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Moving Map Composer - Personal Computer (MMCPC) for the Finnish Air Force, Software Design Document, Version 1.0

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14. ABSTRACT

The Moving Map Composer - Personal Computer (MMCPC) software is specifically designed and configured to support Finnish Air Force (FiAF) F/A-18 mission planners and pilots in the field. Previous versions of MMC were installed on Digital Equipment Corporation (DEC) Alpha workstations, which used the OpenVMS operating system and supported the AN/ASQ-196 Honeywell digital map system. MMCPC is a Microsoft (MS) Windows-based software application that provides data processing and mission/theater map data load support for the Tactical Aircraft Moving-Map Capability (TAMMAC) Digital Map System (DMS). This software release of MMCPC, in sole support of the FiAF F/A-18 program, contains substantial software modifications to meet specific FiAF requirements.

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1. INTRODUCTION

The Moving Map Composer – Personal Computer (MMCPC) software is specifically designed and configured to support Finnish Air Force (FiAF) F/A-18 mission planners and pilots in the field. Previous versions of the Moving-Map Composer (MMC) were installed on Digital Equipment Corporation (DEC) Alpha workstations, which used the OpenVMS operating system, and supported the AN/ASQ-196 Honeywell digital map system. MMCPC is a Microsoft (MS) Windows-based software application that provides data processing and mission/ theater map data load support for the Tactical Aircraft Moving Map Capability (TAMMAC) Digital Map System (DMS). This software release of MMCPC, in sole support of the FiAF F/A-18 program, contains substantial software modifications to meet specific FiAF requirements. For more information about MMC, the user is referred to Lohrenz et al. (2004).

MMCPC is comprised of task-specific menus and tools to assist FiAF mission planners in designing and building theater and mission coverages – and their associated data loads – used in the TAMMAC DMS. This document details the MMCPC software design and includes procedural flowcharts depicting composition development, data processing, and data load methodology in support of TAMMAC.

This version of the Software Design Document records the design and development of MMCPC Version 1.0. It is intended for use as a reference to the design methodology and procedures used to develop MMCPC.

1.1 MMCPC Overview

This report documents a substantial revision of the MMC system developed by scientists at the Naval Research Laboratory (NRL) Geospatial Processing and Analysis (GeoPAL) Team (Code 7440.1).

MMCPC runs on a Windows XP PC configured with a 16-bit PCMCIA (PC Memory Card International Association, or PC card) device to read and write TAMMAC mission and theater map data loads. MMCPC enables mission planners to perform the following functions:

- Process FiAF source Geospatial Tagged Image File Format (GeoTIFF) files into a Compressed Arc Digitized Raster Graphics (CADRG) compatible format;
- Process FiAF and National Geospatial-Intelligence Agency (NGA) source Digital Terrain Elevation Data (DTED) into a TAMMAC-compatible Regridded DTED (RDTED) format;
- Define and save regions of interest (ROI) for mission and theater map data loads as a series of bitmap representations;

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- Populate these ROIs with data from user-specified FiAF GeoTIFF files (converted to CADRG formatted files via MMCPC), NGA CADRG data, FiAF and/or NGA RDTED data, and NGA Controlled Image Base (CIB) data;
- Import and convert non-georeferenced images (e.g., Graphics Interchange Format (GIF) files) into TAMMAC-compatible data frames;
- Write completed TAMMAC theater map data loads to PC cards for aircraft loading;
- Build mission planning data loads from user-specified CADRG, RDTED, CIB, and data frames for use in the FiAF Mission Planning System (MPS);
- Print final compositions, CADRG images, data frames, and map load summaries.

1.2 Document Overview

This document describes the software design for MMCPC, including a history of the system's development, a technical description of the MMCPC architecture (built to accommodate specific data processing protocols, map composition requirements and map data operations), and the MMCPC Graphical User Interface (GUI). A final section discusses error checking and handling.

This document is intended for software engineers and developers who require a thorough understanding of the MMCPC software functionality and technical design. It may also be used as training material for new project members and users. This document will be updated periodically to reflect software revisions driven by changing FiAF program requirements.

1.3 System Overview

MMCPC provides tools to define geographic ROIs, populate these regions with digital geospatial data (including digital charts, satellite imagery, and terrain elevation data), and build mission and theater map data loads to be imported into the FiAF MPS and TAMMAC DMS. Figure 1 illustrates the data flow among these three systems (MMCPC, MPS, and TAMMAC DMS).

MMCPC is organized around three primary tasks – Data Processing, Map Composition, and Map Data Operations – each of which requires a set of GUI functions. Functional requirements are driven by one or more of these tasks. Many MMCPC requirements were inherited from the original MMC software. Data Processing requirements (Fig. 2) include identification of acceptable source data (e.g., GeoTIFF source files at predefined map scales) and color palette verification and validation. Map Composition requirements (Fig. 3) include procedures and tools to define geographic regions of interest at multiple map scales and types. Map Data Operations requirements (Fig. 4) include procedures and tools to read and display all data types, log and maintain processed data, and perform color map operations.

1.4 Data Formats

MMCPC supports map data processing and output formats compatible with the TAMMAC DMS. TAMMAC displays three georeferenced data types: CADRG, RDTED, and CIB. TAMMAC also displays non-georeferenced data frames in Harris Defined Format (HDF), described in Harris (2002). Each of these is supported in MMCPC, as are support files and data structures identified in the TAMMAC performance specification (Boeing 2001). All final TAMMAC data files are written to pre-formatted PCMCIA cards.

Legacy data types (e.g., Compressed Aeronautical Chart (CAC) and ADRG) from MMC v3.4P are not supported in TAMMAC or MMCPC, nor are the data structures, output devices, or storage media specific to the Honeywell AN/ASQ-196 DMS.

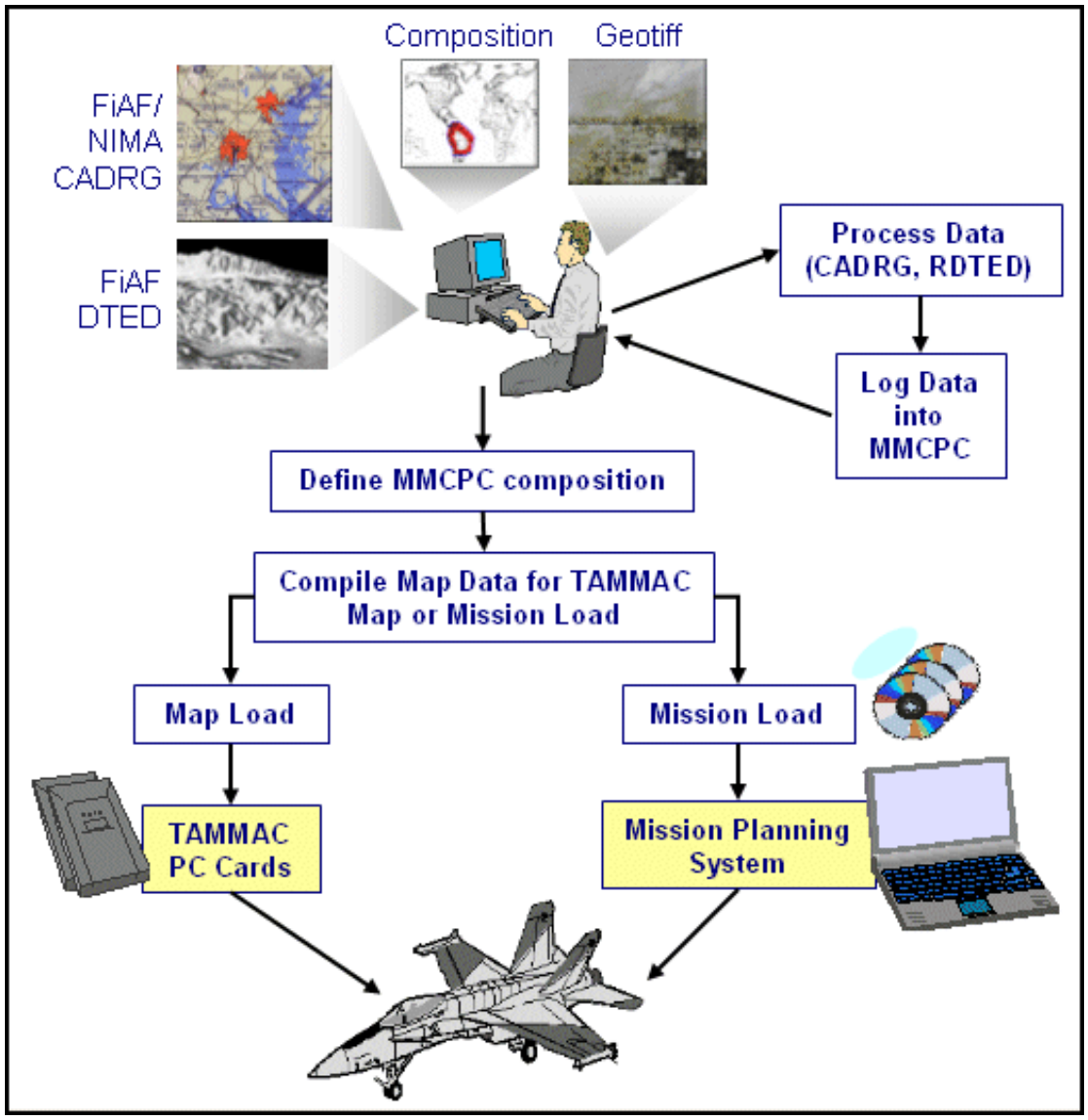

Fig. 1— Data flow among MMC-PC, MPS, and TAMMAC systems

1.5 Design Approach

A primary MMCPC software design goal was to create an appearance and behavior similar to other common Windows-based products. The MMCPC functional diagrams (Figs. 2 through 4) were used to build a requirements matrix (Appendix A), which was redefined and expanded during a series of design reviews, and was subject to mutual approval by technical representatives from NRL, NAVAIR, and the FiAF.

Procedures were developed to accommodate the final requirements matrix. Leveraging the FiAF experience and familiarity with the original MMC software, MMCPC requirements were mapped, when possible, to existing MMC GUI components. The software development tool kit QT, which contains templates for creating Windows-like applications, was used to design and create GUIs and generate C++

programming language code. Some Map Data Processing modules were written in C and later linked into MMCPC as object libraries.

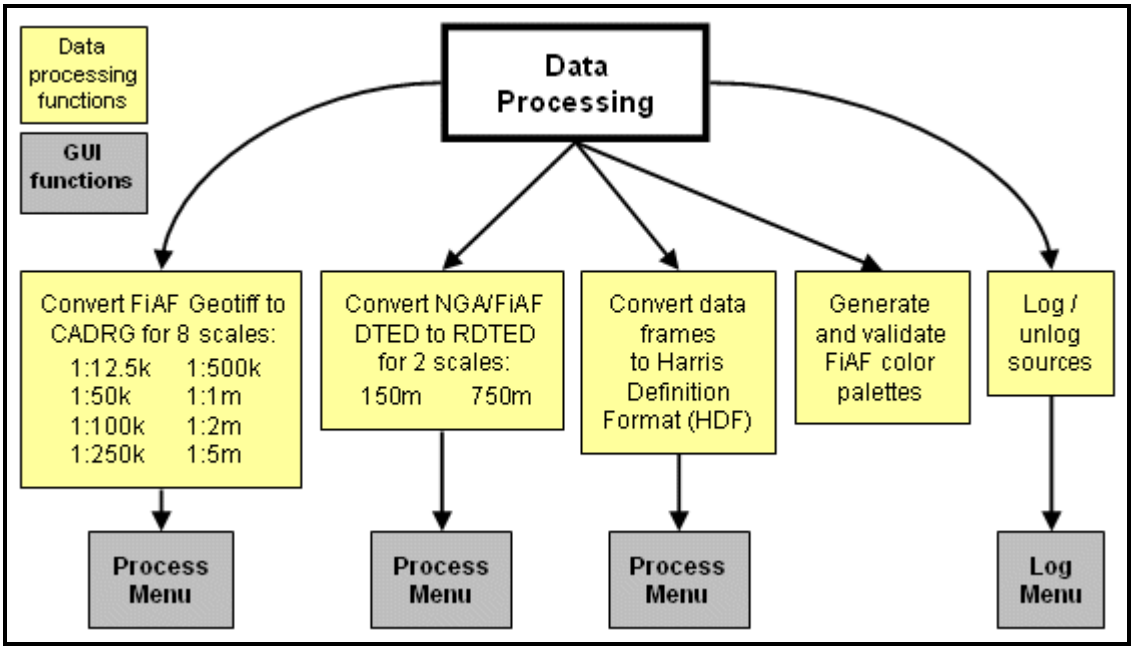

Fig. 2 — MMCPC data processing functional diagram

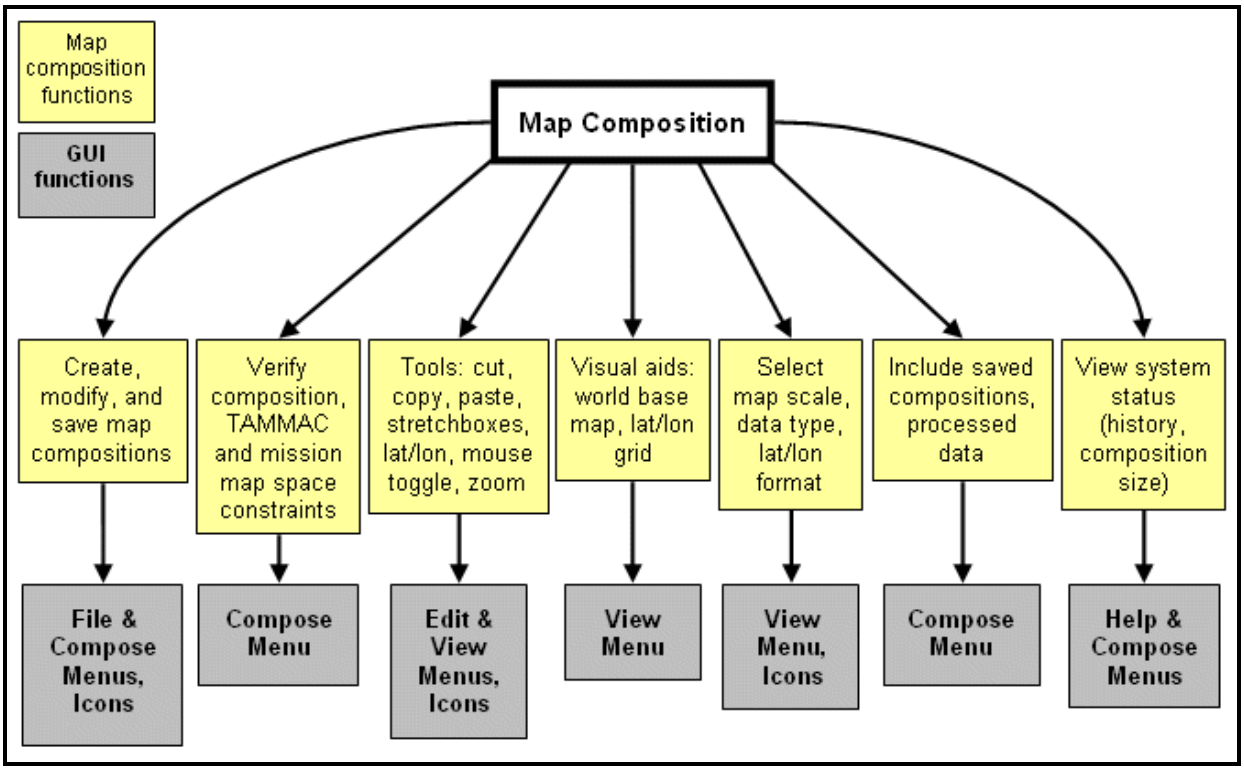

Fig. 3 — MMCPC map composition functional diagram

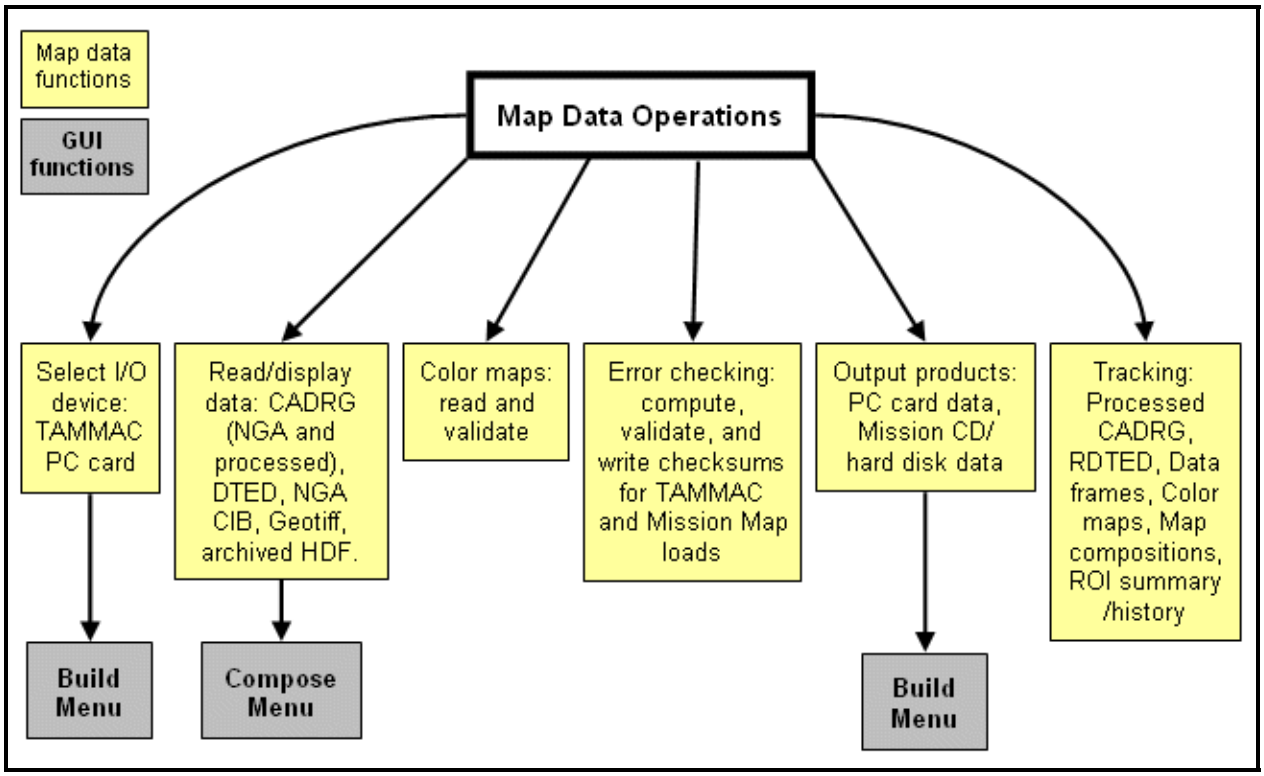

Fig. 4 — MMCPC map data operations functional diagram

GUI menus and options were created to provide the user with tools that are easy to use and facilitate the required tasks. Each GUI option is linked to at least one matrix requirement (Appendix B). Shortcuts and hotkeys for GUI options are defined, as are actions, conditions, and usage cases (i.e., when the menu option is available for use). Since a primary goal was to create a similar appearance and behavior found in other commercial Windows-based software, comparable design conventions were followed and implemented. For example, file browsers were designed to offer access to all valid storage devices and directory locations.

2. MMCPC ARCHITECTURE

The MMCPC architecture supports the three primary tasks described above (data processing, map composition, and map data operations) along with GUI communications and error checking functions. This section describes the design and implementation of each.

2.1 Data Processing

The first step in developing TAMMAC theater/mission data loads is to process any of several types of source data from FiAF or NGA (Table 1) into a TAMMAC-compatible format. NGA CADRG and CIB are already TAMMAC-compatible and require no MMCPC processing. The following sections of this report describe the three data processing functions provided in MMCPC to prepare the non-compatible data types:

- Process FiAF source GeoTIFF files into the CADRG format (MIL-C-89038: NGA 1994).
- Regrid FiAF or NGA source DTED (MIL-PRF-89020A: NGA 1996) into RDTED.
- Reformat non-georeferenced images into HDF formatted data frame files (Harris 2002).

Table 1 — Source Data for MMCPC

Source	Data Type
FiAF	GeoTIFF
FiAF & NGA	Digital Terrain and Elevation Data (DTED) - level 1 (100m)
Any	Data frames (TIF, GIF, PNG, BMP, JPEG, and HDF images)
NGA	Compressed Arc Digitized Raster Graphics (CADRG)
NGA	Controlled Image Base (CIB)

2.1.1 FiAF GeoTIFF to CADRG Processing

CADRG data is processed from source FiAF GeoTIFF data for use in the creation of TAMMAC theater and mission loads. Once processed, this data is available for use in other MMCPC compositions. Figure 5 provides an overview of CADRG processing, which includes five critical phases (color-coded consistently throughout this section): 1) determine finalization status (blue); 2) validate directory structure and source data (orange); 3) define destination path (green); 4) validate color palettes (yellow); and 5) process data (purple). Appendix C provides a full description of CADRG processing, including low-level steps within each phase.

2.1.1.1 Determine CADRG Finalization Status

The finalization procedure determines whether partial map segments (i.e., processed map files that are not completely filled with map data) should be fully processed or should remain in a partial state until additional data is appended to the files. CADRG data processing begins in one of two initial states: 1) all previous CADRG processed data has been finalized or 2) unfinalized CADRG data exists on the system. Processing is assumed to be in the first state when MMCPC is used to process FiAF GeoTIFF source files into CADRG. When unfinalized data are detected, MMCPC prompts the user to either finalize the remaining map files or append additional data.

Data should not be finalized (see Section 2.1.1.5) when multiple sets of source GeoTIFF data (i.e., multiple data CDs) are used until the last data set is loaded into MMCPC. This allows the user to process the current set of source data and resume processing another time. Alternatively, data is finalized when all source data is processed at once, from one source media; however, it cannot be appended later with additional processed data.

After MMCPC has determined the status of CADRG finalization, it defines the data source and destination paths. If unfinalized data exists, the user may choose to either finalize the previous set of data or append more map data to the previously processed data set. When the user chooses to append to the data, the destination path for the newly processed data is automatically preset to the destination of the existing data. If the existing processed data was finalized, then the user must define the path to the FiAF GeoTIFF source data and the destination path (Fig. 6).

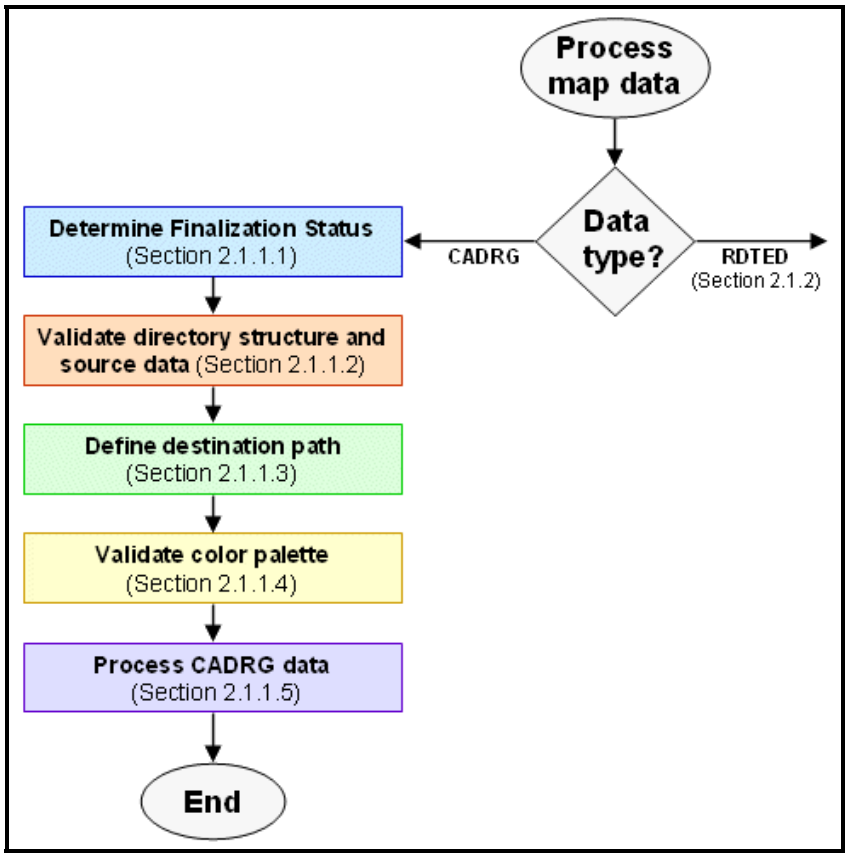

Fig. 5 — High-level flow chart for CADRG data processing

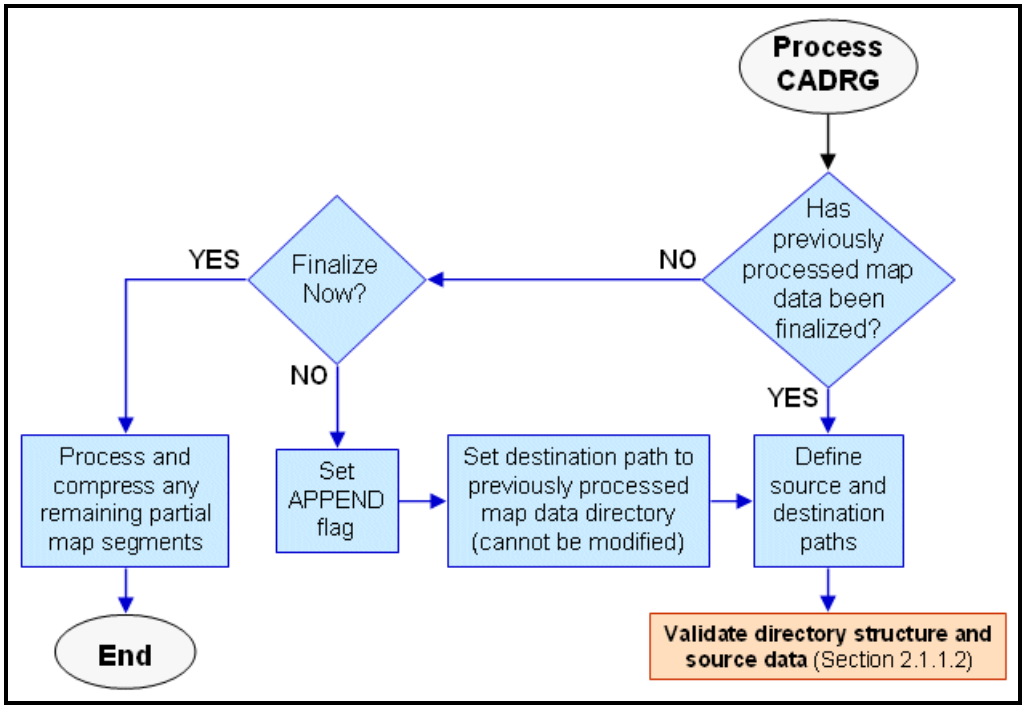

Fig. 6 — Control flow for CADRG finalization phase

2.1.1.2 Validate Source Directory Structure and Data for CADRG Processing

After source and destination paths are set, MMCPC verifies the FiAF GeoTIFF directory structure (Fig. 7). If it is invalid, an error message is displayed, CADRG data processing halts, and MMCPC returns to the main window. If the structure is valid, the header record of every GeoTIFF file in the destination directory is read and verified (Fig. 8). If the source is on CD, the volume label must be FAF_GTIF. A valid source includes a root directory, at least one subdirectory, and a TIF file. The source must be 8-bit GeoTIFF; MMCPC does not yet support 24-bit GeoTIFF. MMCPC verifies that each source GeoTIFF longitude bound is within 3° of its original longitude to minimize geospatial processing errors during transformation to CADRG. If the bounds are invalid, the steps are repeated until a valid directory structure is passed or the operation is cancelled. See Section 2.5 for MMCPC error handling.

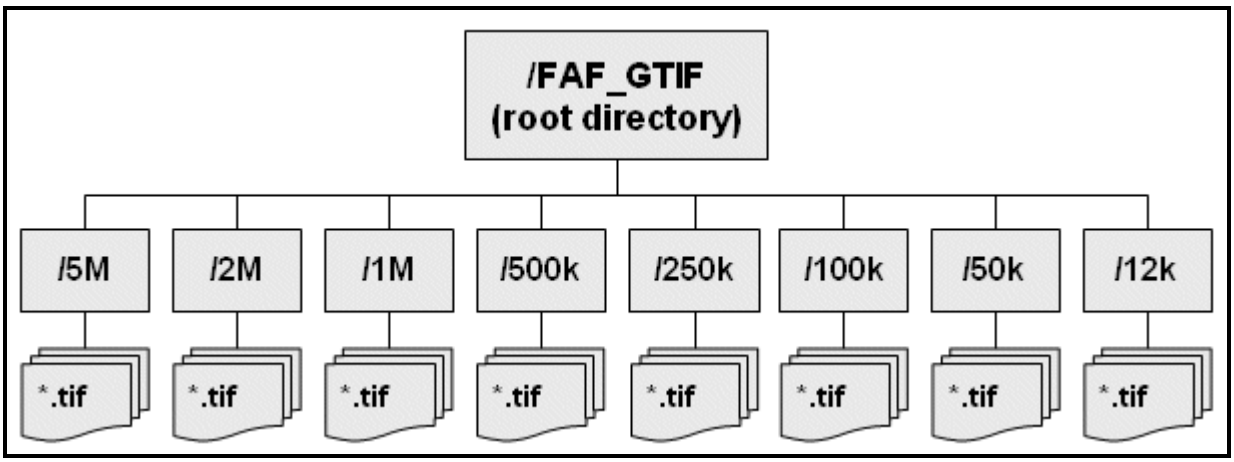

Fig. 7 — Source GeoTIFF directory structure

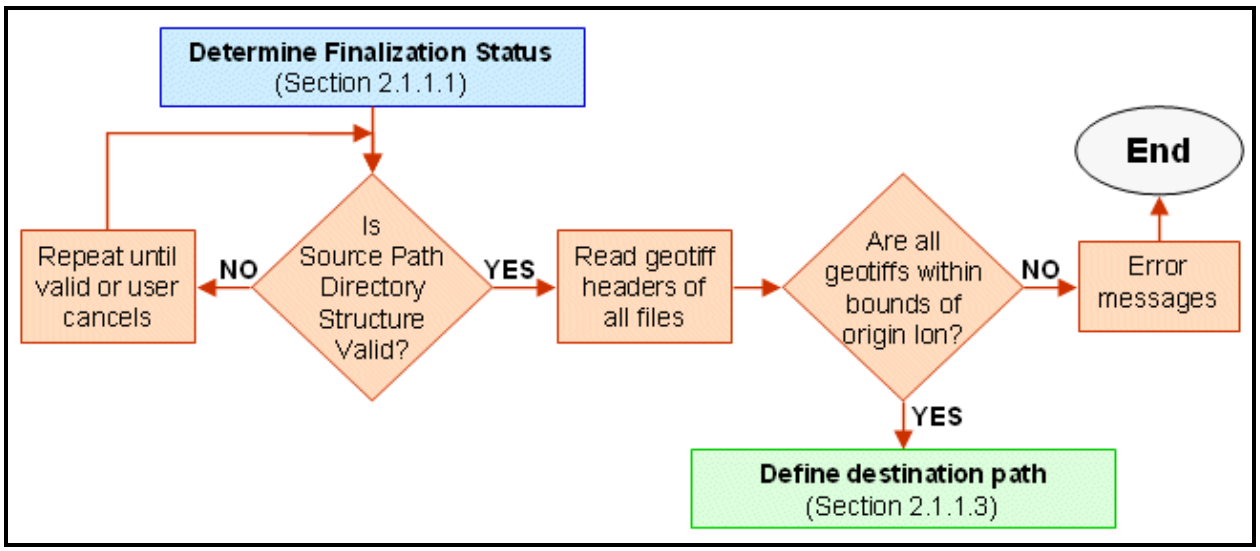

Fig. 8 — Control flow for CADRG directory path and data validation phase

2.1.1.3 Define CADRG Destination Path

After the source FiAF GeoTIFF files have been verified, the destination path is created, if it does not already exist (Fig. 9). The destination directory path provided by the user will be appended with a unique

MMCPC-assigned subdirectory path, or Processed Unique Identification (PUID), in the form of **CDRGFIAFxxxx_s**, where **xxxx** is a unique number (0001-9999) and **s** is a system identifier (A-Z) assigned by the MMCPC system administrator during installation. For example, if the user chooses destination directory **C:\MMCPC\Data\CDRG** for the first FiAF geotiff data processed on the system, with an identifier of "A," then the final path to the processed CADRG data will be **C:\MMCPC\Data\CDRG\CDRGFIAF0001_A**. Figure 10 gives an example of a full CADRG directory structure processed by MMCPC.

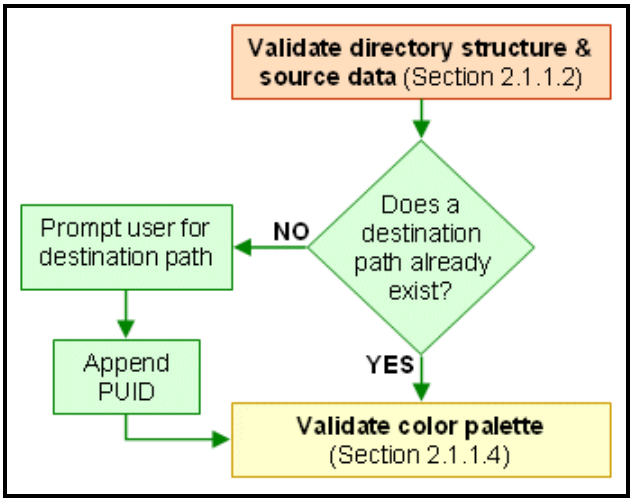

Fig. 9 — Control flow for CADRG destination path creation

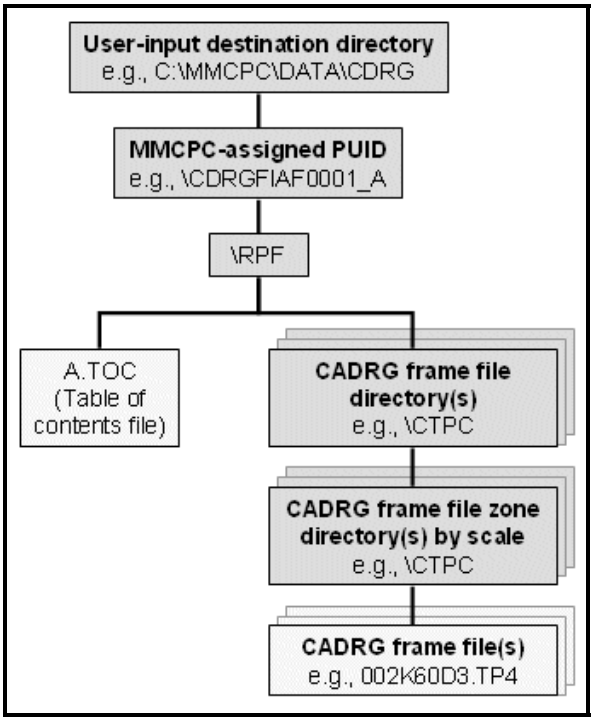

Fig. 10 — CADRG data directory structure and file naming convention

2.1.1.4 Validate Color Palettes

Each map scale supported in CADRG uses a standard 8-bit color palette. During installation of MMCPC, a default set of NGA color palettes is automatically loaded onto the system. This default set of palettes is also used to process FiAF geotiff into CADRG only if no custom color palettes are provided with the geotiff. There is no need to maintain the default color palettes to use NGA CADRG in combination with processed FiAF CADRG. NRL recommends that FiAF operators use their own custom color palettes for processing geotiff files into CADRG to improve color accuracy. The user may process multiple data sets with different color palettes without making the previous map data obsolete.

The format of the custom color palette file (**PALETTE.TXT**) is shown in Fig. 11. The first line of the file contains the number of colors in the palette (maximum = 216). If the actual number of colors does not match the first line, the file will be considered incorrect and the map data will not be processed. Each successive line after the first contains the text: "Set **n r g b**" where **n** is a sequential color identifier and **r g b** are the red, green, and blue values (from 0 to 255) of the color. Note that the "S" in "Set" must be capitalized. Each value is delimited by a single space.

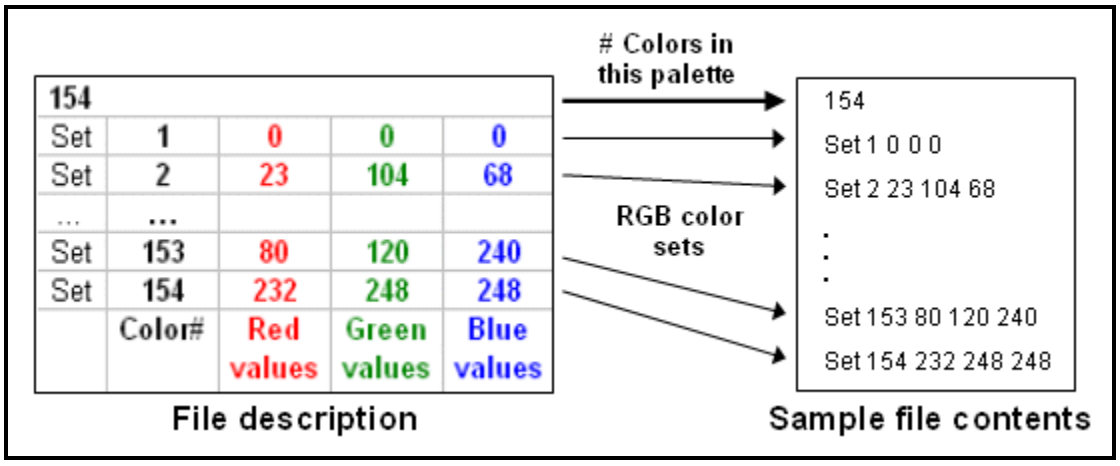

Fig. 11 — FiAF custom color palette format and sample file with 154 colors (maximum = 216)

MMCPC CADRG data processing routines determine whether a custom color palette exists for each scale of source GeoTIFF file (Fig. 12). When a custom color palette file is detected, it is compared to the installed color palette on MMCPC for that scale. If the color values of the two palettes are identical, processing proceeds normally. If a difference exists between the custom color palette and the MMCPC-installed palette for one or more map scales, the user is notified that new color palette(s) will be installed for those scale(s). The user must then decide to either cancel CADRG data processing or to proceed. By proceeding, the user has decided to install ***all*** of the custom color palettes for that scale.

If the current set of source GeoTIFF data is to be appended to the previous set of processed data, an additional check is made to validate the color palettes. For append processing, any color palettes associated with the source data must match the installed color palettes (by scale). All map scales must have either default color palettes or custom color palettes that are identical to the ones already installed. If the color palettes aren't identical, an error condition is detected, and CADRG data processing stops. Note: custom color palettes (and all associated actions) are not installed on the MMCPC system until data processing actually begins.

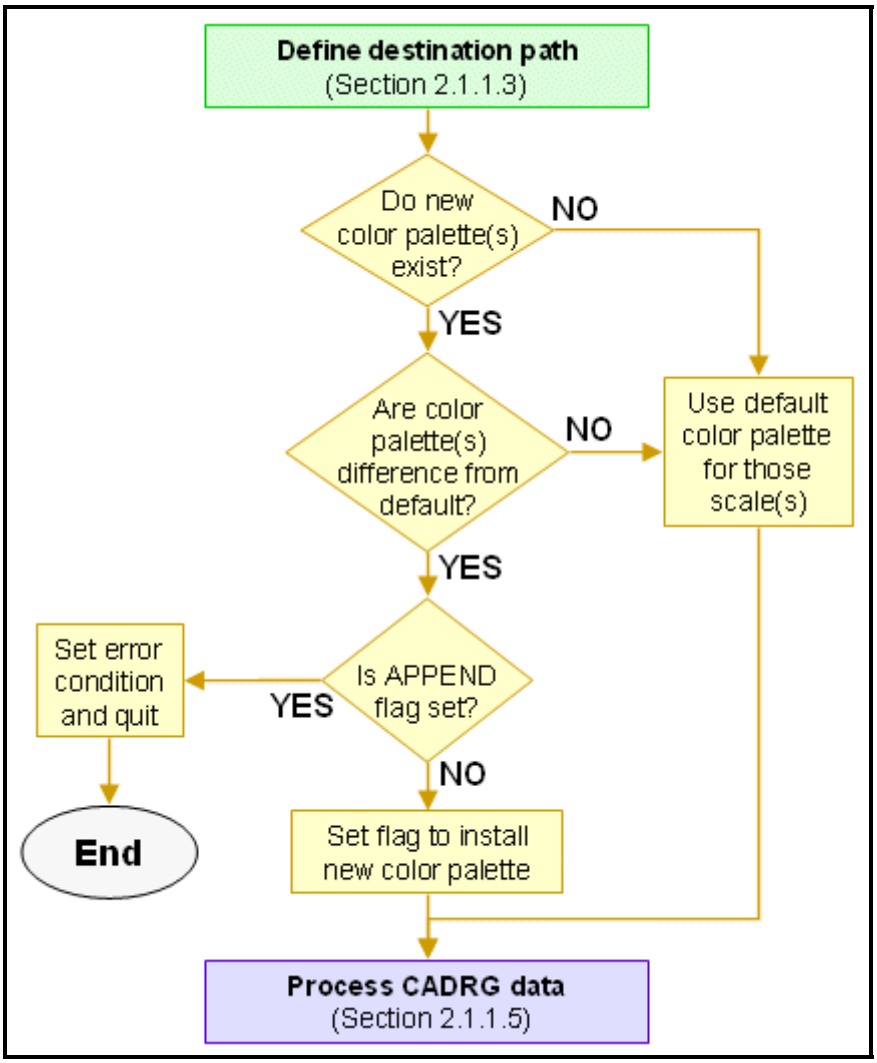

Fig. 12 — Control flow for color palette validation

2.1.1.5 Process CADRG Data

After all color palettes checks are complete, the CADRG processing dialog box prompts the user for the following information:

- *Set Finalize Automatically* (default = yes): If all source data will be processed at once, from one source media, this default setting will finalize the processed data and not allow any additional data to be appended. This setting should be disabled (toggled to "no") when multiple sets of source GeoTIFF data (i.e., multiple data CDs) will be used, or when source data will be processed in multiple parts. Disabling this setting will allow the user to process the current set of source data and resume processing later with no discontinuity.

- *Set Delete Unfilled Segments* (default = no): Removes partially filled processed map files from the final processed CADRG. This option is not applicable if the preceding setting (*Set Finalize Automatically*) is disabled.

- *Descriptive Name*: A name for this processed data (maximum of 16 ASCII characters).

The CADRG processing dialog box shows the estimated map data coverage (after processing) for each scale. The user reviews this information and either proceeds with CADRG data processing (by clicking PROCESS) or aborts the pending action (CANCEL). When processing begins (Fig. 13), new custom color palettes are installed for the applicable map scales.

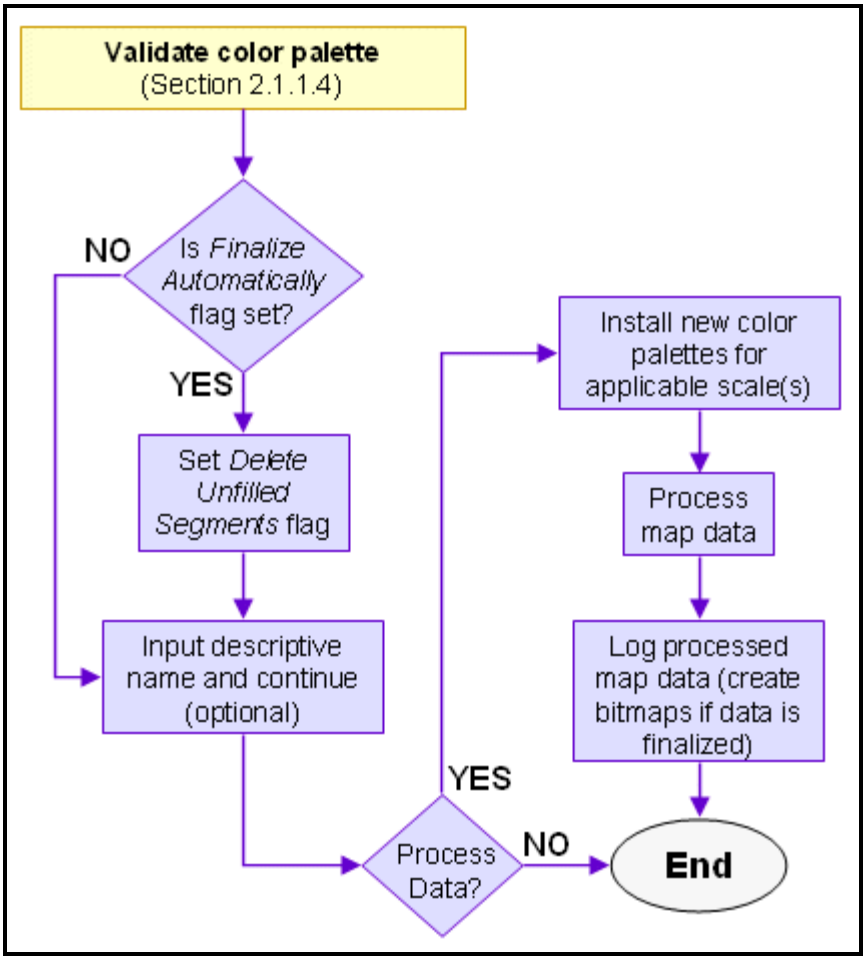

Fig. 13 — Control flow for CADRG data processing

Next, all source GeoTIFF data are processed into CADRG format and stored in the selected destination directory. If the user has chosen to finalize automatically, an **A.TOC** (Table of Contents) file is created at the **\rpf** (Raster Product Format) directory level (Fig. 10), and the processed map data is logged into MMCPC to create compositions and TAMMAC theater/mission data loads. If the user has chosen not to finalize, no **A.TOC** is created, and the processed map data are not logged. Processed map data cannot be used to create compositions or TAMMAC map loads until they have been logged. Map data logging is discussed in Section 2.1.3.

The error checking functions used during CADRG data processing provide descriptive error messages to assist the user in correcting any problems associated with the source data. For example, if a corrupt GeoTIFF source file is encountered, MMCPC will attempt to read the remaining files and report any

errors associated with source GeoTIFF files prior to exiting CADRG processing. Consequently, the user can fix all potential data problems in one session.

2.1.2 RDTED Processing

DTED is processed into RDTED at 750 m (1:5M) and 150 m (1:1M) scales, both of which are automatically included when defined in a composition. RDTED is formatted for use with CADRG during Mission and Theater load builds. Figure 14 provides an overview of RDTED processing, which includes four critical phases (color-coded consistently throughout this section):

1) Determine finalization status (blue)
2) Validate directory structure and source data (orange)
3) Define destination path (green), and
4) Process data (purple).

Appendix D provides a complete description of RDTED processing, including low-level steps within each phase.

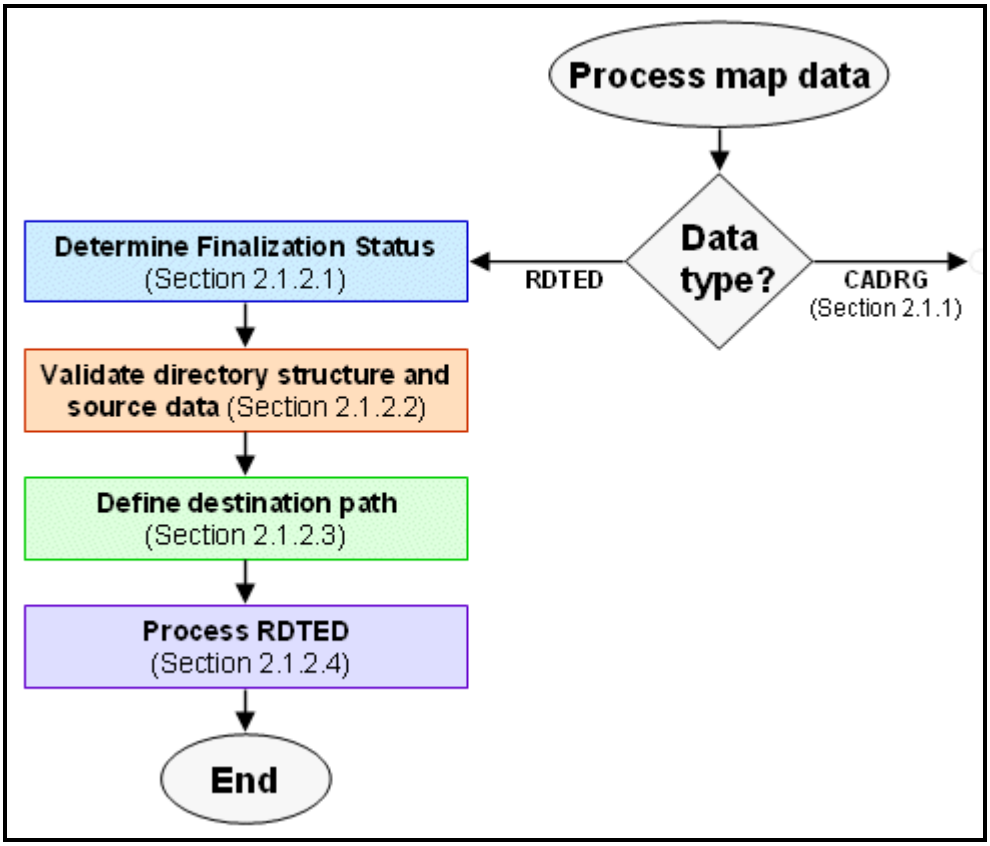

Fig. 14 — High level flow chart for RDTED processing

2.1.2.1 Determination of Finalization Status

As discussed earlier, finalization determines whether partial map segments (i.e., processed files that are not completely filled with map data) should be fully processed or should remain in a partial state until additional data is appended to the files. Like CADRG processing, RDTED processing begins in one of two initial states: 1) all previous RDTED processed data have been finalized or 2) unfinalized RDTED exists on the system. Processing is assumed to be in the first state when MMCPC is used to process FiAF GeoTIFF source files into CADRG. When unfinalized data are detected, MMCPC prompts the user to either finalize the remaining map files or append additional data (Fig. 15).

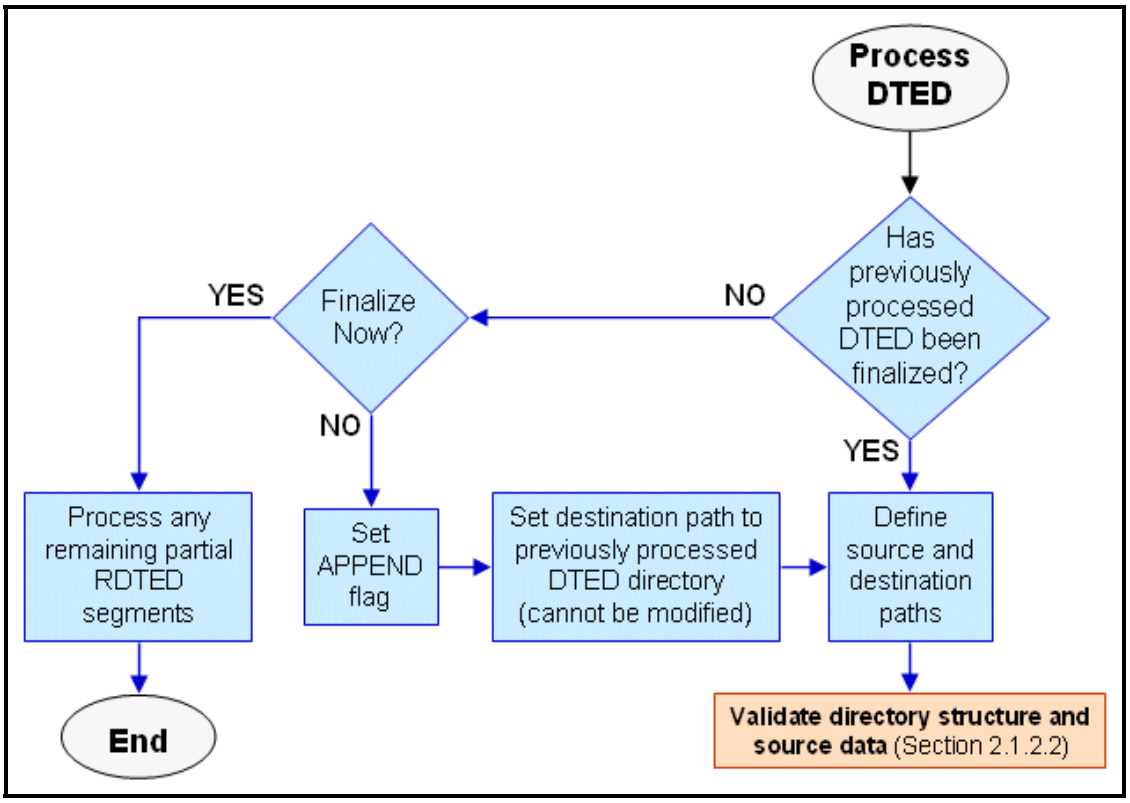

Fig. 15 — Control flow for RDTED finalization

Data should not finalized (Section 2.1.2.4) when multiple CDs of source DTED data are used until the last CD is loaded. This allows the user to process the current set of source data and resume processing another time. Data can be finalized when all source data are processed at once, from one CD, but it cannot be appended later with additional processed data.

After MMCPC has determined the status of RDTED finalization, it defines the data source and destination paths. If unfinalized data exists, the user may choose to either finalize the previous set of data or append more map data to the previously processed data set. When the user chooses to append to the data, the destination path for the newly processed data is automatically preset to the destination of the existing data. If the existing processed data were finalized, then the user must define the path to the source DTED (FiAF or NGA) and the destination path.

2.1.2.2 Validate Source Directory Structure and Data for RDTED Processing

After the source and destination paths are set, MMCPC verifies the source DTED directory structure (Fig. 16). If the directory structure is invalid, an error message is displayed, DTED data processing halts, and MMCPC returns to the main window. If the directory structure is valid, the cell header information of every DTED file in the destination directory is read and verified (Fig. 17). If the source DTED data are on CD and from FiAF, the volume header must be labeled **FAF_DTEDxxx** (where **xxx** is a unique numerical identifier). The DTED directory structure, file structure, and file naming conventions must conform to the DTED specification MIL-PRF-89020B (NGA 2000).

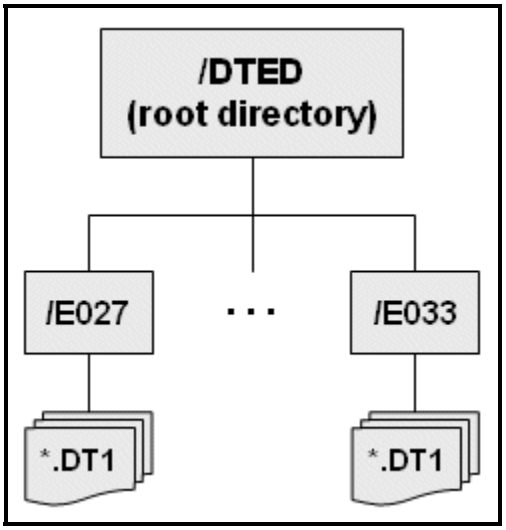

Fig. 16 — Source DTED directory structure

First level subdirectory names are derived from headings and longitude coordinates. For example, subdirectory **E027** is derived from 27 degrees East longitude. Leading "0" placeholders are required for longitude values less than 100. Each subdirectory may contain multiple DTED Level I cells that are each 1 degree by 1 degree in size, with post spacing determined by geographic zone.

MMCPC verifies that the DTED directory structure is correct and at least one valid DTED cell exists. MMCPC supports DTED Level I source data (100 m resolution) for processing into RDTED. Section 2.5 provides further discussion on MMCPC error handling.

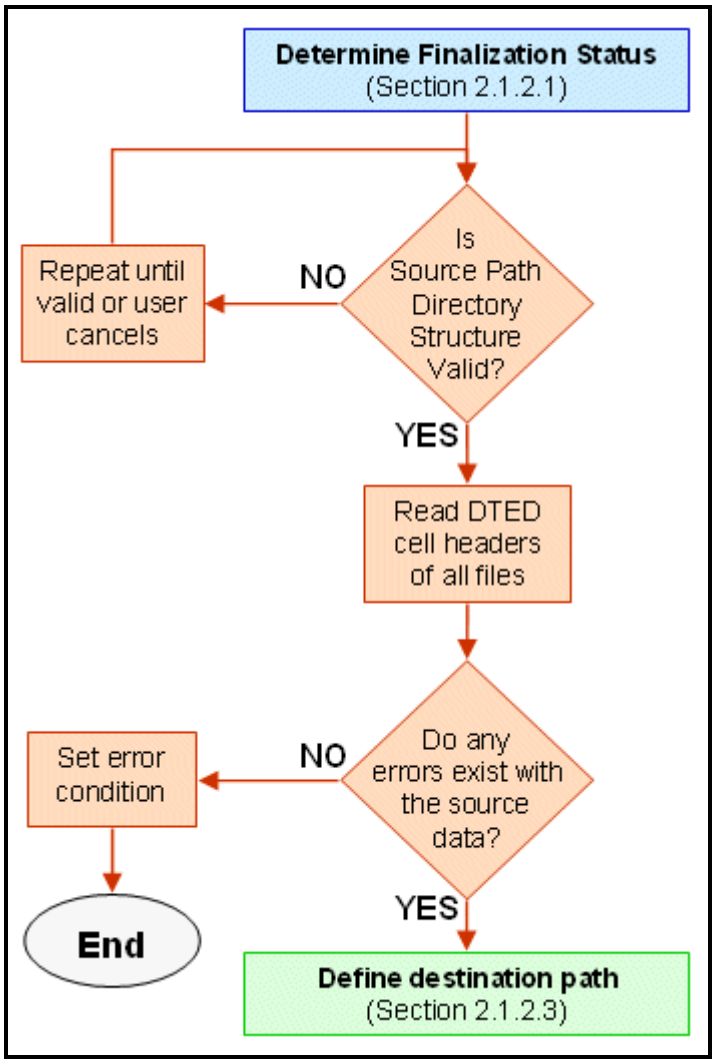

Fig. 17 — Control flow for RDTED data path definitions

2.1.2.3 RDTED Destination Path Creation

After the source DTED files have been verified, the destination path is created, if it does not already exist (Fig. 18). The destination path provided by the user will be appended with a unique MMCPC-assigned subdirectory path, or PUID, in the form of **RDTDFIAFxxxx_s**, where **xxxx** is a unique number (0001-9999) and **s** is a system identifier (A-Z) assigned by the MMCPC system administrator during installation.

For example, if the user chooses destination directory **C:\MMCPC\Data\RDTD** for the first DTED data processed on the system, with an identifier of "A," then the final path to the processed RDTED data will be **C:\MMCPC\Data\RDTD\RDTDFIAF0001_A**. Figure 19 gives an example of a full RDTED directory structure processed by MMCPC.

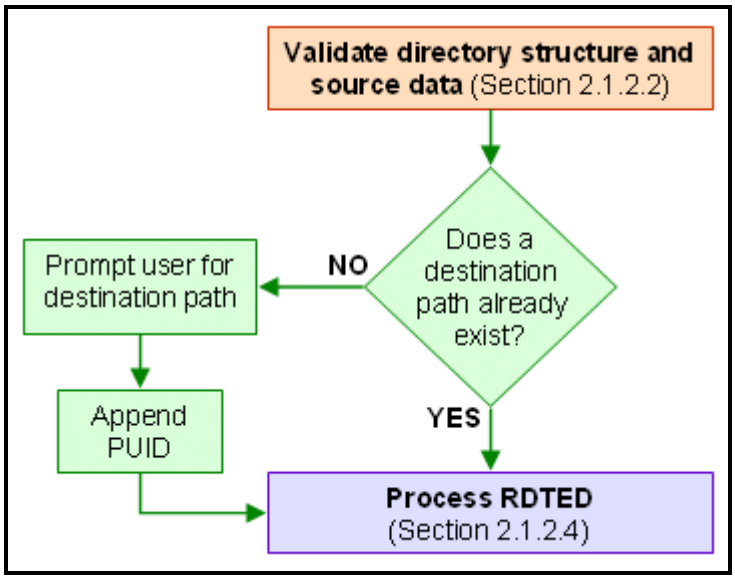

Fig. 18 — Control flow for RDTED destination path creation

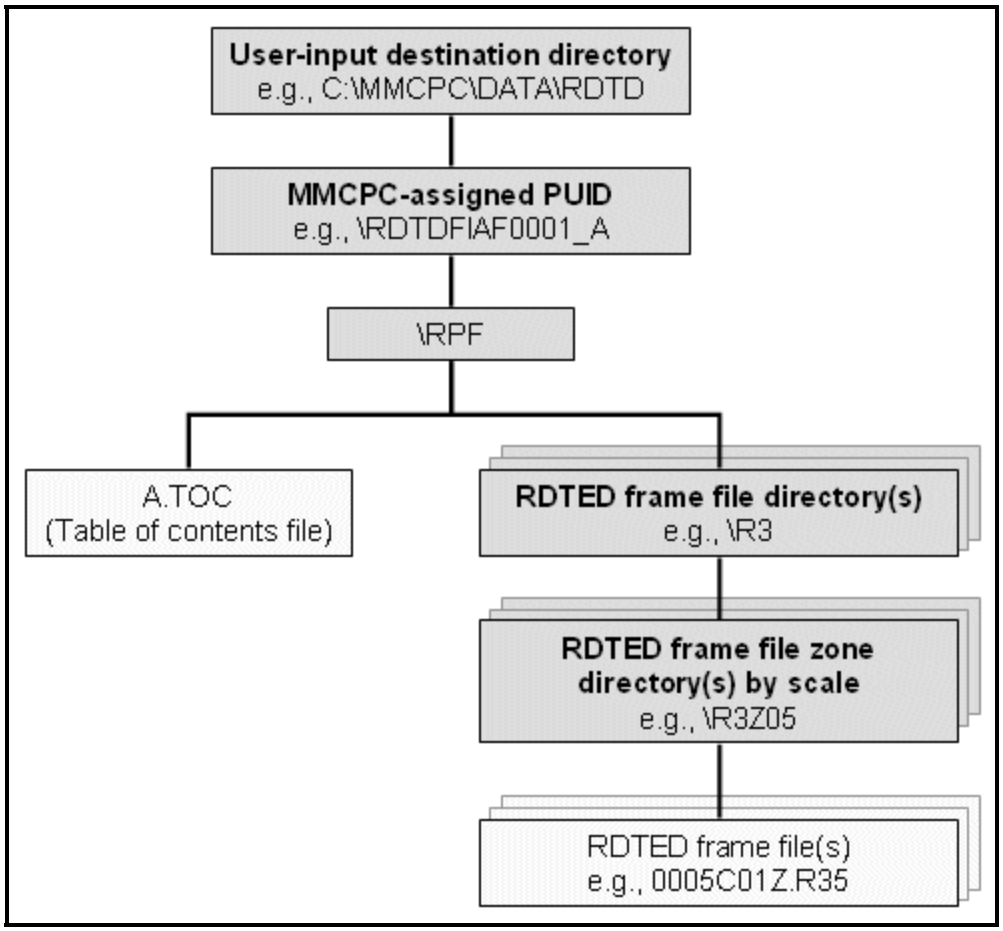

Fig. 19 — RDTED data directory structure

2.1.2.4 Process RDTED Data

Figure 20 presents the control flow for processing DTED into RDTED. First, the RDTED processing dialog box prompts the user for the following information:

- *Set Finalize Automatically* (default = yes): If all source data will be processed at once, from one source media, this default setting will finalize the processed data and not allow any additional data to be appended. This setting should be disabled (toggled to "no") when multiple sets of source DTED (i.e., multiple data CDs) will be used, or when source data will be processed in multiple parts. Disabling this setting will allow the user to process the current set of source data and resume processing later with no discontinuity.
- *Set Delete Unfilled Segments* (default = no): Removes partially filled processed map files from the final processed RDTED. This option is not applicable if the preceding setting (*Set Finalize Automatically*) is disabled.
- *Descriptive Name*: A name for this processed data (maximum of 16 ASCII characters).

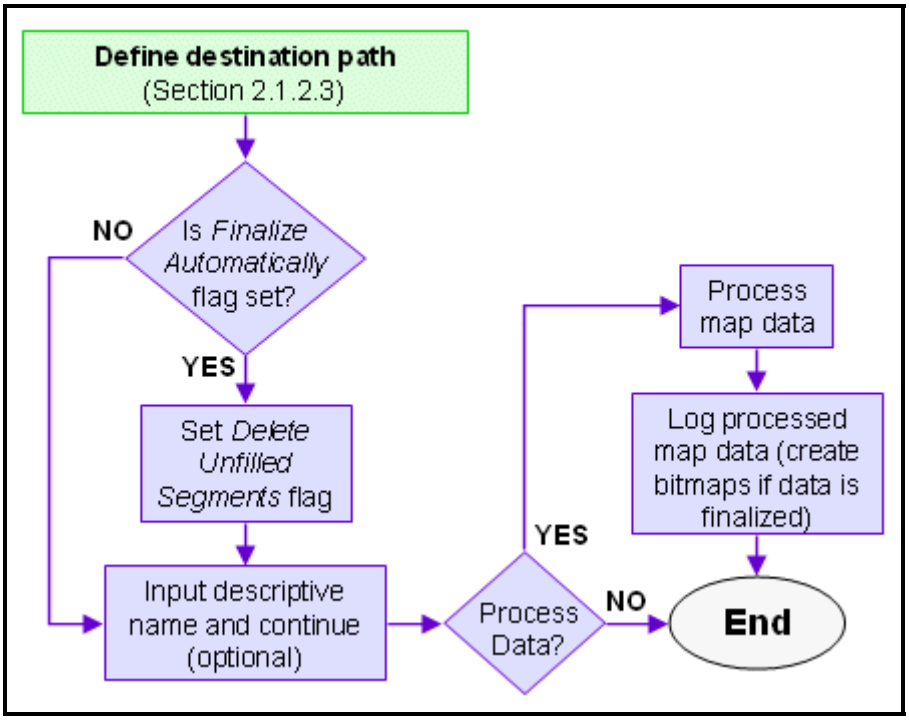

Fig. 20 — Control flow for RDTED processing

The RDTED processing dialog shows the estimated map data coverage (after processing) for each map scale. The user reviews the information presented on the dialog box and either commits to proceed with RDTED processing by clicking the PROCESS button, or aborts the pending action by clicking the CANCEL button.

Next, all source DTED is processed into RDTED and stored in the selected destination directory. If the user has chosen to finalize automatically, an **A.TOC** file is created at the **\rpf** directory level (Fig. 19) and the processed data are logged in MMCPC to create compositions and TAMMAC theater/mission data loads. If the user has chosen not to finalize, no **A.TOC** file is created, and the processed data are not

logged. RDTED data cannot be used to create compositions or TAMMAC map loads until they have been logged (Section 2.1.3).

The error checking functions used in RDTED processing provide descriptive error messages to assist the user in correcting any problems associated with the source data. For example, if a corrupt DTED source file is encountered, MMCPC will attempt to read the remaining files and report any errors associated with source files prior to exiting RDTED processing. Consequently, the user can fix all potential problems with the data at one time.

2.1.3 Logging Data Sources

All necessary map data sources (except data frames) must be logged before any theater/mission compositions can be built. Map data sources are either logged automatically when processed map data are finalized or logged via a MMCPC function call. Figure 21 presents an overview of the MMCPC data logging function, which includes three (color-coded) phases: 1) Define the source data location (blue); 2) Determine CADRG / RDTED data status (orange); and 3) Log processed map data (yellow). Appendix H provides a complete description of data logging, including low-level steps within each phase.

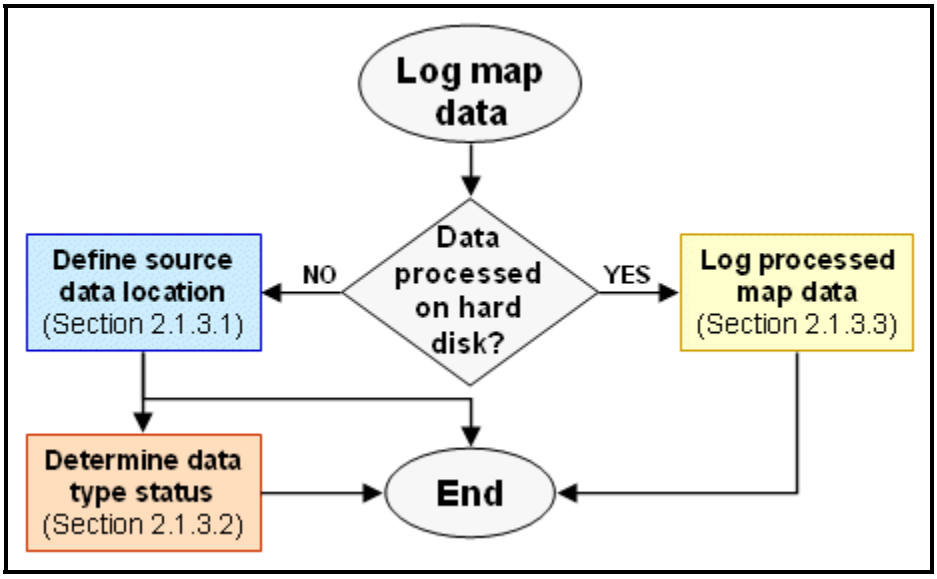

Fig. 21 — High-level flow chart for logging data sources

MMCPC automatically logs all finalized, processed map data that reside on hard disk and maintains all logged information in the directory **C:\MMCPC\coverage\bitmaps\logged**. Important note: Do not modify, add, or delete any files in this directory. MMCPC requires that logged source information (but not the data itself) reside in this directory. Any changes made to the directory outside of MMCPC may result in system failure and loss of data.

The MMCPC **LOG** function logs external map data sources (e.g., NGA CADRG and CIB) not residing on hard disk. If a user chooses to archive processed map data from hard disk to another location (e.g., CD) via an external program, those data must be logged before they can be used as part of a composition. MMCPC will delete processed map data on hard disk when the equivalent data on CD have

been logged, to prevent the logging of duplicate map data sources. Important note: The user is responsible for maintaining all CDs containing logged map data.

All logged sources are identified by their PUID. For map data processed by MMCPC, the PUID is automatically assigned (e.g., **FIAFCDRG0001_A**). For map data used directly from NGA, the PUID is the volume header of the NGA source (e.g., **CDRGXONCTPC05_8**). Each logged source is stored in an MMCPC-specific structure known as a world array bitmap that has a suffix of **.wbr**. Each logged source has a unique RPF information file (with suffix **.rif**) associated with its world array bitmap. The **.rif** file contains a descriptive name (10 characters), date stamp, and the full path to the processed map data.

For example, the files associated with a logged source having a PUID of **CDRGFIAF0001_A** would include **CDRGFIAF0001_A.wbr** and **CDRGFIAF0001_A.rif**. When data are unlogged from the system, all associated map data residing on hard disk are deleted. The unlogged data's world array bitmap and information files are not deleted but copied into a subdirectory for obsolete files and retained for archival purposes only.

2.1.3.1 Define the Source Data Location

Figure 22 presents a control flow diagram for defining the source data location. MMCPC automatically logs finalized, processed map data on hard disk. For external map data (e.g., on CD), the user must invoke the **LOG** function from the **DATA PROCESSING** menu. The **LOG** function will prompt for the data location, which is usually a CD drive but could be a network drive or other location. The volume label (if applicable) and a valid information file in the /**rpf** directory must exist for the map data to be considered a valid source. If the data are not on hard disk, the top-level PUID directory (e.g., **CDRGFIAF0001_A**) also must exist. Important note: A user should not process or archive data nested inside another data set on hard disk (e.g., never attempt to archive **CDRGFIAF0002_A** in the **CDRGFIAF0001_A** directory).

Once a location has been defined, MMCPC checks whether the source data have been processed or are from NGA. All RDTED must be processed, so the only data to be logged directly from NGA are CADRG and CIB. Next, the volume label and directory structure are validated. For processed map data, the volume label should be the PUID. For processed map data on CD, the top-level directory should be /**rpf**. The user must enter the volume name for the archived CD.

If the map data to be logged reside on a networked drive or other location, the map data's PUID must exist as the top-level directory in lieu of the volume label. For NGA map data sources, the last character in the PUID represents the edition number of the map data (this differs in meaning from the processed map data PUID) and indicates an overwrite of the existing logged source.

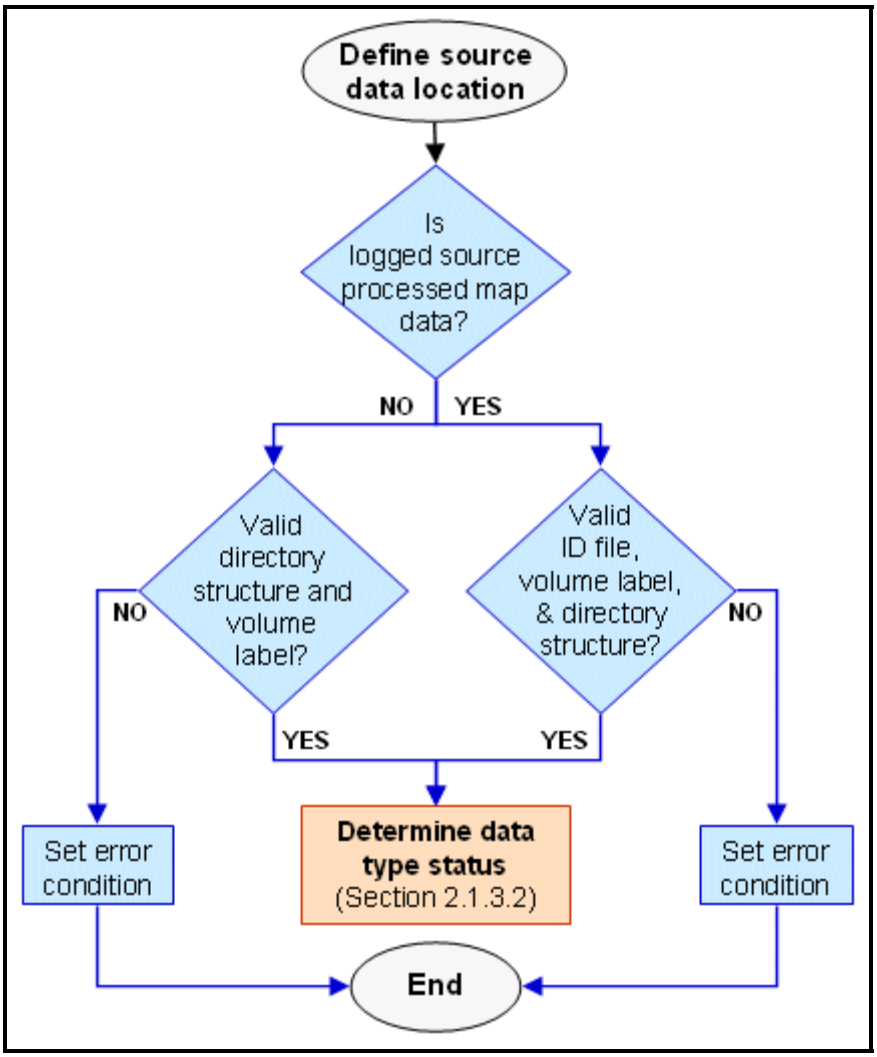

Fig. 22 — Control flow for defining the source data location

2.1.3.2 Determine Data Type Status

Figure 23 depicts the control flow for determining data type status. If the source CADRG has a different color palette from that installed on MMCPC, that particular scale of CADRG cannot be logged. The color palette for each zone and scale must be checked for consistency. If the user wants to reinstall the default NGA palettes, this process is handled by a SYSTEM menu option.

2.1.3.3 Log Processed Map Data

Figure 24 depicts the control flow for logging processed map data. The MMCPC-generated PUID or the volume ID (for NGA data) is used for the Identification (ID) file name. For example, an ID file for CADRG data processed from FiAF source GeoTIFF would be named **CDRGFIAF0001_A.rif**. The ID file resides in the same directory as its corresponding world array bitmap. The contents of the ID file are listed in Appendix J.

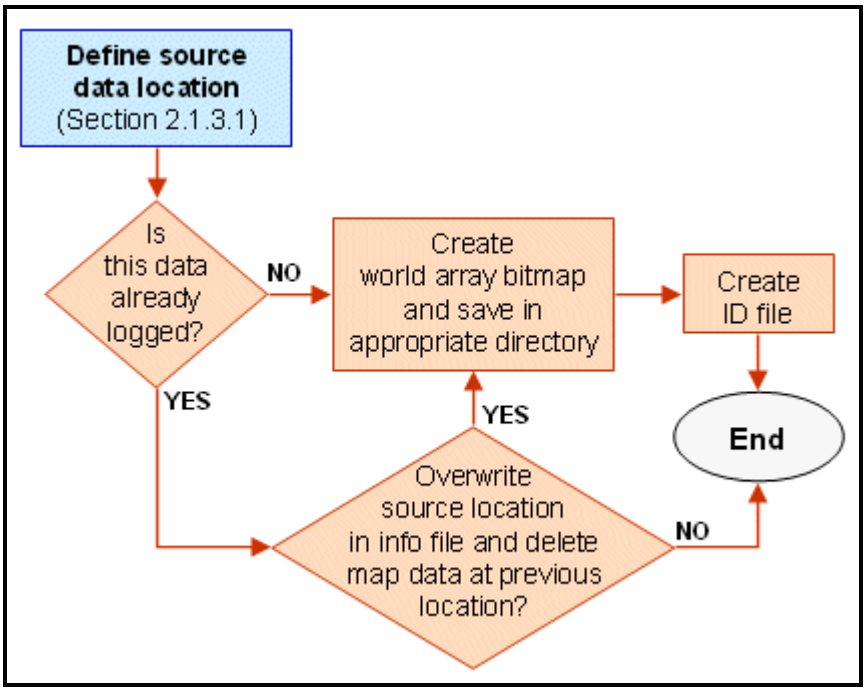

Fig. 23 — Control flow for data type status

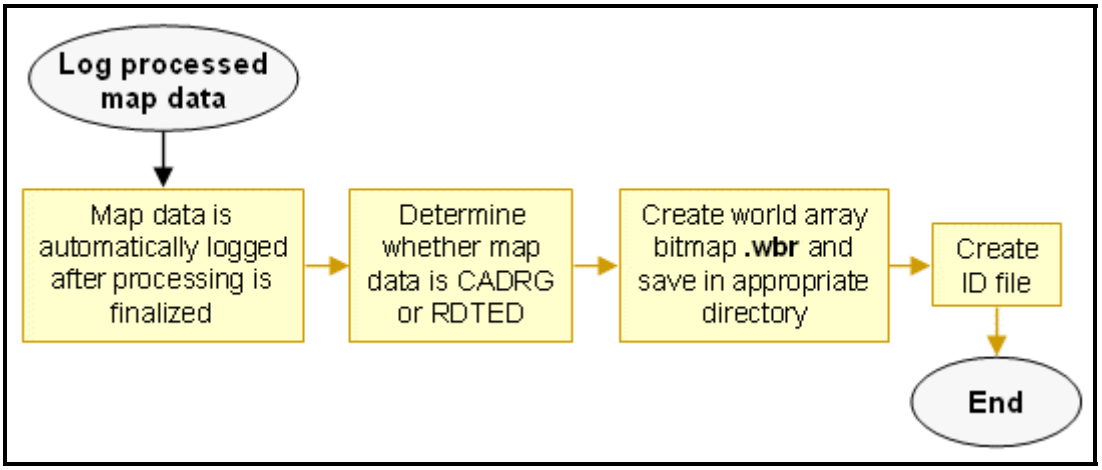

Fig. 24 — Control flow for logging processed map data

2.1.4 Data Frame Processing

Data frames are non-georeferenced images that must be converted to HDF for compatibility with TAMMAC. Like CADRG data and RDTED, data frames can be used to create mission and theatre loads. The supported data frame size is 768 by 768 pixels. Images must be created and cropped to the maximum allowable size prior to use with MMCPC. Data frames are loosely associated with active compositions; associations only become permanent when the composition has been used in a MAP BUILD operation.

Figure 25 presents an overview of data frame processing, which includes viewing and selecting images and image processing phases. Appendix E gives a full description of data frame processing, including low-level steps within each phase.

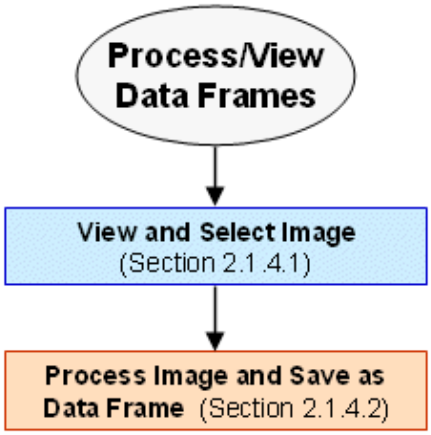

Fig. 25 — High-level flow chart for data frame processing

2.1.4.1 View and Select Image

Image files are first verified for proper format, readability, and size (maximum 768 by 768 pixels). Larger files must be edited (in other software) to meet this constraint. Once these criteria are met, the image is displayed to the user, who can choose to convert the file to a data frame. Figure 26 presents the control flow for viewing and selecting an image to be converted to a data frame.

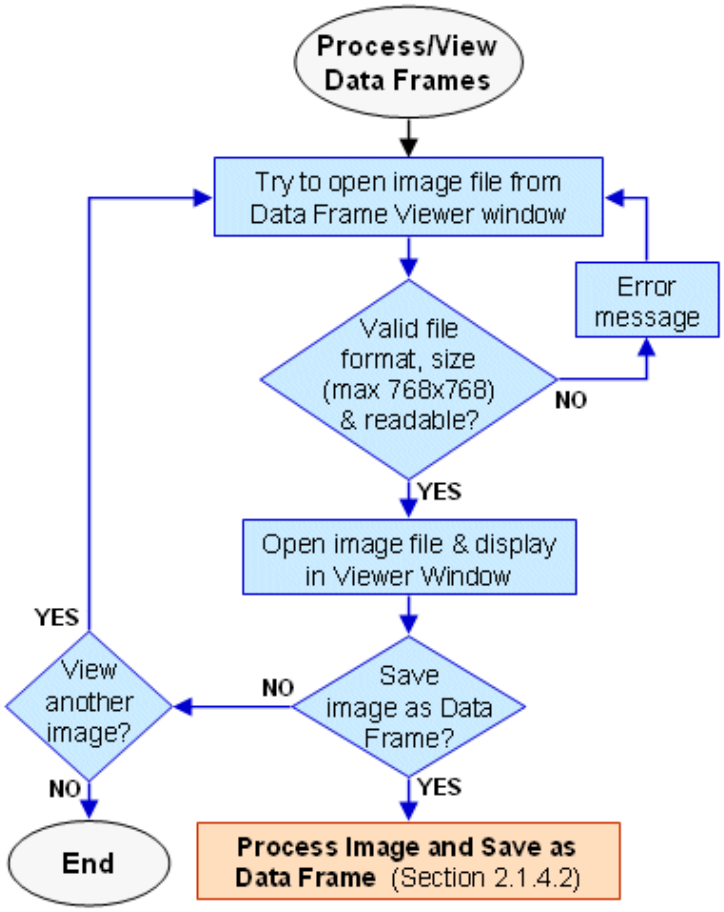

Fig. 26 — Control flow for viewing and selecting an image as a potential data frame

2.1.4.2 Data Frame Image Processing

After an image has been selected to be a data frame, the input destination directory is defined and verified (Fig. 27). If it does not yet exist, a new directory is automatically created. The image is compressed to 8-bit color, if necessary, and written as a data frame in the specified directory. MMCPC then returns to the View and Select Image phase (Section 2.1.4.1) for additional images.

2.2 Map Compositions

Map compositions are user-defined ROIs based on logged sources for CADRG, CIB, and RDTED map data. Requirements include the ability to create, save, and edit these compositions. There are two methods of building a composition in MMCPC (Fig. 28): building a new, user-defined composition (blue), and building a composition based on other, pre-existing compositions (orange). Appendix F provides a complete description of map composition builds.

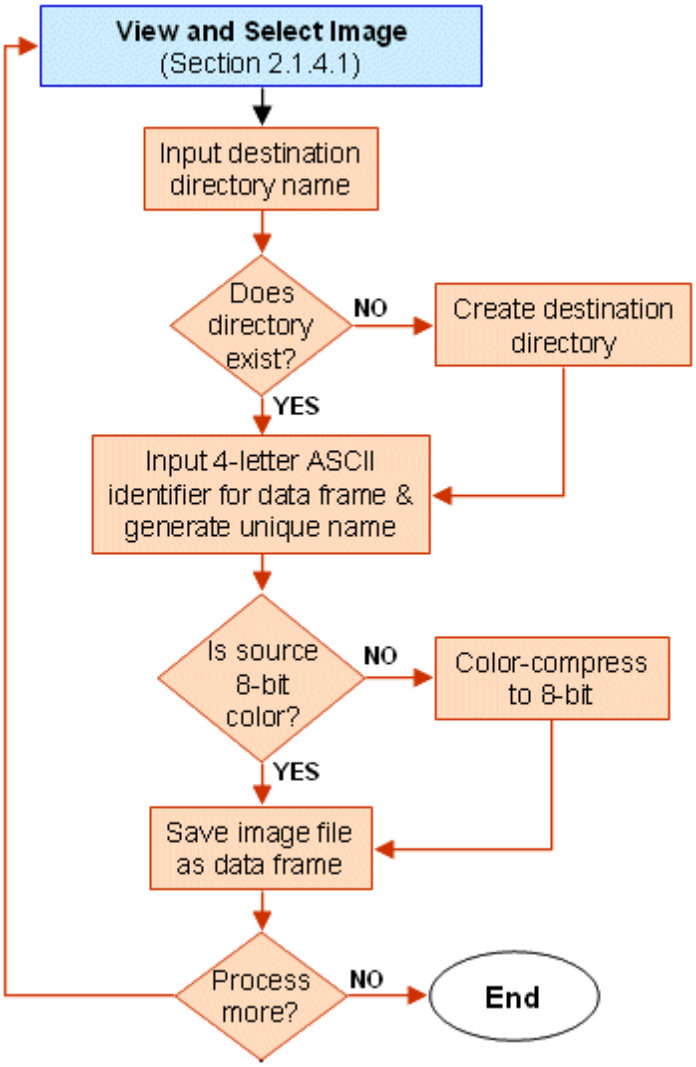

Fig. 27 — Control flow for data frame image processing

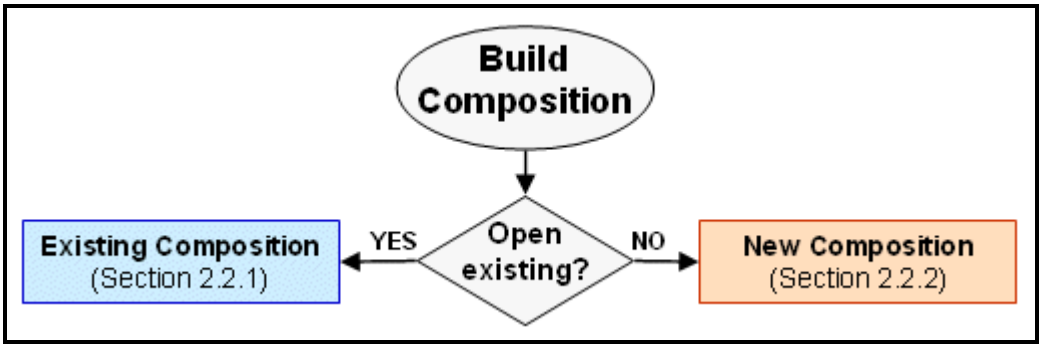

Fig. 28 — High-level flow chart for building compositions

2.2.1 Build from Existing Composition(s)

Compositions can be built from existing user-defined compositions and data frames (Fig. 29). When an import file is opened, all associated map data types and coverage areas must exist as logged sources. The name of the composition defined by the import file must be unique, or the import will fail.

When data frames are defined, the path must be accessible and the data frame source files must be valid image file types (Section 2.1.4). Up to 100 data frames may be imported for use in a composition. When data frames are processed, an association is made between the processed data frames and the composition designated by the import file.

Import files are not valid sources for "included" compositions because they cannot be used to partially define a composition. However, if a file is imported and the coverages are modified, it is possible for a composition derived from this file to be no longer representative of its original coverage, and can be saved as new.

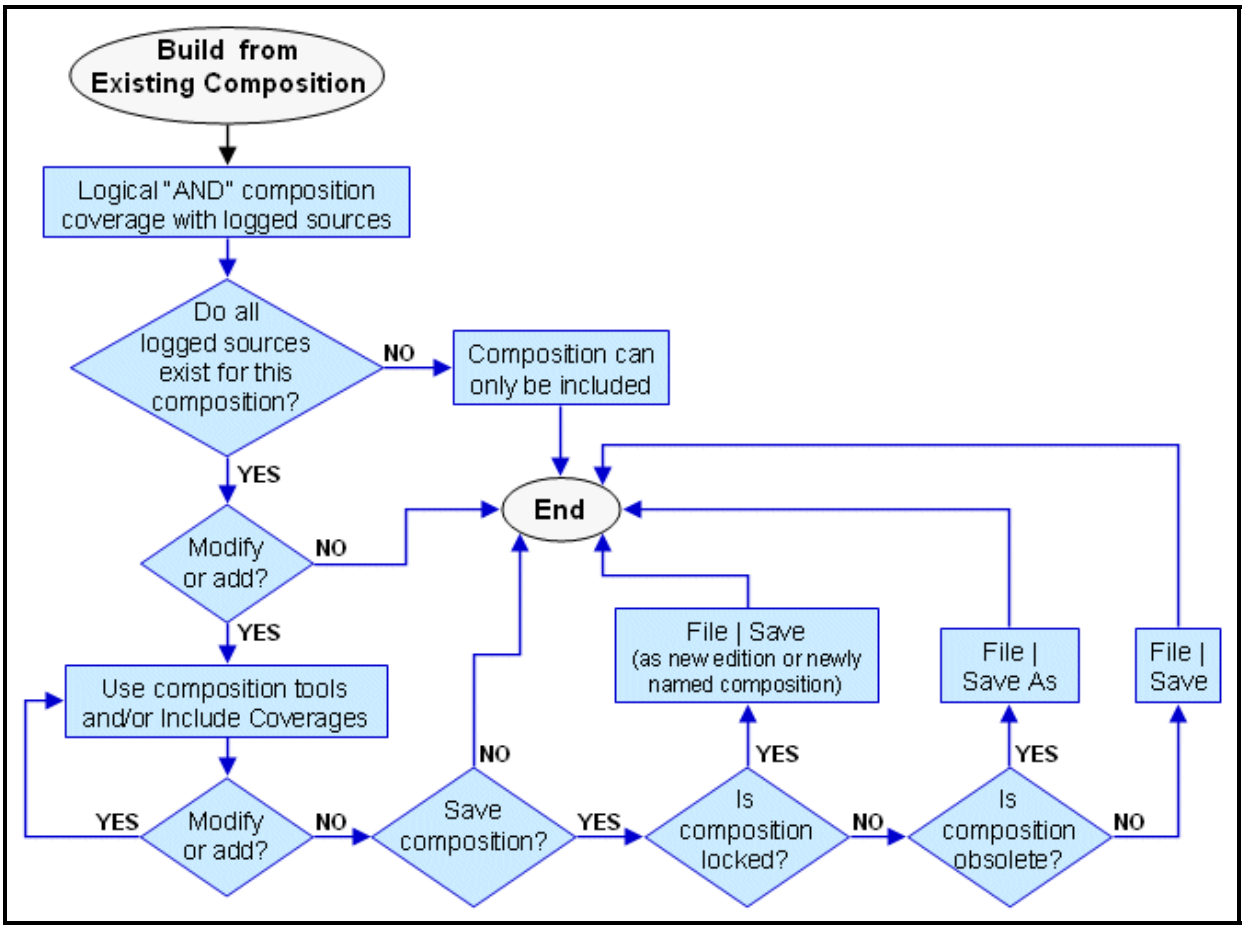

Fig. 29 — Control flow chart for building a new composition based on an existing composition

2.2.2 Build a New Composition

There are three primary tools for defining and creating a new composition:

1. Define a rectangle of coverage by left-clicking on one corner and dragging the mouse to the opposite corner;
2. Define a more precise coverage polygon of coverage by left-clicking on points to define the polygon, and double-clicking to close it; and
3. Define the most precise coverage polygon of coverage by entering a series of latitude/ longitude points in a dialog box to precisely define a polygon.

Figure 30 depicts the control flow for building a new composition. A user may include coverages from logged sources and other user-defined compositions and define the map data type and scales. Zoom options are available to reset the focus to a particular region of the world. During a composition build, MMCPC calculates the estimated composition size and notifies the user if it is expected to exceed 2.8 GB (the maximum size of a TAMMAC theater map load). If so, the user will have to edit the composition.

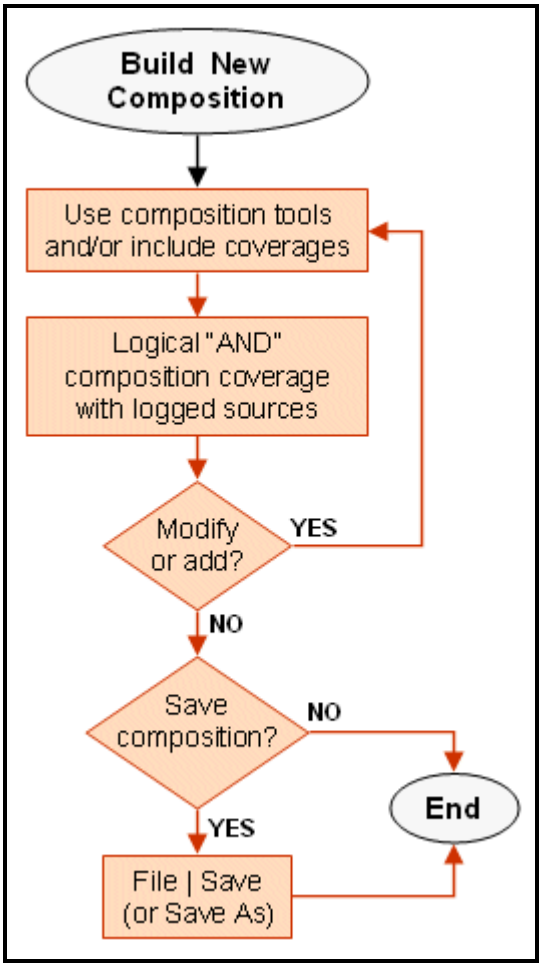

Fig. 30 — Control flow chart for a new composition

Newly created compositions are unlocked and set as edition "1" until they are used for map builds (e.g., **TEST_001.WBU**). When a map build is successful, that composition becomes locked. A new edition can only be created from a locked composition (e.g., **TEST_001.WBL → TEST_002.WBU**). This new edition will not be locked until it too is successfully used in a map build. MMCPC assigns the edition number (**_xxx**), which is not part of the unique composition name. When used for a map build, an updated composition (i.e., a new edition) will only load the difference between the updated composition and its previous edition. The user must ensure that multiple editions are properly loaded into TAMMAC in consecutive order.

2.2.3 Composition Files

A composition is mapped with "world array bitmaps" that represent the composition's latitude/ longitude positions. There are three types of these bitmaps, each with a different file extension:

1. ***.WBU** (World Bitmap Unlocked) is a bitmap representation of a user-defined ROI, based on available logged data sources, that has not been used to build a TAMMAC map, i.e., specific sources have not been locked to a composition. These files can be modified and saved to either the original name or a new name.

2. ***.WBL** (World Bitmap Locked) is the same as a ***.WBU** file, except it has been used for a TAMMAC map build and therefore has been locked to specific logged sources. This file can be saved to its original name, but must have a new edition.
3. ***.WBX** is the same as a ***.WBL** file, except one or more of its sources has been unlogged (i.e., is no longer available).

2.3 Map Data Operations

Map Data Operations requirements include selecting I/O devices, reading and displaying data and TAMMAC theatre/mission loads, reading and writing TAMMAC-specific support files, computing checksums, building and exporting TAMMMAC Theatre/Mission Map loads, and reading, validating, and restoring color maps.

2.3.1 Build Mission/Theater Map Load

A mission and/or theater load can be created after map and other data have been processed for an entire ROI. Figure 31 provides an overview of mission/theater load creation, which includes four critical phases (color-coded consistently throughout this section): 1) composition lock check (blue), 2) include data frames (orange), 3) map mission/theater build (yellow), and 4) saving the current composition (green). Appendix G provides a complete description of mission/theater load creation, including low-level steps within each phase.

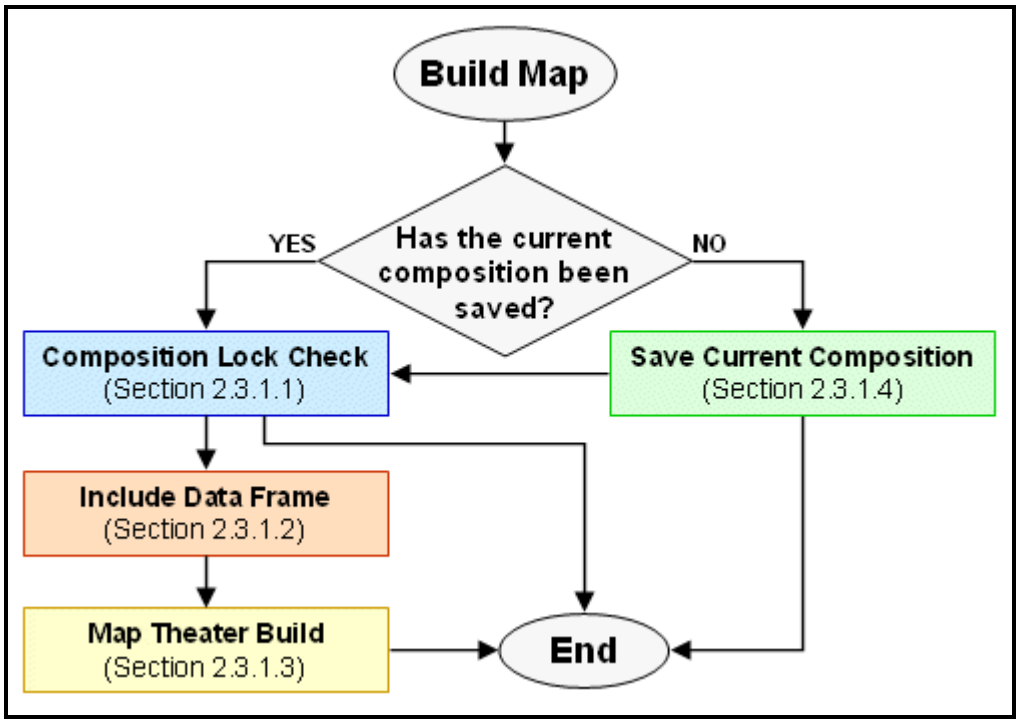

Fig. 31 — High-level flowchart for building a mission/theater map

2.3.1.1 Composition Lock Check

In this step, the map load is verified for compliance with size constraints (Fig. 32). The size of a map load depends on whether the build is for a mission load (typically limited to 20 MB) or a theater load

(limited to 3 GB). In the case of multiple editions, the resultant size is based on the logical "OR" of the current and all preceding versions of the named composition. The maximum sizes for mission and theater loads should not be hard-coded; these values should be set in a parameter file loaded at MMCPC startup. The maximum size allows for some overhead, such as the variability of frame file sizes and the potential for adding data frames.

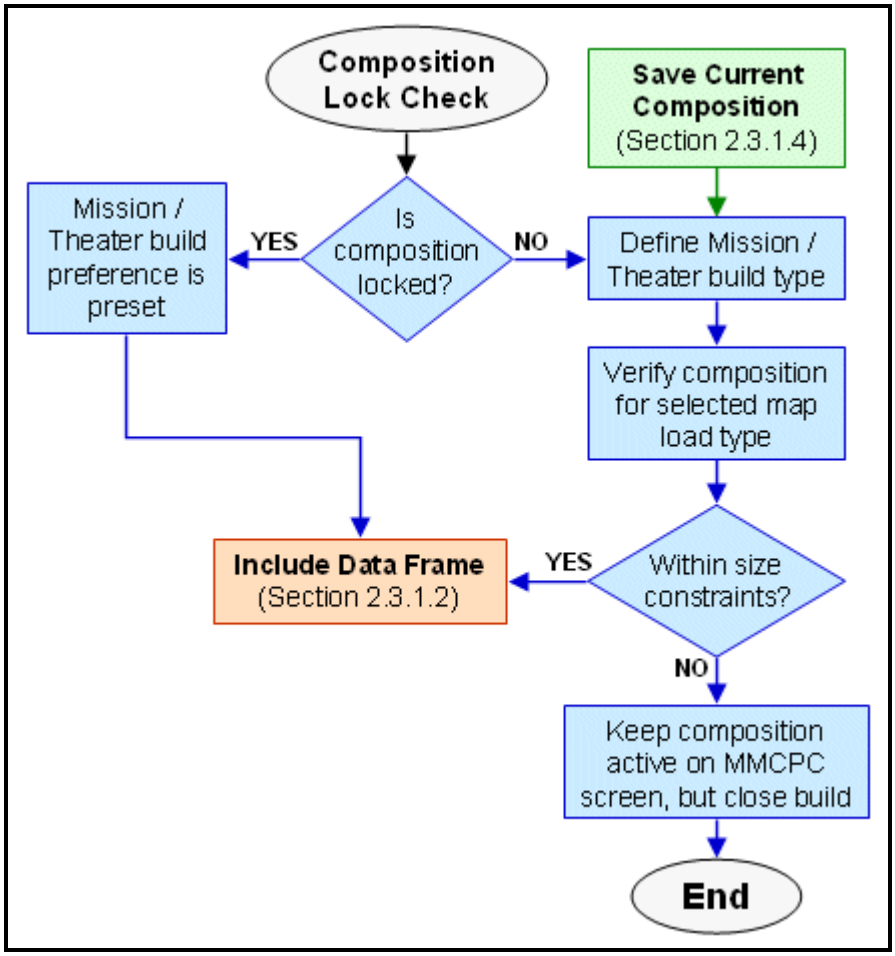

Fig. 32 — Control flow for composition lock check

2.3.1.2 Include Data Frame(s)

In this phase, a maximum of 100 data frames can be included as part of the mission/theater load (Fig. 33). Only one directory of data frames may be selected. If a selected directory contains more than 100 data frames, the map load will not be verified.

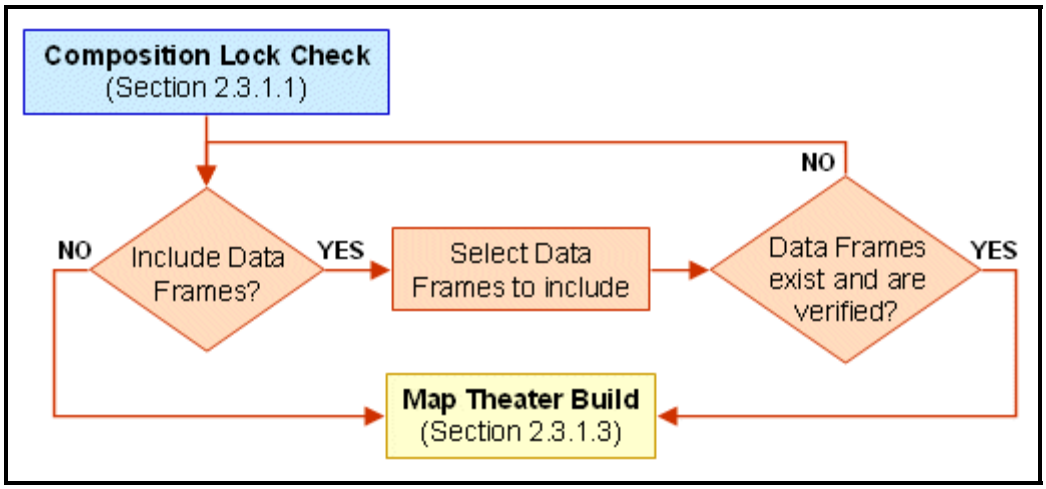

Fig. 33 — Control flow for data frame inclusion

2.3.1.3 Map Theater/Mission Build

Figure 34 presents the control flow for building map theater/mission loads. The PC card size is required for theater loads, since a theater load may span multiple cards (the maximum is three 1-GB cards; the default is one card). Therefore, the data structure for the theater map files must be sized appropriately to fit on each card. The theater card size should be loaded from a parameter file at MMCPC startup.

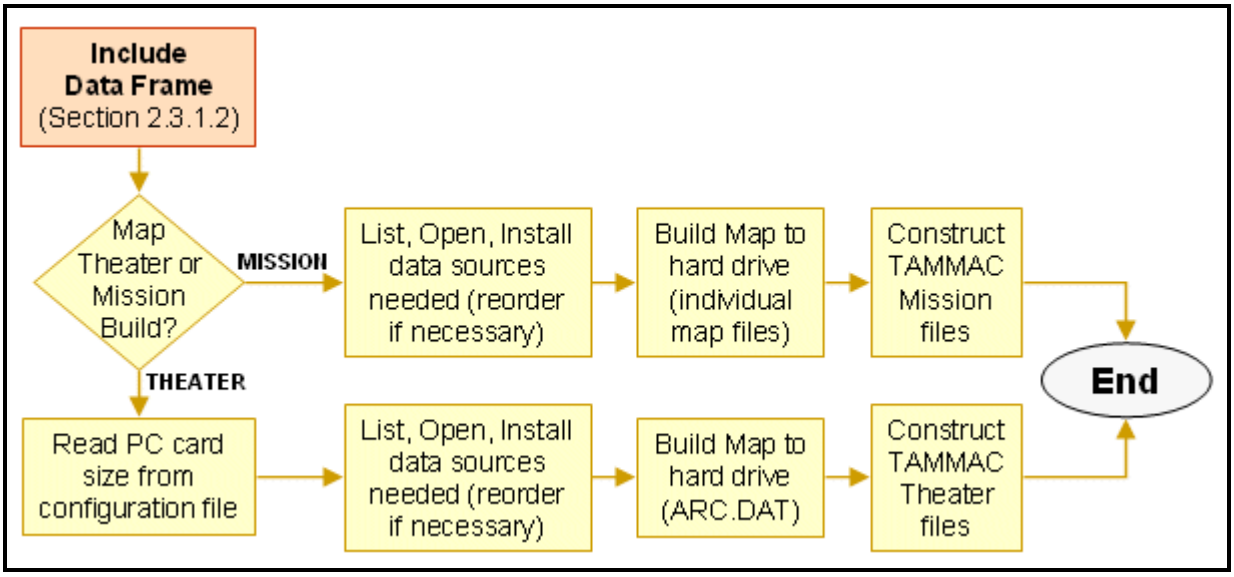

Fig. 34 — Control flow for a map theater or mission build

The theater map-specific files include an **ARC.DAT** file (i.e., the large file or set of files that contain the contents of the map, RDTED, and data frames), a **TIF.DAT** header file associated with each **ARC.DAT** (if spanned over multiple PC cards), a **DIR.DAT** directory listing file associated with each

ARC.DAT file, a **CONFIG.HRS** single option file, and symbol set files (**TEST.DAT**, **100SDIR.HRS**, and **002SDIR.SDR**). See Appendix G of Harris (2001) for details.

The mission map load does not include an **ARC.DAT** file. Individual map files are written to the PC card and, since mission loads are very small, they will always be contained on a single card. Mission-specific files include individual data files (CADRG, CIB, RDTED, and data frames), **DIR.DAT** and **TIF.DAT**. This build does not include **MF.DAT**, which must be built by the MPS system to create a valid mission load to PC card. See Appendix G of Harris (2001) for details.

2.3.1.4 Save Current Composition

If the current composition has not been saved, it will fall into one of the following categories:

1. An unlocked composition (**WBU**) that is new and unnamed or modified from its original, and can be either saved to its previous name or to a new name;
2. An obsolete composition (**WBX**) that may or may not be modified but must now be saved as an unlocked composition with a new name;
3. A locked composition (**WBL**) that has been modified and can be saved to either a new name or as a new edition to its current name.

For each condition, resulting saved composition becomes an unlocked WBU file (Fig. 35).

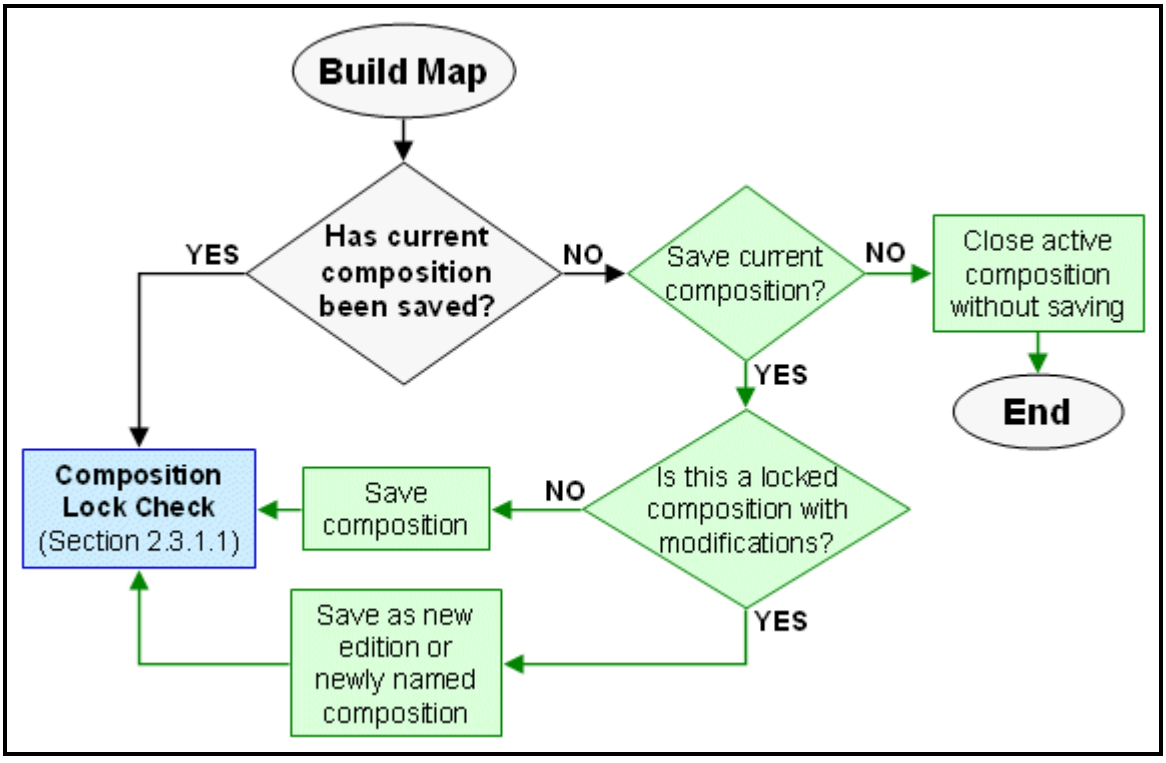

Fig. 35 — Control flow for saving the current composition

2.4 Graphical User Interface (GUI)

Figure 36 shows the main GUI for MMCPC version 1.0. Each GUI component can be linked to one or more functional requirements within the concept areas of Data Processing, Map Compositions, and Map Data Operations. Shortcuts and hotkeys for GUI options are defined, as are actions, conditions, and usage (i.e., when a menu option is available for use). Since a primary goal was to create a similar appearance and behavior found in other commercial software, comparable design conventions were followed. Appendix B lists main menu and submenu options and the functional requirement(s) being met. The MMCPC Software Users Manual provides a full description of the GUI and common operations.

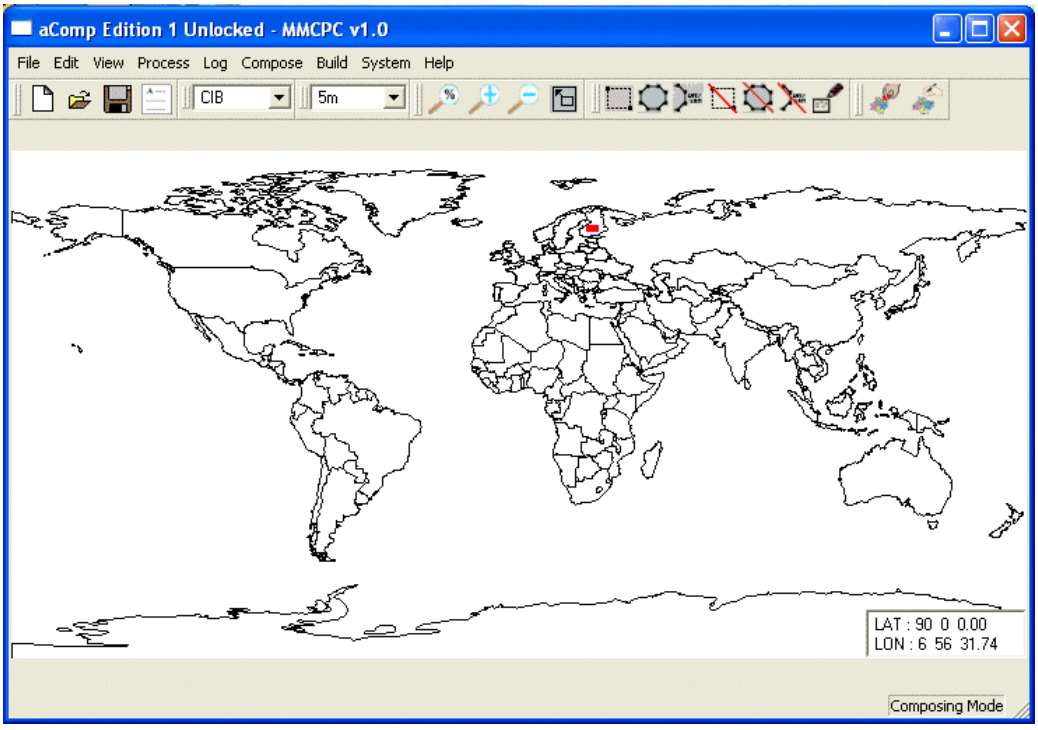

Fig. 36 — MMCPC Main GUI

2.5 Error Checking and Handling

MMCPC uses an error handling methodology that detects error conditions and issues status messages for the following categories:

1. Critical errors and messages: Occur when an action(s) will force termination of MMCPC. These errors could result from software errors, changes made to the system outside MMCPC, or physical removal of required components needed by MMCPC to operate properly.
2. Warning errors and messages: Occur through the use of unanticipated combinations of functions within MMCPC (i.e., programming errors) or by improper user input. In either case, usually the function within MMCPC (e.g. CADRG processing) in which the warning occurred will not be able to proceed or properly complete. However, MMCPC should still continue to operate.

3. Information messages: Any other messages that do not result in an aborted process within MMCPC (e.g., notification that new color palettes have been detected or that CADRG processing has completed).

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Appendix A

SOFTWARE REQUIREMENTS MATRIX

Table A1 defines the color conventions used in the software requirements matrix. Table A2 defines acronyms and abbreviations used in the matrix.

Table A1 — Color Conventions Used in Software Requirements Matrix

Cell Color	Meaning
	Indicates a **Data Processing (DP)** requirement
	Indicates a **Map Composition (MCP)** requirement
	Indicates a **Map Data Operations (MDO)** requirement
	Indicates a **non-testable** requirement within MMC
	Indicates an **obsolete** requirement
Red Text	Indicates **text modifications** within a requirement
~~**Strike through text**~~	Indicates **deleted text**

Table A2 — Acronyms Used in Software Requirements Matrix (Origin Field)

Acronym	Origin of Requirement
FiAF	Finnish Air Force-specific requirement for MMCPC
MMC	A carryover requirement from MMC over to MMCPC
PDR	Preliminary Design Review on 1/20/04
TIM	Technical Information Meeting on 4/28/04

A1. DATA PROCESSING (DP)							
ID	**Requirement**	**Origin**	**Priority**	**Status**	**GUI Implementation**	**Comment**	**Flight Testable?**
DP-0000	Process FiAF geotiff into CADRG frame files.	FiAF	High	Open	~~Data Processing~~ Process: CADRG		N
DP-0001	FiAF geotiff to CADRG processing at 1:5M scale	FiAF	~~High~~ Low	Open	~~Data Processing~~ Process: CADRG		N
DP-0002	FiAF geotiff to CADRG processing at 1:2M scale	FiAF	High	Open	~~Data Processing~~ Process: CADRG		Y
DP-0003	FiAF geotiff to CADRG processing at 1:1M scale	FiAF	~~Medium~~ Low	Open	~~Data Processing~~ Process: CADRG		N
DP-0004	FiAF geotiff to CADRG processing at 1:500k scale	FiAF	High	Open	~~Data Processing~~ Process: CADRG		Y
DP-0005	FiAF geotiff to CADRG processing at 1:250k scale	FiAF	~~Medium~~ High	Open	~~Data Processing~~ Process: CADRG		Y
DP-0006	FiAF geotiff to CADRG processing at 1:100k scale	FiAF	Low	Open	~~Data Processing~~ Process: CADRG		N
DP-0007	FiAF geotiff to CADRG processing at 1:50k scale	FiAF	~~Medium~~ Low	Open	~~Data Processing~~ Process: CADRG		N
DP-0008	FiAF map processing multiple data sets	MMC	Low	Open	~~Data Processing~~ Process: CADRG		N
DP-0009	FiAF custom color palettes for all CADRG scales	MMC	High	Open	~~Data Processing~~ Process: CADRG		N
DP-0010	Process FiAF DTED into RDTED frame files at 1:5M scale	FiAF	High	Open	~~Data Processing~~ Process: DTED		Y
DP-0011	Process FiAF DTED into RDTED frame files at 1:1M scale	FiAF	High	Open	~~Data Processing~~ Process: DTED		Y
DP-0012	Process NGA DTED into RDTED frame files at 1:5M scale	FiAF	~~Medium~~ High	Open	~~Data Processing~~ Process: DTED		Y
DP-0013	Process NGA DTED into RDTED frame files at 1:1M scale	FiAF	~~Medium~~ High	Open	~~Data Processing~~ Process: DTED		Y
DP-0014	Process data frames to Harris Definition Format (HDF)	FiAF	High	Open	~~Data Processing~~ Process: Dataframe	Will only process files that are not greater than 768x768. Requires an outside application to clip the image to an appropriate size. We assume that the file is ready to be converted to HDF. There is a 100 file limit and no subdirectories are allowed.	Y

DP *(continued)*							
ID	**Requirement**	**Origin**	**Priority**	**Status**	**GUI Implementation**	**Comment**	**Flight Testable?**
DP-0015	Calculate and Display RMS errors of processed FiAF geotiff files	MMC	High	Open	~~Data Processing~~ Process: CADRG		N
DP-0016	Display bitmapped locations of source geotiff prior to processing	MMC	~~Medium~~ High	Open	~~Data Processing~~ Process: CADRG		N
DP-0017	Create baseline set of CADRG color palettes from NGA database	FiAF	High	Open		Not in the GUI but done as part of installation	N
DP-0018	Maintain internal tracking of processed map files for partial frame file identification and recovery procedures	MMC	High	Open	~~Data Processing~~ Process: CADRG, DTED		N
DP-0019	Maintain internal message passing to validate processing status	MMC	High	Open	~~Data Processing~~ Process: CADRG, DTED		N
DP-0020	Provide utility to generate and validate FiAF custom color palette	MMC	High	Open		Performed through a separate utility	N
DP-0021	Create a identification scheme for archival of processed data	MMC	High	Open	~~Data Processing~~ Process: CADRG, DTED		N
DP-0022	Generate an A.TOC (Table of Contents) file for processed CADRG archival.	FiAF	~~High~~ Medium	Open	~~Data Processing~~ Process: CADRG		N
DP-0023	Perform color palette validation checks prior to CADRG processing	FiAF	High	Open	~~Data Processing~~ Process: CADRG		N
DP-0024	Automatically log (recognize) processed map data residing on harddisk.	MMC	High	Open		Performed internally once processing is complete	N
DP-0025	Log NGA CADRG into MMC	FiAF	~~Medium~~ High	Open	~~Data Processing~~ Log: Log Source	Scales 1:50k, 1:100k, 1:250k, 1:500k, 1:1m, 1:2m, 1:5m	N
DP-0026	Log FiAF CADRG into MMC	FiAF	High	Open	~~Data Processing~~ Log: Log Source	Scales 1:50k, 1:100k, 1:250k, 1:500k, 1:1m, 1:2m, 1:5m	N
DP-0027	Log NGA / FiAF processed RDTED	FiAF	High	Open	~~Data Processing~~ Log: Log Source	Scales 150m and 750m	N
DP-0028	Log NGA CIB into MMC	FiAF	~~Low~~ Medium	Open	~~Data Processing~~ Log: Log Source		N

DP *(continued)*							
ID	**Requirement**	**Origin**	**Priority**	**Status**	**GUI Implementation**	**Comment**	**Flight Testable?**
DP-0029	Unlog NGA CADRG in MMC	FiAF	High	Open	~~Data Processing~~ Log: Unlog Source		N
DP-0030	Unlog FiAF CADRG in MMC	FiAF	High	Open	~~Data Processing~~ Log: Unlog Source		N
DP-0031	Unlog NGA / FiAF processed RDTED	FiAF	High	Open	~~Data Processing~~ Log: Unlog Source		N
DP-0032	Unlog NGA CIB in MMC	FiAF	~~Low~~ Medium	Open	~~Data Processing~~ Log: Unlog Source		N
DP-0033	Compute and display disk usage; display path names for each processed data set; show min/max extents; number of MB per data set	MMC	High	Open	Data Processing: Statistics; System: Disk Usage	Obsolete - is supported by standard Windows functions. And otherwise is restricted from the user.	N
DP-0034	FiAF geotiff to CADRG processing at 1:12.5k scale	PDR	Low	Open	~~Data Processing~~ Process: CADRG		N

A2. Map Composition (MCP)							
ID	**Requirement**	**Origin**	**Priority**	**Status**	**In GUI**		
MCP-0000	Create a new map composition (Region Of Interest) ~~by scale and data type~~	MMC	High	Open	File: New; Icon	An icon is also provided for this common task	N
MCP-0001	Select map projection	MMC	Low	Open		Obsolete, all map data below 80N and above 80S is mercator projected.	
MCP-0002	Create / modify map composition by point-to-point mouse click of ROI	MMC	High	Open	Icon		N
MCP-0003	Create / modify map composition by stretch-box mouse drag of ROI	MMC	High	Open	Icon		N
MCP-0004	Create / modify map composition by typed lat/lon entries of ROI	MMC	High	Open	Icon		N
MCP-0005	Verify a composition for space constraints on TAMMAC map load	FiAF	High	Open	~~File~~ Compose: Verify Composition	Under System Status Information	N
MCP-0006	Verify a composition for space constraints on Mission map load	FiAF	High	Open	~~File~~ Compose: Verify Composition		N
MCP-0007	Saves a composition to the same name	MMC	High	Open	File: Close, Save; Icon	An icon is also provided for this common task	N
MCP-0008	Open a previously saved, verified (final) composition	MMC	~~Medium~~ High	Open	File: Open Composition; Icon	An icon is also provided for this common task	N
MCP-0009	Close a map composition	MMC	High	Open	File: Close, Exit		N
MCP-0010	Quit a map composition within MMC (I.e., closes without a save)	MMC	High	Open	File: Close		N
MCP-0011	UNDO previous command	MMC	Medium	Open	Edit: Undo; Icon	Will only undo 1 previous command	N
MCP-0012	REDO previous command	MMC	Medium	Open	Edit: Redo; Icon	Will only redo 1 previous command	N
MCP-0013	Perform CUT of selected coverage at a given scale	MMC	Medium	Open	Edit: Cut		N
MCP-0014	Perform COPY of selected coverage at a given scale	MMC	Medium	Open	Edit: Copy		N
MCP-0015	Perform PASTE of selected coverage at a given scale	MMC	Medium	Open	Edit: Paste		N
MCP-0016	Select all map composition coverage by scale via mouse toggle	MMC	Medium	Open	~~Edit: Select/Deselect All~~	This function is managed by mouse-click	N

MCP *(continued)*							
ID	**Requirement**	**Origin**	**Priority**	**Status**	**In GUI**		
MCP-0017	De-select all map composition coverage by scale via mouse toggle	MMC	Medium	Open	~~Edit: Select/Deselect All~~	This function is managed by mouse-click	N
MCP-0018	Refresh display	MMC	Low	Open	View: Refresh		N
MCP-0019	Turn on/off world basemap display	MMC	High	Open	View: World Map		N
MCP-0020	Turn on/off lat-lon grid	MMC	High	Open	View: Lat/Lon Grid		N
MCP-0021	Set spacing for lat-lon grid	MMC	~~Medium~~ High	Open	View: Lat/Lon Grid		N
MCP-0022	Turn on/off user defined polygons (regardless of available coverage)	MMC	Low	Open	View: User-Defined Polygons	This function will be supported in future release	N
MCP-0023	Show available logged coverage by scale / datatype	MMC	High	Open	Compose: Include Coverage; View: Available Coverage		N
MCP-0024	Create and modify map composition by inclusion of saved compositions, saved map loads, logged sourced, ~~or processed map data~~	MMC	High	Open	~~File~~ Compose: Include Coverage: Composition		N
MCP-0025	Open and read an ASCII mission planning coverage file containing bounding rectangles (lat/lon) of map coverages by datatype and scale	FiAF	High	Open	File: Import/Export; Icon	Data frames are not currently well-defined. An icon is also provided for this common task	N
MCP-0026	Create, verify, and save composition from mission planning coverage file	FiAF	High	Open	File: Import/Export		N
MCP-0027	Display lat/lon as decimal degrees or DDDMMSS	MMC	Medium	Open	View: Lat/Lon Grid		N
MCP-0028	Provide print option	MMC	Medium	Open	File: Print	Print screen, audit and log files	N
MCP-0029	~~Archive and~~ Restore Theater and Mission compositions	MMC	High	Open	Tools: Restore	Archive and restore operation is performed outside of MMCPC	N
MCP-0030	~~Archive and~~ Restore logged sources	MMC	High	Open	Tools: Restore	Archive and restore operation is performed outside of MMCPC	N
MCP-0031	Read and display map composition	MMC	High	Open	File: Open ~~Composition~~		N
MCP-0032	Compute and display map composition data size	MMC	High	Open	Window: Compute Data Size	Obsolete - this is a standard Windows function	N

MCP *(continued)*							
ID	**Requirement**	**Origin**	**Priority**	**Status**	**In GUI**		
MCP-0033	Identify and reference Data Sources	MMC	High	Open	Window: Data Sources	Lists logged data sources for current ROI. Obsolete - data source infomration is restricted.	N
MCP-0034	Deselect coverage from a composition by point-to-point mouse click of ROI	MMC	High	Open	Icon	Thru an icon (instead of a menu option)	N
MCP-0035	Deselect coverage from a composition by stretch-box mouse drag of ROI	MMC	High	Open	Icon	Thru an icon (instead of a menu option)	N
MCP-0036	Deselect coverage from a composition by typed lat/lon entries of ROI	MMC	High	Open	Icon	Thru an icon (instead of a menu option)	N
MCP-0037	Set / clear (toggle) individual map tile via mouse click	MMC	Medium	Open	Icon	Thru an icon (instead of a menu option)	N
MCP-0038	Zoom to a ROI via stretch-box mouse drag	MMC	High	Open	Zoom: Zoom Stretchbox; Icon	Thru an icon ~~(instead of a menu option)~~	N
MCP-0039	Zoom to a ROI via zoom mutiplier box	MMC	High	Open	View: Zoom; Icon	Also thru an icon	N
MCP-0040	Zoom out from a point	MMC	High	Open	View: Zoom Out; Icon	Like the PDF magnifyer	N
MCP-0041	Create ~~and archive~~ MMC history and log/unlog history files	MMC	Medium	Open		Performed automatically as actions occuring within MMCPC	N
MCP-0042	Delete compositions and all associated sub-compositions	MMC	Medium	Open	System: Delete Composition	This is not supported in current MMC.	
MCP-0043	Delete processed data for defined coverage	MMC	High	Open		This function is obsolete - now, deletion of processed data is by data type and scale only	
MCP-0044	~~Delete processed data for specified scale and/or data type~~ Deleted map segments in the Partial directory	MMC	High	Open	~~System: Delete Processed Data~~	Obsolete - This is been descoped to become Delete Partial Processes.	N
MCP-0045	Support append (sub) compositions to original compositions	FiAF	Low	Open	File: Open ~~Composition~~		N
MCP-0046	Select data type *TAMMAC*/Mission/Theater	FiAF	High	Open	~~Tools~~ ~~Build~~: Build Map~~,~~ ~~Open Map, Verify Map~~		N

MCP *(continued)*							
ID	**Requirement**	**Origin**	**Priority**	**Status**	**In GUI**		
MCP-0047	Select map scale	FiAF	High	Open	Button	Thru button (instead of a menu option)	N
MCP-0048	Display History	MMC	High	Open	~~Window~~ Help: History Display	Displays log file information	N
MCP-0049	Exit MMC - terminates the application	MMC	High	Open	File: Exit		N
MCP-0050	Saves as a composition to a new name	MMC	High	Open	File: Save As	This implies identifying a descriptive name during save for a newly created composition	N
MCP-0051	Zoom in to a point	MMC	High	Open	View: Zoom In; Icon	Like the PDF magnifyer	N
MCP-0052	Select Map type (CADRG, RDTED, CIB)	FiAF	High	Open	Button	Used to select the map type to include in a composition	N
MCP-0053	Associate dataframe with active composition	FiAF	High	Open	~~File~~ Compose: Associate DF		N

A3. Map Data Operations (MDO)							
ID	**Requirement**	**Origin**	**Priority**	**Status**	**In GUI**		
MDO-0000	Select input data device - CDROM	MMC	High	Open	File: Import/Export; ~~Tools~~ Build: Build Map, ~~Open Map~~		N
MDO-0001	Select input data device - hard disk	MMC	High	Open	File: Import/Export; ~~Tools~~ Build: Build Map, ~~Open Map~~		N
MDO-0002	Select input data device - TAMMAC PC card	FiAF	High	Open	File: Import/Export; ~~Tools Build: Open Map~~		N
MDO-0003	Select input data device - Mission PC card	FiAF	Low	Open	File: Import/Export; ~~Tools Build: Open Map~~		N
MDO-0004	Select output device - CDROM	MMC	High	Open		Obsolete since archives are performed outside of MMCPC	
MDO-0005	Select output device - hard disk	MMC	High	Open	File: Import/Export		N
MDO-0006	Select output device - TAMMAC PC card	FiAF	High	Open	File: Import/Export		N
MDO-0007	Select output device - Mission PC card	FiAF	Low	Open	File: Import/Export	MMCPC is not intended to write to a mission PC card. MMCPC will transfer the mission map data to the MPS application, which then transfer to the mission card.	
MDO-0008	Read and display NGA CADRG	FiAF	Medium	Open	~~Tools Build: Open Map~~	Scales 1:50k, 1:100k, 1:250k, 1:500k, 1:1m, 1:2m, 1:5m Supported in Composition mode with right-mouse click	Y, partial
MDO-0009	Read and display FiAF processed CADRG	FiAF	High	Open	~~Tools Build: Open Map~~	Scales 1:50k, 1:100k, 1:250k, 1:500k, 1:1m, 1:2m, 1:5m Supported in Composition mode with right-mouse click	Y, partial
MDO-0010	Read and display coverage of NGA / FiAF processed RDTED	FiAF	High	Open	~~Tools Build: Open Map~~	Scales 150m and 750m Supported in Composition mode with right-mouse click	N

MDO *(continued)*							
ID	**Requirement**	**Origin**	**Priority**	**Status**	**In GUI**		
MDO-0011	Read TAMMAC ~~map~~ theater data	FiAF	High	Open	~~Tools Build: Open Map~~	This would include reading the TIF.DAT file and any other theater identification information during map load, not sure if this can be tested in the lab. Supported in NRL-supplied stand-alone programs: DUMP_TIF, DUMP_CIF, and DUMP_DIR	Y
MDO-0012	Read Mission map data	FiAF	Low	Open	~~Tools Build: Open Map~~	Supported in NRL-supplied stand-alone programs: DUMP_TIF, DUMP_CIF, and DUMP_DIR	N
MDO-0013	Read and display NGA CIB	FiAF	Low	Open	~~Tools Build: Open Map~~	Supported in Composition mode with right-mouse click	Y
MDO-0014	Display TAMMAC ~~map~~ theater load	FiAF	High	Open	Context-sensitive right mouse click.	Opening a theater/mission load will display bitmap of the coverages. Right mouse click on bitmap to display map data .	N
MDO-0015	Read and validate checksum for TAMMAC and Mission card map data	FiAF	High	Open	~~Tools~~ Build: ~~Verify~~ Build Map		N
MDO-0016	Calculate and write checksums for TAMMAC and Mission Map loads	FiAF	Medium	Open	~~Tools~~ Build: Build Map		N
MDO-0017	Read and display HDF (data frames)	FiAF	High	Open	~~Data Processing~~ Process: Dataframe	These are the image-based dataframes - no text. Dataframes can be displayed after processing.	Y
MDO-0018	Save and export RDTED	FiAF	High	Open		Obsolete since archiving and exporting is perfromed outside of MMCPC	
MDO-0019	Build, ~~archive,~~ and export TAMMAC ~~map~~ theater load	FiAF	High	Open		This was broken down into individual requirements; the build (MDO-0030) and the export (MDO-0031)	
MDO-0020	Build, ~~archive, and export~~ Misson map load	FiAF	High	Open	~~Tools~~ Build: Build Map		N
MDO-0021	Export and archive HDF	FiAF	High	Open		Obsolete since archiving and exporting is perfromed outside of MMCPC	
MDO-0022	Archive a selected set of processed map data	FiAF	High	Open		Obsolete since archiving and exporting is perfromed outside of MMCPC	

MDO *(continued)*							
ID	**Requirement**	**Origin**	**Priority**	**Status**	**In GUI**		
MDO-0023	Read and validate Colormaps	FiAF	Medium	Open	~~Data Processing~~ Process: CADRG; ~~Tools~~ Build: Build Map, Open Map		N
MDO-0024	~~Build, archive and~~ Restore Colormaps	FiAF	Medium	Open	Separate Utility outside MMCPC	The build is preformed by DP-0020 as a separate application outside of MMCPC.	N
MDO-0025	Display TAMMAC/Mission Summary Status	FiAF	Medium	Open		This was broken down into individual requirements; the theater (MDO-0032) and the mission (MDO-0033)	
MDO-0026	Format TAMMAC PC cards	PDR	Medium	Open	~~Tools: Write Map~~ Performed at a separate PC running older OS (Win95/98) for FAT16 requirement. When TAMMAC updates to FAT32, this can be performed with MMCPC hardware. MMCPC expects the PC cards to be formatted during a map load.	Dependent on FAT16 issue??	N
MDO-0027	Read, write, export, ~~archive~~ TAMMAC-specific support files for ~~map~~ theater/ mission load	PDR	High	Open		All support files are created and written during a theater/mission build. This was broken down into individual requirements MDO-0034, 0035 and 0036	
MDO-0028	Delete Mission Loads from a specified area (still need to determine PC Cards)	TIM	High	Open	System: Delete Mission Load	Obsolete - the user can do this manually	N
MDO-0029	Delete Theater Loads from a specified area (still need to determine PC Cards)	TIM	High	Open	System: Delete Theater Load	Obsolete - the user can do this manually	N
MDO-0030	Build a TAMMAC theater load	TIM	High	Open	~~Tools~~ Build: Build Map	See MDO-0019 for requirement traceability	N

MDO *(continued)*							
ID	**Requirement**	**Origin**	**Priority**	**Status**	**In GUI**		
MDO-0031	Export a TAMMAC theater load	TIM	High	Open	~~Tools~~ Build: Write Theater Map	See MDO-0019 for requirement traceability	N
MDO-0032	Display TAMMAC theater summary status	FiAF	Medium	Open	~~Tools~~ Build: Theater/Mission ~~Load~~ Summary	See MDO-0025 for requirement traceability	N
MDO-0033	Display TAMMAC mission summary status	FiAF	Medium	Open	~~Tools~~ Build: Theater/Mission ~~Load~~ Summary	See MDO-0025 for requirement traceability	N
MDO-0034	Read TAMMAC-specific support files for theater/ mission load	PDR	High	Open	~~Tools~~ Build: Build Map, ~~Open Map, Verify Map,~~ Theater/Mission Summary; ~~Theater Load Summary, Mission Load Summary;~~ System: Restore Palettes	See MDO-0027 for requirement traceability	N
MDO-0035	Write TAMMAC-specific support files for theater/ mission load	PDR	High	Open	~~Tools~~ Build: Build Map, Write Theater Map	See MDO-0027 for requirement traceability	N
MDO-0036	Export TAMMAC-specific support files for theater load	PDR	High	Open	~~Tools~~ Build: Write Theater Map	See MDO-0027 for requirement traceability	N

Appendix B
Graphical User Interface Matrix

B1. File Menu Options

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
File Menu		Alt-F					
Associate DF		Alt-FD	Open dialog box with a default directory set to open a data frame directory. Creates an association of the selected dataframe directory with the active composition.	A composition must be active.	Does not affect any current contexts. Sets the dataframe directory in the Title menu bar to show the association (if any). This association can also be cleared.	MCP-0053	Moved to Compose menu
New	Ctrl+N	Alt-FN	Create a new composition			MCP-0000 MCP-0024	
Open	Ctrl+O	Alt-FO	Open an existing composition			MCP-0008 MCP-0025	
Close			Close the current composition	A composition must be active.		MCP-0009 MCP-0010	
Save	Ctrl+S	Alt-FS	Save the open composition to its current file name	A composition must be active.		MCP-0007 MCP-0026	
Save As		Alt-FA	Save the open composition to another file name	A composition must be active.		MCP-0050	
Import/Export		Alt-FI	Sidebox appears with option to: Import Composition or Export Composition. Opens dialog with default directory for import or export and selection of acceptable file types for import / export (ascii *.txt, template *.tem, etc.).	If not initial condition, then check status of composition in work.	If not initial condition, then if composition is in progress, ask user if they wish to save, save as, quit, or cancel (i.e. resume the work on composition). Then, display scrollable dialog with default location based on import / export selection. Mouse click and highlight selection (make selection on import, composition created and stored in default comp. dir / select export composition from default dir and export to deafult export dir). Import or export dir may be changed on default dir text line or via "browse" button.	MDO-0000 MDO-0001 MDO-0002 MDO-0003 MDO-0005 MDO-0006 MDO-0007 MCP-0025 MCP-0026	We do not have a requirement to export compositions to ASCII files. But, we may include this anyway.

File Menu Options *(continued)*

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
Include Coverage		Alt-FC	Sidebox appears with option to include the following types of coverages: Compositions, processed, logged, data load. Once this selection is made a dialog is opened with a listing of available coverages.	Include coverage not dependent on closure of any compositions in work.	No initial conditions. All included coverages must be "ANDed" with current logged sources before included in current context - any discrepancies must be mentioned to user ("not all logged sources available for included coverage").	MCP-0023 MCP-0024	Moved to Compose menu
Print	Ctrl-P	Alt-FP	Only active when a composition or map data load coverage is displayed. Use for printing any map composition in work or print coverage of a data load.	A composition or coverage must be active.	No initial conditions. Need to utilize windows / linux print drivers and "standard" print pop-up menu.	MCP-0028	
Exit		Alt-FX	First, performs the checks that "close" does and then closes the MMC application.	Active at all times.	Same as "close" but also closes MMC application.	MCP-0009 MCP-0049	
Open Map		Alt-FD	Sidebox appears with option to open map or mission load. Opens dialog with a list of available data loads.	If not initial condition, then check status of composition in work.	If not initial condition, then first apply use case as in item 5. Then, display scrollable dialog with default location based on storage medium selection. Mouse click and highlight selection for open. Composition dir may be changed on default dir text line or via "browse" button. Derive composition from the data load(construct bitmap on-the-fly) from the data and display. No modifications are allowed and all MMC PC composition tools are inactive.	MDO-0000 MDO-0001 MDO-0002 MDO-0003 MDO-0008 MDO-0009 MDO-0010 MDO-0011 MDO-0012 MDO-0013 MDO-0017 MDO-0023 MCP-0046	Moved to the Build menu.

B2. Edit Menu Options

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
Edit Menu		Alt-E					
Undo	Ctrl-U	Alt-EU	Only active during a composition build or edit. Can undo the one previous action.	Any composition build with at least one previous edit function.	Only used during the creation or editing of a composition. Will work for the one previous edit. Not applicable to DP or building / transferring map data. Can not undo a Save operation.	MCP-0011	Will be implemented in a future release.
Redo	Ctrl-R	Alt-ER	Only active during a composition build or edit. Can redo the one previous action.	Any composition build with at least one previous edit function.	Only used during the creation or editing of a composition. Will work for the one previous edit. Not applicable to DP or building / transferring map data. Can not redo a Save operation.	MCP-0012	Will be implemented in a future release.
Cut	Ctrl-X	Alt-ET	Removes coverage from a composition based on a selected coverage area, which can be defined through toolbars and mouse actions. Only active during composition build or edit.	Any composition build or opened existing composition with the selection of a defined area	Only used during the creation or editing of a composition. Not applicable to DP or building / transferring map data. Requires a selection be made via remove coverage toolbars before this button is active.	MCP-0013	
Copy	Ctrl-C	Alt-EC	Copies coverage from a composition based on a selected coverage (mouse click actions). Only active during composition build or edit.	Any composition build or opened existing composition with the selection of a defined area	Only used during the creation or editing of a composition. Not applicable to DP or building / transferring map data. Requires a selection be made via appropriate tool bars and mouse clicks before this button is active.	MCP-0014	
Paste	Ctrl-V	Alt-EP	Pastes coverage from a composition based on a previously "cut" or "copied" coverage. Only active during composition build or edit.	Any composition build or opened existing composition with a selection that has been "cut" or "copied".	Only used during the creation or editing of a composition. Not applicable to DP or building / transferring map data. Requires a previously "cut" or "copied" coverage to reside in memory before this button is active.	MCP-0015	
Select / Deselect All	Ctrl-A	Alt-EL	Selects/Deselects all coverage in the composition (current map scale and type),	Any composition build or opened existing composition.	Only used during the creation or editing of a composition. Not applicable to DP or building / transferring map data. Shortcut function to select all composition coverage in a window. Intended to be used with copy function to duplicate coverages at different map types or scales.	MCP-0016 MCP-0017	This is managed by mouse click

B3. View Menu Options

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
View Menu		Alt-V					
World Map		Alt-VW	By default, the world map is displayed. This function acts as a toggle.	Initial condition is to display the world map. Toggle.	Toggle function. The world base map provide geographic references	MCP-0019	
Lat / Lon Grid		Alt-VG	Opens a dialog to activate the lat/lon grid and also specify lat/lon spacing.	Initial condition is lat/lon grid is not active. Dialog box is displayed to toggle and set parameters.	Dialog box will have a set toggle to turn on/off lat/lon grid and also independently allow setting lat/lon spacing (these values can be changed). Also, specifies whether to display all coordinates in decimal degrees or DDDMMSS	MCP-0020 MCP-0021 MCP-0027	
User Defined Polygons		Alt-VP	By default, this function is on. This is a toggle operation used to show the area requested during composition development.	Initial condition is set to on.	Toggle function. The defined polygon will help the user identify areas where map data is desired but may not currently exist during map composition development.	MCP-0022	not supported in initial release
Available Coverage		Alt-VC	Toggle will display available coverage of all logged sources and processed data residing on harddisk for current window (map scale and type, window focus [zoom]). This toggle does not affect the composition in-build, rather it only shows map data coverage as a reference.	Initial condition is off. Button will display all logged and processed data on HD for given map scale and type.	Shows the currently logged and processed data on harddisk or other media for the map scale and type currently active. NOTE: This display is not part of a composition build and is not part of the same context. Available coverage may be shown during composition development.	MCP-0023	
Zoom		Alt-VZ	Dialog box to zoom in or out at preset zoom levels. The number of preset zoom levels are yet to be determined	Initial condition is at world zoom (full world display).	Sets the zoom in or zoom out percentage from the center of map display	MCP-0039	
Zoom In		Alt-VI	Zoom in to a point	Initial condition is at world zoom (full world display).	Performs a zoom in action from the current center location by a pre-set percentage	MCP-0051	
Zoom Out		Alt-VO	Zoom out from a point	Initial condition is at world zoom (full world display).	Performs a zoom out action from the current center location by a pre-set percentage	MCP-0040	
Zoom Stretch		Alt-VS	Zoom to an ROI via stretch-box mouse drag	Initial condition is at world zoom (full world display).	Performs a zoom in action by mouse-stretchbox definition	MCP-0038	

View Menu Options *(continued)*

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
Refresh	Ctrl-H	Alt-VR	Button click to re-draw the base map window.	None.	Used to re-draw the base map screen (with any displayed compositions). Not applicable to pop-up windows or map data displays.	MCP-0018	
Properties, Lat/Lon Grid Spacing			Toggle will display the lat/lon grid	Initial condition is OFF		MCP-0020 MCP-0021	
Properties, Lat/Lon Format			Adjusts the display format	Initial condition is degrees minutes seconds		MCP-0027	

B4. Process Menu Options

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
Process Menu		Alt-P					
CADRG	Ctrl-G	Alt-PC	Activates processing window for converting Geotiff data to CADRG data. Reads data from source media (set default that can be changed) in format defined at PDR.	Closes previous contexts. If unsaved composition is open, asks user to save, quit or cancel.	Processes and compresses Finn source Geotiff data into CADRG data. Can concurrently process multiple scales. Looks for volume header on CD or volume header name of directory folder. Directory structure of data defines map scale(s) to process. Also must check for existence of CADRG palettes for new installation. Color palette comparisons and warnings are same as current MMC.	DP-0000 through DP-0009, DP-0015, DP-0016, DP-0018, DP-0019, DP-0021, DP-0022, DP-0023, DP-0033, DP-0034, MDO-0023	Verify available hard disk space available and estimate of HD required for processing.
RDTED	Ctrl-D	Alt-PR	Activates processing of DTED for source media (set default that can be changed) in format defined at PDR.	Closes previous contexts. If unsaved composition is open, asks user to save, quit, or cancel.	Used to process either Finn or U.S. DTED data into RDTED. Header volume label for U.S. DTED is defined. Finn DTED header information will be same as current MMC. No color palette issues. RDTED processing automatically includes both 150m and 750 m scales.	DP-0010, DP-0011, DP-0012, DP-0013, DP-0018, DP-0019, DP-0021, DP-0033	Verify available hard disk space available and estimate of HD required for processing.
Dataframe	Ctrl-F	Alt-PF	Activates popup window to read any standard graphics file (max size is 768x768 pixels). Converts to HDF file and writes to specified user directory.	Closes previous contexts. If unsaved composition is open, asks user to save, quit, or cancel.	Reads standard graphics files such as GIF, JPG, TIF, BMP, PNG and HDF. Converts only to HDF in default directory but, other directories can be user-defined.	DP-0014	
Archive		Alt-PA				Obsolete, this function will not be supported within MMCPC.	
Log	Ctrl-L	Alt-DL	Function to log media or source data into MMCPC. Data can be logged from CDROM, HD, or networked sources. Sources must have defined header formats.	Closes previous contexts. If unsaved composition is open, asks user to save, quit, or cancel.	Only processed data on HD is automatically logged in system [in default locations] (and only while data exists on HD). All other data must be logged via this function.	DP-0025, DP-0026, DP-0027, DP-0028	Moved to main menu Log option
Unlog		Alt-DU	Function to unlog media or source data from MMCPC. Data can be logged from CDROM, HD, or networked sources. Sources must have defined header formats.	Closes previous contexts. If unsaved composition is open, asks user to save, quit, or cancel.	Processed data on HD is automatically logged in system [in default locations] and cannot be unlogged via this function (the data must be deleted). All other data can be unlogged via this function.	DP-0029, DP-0030, DP-0031, DP-0032	Moved to main menu Log option

Process Menu Options (continued)

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
Statistics		Alt-DS	Informational pop-up window that shows what data currently exists on HD. Shows scale, path, extents, and MB for each processed data set.	Does not affect any active contexts.	Informational: Should include the following information: Map processed types and scales that reside on the system, bounding lat/lon of processed data for each dataset, total size (MB) of each dataset, and remaining overall disk space on HD.	DP-0033	Moved to main menu Log option. MMCPC reads processing.dat file (stores each processing path, data type and scale) to check for the existence of known processed data sets, through the File Menu, Include Coverage option.

B5. Log Menu Options

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
Log Menu		Alt-P					
Log	Ctrl-L	Alt-LL	Function to log media or source data into MMCPC. Data can be logged from CDROM, HD, or networked sources. Sources must have defined header formats.	Closes previous contexts. If unsaved composition is open, asks user to save, quit, or cancel.	Only processed data on HD is automatically logged in system [in default locations] (and only while data exists on HD). All other data must be logged via this function.	DP-0025 DP-0026 DP-0027 DP-0028	Moved from main menu Process option
Unlog		Alt-LU	Function to unlog media or source data from MMCPC. Data can be logged from CDROM, HD, or networked sources. Sources must have defined header formats.	Closes previous contexts. If unsaved composition is open, asks user to save, quit, or cancel.	Processed data on HD is automatically logged in system [in default locations] and cannot be unlogged via this function (the data must be deleted). All other data can be unlogged via this function.	DP-0029 DP-0030 DP-0031 DP-0032	Moved from main menu Process option
Statistics		Alt-LS	Informational pop-up window that shows what data currently exists on HD. Shows scale, path, extents, and MB for each processed data set.	Does not affect any active contexts.	Informational: Should include the following information: Map processed types and scales that reside on the system, bounding lat/lon of processed data for each dataset, total size (MB) of each dataset, and remaining overall disk space on HD.	DP-0033	Function is obsolete - partially supported by Windows functions and other data is restricted from the user. Moved from main menu Process option. Reads the Processing.Dat file (contains each processing path, data type and scale) to check for the existence of known processed data sets. Additional processed data sets are made known through the File Menu, Include Coverage option.

B6. Compose Menu Options

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
Compose Menu		Alt-P					
Include Coverage		Alt-CC	Sidebox appears with option to include the following types of coverages: Compositions, processed, logged, data load. Once this selection is made a dialog is opened with a listing of available coverages.	Include coverage not dependent on closure of any compositions in work.	No initial conditions. All included coverages must be "ANDed" with current logged sources before included in current context - any discrepancies must be mentioned to user ("not all logged sources available for included coverage").	MCP-0023 MCP-0024	Moved from File Menu. Has been broken into 3 separate submenu options
Include Coverage, Logged Sources		Alt-CC	Includes processed and logged sources. Once this selection is made, a dialog is opened with a listing of available coverages.	Include coverage not dependent on closure of any compositions in work.	No initial conditions. All included coverages must be "ANDed" with current logged sources before included in current context - any discrepancies must be mentioned to user ("not all logged sources available for included coverage").	MCP-0023 MCP-0024	
Include Coverage, Composition		Alt-CC	Includes compositions. Once this selection is made, a dialog is opened with a listing of available compositions (locked, unlocked, and obsolete)	Include coverage not dependent on closure of any compositions in work.	No initial conditions. All included coverages must be "ANDed" with current logged sources before included in current context - any discrepancies must be mentioned to user ("not all logged sources available for included coverage").	MCP-0024	
Include Coverage, Map Build		Alt-CC	Includes coverage definition from map builds. Once this selection is made, a dialog is opened with a listing of available map builds.	Include coverage not dependent on closure of any compositions in work.	No initial conditions. All included coverages must be "ANDed" with current logged sources before included in current context - any discrepancies must be mentioned to user ("not all logged sources available for included coverage").	MCP-0024	Obsolete - include coverage effectively performs the same function
Associate DF		Alt-CD	Open dialog box with a default directory set to open a data frame directory. Creates an association of the selected dataframe directory with the active composition.	A composition must be active.	Does not affect any current contexts, Sets the data frame directory in the Title menu bar to show the association (if any). This association can also be cleared.	MCP-0053	Moved from File Menu
Verify Composition		Alt-CV	Asks the user to verify the current composition as a mission or theater type	Inactive until a composition is either opened or in progress	Provides informational message to user about whether current composition is within constructs of specified build type	MCP-0032	

B7. Build Menu Options

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
Build Menu		Alt-T					
Build Map	Ctrl-B	Alt-BB	Requires a composition to be open. Verification of the composition is automatically run first and prompts the user to verify for either a mission or theater load. Once verified for the appropriate load, all underlying data sources (CADRG, RDTED, dataframes) for the current composition are prompted for load and data is copied to HD in required TAMMAC file formats (i.e. archive file).	A composition must be active (either locked or unlocked). A verification of the composition is performed based on mission or theater load. If not within the constraints, user id notified and build process is cancelled. Once a build is complete, the verified composition is locked.	This function is used to acquire the map data that is represented by the current composition and write that data in its TAMMAC-ready format on the HD. The "write map" function is used to transfer the data to the final media. If the current composition has not been saved, a prompt will appear to save and name the composition before proceeding. The required sources for the build will be displayed in a popup window and the order of precedence is user-selectable (e.g., cases of overlapping source data). Once a build is complete, the composition will be locked. Final verification of the composition is performed prior to actual build of the map load.	MDO-0000 MDO-0001 MDO-0015 MDO-0016 MDO-0020 MDO-0023 MDO-0030 MDO-0034 MDO-0035 MCP-0046 MCP-0005 MCP-0006	A theater load from PC card may be duplicated, but cannot be used as source data for building other compositions or theater loads. A mission load cannot be duplicated or used as a source. Data can be written under a default directory, but the directory can be changed to a user-defined directory via browse button. A separate MPS application is responsible for locating these mission loads.
Open Map		Alt-BO	Sidebox appears with option to open theater or mission load. Opens dialog with a list of available loads.	If not initial condition, then check status of composition in work to close before continuing with the open operation.	If not initial condition, then if a composition is in progress, ask user if they wish to save, save as, quit, or cancel (i.e. resume work on the composition). Then, display scrollable dialog with default location based on storage medium selection. Mouse-click and highlight selection for open. Composition dir may be changed on default dir text line or via "browse" button. Derive composition from the data load (construct bitmap on-the-fly) from the data and display. No modifications are allowed and all MMC PC composition tools are inactive.	MDO-0000 through MDO-0003; MDO-0008 through MDO-0013; MDO-0023 MDO-0034 MCP-0046	Not supported in initial release. Allows user to read and display CADRG and RDTED (concurrently??) but NOT data frames - this capability is part of the Dataframe menu under Data Processing
Verify Map		Alt-BV	Performs a verification of the TAMMAC-ready mission or theater load already resident either on HD, CD, or PC card(s).	All open contexts must be closed including any current compositions. A TAMMAC-ready mission or theater load must already be resident on a media (browse capability).	This function is used to perform a standalone verification of the theater or mission load data structure and associated checksums.	MDO-0015 MDO-0034 MCP-0046	Obsolete as a menu function. This is performed as part of a Build Map

B8. System Menu Options

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
System Menu		Alt-S					
Restore Palettes		Alt-SR	Provides capability to restore processed data (watch for color palette incompatibilities), color palettes, dataframes, Theater / Mission loads, compositions, log files, and logged sources.	Closes previous contexts. If unsaved composition is open, asks user to save, quit, or cancel. Assumes archive data have been created outside of MMCPC to be used for this function.	Standard function to restore archived data from another media source.	MDO-0020 MDO-0034 MCP-0029 MCP-0030	Moved from the Build menu for Color Palette restoration, checks by scale for differences/ incompatibilities and warns the user that this restoration will render previously logged data sources (using the older color palettes) as obsolete.
Delete Partial Process		Alt-SD	Deletes partial segments remaining in the MMCPC/System/Partial directories	Inactive unless partial segments exist	A cleanup function for when partial segments are not compressed	MCP-0044	
Delete Mission Load		Alt-SS	Deletes mission load(s) from HD (at default location). User can browse to new location.	Does not affect any active contexts.	Pop-up window to show current mission load(s) and size(s) on HD (browseable). Ability to select one or more Mission Loads for deletion or cancel. The Mission Loads are identified by a descriptive directory name taken from the composition and all mission-specific files are contained within this directory.	MDO-0028	Obsolete: user can do manually
Delete Theater Load		Alt-ST	Deletes theater load(s) from HD (at default location). User can browse to new location.	Does not affect any active contexts.	Pop-up window to show current theater load(s) and size(s) on HD (browseable). Ability to select one or more Theater Loads for deletion or cancel. The Theater Loads are identified by a descriptive directory name taken from a composition and all theater-specific files are contained within this directory.	MDO-0029	Obsolete: user can do manually
Delete Processed Data		Alt-SP	Deletes processed map data from HD (at default location). User can browse to new location. Only one processed data directory is allowed per data type and scale.	Needs to check use of current processed data on HD for any composition. If there is a possibility that deleting processed map data will alter a composition, a pop-up warning is provided to user. Otherwise, does not affect any contexts.	Pop-up window to show the processed data (CADRG at all scales, RDTED, and data frames) that exist on HD, and the size of each dataset. Ability to select processed data for deletion of one or more datasets or cancel. Data frames are identified by user-defined directories where all files therein are deleted.	MCP-0044	Obsolete: this has become Delete Partial Processes, and is now an ancillary function of the Unlog option in the Log menu

System Menu Options *(continued)*

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
Delete Composition		Alt-SC	Deletes compositions from the composition directory (this directory is the only directory alllowed to contain compositions). Pop-up window that displays a list of all the compositions in the directory.	Does not affect any active contexts. However, it will check if a deleted composition is also the active one. If so, then the active composition context is closed and removed from the screen.	Pop-up window that displays list of compositions from composition directory on HD (not browseable). Ability to select one or more compositions for deletion or cancel. If a compsition that is selected for deletion has one or more modifications (append compsitions), those modified compsitions are automatically deleted also (with a notice to the user before proceeding). Once deleted, cannot "undo".	MCP-0042	Obsolete.
Disk Usage		Alt-SD	Displays system usage as related to the MMCPC application.	Does not affect any active contexts.	Pop-up window shows disk usage as related to MMCPC. Processed data, Map and mission loads, compositions, log files and associated disk space. No other actions are allowed.	DP-0033	Obsolete - this a standard Windows function and also incorporated in other MMCPC functions.

B9. Help Menu Options

	Shortcut	Hotkey	Actions	Conditions	Use Case	MMC Req't #	Comments
Help Menu		Alt-W					
History Display		Alt-HH	Shows a pop-up of all MMCPC transactions during the current session.	Does not affect any active contexts.	Informational.	MCP-0048	Moved from Window menu
About MMCPC		Alt-HA		Does not affect any active contexts.	Informational.	None	

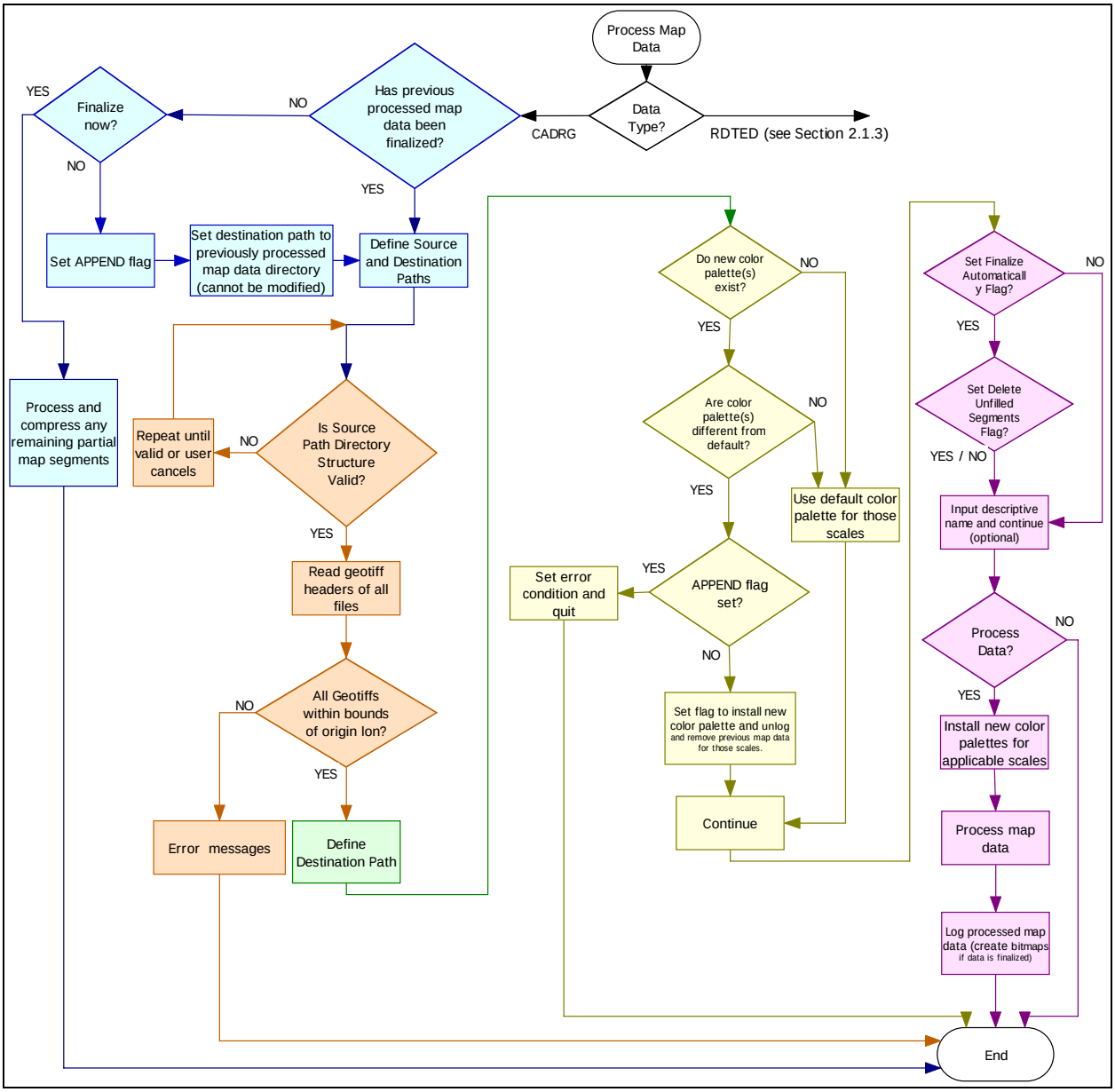
B10. Icon and Button Options

	Image	Hotkey	Actions	Conditions	Use Case	Menu locations	MMC Req't #	Comments
Icons/Buttons								
New		Alt-FN	File New			File: New	MCP-0000	
New design		Alt-VG	Select map projection			View: Lat/Lon Grid	MCP-0001	Obsolete
Existing MMC design			Create / modify map composition by point-to-point (polygon vertices) mouse click of ROI			Thru polygon vertices	MCP-0002	
Existing MMC design			Create / modify map composition by stretch-box mouse drag of ROI				MCP-0003	
Existing MMC design			Create / modify map composition by typed lat/lon entries of ROI				MCP-0004	
New		Alt-FS	File Save			File: Close, Save	MCP-0007	
New		Alt-FO	File Open			File: Open Composition	MCP-0008	
New		Alt-EU	Undo		Will only undo 1 previous command	Edit: Undo	MCP-0011	Not supported in initial release
New		Alt-ER	Redo		Will only redo 1 previous command	Edit: Redo	MCP-0012	Not supported in initial release
New design		Alt-FI	Open and read an ASCII mission planning coverage file containing bounding rectangles (lat/lon) of map coverages by data type and scale			File: Import/ Export	MCP-0025	
Existing MMC design			Deselect coverage from a composition by point-to-point (polygon vertices) mouse click of ROI				MCP-0034	
Existing MMC design			Deselect coverage from a composition by stretch-box mouse drag of ROI				MCP-0035	
Existing MMC design			Deselect coverage from a composition by typed lat/lon entries of ROI				MCP-0036	

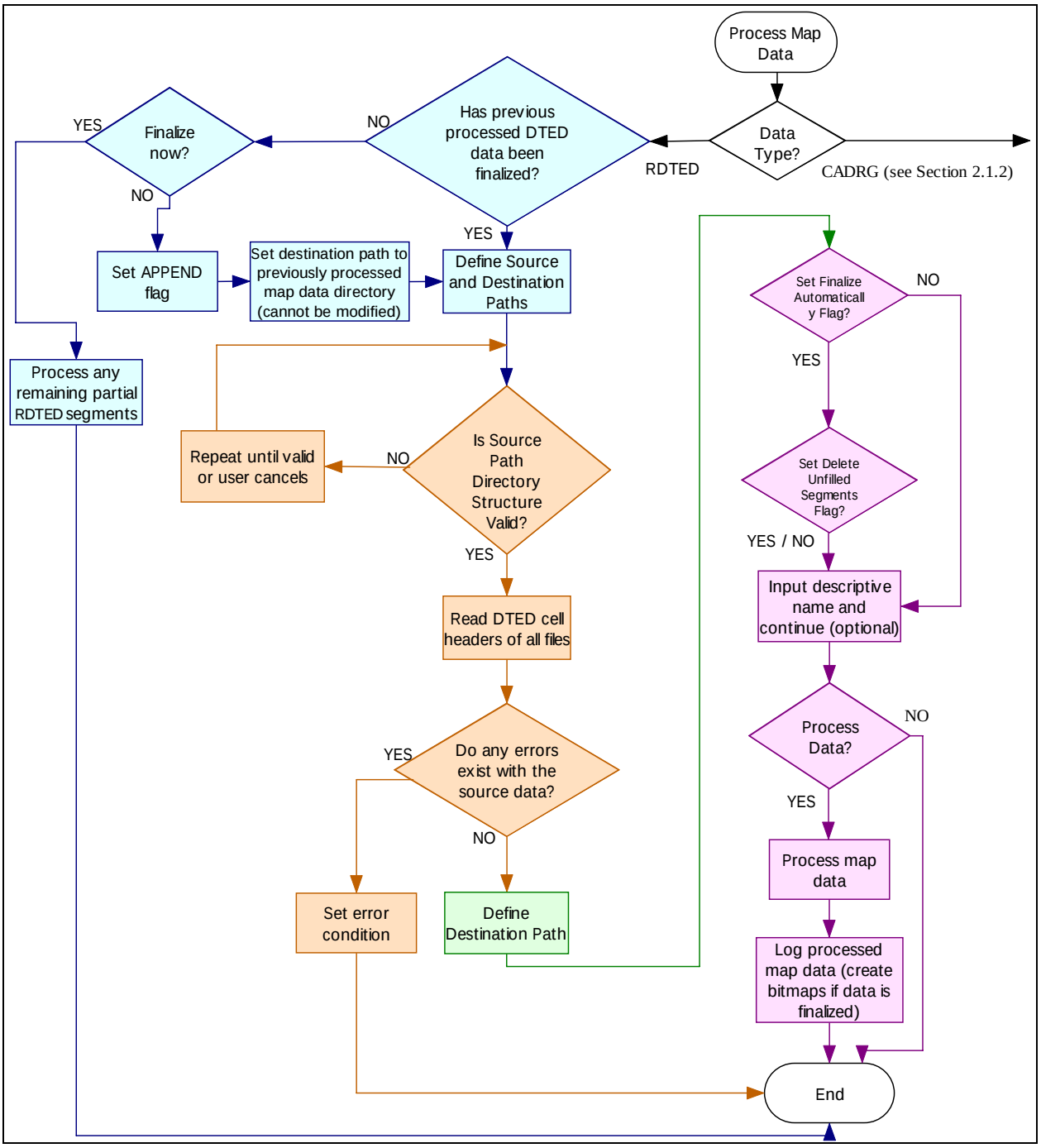
Icon and Button Options *(continued)*

	Image	Hotkey	Actions	Conditions	Use Case	Menu locations	MMC Req't #	Comments
Existing MMC design			Set / clear (toggle) individual map tile via mouse click				MCP-0037	
Existing MMC design			Zoom to a ROI via stretch-box mouse drag				MCP-0038	
New design		Alt-VZ	Zoom to a ROI via zoom multiplier box			View: Zoom	MCP-0039	
Existing MMC design			Zoom out from a point		It will use preset zoom levels		MCP-0040	
New design	labeled button		Select map scale	The default map scale for CADRG is 1:500k, default scale for CIB is 5m, and default scale for RDTED is 150m.	This is tied to Map type and will automatically change to the previously selected scale or default value (when no previous scale was selected) every time map type is changed.		MCP-0047	
Existing MMC design			Zoom in to a point		It will use preset zoom levels		MCP-0051	
New design	labeled button		Select Map type (CADRG, RDTED, CIB)	The default map type is CADRG	This determines what data type used to build a composition. It is selectable and map scales are specific to each data type.		MCP-0052	
Existing MMC design			Set / clear (toggle) individual map tile via mouse click				MCP-0037	
New design			Build a theater/mission load.				MDO-0030	
New design			Write a theater load to PC card.				MDO-0031	

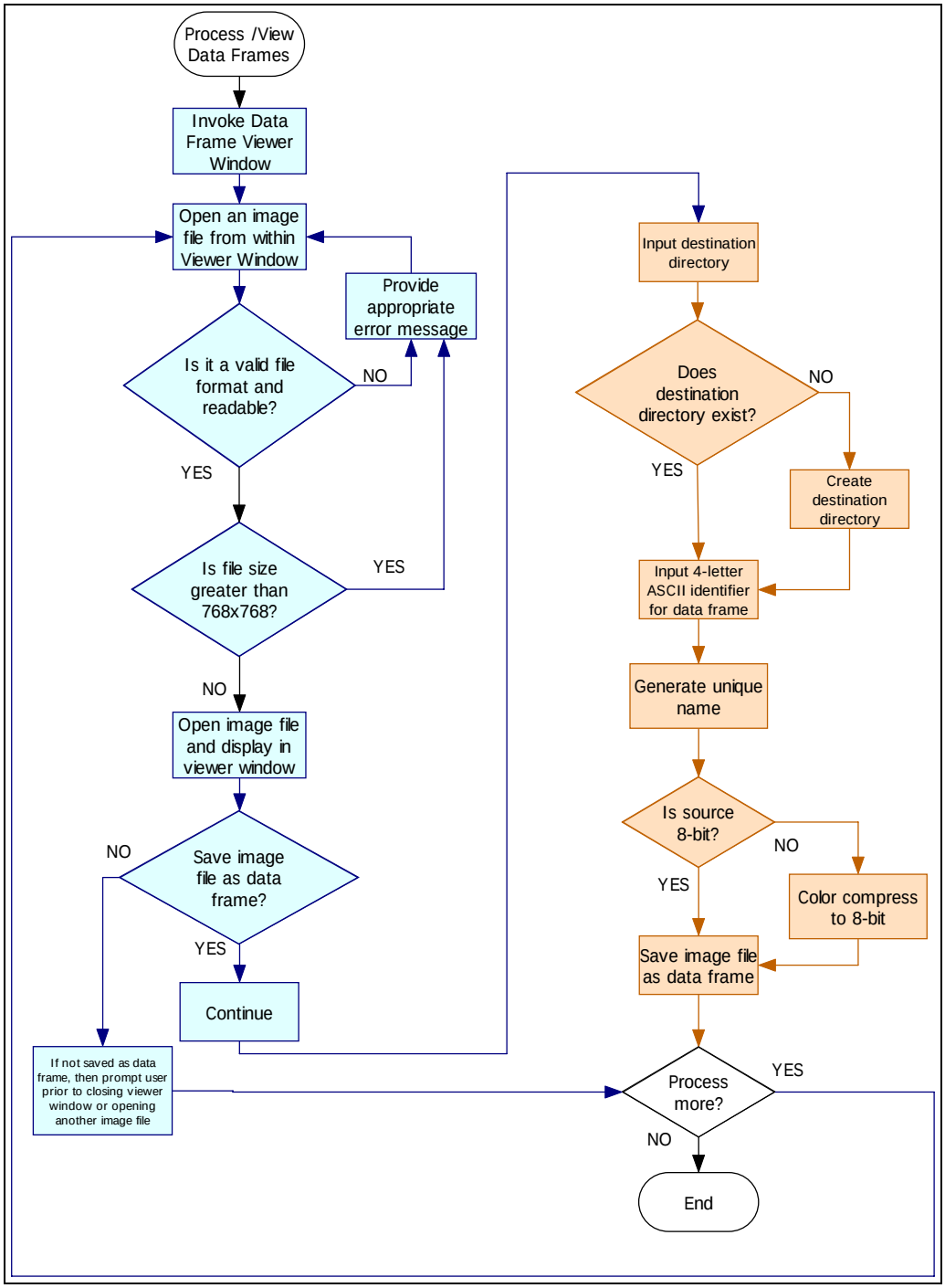
Appendix C
LOW-LEVEL FLOW CHART FOR CADRG PROCESSING



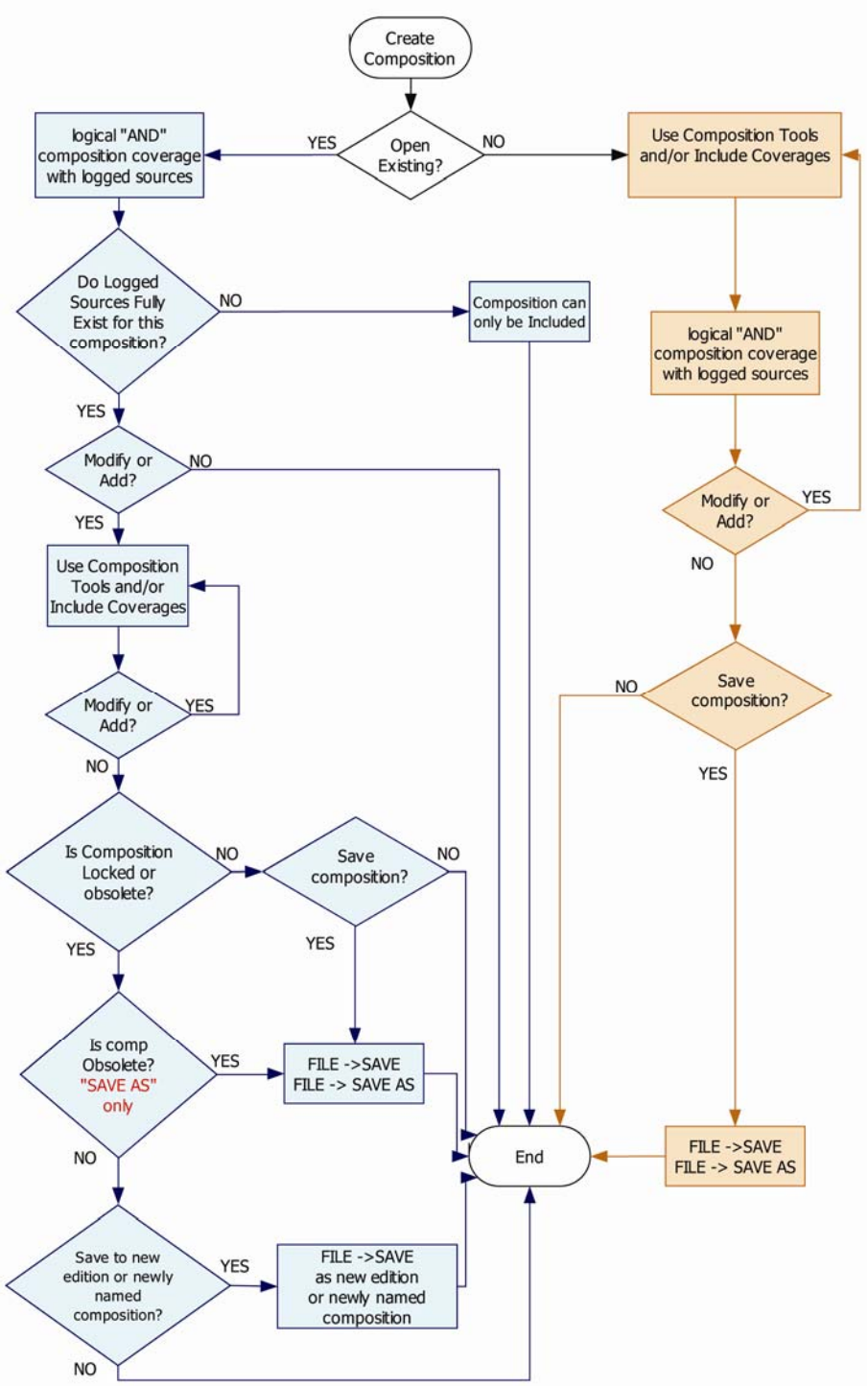
Appendix D
LOW-LEVEL FLOW CHART FOR RDTED PROCESSING



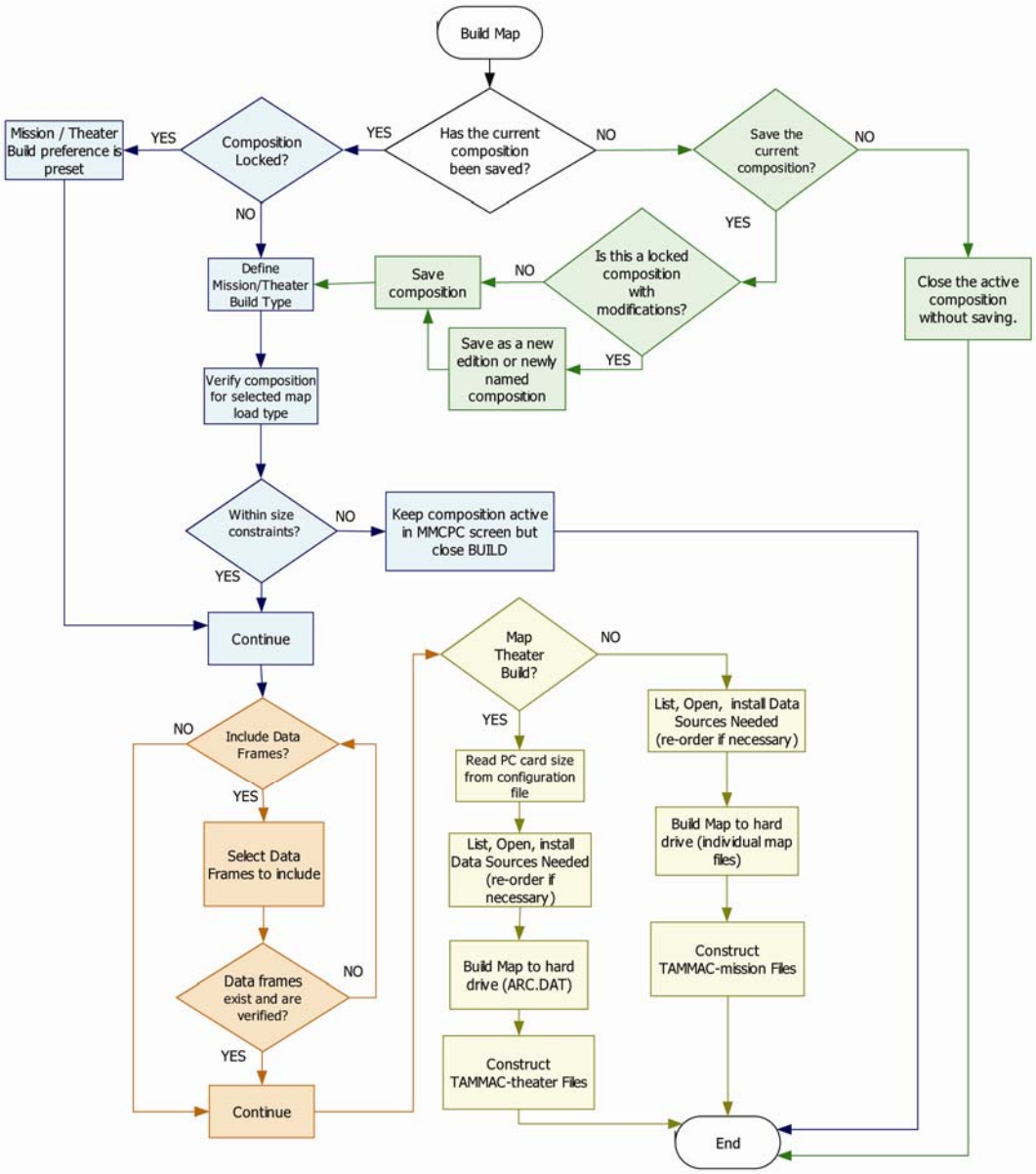
Appendix E
LOW-LEVEL FLOW CHART FOR DATA FRAME PROCESSING



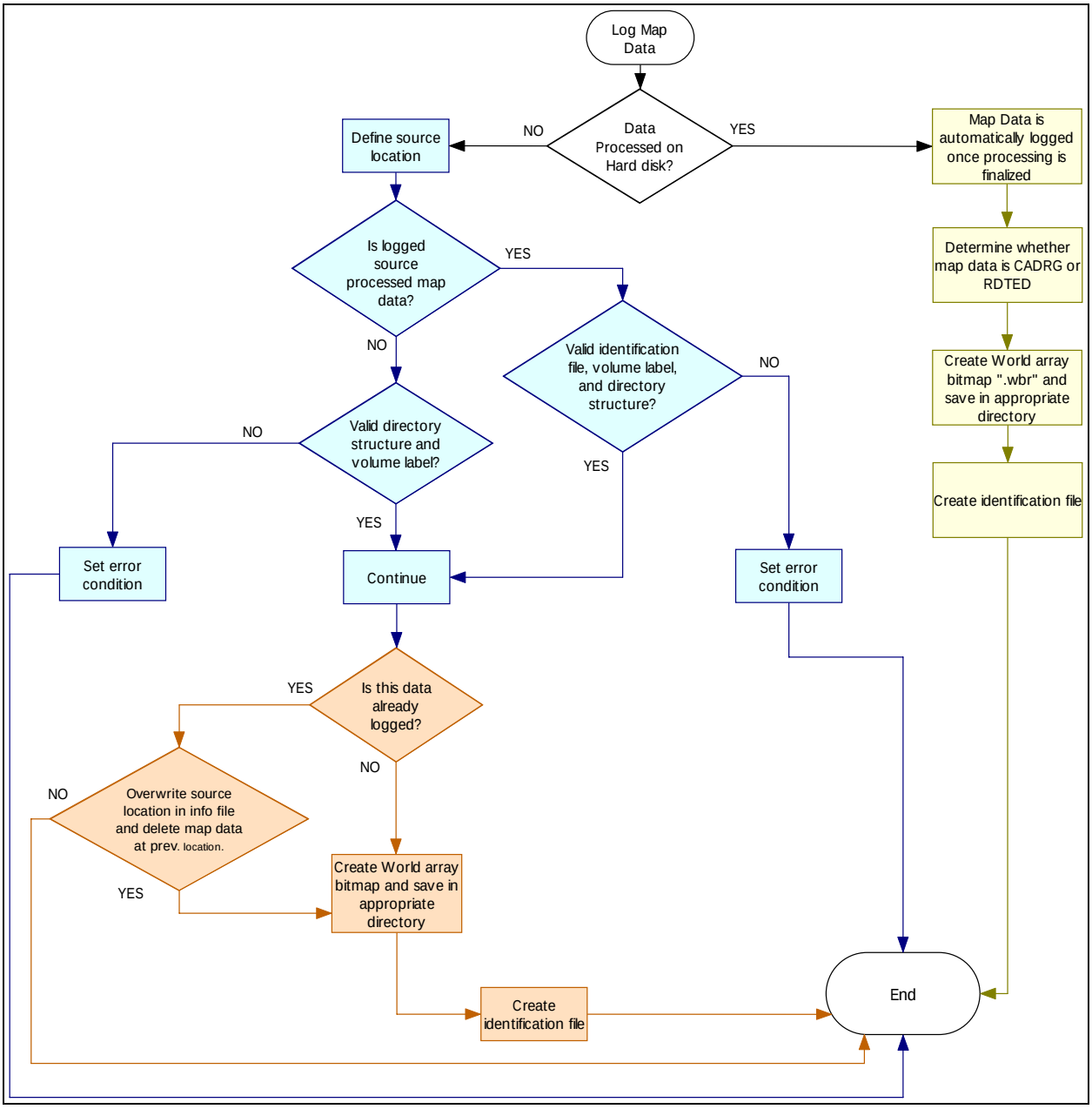
Appendix F
LOW-LEVEL FLOW CHART FOR COMPOSITION CREATION



Appendix G
LOW-LEVEL FLOW CHART FOR MAP BUILD METHODOLOGY



Appendix H
LOW-LEVEL FLOW CHART FOR DATA LOGGING



Appendix I
INPUT FILE: FORMATS AND NAMING CONVENTIONS

This Appendix provides information about the input data sources processed by MMCPC (Table I-1). In addition to the supported Finnish-specific map data (defined below), MMCPC also reads the following data types:

I1. CADRG

For more information about CADRG, refer to the NGA specification for CADRG (NGA 1994).

I2. CIB

For more information about CIB, refer to the NGA specification for CIB (NGA 1995).

I3. Data Frames

For more information about data frames, refer to the Database Design Document for the TAMMAC Map (Harris 2002).

I4. DTED

MMCPC will support *only* DTED level 1. DTED level post (elevation) spacing is defined in Section 3.9 of the DTED military specification (NGA, 2000). Source data from NGA and FiAF are acceptable inputs to MMCPC:

- NGA DTED: for more information, refer to the NGA specification for DTED (NGA 2000).
- FiAF DTED: the directory structure and file naming convention of FiAF DTED must conform to the format defined in the DTED military specification, MIL-PRF-89020A, Section 3.14.2 with the exception that FiAF DTED is not required to have a gazetteer, a DMED file, text files, or the GAZETTE or TEXT directories.

I5. GeoTIFF

Source data from NGA and FiAF are acceptable inputs to MMCPC. All files must contain a **TIF** suffix (e.g., **ABCDEFGH.TIF**). For more information about the GeoTIFF file format, refer to the GeoTIFF Working Group specification (2000).

I6. Digital Map System (DMS)

For more information about DMS, refer to the TAMMAC performance specification for the DMC (Harris 2001).

Appendix J
OUTPUT FILE: FORMATS AND NAMING CONVENTIONS

J1. Composition Information Files (CIF)

The file naming convention for CIF files is the composition name appended with the version number with extension CIF (e.g., **NAME01.CIF**). CIF files contain descriptive information about compositions and include the following fields (one per line in the ASCII file):

- Composition name
- Version number
- Status (LOCKED/UNLOCKED)
- Specific source listings (not applicable for unlocked compositions)
- List of associated data frames with directory paths

All user-defined compositions and CIF files must be stored in one specific directory. The sources used for locked compositions are written to the .CIF file, which references the PUID (processed unique ID) used to create the map load. The PUID is the name of the .RIF files stored in the logged sources directory. These files store the current location of the map data.

J2. Raster Product Format (RPF) Information Files (RIF)

The file naming convention for RIF files is the MMCPC-generated unique PUID (for processed data) or the volume ID (NGA data) with the extension .RIF (e.g., **CDRGFIAF0001_A.rif**). RIF files reside in the same directory as their corresponding world array bitmaps and contain the following information:

- Descriptive name (30 characters)
- Date stamp of when processing begins
- Full path to the processed map data
- Locked compositions that use this logged source (i.e., a list of all compositions added to this file as compositions are locked)

J3. Theater-Specific Map files

The theater-specific map files include the following:

- **ARC.DAT** – a large file or set of files containing the map, RDTED, and data frames
- **DIR.DAT** – a directory listing file for each **ARC.DAT** file
- **TIF.DAT** – a header file for each **ARC.DAT** (if spanned over multiple PC cards)
- **CONFIG.HRS** – a single option file
- Symbol set files – **TEST.DAT**, **100SDIR.HRS**, and **002SDIR.SDR**

J4. Mission-Specific Map Files

The mission-specific map load does not utilize an **ARC.DAT** file. Individual map files are written to the PC card. Since mission loads are very small, they will always be contained on a single PC card. The mission specific map files include individual map data files (e.g., CADRG, CIB, RDTED, Dataframes), **DIR.DAT**, **TIF.DAT**, but not **MF.DAT**, which must be built by the MPS system to create a valid mission load to PC card. The reader is referred to the DMC Specification (Harris 2001), Appendix G for details.

J5. World Array Bitmap Files

Bitmap arrays represent global lat/lon positions. MMCPC builds compositions from these "world array bitmaps," of which there are three types, each with a different file extension:

1. ***.WBU** (World Bitmap Unlocked) is a bitmap representation of a user-defined ROI, based on available logged data sources, that has not been used to build a TAMMAC map. I.e., specific sources have not been locked to a composition. These files can be modified and saved to either the original name or a new name.
2. ***.WBL** (World Bitmap Locked) is the same as a ***.WBU** file, except it has been used for a TAMMAC map build and therefore has been locked to specific logged sources. This file can be saved to its original name, but must have a new edition.
3. ***.WBX** is the same as a ***.WBL** file, except one or more of its sources has been unlogged (i.e., is no longer available).

Appendix K
GLOSSARY OF ACRONYMS AND TERMS

K1. Acronyms

The acronyms and abbreviations used in this document are defined in Table K1.

Table K1 — Acronyms Used In this Document

Acronym	Definition
CAC	Compressed Aeronautical Chart
CADRG	Compressed ARC Digitized Raster Graphics
CD	Compact Disk
CIB	Controlled Image Base
CIF	Composition Information File
DEC	Digital Equipment Corporation
DMC	Digital Map Computer
DMS	Digital Map System
DTED	Digital Terrain Elevation Data
FiAF	Finnish Air Force
GeoTIFF	Geospatial Tagged Image File Format
GIF	Graphics Interchange Format
GUI	Graphical User Interface
HDF	Harris Defined Format (data frame format)
MMC	Moving-Map Composer (precursor to MMCPC)
MMCPC	MMC Personal Computer
MPS	Mission Planning System
NAVAIR	Naval Air Systems Command
NGA	National Geospatial-Intelligence Agency (formerly NIMA)
NIMA	National Imagery and Mapping Agency (now NGA)
NRL	Naval Research Laboratory
PCMCIA	Personal Computer Memory Card International Association
PUID	Processed Unique Identification
RDTED	Regridded Digital Terrain Elevation Data
RIF	RPF Information File
ROI	Region of Interest
RPF	Raster Product Format
TAMMAC	Tactical Aircraft Moving Map Capability
TIF	Tagged Image File
TOC	Table of Contents
WBL	World Bitmap Locked
WBU	World Bitmap Unlocked
WBX	World Bitmap Locked but unavailable

K2. Processing Terms

Composition (for a Region of Interest)

A composition is a user-defined geographic coverage area (or set of areas) saved as a series of bitmaps (Fig. K1). A composition includes a bitmap for each contiguous geographic area, within each zone, and at each map scale required to build a Mission or Theater Map. Each "bit" in the composition's bitmap(s) represents a single segment of CADRG data (and/or RDTED).

Image

An image is the actual data (including CADRG, processed map data, RDTED, or some combination) to be used in a Mission or Theater Map. MMCPC constructs an image from a composition's bitmaps. Figure K2 is a sample image comprised of processed Finn source data.

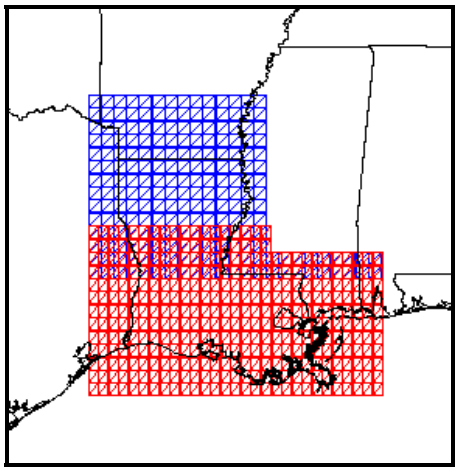


Fig. K1 — Sample composition

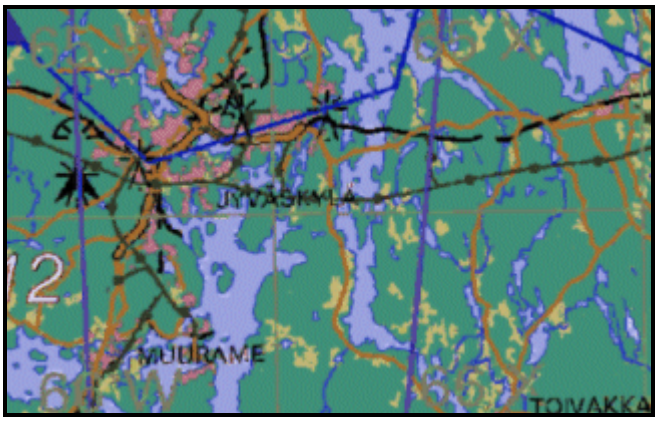


Fig. K2 — Sample image
(processed 1:500 k scale data)

K3. DATA TYPES

Compressed ADRG (CADRG)

Produced and distributed on CD-ROM by NIMA, CADRG was designed to be a jointly coordinated compression of ADRG to be used in any application requiring rapid display of a map image or manipulation of the image of a map in raster form. CADRG achieves a nominal compression of 55:1 over ADRG, excluding supplemental data such as color palettes and codebooks. CADRG is processed similarly to CAC, except that CADRG has a data density of 169 pixels per inch (CAC is 128 ppi) and CADRG maintains the ARC coordinate system of ADRG (CAC uses the TS projection system). CADRG will replace CAC as the standard raster chart data to be used in the TAMMAC cockpit moving-map systems. For more details, refer to NIMA's *Digitizing the Future* report or website (NIMA 1997).

Digital Terrain Elevation Data (DTED)

DTED is a uniform matrix of terrain elevation values that provides basic quantitative data for systems requiring terrain elevation, slope, and/or gross surface roughness information. DTED is produced and distributed on CD-ROM by NIMA. DTED is available at two resolutions (summarized in Table K2):

- Level 1: Content is comparable to the contour information on a 1:250k scale chart. Latitudinal post spacing is 3 arc seconds (about 100 m); longitudinal post spacing varies by latitude.
- Level 2: Content is comparable to the contour information on a 1:50k scale chart. Latitudinal post spacing is 1 arc second (about 30 m); longitudinal post spacing varies by latitude.

Table K2 — DTED Longitudinal Post Spacing (Level 1 vs Level 2)

Zone	Lat Bounds	Post Spacing (arc sec)	
		Level 1	Level 2
I	0º - 50º N/S	3	1
II	50º - 70º N/S	6	2
III	70º - 75º N/S	9	3
IV	75º - 80º N/S	12	4
V	80º - 90º N/S	18	6

For more information about DTED, refer to the NGA specification for DTED (NGA 2000) or the NGA website (www.nga.mil).

World Vector Shoreline (WVS)

WVS is the base map for defining coverages for AOD images and MPS-CD images on the MMC and MMCPC workstations. WVS is a standard NGA digital product consisting of the shorelines, international boundaries, and country names of the world. The uncompressed version of WVS averages 12 data points per nautical mile (nmi), approximately equivalent to the data density of a scanned 1:250k scale chart. WVS conforms to the WGS 84 datum. Compressed and thinned versions of WVS are also available from NGA. For more details, refer to the NGA website (www.nga.mil).

K4. CHART SERIES, SCALES AND DISPLAY RANGES

Chart series and geographic scale typically refer to paper chart products: a Joint Operations Graphic (JOG) chart series is produced at a scale of 1:250k, which means that 1" on the chart represents 250,000" on the ground. For aeronautical charts, larger scales (e.g., 1:50k and 1:100k) provide more detailed map information for low-altitude flying or approach and landing operations. Smaller scales (e.g., 1:2M and 1:5M) are used for faster flying at high altitudes (e.g., cross-country flights).

The term map scale is not always appropriate for digital map products, since the actual scale may become distorted by zooming or subsampling the data. For digital charts, it may be more useful to refer to display range (i.e., the number of nautical miles from top to bottom of the screen on which the digital chart is displayed). Table K3 lists common aeronautical chart series, with their geographic scales and normal (pre-zoom) display ranges. The table also indicates, for each chart series, if it is supported by current moving-map displays and if it will be supported under the new TAMMAC systems.

Table K3 — Common Aeronautical Chart Series, Scales, and Display Ranges

Chart Series	Scale[*1]	Display Range (nmi)[*2] AV-8B	F/A-18	In current system?	In TAMMAC system?
Global Navigation Chart (GNC)	1:5M	200	160	No	No
Jet Navigation Chart (JNC)	1:2M	100	80	Yes	Yes
Operational Navigation Chart (ONC)	1:1M	50	40	No [*3]	No [*3]
Tactical Pilotage Chart (TPC)	1:500k	25	20	Yes	Yes
Joint Operational Graphics (JOG)	1:250k	13	10	Yes	Yes
Topographic Line Map-100 (TLM-100)	1:100k	5	4	No	No
Topographic Line Map-50 (TLM-50)	1:50k	3	2	No	No
City Graphics (CG)	1:12.5k			No	No

[*1] For map scales, M = million, k = thousand.

[*2] AV-8B and F/A-18 use the same display but calculate range differently (Trenchard et al.1995).

[*3] The ONC series is not supported in current systems; instead, pilots can zoom into the JNC chart by 2:1 to simulate an ONC display range.

K5. AGENCIES AND COMPANIES

National Geospatial-Intelligence Agency (NGA)

NGA (formerly NIMA) produces and distributes standard cartographic databases that support the cockpit moving-map, MAP-II, MPS-II, and MDS-II systems, including CAC, DTED, and WVS.

National Imagery and Mapping Agency (NIMA)

NIMA has been reorganized and renamed to NGA.

Naval Research Laboratory (NRL)

The NRL Mapping Sciences Section (Code 7440.1) developed the FiAF MMC workstation and Moving-Map Composers (MMC) software for the AV-8B Muxbus Data System. NRL Code 7440.1 is located at the Stennis Space Center, MS, which is on the Gulf of Mexico approximately 70 miles northeast of New Orleans, LA. The following are key NRL personnel in this effort:

Project Team Leader: Maura Lohrenz

Project Engineers: Michael Trenchard, Stephanie Myrick, Marlin Gendron, Geary Layne, Marvin Roe, Stephanie Edwards, and Lance Riedlinger (contractor with Planning Systems, Inc.).