	Zone Distribution Rectangle