FM 3-09.15
MCWP 3-16.5

TACTICS, TECHNIQUES, AND PROCEDURES FOR FIELD ARTILLERY METEOROLOGY

OCTOBER 2007

HEADQUARTERS, DEPARTMENT OF THE ARMY

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***FM 3-09.15 (FM 6-15)**
MCWP 3-16.5

Field Manual
No. 3-09.15

Headquarters
Department of the Army
Washington, DC, 25 October 2007

Tactics, Techniques, and Procedures for Field Artillery Meteorology

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***This publication supersedes FM 6-15-, 13 August 1997.**

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Preface

This publication provides the United States Army and United States Marine Corps (USMC) commanders, artillerymen, and meteorology (MET) crew members with tactics, techniques, and procedures for the employment of MET sections. This publication describes the equipment and tasks required to develop MET data from the selection of the MET station location to the dissemination of the MET data.

This publication implements the following North Atlantic Treaty Organization (NATO) standardization agreements (STANAGs).

- STANAG 4044, *Adoption of a Standard Atmosphere*.
- STANAG 4061, *Adoption of a Standard Ballistic Meteorological Message*.
- STANAG 4082, *Adoption of Standard Artillery Computer Meteorological Message*.
- STANAG 4103, *Format of Request for Meteorological Message for Ballistic and Special Purposes*.
- STANAG 4140, *Adoption of a Standard Target Acquisition Meteorological Message*.
- STANAG 4168, *Characteristics of Hydrogen Generating Equipment*.

This publication applies to U.S. Army and Marine Corps planning and warfighting personnel, the Active Army, the Army National Guard/Army National Guard of the United States, and the United States Army Reserve unless otherwise stated.

The proponent of this publication is United States Training and Doctrine Command. Send comments and recommendations on DA Form 2028 (*Recommended Changes to Publications and Blank Forms*) directly to:

Commandant
U.S. Army Field Artillery School
ATTN: ATSF-DD
Fort Sill, OK 73503-5600

Chapter 1

Commander and Staff Considerations

Combat experience has proven the importance of providing accurate and timely meteorological data to both artillery and other units. MET sections provide data to enhance first round accuracy, effective downwind predictions, intelligence preparation of the battlefield, and forecast capabilities of the staff weather officer. The commander and staff must include meteorology in the planning process. The planning process focuses on what data is needed, who needs it, and how will they get it. Artillery meteorology, as one of the five requirements for accurate predicted fires, plays an increasingly vital role in today's changing operational environment. Accuracy of indirect fires increases the lethality and directly relates to other issues of strategic importance such as collateral damage.

1-1. Since MET is one of the five requirements for accurate and predicted fires it is considered part of the precision fires system of systems. MET sections provide data to enhance first round accuracy, effective downwind predictions, intelligence preparation of the battlefield, and forecast capabilities of the staff weather officer. The commander and staff who include meteorology in the planning process should always use the most accurate MET data available as it will benefit the most. The planning process focuses on what data is needed, who needs it, and how will they acquire it.

SECTION I OVERVIEW

NOTE: The U.S. Army Intelligence Center and Fort Huachuca is the proponent for Army general and tactical weather requirements, except those relating to artillery MET.

MISSION

1-2. The mission of the MET section is to produce and disseminate valid and timely MET data in formatted messages. Example messages and checking procedures are at appendix A. These messages are as follows:

- Computer
- Ballistic (type 2 and type 3)
- Target acquisition
- Target area MET (Meteorological Measuring Set–Profiler [MMS-P] only)
- Basic wind report (MMS–P only)
- Fallout MET (FOMET)
- World Meteorological Organization (WMO) messages
- Sound ranging messages to allied units.

U.S. ARMY MET SECTIONS

1-3. Under the modular structure, Army MET sections are deployed as follows:

- Each brigade combat team (BCT) will have one Fires Battalion that will include a MET section.
- Each STRYKER Brigade will have one field artillery (FA) battalion (BN) that will include a MET section.
- Each Fires Brigade will have three MET sections as part of the Target Acquisition Battery.

U.S. MARINE CORPS MET SECTION

1-4. The MET section is divided into four MET teams in an artillery regiment. These teams provide support to the battalions and batteries of the regiment. The teams are given tactical missions based on current as well as future operations.

MET SYSTEMS

1-5. There are two basic MET systems deployed throughout the field artillery: The Meteorological Measuring Set (MMS), AN/TMQ-41, and the Meteorological Measuring Set–Profiler (MMS–P), AN/TMQ-52. These systems are highly mobile, automated data processing and MET data acquisition systems. Both systems operate in any type of climatic condition and over any type of terrain where tactical operations require employment of FA. The preferred meteorological support assets during traditional maneuver warfare are the MMS-P and the MMS. Both systems are vehicle-borne systems. The MMS-P provides localized now-casts of atmospheric numerical weather predictions, whereas the MMS provides meteorological data to using units by tracking a balloon borne radiosonde, which provides vertical zoned atmospheric numerical meteorological output.

MMS (AN/TMQ-41)

1-6. The AN/TMQ-41 uses three passive modes to track a balloon-borne radiosonde that transmits the upper air data to the ground station. These are the radio navigational aid (NAVAID), radio direction finding (RDF), and Global Positioning System (GPS) modes. The NAVAID and GPS modes have a remote launch capability. The AN/TMQ-41 can track the radiosonde and process data while on the move.

MMS-P (AN/TMQ-52)

1-7. The AN/TMQ-52 uses mesoscale modeling (MM5) with 4-kilometer grid spacing granularity, as well as software coupled with the Unified Post Processing System (UPPS) to generate MET data upon request. The MM5 model ingests upper air data (NAVAID and GPS modes), surface observation data, terrain data, regional observations, and large scale weather data. The MM5 model also takes into consideration historical, topographical, climatological weather data, as well as vertical and horizontal resolutions. The resulting model output is transferred to the UPPS to eliminate model biases. The model restarts every 30 minutes, providing data with a staleness of no more than 30 minutes. Using this data, the MMS-P generates MET data for the mid point of the trajectory, which is based on the gun location and the target location as well as target area MET. Additionally, the AN/TMQ-52 is capable of operating in two degraded modes (see paragraph 1-9). Future block improvements to MMS–P include decreasing the reliance on radiosondes, decreasing the amount of section equipment, and decreasing the number of section personnel. The ultimate goal of profiler is to be imbedded on to the firing platform.

CAPABILITIES

1-8. The capabilities of the met section vary based on the specific system being used. Both systems provide met data for use by the field artillery. The mms system is the older system and operational concept is based on providing met data from radiosonde observations. The mms-p operational concept is based on the system ingesting a variety of sources of raw met input and producing met data via a model.

1-9. While both systems retain the essential capabilities of obtaining, processing, and disseminating met data, the operational concept of the MMS-P provides the met section with more capabilities than the mms.

MMS EQUIPPED SECTION

1-10. The MMS is equipped to produce electronic soundings of the atmosphere to 30,000 meters, day or night, in various types of weather. An important factor in providing MET data is the time required for a balloon to reach a required height. Generally, altitude requirements for artillery MET messages are low, 10,000 meters or less. Air Force weather (AFW) and chemical, biological, radiological, and nuclear (CBRN) support are high altitude soundings requiring more time. The MET section can provide hourly artillery MET data if necessary during high-intensity battle. The artillery meteorologists do not forecast weather; that is the responsibility of the staff weather officer (SWO). However, the MET crew member can distinguish major types and changes of weather that will affect the validity of MET messages. This knowledge allows the crew member to recommend changes to MET sounding schedules to provide accurate MET data during changing weather conditions.

MMS-P EQUIPPED SECTION

1-11. The MMS-P utilizes sounding data, but requires fewer soundings to maintain continuous MET coverage. The important factor in providing MET data for the MMS-P is the availability of large scale atmospheric data. Large scale atmospheric data is generated by the Naval Operational Global Atmospheric Prediction System (NOGAPS) and is transmitted every 12 hours by the Air Force Weather Agency (AFWA) via satellite. Each NOGAPS transmission provides the system with 72 hours of valid large scale atmospheric data. The profiler is capable of providing MET out to a distance of 500 kilometers from the MMS–P location. This has been characterized with excellent results, but has only been certified to 60 kilometers. Additionally the MMS–P characterization results demonstrated that with 48-hour-old NOGAPS, the radiosonde provided only minimal improvement to model accuracy. Commanders should consider using MMS–P without the radiosonde as a viable solution for MET when radiosondes are scarce or not available and current NOGAPS is available. Degraded operations mode is defined as either no radiosonde and current NOGAPS or no current NOGAPS and operating with only radiosondes.

1-12. The AN/TMQ-41 and AN/TMQ-52 contain external backup systems for obtaining meteorological data when electronic systems are unavailable. The Extrapolated MET Program incorporated into the AN/TMQ-55 tactical meteorology (TACMET) sensor will provide a nine-line extrapolated computer message. Initial development and statistical evaluation demonstrate that the extrapolated MET message provides estimated vertical profile data with the same accuracy as 3-hour-old electronic met data. Simulated artillery firing results show a significant improvement over the default (standard) computer MET message. The extrapolated MET message is to be used only when there is no electronic means to collect upper air sounding data. Additionally, FA units should be advised when the MET section provides MET data using the Extrapolated MET Program.

1-13. USMC MET sections have an additional back-up capability consisting of visual MET. Visual MET is also used when the electronic means of collecting MET is not available. Visual MET procedures will be discussed in chapter 4. Visual MET messages contain accurate winds data as a result of data gathered from visually tracking a pilot balloon with a theodolite. Temperature and pressure data are measured at surface, which serves as a basis for developing temperature and pressure profiles. The accuracy of a visual MET message is dependent on the stability of the atmosphere. The more stable the atmosphere, the more accurate the temperature and pressure profile.

COMMAND AND CONTROL

1-14. Command and control (C2) of artillery MET sections is exercised at the artillery headquarters to which the MET section is assigned or attached. During periods when there are multiple MET sections located in proximity, a senior MET representative may be appointed to coordinate flight schedules, logistics, and MET section location to ensure adequate coverage of the area of operations. He may recommend tasking the mission for high-altitude soundings (WMO and FOMET messages) to MET sections on a rotational basis. An example of decentralized control of MET assets is a MET section deployed forward to support the covering force battle. In this situation, it is best to attach the supporting MET section to the force artillery headquarters of the covering force.

1-15. In the modular force, each BCT, whether heavy or light, will have one MET system. Each fires brigade will have three MET systems; however, owing to lack of assets, each fires brigade will initially be fielded with one MET system.

ARTILLERY S3

1-16. The artillery operations officer (S3) has primary staff responsibility for the control and operations of artillery MET assets. The operations officer is advised on the technical aspects of MET systems by the MET station leader. For MET employment, the operations officer—

- Prepares the MET plan, which is a tab to the FA support plan. During the preparation of the MET plan, considers the following:
  - Commander's intent and concept of the operation.
  - Tactical situation.
  - Terrain features and wind direction.
  - MET assets available.
  - Location of units to be supported.
  - Communications means required.
  - Scheduling requirements.
- Coordinates with the SWO to determine AFW requirements.
- Coordinates with MET station leader and unit signal staff officers to prioritize means of communication and dissemination of messages and to assign radiosonde frequencies.
- Coordinates all radiosonde flight schedules of MET sections within the area of operations (AO) to provide optimal coverage to supported units. This is very important when providing MET support for other than artillery requirements, since flight times are longer for these missions.
- Monitors the operational status of MET sections regarding personnel, maintenance, and logistics.
- Advises the commander on factors affecting MET section mission capabilities.
- Coordinates with adjacent units and the assistant operations officer at the next higher command echelon to maximize MET message coverage. MET messages from adjacent units may be used.
- Coordinates with the MET station leader to develop a positioning scheme for all MET assets in support of the mission.
- Coordinates with maneuver and supported units to gain approval to move MET sections through and to occupy terrain.
- Coordinates with the MET section and supported units to execute remote launch procedures to expand areas of validity.

MET STATION LEADER

1-17. The MET station leader is the primary advisor to the artillery in all matters pertaining to MET support in the division area. With the operations officer, he plans the tactical employment of all MET assets. He also is responsible for the day-to-day operations of the MET section. Specifically, the MET station leader—

- Helps the operations officer prepare the MET plan.
- Advises the operations officer on the employment and operation of the MET assets within the division area.
- Supervises MET section operations.
- Coordinates with the logistics officer for logistical support.
- Performs site selection and location.
- Directs the operation, emplacement, and displacement of the MET section.
- Performs first sergeant type duties when operating independently.
- Maintains quality control of MET data.
- Organizes and supervises the MET section training program.
- Advises the operations officer on all factors affecting mission capabilities, such as personnel, maintenance, and logistics.

SECTION II OPERATIONAL CONSIDERATIONS

SCHEDULING AND POSITIONING

1-18. Proper scheduling and positioning of met sections can enhance the effectiveness of a single met section and maximize the effectiveness of multiple met sections.

1-19. Scheduling and positioning of met sections should be accomplished based on each systems capabilities to best support the mission.

NOTICE TO AIRMEN

1-20. Routine radiosonde observations are, in general, exempt from the provisions of Federal Aviation Regulation 101 relative to filing a notice to airmen (NOTAM) for the following reasons:

- Radiosondes do not weigh more than 4 pounds (1.8 kilograms) or have a weight/size ratio of more than 3 ounces per square inch on any surface of the package.
- Balloons do not carry a total payload package weighing more than 6 pounds (2.72 kilograms).
- Balloons do not transport two or more packages that weigh more than 12 pounds (5.44 kilograms).
- Trains do not use a rope or other devices for suspension of the payload that require an impact force of more than 50 pounds (22.88 kilograms) to separate the suspended payload from the balloon.

NOTE: In most cases, local aviation policies and regulations require aviation tower or flight operations to be notified prior to release of a balloon in an aviation operations area.

SCHEDULING

1-21. Scheduling considerations are different for the MMS and MMS–P systems. The MMS system determines MET data from balloon-borne radiosondes. The resulting MET data is broadcast to users (Push method) based on a schedule of balloon flights determined by operational requirements. The MMS–P system determines MET data from a mesoscale model of the area of operations. Data produced by the MMS-P may be disseminated by a user querying the system (Pull) or met data may be broadcast to users (Push).

MMS Scheduling

1-22. The operations officer is responsible for scheduling flights within the area of operations. Users who require MET support and who are not in normal MET message dissemination schemes forward their request for MET support to the artillery operations officer. The format for the request is in appendix C. The operations officer will coordinate with firing units and other MET data users (especially the SWO for AFW requirements and the chemical officer for downwind prediction requirements) to determine if there are any special requirements that must be considered. This includes the flight schedule in the MET support plan. MET data will be transmitted to subscriber units (Push method) based on this schedule. In coordination with the MET station leader, the operations officer develops a flight schedule based on the following:

- Mission requirements (low and high altitude flights).
- Area of validity (terrain).
- Prevailing winds.
- Transition periods.
- Availability of supplies.

MMS–P Scheduling

1-23. The MMS–P system provides more scheduling flexibility owing to the nature of how the MMS–P obtains MET data. The MMS–P does not solely rely on a balloon borne radiosonde to provide a MET data. When operating under normal conditions, the MMS–P primarily relies on a mesoscale model to develop MET data. Modeling provides the MMS–P the capability of producing an updated MET message every 30 minutes. Options for scheduling MET from an MMS–P equipped section are—

- MET may be requested (pull method) by subscriber units.
- MET may be scheduled at predetermined times (Push method).
- MET may be scheduled based on changes in weather conditions as determined by the MET section leader.
- MET may be scheduled on call as determined by the artillery mission.

1-24. When operating in MMS only degraded mode, the MMS–P relies on balloon-borne radiosonde soundings to develop a MET message. MET messages are generated upon request, but the area of MET validity is reduced from 60 to 30 kilometers.

NOTE: A practical approach should be observed when scheduling MET from MMS or MMS–P equipped sections. Scheduling should be based on times when MET data will make the greatest contribution to correcting MET error. MET station leaders are encouraged to provide the artillery operations officer information relating to routine and nonroutine changes in the weather. This allows the operations officer to schedule MET at time most beneficial to the artillery.

1-25. Request for MET for an MMS–P equipped section may take the form of—

- Manual plain text message (or secure) digital message.
- Automated digital message request.
- Voice (radio or landline).
- Courier.

NOTE: All requests for MET for an MMS–P equipped section must include the gun and target information. If the MET request is for multiple firing units, the gun location will be the battery center.

Scheduling MET for Firing Units Supporting Maneuver Units on the Move

1-26. Scheduling MET for firing units that are supporting maneuver units on the move will be different as a result of the different capabilities of the MMS and MMS-P. The different areas of validity for the two system will dictate scheduling MET for firing units supporting maneuver on the move.

1-27. Another consideration when scheduling MET for firing units supporting maneuver units on the move is the process by which met data is produced. When scheduling MET from a MMS, consideration should be given to the time required to conduct a radiosonde observation. Whereas the MMS-P does not have the limitation of waiting on the completion of a Radiosonde Observation prior to producing Met Data. MET Data (Push Method)

MET Data (Push Method)

1-28. If data is pushed, the MET section chief will coordinate a schedule of broadcast times and ensure the user provides gun and target locations for the requested MET messages. If the firing units are operating in close proximity to each other and firing on the same target, the gun location for all guns may be the battery center. This will preclude having to process multiple MET messages resulting from the different locations of the guns. Additionally, the MET chief will coordinate a means of broadcasts (radio, LAN, wire, courier, phone, others)

MET Data (Pull Method)

1-29. When data is pulled (Protocol 220C), MET data is requested by the user via the user's communications system using the K02.56 Message Request or the K01.03 Information Request Message. The messages require the requestor to provide the unit reference number (URN), gun and target location, and the type message requested. The profiler automatically generates the MET data in the requested format. The request is automatically sent to the MMS–P where the system generates MET data based on the user's request. The MET data generated by the system is validated and sent to the requester by the operator. If the MMS–P is equipped with Protocol 220A, the user requests MET using a free text message containing the required information.

Scheduling MET for Firing Units Supporting Fixed Locations

1-30. Scheduling MET for firing units supporting fixed locations is less complex than scheduling MET for firing units supporting maneuver units on the move. The required area of coverage is usually such that both systems will operate from fixed locations.

1-31. When providing MET with the MMS, consideration must be given to the time required to conduct Radiosonde Observations. The MMS-P does not have the limitation of waiting on the completion of a Radiosonde Observation to provide data.

MET Data (Push Method)

1-32. When providing MET to firing units providing counter-fire support, the MET section chief coordinates a schedule of broadcasts. If the gun and target locations are known, the MET section chief will ensure the correct gun and target locations are entered for message processing.

1-33. When providing MET to firing units supporting fixed locations, the gun location is known; however, the target location may not be known until just before the firing unit conducts a fire mission. In this case, enter the gun location data in the target location fields (gun and target location will be the same).

MET Data (Pull Method)

1-34. When data is pulled (Protocol 220C), MET data is requested by the user via the user's communications system using the K02.56 Message Request or the K01.03 Information Request Message. The messages require the requestor to provide the URN, Gun and target location and the type message requested. The profiler automatically generates the MET data in the requested format. The request is automatically sent to the MMS–P where the system generates MET data based on the user's request. The MET data generated by the system is validated and sent to the requester by the operator. If the MMS–P is equipped with Protocol 220A, the user requests MET using a free text message containing the required information.

MMS Mission Requirements

1-35. A limiting factor in determining mission assignments is the time required for a sounding balloon to reach a required altitude. When in position, a MET section can produce all types of MET messages for low-level artillery fire about 30 minutes after releasing the balloon. A high-altitude mission requires about 90 minutes from the release time. When units are coordinating MET requirements, they must be careful not to request higher altitudes (more lines) than required. Requesting higher altitudes causes a delay of message delivery times due to the increased time needed to reach the higher altitudes. See appendix C for MET message request format.

MMS–P Mission Requirements

1-36. The MMS–P, with the mesoscale model initialized, produces requested MET messages without the time considerations associated with the Radiosonde Observation (RAOB). When the MMS–P is operating in a MMS-only degraded mode, the time constraints associated with flying a RAOB will exist prior to producing a MET message.

Positioning MET Sections and Area of MET Validity

1-37. The operations officer consults with the MET station leader to analyze the terrain and its effect on the area of meteorology validity (AMV). The following is a planning guide based on the meteorological datum plane (MDP). See figure 1-1 for the AMV for the MMS.

TYPE TERRAIN	AREA OF VALIDITY
LEVEL	20-KM RADIUS
MOUNTAINOUS	10-KM RADIUS
COSTAL	15 KM RADIUS

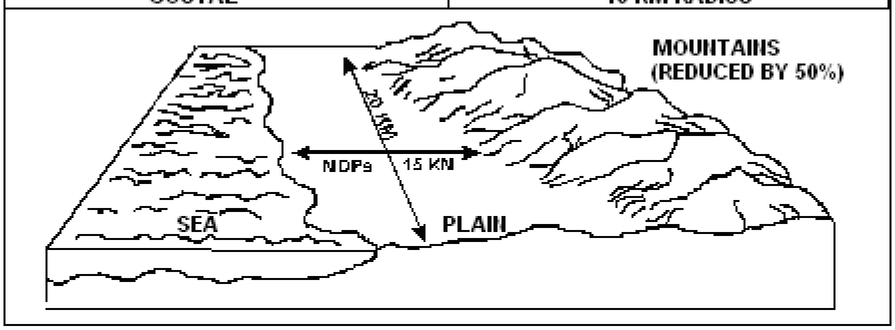

Figure 1-1. MMS MET message area of validity

1-38. The area of validity for the MMS–P is 60 kilometers. This extended AMV gives planners additional flexibility in providing MET coverage. The MMS–P uses terrain data when calculating MET data negating the effects of terrain on AMV. If the MMS–P is operating in degraded mode (valid NOGAPS data is not available), the AMV for the MMS–P is 30 kilometers. See figure 1-2 for the AMV for the MMS–P.

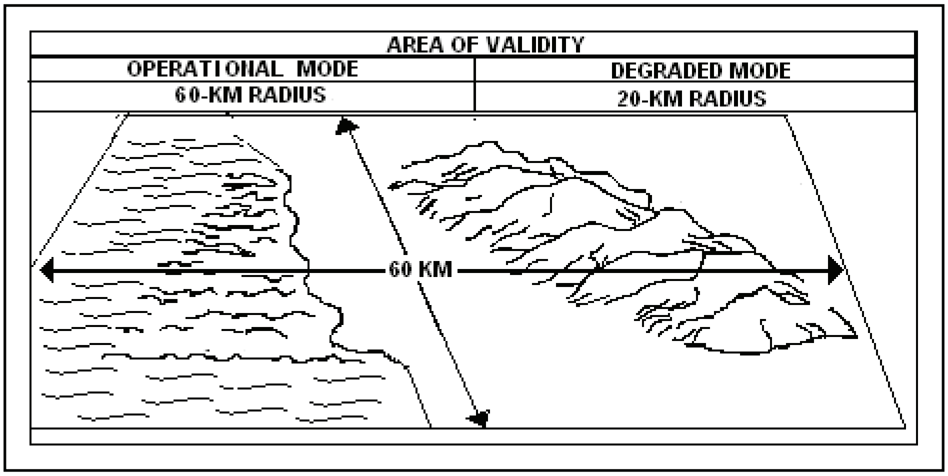

Figure 1-2 MMS–P MET message area of validity

1-39. The MMS–P generates MET data based on the midpoint between the requesting unit's location and the target location. This capability coupled with the 60-kilometer AMV provides planners with increased flexibility when positioning the MMS–P.

PROFILER CHARACTERIZATION

1-40. Characterization of the Profiler can be looked at as an evaluation to determine its strengths and weaknesses. There have been three characterizations of the Profiler to determine how well the system could perform out to 500 KM from its' position without the radiosonde. The characterization results indicate the radiosonde had little effect on accuracy of the MET DATA produced by the Profiler when current NOGAPS is used by the system. The overall accuracy of the system was similar to that seen during the Developmental Test.

1-41. Based on the characterization results, Profiler without a balloon and radiosonde should be considered a viable solution for accurate MET data when radiosondes are scarce or not available.

PREVAILING WINDS

1-42. Prevailing winds has a greater effect on positioning mms equipped sections than MMS-P equipped sections. The manner in which met data is produced and the increased area of validity for the mms-p removes much of the effect of prevailing winds on the positioning of the MMS-P.

1-43. MMS equipped sections are significantly affected by prevailing winds due to the need to produce data from radiosonde observations.

MMS Equipped Sections

1-44. The prevailing winds and their effects on the flight path of the balloon are important factors in positioning the MMS equipped MET section. The soundings made by the MET section only begin at the location where the instrument is released. The remainder of the data is acquired along the balloon path as it rises. The ideal MET section location allows for the balloon to travel to the horizontal and vertical location corresponding to the maximum ordinate of the projectile. Using knowledge of the prevailing winds in the area, the MET station leader advises the operations officer on the sites that will provide the best MET coverage of the battlefield. Information on prevailing winds in general may be obtained from the climatological data provided in the operation order (OPORD). This data can also be obtained from the supporting SWO.

1-45. If the prevailing wind pattern is such that the contemplated balloon path is beyond the forward line of own troops (FLOT), the section may be employed farther from the FLOT. (See figure 1-3, [A]).

1-46. If the prevailing wind pattern is from a flank, (see figure 1-3, [B]), the MET section is employed so that the sounding balloon will measure the atmosphere in the zones where most of the weapon trajectories will pass.

MMS–P Equipped Sections

1-47. Wind is not a critical consideration when positioning the MMS–P. The MMS–P determines MET data based on the midpoint between the gun location and the target location. The MMS–P also provides a target area Met message.

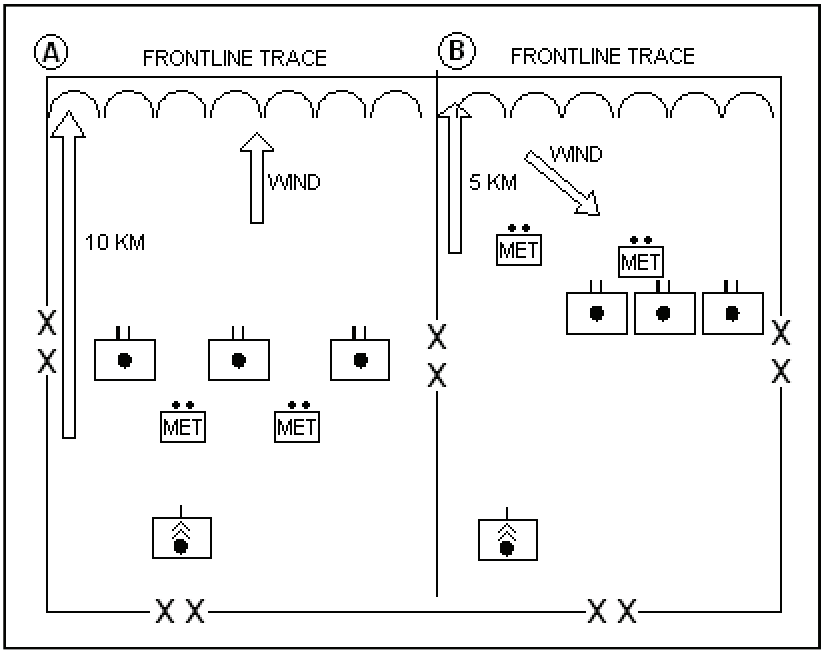

Figure 1-3. Examples of positioning for wind

TRANSITION PERIODS

1-48. The validity of a MET message decreases over time. There are no specific rules for determining how long a MET message is usable because that determination depends on the atmospheric conditions. The general guidance to help the operations officer prepare flight schedules for soundings is discussed below. (See figure 1-4.)

1-49. During and just after sunrise, temperature changes occur as the atmosphere becomes heated. Temperatures are more stable throughout the afternoon. Therefore, soundings are performed more often (every 2 hours) in the morning and less often (every 4 hours) in the afternoon.

1-50. As sunset approaches, the air cools rapidly. During this time, changing temperatures are monitored closely. Flight schedules may need adjusting (to one every 2 hours) as the atmosphere cools. The cooling of the air stabilizes about 2 hours after sunset.

1-51. During night and early morning hours, the atmosphere reaches maximum cooling and becomes stabilized. During this time, soundings could be taken at intervals that exceed 2 hours, and 4-hour intervals between flights are common.

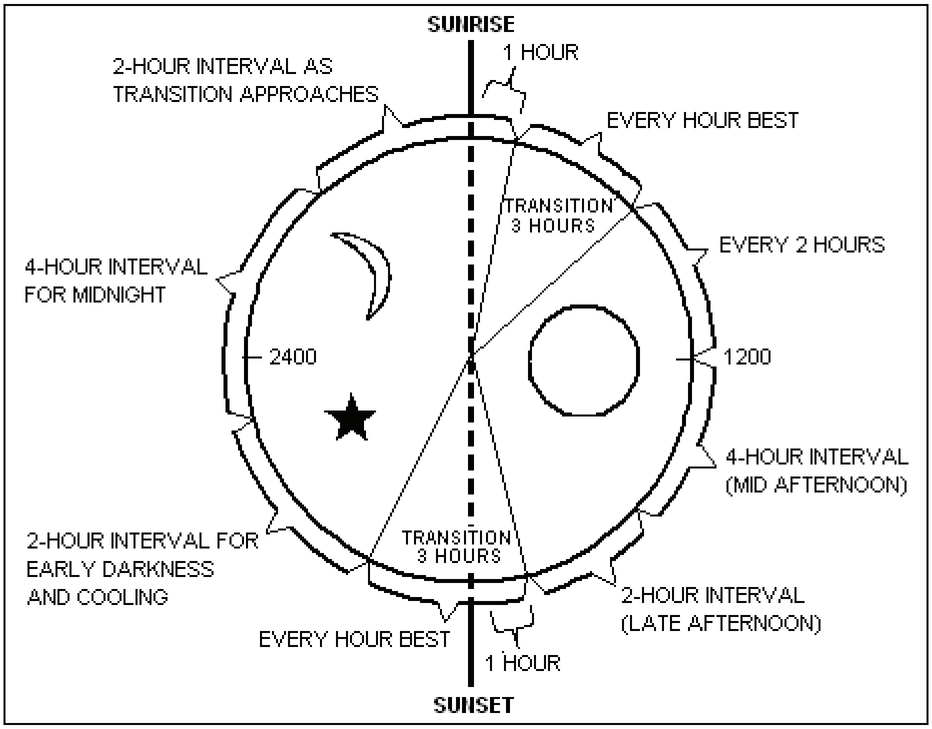

Figure 1-4. MET day

NOTE: The MMS–P provides more flexibility during transition periods as a result of the systems capability to generate a new MET message every 30 minutes.

FRONTAL PASSAGES

1-52. The passage of a weather front is associated with changes in current conditions. Because of this, the MET section should conduct a sounding immediately following the passage of a front. As a result, MET schedules may be adjusted. The modeling capability of the MMS–P predicts the effects of frontal activity when processing data for MET messages. The effects of frontal passages are similar for the MMS and the MMS–P when the MMS–P is operating in a degraded mode.

COMMANDER'S INTENT

1-53. Regardless of the above, the tactical situation and the immediate needs of the field artillery commander are the main considerations that determine positioning and scheduling.

MET MESSAGE SELECTION

1-54. Met message selection is selecting the best met message from multiple sections for a particular mission. When multiple met sections are producing met in a single area of operations, the most appropriate (best) met data for the mission should be provided to firing units.

1-55. there is selection criteria for mms equipped sections that should be applied to provide the best met data. The message selection criteria is not as important for MMS-P equipped sections because the MMS-P produces MET data on demand.

MMS EQUIPPED SECTION

1-56. When MET messages from several sections are available, the selection criteria below should be used to determine which MET section should provide support to a given unit. The following criteria are established and proven by controlled live-fire testing. Variations of this priority may exist. The MET station leader can provide guidance in this area and advise when the use of one MET message is better than the use of another.

- The best data are current and provided by a MET section and balloon flight path within 20 kilometers of the midpoint of the projectile trajectory.
- The second best data are less than 2 hours old and from the nearest section within 80 kilometers from the trajectory midpoint (upwind is best).
- The third best data are between 2 to 4 hours old and from a section within 20 kilometers of the trajectory midpoint.
- The fourth best data are from a 4-hour old message, if provided by a section and balloon flight path within 20 kilometers of the projectile trajectory midpoint.

MMS–P EQUIPPED SECTION

1-57. The MMS–P generates MET data upon demand based on the gun location and the target location. Units request MET messages as required.

1-58. The MET data provided by the MMS–P is provided for a location at the center-point of the gun location and target location.

1-59. MET messages provided by the MMS–P, when operating in MMS degraded mode, are NATO formatted Met messages.

EMPLOYMENT PLANNING

NOTE: Army MET sections may use hydrogen gas for inflation. This gas is extremely volatile. Leaders at all levels must consider safety and environmental protection requirements during the planning process. For MMS–P equipped sections, hydrogen gas is only available in commercial bottles. See appendix H for additional information

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1-60. When planning the employment of artillery assets in the division area, the commander and staff use the staff planning process outlined in FM 5-0. The planning of MET operations in support of the commander's intent and concept of the operation should be included in this process. This planning is done by the operations officer and the MET station leader.

MISSION, ENEMY, TERRAIN, TROOPS, TIME AVAILABLE, AND CIVIL CONSIDERATIONS

1-61. Selection of modes of operation and general position areas for MET sections is influenced by a thorough analysis of the mission, enemy, terrain, troops, time available, and civilians (METT-TC).

MISSION

1-62. The type of mission assigned to a MET section greatly influences its positioning. The main consideration in positioning a MET section when it is providing MET data in support of artillery operations is to locate the section where it provides optimum coverage for the most firing units. Other (high-altitude) MET support requirements, such as AFW support and FOMET message production to support smoke or Chemical Biological Radiological and Nuclear (CBRN) operations, also influence the positioning of MET assets.

1-63. The MMS–P has the capability of generating target area meteorology (TAM) data. This data is used by planners when selecting the type of munitions to use against a target. Meteorological conditions may limit the effectiveness of certain types of munitions. TAM data allows planners to select the most effective munitions to neutralize the target.

ENEMY

1-64. The enemy situation, capabilities, and probable courses of action developed by the S2 during intelligence preparation of the battlefield (IPB) greatly determine the employment of MET assets. Security of the sections must be weighed against mission requirements.

TERRAIN

1-65. Terrain acts upon the area of validity of MET messages for the MMS system. Generally, the AMV decreases as the distance from the user increases. Mountainous terrain and large bodies of water also affect validity areas. The MMS–P system uses terrain data. Using this data, the weather model accounts for the affects of terrain. Terrain does not have an effect on the AMV for the MMS–P system.

TROOPS

1-66. The size of the area to be covered and the disposition of artillery units greatly govern the way the MMS MET section is employed. The section must be positioned where it can provide support for the largest number of firing units. MET sections also should be located where logistical support can be provided. Finally, MET sections must be within effective and practical communications range of the units they support. Positioning of the MMS–P section is less dependent on the location of the firing units owing to the 60-kilometer AMV.

TIME AVAILABLE

1-67. The operations officer and the MET station leader must consider how much time is required for reconnaissance, movement, and occupation of initial and subsequent section positions. Upon arrival at a location, the MET section requires about 20 minutes to emplace. Displacement time is approximately 15 minutes. Travel time is figured at the standard rate for the local conditions for wheeled vehicles.

CIVIL CONSIDERTIONS

1-68. Civil considerations relate to the civilian population, culture, organizations, and leaders within the AO. The operations officer and the MET station leader must consider how all MET operations may directly or indirectly affect the civilian population. This will include civilian activities and attitudes in the profiler's employment area

EMPLOYMENT IN SUPPORT OF INTELLIGENCE PREPARATION OF THE BATTLEFIELD

1-69. The weather analysis has a great impact on both friendly and enemy capabilities. Analyzing the weather data in detail to determine their effect on friendly and enemy capabilities to move, shoot, and communicate is essential to the IPB process. Because weather also has a tremendous effect on terrain, MET section input to terrain and weather analysis is a crucial part of the METT-TC methodology. MET sections have the capability of providing limited surface observation data that includes terrain, visibility, water surface, and surface atmospheric data.

1-70. The SWO is responsible for providing weather information for the AO and the area of interest (AI) as part of the weather analysis process. The artillery MET section provides critical surface and upper atmospheric weather data in support of weather analysis to the SWO.

1-71. The S-3 considers high-altitude requirements, WMO, and FOMET, as well as artillery requirements when positioning and scheduling a MET section. Direct coordination among the intelligence officer, SWO, and operations officer is required to determine requirements in support of the weather analysis process.

TACTICAL MOVEMENT

1-72. A MET section may deploy anywhere on the battlefield to achieve its mission of providing MET support. Movement may be toward or away from the frontline trace or laterally, depending on weather conditions (mainly prevailing wind direction) and the tactical situation. The requirement to provide continuous coverage is an important consideration in determining movement schedules. A number of widely separated section positions must be planned. Additionally, an analysis of areas of MET validity is necessary. Primary, alternate, and possibly even third-choice position areas are selected. The operations officer coordinates with the maneuver element to receive approval for occupation of positions and to obtain route clearances. MET sections then must conduct reconnaissance and select the most suitable sites within the areas.

1-73. The increased AMV and capability of the MMS–P to generate MET data based on the midpoint between the firing unit location and target provides greater flexibility to planners when deploying MMS–P equipped MET sections. The ability of the MMS–P to generate MET data is not affected by prevailing winds and terrain and is not a limiting factor when positioning the system.

MET SUPPORT IN THE OFFENSE

1-74. Each MET section must be prepared to increase the frequency of message production. For MMS equipped MET sections, planning in support of the operation must ensure adequate supplies are available to meet increased demand. Prior planning allows the MMS equipped MET section to increase frequency of flights and transmissions of MET data. The MMS–P equipped MET section, using the weather model, is not required to increase balloon flights to respond to increased demands for MET data.

MOVEMENT TECHNIQUE

1-75. The basic movement technique is leapfrogging. When the battle is fluid and the rate of movement is rapid, MET sections may employ the leapfrogging technique to keep pace. In this technique, one MET section, having established a position, remains in operation while a second displaces to a new location. When the second section becomes operational, the first section is displaced by moving past the newly occupied position of the second section. This procedure is repeated as often as necessary. (See figure1-5.)

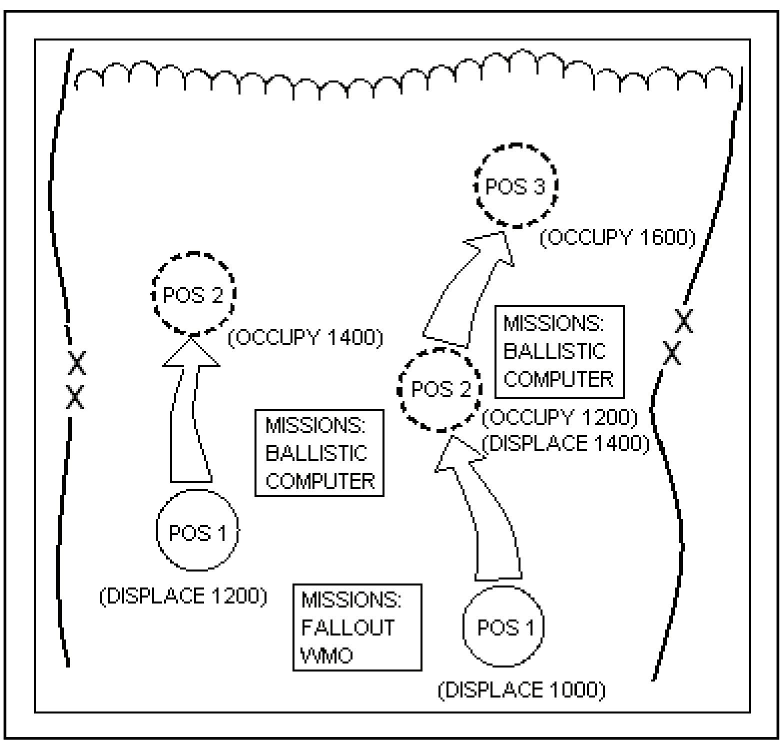

Figure 1-5. Leapfrog movement technique

1-76. The leapfrogging technique is still a valid movement technique for the MMS–P equipped section. The increased AMV of the MMS–P system requires less movement to keep up with the flow of the battlefield. Movement planners will have to monitor the AMV of the MMS–P systems and reposition systems as necessary to maintain continuous coverage.

MET SUPPORT IN THE DEFENSE

1-77. Accurate, concentrated artillery fire is a key element in any defense. MET messages improve the effectiveness of the artillery response by increasing the accuracy. Control of the MET section in the defense is normally centralized once the main battle commences. Movements are limited to ensure continuous support.

COMMUNICATIONS

1-78. Disseminating met data to the firing units is an important part of the mission of the met section. A specific plan for disseminating met data is necessary.

1-79. The communications plan will provide critical information relating to methods of communication, coordination procedures, and operational procedures.

COMMUNICATIONS PLANS

1-80. MET data is perishable. The timely dissemination of messages is essential. Digital communications is the primary means of MET message distribution. MET messages may be disseminated in a centralized or decentralized manner, depending on the tactical situation. Centralized dissemination normally is used when the tactical situation is stable. Decentralized dissemination may be used when the controlling headquarters is continually relocating or its capability to relay data was terminated. The communications plans must support the deployment of MET assets within the AO. The operations officer establishes communications priorities and means of dissemination and incorporates them into the MET plan. Unit plans and procedures documents should address the following:

- Communications means.
- Assignment of radiosonde frequencies.
- Procedures for coordinating MET support from adjacent units.
- Network identification information.
- Procedures for passing AFW and FOMET messages to the staff weather officer.

METHODS OF COMMUNICATIONS

1-81. The MMS equipped MET section normally transmits all messages (Push method) to its controlling headquarters' fire direction center (FDC). The FDC then passes the MET messages electronically to the using elements. The FDC must pass the AFW and FOMET messages to the controlling fire support element (FSE) for dissemination to the SWO and chemical officers. This data is used for forecasting, downwind predictions, and close air support.

1-82. The MMS–P equipped MET section (220C Protocol) transmits MET messages upon request (pull method) directly to the using unit with the controlling headquarters acting as a relay. (MMS–P sections using 220A Protocols uses the push method of disseminating MET.)

RADIO COMMUNICATIONS

1-83. Each MET section is authorized the single-channel ground and airborne radio system (SINCGARS). The section operates in two tactical radio nets as directed by the controlling headquarters. Normally, these are the FA command net for C2 and a FA operations/fire net for MET message dissemination. When digital radio communication is not possible, the MET section may disseminate messages by frequency modulation voice.

WIRE

1-84. Whenever practical, wire lines are installed for voice and digital communications with the supported units. Radios serve as a backup means of dissemination.

MESSENGERS

1-85. Messengers may be used when communications systems are not functioning or if the supported unit is nearby. However, extensive travel time for delivery may exhaust the validity time.

MET PLAN DEVELOPMENT

1-86. The MET plan contains the information needed to understand how MET assets will be used during a specific operation. The MET plan conforms to the standard five-paragraph OPORD format. The heading of the plan includes the security classification, the title line, references, and the time zone used throughout. The classification is shown at the top and bottom of each page of the document. Major paragraphs of the plan are the same as the five-paragraph OPORD format. See appendix D for an example of a MET plan.

STABILITY OPERATIONS

1-87. Field artillery MET sections can provide upper air data, wind speed and direction, temperature, and pressure in support of these operations. Military and civilian authorities use this information to maintain current weather maps and to assist them in predicting future conditions. The MET sections are also equipped with SINCGARS, which could support the operation as the commander deemed necessary.

SAFETY IN STABILITY OPERATIONS

1-88. During these operations helium should be used for inflating balloons. If the section must use hydrogen gas, extreme caution must be taken especially in built-up areas.

NONLINEAR BATTLEFIELD

1-89. Operating in an area where the enemy operates in small groups and there are no defined enemy concentrations creates a nonlinear battlefield. (see figure 1-6) In a nonlinear battlefield, forward operating bases (FOBs) are created. Each FOB has a responsibility for a specified area based on the capabilities of the assigned units.

1-90. MET operations in a FOB are outlined in the MET plan portion of the operations order. While operating from a FOB, it may be practical for MMS–P equipped sections to push MET data to units. This is not the normal procedures for MMS–P, but can be accomplished because the gun locations are known to the section. Using the message generation function, the section can enter the gun location into both the gun location fields and the target location fields. The system will generate MET data for the gun location. The MET message is then transmitted based on an established schedule.

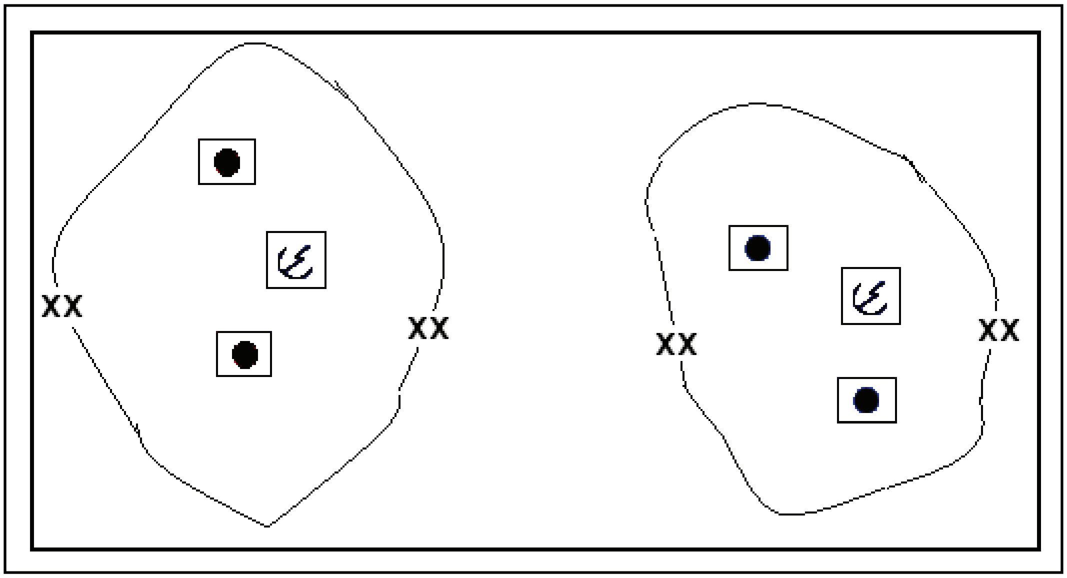

Figure 1-6. Nonlinear battlefield

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Chapter 2

Additional Sources of Meteorological Information

There are additional sources of meteorological (MET) information when MET data is not available from organic assets. This chapter discusses these sources.

ALLIED NATIONS

2-1. Because there will be occasions when the artillery of one nation may wish to use the MET data produced by the MET services of another, standard forms of MET message structure and standards have been agreed upon. Through North Atlantic Treaty Organization (NATO) standardization agreements (STANAGs) the U.S., along with several of its allies, has adopted a standard database from which all MET information is derived. This means that atmospheric data can be freely exchanged among member countries with the assurance that the same atmospheric standards were used. Member countries produce ballistic data that is applicable to U.S. Army weapons systems. When exchanging data between member countries, commanders and operations officers must ensure that the validity criteria explained in chapter 1 are applied. MET station leaders can advise commanders and operations officers on these matters. The following is a list of countries that have adopted these standards:

- Belgium
- Bulgaria
- Canada
- Czech Republic
- Denmark
- Estonia
- France
- Germany
- Greece
- Hungary
- Iceland
- Italy
- Latvia
- Lithuania
- Luxembourg
- Netherlands
- Norway
- Poland
- Portugal
- Romania
- Slovakia
- Slovenia
- Spain
- Turkey
- United Kingdom
- United States

U.S. AIR FORCE

2-2. The United States Air Force (USAF) currently has fixed and deployable weather teams deployed throughout the world capable of performing upper air soundings. The information they gather cannot be used for ballistic solutions to the gunnery problem; however, this information can be used by chemical sections for downwind predictions when fallout messages from organic MET sections are not available. This additional source of MET does not relieve U.S. Army MET sections of the responsibility; however, this information can be provided when the U.S. Army cannot produce the data. When available, these teams will normally be employed at corps or higher; however, they could be positioned in areas forward of the division main. Other USAF assets include special observation weather teams (SOWTs) attached to Special Forces Groups. When approved by the group commander, SOWT members may assist operational detachments in gathering critical weather observations in denied areas to support deep strike operations. This SOWT-derived information is obtained through coordination with the Special Operations Command and Control Element normally attached to corps and higher levels. The weather data gathered through SOWTs in cross-FLOT/fire support coordination line (FSCL) areas are similar in scope to that derived by forward area limited observation program operations conducted in corps/division operational areas. Although this information is unsuitable for MET ballistic gunnery solutions, it may prove invaluable for deep attack (missile/rocket) targeting solutions for chemical downwind predictive measurements. Fire support coordinators (FSCOORDs)/Fires Cell (FC) should consider SOWT capabilities when conducting mission analysis for deep strike operations.

U.S. NAVY

2-3. The U.S. Navy has mobile environmental teams capable of sounding the atmosphere and producing ballistic data. The message produced is in STANAG format. These teams are deployed on a mission basis. The teams are composed of one to five members. They typically support their own units, but also support joint operations and could be requested to support U.S. Army artillery operations. Requests for support must be coordinated well in advance of the time of need.

2-4. The U.S. Navy produces the worldwide forecast model data using the Navy Operational Global Atmospheric Prediction System (NOGAPS). The data is not direct MET observation data, but resultant forecast data created after analysis. The NOGAPS data is broadcast via satellite twice daily (every 12 hours) by the Air Force Weather Agency (AFWA). Each transmission provides 72 hours of valid data.

MARINE CORPS

2-5. The Marine Corps fields four MET teams per artillery regiment. Each team is equipped with the AN/TMQ-49 Meteorological Station Group (MSG), which includes the AN/TMQ-41 meteorological measuring set (MMS), as well as visual meteorological measuring equipment (PI-BAL). These teams are capable of producing meteorological data in useable formats for artillery, mortar, target acquisition assets, nuclear biological and chemical downwind data and data that can be incorporated into meteorological models.

NUMERICAL WEATHER PREDICTION

2-6. Current operational concepts, which address the full spectrum of warfare, require that additional capabilities are available to support indirect fires. Marine Air-Ground Task Force (MAGTF) concepts such as Distributed Operations, Over the Horizon operations, and Ship to Objective Maneuver (STOM) operations must rely on non-hardware based solutions such as numerical weather prediction. Groups such as the Joint Air Force and Army Weather Information Network (JAAWIN) and the Fleet Numerical Meteorological Oceanographic Center (FNMOC) have implemented web-based interfaces to access modeled meteorological data forming the foundation of numeric weather prediction in support of indirect fires. Numeric weather prediction has been characterized with excellent results out to 500 kilometers, but has not yet been certified by the Army. Any backup capabilities should only be used when MMS or MMS-P systems are not available.

2-7. Numerical Weather Prediction takes into account historical, topographical, climatological weather data, as well as vertical and horizontal resolutions, to form a mesoscale model of the atmosphere. Local Upper Air Observations ((Radiosonde Observations) in the form of World Meteorological Organization (WMO) messages can be ingested into this model to refine the numerical data and decrease model bias. The resolution chosen for a certain region will determine how many MET points are available to pull numerical data from a particular area. There are currently three different resolutions used: 45 kilometers, 15 kilometers, and 5 kilometers. (see figures 2-1, 2-2, and 2-3)

2-8. The 45-kilometer resolution is the least preferred resolution. When this resolution is chosen for an area of operations, the using unit could be a maximum of 22.5 kilometers away from the closest MET point. The 45-kilometer resolution can produce a numerical forecast every 3 hours for up to 72 hours in advance.

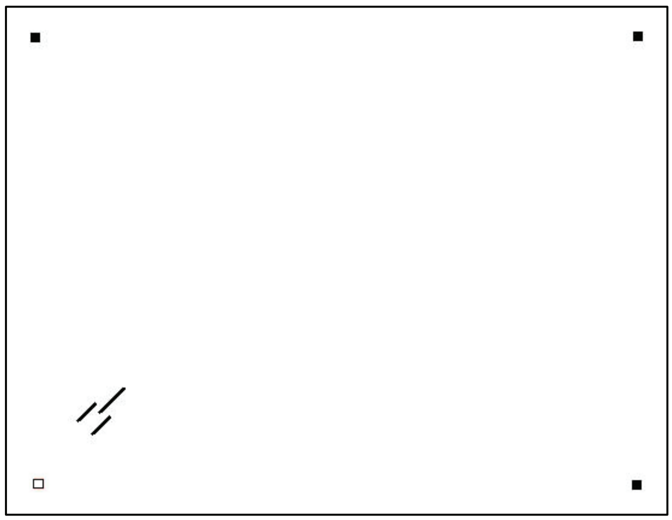

Figure 2-1. 45 kilometers

NOTE**:** Using 45-kilometer resolution, your MET point can be up to 22.5 kilometers away from the requesting unit.

2-9. The 15-kilometer resolution is available in most regions. When using the 15 kilometers for an area, the using unit could be a maximum of 7.5 kilometers away from the closest MET point. The numerical forecast from the 15-kilometer resolution can be produced every 3 hours for up to 48 hours in advance. Non-classified Internet Protocol Router Network (NIPRNET) is required to obtain 45 kilometers and 15 kilometers data.

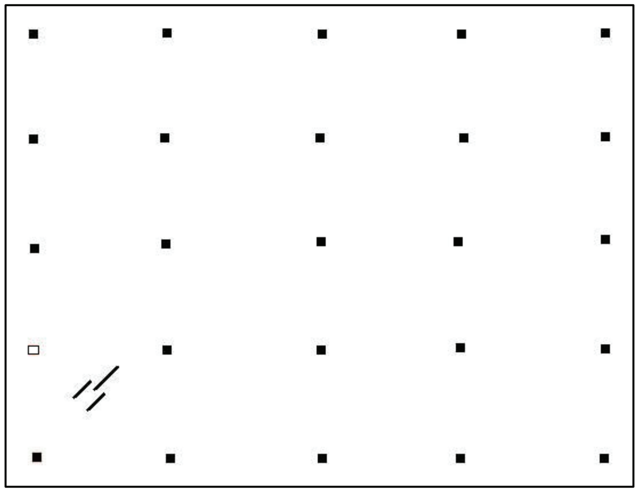

Figure 2-2. 15 kilometers

NOTE: Using 15-kilimeter resolution, your MET location can be up to 7.5 kilometers away from the requesting unit.

2-10. The 5-kilimeter resolution is the preferred resolution when available. However, it is currently only available in contingency areas and other locations for brief periods of time during testing operations or upon special requests. Five-kilometer resolutions are only available on the Secret Internet Protocol Router Network (SIPRNET). When the 5-kilometer resolution is selected for an area, the using unit could be a maximum of 2.5 kilometers away from the closest MET point. The 5-kilometer resolution can produce a numerical forecast every hour on the hour for up to 24 hours in advance. Currently, 5 kilometers is the best resolution available. A 1.66-kilometer resolution will soon be available via the SIPRNET as well. Data obtained from Numerical Weather Prediction is usually manually entered into fire direction programs. Remember that when operating in contingency areas, the best resolution possible will always be available.

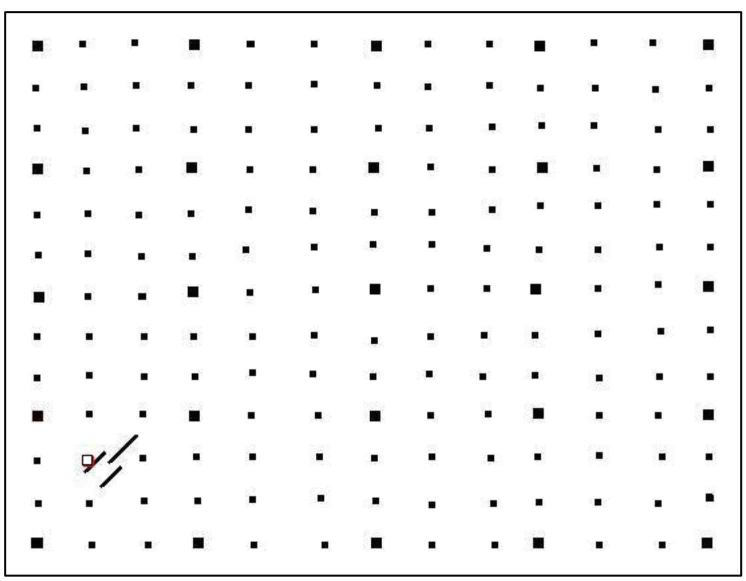

Figure 2-3. 5 kilometers

NOTE: Using 5-kilometer resolution, your MET location can be up to 2.5 kilometers away from the requesting unit.

2-11. Commanders should consider this capability as a viable option for Meteorological support, if their MMS or MMS–Profiler are not operational and should always; whenever possible, consult Meteorological personnel for the best available option of Meteorological support for a specific area of operations. For more information on numerical weather prediction, contact the Meteorology Instruction School, Fort Sill, Oklahoma.

NOTE: If the altitude on the Computer Meteorological Message (METCM) is different from the firing battery altitude, the Advanced Field Artillery Tactical Data System (AFATDS) will adjust the pressure and temperature to the altitude of the firing battery, however the winds will not be changed.

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Chapter 3

Weather and Its Effects

Weather greatly impacts military operations. Weather data is part of the intelligence information required to plan and conduct combat operations. This chapter discusses terms and the impact weather has on the field artillery operations.

SECTION I ELEMENTARY METEOROLOGY

3-1. Meteorology is the science dealing with the earth's atmosphere and its phenomena, including weather and climate. Besides the physics, chemistry, and dynamics of the atmosphere, MET includes many of the direct effects of the atmosphere on the earth's surface, the oceans, and life in general. MET effects such as wind, temperature, air density, and other phenomena influence military operations.

ATMOSPHERE

3-2. The atmosphere (figure 3-1) is the envelope of air that surrounds the earth in several distinct layers. It is the lower portion of the atmosphere that concerns artillery meteorologists.

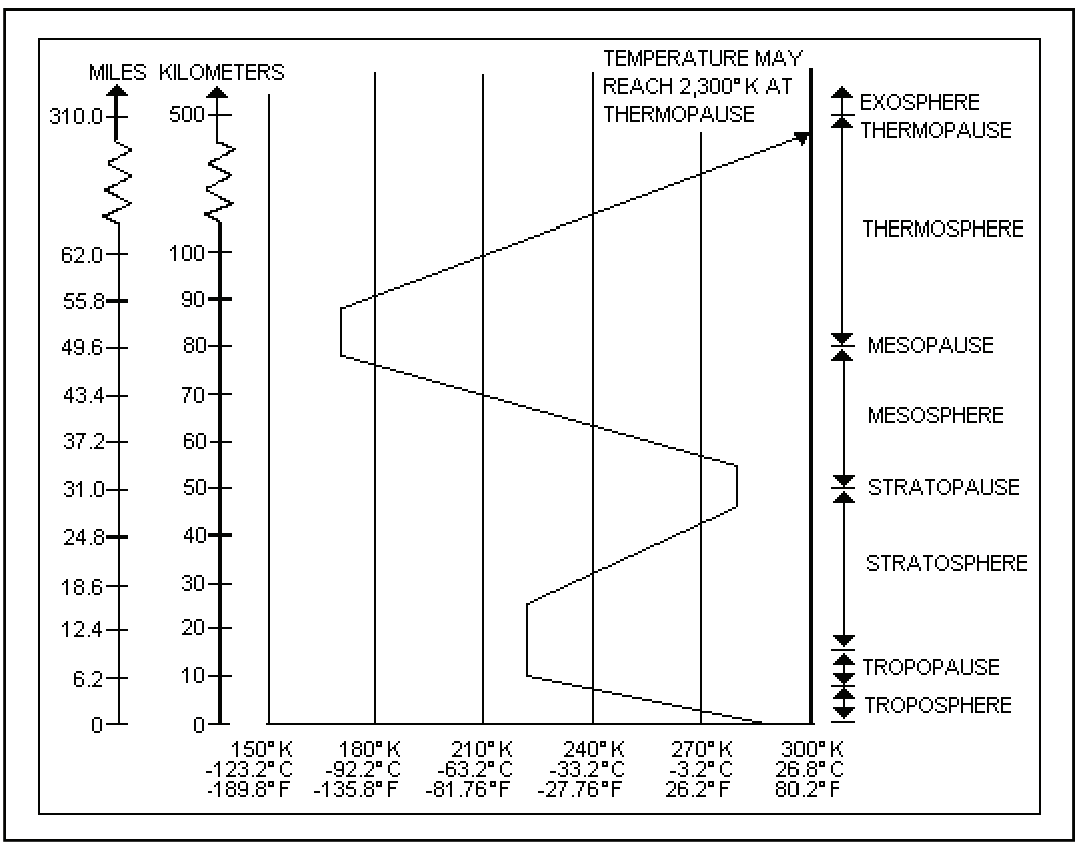


Figure 3-1. Earth's atmosphere

TROPOSPHERE

3-3. About three-quarters of the air in the atmosphere is compressed into the lowest layer, which is called the troposphere. In this layer, the change of temperature in relation to height is relatively large. It is the region where clouds form and air masses continuously mix. Within the troposphere, air consists of 78 percent nitrogen; 21 percent oxygen; and 1 percent argon, carbon dioxide, and minute amounts of other gases. Air also contains variable amounts of water vapor and a mixture of minute impurities, such as particles of dust and salt. The thickness of the troposphere varies with the season of the year. However, it is generally 8 kilometers thick at the poles and 18 kilometers thick at the equator.

TROPOPAUSE

3-4. The top of the troposphere is known as the tropopause. It is a transition zone between the troposphere and the stratosphere. It acts as a lid that tends to hold in the lower atmosphere. This lid contains occasional breaks and overlaps that provide paths for high-velocity winds called jet streams. The jet streams cause constant turbulence and mixing of the lower atmosphere. It is this mixing of air masses that causes our weather. The weather below the tropopause has the greatest effect on artillery operations.

STRATOSPHERE

3-5. The layer immediately above the tropopause is the stratosphere. It has a stable temperature in the lower half of the layer and an almost complete lack of clouds. In the upper half of the stratosphere, at about 25 kilometers, the temperature begins to increase with height up to about 50 kilometers at the stratopause. In the stratopause, the temperature is about the same as that at the earth's surface. This warm region is caused by the presence of ozone, which absorbs part of the ultraviolet radiation from the sun. Without the ozone layer, life on earth would be difficult, if not impossible. Further layers are not discussed because artillery data is gathered only to an altitude of 30,000 meters.

HEAT

3-6. Determining the level of heat and how heat is transferred is significant when considering weather effects.

3-7. Understanding the correlation of the different temperature scales enhances accuracy when utilizing or converting between the different temperature scales.

CONVECTION

3-8. Convection is the transfer of heat by the physical movement of heated substances, such as liquid or gas. In MET, convection denotes vertical air motion.

CONDUCTION

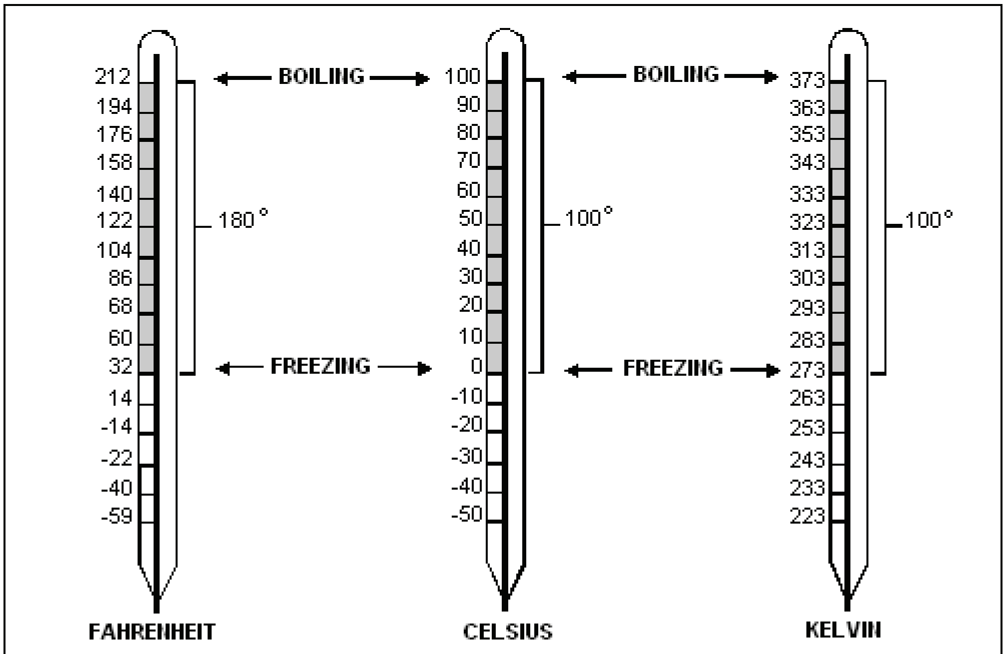
3-9. Conduction is the transfer of heat between two parts of a stationary system caused by a temperature difference between the parts. Conduction warms the layer of air in contact with the earth's surface during daylight, which causes it to expand and become less dense. The less dense air rises and is replaced by cooler air, which is warmed in turn, thus creating a convective cell.

TURBULENCE

3-10. On a small scale, this vertical motion is called turbulence and is quite irregular because of unequal heating and cooling over various types of terrain. On a large scale, the vertical motion in conjunction with the horizontal motion carries excess heat from equatorial regions to the cooler areas at higher latitudes. This mass transfer of heat by means of large-scale movement of the atmosphere is essential in the overall heat balance of the world.

TEMPERATURE SCALES

3-11. There are three different scales used to express temperature. The most familiar is the Fahrenheit (F) scale. On the Fahrenheit scale, the freezing point of water is 32 degrees. Another scale is the Celsius (C) scale on which the freezing point of water is O degrees. The third scale is the Kelvin (K) scale on which the freezing point of water is 273.2 degrees. The Kelvin scale has no negative values and is often used for temperature computations. A direct relation exits between these scales (figure 3-2).



NOTE:
Degrees Celsius = (degrees Fahrenheit - 32) X 5 / 9.
Degrees Fahrenheit = (degrees Celsius X 9 / 5) + 32.
Degrees Kelvin = degrees Celsius + 273.2.

Figure 3-2. Temperature scales

MOISTURE

3-12. The various forms of moisture are more involved with weather than any other weather aspects. Almost no important weather takes place without it. Without some form of moisture, there would be no clouds or precipitation.

3-13. The discussion of water vapor and relative humidity is essential to understanding the development process of many significant aspects of weather.

WATER VAPOR

3-14. The oceans provide the major source of moisture for the air. Every day the energy from the sun transforms millions of tons of water into water vapor. Air currents then distribute the water vapor within the atmosphere. Though water vapor represents only a small percentage of the atmospheric gases, it is by far the most important in relation to weather processes. There is an upper limit to the amount of water vapor that can be contained in any given volume of air at a specific temperature. Warm air can hold more water than cool air.

RELATIVE HUMIDITY

3-15. The moisture content of air can be expressed in several different terms. However, the most common term is relative humidity. Relative humidity is the ratio (percentage) of the actual amount of water vapor present in the air to the maximum amount of water vapor the air could hold at the existing pressure and temperature. As the air cools and its ability to hold water vapor decreases, the percentage of relative humidity increases until saturation (100 percent) occurs. At this saturation point, water vapor begins to condense into water droplets around particles of salt or dust in the atmosphere. As droplets grow bigger and heavier, they eventually fall toward the earth as rain or snow, depending on the temperature of the atmospheric levels through which they pass.

ATMOSPHERIC PRESSURE

DEFINITION

3-16. Since the atmosphere is a mixture of gases, it is quite natural to think of air as being very light in weight. However, the total weight of the entire atmosphere is tremendous. If the entire weight of the atmosphere were replaced by an equal weight of water, the water would cover the earth's entire surface to a depth of 10 meters. The weight of the air pressing down upon itself produces atmospheric pressure. Pressure is continuously changing, mainly because of changes in air density brought about by variations in temperature and moisture content. At higher altitudes in the air column, the air pressure is less because there is less air above the higher altitude. More specifically, atmospheric pressure is the weight of a column of air that extends upward to the top of the atmosphere. (See figure 3-3.)

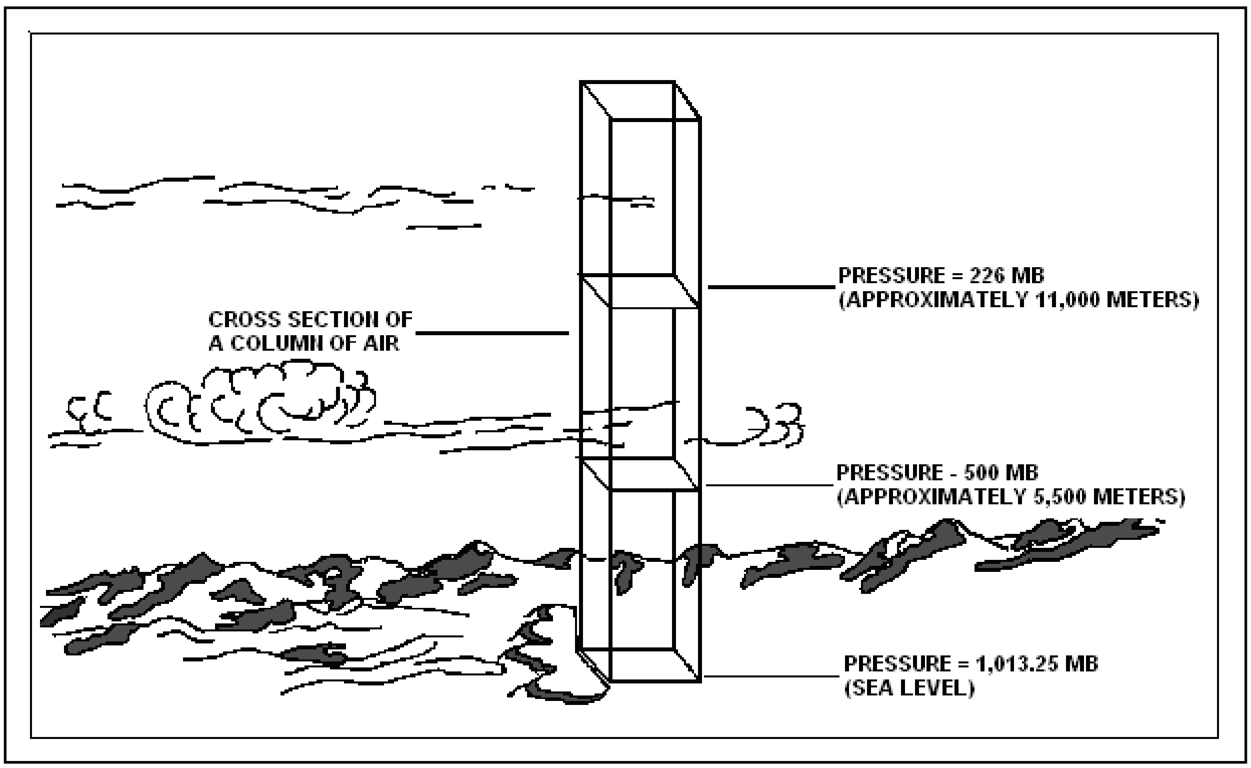


Figure 3-3. Atmospheric pressure

PRESSURE MEASUREMENT

3-17. Air pressure is measured with barometers and reported in millibars (mb). One type of barometer is mercurial, which is very accurate but not portable. A mercurial barometer measures air pressure in inches of mercury, which are then converted to millibars. Another type of barometer is the aneroid, which measures air pressure in millibars and is portable. A third type of barometer is a digital device that measures and displays pressure. Artillery MET sections use the aneroid and digital barometers.

CLOUDS

3-18. Most weather phenomena are associated either directly or indirectly with clouds. Therefore, observer personnel must understand the significance of clouds. This enables them to make pertinent and timely decisions on the effect of weather on operations.

CLOUD COMPOSITION

3-19. Clouds are composed of millions of water droplets and/or ice crystals suspended in the atmosphere.

Condensation

3-20. Condensation is the process whereby water vapor is changed into small droplets of water. For condensation to occur there must be something present in the atmosphere upon which the water vapor can condense. Virtually billions of minute particles, which result from ordinary dust, combustion products, and sea salt crystals, exist in the atmosphere. These particles are condensation nuclei. Condensation of water vapor upon these particles forms clouds and fog. Condensation may result from a decrease in temperature, a decrease of pressure, or an increase of water vapor in the air. In the atmosphere, condensation normally occurs when warm, moist air rises and cools by expansion. Frontal activity, terrain features, and unequal heating of land and sea surfaces cause the air to be lifted.

Precipitation

3-21. Precipitation is visible moisture, either liquid or solid, that falls from a cloud to the surface of the earth. It occurs when the cloud particles become so large that the pull of gravity overcomes the buoyant force of the surrounding air in the cloud. The size of cloud droplets may be increased by collisions with other droplets or by the freezing of super-cooled water droplets on ice crystals.

Virga

3-22. Clouds do not always produce precipitation since the initial water droplets are extremely small and simply float in the atmosphere. Precipitation may fall from clouds without reaching the earth's surface because on many occasions it evaporates before reaching the surface. This phenomenon is called virga.

CLOUD CATEGORIES

3-23. Clouds are classified by their appearance and the physical processes that produce them. All clouds, by their shape, fall into two general categories, cumuliform (cumulus) and stratiform (stratus) (Seefigure3-4.)

Cumulus

3-24. Cumulus means heaped or accumulated. Cumulus clouds look that way because they are always formed by rising air currents. Cumulus clouds may produce local showers or severe thunderstorms and extremely strong vertical air currents.

Stratus

3-25. Stratus or sheets like, clouds are formed when a layer of air is cooled below its saturation point without pronounced vertical motion. The vertical thickness of stratiform-type clouds may range from several meters up to a few kilometers. Precipitation, if any, from stratiform clouds is generally continuous with only gradual changes in intensity and covers a relatively large area.

CLOUD CLASSIFICATION

3-26. Clouds may be further classified as high, middle, low, and towering. (See figure 3-4.)

Low

3-27. When the bases of clouds are lower than 2,000 meters above the surface of the earth, the clouds generally are designated as cumulus or stratus, unless they are producing precipitation. In that case, they are referred to as cumulonimbus or nimbostratus. Nimbus means rain cloud. Another common low cloud, with some of the characteristics of both cumulus and stratus clouds, is called stratocumulus.

Middle

3-28. Between 2,000 and 6,000 meters, clouds generally are identified with the prefix *alto* preceding the cloud name. Altocumulus and altostratus clouds are in this category.

High

3-29. Above 6,000 meters, clouds are composed of ice crystals and generally have a delicate appearance. These clouds are designated as cirrocumulus and cirrostratus. At still greater altitudes, a fibrous type of cloud, which appears as curly wisps and is composed of ice crystals, is designated as cirrus.

Towering

3-30. Bases of towering clouds may be as low as the typical low clouds, but their tops may extend to, or even above, the tropopause.

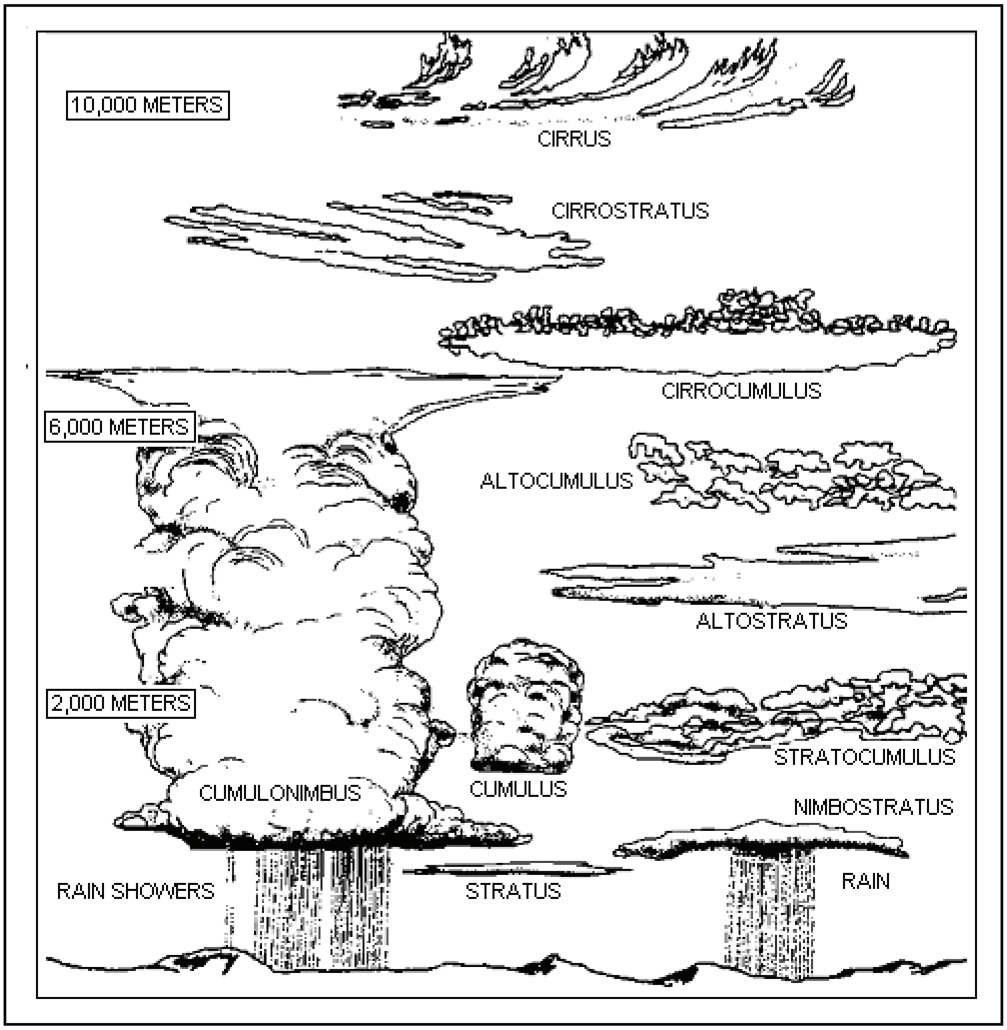


Figure 3-4. Cloud types

AIR CIRCULATION

3-31. Simple atmospheric circulation is the movement of air over the surface of the earth. Solar radiation is the energy source that heats the atmosphere and sets it into motion. The equator receives the greatest amount of solar heating, whereas the poles receive the least. This unequal heating creates temperature differences between various locations on the earth. The temperature differences produce pressure changes that cause air motion in our atmosphere.

General Circulation

3-32. General air circulation can be explained by the three-cell theory. Hot, moist air near the equator rises to high altitudes and flows toward the poles. As the air rises and travels away from the equator, it cools and dries, becoming denser. Some of the cold, dry air sinks back to the surface at about 30 degrees latitude. Some of the descending air returns to the equator, replacing the rising, less dense air. Thus, the first cell of circulation is complete. The remainder of the descending air at 30 degrees latitude travels toward the poles along the earth's surface. At about 60 degrees latitude, this cool air meets the very cold air flowing along the surface away from the poles. The cool air is forced upward until it rejoins the remaining upper air moving from the equator to the poles. Thus, the second and third cells of circulation are formed. (See figure 3-5.) Within this general pattern of circulation, several semi-permanent pressure regions exist. Low-pressure regions exist at the equator and at 60 degrees latitude. High-pressure regions exist at 30 degrees latitude and in the polar regions.

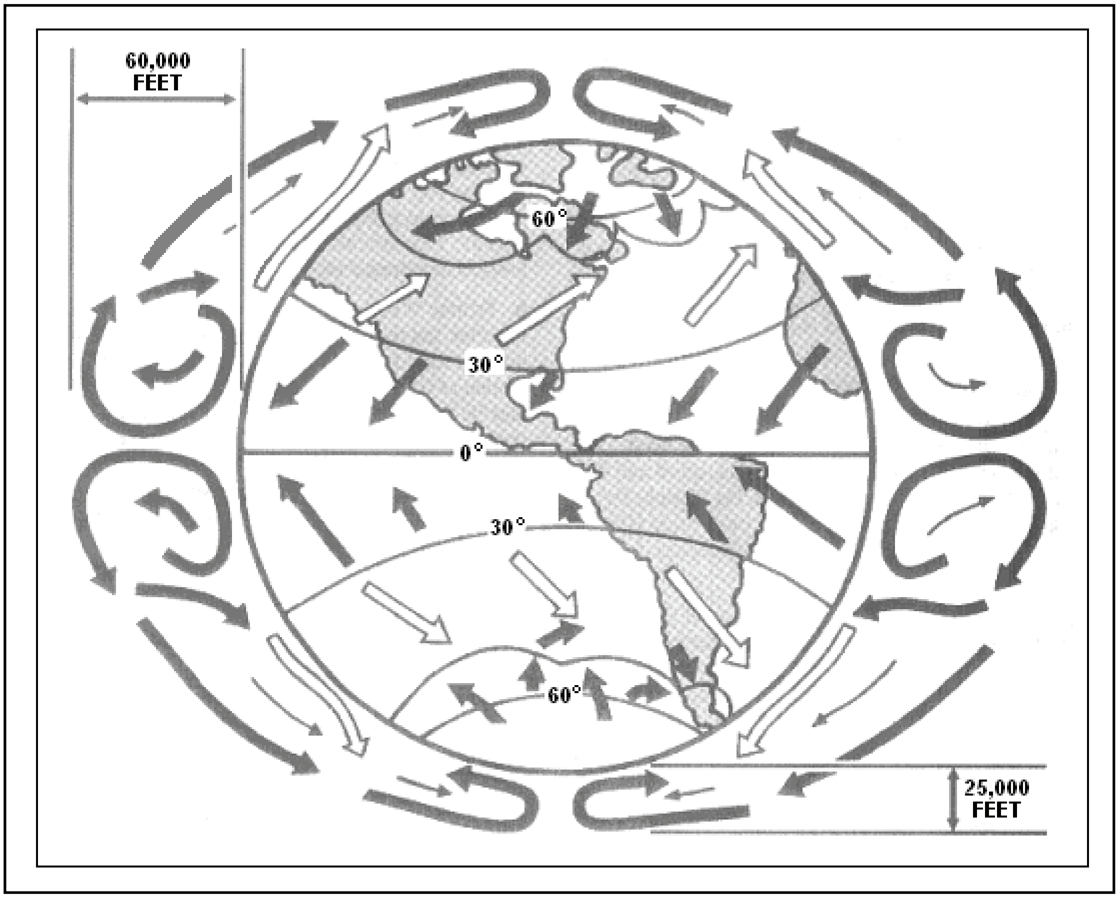


Figure 3-5. General circulation pattern

Earth's Effect on General Circulation

3-33. Irregular formations of land and water, the rotation of the earth, and the tilted axis of the earth affect air circulation. Because water heats and cools much slower than does land, local patterns are set up and superimposed on the general flow. High pressures form over land during winter and over the oceans during summer. This results in large-scale seasonal circulation, such as the monsoon. On a smaller scale, this unequal heating causes a daily circulation pattern along the shoreline. During fair weather, the land is warmed by the sun during the day and cooled by terrestrial radiation at night. This creates a sea breeze by day and a land breeze by night. The rotation and tilted axis of the earth affect circulation patterns.

Secondary Circulation

3-34. When air circulates, several forces act to create disturbances and irregularities in the lower levels of the troposphere. The result is secondary circulation, which consists of moving pressure systems that are smaller than the general circulation patterns. These forces are as follows:

- Pressure gradient force.
- Coriolis force.
- Centrifugal force.
- Frictional force.

Pressure Gradient Force

3-35. The pressure gradient force tends to move air from high to low pressure, normally both vertically and horizontally. Since pressure decreases with altitude, an upward force exists. Vertical air motion may occur over large areas where the mean vertical velocities generally are very slow. Vertical air motion that is restricted to a small column (an updraft) may have velocities greater than 20 knots. Pressure also varies in the horizontal between surface pressure systems. This produces horizontal pressure gradients, which tend to displace the air in the direction of the lower pressure. Although vertical air motion is important in cloud formation and weather, the large-scale wind systems throughout the world consist mainly of horizontal air motion.

Coriolis Force

3-36. If the earth did not rotate, the air would always move directly toward lower pressure. However, the rotation of the earth causes a deflective force, Coriolis force, which tends to counteract both the vertical and horizontal pressure gradient forces. Coriolis force causes moving air to deflect to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

Centrifugal Force

3-37. Lines of constant pressure (isobars) usually are curved around pressure systems. This curvature results in a centrifugal force upon the wind. The effect of the centrifugal force depends on the speed and the existing path of the air. In high latitudes, the Coriolis force has a greater effect than does the centrifugal force. However, near the equator, centrifugal force has a greater effect.

Friction

3-38. Friction tends to slow air movement. Frictional effects on the air are greatest near the ground, but they also are carried aloft by turbulence. Surface friction has a slowing effect on the wind up to about 2,000 feet. Above 2,000 feet, altitude friction effects are negligible.

AIR MASSES

3-39. The physical properties of air masses are largely determined by the type of surface over which they form. A source region for an air mass is an extensive portion of the earth's surface on which temperature and moisture properties are fairly uniform. The time required for a mass of air to acquire the properties of an underlying surface varies greatly with the surface and, in some cases, may take a period of weeks.

CONTINENTAL AND MARITIME MASSES

3-40. The type of surface determines the basic moisture properties of an air mass. The latitude establishes the basic temperature characteristics of an air mass. The two types of surfaces are continental (land) and maritime (oceanic). The location at which the air mass is formed is either polar or tropical. Therefore, air masses originating in polar regions over land are called continental polar, and air masses formed in tropical regions over the ocean are called maritime tropical.

MOVEMENT OF AIR MASSES

3-41. When an air mass leaves its source region, the state of equilibrium that existed with the underlying surface becomes disturbed and the air mass undergoes a modification. The degree of modification depends on the contrast with the underlying surface and the speed at which the air mass is traveling. The modification process is important. It affects the stability of the air mass, which, in turn, influences the type of weather that may be expected. For example, when a continental polar air mass moves over a warmer surface, it absorbs heat from the surface and develops instability in its lower levels because cold air is lying on top of a warm surface. This unstable condition leads to convective activity and the formation of cumulus clouds. The cumulus clouds may provide showers or possibly thunderstorms.

Fronts

3-42. When two or more different air masses come together, the boundary on the surface between the air masses is called a front. Fronts are classified by the relative motion of the warm and cold air masses. The frontal system may be from 10 to 500 kilometers wide, the width varying with the type of front. The height of the front may vary considerably because the frontal surface is not vertical. This is due to the differing densities of the two air masses. The colder air, which is denser (and thus heavier), always wedges under the warmer air mass, causing the warmer air to be lifted. All true fronts actually separate distinct air masses of different densities. A frontal position is characterized by a distinct change in wind direction. The weather associated with fronts is called frontal weather and is more complex and variable than air mass weather. The type and intensity of frontal weather largely depend on such factors as the slope of the frontal surface, the amount of moisture, the stability of the air masses, and the speed of frontal movement. Because of the variability of these factors, frontal weather may range from a minor wind shift with no clouds to thunderstorms, hail, and severe turbulence. The passage of a front may cause rather abrupt changes in the weather.

Cold Front

3-43. When cold air displaces warm air at the earth's surface, it is called a cold front (figure 3-6). A slow-moving cold front has a rather gentle slope. However, as the front accelerates, the slope becomes steeper (more vertical) near the surface because of the friction of the terrain. Cold fronts normally move faster and have steeper slopes than warm fronts. The advancing wedge of cold air lifts the lighter warm air mass and produces a relatively narrow band of clouds.

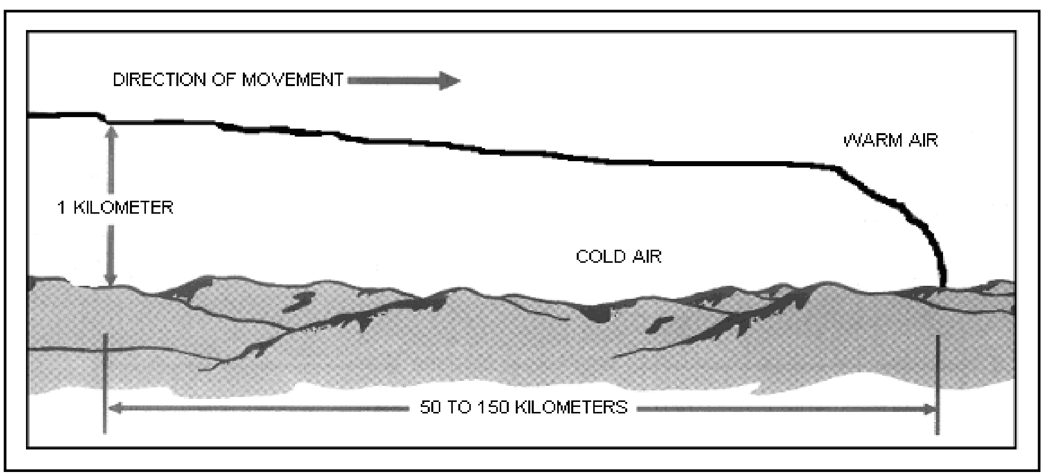


Figure 3-6. Cold front

3-44. The type of clouds formed by the cold front depends on the properties of the air masses involved and the speed of the frontal system. Fast-moving cold fronts, when lifting moist, unstable air, generate cumuliform clouds that are slightly ahead of the front. A line of thunderstorms that frequently develops parallel to and some distance ahead of rapidly moving cold fronts may have cloud systems that extend to the rear of the surface position of the front. The clouds are mainly stratiform when the warm air is moist and stable. When the warm air is quite dry, little or no cloudiness occurs with the passage of a cold front. At the surface, the passage of a cold front is characterized by—

- An abrupt decrease in temperature.
- A marked shift of surface wind, usually greater than 90 degrees.

- A decrease in moisture content of the air.
- A marked decrease in pressure as the front approaches, followed by a rising pressure after the front passes.

Warm Front

3-45. When warm air replaces cold air at the surface, it is called a warm front (figure 3-7). The speed of the advancing warm air is greater than that of the retreating cold air. Therefore, the warm air flows upward over the sloping wedge of dense, cold air. The force of the rising warm air slowly pushes the cold air back. The effect of the earth's surface causes the slope of the warm front to be very flat. The dimensions of a warm front wedge range from 100 to 300 kilometers horizontal distance with an altitude from 0 to 1 kilometer. With the same winds, the speed of a warm front is about half that of a cold front. The clouds associated with a warm front are mainly stratiform and extend well ahead of the surface position of the front. The weather depends largely on the stability and moisture content of the overrunning air. Steady precipitation with low ceiling and limited visibility is normal in advance of warm fronts. At the surface, the passage of a warm front is characterized by—

- A marked increase in temperature.
- A slight shift of surface wind, usually less than 90 degrees.
- An increase in moisture content of the air.
- A decrease in pressure as the front approaches, followed by a leveling off or slowly rising pressure after the front passes.

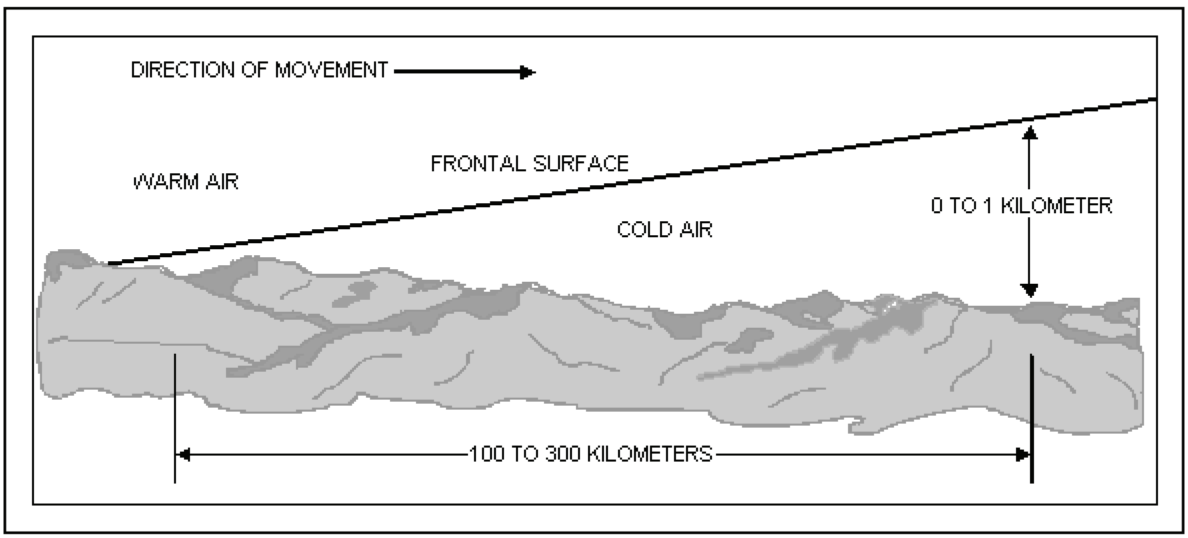


Figure 3-7. Warm front

Occluded Front

3-46. An occluded front is formed when a cold front overtakes a warm front and forces aloft the warm air that originally occupied the space between the two fronts. There are two types of occlusions: the warm front occlusion (figure 3-8) and the cold front occlusion (figure 3-9). The type that will occur depends on whether the cold air of the advancing cold front is colder or warmer than the retreating wedge of cold air in advance of the warm front. However, the essential point in both warm and cold front occlusions is that two cold air masses meet and force the warm air aloft. This causes extensive cloudiness. The weather associated with an occlusion depends on the properties of the three air masses involved.

Stationary Front

3-47. On occasion, both warm and cold air masses contain almost equal amounts of energy and neither can move appreciably. During the period when little or no frontal movement takes place, the system is known as a stationary front. The weather associated with a stationary front is quite similar to that with a warm front.

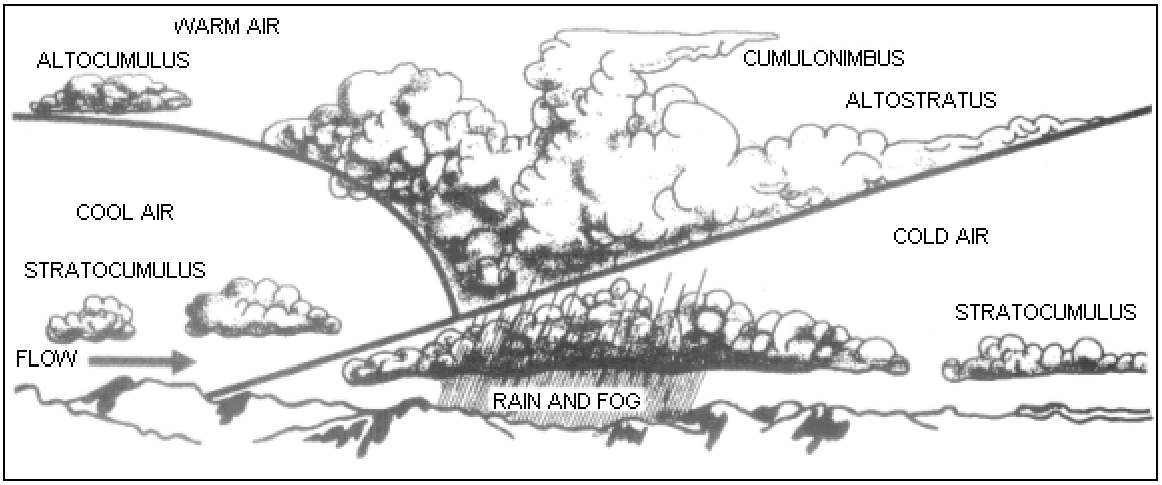


Figure 3-8. Warm front occlusion

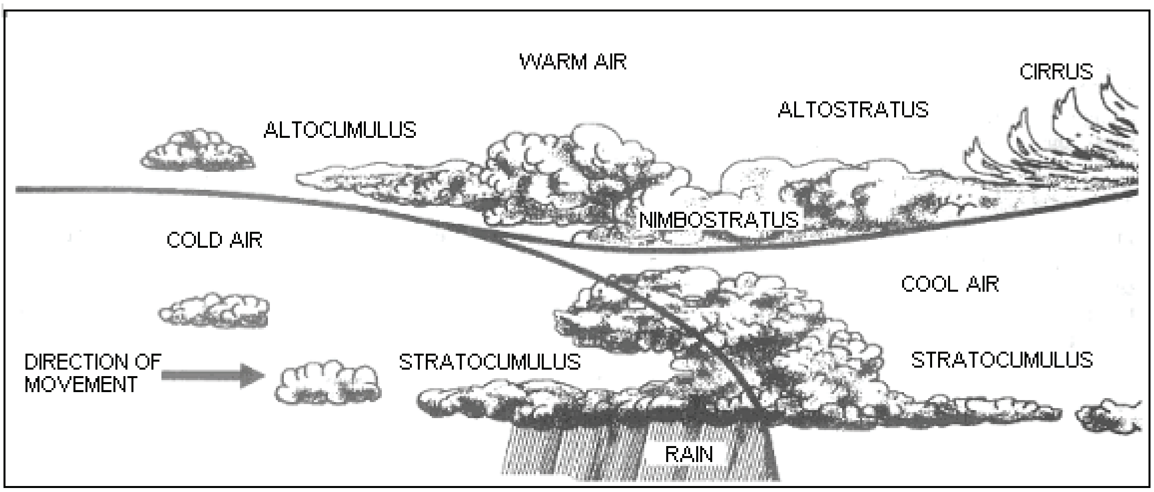


Figure 3-9. Cold front occlusion

SECTION II WEATHER AS IT APPLIES TO THE ARTILLERY

FIELD ARTILLERY MET

3-48. Field artillery MET deals with the techniques and procedures for determining current atmospheric conditions. Atmospheric conditions along the trajectory of a projectile or rocket directly affect its accuracy and may cause the projectile or rocket to miss the desired point of impact. A 5 to 10 percent effect on the firing tables is possible even with stable atmospheric conditions. For example, tests in Southwest Asia have shown that firing artillery at maximum ranges in extreme heat and low air density resulted in MET corrections up to 4,700 meters.

3-49. MET data is one of the prerequisites for accurate predicted fire. With today's emphasis on first round fire for effect and trends toward longer distances, accurate MET corrections for artillery fires are crucial. The use of invalid or no MET corrections could cause artillery projectiles to impact on friendly troops. Accurate MET data must be obtained and appropriate corrections applied to all fires to—

- Conserve ammunition.
- Decrease time in adjustment.
- Obtain a greater surprise effect.
- Reduce the potential for fratricide.

3-50. Despite automation, all MET section crew members should have a common understanding of certain atmospheric and ballistic terms and the effects of MET conditions on artillery fires. Supervisors also must be able to recognize adverse weather changes that could abruptly negate the accuracy of MET messages.

ATMOSPHERIC TERMS

3-51. In addition to the weather-related terms identified earlier in this chapter, there are other atmospheric terms used consistently by the FA MET crew member. They are called ballistic terms and are discussed in the following paragraphs.

Standard Atmosphere

3-52. When computing trajectories, ordnance ballisticians use the International Civil Aviation Organization (ICAO) standard atmosphere. This standard atmosphere is the basis for all data of the ballistic solution as well as a point of departure for ballistic MET corrections. The ICAO atmosphere at sea level is described as follows:

- Dry air.
- No wind.
- Surface temperature of 15 Celsius degrees with a decrease, or lapse rate, of -6.5 Celsius degrees per 1,000 meters up to a height of 11,000 meters and a constant temperature of -56.5 Celsius degrees between 11,000 and 25,000 meters.
- Surface pressure of 1,013.25 millibars, decreasing with height.
- Surface density of 1,225 grams per cubic meter (gm/m^3), decreasing with height.

Atmospheric Zones

3-53. For convenience in computing, reporting, and applying corrections, the standard atmosphere is further identified by atmospheric zones. The atmospheric zones for various MET messages and the thickness and heights of the zones are in table 3-1.

Table 3-1. Atmospheric Structure of MET Message

HEIGHT (meters)	*LINE (ZONE) NUMBERS*				
	COMPUTER	***BALLISTIC***	***TARGET ACQUISITION***	***SOUND RANGING***	***FALLOUT***
SURFACE	0	0	0	0	0
50			1		
100	1	1	2	1	
200			3		
300			4		
400	2	2	5	2	
500			6		
600			7	3	
700			8		
800	3	3	9	4	
900			10		
1,000			11		1
1,100			12		
1,200			13		
1,300	4	4	14		
1,400			15		
1,500			16		
1,600			17		
1,700			18		
1,800	5	5	19		
1,900			20		
2,000			21		
2,100			22		
2,200			23		
2,300	6		24		
2,400		6	25		
2,500			26		
2,600			27		2
3,000	7				
3,500	8				
4,000	9	7			
4,500	10				
5,000	11	8			3
6,000	12	9			
7,000	13				
8,000	14	10			4
9,000	15				
10,000	16	11			5
11,000	17				
12,000	18	12			6
13,000	19				
14,000	20	13			7
15,000	21				
16,000	22	14			8
18,000	24				
19,000	25				
20,000	26				10
******					*****
30,000					15

Ballistic Wind

3-54. Ballistic wind is a wind of constant speed and direction that has the same effect on a projectile during its flight as all the varying winds serially encountered by the projectile.

Ballistic Density

3-55. Ballistic density is a constant density, expressed as a percentage of standard density that has the same effect on a projectile's trajectory as the varying densities serially encountered by the projectile.

Ballistic Temperature

3-56. Ballistic temperature is a constant vertical temperature, expressed as a percentage of standard temperature that has the same effect on a projectile in flight as the varying temperatures serially encountered by the projectile.

MET EFFECTS ON ARTILLERY

3-57. It is important to identify the weather effects on artillery because it provides MET personnel an understanding of the importance of the met section's mission.

3-58. The following text provides detailed information and a graphical explanation of how certain aspects of weather affects the artillery.

Wind

3-59. The effects of wind on a projectile are easy to understand. A tail wind causes an increase in range, and a head wind causes a decrease in range. A crosswind blows the projectile to the right or left, which causes a deflection error. FDC personnel convert ballistic wind measurements into range and deflection and apply corrections to the deflection and elevation of the artillery piece. Figures 3-10 and 3-11 show the effects of a 20-knot wind on a 155-millimeter howitzer firing at a range of 11,000 meters, charge 7 white bag (WB).

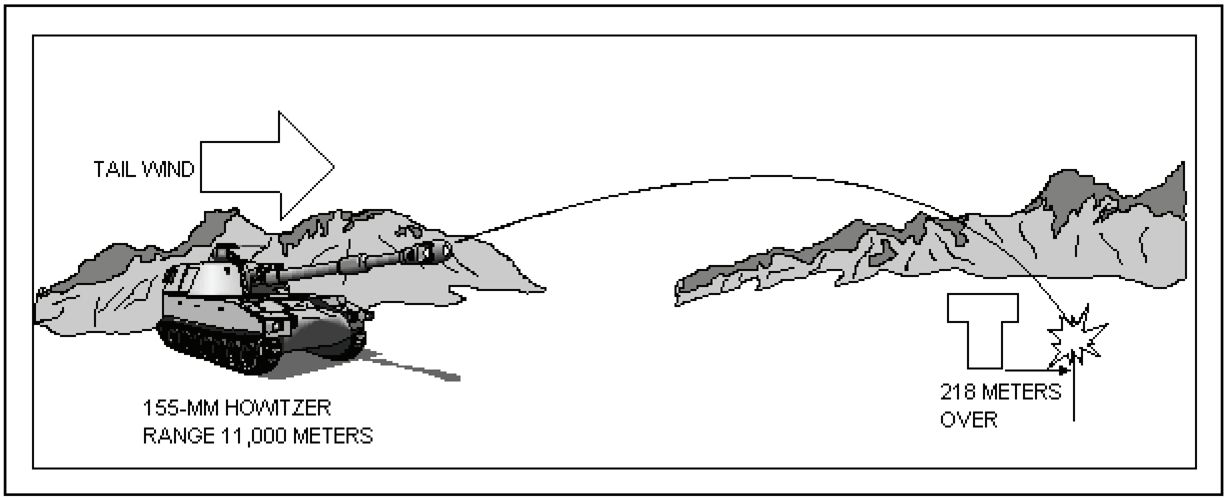


Figure 3-10. Effect of a 20-knot tail wind

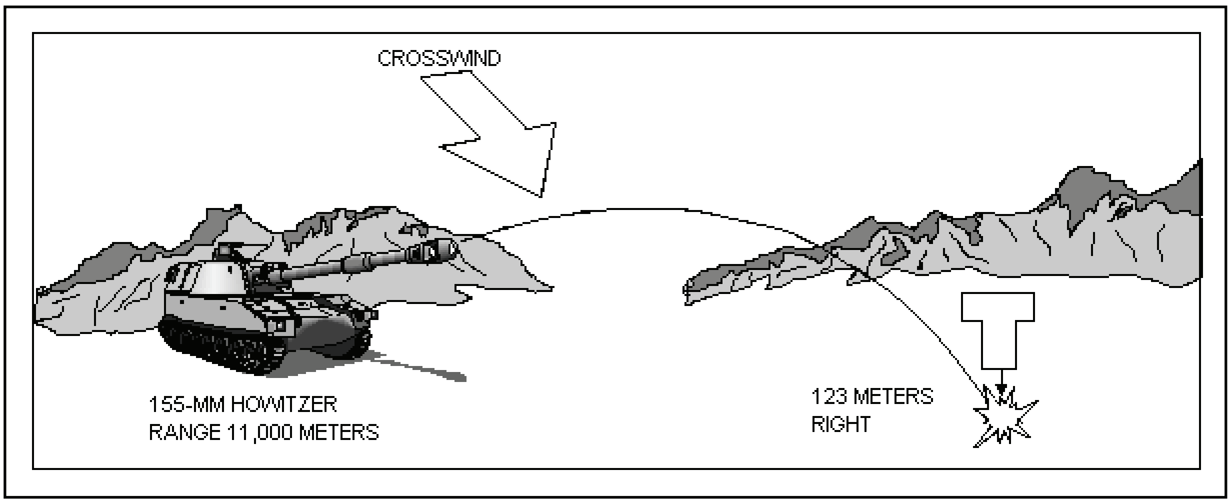


Figure 3-11. Effect of a 20-knot crosswind

Temperature

3-60. Variations in air temperature cause two separate effects on a projectile. One effect is caused by the inverse variation of density with temperature (equation of state). This effect is compensated for when density effects are considered. The second effect is regarded as the true temperature effect. It is the result of the relationship between the speed of the projectile and the speed of the air compression waves that form in front of or behind the projectile. These air compression waves move with the speed of sound, which is directly proportional to the air temperature. The relationship between the variation in air temperature and the drag on the projectile is difficult to determine. This is particularly true for supersonic projectiles since they break through the air compression waves after they are formed. As firing tables indicate, an increase in air temperature may increase, decrease, or have no effect on achieved range, depending on the initial elevation and muzzle velocity of the weapon. Figure 3-12 shows the effect of a 5-percent deviation from standard temperature.

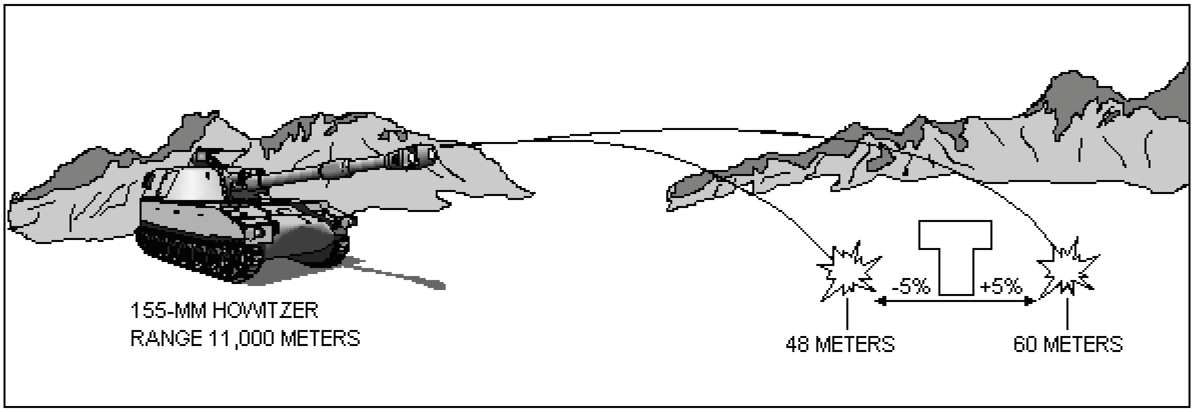


Figure 3-12. Effect of temperature

Density

3-61. Density of the air through which a projectile passes creates friction that affects the forward movement of the projectile. This affects the distance the projectile travels. The density effect is inversely proportional to the projectile ranges; that is, an increase in density causes a decrease in range. Figure 3-13 shows the effect of a 5-percent deviation from the standard air density. Air density decreases rapidly with height. Therefore, the altitude of the firing battery and the ordinate of the trajectory have a direct effect on the magnitude of the density correction. Given equal deviations from standard of each MET effect on the flight of a projectile, air density has the greatest range effect.

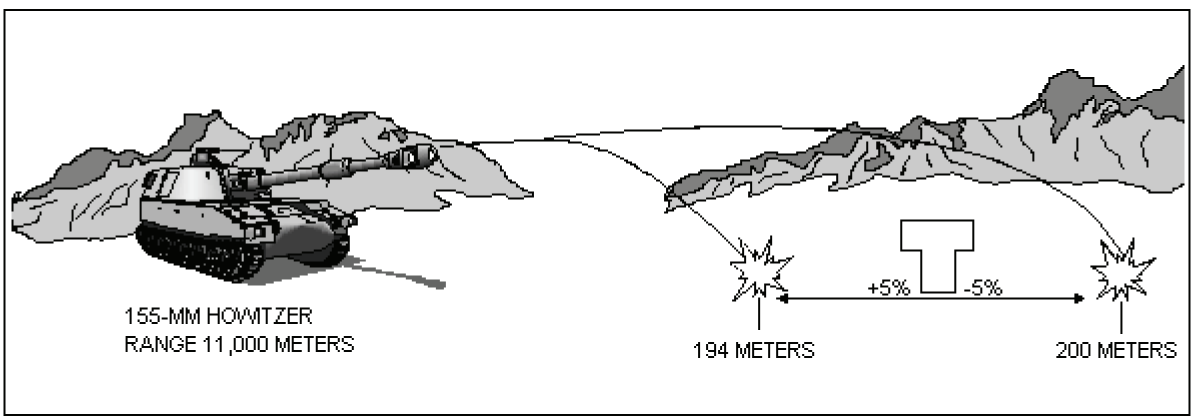


Figure 3-13. Effect of density

MESOSCALE MODELING

3-62. Throughout history, man has attempted to predict weather and its effects. Advances in technology have allowed meteorologists to measure weather phenomenon on a global scale. This large scale data is of little use in predicting weather until it is evaluated against the factors affecting weather (terrain, temperature, bodies of water, vegetation, and others) and applied to a specific area. Scientists have developed computer modeling programs to evaluate the massive amounts of data, giving meteorologist a tool to accurately predict weather.

3-63. Artillery MET sections are concerned with creating a vertical profile of the atmosphere, which is used by artillery units to develop more accurate firing solutions. Traditionally, this vertical profile of the atmosphere was created from surface observations and data collected from balloon-borne sondes. While this method provides accurate data at the MET section's location, the further away the firing unit is located from the MET section the less effective the data for computing firing solutions.

3-64. The Mesoscale model has been developed in order to provide sufficient data to create accurate vertical profiles. The vertical profiles can be generated anywhere within a 60-kilometer radius of the MET section location. The MMS–P equipped MET section, using the Mesoscale model, can generate MET data on demand.

3-65. The capability of the model to generate a vertical profile within a 60-kilometer radius of the MET section allows the system to generate target area MET for targets within the radius. The system generates a vertical profile over the target that is used to increase the accuracy of smart munitions.

Initializing The Model

3-66. Model processing is done automatically by the MMS-P computers. Data from all available sources are incorporated into the model. The more data provided to the model, the more accurate the model output will be.

3-67. While MET personnel cannot see the numerical values processed by the model, they can observe the system building each domain on the model status screen. The model status screen will indicate when each domain has completed processing. Additionally, the model status screen will provide information when output is available from each model run.

Domains

3-68. Initialization of the Mesoscale model begins with establishing domains. A domain is a grid system defining the geographic area for which MET data will be collected and processed.

3-69. The MMS–P equipped MET section establishes three domains when initializing the system by entering each domain's center point. The outer and largest domain measures 3,600 x 3,600 kilometers. It is divided into a grid of 36-kilometer squares and is referred to as the "36-kilometer domain." Nested within the 36-kilometer domain, and using the same center point, lies a 1,500 x 1,500-kilometer area divided into a grid of 12-kilometer squares and referred to as the "12-kilometer domain." Nested within the 12-kilometer domain, and using a center point that does not have to be the same as the other grids, lies a 500 x 500-kilometer area divided into a grid of 4-kilometer squares known as the "4-kilometer domain." Figure 3-14 shows the nested domains.

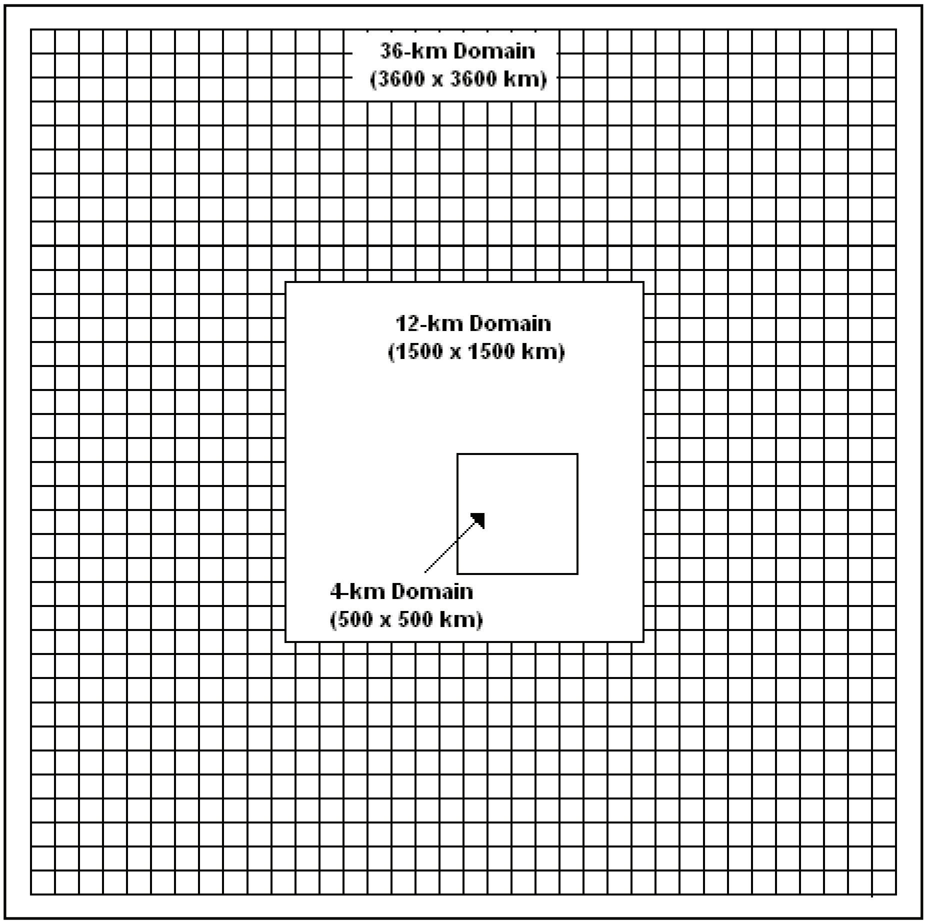


Figure 3-14. Nested domains

3-70. The MM5 model first builds the 36-kilometer domain. The model applies terrain data to the grid acquired from the National Imagery and Mapping Agency (NIMA) Digital Terrain Elevation Data (DTED) database contained on the system computers. Terrain data includes elevation, land use (vegetation), and land-water mask information.

3-71. The MM5 model next applies worldwide forecast model data generated by the Naval Operational Global Atmospheric Prediction System (NOGAPS). NOGAPS data is not direct MET observation data, but resultant forecast data created after analysis. NOGAPS data is broadcast via satellite twice daily by the Air Force Weather Agency (AFWA). Each transmission provides the MMS–P equipped section with 72 hours of forecast data. The MM5 model requires a minimum of 24 hours of valid NOGAPS data to be able to initialize.

3-72. In addition to the NOGAPS data, the model applies surface observations and local observations (upper air data generated by balloon-borne sondes) acquired by the MET section. Additional local observations acquired by other MET sections in the area of operations can also be used by the model to increase the accuracy of the output.

3-73. The MM5 model data from the computation of the 36-kilometer domain is used to compute the 12-kilometer domain. The data generated from the computation of the 12-kilometer domain is used to compute the 4-kilometer domain. This results in a refined vertical profile of the atmosphere in each domain up to 30,000 meters. The MM5 model reinitializes every 30 minutes using the newest inputs. This allows the MM5 model to generate freshest possible data. Figure 3-15 shows the atmospheric profile.

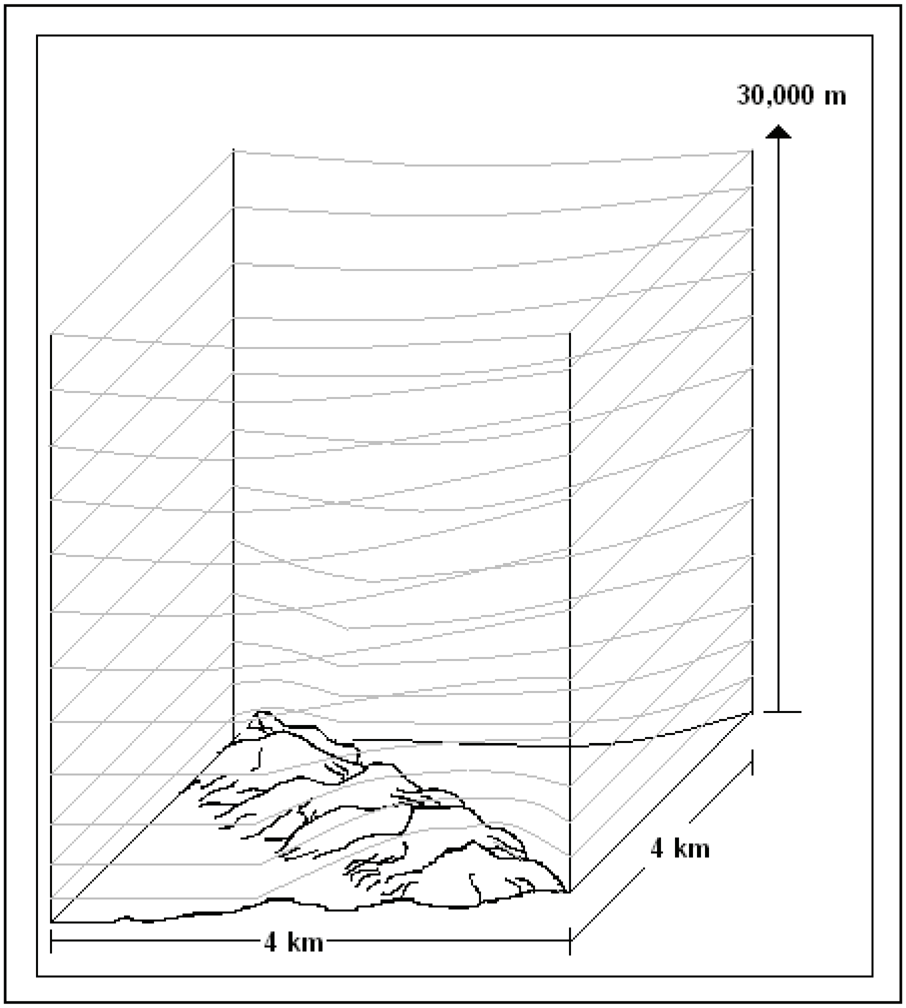


Figure 3-15. Atmospheric profile

3-74. The MET domain establishes for the mesoscale model and the post processor its "area of operations." The default location for the MET domain is the profiler location in the center of the 4-kilometer resolution of 500 x 500-kilometer grid. This coverage should be sufficient for most operations. The MET domain center however can be different than the profiler location. This is useful if the line of march/operational area is known for the mission. For example, given a line of march moving in a due north direction, a profiler could be located at the southern edge (60 kilometers from the MET domain end) of the MET domain (figure 3-16). This gives the profiler greater coverage as it moves north with friendly forces. This is important as the model reduces its error over time if left running without a change in domain. If either the MET domain changes or the system is shutdown the model will need to rerun.

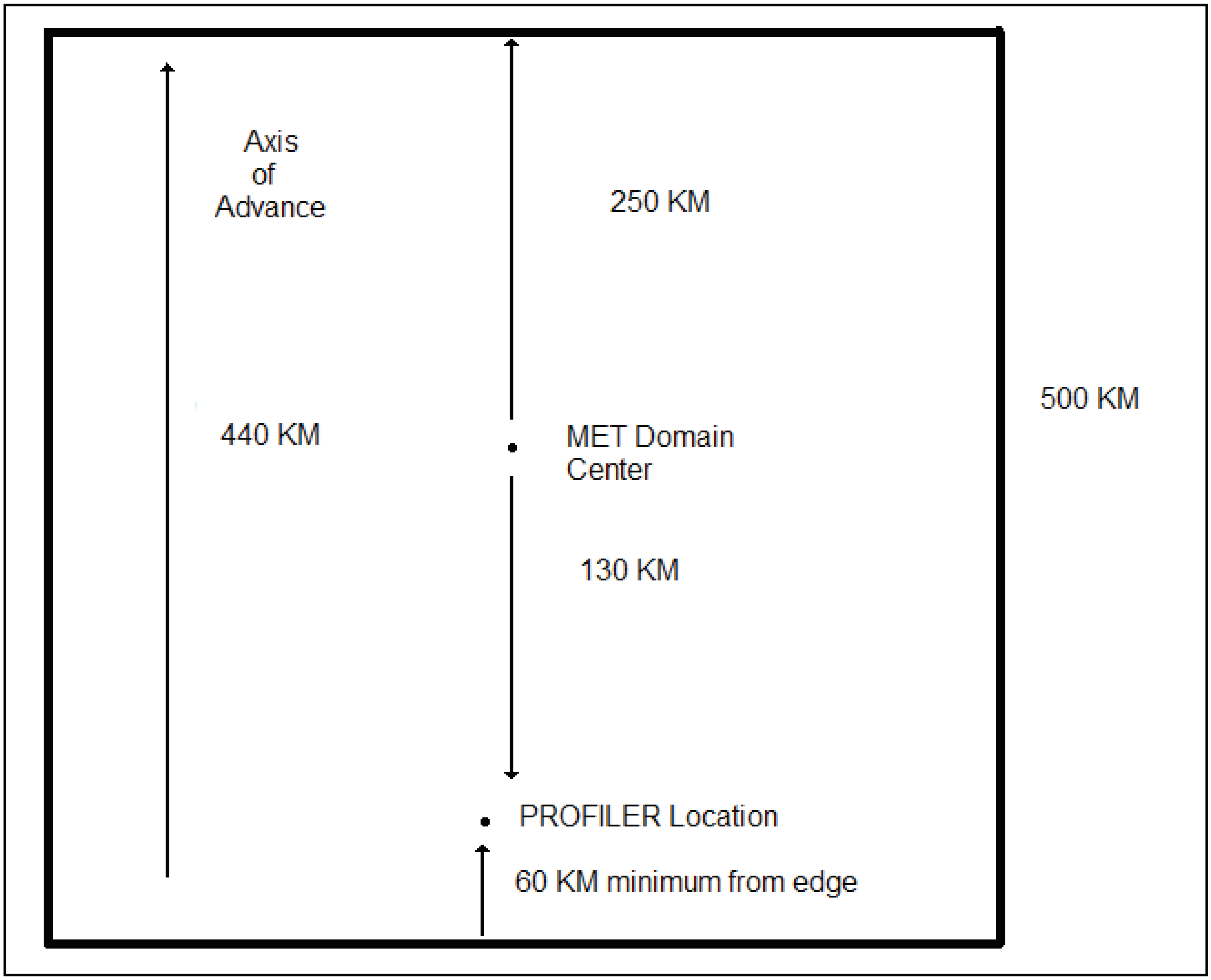


Figure 3-16. MET Domain Profiler Location

UNIFIED POST PROCESSING SYSTEM

3-75. Once the MM5 model is initialized, the MMS–P equipped system is prepared to generate MET data upon demand based on type of MET data required. The data from the model alone is not sufficiently accurate for use by artillery units. The data from the model is transferred to the Unified Post Processing System (UPPS).

Nowcasts

3-76. The UPPS processes the MM5 model output, surface observations data, and upper air data to reduce model bias to produce a nowcast, which can be reformatted into the type of MET message requested by the user. The UPPS repeatedly recycles, creating nowcasts using the newest available data.

3-77. A request for MET from a user contains the gun location and the target location. The UPPS identifies the gun location and the target location within the model domain. Using the current nowcast, the UPPS generates the requested MET data based on the midpoint between the gun location and the target location. The resulting data is input into the appropriate message format and sent to the Common Message

Processor for verification and transmission to the requesting user. Figure 3-17 shows the reference point where MET data was generated when requested.

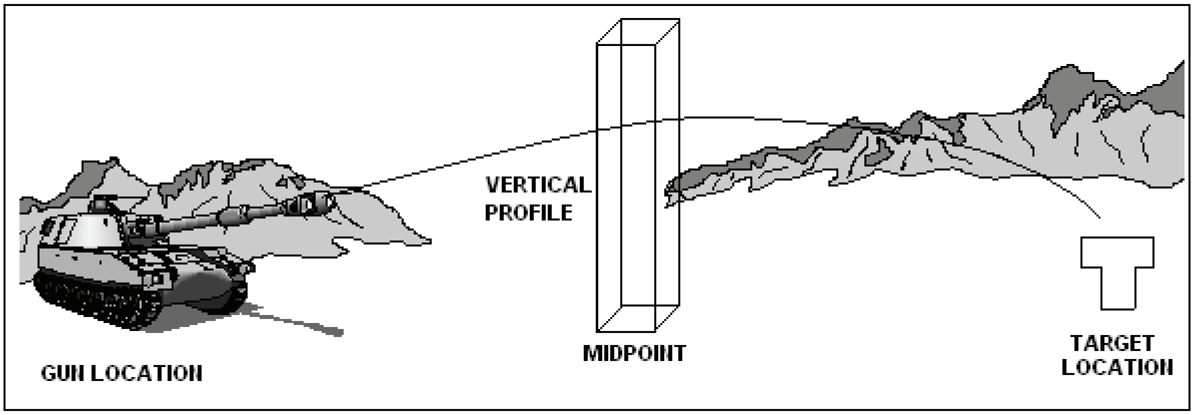


Figure 3-17. MET data reference point

MET EFFECTS ON SMART MUNITIONS

3-78. MET conditions at the target location effects the accuracy of smart munitions. Smart munitions are subject to the same affects of wind, temperature, and humidity as a free flight projectile. These effects are moderated by the ability of smart munitions to make in-flight corrections using passive guidance methods. The greatest effect of MET conditions on smart munitions is the effect of conditions on the ability of the smart munitions acquiring targets. Smart munitions that acquire targets by visual means can have difficulty identifying targets when the target area is obscured by clouds or blowing sand and other adverse conditions.

3-79. The MMS–P equipped section can generate a target area MET message. This knowledge of the target area MET can be used to increase the accuracy of smart munitions or can influence the decision to utilize these expensive munitions. The MET conditions may be such that fire planners will select a different asset to engage the target.

Chapter 4

Operating Principles

Although the operating principles of the Meteorological Measuring Set (MMS) system and the Meteorological Measuring Set – Profiler (MMS–P) system are very different, the principles of data collection are basically the same with a few exceptions. This chapter discusses these principles and differences beginning with the navigational aid systems and then describes the operating modes.

SECTION I MMS SECTIONS

4-1. The MMS equipped section produces MET data from upper-air data collected by balloon-borne radiosondes. The MMS uses one of three operating modes to track the radiosonde. These operating modes are Long-Range Aid to Navigation (LORAN) , Radio Direction Finding (RDF), and Global Positioning System (GPS)

NAVIGATIONAL AID (NAVAID) SYSTEM

4-2. The NAVAID system producing signals suitable for use by MET sections is Long Range Aid to Navigation (LORAN). A NAVAID signal receiver inside a radiosonde in flight receives transmissions from groups of fixed stations. The radiosonde then transmits the NAVAID information to the ground equipment. The differences in the time of arrival of the signal and the phases of the signals are computed by using triangulation to determine the geographical position of the radiosonde.

4-3. The LORAN system is an established low-frequency commercial navigational system. The LORAN produces a highly stable ground wave that can be received about 2,000 kilometers from the system transmitters. Ideal atmospheric conditions can extend the range of LORAN system transmitters to 8,000 kilometers.

4-4. The LORAN system currently has several operational groups of stations called chains. These chains cover a substantial part of the world's coastal areas. One station of each chain is the primary transmitting station, identified as the master station. The others are secondary stations. The primary and secondary transmitters emit synchronized signals that radiate away from the antenna.

4-5. The map at figure 4-1 represents a LORAN chain in the southeastern part of the United States. It has five transmitting stations. Station M, or Malone, is the primary station. Assume, for example, that a NAVAID radiosonde is operating aloft at point R on the map. The signals received by the radiosonde from stations W, M, and Z arrive at different times. The met system receives and processes these different arrival times. The met system then determines the phase relationship of the signals received from the radiosonde. Finally, the met system converts the information into wind data aloft. A list of LORAN chains is at appendix F.

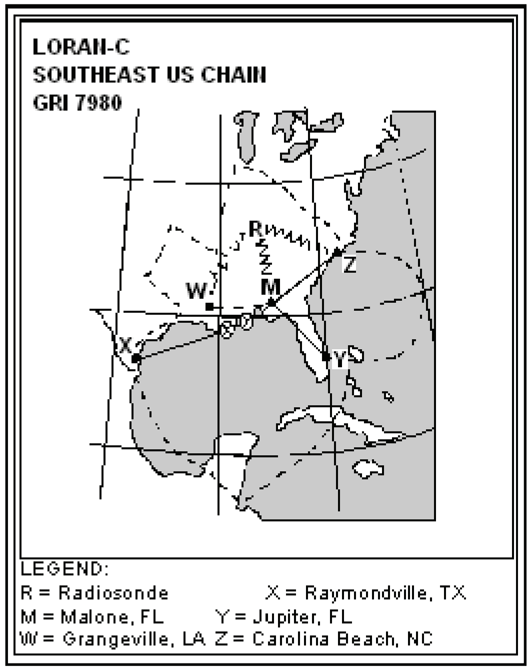


Figure 4-1. Southeast U.S. chain

4-6. In the NAVAID mode the met section can operate from a fixed location, while on the move, or the section can conduct a remote launch.

4-7. Fixed location operations allow the met section to provide continuous met coverage for a particular area of interest.

4-8. Mobile operations allow a met section to start a NAVAID sounding before moving to another site. The system will continue to process data while the section is moving and messages can be transmitted once the section has stopped in the new location. Mobile operations allow an uninterrupted sounding schedule. The operations officer should consider this capability when planning met section employment.

4-9. Remote launch allows the section to release balloon-borne radiosondes from a position up to 20 kilometers from the primary section location. Remote launch allows data to be collected close to the area of interest without displacing the entire section. When coordinated properly, this capability can greatly increase the AMV of one section. Limiting factors of remote launch are detailed in the paragraphs below.

4-10. During offensive operations, supported units may move quickly forward out of AMV coverage. Remote launch helps to provide continuous availability of valid MET data to rapidly moving artillery units. An example of a routine use of the NAVAID remote launch capability is to deploy a balloon launch team forward with artillery advance parties. The launch team receives commands from the primary section location by radio. On arrival at the remote launch site, the team takes surface measurements and launches the balloon on command of the section headquarters. The launch team either returns immediately to the primary section location, travel to a second remote launch site, or remain at its present location. Figure 4-2 shows a graphic example of remote launch capability.

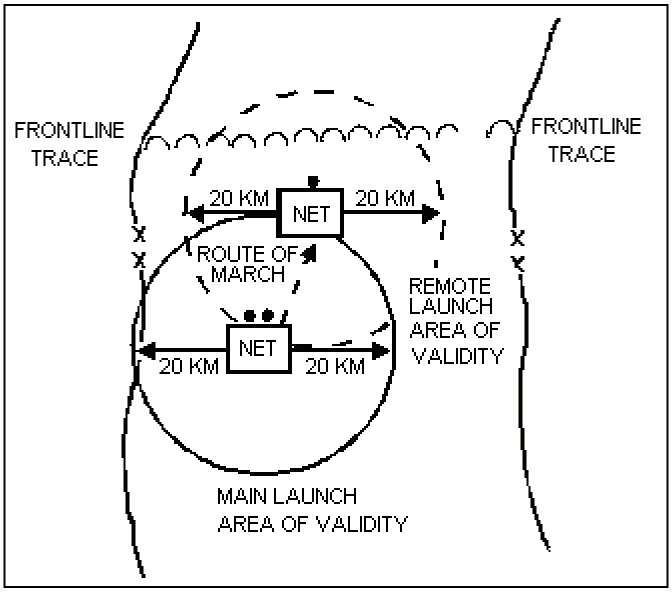


Figure 4-2. Remote launch capability

4-11. Each remote launch mission is different and requires extensive planning before execution. The operations officer and the MET station leader plan remote launches and incorporate them into the MET section positioning scheme.

RDF OPERATIONS

4-12. The RDF operating mode is designed to be used whenever NAVAID systems are unavailable. It only operates from a fixed location. A ground device tracks the path of a radiosonde as it rises in the atmosphere. Angular and meteorological data are passed on to the equipment shelter for processing and dissemination.

GPS OPERATIONS

4-13. The GPS operating mode uses satellites to track the path of the radiosonde as it rises in the atmosphere. Angular and meteorological data are passed to the equipment shelter for processing and dissemination. See appendix E for an explanation of GPS satellite coverage.

SECTION II MMS–P SECTIONS

4-14. Previous MET systems used upper air data collected from a balloon-borne radiosonde to generate MET data required to support operations. The MMS–P produces MET data from an atmospheric model of the operational area. While upper air data is collected by balloon-borne radiosondes, it is but one of the inputs utilized by the mesoscale modeling software (MM5). The additional inputs required by the MM5 model are large-scale weather data received via satellite and area observations.

4-15. Operational Modes for the MMS–P are described as operational mode (with model initialized) and degraded mode (without model initialized). In the operational mode, the AMV for the MMS–P is 60 kilometers. When in degraded mode, the AMV for the MMS–P is reduced to 30 kilometers. This reduction in AMV requires the operations officer and MET station leader to adjust the MET section positioning scheme when the system is in degraded mode.

SURFACE OBSERVATION DATA

4-16. Surface observation data is acquired using the TACMET surface sensor and provides the system with surface wind speed/direction, temperature, and air pressure at the section location.

SOUNDING DATA

4-17. MMS–P equipped sections uses two modes for determining upper air data, LORAN-Commercial (LORAN-C) and GPS.

LORAN-C MODE

4-18. A NAVAID signal receiver inside a radiosonde in flight receives transmissions from groups of fixed stations. The radiosonde then transmits the NAVAID information to the ground equipment. The differences in the time of arrival of the signal and the phases of the signals are computed by using triangulation to determine the geographical position of the radiosonde.

4-19. The MMS–P is currently not capable of mobile operations. LORAN-C can only be performed from a fixed location.

GPS MODE

4-20. The GPS operating mode uses satellites to track the path of the radiosonde as it rises in the atmosphere. Angular and meteorological data are passed to the equipment shelter for processing and dissemination. See appendix E for an explanation of GPS satellite coverage.

4-21. The MMS–P is currently not capable of mobile operations. GPS can only be performed from a fixed location.

NOGAPS DATA

4-22. The MMS–P requires large-scale weather data to initialize the MM5 model. This data is generated by the Naval Operational Global Atmospheric Prediction System (NOGAPS). This data is transferred to the Air Force Weather Agency (AFWA) where it is broadcast via satellite. Each transmission of NOGAPS data contains 72 hours of valid data.

4-23. The MMS–P equipped section downloads NOGAPS transmissions using the Tactical-Very Small Aperture Terminal (T-VSAT). The NOGAPS data is processed by the system and made available to the MM5 model. A secondary method for input of NOGAPS data is using a CD-ROM. The CD-ROM can be created by another MMS–P with valid data or the data can be downloaded from the internet and written to a disk. **The CD-ROM should be destroyed once the NOGAPS data is downloaded to the profiler**.

AREA OBSERVATIONS

4-24. Area observations are meteorological observations that come in via messages over the SINCGARS network from other MMS and MMS–P systems in the current theater of operations. While not required for the MMS–P to be operational, the area observation data is used to increase the accuracy of the model output.

REGIONAL OBSERVATIONS

4-25. Regional Observations are transmitted hourly by Air Force Weather Teams. This information is downloaded via satellite using the T-VSAT and ingested by the MM5 Mesoscale model.

DEGRADED MODE OPERATIONS

4-26. When sufficient NOGAPS data is not available to initialize the MM5 model, the MMS–P system operates in degraded mode. In degraded mode, the MMS–P equipped section must conduct a sounding in order to generate MET messages with valid data. The sounding data is processed by the Unified Post Processing System (UPPS).

4-27. From the time the sonde is launched, it takes approximately 35 to 65 minutes for sounding data to be processed to the point where a MET message can be populated with data. Typically, the first run of the UPPS cycle that ingests sounding data contains data for MET zones zero through six. As the sounding progresses in altitude and feeds data to the system, subsequent MET zones will be populated. The operator can generate a MET message following each cycle of the UPPS until the number of levels required for the message is achieved. See figure 4-3 for an example timeline showing how degraded mode operates when initializing the system without valid NOGAPS data.

NOTE: Times may vary depending on startup, initialization and sonde launch times. The timeline shows a scenario where it takes 35 minutes for sonde data to be made available and to be ingested by the UPPS.

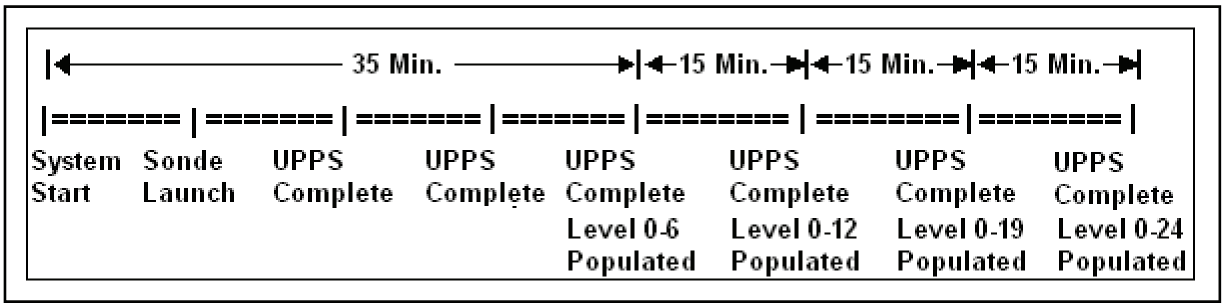


Figure 4-3. Example degraded mode timeline

4-28. The MMS–P system returns to a fully operational mode upon receipt of valid NOGAPS data downloaded via T-VSAT antenna or input using a CD-ROM. The system computers have to be rebooted in order to return to a fully operational mode.

SECTION III VISUAL MET

PILOT BALLOON (PIBAL) OBSERVATIONS (USMC)

4-29. The primary means to determine meteorological data is using electronic meteorological equipment. When electronic meteorological equipment fails or is not available, MET data may be determined from observation of pilot balloons along with approved MET software. MET data determined from PIBAL observation is not as accurate as MET data determined from electronic meteorological equipment. PIBAL is only accurate in the form of wind speed and wind direction. Temperature and pressure are derived from a set lapse rate based off the surface readings the operator provides to the Visual Meteorology Computer Program.

4-30. PIBALs are issued in two sizes, 30-gram and 100-gram (representing the weights of the deflated balloons). Under various sky conditions, some colors are more easily detected by the eye than others. For this reason, PIBALs are issued in several colors, the most common being white, red, and black. The rule to remember when deciding which color balloon to use is “darker the sky the darker the balloon.”

4-31. The rate of rise of the 30-gram balloon is approximately 180 meters per minute, after a steady rate of rise is attained. The rate of rise of a 100-gram balloon is approximately 300 meters per minute after a steady rate of rise is attained.

4-32. Approximate cloud heights may be determined by timing the ascent of PIBAL, multiplying the time by the rate of rise to determine the height of the balloon. When timing the ascent of the PIBAL to determine cloud height, the balloon is timed until it is obscured by the lowest level of clouds. Computing cloud height in this manner provides an approximate cloud height.

INFLATING PIBALS

4-33. When inflating PIBALs, the nozzle ML-373/GM is connected to the hose ML-81. The ML-81 is connected to the gas cylinder. The ML-373/GM provides a valve for controlling the flow of gas, and to act as a calibrated weight to determine the correct amount of gas needed for inflation. The ML-373/GM may be used when inflating with helium or hydrogen. Therefore, when using the ML 373/GM with helium, you must use locally produced work sheet with properly computed times for tops of zones.

4-34. The ML-373/GM nozzle has two connections at opposite ends: a large connection for PIBALs with a large neck and a small connection for PIBALs with a small neck. Most commercially purchased balloons must be connected to the smaller connection on the ML-373/GM nozzle. Projecting from the middle of the nozzle is the fitting for the hose ML-81. Opposite the hose fitting is a wing nut, which controls the valve. The nozzle alone weighs 132 grams, which is the correct free lift weight for a 30-gram PIBAL during a daytime flight. Adding the 443-gram weight to the nozzle brings the complete nozzle weight to 575 grams, the correct free lift for a 100-gram PIBAL during a daytime flight.

4-35. When a nighttime flight is flown, additional weights are added to the nozzle to compensate for the greater air resistance caused by increased size of the balloon. The additional weights required are 70 grams for the 30 gram PIBAL and 50 grams for the 100-gram PIBAL. Also, remember when using nonstandard night lighting devices during nighttime flights, the devices should be connected to the nozzle during inflation to account for the additional weight.

4-36. Once the proper weights are attached to the nozzle, free lift must be obtained. Free lift is the net upward force required for the balloon to ascend at a given rate. Simply stated, the balloon must be inflated until it is suspended in midair with the nozzle and additional weights (if any were needed) still attached to the balloon without the hose ML-81. Once free lift is achieved, you may now disconnect the balloon from the nozzle and tie the balloon off. The balloon is now properly inflated and ready for release.

TRACKING AND RECORDING PROCEDURES

4-37. The primary function of the theodolite in the meteorology section is to visually observe an ascending PIBAL while providing azimuth and elevation angles from the theodolite to the pilot balloon. The azimuth and elevation angles are observed and recorded at predetermined times. These times are the time it takes the PIBAL to reach specific heights. The times for specific heights are determined based on a known ascent rate of the balloon. For example, if the balloon rises at 200 meters per minute, it would take 5 minutes for the balloon to reach 1,000 meters.

4-38. Recording worksheet will contain the times at which azimuth and elevation angles should be read and recorded. This form will also contain all of the surface readings and information needed by the operators prior to release of the balloon. Ensure before release of the balloon that the balloon is downwind from the theodolite so it does not fly directly over the theodolite and that the recorder records the offset azimuth. The offset azimuth is the azimuth from the theodolite to the balloon just before it is released. It is important that the azimuth and elevation angles are read at the exact time identified on the worksheet.

4-39. Additionally, when the elevation and azimuth angles are read, the balloon should be centered in the crosshairs of the eyepiece of the theodolite. The timer/recorder must alert the theodolite operator when it is approaching the time the azimuth and elevation angles are to be read. The timer/recorder must alert the theodolite operator in order that the operator will ensure the balloon is in the center of the crosshairs at precisely the moment the azimuth and elevation angles are read.

4-40. The timer/recorder must alert the operator at least 5 seconds before the azimuth and elevation angles are to be read. The timer/recorder alerts the theodolite operator with the command ‘WARNING’. Once the command ‘WARNING’ is given, the theodolite operator should ensure the balloon is exactly centered in the crosshairs of the theodolite’s eyepiece.

4-41. After the ‘WARNING’ command is given, the timer/recorder should voice the command ‘Read’ at the moment the predetermined times are reached. The timer/recorder may record the azimuth and elevation angles from one of the digital displays on the theodolite, or the theodolite operator may read the angles from the mechanical angles located in the eyepiece of the theodolite.

4-42. The azimuth and elevation angles are recorded on the form provided to“tenth of a degree” accuracy. The azimuth and elevation angles from the form will be entered in data fields of a visual meteorology computer program. The computer program will process the information and produce a formatted meteorology computer message (METCM) that may be delivered by courier, voice radio or entered into a digital communication device for digital transmission. For more information on PIBAL operations, refer to Operations Manual 79-95M01.

4-43. All forms and MET messages are to be maintained in the manner of electronic MET messages and forms.

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Chapter 5

Meteorological Measuring Set (MMS), AN/TMQ-41

This chapter discusses the components, site considerations, and personnel of the AN/TMQ-41 equipped section.

SECTION I MMS AN/TMQ-41 EQUIPMENT

SHELTER EQUIPMENT GROUP

5-1. The AN/TMQ-41 is an automated meteorological data processing system. It consists of two main equipment groups, the Shelter Group and the Radio Direction Finding (RDF) group. This section discusses the AN/TMQ-41 and additional equipment. Figure 5-1 shows the AN/TMQ-41 equipment.

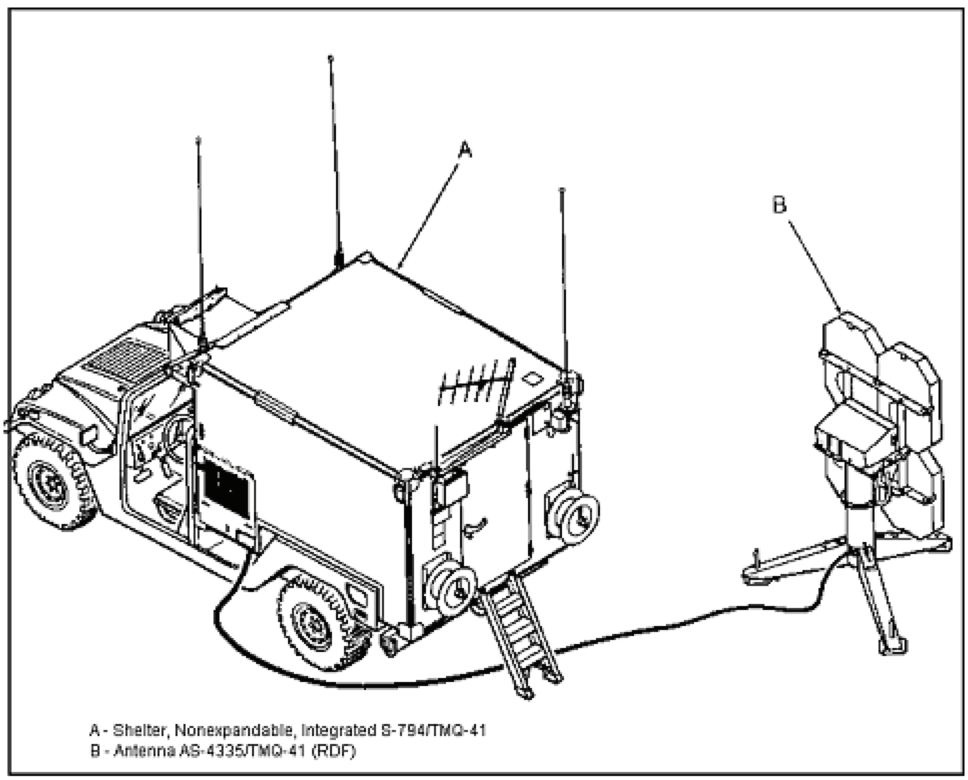


Figure 5-1. AN/TMQ-41 equipment

5-2. The shelter equipment group contains the equipment needed to receive and process MET data transmitted by a radiosonde. The shelter equipment group consists of the systems described below.

NAVIGATIONAL AID (NAVAID) ANTENNA SYSTEM

5-3. When the AN/TMQ-41 operates in the NAVAID mode, the NAVAID antennas receive signals from very low frequency (VLF) antenna.

Receiving System

5-4. This system amplifies and converts signals received by the Global Positioning System (GPS), NAVAID and RDF antennas and passes them to the Marwin processor. The Marwin processor contains a GPS card that processes GPS signals enabling the Marwin to determine wind speed and direction.

Communications System

5-5. The Marwin receives and processes MET data and position information. It formats the data into MET messages for transmission to using units.

Page Printer

5-6. The printer provides a hard copy record of all MET messages.

Power Supply System

5-7. The AN/TMQ-41 operates from a 230 volts alternating current (VAC) or +28 volts direct current (VDC) primary power input. A power entry assembly and power control unit convert the supplied power to the correct voltage for operating the equipment. The RDF and air conditioners can be operated only when alternating current AC power is used.

RDF Equipment Group

5-8. The RDF is a tripod-mounted antenna system that automatically tracks the radiosonde in the atmosphere. It receives MET data and detects position information used for wind computation. The RDF passes this data to the shelter equipment for processing and dissemination. A hand terminal connected to the antenna by cable allows for manual control of the positioning system as well as the receiver tuning circuit.

Generator Cable Equipment

5-9. The cable equipment provides primary AC power to the system. It consists of two 50-foot cables and a pigtail cable to connect the generator or commercial power source to the power entry assembly at the shelter. A cable reel is provided for storing one cable on the back of the equipment shelter. The second cable and the pigtail are stored in the tunnel.

Associated Equipment

Radiosonde

5-10. The radiosonde is a small electronic instrument carried aloft by a free-flight balloon. The aloft radiosonde senses and transmits pressure, temperature, and relative humidity to the MET section. The AN/TMQ-41 uses different types of radiosondes, depending on the operating mode selected for the planned sounding.

Power Equipment

5-11. The AN/TMQ-41 operates either from vehicle power or an external power source. When performing mobile operations, power is supplied by the vehicle on which it is mounted. When the air conditioners are on or when operating the RDF, an external source of power is required. A trailer-mounted power plant is towed by one of the sections vehicles to provide power.

Communications Equipment

5-12. The met section usually disseminates met data via on-board communications equipment. There are multiple options available to the met section to disseminate met data.

5-13. Care must be taken to use the appropriate communications equipment when disseminating met data. The communications equipment will be identified during the section planning process

Radios

5-14. The MET section is authorized single-channel ground and air-borne radio system (SINCGARS). They are used for communications with MET users and command and control.

Digital Computer System, Lightweight Computer Unit

5-15. This two-way interface device is used for routing digital communications between the MET section and remote users.

Digital Nonsecure Voice Terminal

5-16. This telephone, with associated wire connections, is a mobile subscriber equipment (MSE) device that allows for voice and digital communications. The digital nonsecure voice terminal DNVT provides access to the common user area communications network.

VEHICULAR EQUIPMENT

5-17. Each section is authorized three high-mobility multipurpose wheeled vehicles (HMMWVs) and three trailers. The three vehicles are the heavy-variant HMMWV, and each is equipped with a 200-amp kit. Vehicle one transports the operations shelter and tows the power generator. Vehicle two transports supplemental equipment and tows the trailer containing the balloon inflation equipment and expendable supplies. Vehicle three transports section equipment. Section IV provides example load plans.

SECTION II AN/TMQ-41 SECTION SITE OPERATIONS

SITE SELECTION

5-18. MET sections are positioned by the S-3 and MET station leader to provide the best possible area of coverage and most valid MET data. Section deployment depends largely on the location of firing units, targets, terrain, and weather. When selecting a site, the MET section leader must weigh the following considerations:

- Safety.
- Tactical situation.
- Weather forecast and prevailing winds.
- Availability of NAVAID signals.
- Security.
- Communications modes and nets.
- Operating frequencies.
- Electronic warfare activities.
- Areas of coverage.
- Terrain.
- Availability of adequate supply of water.
- Logistical support.
- Unit attachment.

SURVEY REQUIREMENTS

5-19. The met station leader conducts a ground reconnaissance to determine the exact positions for major items of equipment. Once this is done, the station leader selects two reference points to facilitate orienting the RDF to true north. Reference points should be fixed, easily identified objects, such as a tall pole or the fork of a large tree.

SURVEY AVAILABLE

5-20. The MET station leader emplaces the system to fifth-order accuracy or with the GPS. The survey section will provide the MET section with the latitude, longitude, and height of the MET section.

SURVEY NOT AVAILABLE

5-21. If survey support is not available, the MET station leader determines station altitude and location from an area map. The map datum is World Geodetic System 84.

RDF EMPLACEMENT

NOTE: If the soundings are performed in the NAVAID or GPS modes, the RDF is not emplaced.

5-22. The RDF cannot be emplaced more than 100 feet (30 meters) from the equipment shelter owing to cable length. The RDF should be placed on reasonably level terrain. It should not be screened by large obstacles that may interfere with signal reception. The position selected for the RDF should have a clear area downwind to observe balloon release. There must be no tall objects to obstruct line of sight from the RDF to a radiosonde in flight.

EQUIPMENT SHELTER EMPLACEMENT

5-23. The MET station leader positions the shelter on firm level ground. The shelter cannot be positioned more than 100 feet (30 meters) from the RDF or power equipment owing to cable length. It should not be positioned under power lines.

POWER EQUIPMENT EMPLACEMENT

5-24. The power plant provides the shelter with power. It can be no more than 100 feet (30 meters) from the shelter. Once the power equipment trailer is disconnected from the vehicle that tows it, the vehicle moves to a concealed area.

BALLOON INFLATION SITE

5-25. Upon entering the area of operation, the vehicle transporting the balloon inflation and launching equipment moves to the inflation site. The necessary equipment is unloaded, and the vehicle moves to a concealed area. The inflation site should be downwind of the equipment shelter and RDF, if possible.

5-26. Figure 5-2 provides an example of a site occupation. Because the maximum cable length is 100 feet (30 meters), the distance between the shelter and its interfacing equipment cannot exceed the following:

- Shelter to RDF antenna (one cable W103) - 100 feet (30 meters) maximum.
- Shelter to generator trailer (two cables W401 and one cable W405) - 100 feet (30 meters) maximum.
- Shelter to remote NAVAID antennas (one cable W111, one cable W112) - 100 feet (30 meters) maximum.

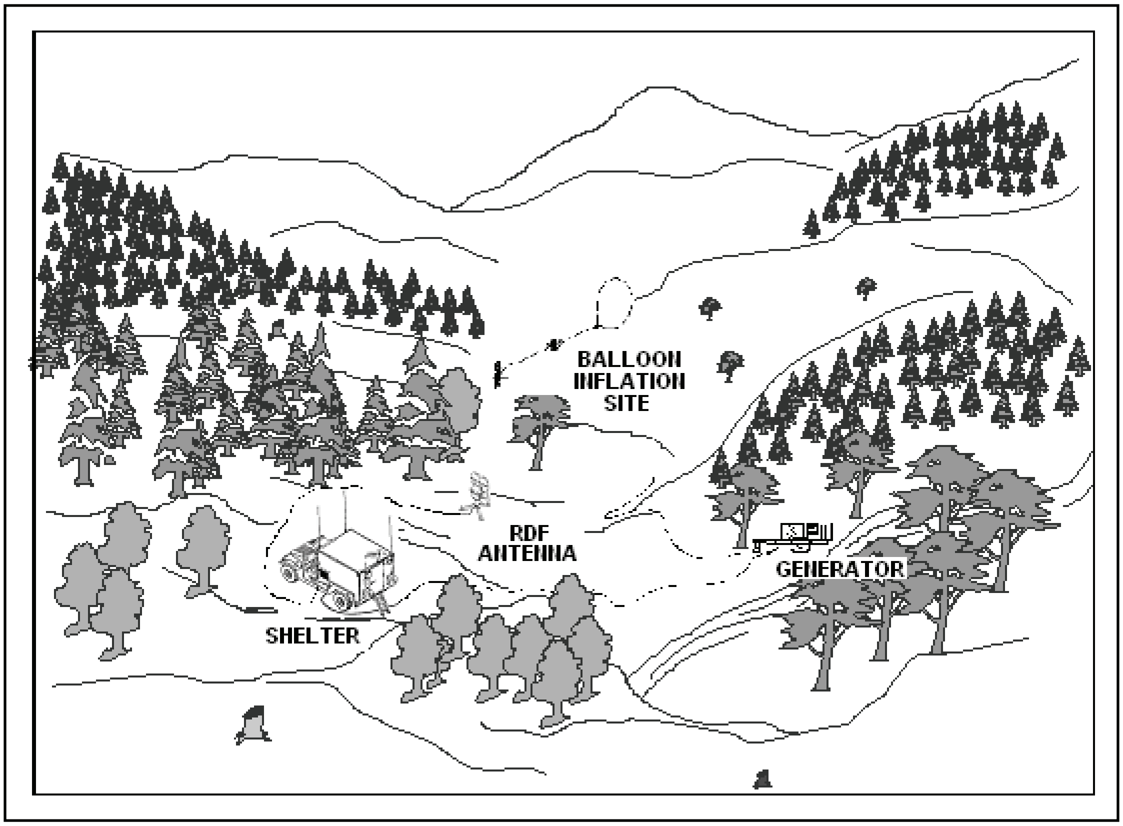


Figure 5-2. Site occupation

CAMOUFLAGE

5-27. The modules of radar-scattering camouflage in table 5-1 are required for camouflaging the system. Camouflage procedures are outlined in TM 5-1080-200-13&P.

Table 5-1. Radar Scattering Camouflage Modules

Equipment	*Modules*
1 1/4-ton truck with shelter	2
1 1/4-ton truck (transports MHG if issued)*	3
1 1/4-ton truck	2
1 1/4-ton trailer (3 each)	3
NAVAID Antenna Set	1
RDF	1
Tent	2
*Ensure the generator chimney is not covered with camouflage when generator is operating.	

5-28. Commanders move MET sections as needed to maintain MET support. Therefore, crew members must be trained and able to displace, move, and occupy a new site rapidly during critical periods of the battle. The MET station leader informs the operations officer when the validity of the last message from the current position will expire and how much time is required to march-order the section. He recommends the best time to make the displacement and a course of action to relay MET data from adjacent sections while the section is displacing. The MET station leader's briefing of section personnel before each displacement should include, as applicable, the following:

- Broadcast time of the last met message from the current position.
- Broadcast time of the first met message from the next position.
- Procedures for monitoring, copying, and transmitting met data from adjacent met sections on both the left and right flanks.
- Section march-order sequence and when the camouflage systems will be dropped, packed, and loaded.
- Departure time and whether the section has road clearance to move independently.
- Where the MET vehicles will be positioned in the battery column.
- Route of march and any significant landmarks.
- Designation of the section representative on the reconnaissance party.

SECTION III AN/TMQ-41 SECTION PERSONNEL

Table 5-2. AN/TMQ-41 Section Personnel (U.S. Army) and AN/TMQ-41 Section Personnel (U.S. Marine Corps)

5-29. The MOS and Rank for personnel in a MMS Section is directly related to the level of responsibility and knowledge required. The more senior the Rank, the more responsibility and knowledge the individual is expected to possess.

5-30. All personnel within the MMS section will possess the 13W MOS. However, two positions will have an Additional Skill Identifier (ASI) that indicates they have successfully completed the Unit level maintenance course for Meteorology Equipment.

U.S. ARMY			
Title	***MOS***	***Rank***	***Quantity***
MET station leader	13W40	SFC	1
FA MET section sergeant	13W30	SSG	1
FA MET equipment repairer	13W20H1	SGT	1
FA MET equipment repairer	13W10H1	SPC	1
FA MET crew member	13W10	SPC	1

Table 5-2. AN/TMQ-41 Section Personnel (U.S. Army) and AN/TMQ-41 Section Personnel (U.S. Marine Corps)

5-29. The MOS and Rank for personnel in a MMS Section is directly related to the level of responsibility and knowledge required. The more senior the Rank, the more responsibility and knowledge the individual is expected to possess.

5-30. All personnel within the MMS section will possess the 13W MOS. However, two positions will have an Additional Skill Identifier (ASI) that indicates they have successfully completed the Unit level maintenance course for Meteorology Equipment.

FA MET crew member	13W10	PFC	1
		Total	6
Legend: SFC = Sergeant First Class SSG = Staff Sergeant SGT = Sergeant	SPC = Specialist PFC = Private First Class		
U.S. MARINE CORPS			
Title	***MOS***	***Rank***	***Quantity***
Team chief	0848	SSGT	1
Arty MET man	0847	SGT	1
Arty MET man	0847	CPL	1
Arty MET man/driver	0847	LCPL	1
Arty MET man/driver	0847	PFC	2
		Total	6
Legend: SSGT = Sergeant First Class SGT = Staff Sergeant	CPL = Corporal LCPL = Lance Corporal PFC = Private First Class		

NOTE: Duties are the same for both Army and Marine Corps personnel.

FIELD ARTILLERY (FA) MET STATION LEADER (SFC, MOS 13W40)

5-31. The FA met station leader will—

- Help the operations officer prepare the MET plan.
- Advise the operations officer on the employment and operation of the MET assets within the division area.
- Supervise MET section operations.
- Coordinate with the S4 for logistical support.
- Coordinate with the signal staff officer to prioritize means of communication and dissemination of messages.
- Perform site selection and location.
- Perform first sergeant-type duties when operating independently.
- Direct the operation, emplacement, and displacement of the MET section.

- Maintain quality control of MET data. Submit necessary reports, and maintain a flight log showing the following:
  - Dates.
  - Location.
  - Flight number.
  - Expendables consumed.
  - Other pertinent information.
- Retain the flight log and copies of messages in accordance with AR 25-400-2.
- Advise the operations officer on all factors affecting mission capabilities, such as personnel, maintenance, and logistics.
- Review, consolidate, and prepare technical, personnel, and administrative reports covering MET section and station activities.
- Organize and supervise the MET section training program.
- Supervise operator maintenance of MET, communications, and vehicular equipment.
- Supervise preparation and distribution of all MET messages.
- Ensure adherence to safety procedures during inflation.
- Manage met section logistics for repair parts and expendable items.
- Assign personnel to MET teams.
- Instruct and lead crew members in MET procedures.

FA MET SECTION SERGEANT (SSG, MOS 13W30)

5-32. The FA met section sergeant will—

- Provide leadership and technical guidance to subordinate personnel.
- Serve as off-shift senior sergeant during periods of extended operation.
- Check data and records.
- Examine data samples for quality control.
- Inspect grounding equipment.
- Decode wind messages.

FA MET EQUIPMENT REPAIRER (SGT, MOS 13W20H1)

5-33. The FA met equipment repairer sergeant will—

- Supervise the second shift during 24-hour operations.
- Perform unit maintenance on section MET equipment.
- Ensure communications are maintained with all users.
- Perform administrative duties as required.

FA MET EQUIPMENT REPAIRER (SPC, MOS 13W10H1)

5-34. The FA met equipment repairer specialist will—

- Operate MET equipment on his assigned shift.
- Perform unit maintenance on section MET equipment.
- Operate organic communications equipment.
- Drive the vehicle.

FA MET CREWMEMBER (SPC, MOS 13W10)

5-35. The FA MET crew member specialist will—

- Operate MET equipment on his assigned shift.

- Help prepare the balloon train.
- Drive the vehicle.

FA MET CREWMEMBER (PFC, MOS 13W10)

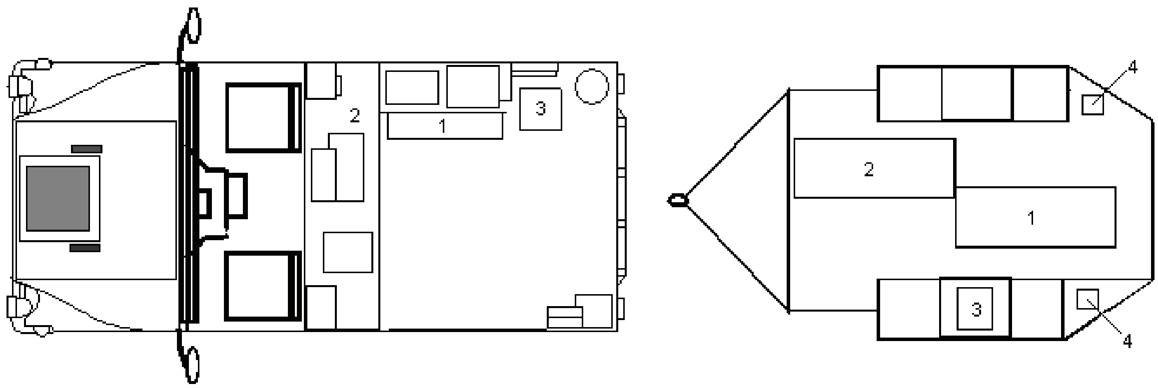
5-36. The FA MET crew member private will—

- Operate MET equipment on his assigned shift.
- Help prepare the balloon train.
- Drive the vehicle.

SECTION IV SUGGESTED LOAD PLANS

5-37. The loading plan for the MMS Section is extremely important. Loading plans are the key to ensuring everyone knows where each component or piece of equipment is located.

5-38. A good load plan will cut down on the time required to find items as well as store items for transport (for examples see figures 5-3, 5-4, and 5-5.

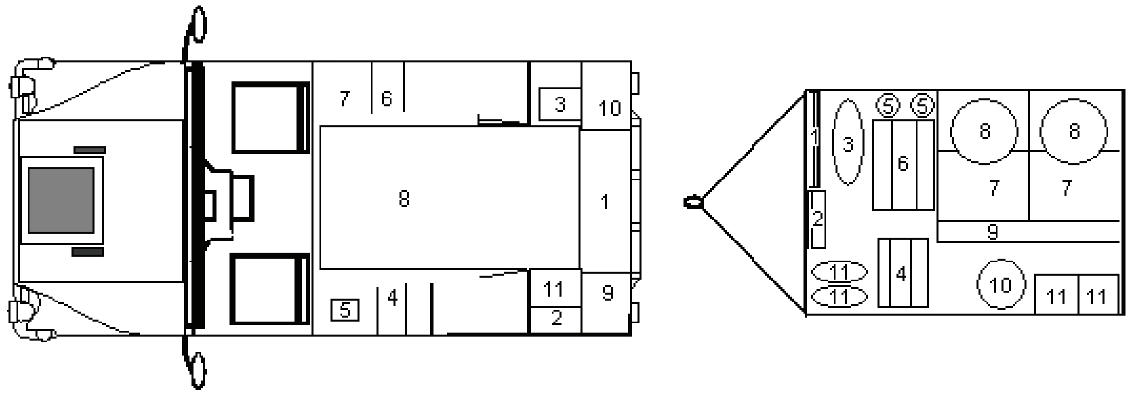


LEGEND

VEHICLE
1. Storage Shelf
   A. Anemometer
   B. Aspirator, Psychrometer
   C. Barometer, Digital
   D. Compass, Magnetic
   E. Multimeter
   F. Tool Kit, TK-33
   G. Radiosondes
2. Tunnel (storage area under shelter)
   A. Computer Paper
   B. Radiosondes
   C. Reeling Machine RL-39
   D. Cable Telephone WF-16/U
   E. Cable Telephone WD-1
3. Tool Box TK-101

TRAILER
1. Generator
2. Generator
3. Control Unit
4. Fire Extinguisher

Figure 5-3. Vehicle 1 with trailer



LEGEND:

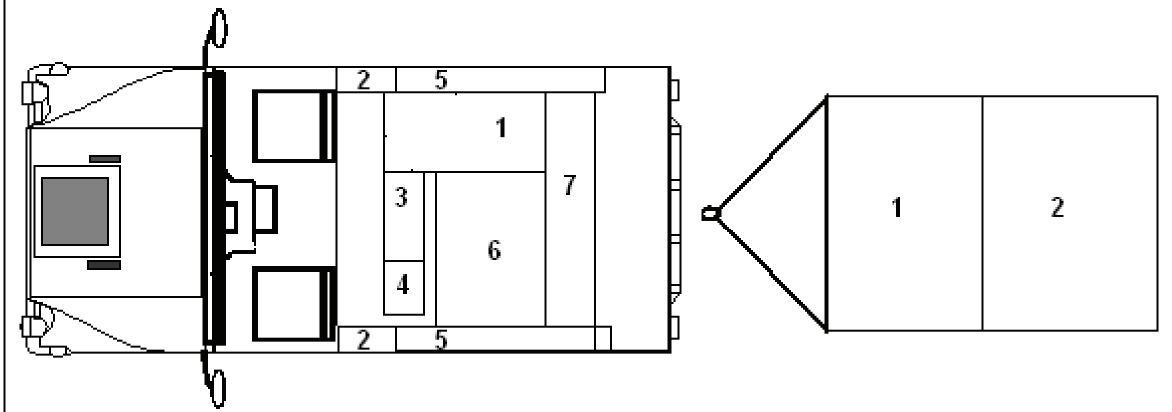
VEHICLE

1. Inflation launching device
2. Balloons, ML-635
3. Balloons, ML-519
4. Balloons, ML-537
5. Balloons, ML-159A
6. Balloons, ML-160
7. Balloons, ML-161
8. Helum Rack (16 Bottles)
9. Volume Meter
10. Parachutes
11. Box, Light Sticks, Wrist Strap, Nozzles, etc.

TRAILER

1. Field Tables
2. Chairs
3. Cargo Net
4. 5-Gal Water Containers
5. Stove
6. Cots
7. Tents
8. Camouflage Nets
9. Tent Poles
10. B-Bags
11. Ruck Sacks

Figure 5-4. Vehicle 2 with trailer



LEGEND:

Vehicle
1. Tents
2. Stove
3. Cots
4. Lantern
5. Crew TA-50
6. Camouflage Net
7. Camouflage Poles

Trailer
1. Camouflage Net
2. Camouflage Poles

Figure 5-5. Vehicle 3 with trailer

Chapter 6

Meteorological Measuring Set-Profiler, AN/TMQ-52

This chapter discusses the components, site considerations, and personnel of the AN/TMQ-52 equipped section.

SECTION I MMS–P AN/TMQ-52 EQUIPMENT

SHELTER EQUIPMENT GROUP

6-1. The AN/TMQ-52 is a mobile upper air meteorological data collection, processing, and dissemination system. The AN/TMQ-52 system consists of the S-832/G non-expandable shelter housing the system components mounted on a high mobility multipurpose wheeled vehicle (HMMWV) M-1113, the Tactical-Very Small Aperture Terminal (T-VSAT) antenna, and the Meteorological Station, Automatic, AN/TMQ-55 (TACMET). This section discusses the AN/TMQ-52 and additional equipment. Figure 6-1 shows the AN/TMQ-52 equipment.

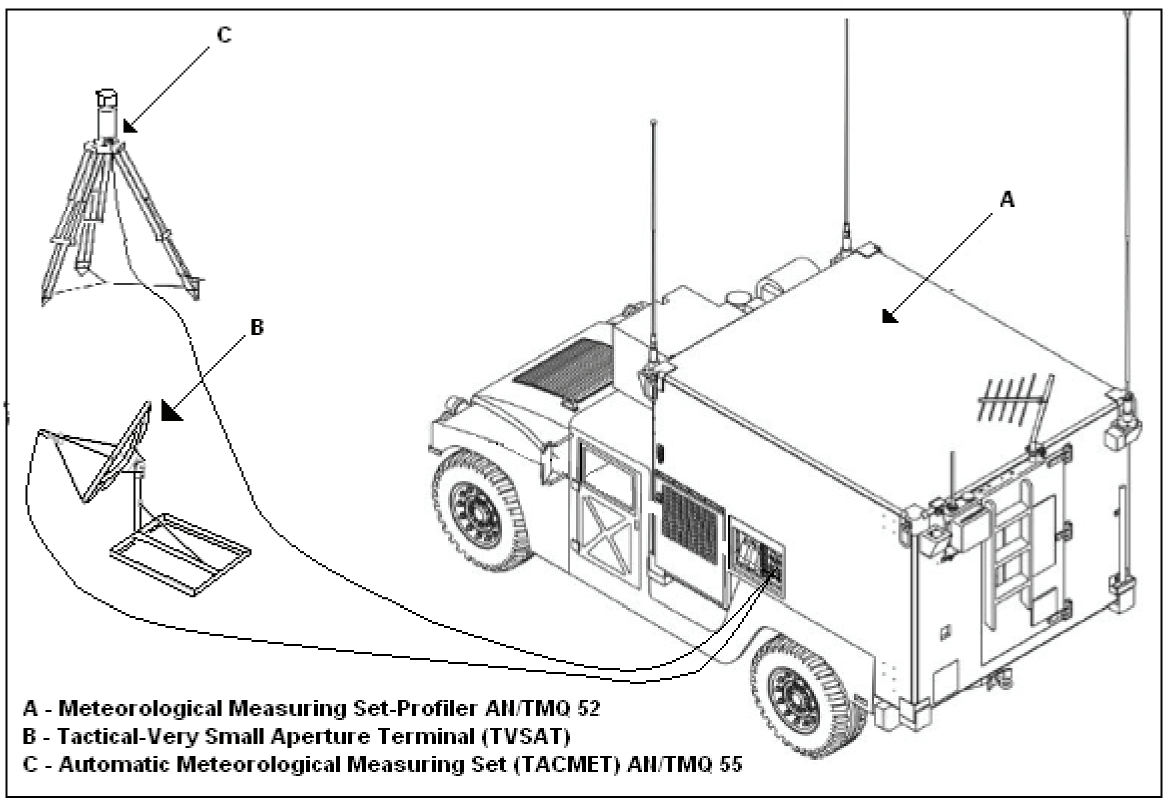


Figure 6-1. AN/TMQ-52 equipment

6-2. The shelter equipment group contains the equipment needed to receive and process MET data transmitted by a radiosonde, obtained by a surface sensor, and received via satellite. The shelter equipment group consists of the systems described below.

NAVAID Antenna System

6-3. When the AN/TMQ-52 operates in the NAVAID mode, the system receives signals from a radiosonde using a VLF antenna. The signal is amplified and passed to the Marwin processor to be used in wind finding.

GPS Antenna System

6-4. When the AN/TMQ-52 operates in the GPS mode, the system receives signals from satellites using the GPS antenna.

6-5. Signals received by the GPS antenna are sent to the Marwin III through the PLGR II/DAGR to be used in GPS wind finding. Using the PLGR II/DAGR provides the MMS–P the capability for using the Precise Positioning Service (PPS) provided by the GPS system. This will allow future Selective Availability Anti-Spoofing Module (SAASM) compliance.

Receiving System

6-6. In both NAVAID and GPS modes, temperature, pressure, and humidity (PTU) data is received by either the omni or directional antenna, amplified by the system and passed to the Marwin processor.

Communications System

6-7. The Unified Post Processing System (UPPS) generates the MET data required to populate the requested MET message. The data is formatted and transferred to the common message processor (CMP) located on the operator interface computer (OIC). The data is available for review in the CMP and is transmitted via SINCGARS radio to the requesting unit.

Lightweight Laser Printer (LLP 2)

6-8. The printer provides a hard copy record of all MET messages.

Power Supply System

6-9. The AN/TMQ-52 operates from an onboard 10-kilowatt auxiliary power unit (APU) providing 240 VAC primary input. The power entry panel and shelter control panel converts the supplied power to the correct voltage for operating the equipment. The system has the capability to be powered by an external power source or can operate using the HMMWV battery and generator system (28 VDC). The air conditioners can be operated only when AC power is used.

T-VSAT Antenna

6-10. The T-VSAT antenna is the primary communications method for receiving a large volume of weather data from the Air Force Weather Agency (AFWA). AFWA transmits, via satellite, NOGAPS data every 12 hours and regional observations each hour. The data is downloaded by the MMS–P using the T-VSAT antenna.

TACMET (AN/TMQ-55)

6-11. The TACMET is a tripod-mounted system that measures barometric pressure, temperature, humidity, and wind speed and direction at the earth's surface. The TACMET is connected to the shelter signal entry panel and surface meteorological data is routed to the OIC. The OIC makes this data available to the modeling software and the Marwin III in support of radiosonde launches.

ASSOCIATED EQUIPMENT

6-12. The radiosonde is a small electronic instrument carried aloft by a free-flight balloon. The radiosonde senses and transmits pressure, temperature, and relative humidity to the MET section. Wind direction and speed are determined through relative measurements of the position of the radiosonde while in flight. The AN/TMQ-52 uses different types of radiosondes (NAVAID or GPS), depending on the operating mode selected for the planned sounding.

COMMUNICATIONS EQUIPMENT

6-13. The communications equipment of previous MET system was configured to transmit MET data based on a planned schedule (push method). The MMS–P communications equipment is configured to allow units to request MET data on demand (pull method). This is accomplished by establishing communications with the Advanced Field Artillery Tactical Data System (AFATDS) device located at the controlling headquarters. The AFATDS device relays requests for MET data to the MMS–P and the resulting MET message to the requesting unit. (Only MMS–P systems using 220C protocol can auto-process MET requests).

Radios

6-14. The MET section is authorized SINCGARS. They are used for communications with MET users and command and control.

Operator Interface Computer

6-15. The operator interface computer contains the CMP software. The CMP allows the operator to view and generate digital message traffic. The OIC interfaces with the tactical communications interface module (TCIM) and the SINCGARS radios used for sending and receiving digital communications between the MET section and remote users.

Interface Unit, Automatic Data Processing (CA-67)

6-16. This telephone, with associated wire connections, is a MSE device that allows for voice and digital communications. The CA-67 provides access to the common user area communications network.

VEHICULAR EQUIPMENT

6-17. Each section is authorized three HMMWV and three trailers. The three vehicles are the heavy-variant HMMWV, and each is equipped with a 200-amp kit. Vehicle one transports the operations shelter. Vehicle two transports helium bottles and tows the trailer containing the balloon inflation equipment and expendable supplies. Vehicle three and trailers transport supplementary equipment. Section IV provides example load plans.

SECTION II AN/TMQ-52 SECTION SITE OPERATIONS

SITE SELECTION

6-18. MET sections are positioned by the operations officer and MET station leader to provide the best possible area of coverage. The modeling capability and the large size (60-kilometer radius) of the MMS–P coverage area gives planners increased flexibility when positioning the system. When selecting a site, the MET section leader must weigh the following considerations:

- Safety.
- Tactical situation.
- Line of sight to satellite (NOGAPS).
- Availability of LORAN and GPS signals.

- Security.
- Communications modes and nets.
- Operating frequencies.
- Electronic warfare activities.
- Areas of coverage.
- Terrain.
- Logistical support.
- Unit attachment.

SURVEY AVAILABLE

6-19. The MET station leader conducts a ground reconnaissance to determine the exact positions for major items of equipment. The MET station leader emplaces the system to fifth-order accuracy or with the GPS. The survey section will provide the MET section with the latitude, longitude, and height of the MET section. The MET station leader can determine station location using the PLGR II. When using the PLGR II, the MET station leader needs to verify the station altitude.

SURVEY NOT AVAILABLE

6-20. If survey support is not available, the MET station leader determines station altitude and location from an area map. The map datum is World Geodetic System 84.

EQUIPMENT SHELTER EMPLACEMENT

6-21. The MET station leader should take into consideration the following when positioning the shelter:

- The shelter should be positioned on firm level ground.
- The shelter cannot be positioned more than 100 feet (30 meters) from the T-VSAT antenna or TACMET because of cable length.
- The shelter should not be positioned under power lines.
- The GPS antenna requires a clear view of the sky for best satellite visibility.
- The T-VSAT antenna requires line of sight to the satellite for the operational area. When locating the T-VSAT antenna, ensure there is no upslope exceeding 3 degrees in front of the antenna.

BALLOON INFLATION SITE

6-22. Upon entering the area of operation, the vehicle transporting the balloon inflation and launching equipment moves to the inflation site. The necessary equipment is unloaded, and the vehicle moves to a concealed area. The inflation site should be downwind of the equipment shelter if possible.

6-23. Figure 6-2 provides an example of a site occupation. Because the maximum cable length is 100 feet (30 meters), the distance between the shelter and its interfacing equipment cannot exceed the following:

- Shelter to T-VSAT antenna - 100 feet (30 meters) maximum.
- Shelter to TACMET sensor- 100 feet (30 meters) maximum.

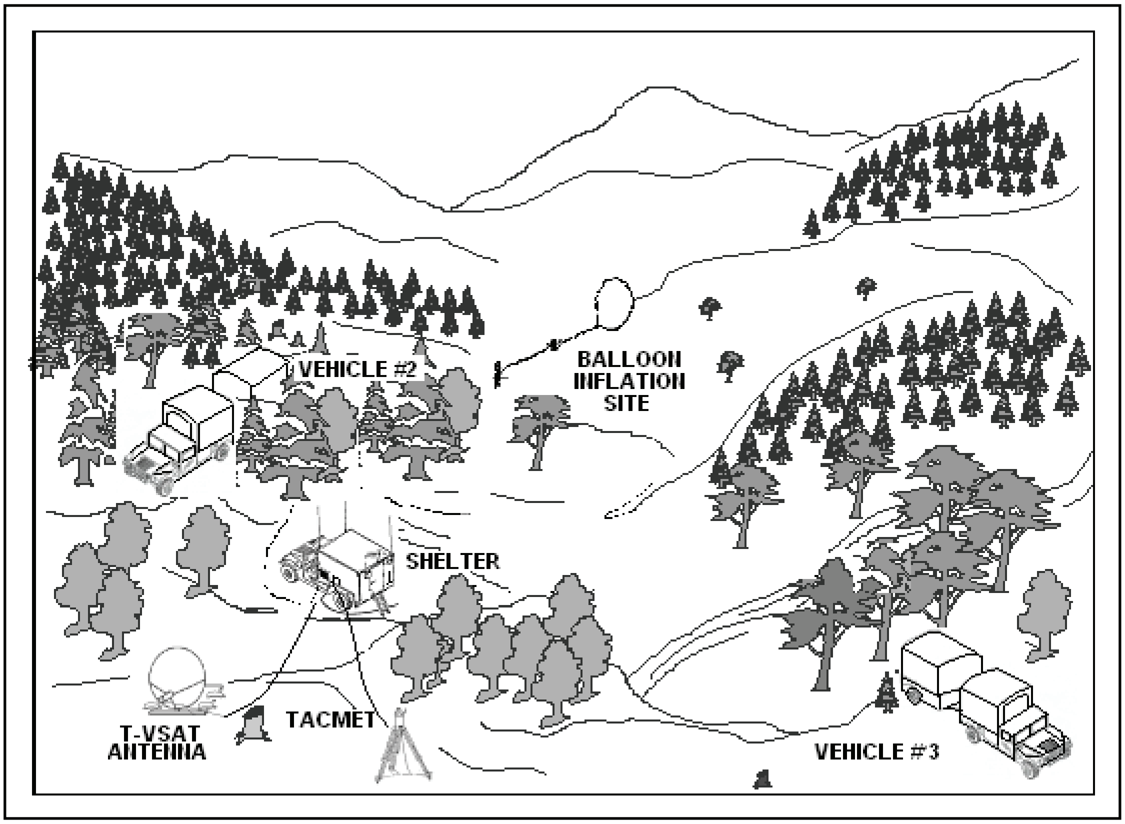


Figure 6-2. Site occupation

CAMOUFLAGE

6-24. The modules of radar-scattering camouflage in table 6-1 are required for camouflaging the system. Camouflage procedures are outlined in TM 5-1080-200-13&P.

Table 6-1. Radar Scattering Camouflage Modules

Equipment	*Modules*
1 1/4-ton truck (shelter) with trailer	3
1 1/4–ton truck with trailer	3
1 1/4–ton truck with trailer	3

DISPLACEMENT PROCEDURES

6-25. Commanders move MET sections as needed to maintain MET support. Therefore, crew members must be trained and able to displace, move, and occupy a new site rapidly during critical periods of the battle. The MET station leader informs the operations officer when the validity of the last message from the current position will expire and how much time is required to march-order the section. He recommends the best time to make the displacement and a course of action to relay MET data from adjacent sections while the section is displacing. The MET station leader's briefing of section personnel before each displacement should include, as applicable, the following:

- Broadcast time of the last MET message from the current position.
- Broadcast time of the first MET message from the next position.

- Download time for current NOGAPS data. (NOGAPS data is transmitted every 12 hours and provides the section with 72 hours of valid data. If the section is displacing during the NOGAPS download period, coordination is made with adjacent MMS–P to acquire NOGAPS download.)
- Procedures for monitoring, copying, and transmitting MET data from adjacent MET sections on both the left and right flanks.
- Section march-order sequence and when the camouflage systems will be dropped, packed, and loaded.
- Departure time and whether the section has road clearance to move independently.
- Where the MET vehicles will be positioned in the battery column.
- Route of march and any significant landmarks.
- Designation of the section representative on the reconnaissance party.

SECTION III AN/TMQ-52 SECTION PERSONNEL

6-26. The MOS and Rank for personnel in a MMS Section is directly related to the level of responsibility and knowledge required. The more senior the Rank, the more responsibility and knowledge the individual is expected to possess (see Table 6-2).

6-27. All personnel within the MMS section will possess the 13W MOS. However, two positions will have an Additional Skill Identifier (ASI) that indicates they have successfully completed the Unit level maintenance course for Meteorology Equipment.

Table 6-2. AN/TMQ-52 Section Personnel (U.S. Army)

U.S. ARMY			
Title	***MOS***	***Rank***	***Quantity***
MET station leader	13W40	SFC	1
FA MET section chief	13W30	SSG	1
FA MET equipment repairer	13W20H1	SGT	1
FA MET equipment repairer	13W10H1	SPC	1
FA MET crew member	13W10	SPC	1
FA MET crew member	13W10	PFC	1
		Total	6
Legend: SFC = Sergeant First Class SSG = Staff Sergeant SGT = Sergeant	SPC = Specialist PFC = Private First Class		

NOTE: Marine Corps do not currently field MMS–P system.

FA MET STATION LEADER (SFC, MOS 13W40)

6-28. The MET station leader will—

- Advise the operations officer and staff of tactical and technical considerations affecting employment of the MMS–P and assist in preparing the MET plan.
- Supervise MET section operations.
- Coordinate with the S4 for logistical support.
- Coordinate with the signal staff officer to prioritize means of communication and dissemination of messages.

- Perform site selection and location.
- Direct the operation, emplacement, and displacement of the MET section.
- Maintain quality control of MET data, submit necessary reports, and maintain a flight log.
- Retain the flight log and copies of messages in accordance with AR 25-400-2.
- Advise the operations officer on all factors affecting mission capabilities, such as personnel, maintenance, and logistics.
- Review, consolidate, and prepare technical, personnel, and administrative reports covering MET section and station activities.
- Organize and supervise the MET section training program.
- Supervise operator maintenance of MET, communications, and vehicular equipment.
- Supervise preparation and distribution of all MET messages.
- Ensure adherence to all safety procedures.
- Manage met section logistics for repair parts and expendable items.
- Assign personnel to MET teams.
- Instruct and lead crew members in MET procedures.
- Determine information relative to NOGAPS download (transmission times and satellite information).
- Perform first sergeant type duties when operating away from the unit for extended periods of time.

FA MET SECTION SERGEANT (SSG, MOS 13W30)

6-29. The FA MET section sergeant will—

- Provide leadership and technical guidance to subordinate personnel.
- Serve as off-shift senior sergeant during periods of extended operation.
- Check data and records.
- Examine data samples for quality control.
- Inspect grounding equipment.
- Decode wind messages.

FA MET EQUIPMENT REPAIRER (SGT, MOS 13W20H1)

6-30. The FA MET equipment repairer sergeant will—

- Supervise the second shift during 24-hour operations.
- Perform unit maintenance on section MET equipment.
- Ensure communications are maintained with all users.
- Perform administrative duties as required.
- Supervise subordinate equipment repairer during maintenance procedures.

FA MET EQUIPMENT REPAIRER (SPC, MOS 13W10H1)

6-31. The FA met equipment repairer specialist will—

- Operate MET equipment on his assigned shift.
- Perform unit maintenance on section MET equipment.
- Operate organic communications equipment.
- Drive the vehicle.

FA MET CREWMEMBER (SPC, MOS 13W10)

6-32. The FA MET crew member specialist will—

- Operate MET equipment on his assigned shift.
- Help prepare the balloon train.
- Drive the vehicle.

FA MET CREWMEMBER (PFC, MOS 13W10)

6-33. The FA met crew member private will—

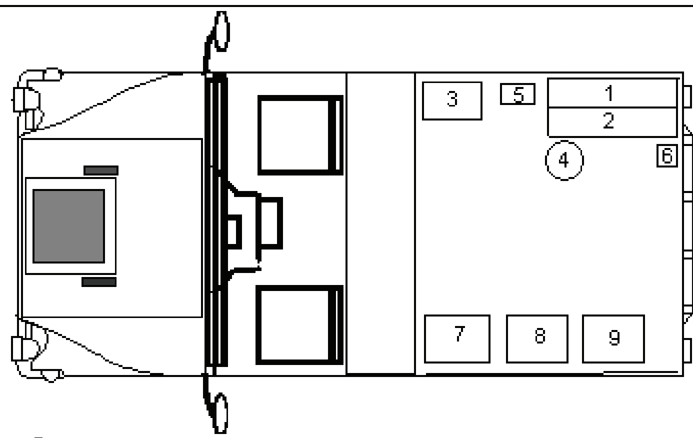
- Operate MET equipment on his assigned shift.
- Help prepare the balloon train.
- Drive the vehicle.

SECTION IV SUGGESTED LOAD PLANS

6-34. The loading plan for the MMS Section is extremely important. Loading plans are the key to ensuring everyone knows where each component or piece of equipment is located (for examples see figure 6-3, 6-4, and 6-5.

6-35. A good load plan will cut down on the time required to find items as well as store items for transport.

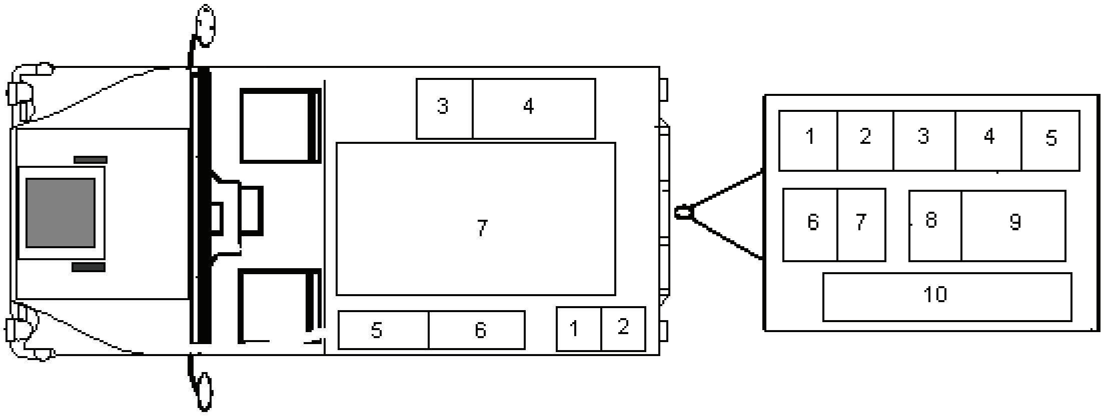
Figure 6-3 Vehicle 1 (shelter) load plan



LEGEND

VEHICLE

1. Storage Drawer #1
   A. Computer Paper (1 Ream)
   B. Toner Cartridge (1 ea)
   C. Cleaning Kit (1 ea)
   D. Replacement Filers (VCU/CFPD)
2. Storage Drawer #2
   A. Anemometer (1 ea)
   B. Aspirator, Psychrometer (1 ea)
   C. Barometer, Digital (1 ea)
   D. Compass, Magnetic (1 ea)
   E. Multimeter (1 ea)
   F. Tool Kit, TK-33
   G. Tool Box TK-101
3. Safe
4. Fire Extinguisher (1 ea)
5. CA-67 Telephone (1 ea)
6. Grounding Equipment (1 Set)
7. BII (1 Set)
8. Field and Technical Manuals (1 Set)
9. Combat Lifesavers Bag (1 ea)



LEGEND:

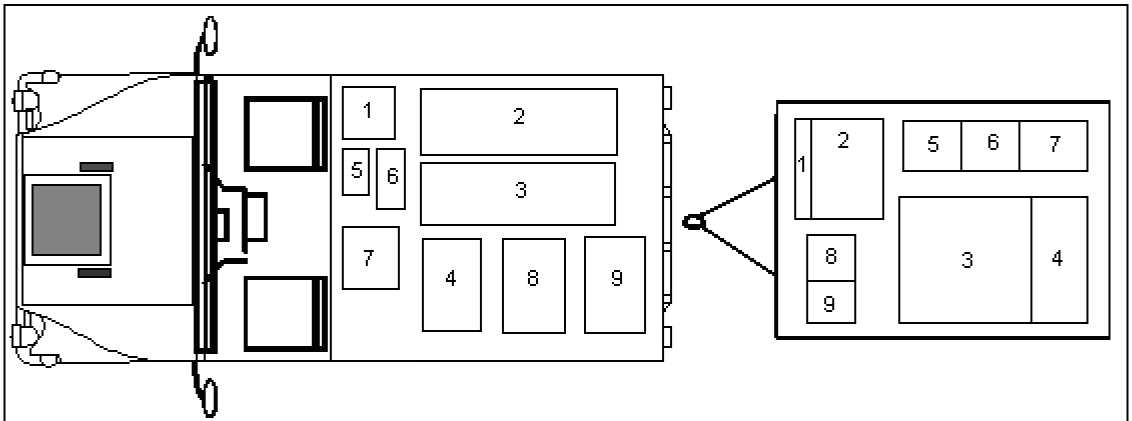
VEHICLE

1. Fire Extinquisher (1 ea)
2. 5 gal water cans (2 ea)
3. BII (1 set)
4. Personnel Ruck Sack (2 ea)
5. Personnel A bags (2 ea)
6. Personnel B bags (2 ea)
7. Helium Rack (16 Helium Bottles)

TRAILER

1. Balloon Inflation Launching Device (1 ea)
2. Volume Meter (1 ea)
3. Balloons
4. Parachutes
5. Radiosondes
6. Inflation Kit (twine, scissors, light sticks, wrist grounding strap, nozzles, shroud, volume regulator, 20 balloons)
7. Cots (2 ea)
8. MRE (4 ea)
9. Camouflage Nets (3 ea)
10. Camouflage Support Systems (3 ea)

Figure 6-4 Vehicle 2 load plan



LEGEND:

VEHICLE

1. Petroleum, Oils, and Lubricants
2. Personnel A Bags (4 ea)
3. Personnel B Bags (4 ea)
4. Personnel Ruck Sacks (4 ea)
5. 5 Gallon Water Can (2 ea)
6. BII (1 set)
7. MRE (8 cases)
8. Camouflage Nets (6 ea)
9. Camouflage Support Systems (6 ea)

TRAILER

1. Field Table
2. Heating Stove
3. Tents, GP Small (1 ea)
4. Cots (4 ea)
5. Maintennace Supplies including spare parts
6. Communications Box
7. TA 312, DRKw/reels
8. OE-254 Antenna
9. Test/diagnostic Equipment (1 ea)

Figure 6-5 Vehicle 3 load plan

Chapter 7

Balloon Inflation and Launching Procedures

This chapter describes the procedures for inflating and launching balloons.

SECTION I OVERVIEW

WARNING

HYDROGEN GAS IS EXTREMELY FLAMMABLE AND SHOULD BE CONSIDERED EXPLOSIVE WHEN CONFINED UNDER PRESSURE IN THE PRESENCE OF AMBIENT AIR. STORAGE, HANDLING, AND DISPOSAL PROCEDURES MUST BE STRICTLY FOLLOWED. SEE APPENDIX G FOR DETAILED INFORMATION.

7-1. While the MET equipment is being emplaced, powered, and initialized, the MET station leader dispatches two crew members to the balloon inflation area to prepare a balloon for the sounding. Since balloon inflation is the most time-consuming of all the section tasks, the section should begin this task as soon as possible after it arrives at the site (MMS equipped sections). The MET section inflates sounding balloons by using the inflation and launching device or an inflation shelter. The balloons are inflated by compressed gas.

SAFETY PROCEDURES

7-2. In addition to the normal safety measures prescribed for all Soldiers, MET personnel must be cautious when using compressed gas.

HYDROGEN GAS

7-3. Hydrogen gas is highly flammable. Since helium is an inert gas, it should be used, when available, to inflate balloons. If hydrogen must be used, the safety precautions below must be carefully followed. MET crew members should—

- Display conspicuous warning signs where hydrogen is generated, used, or stored. For example, **DANGER-HYDROGEN - No Smoking Within 50 Feet (15 meters)**.
- Never light a match, smoke, or create sparks near a site where hydrogen is used. They should remove all possible sources of flame and sparks.
- Wear rubber-soled shoes during inflation. They should not wear shoes with exposed nails, which might strike against metal, stones, or concrete floors and produce a spark. Materials such as wool and nylon should not be worn when inflating with hydrogen gas.
- Never drop or strike metal tools against anything that might cause a spark.
- Remove all metal objects, such as watches and key chains, prior to inflating the balloon.
- Never mix hydrogen with air. They should expel all air from the balloon before inflating it with hydrogen.
- Never expose the hydrogen cylinders to direct sunlight. Always store hydrogen bottles in the shade.

- Remove all constrictions from the balloon neck; keep all hydrogen passages clear.
- Use inflation and launching device to minimize balloon handling.
- Inflate the balloon slowly on days of low relative humidity when static electricity is easily generated. If the air temperature is above freezing, MET crew members should lightly sprinkle the inflation area with water.
- Inflate the balloon slowly when using compressed hydrogen or helium in order to avoid bursting or over-inflation. They should use the compressed gas regulator. A crew member adjusts the regulator so that no more than 10 pounds per square inch (PSI) (.7030696 Kg/Cm squared) of gas is being released into the balloon.
- Never deflate a hydrogen-filled balloon; release it gradually.

WARNING

IF THE HISSING SOUND OF A GAS LEAK FROM THE BALLOON IS HEARD, CLOSE THE CYLINDER VALVE IMMEDIATELY. TWIST THE NECK OF THE BALLOON, REMOVE IT FROM THE INFLATION LAUNCHING DEVICE, AND RELEASE IT.

- Wear a metal wristband connected to a flexible wire that leads to a good ground when in an area where inflation is in progress. The band and wire will provide a path to ground for static electricity.
- Ground the inflation equipment to provide a path to ground for any static electricity generated in the equipment. They should also use ground cables to interconnect all metal parts of the inflation equipment with ground.
- Follow the two-man rule for safety even though not all procedures require two personnel.
- See TMs 11-6660-222-12, 11-2413, and 11-6660-287-13, and Federal Meteorological Handbook (FMH) No. 3 for further information on hydrogen safety precautions. Safety precautions for handling commercial hydrogen are in AR 700-68.

GROUNDING PROCEDURES

7-4. Whenever hydrogen is used, MET crew members must use ground cables to connect all metal parts of the equipment to each other and to a grounding field made of a minimum of two ground rods. On days of low relative humidity, when static electricity is high, use additional grounding rods. Metal surfaces are cleaned with sandpaper to get a good connection. Then ground clamps or alligator clips are used to connect the cables to the metal. A crew member in the immediate area where hydrogen is being used should be individually grounded by using the issued grounding strap assemblies. A path to ground for static electricity is particularly important for the crew member who actually handles the balloon. Detailed grounding techniques are explained in TC 11-6 and FMH No. 3. Also, see figures 7-1 and 7-2 for examples.

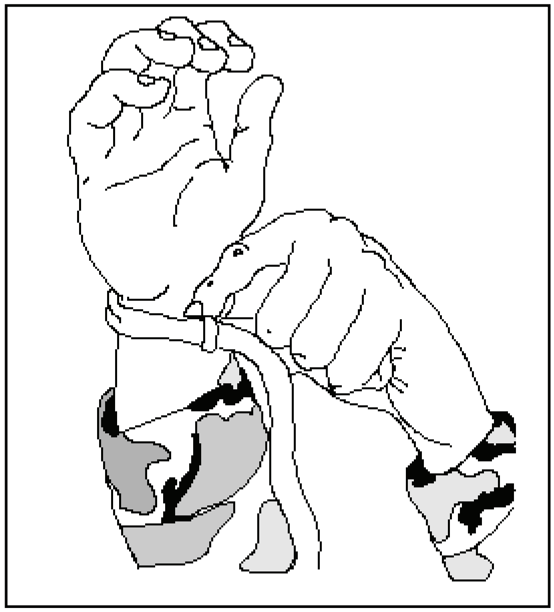


Figure 7-1. Personnel ground

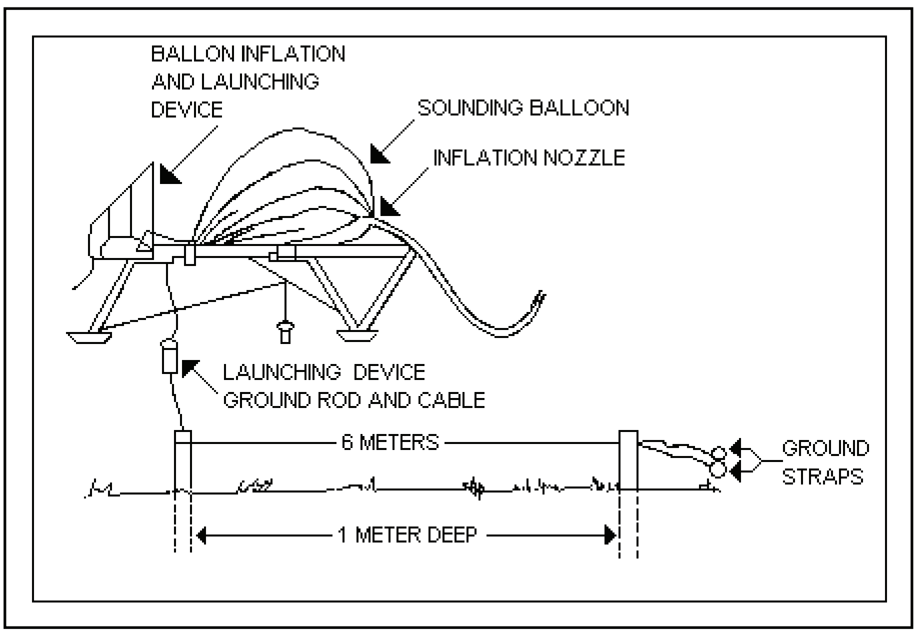


Figure 7-2. Completed grounding field

GASES USED FOR INFLATION

7-5. The MET section inflates all balloons with either hydrogen or helium gas. Helium and hydrogen are available commercially in compressed gas cylinders. MET sections normally use cylinders containing approximately 200 cubic feet (5.67 cubic meters) of gas. The MET station leader must plan time carefully to ensure that a balloon is fully inflated and ready for release at the scheduled release time.

Helium

7-6. Helium is the safest gas to use because it is not explosive, but it cannot be made artificially. Helium is extracted from mines, stored in heavy cylinders, and shipped in cylinders for MET section use. Using commercially produced helium gas to inflate a balloon is quicker and much safer than inflating with locally generated hydrogen; however, it is difficult to resupply.

Hydrogen

7-7. Hydrogen gas, unlike helium, is explosive and using it is dangerous. Accordingly, MET crewmembers must follow all safety procedures for use of hydrogen to include using the balloon inflation launching device. The MET station leader schedules classes on inflation using hydrogen gas to maintain section members' proficiency.

SECTION III INFLATION PROCEDURES

BALLOON INFLATION AND LAUNCHING DEVICE, ML-594/U

7-8. The balloon inflation and launching device, ML-594/U, is a portable inflation shelter and launch platform designed for field use. It secures the sounding balloon and protects it from weather during inflation and launching. It can be used with a compressed gas supply by using the hydrogen-helium volume meter ML-605/U. It should be used whenever hydrogen gas is used for inflation. The balloon inflation and launching device is explained in TM 11-6660-238-15.

COMMERCIAL GAS REGULATORS

7-9. Pressure regulators are used along with associated couplings with commercial hydrogen or helium cylinders to control the pressure of the compressed gas being released for inflation of a balloon. The regulator also indicates the amount of gas remaining in the cylinder. The regulators are adjusted to allow no more than 10 PSI (.7032 kg/cm) of gas to be released into the balloon.

BALLOONS

7-10. Balloons should be kept sealed in their original containers until just before use. They should be stored in a dry place and at moderate temperatures. All balloons deteriorate with age; therefore, oldest balloons should be used first.

Sounding Balloons

7-11. The sounding balloon carries aloft a radiosonde and associated equipment, such as a parachute and a night-lighting unit. Sounding balloons are made of neoprene and are designed to lift radiosondes to certain minimum altitudes at specified rates of ascent. The bursting altitude of a sounding balloon depends on its condition and type and on the inflation procedure used. High-altitude balloons weigh 1,000 to 1,200 grams and burst near an altitude of 32,000 meters. At night, the balloons normally burst at lower altitudes. Bursting altitudes are with respect to mean sea level.

Pilot Balloon

7-12. This balloon provides a means of determining the speed and direction of winds aloft. The 100-gram pilot balloon also can be used as a sounding balloon up to 3,000 meters. The theodolite operator can observe a pilot balloon to a height of about 14,000 meters. Under various sky conditions, some colors are more easily detected by the eye than others. For this reason, pilot balloons are issued in several colors. The most common colors are white, red, and black. A general rule in selecting the color of the balloon is the darker the sky, the darker the balloon.

7-13. Pilot balloons are also used to determine cloud height. This is done by inflating the balloon to a known rate of rise and timing the balloon until it goes into the clouds.

PREPARATION OF BALLOONS

7-14. After exposure to relatively low temperatures and extended periods in storage, neoprene balloons lose some of their elasticity through the crystallization of the balloon film. Neoprene balloons burst prematurely if used in this state. MET personnel should inspect balloons prior to their use and discard any that are brittle,-especially when using hydrogen. MET personnel should also discard any balloons older than 5 years.

BALLOON CONDITIONING

7-15. Usually, exposure of the balloon to room temperature (21°C) for 24 hours is all the conditioning required. Store balloons in their sealed package and do not expose to direct light or heat. Discoloration has no effect on the balloon film as long as it is not the result of exposure to direct sunlight for several hours. In direct sunlight and in most types of artificial lighting, discoloration is caused by the antioxidant included in the compounding.

INFLATION

7-16. A balloon may be inflated immediately after conditioning, or it may be kept under normal storage conditions and then inflated. All balloons should be at room temperature before inflation.

NIGHT-LIGHTING UNIT

7-17. The night-lighting unit provides a light source that allows the tracking of pilot and sounding balloons at night. The lighting unit is called a light stick. A light stick is a small transparent tube containing a liquid chemical. When the light stick is snapped, the chemical begins to emit enough light for tracking balloons.

DETERMINING LIFT FOR BALLOONS

7-18. A crew member determines the amount of gas required for the balloon to be used before beginning the inflation process. The procedure below is used to determine the amount of gas required.

DETERMINING REQUIRED FREE LIFT

7-19. Free lift is the net upward force required for the balloon to ascend at a given rate. The ascent rate of the balloon mainly depends on the amount of gas in the balloon. Other factors affecting ascent rate are the shape, size, and physical texture of the balloon and the state of the atmosphere through which the balloon travels. Table 7-1 is used to determine the amount of free lift for sounding and pilot balloons during fair weather.

Table 7-1. Balloon Ascent Rate, Free Lift, Weight, and Bursting Altitude

Balloon Type	***Ascent Rate (meters per minute)***	***Free Lift Weight (grams)***	***Balloon Weight (grams)***	***Bursting Altitude (meters)***
Sounding Balloons				
(Day)				
200 Gram Balloon	320	510	200	21,200
ML-635	400	1,100	150	10,668
ML-537	305	1,600	1,000	30,479
ML-519	300	1,200	300	16,000
(Night)				
ML-635	400	1,300	150	10,668
ML-537	305	1,900	1,000	30,479
ML-519	300	1,200	300	16,000
Pilot Balloons				
ML-159A (White)	302	500	100	15,000
ML-160A (Black)	302	500	100	15,000
ML-161A (Red)	302	500	100	15,000
ML-50A (White)	183	140	30	10,000
ML-51A9 (Black)	183	140	30	10,000
ML-64A (Red)	183	140	30	10,000

COMPUTING REQUIRED TOTAL LIFT

7-20. Total lift is defined as the weight (grams) of the balloon with attachments that must be balanced by the gas volume in the inflated balloon for the balloon to ascend at a desired rate. Total lift is composed of the weight of the balloon, its free lift, the weight of any attachment to the balloon train, and the weight added, if any, to compensate for adverse weather. See table 7-2 for weights of attachments. Table 7-3 indicates additional weights needed to compensate for adverse weather conditions.

Table 7-2. Weights of Attachments

Attachment	***Weight (grams)***
Radiosonde with Battery	
ML-659	823
ML-662	250
ML-663	250
ML-664	250
ML-665	450
ML-666	450
ML-667	450
RS-92-KL	250
RS-92-AM	270
Parachute-ML 132	150
Commercial Parachute	80
Lighting Unit	15
Sounding Balloons	
ML-635	150
ML-537	1,000
ML-519	300
Pilot Balloons (PIBAL)	
ML-159A	100
ML-160A	100
ML-161A	100
ML-50A	30
ML-51A	30
ML-64A	30
NOTE: Balloon weights vary. The weight of the balloon is stamped on the box.	

Table 7-3. Additional Weights for Adverse Weather Conditions (Sounding only)

Weather Conditions	***Additional Weight Required (Grams)***
Light precipitation	200
Heavy precipitation	400
Zone winds averaging more than 60 knots (1000-gram or larger balloons only)	600-1,200

DETERMINING GAS VOLUME REQUIRED

7-21. To obtain the proper amount of gas required for total lift, a crew member must convert total lift in grams to cubic feet. He does this by using the nomograph (figure 7-3).

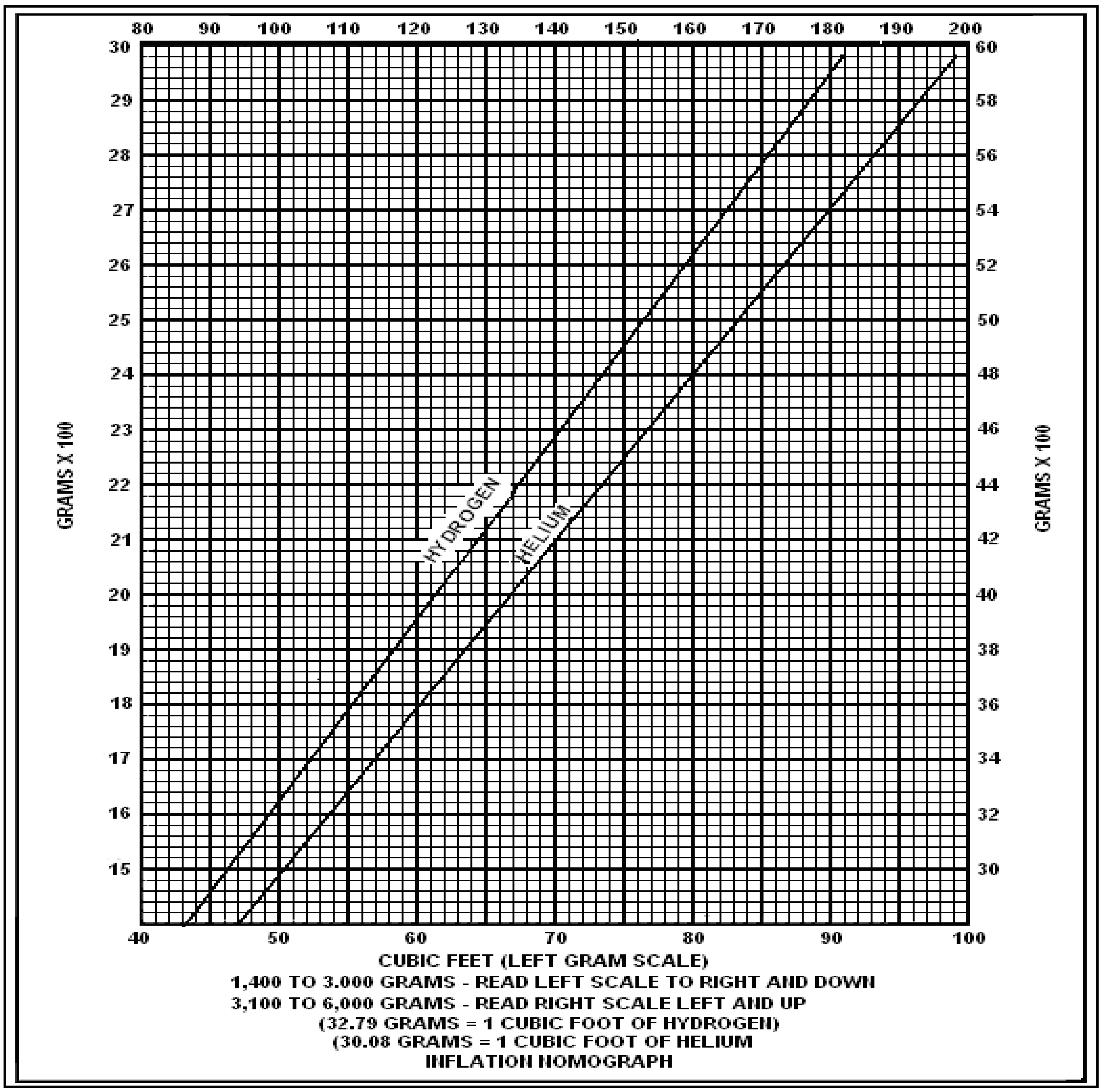
TOTAL LIFT LESS THAN 3,000 GRAMS

7-22. If total lift is from 1,400 to 3,000 grams, he enters the nomograph with total lift in grams along the **left** edge. He reads across to the line on the chart that represents the gas to be used (helium or hydrogen) and then **down** from the line to the metered cubic feet required for total lift.

TOTAL LIFT GREATER THAN 3,100 GRAMS

7-23. If total lift is 3,100 grams or greater, he enters the nomograph with total lift along the **right** edge. He reads across to the line on the chart that represents the gas to be used (helium or hydrogen) and then **up** from the line to the metered cubic feet required for total lift.

Figure 7-3. Inflation Nomograph



INFLATION USING THE INFLATION AND LAUNCHING DEVICE

7-24. The inflation and launching device should be used when inflating with hydrogen. When the inflation launching device is used, the crew members inflate the sounding balloon with the required amount of gas volume determined from the nomograph. See figure 7-4 for an example.

An example of the computation of the total lift required for a typical daytime radiosonde ML-659 flight using balloon ML-537/UM is as follows.	
Balloon ML-537 (Table 8-1)	1,000 grams
Required free lift (Table 8-1)	1,600 grams
Weight of radiosonde and parachute (Table 8-2)	973 grams
Total lift required	3,573 grams
Total lift expressed to next higher 100 grams	3,600 grams
The total lift is 3,600 grams and the compressed gas being used is helium. From the nomograph (Figure 8-4) 3,600 grams equals 120 cubic feet. Thus, the operator meters 120 cubic feet of compressed gas.	

Figure 7-4. Required total lift example

7-25. When crew members use commercial gas for inflation, they obtain the correct total lift by inflating the balloon until the volume meter ML-605/U reads the cubic feet required as determined from the nomograph.

INFLATION SHELTER

7-26. There may be times when a MET station is in a fixed position and has some type of inflation shelter. If an inflation shelter is available, MET section personnel do not use the inflation and launching device. The section uses an inflation shelter; that is., the covered cargo area of a prime mover, to inflate the small pilot balloon.

WEIGHING-OFF PROCEDURE

7-27. When an inflation shelter is used for inflation, the crew members determine when the balloon is properly inflated by using a weighing-off procedure. A crew member attaches the balloon to an inflation nozzle with appropriate weights to simulate the effect of free lift and the weight of the balloon train. When the sounding balloon lifts the inflation nozzle off the surface, it is properly inflated. The pilot balloon is properly inflated when it hangs suspended in midair, neither rising nor falling.

WEIGH-OFF CALCULATIONS

7-28. To achieve weigh-off, a crew member must calculate the required weights to be added to the inflation nozzle. For example, to calculate the weight required to be added to the ML-196 nozzle of a sounding balloon, a crew member must determine total lift. The weight of the balloon is not figured in the total weight because as the balloon is inflated it automatically compensates for itself. The nozzle weight (1,500 grams) is deducted, and the remainder is the additional weight required to be placed on the nozzle. The nozzle weights are 100, 200, 400, 500, and 1,000 grams. See figure 7-5 for an example.

To achieve weigh-off, a crew member calculates the following:	
Total lift required	3,600 grams
Minus the weight of the balloon	-1,000 grams
Minus the weight of nozzle ML-196	-1,500 grams
Additional weight required	-1,100 grams
Thus, a crew member adds the 1,000- and the 100-gram weights to the nozzle and attaches them to the balloon to equal the required total lift. When he has allowed enough gas to flow into the balloon to cause the balloon to just lift the inflation nozzle with weights off the ground, the inflation is completed.	

Figure 7-5. Weigh-Off example

NOZZLES AND WEIGHTS

7-29. Inflation nozzle ML-575, ML-373/GM, and ML-196 are component parts of the MET station. They are used in the weighing-off procedure performed in an inflation shelter or in an area of still air. They provide a connection between the hose ML-81 and the balloon during inflation and act as a calibrated weight in determining the correct amount of total lift during weigh-off.

PILOT BALLOON NOZZLES

7-30. ML-575 or ML-373 nozzles are used to inflate the pilot balloon. The correct free lift for a 100-gram pilot balloon is 500 grams. The ML-575 and the ML-373 with its collar weight compensate for the free lift.

SOUNDING BALLOON NOZZLE

7-31. The inflation nozzle ML-196 weighs 1,500 grams and is issued with five weights. A crew member must add the correct combination of weights to the nozzle to simulate free lift and balloon train weight before inflation.

NOZZLE CARE

7-32. Crew members must keep the nozzles free of dirt, lime, or other foreign matter that will alter its weight or obstruct the gas passages.

INFLATING THE PILOT BALLOON

7-33. A crew member first shakes the balloon to remove the powder inside and rolls it up to expel any air. To expel the air and debris from the hose and connections to the gas source, briefly turn the gas on and immediately shut the gas off. The balloon is weighed-off properly when it hangs suspended in midair with appropriate weights attached. When inflating the pilot balloon, a crewmember must first install weights, when required, on the neck of the nozzle. If a night-lighting device is to be attached to the balloon, he must add additional weights to the nozzle to compensate for the greater air resistance caused by the increased size of the balloon. The additional weights required are 70 grams for the 30-gram pilot balloon and 50 grams for the 100-gram pilot balloon. Once he has added the weights to the nozzle, he then stretches the neck of the balloon over the connection of the nozzle.

INFLATING THE SOUNDING BALLOON

7-34. The procedures for inflating the sounding balloon when using the inflation and launching device and when using an inflation shelter are discussed below.

INFLATION AND LAUNCHING DEVICE

7-35. The inflation and launching device should be used when inflating with hydrogen. A crew member first shakes the balloon to remove the powder inside and rolls it up to expel any air. To inflate the sounding balloon with the required volume of gas, crew members use the procedure in TM 11-6660-238-15. Crew members must fill the balloon with gas by using the volume meter.

INFLATION SHELTER

7-36. A crewmember first shakes the balloon to remove the powder inside and rolls it up to expel any air. The balloon is attached to the inflation nozzle by tying it with a small piece of twine. The crewmenber then attaches to the inflation nozzle the combination of weights required to balance the required total lift.

TYING OFF THE BALLOON

7-37. When inflation of either the pilot balloon or the sounding balloon is complete, the crewmember firmly seals the balloon neck with twine and disconnects the hose from the inflation nozzle. The inflation nozzle and any weights used from the tied off balloon is removed. The crewmember is then ready to attach the balloon train to the balloon, if one is required. Figure 7-6 shows the correct tying off procedures.

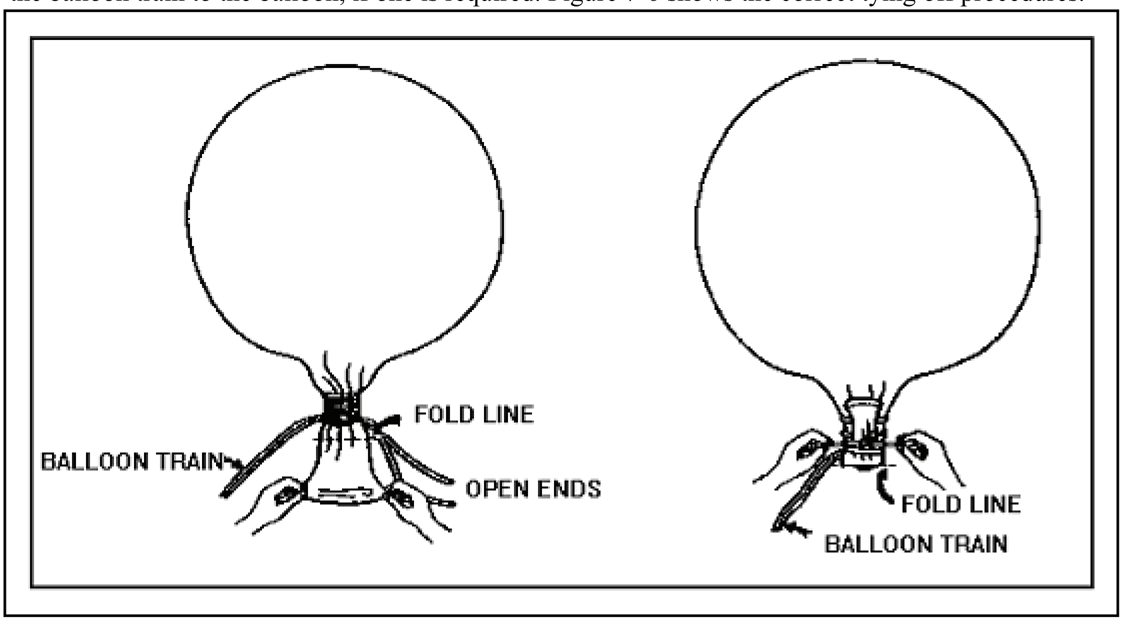


Figure 7-6. Tying off the balloon

BALLOON TRAIN

7-38. The balloon train is the trailing end of the twine used to seal or tie off the inflated balloon. Components such as the radiosonde and parachute are further attached to the balloon train and become a part of it. A night-lighting device may be included in the train between the parachute and the radiosonde to aid initial tracking of the balloon-borne radiosonde. The balloon train is normally approximately 20 meters long in order to dampen the oscillation of the radiosonde.

7-39. When a crew member has properly inflated the balloon, he/she removes the inflation nozzle and seals and ties off the balloon. The crew member doubles a 20-meter length of twine to a 10-meter length (double strength) and ties and seals the neck of the balloon with the open end of the twine. Next, unless the crew member is in an active theater of operations, the parachute is secured to the closed end of the doubled twine. Normally, the parachute is not used in combat operations. The crew member then doubles another 20-meter length of twine, secures the open end to the bottom of the parachute suspension lines, and ties the radiosonde to the closed end. If the radiosonde being used has an unwinder, the crew member shortens the length of twine from the balloon to the parachute to approximately 1 meter and ties the radiosonde directly to the parachute suspension lines. In moderate to high winds, twine should be manually unwound and secured to prevent damage to the radiosonde during release. Figure 7-7 shows the balloon train.

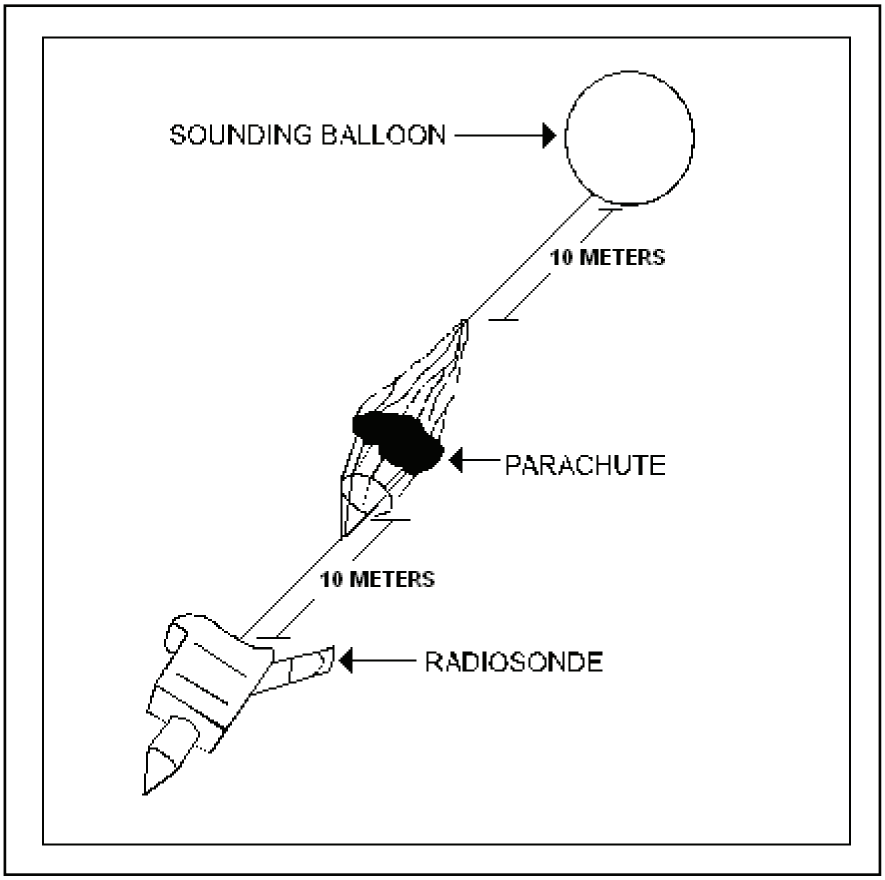


Figure 7-7. Balloon train

SECTION IV RELEASE PROCEDURES

NOTE: If operating in the vicinity of an airfield, notify the air traffic control tower prior to balloon release.

7-40. Because of the time it takes to prepare each sounding and the cost of the components, the MET section crew members must make every effort to release a balloon without damaging the components. Damaging the train during release causes disruption of the scheduled release times. This could affect the mission of the artillery. There are several release methods. Which method to use depends on the surface weather conditions at the time of release. The release methods for the balloon train are discussed below. They should be followed to ensure that the balloon train release is achieved without damaging any component.

RELEASING FROM THE INFLATION AND LAUNCHING DEVICE

7-41. During periods of no wind, one crewmember can release the balloon train by using the inflation and launching device; however, release normally requires two or more persons. During periods of moderate winds, two crew members release the balloon train. If there are high winds or rain or if the section is using a larger sounding balloon, additional crewmembers may need to help in the release. After the balloon is inflated, crewmembers move the inflation and launching device with the balloon train attached downwind and position it with the front of the inflation and launching device pointing downwind. If there are high winds, they may have to stake the skids of the inflation and launching device to the ground to ensure stability. Just before release, a crew member removes the safety strap from the lift dot fastener stud and manually positions the release strap fastener in the groove on the stud to ensure that the proper release action will occur. When the section is ready to release, a crew member takes the radiosonde part of the balloon train downwind from the inflation and launching device. The crewmember holding the radiosonde pulls on the radiosonde end of the balloon train. This action frees the master loop and allows the end of the canopy to open. When the canopy opens, the balloon is released. When the balloon has risen to an altitude where the balloon train supports the attached components clear of the ground, the release of the radiosonde is completed and the sounding is underway. Figure 7-8 shows a release from the inflation and launching device.

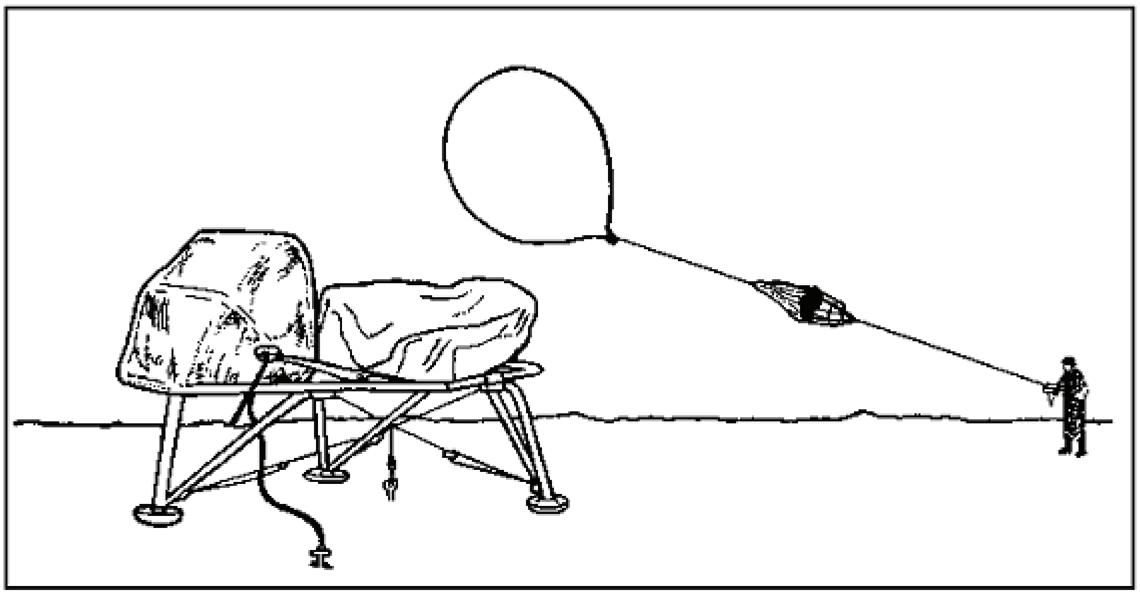


Figure 7-8. Release from the inflation and launching device

RELEASING FROM AN INFLATION SHELTER

7-42. When the section uses an inflation shelter to inflate the balloon, the crewmembers release the balloon by using either the hand-over-hand method or the two-man running-release method.

HAND-OVER-HAND

7-43. The section uses the hand-over-hand method when the surface winds are relatively calm. Normally, use of this method of release requires two crew members. One crewmember takes the radiosonde and moves downwind until the length of the train is taut. This crew member serves as the balloon train anchor until time of release. The second crew member grasps the balloon by the neck and removes the balloon from the inflation shelter. He/she then plays out the balloon and its attached train in a hand-over-hand fashion, moving toward the first crew member and keeping the twine taut until the radiosonde is lifted off the ground.

NOTE: Do not use this method with a hydrogen-filled balloon.

TWO-MAN RUNNING RELEASE

7-44. The section uses the two-man running-release method in moderate to high winds. One crew member holds the balloon neck. Another crew member holds the radiosonde upright and assumes a position the full length of the train downwind from the balloon. The first crew member releases the balloon at the given signal, and as the balloon rises, the crew member holding the radiosonde runs with it while trying to keep the train taut and maintain a position downwind of the rising balloon. When the balloon is directly overhead and the train is taut, the crew member holding the radiosonde allows the balloon to lift the radiosonde from the hands.

RELEASE USING A BALLOON SHROUD

7-45. When using the inflation shelter in moderate to high wind conditions, the crew member may choose to use the shroud to aid in the release of the balloon train. The shroud is designed to protect the sounding balloon while it is being moved to the point of release and to aid in releasing it under high wind conditions. The shroud consists of a hood, four flaps (each of which terminate in a D handle), and a top cord. The procedure for releasing a balloon by using a balloon shroud is discussed below.

NOTE: Do not use the balloon shroud with a hydrogen-filled balloon.

SHROUD POSITIONING

7-46. To place the balloon in the shroud, a crew member must lower the balloon as close as possible to the ground. The crew member then places two of the shroud flaps over one side of the balloon and allows the balloon to rise under the shroud. The top cord is attached to the loop at the top of the shroud so that the crew member can handle the bottom end of the top cord. The crew member holds the four D handles with one hand and the top cord with the other and moves the balloon to the release point. Ordinarily, the balloon can be moved to the release point by one crew member holding the D handles and the top cord while a second crew member carries the radiosonde and parachute. In very high winds, two crew members are needed to hold the balloon, one to hold the top cord and the other to hold the D handles.

NOTE: To prevent accidental loss of the shroud if all four D handles are released, the top cord should be tied to the crew member releasing the balloon.

RELEASE PROCEDURE

7-47. Normally, one crew member holds the shroud while the other crew member holds the radiosonde downwind from the balloon. The crew member holding the shroud releases the front two D handles at the same time while continuing to hold the rear two D handles and the top cord. The balloon slides out from under the shroud. As the balloon ascends, the second crew member maintains a position directly under the drifting balloon until the radiosonde lifts from the hands. Figure 7-9 shows a release using a shroud.

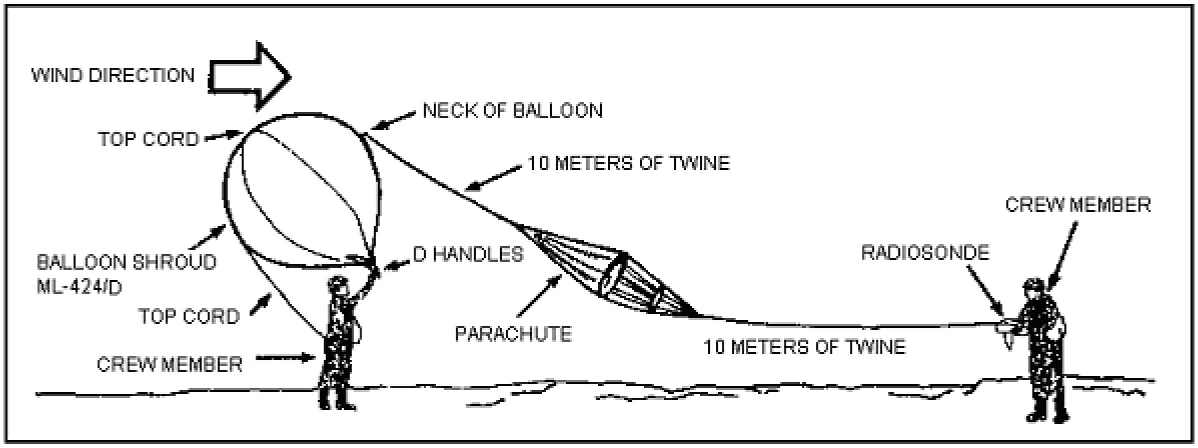


Figure 7-9. Release using a shroud

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Chapter 8

Personnel, Logistics, and Maintenance

Manning, fixing, and sustaining the force is essential for effective combat operations. Sound planning is essential so that MET support is always available in the area of operations. Planning is done at force artillery headquarters to ensure MET sections receive adequate and timely support. This chapter focuses on logistic planning considerations that are the responsibility of the MET station leader and the operational supervisors.

PERSONNEL

8-1. Strength accounting is the process by which personnel combat readiness is measured. It keeps track of the troops on hand, identifies those that have been lost, and identifies those that are needed.

READINESS MANAGEMENT

8-2. Commanders must be very cautious when filling vacancies for the MET personnel because of the low density and criticality of the 13W MOS. Commanders must request personnel far enough in advance to ensure a smooth rotation of MET personnel. Further care must be taken to ensure that the request for repair personnel (13WlOHl, 13W2OHl) contains the required additional skill identifier (ASI) of Hl after the base MOS. If the Hl ASI is not annotated, only MET crew members without maintenance training will be received by the unit. This leaves the MET section without the required maintenance personnel to repair the MET equipment. All requests for replacements and evacuation reporting should be handled by the unit S1. All shortages of positions that require the H1 ASI should be reported as critical.

SUSTAINING SOLDIERS

8-3. Commanders and MET station leaders must diligently manage and execute sustainment support for MET personnel. Oftentimes the MET section is not with its parent organization; therefore, timely food, medical, chaplain, pay, and postal services must be provided to ensure Soldier morale and combat effectiveness. MET station leaders must coordinate with supported units for this support. MET station leaders must also direct the health and welfare activities of section personnel. These include but are not limited to the following:

- Coordinate for food, water, and other life support.
- Inspect Soldier's personal hygiene.
- Inspect Soldier's personal gear.
- Ensure medical problems are promptly attended.
- Schedule rest periods.

LOGISTICS PLANNING

8-4. Logistic planning must include the requirements for sustaining MET sections during extended combat operations. The logistic plan based on adequate and timely support of the tactical operation must be complete, simple, and flexible. Logistic planning must address the following:

- Movement and load planning.
- Basic loads and stock levels.
- Supply channels and location of reserve stocks.

- Communications.
- Maintenance concept.

BASIC LOAD AND STOCKAGE LEVELS

8-5. Met Personnel must be fully aware of the status of basic load quantities. The successful accomplishment of the mission depends on having the necessary of quantities of expendables to perform the mission.

8-6. The status of the basic load should be monitored at all times to ensure sufficient expendables remain available to accomplish the mission.

8-7. A MET section basic load is the amount of expendables (radiosondes, balloons, parachutes, and so forth) required to sustain combat operations for 72 hours. Basic loads for MET sections are determined by the amount of expendables needed for the maximum number of balloon releases per section per day of operations. A MET section can run one flight per hour, up to a maximum of 12 flights per day. Each section is allocated 6 hours per day for maintenance and movement. The maximum numbers of flights cited here are for intense battle only. The cost of expendables precludes the maximum number of flights being flown for training.

8-8. Current authorized stockage levels are listed in TM 11-6660-218-20P, TM 11-6660-283-13, and TM 11-6660-293-12&P (MMS–P equipped sections).

LOGISTICAL SUPPLY CHANNELS AND LOCATIONS OF RESERVE STOCKS

8-9. In addition to monitoring the status of the basic load, it is necessary to establish a reorder level for all expendables. The tempo of operations will be the determining factor in establishing the best reorder level.

8-10. Met personnel should be aware of the location of all resupply points

SUPPLY CHANNELS

8-11. With current authorizations of vehicles and personnel, each MET section can only transport a 72-hour supply of expendables. As supplies are expended, resupply must be done by the division support command (DISCOM). Maneuver experience factors indicate that the DISCOM should keep a 14-day supply level per MET section and the corps support command (COSCOM) should keep a 30-day supply level per MET section.

RESUPPLY PUBLICATIONS

8-12. The nomenclature and quantities of items authorized per MET section are in TM 11-6660-265-10-HR, TM 11-6660-218-20P, and TM 11-6660-283-13, and TM 11-6660-293-12&P (MMS–P equipped sections). Because MET section expendables are very low-density items, division and corps stockage levels must be carefully monitored. Careful management prevents exhaustion of supplies and subsequent interruption of MET support on the battlefield.

ADDITIONAL RESUPPLY

8-13. Met sections require other forms of supplies. The most important supplies are petroleum, oils, and lubricants (POL); spare parts; food; water; and ammunition. It is very important that all aspects of resupply are considered when developing the resupply rate for MET sections. The MET station leader must develop proper usage rates for all supplies to ensure smooth, continuous operations.

COMMUNICATIONS

8-14. For the MET section to achieve its mission, communications must be established quickly and maintained. Primary references for MET section communications are TM 11-5820-401-10-1 and -2. The MET station leader must ensure all members of the section are properly trained in correct communications procedures and on section communications equipment. The MET section point of contact for communications requirements and training is the unit signal officer. The MET station leader is responsible for maintaining all aspects of communications to include the following:

- Familiarity with the unit signal operating instructions (SOI).
- Communication systems initialization and setup.
- Assigned frequencies and network protocols.
- Encryption procedures.
- Radio procedures.
- Communications security.
- Message development and emergency procedures.
- Alternate forms of communication.

MAINTENANCE CONCEPT

8-15. The Army adheres to a two-level maintenance concept as outlined in the maintenance allocation chart (MAC) for each system. The MAC designates overall authority and responsibility for the performance of all maintenance and repair functions. Under the two-level maintenance concept, the levels are organized as follows:

- The field level includes operator /crew maintenance, unit maintenance, and direct support maintenance.
- The sustainment level includes general support and depot level maintenance.

8-16. The increasing complexity of equipment has lead to systems designed around the concept of line replaceable units (LRU). When a faulty unit is identified, the LRU is replaced and sent to depot for repair. Depot level maintenance is often performed by the original equipment manufacturer or contractor through a Commercial Logistical Support warranty program.

8-17. The limited availability of spare LRUs and the time required for faulty units to be repaired at depot level places an additional burden on logistics planners to ensure systems are not nonoperational due to lack of operational LRUs. When troubleshooting the system, MET equipment repairers need to make every effort to ensure an LRU is faulty prior to turning the component in for repair.

8-18. There is one maintenance standard. This standard is based on TM 10 and 20 series preventive maintenance checks and services (PMCS). The goal of all levels of maintenance is to limit the downtime of equipment. The objective of maintenance in combat is to fix as far forward as possible.

FIELD LEVEL

8-19. Field level maintenance consists of operator, unit, and direct support maintenance. The majority of the system maintenance is accomplished as 'fix forward' maintenance.

8-20. The unit level maintainer is charged with all field maintenance.

Operator/Unit Maintenance

8-21. Unit level maintenance is the most critical. Unit level maintenance consists of the operator and MET equipment repairer.

- Operator maintenance includes the following:
  - Before, during, and after operations checks.
  - PMCS.
  - Scheduled maintenance.

- Met equipment repairer performs unit maintenance consists of the following:
  - Visual inspections.
  - Execution of diagnostic programs.
  - Services and replacements as authorized by the MAC.
  - Scheduled and unscheduled maintenance, to include adjustments and alignments authorized by the MAC.

8-22. Unscheduled maintenance includes diagnosis and fault isolation as authorized by the MAC. To analyze malfunctions, the trained mechanics in the MET section use built-in test equipment (BITE) along with appropriate technical manuals.

Direct Support Maintenance

8-23. Direct support (DS) maintenance is performed by the supporting DS maintenance unit. DS electronic repair personnel provide required maintenance support when maintenance falls outside the echelon of the MET section repairer. Most DS repair is performed onsite at the MET section location. If repair cannot be performed onsite or the problem requires equipment evacuation to a higher level, the MET equipment is evacuated to its supporting DS unit by the most appropriate method. This can be done by the unit supply section or S4. Because of the low density of MET equipment and the difficulty in procuring repair parts, the DS unit must keep an adequate stock of repair items on hand. This prevents long downtimes due to unavailability of parts.

SUSTAINMENT LEVEL

8-24. Sustainment level maintenance is performed on the MMS-P by the manufacturer. Prior to sending a system to the manufacturer, the logistics assistance representative and/or the field support representative should be consulted.

8-25. Sustainment level maintenance is performed on the MMS by the DS maintenance initially. In most cases, the entire system should not be sent to depot. Only the affected component is forwarded. Prior to forwarding any item to depot, the logistics assistance representative and/or field support representative should be consulted.

General Support Maintenance

8-26. General support (GS) maintenance is not used for MET systems peculiar items; however, GS maintenance is required for associated items of support. MET peculiar equipment that cannot be repaired at the DS level must be evacuated to depot. Non-MET peculiar items undergo GS maintenance as identified on their particular maintenance allocation chart.

Depot Maintenance

8-27. The depot repairs those modules and assemblies that are beyond field-level capability and overhauls or rebuilds MET equipment as required.

SOFTWARE MAINTENANCE (COMPUTER PROGRAMS)

8-28. Computer software is the responsibility of Headquarters, Communications-Electronics Command (CECOM), at Fort Monmouth, NJ. CECOM will distribute updated programs to the user as changes are made.

> **CAUTION**
>
> **Personnel in field units will not create computer programs or update existing programs.**

Appendix A

MET Messages

All MET messages are coded in a format that is recognized and used by United States and allied forces and weather services worldwide. These formats are mandated by several standardization agreements and quadripartite standardization agreements and the World Meteorological Organization. This appendix discusses these messages.

This appendix implements STANAG 4061, STANAG 4082, STANAG 4131, STANAG 4140.

SECTION I MMS FATDS MET MESSAGES

OVERVIEW

A-1. Digital transmission is the primary means of sending MET messages to FA units. The MMS equipped MET section contains advanced field artillery tactical data system (AFATDS) formats for all MET messages. MET messages are sent to FA firing units and FSEs, as required. The MET messages normally are transmitted to the controlling headquarters fire control element (FCE). The communications aspect (message address, message source, and authentication) of data transmission is in the first message element, the communications (comm) line. There are two format differences between a digital MET message and a standard MET message. The first is the comm line, which is required to transmit the message. The second difference is the format of the MET data provided, which is by data line.

MET MESSAGE COMMUNICATIONS LINE

A-2. The first line of every message segment is the comm line which contains the same information for all MET messages. The comm line consists of nine parts. Each part has a field. A semicolon separates each field. The format of the comm line is shown in figure A-1. The numbers above the comm line format indicate position spaces only (72 total). These numbers are not part of the message.

```
         1         2         3         4         5         6         7
123456789012345678901234567890123456789012345678901234567890123456789012
_______; P: _ ;SB: _/ _/_/ _____; C : __ ___ ;SG: __, __; DT:_ _,_ _/__/ __ ; ID:____ ; A:_;_
```

Figure A-1. Comm line format

HEADER

A-3. The first six character positions in the comm line comprise the header field. The first six positions are entry variables. The semicolon (seventh position) signifies the end of the header. The format for the comm line header is shown in figure A-2.

```
1  2  3  4  5  6  7
_  _  _  _  _  _  ;
```

Figure A-2. Comm line header format

Destination

A-4. The first position in the header field shows the destination of the message. On a received message, the first position shows the sender. Specific FDCs may be addressed by using any letter or number, as specified by the controlling FDC or FCE, SOI, or standing operating procedures (SOP).

Transmission Repeat Number

A-5. The second position contains the transmission repeat number (TRN). The TRN is first set to zero. The TRN is advanced by one digit each time the message is retransmitted. After four unsuccessful transmissions, voice contact is required to determine the problem.

Authentication Characters

A-6. Positions 3 and 4 are the authentication or serialization characters. These characters are the next unused authentication codes. If no acknowledgment is received, the next set of numbers is used, and the TRN is advanced one number.

Message Type

A-7. The message type (position 5) is a single number that represents the type of message being composed for transmission or processing. The message type must be entered in the header by the operator when he composes the message. MET messages are always type 3.

Message Source

A-8. The message source character (position 6) represents the source that transmitted the message as specified by the controlling FDC or FCE, the SOI, or the SOP. The source character for a message originated by a MET section is entered during initialization.

PRIORITY

A-9. The message priority is determined by the message category and type. It is specified by the controlling FDC at the time of loading or system initialization. The priority scheme is numbered from 1 to 8, with 1 being highest priority. Message priority should not be altered by the MET system operator. The priority field occupies positions 8 through 11. Its format in the comm line is shown in figure A-3.

```
      1
8  9  0  1
P  :  _  ;
```

Figure A-3. Priority field format

SUBSCRIBER

A-10. The subscriber is the logical name of the recipient of the message. The subscriber is specified by SOI or controlling headquarters SOP. The subscriber field (figure A-4) occupies positions 12 through 27 in the comm line and consists of five separate subfields (indicated by slashes and commas). The first subfield (position 15) is the section number, and the second (position 17) is the platoon number. These two subfields are not used for all subscribers. The third subfield (position 19) designates the battery. The fourth subfield designates the battalion and has two positions (21 and 22) for numbers. The fifth subfield designates the regiment and has three positions (24, 25, and 26). When the MET section originates a message, the subscriber name of the addressee may be specified; however, the destination code in the header must be specified. If the subscriber name is left blank, the subscriber name defaults to the logical name of the destination code. Therefore, the sender should enter the subscriber name if he wishes to relay the message through to another subscriber.

```
                  2
2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7
S B : - / _ / _ / _ _ , _ _ _ ;
```

Figure A-4. Subscriber field format

SECURITY CLASSIFICATION

A-11. The security classification field occupies positions 28 through 33. It is entered automatically. This field contains one of the entries in table A-1. The security classification field format is shown in figure A-5.

Table A-1. Security Classification Field Entries

Entries	*Meanings*
UN	Unclassified
ETO	Encrypt for transmission only
C	Confidential
S	Secret
CFR	Secret formerly restricted data
SRD	Secret restricted data
C*C	Secret cryptography (crypto)
S#C	Secret Crypto

```
        3
8   9   0   1   2   3
C   :   _   _   _   ;
```

Figure A-5. Security Classification Field

SEGMENT INFORMATION

A-12. The segment information field (figure A-6) occupies positions 34 through 42. Positions 37 and 38 indicate the message segment. Positions 40 and 41 indicate the total number of segments in the message chain. For example, "SG: 03,10;" means that this message segment is the third of 10 message segments. If the field is not specified, one segment is assumed by the receiving computer. Message segment numbers are automatically inserted in all transmitted messages.

```
                  4
4  5  6  7  8  9  0  1  2
S  G  :  _  _  ,  _  _  ;
```

Figure A-6. Segment information field format

DATE-TIME GROUP

A-13. The date-time-group field (figure A-7) occupies positions 43 through 57 of the comm line. For FDC originated messages, the FDC enters the time of the last computer action or transmission. For MET section originated messages, the date-time group should be left blank since the FDC inserts the time of receipt. Positions 46 and 47 indicate the day of the month (1 through 31). Positions 49 and 50 indicate the hour (00 through 23). Positions 52 and 53 indicate the minutes (00 through 59). Positions 55 and 56 indicate the seconds (00 through 59).

```
              5
3 4 5 6 7 8 9 0 1 2 3 4 5 6 7
D T : _ _ , _ _ / _ _ / _ _ ;
```

Figure A-7. Date-time-group field format

MESSAGE IDENTIFICATION NUMBER

A-14. This number is a unique serial identification number assigned by the computer at the FCE. This field (figure A-8) occupies positions 58 through 65.

```
      6
8  9  0  1  2  3  4  5
I  D  :  _  _  _  _  ;
```

Figure A-8. Message identification number field format

AUTOMATIC TRANSMISSION

A-15. The automatic transmission field (figure A-9) occupies positions 66 through 69. The initial setting of this field is left blank. If automatic transmission is used, the computer inserts the character A in position 68.

```
6 7 8 9
A : _ ;
```

Figure A-9. Automatic transmission field format

DIGITAL DATA TERMINAL

A-16. Position 70 indicates the digital data terminal (DDT) at the FDC that is used to transmit the message. Positions 71 and 72 are not used. Figure A-10 shows the DDT field format.

```
7
0  1  2
_
```

Figure A-10. Digital data terminal field format

MET MESSAGE BODY

A-17. The body of the MET message is composed of a heading and up to five data lines.

HEADING

A-18. The message heading gives the message type, location of the MET section, date and time group in Greenwich Mean Time (GMT), altitude above sea level, atmospheric pressure, and for the target acquisition (TA) message, the cloud height from surface and the mean refractive index. Figure A-11 is an example of the heading of a MET message. Table A-2 identifies individual fields of the heading.

```
MET;CM;Q:X;POSI:xxxxxx;DTI:YY/GG.G/V;HGT:hhh;ATMS:ppp;
```

Figure A-11. FATDS MET message heading format

Table A-2. FATDS MET Message Heading Fields

Fields	***Descriptions***
MET;	Designates message category-meteorological.
CM;	Designates message type (for this example, computer). Other message designator types are as follows: BM - ballistic (plaintext message [PTM]). CFL - fallout.

Table A-2. FATDS MET Message Heading Fields

Fields	*Descriptions*
	TA - target acquisition. W - WMO (PTM)
K;t; (ballistic only)	Designates the types of ballistic messages as follows: 2 - surface to air. 3 - surface to surface.
_/_/_/_ _ _; (target acquisition only)	Identifies MET station. The first five spaces are left blank. Fires battalion units may use FB1 or FB2 in the last three spaces. FA brigade units may use BD1 or what is designated by tactical standing operating procedure (TSOP).
Q:X;	Designates octant of the globe. The X is Octant 0, 1, 2, 3, 5, 6, 7, 8, or 9. Octant 4 is not used. Octant 9 is used when location is other than by latitude and longitude.
POSI:xxxxxx;	Designates location of station in six digits. The first three digits are used to encode the latitude and the last three to encode the longitude in degrees and tenths of degrees. When longitude is greater than 100, the hundreds digit is omitted. The location may be expressed in code.
DTI:YY/GG.G/V;	Designates date-time. The YY is the day of he month. The GG.G is the time of day in hours and tenths of an hour (24-hour clock). The V is the valid time period. **NOTE**: U.S. Forces use 0 for valid time, since they do not predict a period of validity.
HGT:hhh;	Designates altitude of the MET station above mean sea level in tens of meters.
ATMS:PPP;	Designates MET station pressure to the nearest millibar. For pressures greater than 1,000 mb, thousands digit (000 to 999) is omitted. **NOTE:** This field is used for all MET messages **except** the fallout MET message.
CBMRI:CCC/NNN;	Designates cloud height (CCC) above the surface of the lowest cloud at the point of observation and the mean refractive index in "N" units. Cloud height is in tens of meters. If NNN is not included in the message, the spaces are left blank. **NOTE:** This field is used only for the target acquisition MET message.

DATA LINES

A-19. Each data line contains the MET data for several zones, rather than each zone being transmitted by a separate line as in the standard message. Data for each zone within the data line are terminated by a comma. The data line is terminated by a semicolon.

Computer MET Message

A-20. Each data line in the body of the computer message contains zone data for line number, wind direction and speed, and temperature and midpoint pressure. Figure A-12 shows the format for a computer MET message. The symbols in the body of the computer MET message are defined in table A-3.

```
(comm line)
MET;CM;Q:X;POSI:xxxxxx;DTI:YY/GG.G/V;HGT:hhh;ATMS:PPP;
LINEA:ZZ/DDD/FFF/TTT.T/PPPP,ZZ/DDD/FFF/TTT.T/PPPP,ZZ/DDD/FFF/TTT.T/PPPP;
```

Figure A-12. FATDS computer MET message format

Table A-3. FATDS Computer MET Message Body Symbols

Symbols	***Definitions***
ZZ/	Line number (zone) for message (00 to 26)
DDD/	Zone wind direction in tens of mils (000 to 640)
FFF/	Zone wind speed in knots (000 to 300) **NOTE:** When FFF is 000, then DDD is 000.
TTT.T/	Zone mean virtual temperature to the nearest tenth of a degree Kelvin (000.0 to 500.0)
PPPP	Zone midpoint pressure in millibars (0000 to 1,100)

Fallout MET Message

A-21. Each data line in the body of the FOMET message contains zone data for zone number and wind direction and speed. Figure A-13 shows the format for the FOMET message. The symbols in the body of the FOMET message are defined in table A-4.

```
(comm line)
MET;CFL;Q:X;POSI;xxxxx;DTI:YY/GG.G/V;HGT:hhh;
LINA:ZZ/DDD/FFF,ZZ/DDD/FFF,ZZ/DDD/FFF;
```

Figure A-13. FATDS fallout MET message format

Table A-4. FATDS Fallout MET Message Body Symbols

Symbols	***Definitions***
ZZ/	Line designator for 2,000-meter zones (00 to 15)
DDD/	Zone wind direction in tens of mils (000 to 640)
FFF	Zone wind velocity in knots (001 to 300)

A-22. Each data line in the body of the TA MET message contains zone data for zone number, wind direction, wind speed, temperature, and relative humidity (RH). Figure A-14 shows the format for the TA MET message. The symbols in the body of the TA MET message are defined in table A-5.

```
(comm line)
MET;TA;_/_/_/__/___;Q:9;POSI:xxxxxx;DTI:YY/GG.G/V;HGT:HHH;ATMS:PPP;CMBRI:CCC/NNN;
LNA:ZZ/DDD/FFF/TTTT/UU/,ZZ/DDD/FFF/TTTT/UU/,ZZ/DDD/FFF/TTTT/UU;
LNB:ZZ/DDD/FFF/TTTT/UU/,DDD/FFF/TTTT/UU/,ZZ/DDD/FFF/TTTT/UU;
```

Figure A-14. FATDS target acquisition MET message format

Table A-5. FATDS Target Acquisition Message Symbols

Symbols	*Definitions*
ZZ/	Line number code (00 to 27)
DDD/	Wind direction in tens of mils (000 to 640)
FFF/	Wind speed in knots (000 to 300)
TTTT/	Air temperature in tenths of Kelvin (000.0 to 500.0)
UU	Relative humidity as a percentage (01 to 00, where 00 is 100 percent)

PLAIN TEXT MET MESSAGES

A-23. As stated before, some receiving systems may not have the formats for the ballistic MET message or the WMO MET message in their database. However, a ballistic MET message can be transmitted to an FA unit in a plaintext message (PTM) and the WMO MET message can be sent to the SWO by PTM. The comm line of the PTM is the same as the comm line of the computer, fallout, and TA MET messages. The main differences are the heading and the body of the messages.

BALLISTIC MET MESSAGE

A-24. The heading of the ballistic MET message contains the same information as the formatted messages. However, the ballistic MET message is preceded by the words ** *BALLISTIC MESSAGE* **. Symbols in the heading of the PTM format ballistic MET message are defined in table A-6. The body of the PTM ballistic MET message (figure A-15) contains four data lines (LNA through LND). Each data line consists of four zones separated by commas. Symbols in the body of the PTM format ballistic MET message are defined in table A-7.

```
(comm line)
SYS;PTM:  **  BALLISTIC MESSAGE **
MET BM K:t Q:x POSI:xxxxxx DTI:YY/GG.G/V HGT:hhh ATMS:PPP
LNA:ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR;
LNB:ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR;
LNC:ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR;
LND:ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR,ZZ/DD/FF/TTT/RRR;
```

Figure A-15. Ballistic MET message (PTM) format

Table A-6. FATDS Ballistic MET Message Heading Symbols

Symbols	*Definitions*
MET	Designates message category-meteorological.
BM	Designates message type-ballistic.
K:t	Designates type of ballistic MET message. The t is a 2 for type 2 (surface to air) or a 3 for type 3 (surface to surface) message.
Q:X	Designates octant of the globe. The X is octant 0, 1, 2, 3, 5, 6, 7, 8, or 9. Octant 4 is not used. Octant 9 is used when location is other than by latitude and longitude.
POSI:xxxxxx	Designates location of station is six digits. The first three digits are used to

Table A-6. FATDS Ballistic MET Message Heading Symbols

Symbols	*Definitions*
	encode the latitude and the last three to encode the longitude in degrees and tenths of degrees. When longitude is greater than 100 degrees, the hundreds digit is omitted. The location may be expressed in code.
TI:YY/GG.G/V	Indicates date-time. The YY is day of the month. The GG.G is the time of day in hours and tenths of an hour (24-hour clock). The V is the valid time period. NOTE: U.S. Forces use 0 for valid time, since they do not predict a period of validity.
HGT:hhh	Designates altitude of the MET station above mean sea level (MSL) in tens of meters.
ATMS:PPP	Designates MET station pressure to 0.1 percent of standard. If pressure is greater than 100 percent the hundreds digit is omitted.

Table A-7. Ballistic MET Message Body Symbols

Symbols	*Definitions*
ZZ/	Line number (zone) (00 to 15)
DD/	Ballistic wind direction in hundreds of mils (00 to 64) **NOTE:** When FF is 00, the DD is 00.
FF/	Ballistic wind speed in knots (00 to 99). (When wind speed equals or exceeds 100 knots, add 80 to the line number [ZZ].)
TTT/	Ballistic air temperature in percent of standard to the nearest 0.1 percent (000 to 999)
RRR	Ballistic air density in percent of standard to the nearest 0.1 percent (000 to 999)

WORLD METEOROLOGICAL ORGANIZATION MET MESSAGE

A-25. The heading of the WMO MET message is included in the SYS;PTM line instead of having a separate line as with other messages. The body of the message contains atmospheric data presented in the standard WMO message format, not in the data line format. The PTM format for the WMO MET message is shown in figure A-16. All of the entries for each part are not shown. The symbols in the heading of the PTM format WMO MET message are defined in table A-8.

(comm line)
SYS;PTM: METWQ $L_aL_aL_a$GG $L_oL_oL_o$gg YYHHH PASS TO STAFF WEATHER OFFICER
TTAA

(comm line)
SYS;PTM: METWQ $L_aL_aL_a$GG $L_oL_oL_o$gg YYHHH PASS TO STAFF WEATHER OFFICER
TTBB

(comm line)
SYS;PTM: METWQ $L_aL_aL_a$GG $L_oL_oL_o$gg YYHHH PASS TO STAFF WEATHER OFFICER
PPBB

(comm line)
SYS;PTM: METWQ $L_aL_aL_a$GG $L_oL_oL_o$gg YYHHH PASS TO STAFF WEATHER OFFICER
TTCC

(comm line)
SYS;PTM: METWQ $L_aL_aL_a$GG $L_oL_oL_o$gg YYHHH PASS TO STAFF WEATHER OFFICER
TTDD
PPDD

Figure A-16. WMO MET message PTM format

Table A-8. WMO MET Message Heading Symbols

Symbols	***Definitions***
MET	Message category-meteorological
W	Message type-WMO
Q	Octant of the globe (0 to 3 or 5 to 9)
$L_aL_aL_a$	Latitude of the station
GG	Release hour GMT (00 to 23)
$L_oL_oL_o$	Longitude of the station
Gg	Release minute (GMT) (00 to 59)
YY	Date of release (GMT)
HHH	Altitude of MET station in tens of meters

SECTION II JVMF MET MESSAGES (MMS–P)

OVERVIEW

A-26. Digital transmission is the primary means of sending MET messages to FA units. The MMS–P equipped MET section produces MET messages on demand in the format requested by the using unit. This is a shift from the manner MET messages were previously disseminated. Previously, a MET message was generated on a planned schedule and transmitted to the controlling headquarters FCE. The MET message was then broadcast (push method) to using units. The MMS–P processes requests for MET (pull method) from using units. Upon the receipt of a request for MET, the MMS–P system generates MET data based on the midpoint between the unit's location and the target location.

A-27. Requests for MET and the resulting MET messages are normally routed through the controlling FCE. Using the primary/indirect option on the Advanced Field Artillery Tactical Data System (AFATDS), the using units can send requests to the MMS–P equipped system.

A-28. The MMS–P equipped section uses the common message processor (CMP). CMP use is mandated in all newer systems to increase interoperability between systems. The MET messages generated by the MMS–P display in a format consistent with the requirements of the CMP. The data generated complies with all standardized agreements, and can be generated in STANAG format when that option is selected. The MMS–P system can produce all messages generated by the MMS if specifically selected during the sounding operation.

A-29. The exception is the target area MET (TAM) message. There is currently no STANAG agreement for this message.

MMS–P MET MESSAGES

A-30. The MMS–P message generation function generates five different MET messages. The four MET messages generated upon request are the computer MET, target area MET, target acquisition MET, and basic wind report. The fifth MET message generated by the MMS–P is the upper air message. The upper air message is automatically generated by the MMS–P at the termination of a sounding flight.

Computer MET Message

A-31. The computer MET (local area MET) message contains atmospheric data (that is, wind direction/speed, temperature, and air pressure) for the midpoint of the trajectory (highest point a round would travel) between the unit grid and the target area grid. Refer to figure A-17 for computer MET message format.

- Atmospheric data at midpoint of the trajectory covers a 4- by 4-kilometer square by 30 kilometer high area.
- Target grid is determined from the actual or suspected target location.

cmp_met_msg

TO: (Requesting Unit URL)
CC: (Curtesy Copy URL)
FROM: (MET Section URL)

DTG: 262050Z OCT 2006
PRECEDENCE: ROUTINE
CLASSIFICATION: UNCLASSIFIED

MESSAGE BODY:
  MET DATA DESIGNATOR: 0
  GLOBAL OCTANT: 1

MET VALIDITY DATA:
  MET VALIDITY DURATION: 0
  MET VALIDITY START DAY: 26
  MET VALIDITY START HOUR: 20
  MET ACTION DESIGNATOR: 1
  MET STATION ELEVATION: 370
  MET STATION ATOMOSPHERIC PRESSURE: 973
  MET STATION LOCATION DATA
    LATITUDE MET STATION: 34.7092
    LONGITUDE MET STATION: 98.4085
COMPUTER MET DATA
  COMPUTER MET DATA RECURRENCE (1 OF 32) (MAXIMUM 32)
    COMPUTER MET ALTITUDE ZONE: 1
    MET WIND DIRECTION: 2510
    MET WIND SPEED: 8
    AIR VIRTUAL TEMPERATURE: 287
    AIR PRESSURE: 973
  COMPUTER MET DATA RECURRENCE (2 OF 32) (MAXIMUM 32)
    COMPUTER MET ALTITUDE ZONE: 1
    MET WIND DIRECTION: 2590
    MET WIND SPEED: 8
    AIR VIRTUAL TEMPERATURE: 287
    AIR PRESSURE: 960

Figure A-17. Computer MET message format

Target Area MET (TAM) Message

A-32. The target area MET (TAM) message figure A-18 contains the atmospheric and visibility data (that is, winds, cloud height, precipitation type/rate, and horizontal visibility) at the target location.

- Target grid is determined from the actual target location.
- Data can be used to determine the appropriate munitions to use on the target. For example, if the winds, precipitation, or visibility conditions in the target area are too great, then instead of using laser-guided munitions, where the laser could be refracted off the target, a GPS guided, or dumb munitions, may be used instead.

NOTE: There is no STANAG agreement for the TAM messages. Currently the only units that will use a target area MET message are Multiple Launch Rocket System (MLRS) equipped units. They will use the TAM for a decision aid only.

```
met_targ_acq_msg

TO: (Requesting Unit URL)
CC: (Curtesy Copy URL)
FROM:  (MET Section URL)

DTG: 262050Z OCT 2006
PRECEDENCE: ROUTINE
CLASSIFICATION: UNCLASSIFIED

Message Body:
MET DATA  DESIGNATOR:  4
GLOBAL OCTANT:  1
MET VALIDITY DATA:
   MET VALIDITY DURATION:  0
   MET VALIDITY START DAY: 26
   MET VALIDITY START HOUR: 20
MET STATION ELEVATION:  370
MET STATION ATMOSPHERIC PRESSURE:  973
MET STATION LOCATION DATA
   LATITUDE MET STATION:  34.7092
   LONGITUDE MET STATION:  98.4085
TALL MET DATA
   TALL MET IDENTIFICATION:
   TALL MET ATMOSPHERIC DATA:
      PRECIPITATION TYPE:  0
      PRECIPITATION RATE:  0
      MET CLOUD BASE HEIGHT: 166 (TENS OF METERS)
      MEAN REFRACTIVE INDEX:  294
      TALL MET ZONE DATA RECURRENCE (1 0F 26) (MAXIMUM 26)
         TALL MET ALTITUDE ZONE:  0
         MET WIND DIRECTION:  2510
         MET WIND SPEED:  5
         AIR VIRTUAL TEMPERATURE:  288
         RELATIVE HUMIDITY:  41
      TALL MET ZONE DATA RECURRENCE (2 0F 26) (MAXIMUM 26)
```

Figure A-18. Target area MET message format

Target Acquisition (TA) MET Message

A-33. The target acquisition (TA) MET message figure A-19 contains atmospheric data (that is, wind speed/direction, temperature, and relative humidity), which is used by the target acquisition systems (that is, Ground Surveillance Radars and Firefinder Radars) on the battlefield.

NOTE: For the field artillery, the primary requestor will be the Firefinder Radar.

```
met_targ_acq_msg

TO: (Requesting Unit URL)
CC: (Curtesy Copy URL)
FROM:  (MET Section URL)

DTG: 262050Z OCT 2006
PRECEDENCE: ROUTINE
CLASSIFICATION: UNCLASSIFIED

Message Body:
    MET MESSAGE DESIGNATOR:   2
MET VALIDITY DATA:
    MET VALIDITY DURATION:  0  (HOURS)
    MET VALIDITY START DAY: 26  (EA)
    MET VALIDITY START HOUR: 20  (HOURS)
MET ACTION DESIGNATOR:  1
MET STATION LOCATION DATA
    MET STATION LATITUDE:  34.7092  (DEGREES)
    MET STATION LONGITUDE :  98.4085  (DEGREES)
    MET STATION ELEVATION:  370   (METERS)
MET STATION PRESSURE:  973 (MILLIBARS)
TARGET ACQUISITION  MET DATA
    TARGET ACQUISITION ATMOSPHERIC DATA
        MET CLOUD BASE HEIGHT: 166 (METERS)
        MEAN REFRACTIVE INDEX:  257 (EA)
    TARGET ACQUISITION ZONE DATA (1 OF 28) (MAXIMUM 28
        TA MET ALTITUDE ZONE: 0
        MET WIND DIRECTION: 0 (MILS)
        MET WIND SPEED: 0 (KNOTS)
        AIR VIRTUAL TEMPERATURE:  292 (DEGREES K)
        RELATIVE HUMIDITY:  26 (PERCENT)
```

Figure A-19. Target area MET message format

Basic Wind Report

A-34. The basic wind report figure A-20, formally known as the fallout MET message, contains wind data (that is, direction and speed) from surface to 30,000 meters that is used by the SWO to produce the chemical downwind report, which is used to predict the downwind hazard area and fallout patterns.

```
Bwr_out_msg

TO: (Requesting Unit URL)
CC: (Curtesy Copy URL)
FROM:  (MET Section URL)
DTG: 262050Z OCT 2006
PRECEDENCE: ROUTINE
CLASSIFICATION: UNCLASSIFIED
Message Body:
FORECAST/REPORT INDICATOR: 1
ARTILLERY METEOROLOGICAL STATION LOCATION
    MET STATION LATITUDE: 32.63 (DEGREES)
    MET STATION LONGITUDE: -106.39 (DEGREES)
    MET STATION ELEVATION: 1220 (METERS)
OBSERVATION TIME
    OBSERVATION DAY:  31 (EA)
    OBSERVATION HOUR: 19 (HOURS)
    OBSERVATION MINUTE: 3 (MINUTES)
TIME OF VALIDITY
    R1(1 OF 1) (MAXIMUM 2)
        VALIDITY DAY: 31 (EA)
        VALIDITY HOUR: 19 (HOURS)
        VALIDITY MINUTE: 3 (MINUTES)
 R2 (1 OF 16) (MAXIMUM16)
    BWR MET ALTITUDE ZONE: 0
    BWR MET WIND DIRECTION: 511 (DEGREES)
    MET WIND SPEED: 0 (KNOTS)
 R2 (2 OF 16) (MAXIMUM16)
    BWR MET ALTITUDE ZONE: 1
    BWR MET WIND DIRECTION: 151 (DEGREES)
    MET WIND SPEED: 3 (KNOTS)
```

Figure A-20. Basic wind report

Upper Air Message

A-35. The upper air message, also known as the WMO MET message, consists of high-altitude data (that is, wind speed/direction, pressure, height, temperature, and humidity), which is sent to either the SWO for weather predictions or the Integrated Meteorological System IMETS for transmission to other weather teams.

COMMON MESSAGE PROCESSOR

A-36. Common message processor (CMP) is the operator's interface to the digital communications network. The graphical user interface (GUI) for the CMP is the messaging main menu screen. The messaging main menu is similar to a typical E-mail browser. Using messaging main menu figure A-21, the operator can send and receive, view, and transmit message traffic. The main menu screen is divided into areas with different functions. These include—

- Title bar, menu bar, and toolbar (1).
- Folder select area (2).
- Folder display area (3).
- Message transmission information (4).
- Precedence listing (5).
- User view (6).
- Status bar (7).

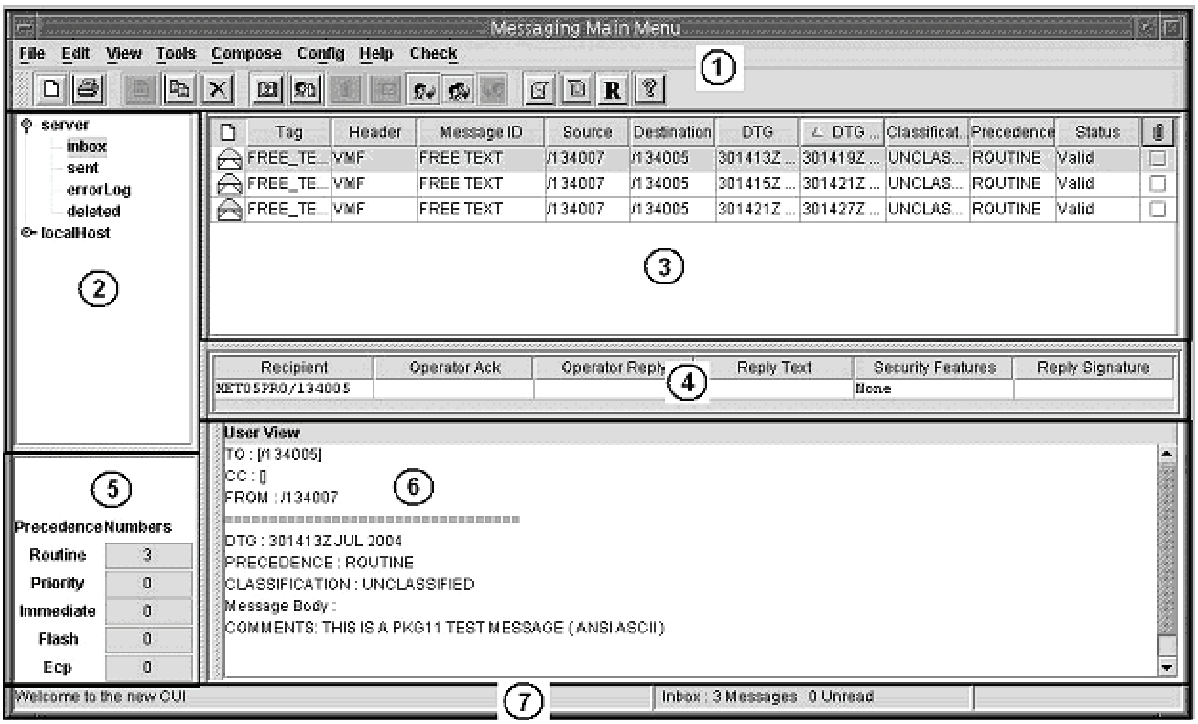

Figure A-21. Main message menu screen

Refer to TM 11-6660-293-12&P, appendix G, for a detailed explanation of using the CMP with the MMS–P.

Communications Setup

Communications GUI

A-37. The communications GUI provides the MMS–P operator with a method for defining the network configuration, establishing the system's address, and turning the network on and off. The network is configured based on the type system with which the MMS–P is to communicate. Consult the unit communications SOPs for guidance determining network configuration settings. Refer to TM 11-6660-293-12&P, appendix I, for a detailed explanation of the use of the communication GUI.

IP Address

A-38. The internet protocol (IP) address is used by the TCIM device for sending and receiving communications. This is the address other units in the field will use to address the MMS–P section. It is entered in dotted decimal format. This address is assigned by unit SOP. Figure A-22 shows an example of the local IP address.

A-39. The subnet mask address establishes defines which parts of the IP address belong to the network address and the host address. The subnet mask is entered in dotted decimal format. This address is assigned by unit SOP. Figure A-22 shows an example of the subnet mask address.

Unit Reference Number

A-40. The unit reference number (URN) is specified by the commanding AFATDS master unit list (MUL) and assigned to the MMS–P section. Any incoming messages with a destination URN that matches the MMS–P section URN will be delivered to the CMP inbox. Figure A-22 shows an example of the URN.

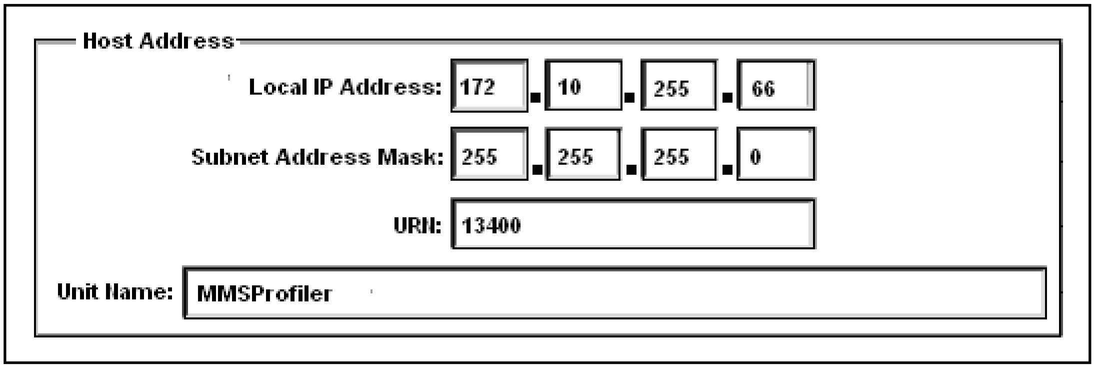

Figure A-22. Host address block

Subscriber Table

A-41. Prior to establishing communications, the MMS–P operator is required to populate the subscriber table. The subscriber table contains the unit name, URN, and IP address for each element communicating with the section.

Address Book

A-42. After populating the subscriber table, the MMS–P operator adds each of the units listed in the subscriber table to the CMP address book. The operator will now be able to send message traffic to all elements of the subscriber table.

JOINT VARIABLE MESSAGE FORMAT

A-43. The MMS–P message generator automatically populates MET messages with meteorological data in the requested format. All other messages are created using message templates. As a common message processor, the CMP contains various message sets with the corresponding message templates. This allows the CMP to be used on a variety of platforms. The operator will have to determine which message set to use for the current operation.

A-44. The MMS–P was developed to use the joint variable message format (JVMF) message set (baseline). Systems not based on the variable message format (VMF) message set will not be able to use information request message to request MET data. The information request message is automatically processed by the MMS–P systems using 220 Protocols above version A. Requesting units not able to use the information request message can request MET using a free text message containing the unit location, target location, and the type MET needed. Requests for MET using a free text message is not automatically processed by the MMS–P. Refer to TM 11-6660-293-12&P, appendix G, for a detailed explanation of VMF message formats.

TRANSMITTING MESSAGES

A-45. The manner messages are transmitted is dependent upon the message type and the conditions under which the messages is being generated. Messages generated by the message generation function (MET messages) are placed in the draft folder of the CMP to allow the section personnel to perform MET checking procedures prior to transmitting the message to the requesting unit. These messages are transmitted using the Send button on the CMP toolbar. Figure A-23 shows the location of the Send button on the CMP toolbar.

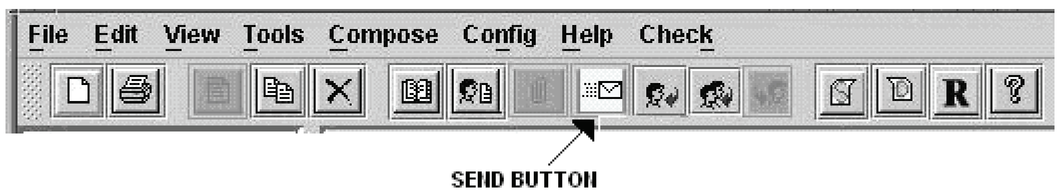

Figure A-23. CMP toolbar

A-46. Messages created from a message format can be transmitted using the Send button located on message format. Messages selected for editing display in the same message format used to create the message and can be transmitted in the same manner. Figure A-24 shows the location of the Send button on the message format toolbar.

Figure A-24. Message format toolbar

SECTION III STANDARD MET MESSAGES

TRANSMISSION OF STANDARD MET MESSAGES

A-47. Standard MET messages can be transmitted to users by radio, messenger, or any other means necessary. When radio is to be the primary means of transmission, the MET section normally broadcasts to all users at the same time. Each standard MET message is discussed in the following paragraphs.

COMPUTER MET MESSAGE

A-48. The computer MET message is the primary MET message used by artillery units. The computer MET message differs from the ballistic message as follows:

- Zone structure is different.
- Zone values are not weighted.
- Atmospheric pressure is reported instead of air density.
- Weather elements are reported as zone values.

COMPUTER MET MESSAGE ENCODING

A-49. DA Form 3677-R (*Computer MET Message [LRA]*) is used for recording purposes. A coded computer message is shown in Figure A-25. A reproducible copy of this form is at the rear of this manual.

COMPUTER MET MESSAGE For use of this form, see FM 3-09.15; the proponent agency is TRADQC								
IDENTIFI-CATION METCM	OCTANT Q	LOCATION $L_aL_aL_a$ or xxx	$L_oL_oL_o$ or xxx	DATE YY	TIME (GMT) $G_oG_oG_o$	DURATION (HOURS) G	STATION HEIGHT (10's M) hhh	MDP PRESSURE MB $P_dP_dP_d$
METCM	1	347	984	25	138	0	036	974

ZONE HEIGHTS METERS	LINE NUMBER ZZ	ZONE VALUES WIND DIRECTION (10s M) ddd	WIND SPEED (KNOTS) FFF	TEMPERATURE (1/10 °K) TTTT	PRESSURE (MILLIBARS) PPPP
SURFACE	00	310	004	2923	0974
200	01	250	011	2931	0962
500	02	316	011	2946	0932
1000	03	361	014	2931	0893
1500	04	371	011	2871	0841
2000	05	504	007	2826	0793
2500	06	453	015	2826	0745
3000	07	473	014	2741	0702
3500	08	521	014	2669	0658
4000	09	582	019	2632	0617
4500	10	576	023	2654	0578
5000	11	568	017	2653	0544
6000	12	570	017	2633	0493
7000	13	589	011	2648	0434
8000	14	611	014	2721	0383
9000	15	256	015	2683	0338
10000	16	395	018	2658	0297
11000	17	382	019	2608	0262
12000	18	377	037	2539	0229
13000	19	394	027	2488	0201
14000	20	438	020	2460	0174
15000	21	626	023	2386	0151
16000	22	002	025	2311	0131
17000	23	634	031	2264	0113
18000	24	074	038	2267	0097
19000	25				
20000	26				

FROM FORT SILL MET TO FDC 2/2 FA	DATE AND TIME (GMT) 25 1400 NOV 04	DATE AND TIME (LST) 25 0800 NOV 04
MESSAGE NUMBER 1	RECORDER ROBERTS	CHECKED McADAMS

DA FORM 3677-R, MAY 1992 PREVIOUS EDITIONS ARE OBSOLETE. APD PE v1.01

Figure A-25. DA Form 3677-R

IDENTIFICATION LINE

A-50. The identification (ID) line is arranged in four 6-digit groups. A symbolic code is used to identify and encode the data in the proper format. Thus the symbols for the ID line are METCMQ, $L_aL_aL_aL_oL_oL_o$, $YYG_oG_oG_oG$, and $hhhP_dP_dP_d$. In Figure A-26, the ID line is shown encoded.

COMPUTER MET MESSAGE									
IDENTIFI-CATION	OCTANT	LOCATION		DATE	TIME (GMT)	DURATION (HOURS)	STATION HEIGHT (10s M)	MDP PRESSURE MB
METCM	Q	$L_aL_aL_a$ or xxx	$L_oL_oL_o$ or xxx	YY	$G_oG_oG_o$	G	hhh	$P_dP_dP_d$
METCM	1	347	984	25	138	0	036	974

Figure A-26. Computer MET message identification line

Group 1

A-51. Group 1 consists of METCMQ. The symbol METCM is placed at the beginning of each computer message. This symbol indicates that it is a MET message and that it contains computer-type MET data. The digit under the symbol Q represents the global octant in which the MET section is located. For convenience in determining the geographical location of the reporting MET section, the globe was divided into octants numbered 0 through 8. Table A-9 lists the octants of the globe.

NOTE: The number 4 is not used. The number 9 is used when the location is coded.

Table A-9 Octant of Globe Q Code

Symbols	*Definitions*
0	North latitude-0° to 90° west longitude
1	North latitude-90° to 180° west longitude
2	North latitude-180° to 90° east longitude
3	North latitude-90° to 0° east longitude
4	Not used
5	South latitude-0° to 90° west longitude
6	South latitude-90° to 180° west longitude
7	South latitude-180° to 90° east longitude
8	South latitude-90° to 0° east longitude
9	To be used when the location of the MET station is not indicated by latitude and longitude.

Group 2

A-52. Group 2 consists of $L_aL_aL_aL_oL_oL_o$ or XXXXXX. These six spaces are used to specify the location to the nearest tenth of a degree. The symbol $L_aL_aL_a$ represents the latitude to the nearest tenth of a degree. The symbol $L_oL_oL_o$ represents the longitude to the nearest tenth of a degree. When the longitude is over 100 degrees, the first digit is dropped.

Group 3

A-53. Group 3 consists of $YYG_oG_oG_oG$. The symbol YY represents two digits for reporting the Greenwich date of the observation on which the message is based. The Greenwich date may differ from the local date, depending on the location and the hour of the day. The symbol $G_oG_oG_o$ represents three digits for reporting hours in tens, units, and tenths of hours. Appendix G contains a chart of the world map that gives the information needed to convert local standard time and date to GMT and date. The symbol G represents the duration of validity of the message in hours. U.S. Forces always enter 0 in the space under G since the period of validity is not predicted. Other NATO forces use digits 1 through 8 in this space. A code of 9 indicates a predicted validity of 12 hours.

Group 4

A-54. Group 4 consists of $hhhP_dP_dP_d$. The symbol hhh represents the MET station altitude in tens of meters above mean sea level. The symbol $P_dP_dP_d$ represents the surface pressure in millibars. When the surface pressure is 1,000 millibars or higher, the first digit is dropped.

Explanation Identifiction Line

A-55. The identification line (for transmittal) is shown in figure A-26 and explained as follows:

- The METCM1 indicates a computer-type message and a station location in octant 1.
- The 347984 indicates station location at 34°42'N latitude and 98°24'W longitude.
- The 251380 indicates the date of the message is the 25th day of the month, GMT date, at 1348, and it is from a U.S. Army artillery MET section. (This does not predict the period of validity of the message.)
- The 036974 indicates the station altitude is 360 meters above mean sea level and the surface pressure is 974 millibars.

Message Body

A-56. The remaining lines of the message (ZZdddFFF TTTTPPPP) represent surface and zone MET data. The symbol ZZ represents the line number that identifies the reported MET information with the appropriate atmospheric layer. The line numbers begin with 00 (surface) and are numbered consecutively through line 26. The symbol ddd represents the true direction from which the wind is blowing. The direction is reported in tens of mils. The symbol FFF represents the true wind speed in knots. The symbol TTTT represents the virtual temperature. This temperature is expressed to the nearest 0.1°K. The symbol PPPP represents the air pressure. This pressure is expressed to the nearest millibar. The lines of the computer MET message are encoded and transmitted in eight-digit groups with two groups for each line. An example of the first two lines of a computer MET message is shown in figure A-27. The lines are explained in the following paragraphs.

ZONE HEIGHTS METERS	LINE NUMBER	WIND DIRECTION (10s M)	WIND SPEED (KNOTS)	TEMPERATURE (1/10°K)	PRESSURE (MILLIBARS)
	ZZ	ddd	FFF	TTTT	PPPP
SURFACE	00	**310**	**004**	**2923**	**0974**
200	01	**250**	**011**	**2931**	**0962**

Figure A-27. Example MET message body

First Line

A-57. The 00 indicates surface level, 310 is a wind direction of 3,100 mils, 004 is a wind speed of 4 knots, 2923 is a temperature of 292.3°K, and 0974 is a pressure of 974 millibars.

Second Line

A-58. The 01 indicates surface level, 250 is a wind direction of 2,500 mils, 011 is a wind speed of 11 knots, 2931 is a temperature of 293.1°K, and 0962 is a pressure of 962 millibars.

Authentication and Dissemination Blocks

A-59. At the bottom of the form, spaces are provided for entering the units to whom the message was sent or from whom it was received, the message number, the names of the persons who recorded and checked the message, and the date-time groups.

Reverse Side

A-60. The back of DA Form 3677-R (figure A-28) shows a sample computer MET message and explains the coding of the message. Also, the coding for octant of the globe is shown.

COMPUTER MET MESSAGE IS ENCODED AS FOLLOWS

1. The message is arranged in groups to be conveniently transmitted by radio or teletypewriter.

2. Information data: In the first five letters denote that the message is a computer message and the digit denotes the Q code of the global octant of the met station. The next group of six digits denotes the location of the met station in degrees and tenths of degrees. When 9 of the Q code is used, the six digits denote the clear or coded location of the met station. The third group of digits denotes the day of the month, time of commencement of validity in hours and tenths of hours (GMT), and duration of validity in hours from 1 to 8; code figure 9 indicates 12 hours. (Note: US Forces will always use 0, since period of validity is not predicted.) The first three digits of the fourth group denote the height of the met station (met datum plane) above sea level in multiples of 10 meters. The succeeding groups of eight digits are zone values, two groups of each line of the message.

3. The following specimen message was transmitted by radio:

METCM1	347983	081450	123903
00451025	29310903		
01454027	29200892		
……………			

EXPLANATION:

Group 1	Computer message. Met station located in global octant 1 (N latitude, 90°-180° longitude W.)
Group 2	Center of the area of applicability of the message (station location) is 34°42'N; 98°18'W.
Group 3	8th day of the month. Valid time commences at 1430 hours GMT. Period of validity is not predicted by US units.
Group 4	Met station is 1,230 meters above MSL. The MDP pressure is 903 millibars.
Group 5 & 6	At the surface (line 00), the wind direction is 4,510 mils and the wind speed is 25 knots. The surface temperature is 293.1°K, and surface pressure is 903 millibars.
Group 7 & 8	For line 01 (0-200 meters), the zone wind direction is 4,540 mils and wind speed is 27 knots. Zone temperature is 292.0°K, and zone pressure is 892 millibars.

Q Code for Octant of Globe

0-North latitude 0-90 west longitude	5-South latitude 0-90 west longitude
1-North latitude 90-180 west longitude	6-South latitude 90-180 west longitude
2-North latitude 180-90 east longitude	7-South latitude 180-90 east longitude
3-North latitude 90-0 east longitude	8-South latitude 90-0 east longitude
4-Note used	9-Used when the location of the meteorological station is not indicated by latitude and longitude.

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Figure A-28. DA Form 3677-R (Reverse)

BALLISTIC MET MESSAGE

A-61. The standard ballistic MET message provides for the common use and exchange of ballistic MET data among the allied countries during joint combat operations. DA Form 3675-R, *Ballistic Message (LRA)*, is used for encoding the standard MET message (Figure A-29). A copy of this form is located at the rear of this manual.

BALLISTIC MESSAGE

For use of this form, see FM 3-09.15; the proponent agency is TRADOC.

IDENTIFICATION	TYPE MSG	OCTANT	LOCATION $L_aL_aL_a$ or xxx	LOCATION $L_oL_oL_o$ or xxx	DATE	TIME (GMT)	DURATION (HOURS)	STATION HEIGHT (10s M)	MDP PRESSURE % OF STD
METB	K	Q	xxx	xxx	YY	$G_oG_oG_o$	G	hhh	PPP
METB									

ZONE HEIGHT (METERS)	LINE NUMBER ZZ	BALLISTIC WINDS DIRECTION (100s MILS) dd	BALLISTIC WINDS SPEED (KNOTS) FF	BALLISTIC AIR TEMPERATURE (% OF STD) TTT	BALLISTIC AIR DENSITY (% OF STD) ΔΔΔ
SURFACE	00	31	04	014	949
200	01	25	11	020	944
500	02	30	11	028	938
1000	03	35	14	032	936
1500	04	36	11	030	938
2000	05	41	07	027	940
3000	06	44	12	025	940
4000	07	51	10	014	947
5000	08	54	12	021	946
6000	09	54	13	030	947
8000	10	57	11	030	934
10000	11				
12000	12				
14000	13				
16000	14				
18000	15				

REMARKS

DELIVERED TO: FDC 2/2 FA RECEIVED FROM: FORT SILL MET	TIME (GMT) 1400	TIME (LST) 0800

MESSAGE NUMBER	DATE
1	25 NOV 04
RECORDER	**CHECKED**
ROBERTS	McADAMS

DA FORM 3675-R, MAY 1992 PREVIOUS EDITIONS ARE OBSOLETE. APD PE v1.01

Figure A-29. DA Form 3675-R

BALLISTIC MET MESSAGE ENCODING

A-62. A symbolic code is used to conveniently encode the ballistic MET message data in proper format. The data are arranged in six-digit groups for transmitting the message.

IDENTIFICATION LINE

A-63. The first four 6-digit groups pertain to the ID line of the ballistic MET message. The symbols are not transmitted; they are only used by the encoder to put the information in proper format and sequence. Detailed explanations of the symbols and the coding procedures for the ID line are discussed in the following paragraphs. Figure A-30 shows an encoded identification line.

BALLISTIC MESSAGE									
IDENTIFICATION	TYPE MSG	OCTANT	LOCATION		DATE	TIME (GMT)	DURATION (HOURS)	STATION HEIGHT (10s M)	MDP PRESSURE % OF STD
METB	K	Q	$L_aL_aL_a$ or XXX	$L_oL_oL_o$ or XXX	YY	$G_oG_oG_o$	G	hhh	PPP
METB	3	1	347	984	25	38	0	036	961
		BALLISTIC WINDS				BALLISTIC AIR			

Figure A-30. Ballistic MET message identification line

Group 1

A-64. Group 1 consists of METBKQ. The symbol METB is placed at the beginning of each ballistic MET message. These letters indicate that it is a MET message and that it includes ballistic MET data. Either a 2 or a 3, depending on the type of ballistic MET message, is entered for the symbol K. The type 2 message is prepared for surface-to-air trajectories. The type 3 message is prepared for surface-to-surface trajectories. The digit under the symbol Q represents the code for the global octant in which the MET section is located. For convenience in determining the geographical location of the reporting MET station, the globe was divided into octants numbered 0 through 8.

NOTE: The number 4 is not used. The digit 9 is used when the location is coded.

Group 2

A-65. Group 2 consists of $L_aL_aL_aL_oL_oL_o$ or XXXXXX. The symbol $L_aL_aL_a$ represents the latitude to the nearest tenth of a degree. The symbol $L_oL_oL_o$ represents the longitude to the nearest tenth of a degree. When the longitude is over 100 degrees, the first digit is dropped.

Group 3

A-66. Group 3 consists of $YYG_oG_oG_oG$. The symbol YY represents two digits for reporting the Greenwich date of the observation on which the message is based. The Greenwich date may differ from the local date, depending on the location and the hour. The symbol $G_oG_oG_o$ represents three spaces for reporting the time of commencement of the validity of the message in hours and tenths of hours. Local standard time must be corrected to reflect GMT in this block. This correction can be made by referring to the world map in appendix G. The symbol G represents the duration of validity of the MET message in hours from 1 to 8. The code numeral 9 indicates a period of validity of 12 hours. U.S. Forces always enter a 0 in the space under G since the period of validity is not predicted.

Group 4

A-67. Group 4 consists of hhhPPP. The symbol hhh represents the three digits indicating the altitude of the MET station. The three spaces under hhh are used to express the altitude in tens of meters above mean sea level. The symbol PPP represents the three digits indicating the atmospheric pressure at the MET station to the nearest 0.1 percent of the ICAO standard. When pressure is 100 percent or over, the first digit is dropped.

Explanation

A-68. The identification line is shown in Figure A-30 and explained as follows:

- The METB31 indicates a ballistic message type 3, surface to surface, and a station location in octant 1.
- The 347984 indicates a station location at 34° 42'N latitude and 98° 24'W longitude.
- The 251380 indicates the date of the message is the 25th day of the month, GMT date, at 1348, and it is from a U.S. Army MET section (This does not predict validity).
- The 036961 indicates the station altitude is 360 meters above mean sea level and the surface pressure is 96.1 percent of standard.

MESSAGE BODY

A-69. The columns and lines in the body of the message (figure A-31) are used for encoding the ballistic data for each line of the ballistic message. The first column is a list of the standard zone heights in meters. The zone height data are not transmitted. The second column lists the line numbers identifying each artillery zone of the atmosphere. The remaining four columns are used for encoding the ballistic MET data pertaining to each line. Each line is transmitted in two 6-digit groups representing the line number and the ballistic data in each standard zone. For example, the symbols for a line are ZZddFF and TTT ΔΔΔ.

		BALLISTIC WINDS		BALLISTIC AIR	
ZONE HEIGHT (METERS)	LINE NUMBER ZZ	DIRECTION (100s M) dd	SPEED (KNOTS) FF	TEMPERATURE (% OF STD) TTT	DENSITY (% OF STD) ΔΔΔ
SURFACE	00	**31**	**04**	**014**	**949**
200	01	**25**	**11**	**020**	**944**
500	02	**30**	**11**	**028**	**938**
1000	03	**35**	**14**	**032**	**936**
1500	04	**36**	**11**	**030**	**938**
2000	05	**41**	**07**	**027**	**940**
3000	06	**44**	**12**	**025**	**942**
4000	07	**51**	**10**	**014**	**947**
5000	08	**54**	**12**	**021**	**946**
6000	09	**54**	**13**	**030**	**947**
8000	10	**57**	**11**	**030**	**934**
10000	11				
12000	12				
14000	13				
16000	14				
18000	15				

Figure A-31. Ballistic MET message body

Group 1

A-70. The symbol ZZ indicates 00 for surface, 01 for line 1, 02 for line 2, and so on. The symbol dd represents the two digits indicating ballistic wind direction in hundreds of mils. The symbol FF represents the two digits indicating ballistic wind speed in knots.

Group 2

A-71. The symbol TTT represents the three digits indicating ballistic temperature in percentage of standard to the nearest tenth of a percent. For temperatures above 100 percent, the first digit is dropped. The symbol ΔΔΔ represents the three digits indicating ballistic density in percentage of standard to the nearest tenth of a percent. For densities over 100 percent, the first digit is dropped.

Explanation

A-72. The first line, (003104 and 014949), of the MET message (figure A-31) indicates the following:

- 00-Surface information follows.
- 31-Surface wind direction is 3,100 mils.
- 04-Surface wind speed is 4 knots.
- 014-Surface temperature is 101.4 percent of standard.
- 949-Surface density is 94.9 percent of standard.

Winds Exceeding 100 Knots

A-73. Anytime a ballistic wind exceeds 100 knots, 100 is subtracted from the speed (for example, 105 - 100 = 05). The result (05) is entered in the winds speed column of the ballistic message. To permit easy identification of a line number in which the ballistic wind exceeds 100 knots, 80 is added to that line number (for example, line 05 + 80 = 85).

Remarks Section

A-74. Below the ballistic data (figure A-32), a space is provided for any remarks deemed appropriate, such as a comment on any unusual data in the message.

REMARKS		
DELIVERED TO: **FDC 2/2 FA** RECEIVED FROM : **FORT SILL MET**	DATE (GMT) **1400**	TIME (LST) **0800**
MESSAGE NUMBER **1**	DATE **25 NOV 91**	
RECORDER **ROBERTS**	CHECKED **McADAMS**	
DA FORM 3675-R, MAY 92 PREVIOUS EDITION OF THIS FORM MAY BE USED UNTIL EXHAUSTED.		

Figure A-32. DA Form 3675-R

Authentication and Dissemination Blocks

A-75. At the bottom of the form, spaces are provided for entering the units to whom the message was sent or from whom it was received, the message number, the names of the persons who recorded and checked the message, and the date-time groups.

Reverse Side

A-76. The back of the form (figure A-33) shows a sample ballistic MET message and explains the encoding. Also, the information for coding the octant of the globe is shown.

THE BALLISTIC MET MESSAGE IS ENCODED AS FOLLOWS

1. The ballistic met message is arranged to be conveniently transmitted by radio or teletypewriter in groups of six digits or letters. 2. Information data: The first four letters denote that the message is a ballistic met message. The next letter denotes the type of ballistic met message-2 for surface-to-air trajectories or 3 for surface-to-surface trajectories. The sixth digit is the Q code of the global octant location of the met station, and the following six digits denote the location of the met station in degrees and tenths of degrees. When 9 of the Q code is used, the following six digits denote the clear or coded location of the met station. The third group of six digits denotes the day of the observation, time of commencement of validity in hours and tenths of hours (GMT), and duration of validity in hours from 1 to 8; code figure 9 indicates 12 hours. (Note: US Forces will always use 0, since period of validity is not predicted.) The fourth group of six digits denotes the station height and the station pressure expressed in percent of standard ICAO pressure. All succeeding groups of six are ballistic data. 3. The following specimen message was transmitted by radio: METB31 625468 290250 025001 000701 860163 015510 863162	EXPLANATION: Group 1 Met message for surface-to-surface fire, type 3 message. The met station located in global octant 1. Group 2 Center of the area of applicability of the message (station location) 62°30' N; 146°48' W. Group 3 29th day of the month. Valid time commences at 0230 hours GMT. Period of validity is not predicted by US units. Group 4 Met station is 250 meters above mean sea level. Station pressure is 100.1% of standard ICAO pressure. Group 5 For line 00 (surface), ballistic wind direction is 700 mils and wind speed is 1 knot. Group 6 For line 00, the ballistic temperature is 86.0% of standard and the ballistic density is 116.3% of standard. Group 7 For line 01 (0-200 meters), ballistic wind direction is 5,500 mils and wind speed is 10 knots. Group 8 For line 01, the ballistic temperature is 86.3% of standard and ballistic density is 116.2% of standard.

Q Code for Octant of Globe

0-North latitude 0-90 west longitude 1-North latitude 90-180 west longitude 2-North latitude 180-90 east longitude 3-North latitude 90-0 east longitude 4-Note used	5-South latitude 0-90 west longitude 6-South latitude 90-180 west longitude 7-South latitude 180-90 east longitude 8-South latitude 90-0 east longitude 9-Used when the location of the meteorological station is not indicated by latitude and longitude.

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Figure A-33. DA Form 3675-R (Reverse)

TARGET ACQUISTION MET MESSAGE

A-77. The TA MET message defines a format for use with unmanned aerial systems (UASs), remotely piloted vehicles (RPVs), drones, and weapons-locating radars (WLRs). The TA MET message standardizes the number of information digits in the message and their meanings. This standardization makes it possible for all armed forces to understand and use TA MET message information issued by any service of any armed forces.

TARGET ACQUISTION MET MESSAGE ENCODING

A-78. The sequence and number of symbols for a TA MET message are in table A-10.

Table A-10. TA MET Message Groups

Groups	***Symbols***
1	METTAQ
2	$L_aL_aL_aL_oL_oL_o$ or XXXXXX
3	$YYG_oG_oG_oG$
4	hhh $P_dP_dP_d$
5	CCC NNN
6	$Z_tZ_t$ddd FFF
7	ttttUU
8	99999

NOTES:

1. Group 6 and 7 are repeated for each zone number of the message. Only those zones of the message that are required by the recipient need be used.

2. If any data are not available, the missing data are indicated with a slash (/) for each missing digit. This note applies also to optional groups such as NNN in group 5.

GROUP 1

A-79. Group 1 consists of METTAQ. The symbol METTA indicates that this is a TA MET message. The symbol Q represents the octant of the globe.

GROUP 2

A-80. Group 2 consists of $L_aL_aL_aL_oL_oL_o$ or XXXXXX. The symbol $L_aL_aL_a$ represents the latitude to the nearest tenth of a degree. The symbol $L_oL_oL_o$ represents the longitude to the nearest tenth of a degree. When the longitude is over 100, the first digit is dropped.

GROUP 3

A-81. Group 3 consists of $YYG_oG_oG_oG$. The symbol YY represents the day of the month (GMT) of the commencement of the period of validity of the message. The symbol $G_oG_oG_o$ represents the time of commencement of the period of validity of the message. Time is recorded in tens, units, and tenths of an hour (GMT). The symbol G represents the duration of the period of validity in hours from 1 to 8. Code figure 9 indicates 12 hours. U.S. Forces use 0 since the period of validity is not predicted.

GROUP 4

A-82. Group 4 consists of $hhhP_dP_dP_d$. The symbol hhh represents the height of the MET section above mean sea level in tens of meters. The symbol $P_dP_dP_d$ represents the pressure at the MET section location expressed in hundreds, tens, and units of millibars. When the value of the air pressure is 1,000 millibars or more, the first digit is omitted.

GROUP 5

A-83. Group 5 consists of CCCNNN. The symbol CCC represents the height of the base of the lowest cloud at the point of observation. It is given in tens of meters according to the cloud code in table A-11. The symbol NNN represents mean refractive index at the surface in N units. If NNN is not to be included in the message, these missing data will be indicated by three slashes (///).

Table A-11 Cloud Code

Code	*Description*
000	Indicates sky obscured by fog.
001-160	Indicates visual estimate of base of lowest cloud, in tens of meters, below 1,600 meters.
166	Indicates visual estimate of base of lowest cloud above 1,600 meters.
199	Indicates clear sky.
301-460	Indicates base of lowest cloud observed by searchlight or laser. Subtract 300 to obtain base of lowest cloud observed by searchlight or laser, in tens of meters, if below 1,600 meters.
466	Indicates base of lowest cloud observed by searchlight or laser above 1,600 meters.
477	Indicates searchlight or laser observation unreliable.
499	Indicates no cloud detected by searchlight or laser.
501-660	Indicates height at which a balloon was lost in cloud. Subtract 500 to obtain height at which a balloon was lost in cloud, in tens of meters, if below 1,600 meters.
666	Indicates balloon lost above 1,600 meters.
677	Indicates balloon observation unreliable.
NOTE: Each service uses that portion of the code appropriate to its own procedures.	

GROUP 6

A-84. Group 6 consists of $Z_tZ_t$dddFFF. The symbol Z_tZ_t represents the zone number code. Table A-12 lists zone number codes. The symbol ddd represents the mean wind direction for the zone given in thousands, hundreds, and tens of mils. For zone number 00, the value is the wind direction at the MET section location. The symbol FFF represents the mean wind speed of the zone in hundreds, tens, and units of knots. For zone number 00, the value is the wind speed at surface.

Table A-12. Zone Number Code

Z_tZ_t	*Height Of Midpoint Of Zone Above MDP (Meters)*	*Height Above MDP Of Zone (Meters)*	
		Base	Top
00	0	-	-
01	25	0	50
02	75	50	100
03	150	100	200
04	250	200	300
05	350	300	400
06	450	400	500
07	550	500	600
08	650	600	700
09	750	700	800
10	850	800	900
11	950	900	1,000

Table A-12. Zone Number Code

Z_tZ_t	*Height Of Midpoint Of Zone Above MDP (Meters)*	*Height Above MDP Of Zone (Meters)*	
12	1,050	1,000	1,100
13	1,150	1,100	1,200
14	1,250	1,200	1,300
15	1,350	1,300	1,400
16	1,450	1,400	1,500
17	1,550	1,500	1,600
18	1,650	1,600	1,700
19	1,750	1,700	1,800
20	1,850	1,800	1,900
21	1,950	1,900	2,000
22	2,050	2,000	2,100
23	2,150	2,100	2,200
24	2,250	2,200	2,300
25	2,350	2,300	2,400
26	2,450	2,400	2,500
27	2,550	2,500	2,600

GROUP 7

A-85. This group consists of ttttUU. The symbol tttt represents the mean air temperature of the zone in hundreds, tens, units, and tenths of a degree Kelvin. For zone number 00, the value is the air temperature at surface. The symbol UU represents the mean RH expressed as a percentage in tens and units. A mean RH of 100 percent is denoted by 00.

GROUP 8

A-86. Group 8 consists of 99999. This group is a message terminator. It is used only when the message is transmitted by telegraphic means.

SOUND RANGING MET MESSAGE

A-87. Sound ranging MET messages are used by sound ranging platoons to determine the location of sound sources. Locating sound sources requires hourly updates concerning the atmosphere through which the sound waves pass. Required data is the effective temperature characteristics of the atmosphere between the sound source and the sound base and the effect of the wind on the rate and direction of travel of the sound wave. Sound ranging platoons can provide the required data themselves on an hourly basis. MET sections can provide the data only when soundings are made as scheduled, but normally not hourly. Also, MET sections may be positioned a great distance from a sound ranging platoon. Because the U.S. Army no longer has sound ranging platoons in the force structure, MET sections will probably have a requirement for sound ranging MET messages only when supporting allied operations.

SOUND RANGING MET MESSAGE ENCODING

A-88. When used, the sound ranging MET message is provided in the format shown in figure A-34. The parts of the sound ranging MET message are as follows:

- The symbol METSR indicates that this is a sound ranging MET message.

- The symbol Q represents the octant of the globe in which the MET station is located.
- The symbol $L_aL_aL_a$ represents the latitude of the MET station to the nearest tenth of a degree.
- The symbol $L_oL_oL_o$ represents the longitude of the MET station to the nearest tenth of a degree.
- The symbol dd represents the day of the month (GMT) of the sound ranging MET message.
- The symbol tttt represents the time message validity begins.
- The symbol TTT represents the effective (sonic) temperature to the nearest tenth of a degree Celsius.
- The symbol DDD represents the effective wind direction in mils.
- The symbol SS represents the effective wind speed in knots.

	METSR Q $L_aL_aL_aL_oL_oL_o$ dd tttt TTT DDD SS	

Figure A-34. Sound ranging MET message format

WORLD METEOROLOGICAL ORGANIZATION MET MESSAGE

A-89. The WMO MET message provides high-altitude sounding data. The MET section automatically provides the message in the WMO format to support the SWO.

WORLD METEOROLGICAL ORGANIZATION MET MESSAGE ENCODING

A-90. The automated WMO message consists of a heading and a message body. The encoded format conforms to the WMO format for worldwide transmission of MET data. The body of the message is in six parts; each part consists of groups of five digits.

HEADING

A-91. The heading of the WMO MET message is an identification line encoded in the format shown in figure A-35. The parts of the MET message identification line are as follows:

- The symbol METW identifies the MET message as being a MET message in WMO format.
- The symbol Q represents the octant of the globe. The octant identifies the part of the globe in which the MET section is located.
- The symbol $L_aL_aL_a$ identifies the latitude of the MET station location.
- The symbol GG identifies the release hour (GMT) of the sounding.
- The symbol $L_oL_oL_o$ identifies the longitude of the MET station location.
- The symbol gg identifies the release time to the nearest minute (GMT).
- The symbol YY represents the date of release (GMT).
- The symbol hhh represents MET station altitude in tens of meters.

METWQ$L_aL_aL_a$GG$L_oL_oL_o$ggYYhhh

Figure A-35. WMO MET message identification line

PART A (TTAA)-MANDATORY LEVEL DATA

A-92. Part A consists of mandatory level temperature, dew point (DP), and wind direction and speed below 100 millibars. The format of part A data is in figure A-36.

IDENTIFICATION-POSITION (Section 1)					
TTAA YYGGId		IIiii			
SURFACE-STANDARD ISOBERIC LEVELS (Section 2)					
$99P_oP_oP_o$	$T_oT_oT_{ao}D_oD_o$	$d_od_of_of_of_o$	00hhh TTT_aDD	ddfff 92hhh TTT_aDD	ddfff
85hhh	TTT_aDD	ddfff	70hhh TTT_aDD	ddfff 50hhh TTT_aDD	ddfff
40hhh	TTT_aDD	ddfff	30hhh TTT_aDD	ddfff 25hhh TTT_aDD	ddfff
20hhh	TTT_aDD	ddfff	15hhh TTT_aDD	ddfff 10hhh TTT_aDD	ddfff
TROPOPAUSE DATA (Section 3)					
$88P_tP_tP_t$	$T_tT_tT_{at}DtD_td_td_tf_tf_tf_t$				
MAXIMUM WIND DATA (Section 4)					
77 or 66	$P_mP_mP_m$	$d_md_mf_mf_mf_m$	$4v_bv_bv_av_a$		

Figure A-36. Format for part A (TTAA) of WMO MET message

Section 1

A-93. Section 1 of part A contains individual position identification data. Individual entries for section 1 of part A are discussed below. The format for section 1 is shown in figure A-37.

- The symbol TTAA identifies the data as Part A (mandatory levels).
- The symbol YY represents the date of the flight (GMT).
- **NOTE:** If wind speeds are recorded in knots, then 50 is added to the date. For example, 15 May is encoded 65. If wind speeds are recorded in meters per second, then the date is recorded in the normal manner.
- The symbol GG represents the time of observation to the nearest whole hour (GMT).
- The symbol Id represents the hundreds' digit of the last millibar level that winds are available. See Table A-13 lists the codes for last millibar level that winds are available.
- The symbol IIiii is a USAF location code. The II identifies the country or geographic area. The iii identifies individual stations within the country or geographic area.

IDENTIFICATION-POSITION (Section 1)					
TTAA YYGGId		IIiii			

Figure A-37. Format for section 1, part A (TTAA) of WMO MET message.

Table A-13. Codes for Last Millibar Level That Winds Are Available

Code Figure	*Wind group reported up to and including the following standard isobaric surfaces:*	
	Part A	*Part C*
1	100 OR 15 mb	10 mb
2	200 or 250 mb	20 mb
3	300 mb	30 mb
4	400 mb	....
5	500 mb	50 mb
6	....	....
7	700 mb	70 mb
8	850 mb	....
9	....	....
0	1,000 mb	....
/	No wind groups reported for any of the standard isobaric surfaces	No wind groups reported for any of the standard isobaric surfaces

Section 2

A-94. Surface data and standard isobaric surfaces data comprise section 2 of part A. Entries for section 2 are discussed in the following paragraphs. The format for section 2 is shown in figure A-38.

SURFACE-STANDARD ISOBERIC LEVELS (Section 2)					
$99P_oP_oP_o$	$T_oT_oT_{ao}D_oD_o$	$d_od_of_of_of_o$	00hhh TTT_aDD	ddfff 92hhh TTT_aDD	ddfff
85hhh	TTT_aDD	ddfff	70hhh TTT_aDD	ddfff 50hhh TTT_aDD	ddfff
40hhh	TTT_aDD	ddfff	30hhh TTT_aDD	ddfff 25hhh TTT_aDD	ddfff
20hhh	TTT_aDD	ddfff	15hhh TTT_aDD	ddfff 10hhh TTT_aDD	ddfff

Figure A-38. Format for section 2, part A (TTAA) of WMO MET message

A-95. The number 99 is the surface indicator.

A-96. The symbol $P_oP_oP_o$ represents the surface pressure. If the surface pressure is over 1,000 millibars, drop the thousands' digit.

A-97. The symbol $T_oT_oT_{ao}$ represents the temperature to the tenths of a degree Celsius. The last digit (T_{ao}) indicates if it is a positive or negative temperature value. Table A-14 lists temperature codes.

Table A-14. Temperature Tenths Value Code

Positive Temperature Tenths Value	*Code Figure*	*Negative Temperature Tenths Value*	*Code Figure*
.0	0	.0	1
.1	0	.1	1
.2	2	.2	3
.3	2	.3	3
.4	4	.4	5

Table A-14. Temperature Tenths Value Code

Positive Temperature Tenths Value	*Code Figure*	*Negative Temperature Tenths Value*	*Code Figure*
.5	4	.5	5
.6	6	.6	7
.7	6	.7	7
.8	8	.8	9
.9	8	.9	9

A-98. The symbol D_oD_o represents the DP depression. Table A-15 lists DP depression codes. DP depressions of 0.0 to 4.9 are encoded as 00 to 49. DP depressions from 5.0 to 5.5 are encoded as 50. DP depressions 5.5 and above are rounded off to the nearest whole degree and 50 is added to the result. (For example, DP depression 15.8 is encoded 16 + 50 = 66.)

Table A-15. Dew Point Depression Code

Code Figure	*Depression of the Dew Point in Degrees Celsius*	*Code Figure*	*Depression of the Dew Point in Degrees Celsius*
00	0.0	40	4.0
01	0.1	41	4.1
02	0.2	42	4.2
03	0.3	43	4.3
04	0.4	44	4.4
05	0.5	45	4.5
06	0.6	46	4.6
07	0.7	47	4.7
08	0.8	48	4.8
09	0.9	49	4.9
10	1.0	50	5
11	1.1	51	
12	1.2	52	
13	1.3	53	NOT USED
14	1.4	54	
15	1.5	55	
16	1.6	56	6
17	1.7	57	7
18	1.8	58	8
19	1.9	59	9
20	2.0	60	10
21	2.1	61	11
22	2.2	-	-
23	2.3	70	20
24	2.4	71	21
25	2.5	-	-

Table A-15. Dew Point Depression Code

Code Figure	*Depression of the Dew Point in Degrees Celsius*	*Code Figure*	*Depression of the Dew Point in Degrees Celsius*
26	2.6	80	30
27	2.7	81	31
28	2.8	-	-
29	2.9	89	39
30	3.0	90	40
31	3.1	91	41
32	3.2	-	-
33	3.3	98	48
34	3.4	99	49 or more
35	3.5		
36	3.6		
37	3.7		
38	3.8		
39	3.9		

A-99. The symbol $d_od_of_of_of_o$ represents wind direction and speed. Wind direction is rounded to the nearest 5 degrees. The last digit of the wind direction is added to the first digit of the wind speed when wind speed exceeds 99 knots. (For example, a wind direction of 293 and a wind speed of 45 knots are encoded as 29545. A wind direction of 115 and a wind speed of 126 knots are encoded as 11626.)

A-100. The symbol hhh represents height in geopotential meters. This is a mandatory data entry for mandatory pressure levels. Table A-16 lists mandatory pressure levels.

Table A-16. Mandatory Pressure Levels

Level	*Millibars*
00	1,000
92	925
85	850
70	700
50	500
40	400
30	300
20	200
15	150
10	100

NOTES:

1. Geopotential heights are reported in whole geopotential meters for surface up to 500 mb. Geopotential heights are reported in tens of geopotential meters for heights at the 500 mb level and above. Geopotential heights below mean sea level are coded by adding 500 to the absolute value. (For example, -239 is encoded as 739 [500+239])

2. Sometimes the surface pressure is lower than 1,000 mb, 850 mb, and so on. In this case, the 1,000 mb level is reported with slashes (///) after the height entry. Figure A-39 shows an example of this reporting.

(surface)	99 982 1065032001
(1,000-mb level)	00 612 ///////////////

Figure A-39. Surface pressure reporting

A-101. The symbol TTTa represents the surface temperature. This is a mandatory data entry for standard isobaric surfaces.

A-102. The symbol DD represents the DP depression. This is a mandatory data entry for standard isobaric surfaces.

A-103. The symbol ddfff represents the wind direction and speed. This is a mandatory data entry for standard isobaric surfaces.

Section 3

A-104. Tropopause data entries are in Section 3 of Part A. These entries are discussed below. The format for section 3 is shown in Figure A-40.

- The number 88 is the tropopause data indicator.

NOTE: If tropopause data are missing, the missing data are reported encoded as 88999.

- The symbol $P_tP_tP_t$ represents the pressure of the tropopause.
- The symbol $T_tT_tT_{at}$ represents the temperature at the tropopause.
- The symbol D_tD_t represents the DP depression at the tropopause.
- The symbol $d_td_tf_tf_tf_t$ represents the wind direction and speed at the tropopause.

TROPOPAUSE DATA (Section 3)					
$88P_tP_tP_t$	$T_tT_tT_{at}D_tD_td_td_tf_tf_tf_t$				

Figure A-40. Format for section 3, part A (TTAA) of WMO MET message

Section 4

A-105. Maximum wind data entries are in section 4 of part A. These entries are discussed below. The format for section 4 is shown in figure A-41.

- The number 66 or 77 is the maximum wind indicator. A 66 maximum wind indicator indicates the greatest wind speed observed throughout the sounding and occurring at the terminating level of sounding. A 77 maximum wind indicator indicates the level of maximum wind speed occurring within the sounding. Maximum winds must be above the 500-mb level and over 60 knots in speed to be reported. When no maximum wind data is observed, 77999 shall be reported for Section 4.
- The symbol $P_mP_mP_m$ represents the pressure at wind data.
- The symbol $d_md_mf_mf_mf_m$ represents the maximum wind direction and speed. Wind direction is encoded to the nearest 5°. The rounded digit is added to the hundreds digit of the speed. (For example, 30160 is 300° at 160 knots.)

- The symbol $4v_bv_bv_av_a$ represents the vertical wind shear data. These values are derived by using analytical geometry and are not easily checked in the field. The data reported with this entry are as follows:
  - 4 - Vertical wind shear data indicator.
  - v_bv_b - Value of vector difference between maximum wind speed and the wind blowing at 3,000 feet below the level of the maximum winds, in knots.
  - v_av_a - Value of the vector difference between the maximum wind speed and the wind blowing at 3,000 feet above the level of the maximum winds, in knots.

MAXIMUM WIND DATA (Section 4)					
77 or 66	$P_mP_mP_m$	$d_md_mf_mf_mf_m$	$4v_bv_bv_av_a$		

Figure A-41. Format for section 4, part A (TTAA) of WMO MET message

PART B (TTBB)-SIGNIFICANT DATA (TEMPERATURE AND DEW POINT) BELOW 100 MILLIBARS

A-106. The format for part B (TTBB) is shown in figure A-42.

IDENTIFICATION-POSITION (Section 1)							
TTBB	TTGG/	IIiii					
SIGNIFICANT LEVELS WITH RESPECT TO TEMPERATURE AND/OR HUMIDITY (Section 5)							
$00P_oP_oP_o$	$T_oT_oT_{ao}D_oD_o$	TTPPP	TTT_aDD	22PPP	TTT_aDD	33PPP	TTT_aDD
44PPP	TTT_aDD	55...ETC.					
DATA ON SEA-SURFACE TEMPERATURE AND SOUNDING SYSTEM (Section 7)							
31313	$s_rr_ar_as_as_a$	8GGgg	$9s_aT_wT_wT_w$				
CLOUD DATA SYMBOLIC LETTERS AND DEFINITIONS (Section 8)							
41414	$N_hC_LhC_MC_H$						
CODE GROUPS TO BE DEVELOPED REGIONALLY (Section 9)							
51515	$101A_{df}A_{df}$						

Figure A-42. Format for part B (TTBB) of WMO MET message

Section I

A-107. Section 1 of Part B contains position identification data. The data entries are discussed below. Section I is shown in figure A-43.

- The symbol TTBB is the Part B significant levels indicator. TT means sounding was made by a land-based station. UU means the sounding was made by a ship-based station.
- The symbol YY represents the date (GMT).
- The symbol GG represents the time of observation to the nearest whole hour (GMT).

- The symbol / represents the last level at which wind data were obtained.
- The symbol IIiii is a USAF identification code. The II identifies the country or geographic area. The iii identifies individual stations within the country or geographic area.

IDENTIFICATION-POSITION (Section 1)							
TTBB	TTGG/	IIiii					

Figure A-43. Section 1, part B (TTBB) of WMO MET message

Section 5

A-108. Section 5 of part B (TTBB) is composed of surface data and significant levels of temperature and DP. The surface data entries and the significant level data entries are discussed below. Section 5 is shown in figure A-44.

- The symbol 00 is a surface indicator.
- The symbol $P_oP_oP_o$ represents the surface pressure.
- The symbol $T_oT_oT_{ao}$ represents the surface temperature.
- The symbol D_oD_o represents the surface DP depression.
- The symbol 11 and symbols continuing on in multiples of 11 are level indicators.
- The symbol PPP represents pressure.
- The symbol TTT_a represents temperature.
- The symbol DD represents DP depression.

SIGNIFICANT LEVELS WITH RESPECT TO TEMPERATURE AND/OR HUMIDITY (Section 5)							
$00P_oP_oP_o$	$T_oT_oT_{ao}D_oD_o$	TTPPP	TTT_aDD	22PPP	TTT_aDD	33PPP	TTT_aDD
44PPP	TTT_aDD	55...ETC.					

Figure A-44. Section 5, part B (TTBB) of WMO MET message

Section 7

A-109. Section 7 of part B (TTBB) contains data on sea-surface temperature and sounding system used. The 31313 is the section indicator. Section 7 is shown in figure A-45.

- The symbol S_r represents solar and infrared radiation correction.
- The symbol R_aR_a is the radiosonde/sounding system used.
- The symbol S_aS_a is the tracking technique/status of the system used.
- The symbol 8 is the indicator for time.
- The symbol Gg_{gg} represents time of observation, in hours and minutes.
- The 9 is the indicator for the sign of data, relative humidity, and sea-surface temperature.
- The symbol S_n represents the sign of data and relative humidity indicator.
- The symbol $T_wT_wT_w$ is the sea-surface temperature reported in tenths of a degree Celsius.

DATA ON SEA-SURFACE TEMPERATURE AND SOUNDING SYSTEM (Section 7)							
31313	$s_rr_ar_as_as_a$	8GGgg	$9s_aT_wT_wT_w$				

Figure A-45. Section 7, part B (TTBB) of WMO MET message

Section 8

A-110. Section 8 of part B (TTBB) contains cloud code information. 41414 is the section indicator. The codes can be found in appendix B of this manual. Section 8 is shown in figure A-46.

- The symbol N_h is the amount of C_L present or, if no C_L is present, the amount of all the C_M cloud present.
- The symbol C_L represents cloud classes stratocumulus, stratus, cumulus, and cumulonimbus.
- The symbol h represents the height above surface of the base of the lowest cloud seen.
- The symbol C_M represents cloud classes altocumulus, altostratus, and nimbostratus.
- The symbol C_H represents cloud classes cirrus, cirrocumulus, and cirrostratus.

CLOUD DATA SYMBOLIC LETTERS AND DEFINITIONS (Section 8)							
41414	$N_hC_LhC_MC_H$						

Figure A-46. Section 8, part B (TTBB) of WMO MET message

Section 9

A-111. Section 9 of part B (TTBB) contains additional codes developed regionally. Section 9 is shown in Figure A-47.

- The 51515 is the section indicator.
- The symbol $A_{df}A_{df}$ represents the form of the additional data reported.

CODE GROUPS TO BE DEVELOPED REGIONALLY (Section 9)							
51515	$101A_{df}A_{df}$						

Figure A-47. Section 9, part B (TTBB) of WMO MET message

PART B (PPBB)-SIGNIFICANT DATA (WIND DIRECTION AND SPEED) BELOW 100 MILLIBARS

A-112. The format for part B (PPBB) is shown in figure A-48.

IDENTIFICATION-POSITION (Section 1)						
PPBB	YYGGa4	IIiii				
FIXED REGIONAL LEVELS AND SIGNIFICANT LEVELS (Section 4)						
$9t_nu_1u_2u_3$	ddfff	ddfff	ddfff			
………………………………………………………………………						
$9t_nu_1u_2u_3$	ddfff	ddfff	ddfff			

Figure A-48. Format for part B (PPBB) of WMO MET messages

Section I

A-113. Section 1 of part B (PPBB) contains position identification data. Data entries are discussed below.

- The symbol PPBB is the part B (winds data) below 100 millibars.)
- The symbol YY represents the date (GMT).
- The symbol GG represents the time of observation to the nearest whole hour (GMT).
- The symbol a_4 represents the type of instrument used in the observation. The symbol IIiii is a USAF location code. The II identifies the country or geographic area.
- The iii identifies individual stations within the country or geographic area.

Section 4

A-114. Section 4 of part B (PPBB) contains fixed regional levels data. The data entries are discussed in the following paragraphs. Fixed regional level data for part B are in table A-17. Heights indicated are above mean sea level.

Table A-17. Fixed Regional Levels

Feet	***Meters***
1,000	300
2,000	600
3,000	900
4,000	1,200
6,000	1,800
7,000	2,100
8,000	2,400
9,000	2,700
12,000	3,600
14,000	4,200
16,000	4,800
20,000	6,000
25,000	7,500
30,000	9,000
35,000	10,500
50,000	15,000

A-115. In the symbol $9t_nu_1u_2u_3$, the 9 is a height indicator, and t_n is the 10,000-foot indicator. The u_1 is the first wind level, u_2 is the second wind level, and u_3 is the third wind level. (For example, 90012 indicates surface level, 1,000-foot level, and 2,000-foot level. If surface level were over 1,000 feet above sea level, the indicator would be 90023. The 9205/ indicates 20,000-foot level and 25,000-foot level.)

A-116. The symbol ddfff represents wind direction and speed. Wind direction is given to the nearest 10 degrees. Winds are reported to the nearest 5 degrees by adding 500 to wind speed.

PART C (TTCC)-MANDATORY LEVEL TEMPERATURE, DEW POINT, AND WIND DATA ABOVE 100 MILLIBARS

A-117. The format for part C (TTCC) is shown in figure A-49. Identification of individual entries is the same for part C (TTCC) as for part A (TTAA). This section is omitted if the balloon bursts between 100 and 70 millibars. However, in this case, TTDD and PPDD must be transmitted so that the user can determine what data are available between 100 and 70 millibars.

IDENTIFICATION-POSITION (Section 1)							
TTCC	YYGGId	IIiii					
STANDARD ISOBARIC LEVELS (Section 2)							
70hhh TTT_aDD		ddfff 50hhh TTT_aDD		ddfff 30hhh TTT_aDD		ddfff	
TROPOPAUSE DATA (Section 3)							
$88P_tP_tP_t$	$T_tT_tT_{at}D_tD_t$		$d_td_tf_tf_tf_t$				
MAXIMUM WIND DATA (Section 4)							
77 or 66	$P_mP_mP_m$	$d_md_mf_mf_mf_m$		$4v_bv_bv_av_a$			

Figure A-49. Format of part C (TTCC) of WMO MET message

PART D (TTDD) – SIGNIFICANT LEVEL (TEMPERATURE AND DEW POINT ABOVE 100 MILLIBARS

A-118. The format for part D (TTDD) is shown in Figure A-50. Identification of individual entries is the same for part D (TTDD) as for part B (TTBB).

IDENTIFICATION-POSITION (Section 1)					
TTDD YYGG/	IIiii				
SIGNIFICANT LEVELS WITH RESPECT TO TEMPERATURE AND/OR HUMIDITY (Section 5)					
11PPP TTT_aDD	22PPP TTT_aDD	33PPP TTT_aDD	44PPP TTT_aDD		
55...ETC.					

Figure A-50. Format of part D (TTDD) of WMO MET message

PART D (PPDD)-SIGNIFICANT DATA (WIND DIRECTION AND SPEED) ABOVE 100 MILLIBARS

A-119. The format for part D (PPDD) is shown in figure A-51. Identification of individual entries is the same for part D (PPDD) as for part B (PPBB). Fixed regional level data for part D are included in Table A-18. Altitudes are above mean sea level.

IDENTIFICATION-POSITION (Section 1)					
PPDD YYGGa4	IIiii				
FIXED REGIONAL LEVELS AND SIGNIFICANT LEVELS					
9					
or	$t_a u_1 u_2 u_3$	ddfff ddfff ddfff			
1					
……………………………………………………………………….					
9					
or	$t_a u_1 u_2 u_3$	ddfff ddfff ddfff			
1					

Figure A-51. Format of part D (PPDD) of WMO MET message

Table A-18. Fixed Regional Level Data

Feet	*Meters*
70,000	21,000
90,000	27,000
100,000	30,000
110,000	33,000
140,000	42,000
and for every 10,000-foot level upward	and for every 3,000-meter level upward

FALLOUT MET MESSAGES

A-120. The FOMET message contains only wind data recorded at 2,000-meter intervals from the surface to 30,000 meters. This data is used by CBRN personnel mainly at division and corps levels to develop the downwind messages that predict fallout patterns.

ENCODING FALLOUT MET MESSAGES

A-121. Met data for fallout predictions are recorded on DA Form 3676-R, *Fallout Message (LRA)*. Figure A-52 shows an encoded fallout message. A copy of this form is at the rear of this manual. The following paragraphs discuss how the data recorded on the form are encoded.

FALLOUT MESSAGE

For use of this form, see FM 3-09.15; the proponent agency is TRADOC.

IDENTIFICATION	OCTANT	LOCATION		DATE	TIME (GMT)	DURATION (HOURS)	STATION WEIGHT (10s M)
		$L_aL_aL_a$ or xxx	$L_oL_oL_o$ or xxx				
METFM	Q			YY	GGG	G	hhh
METFM	1	347	984	25	138	0	036

ZONE HEIGHT (METERS)	LINE NUMBER ZZ	TRUE WIND DIRECTION (10s MILS) ddd	TRUE WIND SPEED (KNOTS) FFF	ZONE HEIGHT (METERS)	LINE NUMBER ZZ	TRUE WIND DIRECTION (10s MILS) ddd	TRUE WIND SPEED (KNOTS) FFF
SURFACE	00	310	004	16000	08	635	024
2000	01	366	008	18000	09	035	032
4000	02	512	014	20000	10		
6000	03	571	018	22000	11		
8000	04	601	012	24000	12		
10000	05	376	016	26000	13		
12000	06	379	028	28000	14		
14000	07	411	024	30000	15		

REMARKS

RECEIVED FROM: FORT SILL MET DELIVERED TO: CHEMICAL OFFICER 4th ID	DATE AND TIME (GMT) 25 1600 NOV 04
RECORDER JONES	
CHECKER SMITH	

DA FORM 3676-R, MAY 1992 PREVIOUS EDITIONS ARE OBSOLETE. APD PE v1.01

Figure A-52. DA Form 3676-R

OCTANT AND LOCATION

A-122. The area is identified by either a geographic location or a coded location of the MET station. In either case, the location is preceded by a number from the Q code, which designates the octant of the globe in which the station is located. The geographic location of the MET station may be determined from a military map and is recorded in degrees and tenths of degrees. If the longitude is equal to 100 degrees or more, the first digit, 1, is dropped. For example, latitude 34°42°N, longitude 98°24'W would be encoded as 1 347984. When operations require that the station be identified by a code, the Q code number 9 is used to signify that the next six digits are a coded location of the MET station. The using unit must understand the code used for the location.

A-123. The day of the month is entered in two digits. For example, the number 25 indicates the message is for the 25th day (GMT) of the month.

A-124. The release time in hours and tenths of hours is entered in three digits. Thus, the number 138 indicates a release time of 1348 GMT.

A-125. A digit from 1 to 8 is entered to represent duration of validity in hours. Code figure 9 indicates 12 hours. U.S. Forces use the digit 0 since they do not predict how long MET messages will be valid.

A-126. The altitude of the MET station above mean sea level is entered in tens of meters. The altitude of the station may be determined from a military map or from the survey section and is encoded in three digits. For example, the number 036 indicates the station is 360 meters above mean sea level.

A-127. The line number is identified by two digits that correspond to the zone number. The first line number, 00, indicates surface; 01, surface to 2,000 meters; 02, 2,000 meters to 4,000 meters; and so on.

A-128. Wind direction is encoded in three digits to the nearest 10 mils. Wind speed is encoded in three digits to the nearest knot. The number 310 indicates the wind direction is 3,100 mils. The number 004 indicates a speed of 4 knots.

A-129. The remarks block is used to record other pertinent data.

A-130. The FOMET message is transmitted in a certain code group format. An example of the format is METFMQ $L_aL_aL_aL_oL_oL_o$ (pause) YYGGGG (pause) hhh (pause) ZZdddFFF (pause) ZZdddFFF, and so on.

ENCODING STANDARD MESSAGES FROM MMS–P MET MESSAGES

A-131. MMS and STANAG MET message formats are arranged in a tabular format. The message will contain heading information followed by line numbers corresponding to a predetermined atmospheric zone. Associated with the line number are the wind speed, wind direction, temperature, and pressure for that atmospheric zone.

A-132. MMS–P system generates the same MET data for each type of message as required by STANAG agreement. The MMS–P system displays the data in a different format. Each line of the message contains one item of data. It is displayed with the data label and the value. Once familiar with the STANAG forms, transferring the data from the MMS–P format is self-explanatory. Figure A-53 shows the MMS–P message format.

```
TO: 129456
CC: []
FROM: 1802101

DTG: 252050ZOCT2005
PRECEDENCE: ROUTINE
CLASSIFICATION : UNCLASSIFIED

Message Body:

MET DATA DESIGNATOR: 0
GLOBAL OCTANT: 1
  MET VALIDITY DATA
  MET VALIDITY DURATION: 0
  MET VALIDITY START DAY:  26
  MET VALIDITY START HOUR: 20
MET ACTION DESIGNATOR: 1
MET STATION ELEVATION: 370
MET STATION ATOMOSPHERIC PRESSURE: 973
MET STATION LOCATION DATA:
  LATITUDE MET STATION:  34.7092
  LONGITUDE MET STATION: 98.4085
COMPUTER MET DATA
 COMPUTER MET DATA RECURRENCE (1 OF 32)(MAXIMUM 32)
  COMPUTER MET ALTITUDE ZONE: 0
  MET WIND DIRECTION: 2590
  MET WIND SPEED:  5
  AIR VIRTUAL TEMPERATURE:  288
  AIR PRESSURE:  973

 COMPUTER MET DATA RECURRENCE (2 OF 32)(MAXIMUM 32)
  COMPUTER MET ALTITUDE ZONE: 1
  MET WIND DIRECTION: 2590
  MET WIND SPEED:  8
  AIR VIRTUAL TEMPERATURE:  287
  AIR PRESSURE:  961

(The remaining 30 lines of MET are listed in the same format.)
```

Figure A-53. MMS–P MET message format

SECTION IV ARTILLERY LIMITED SURFACE OBSERVATION MET MESSAGE

OVERVIEW

A-133. All FA MET sections can produce an artillery limited surface observation (ALSO) MET message in support of Army tactical operations. Only surface observation equipment is used to collect the data, which are entered on DA Form 5033-R, *Limited Surface Observation (LRA)*. A copy of this form is at the rear of this manual. MET sections deliver the data to requesting agencies in plaintext format. The message will be transmitted in six-digit groups. The order of groups must be maintained. Only the 99 group will be considered optional and may be omitted if not applicable. If an element within a group cannot be reported, it must be entered as a slash. Correct procedures for producing an ALSO MET message are described below.

MESSAGE IDENTIFIER (SUPRP Q)

A-134. Use the five-letter SUPRP identifier followed by octant of globe for the first six-letter/number group.

STATION LOCATION ($L_AL_AL_A$ $L_OL_OL_O$)

A-135. In the second six-number group, three numbers are for latitude and three are for longitude to a tenth of a degree. When the location must be coded, the code is in agreement with the receiving and transmitting units.

DATE AND TIME (YY GGGG)

A-136. Both are given in GMT in hours and minutes at time of observation.

TOTAL AMOUNT OF CLOUD COVER (NA)

A-137. Of all the weather conditions that adversely affect aircraft operations, low clouds and low visibility are by far the most common. Sky condition observations consist of two elements, the amount of clouds or obscuration present and remarks about the sky condition in the area that would be helpful to the weather forecaster or to the aviator. This paragraph describes the method of observing the sky conditions.

Sky Cover Amounts (Na)

A-138. The total amount of the sky covered by clouds or an obscuration can be described by using one of the following words:

- **Clear**. Less than 1/8 of the sky is covered by clouds.
- **Scattered**. 1/8 to less than 1/2 of the sky is covered (approximately 10-50 percent).
- **Broken**. 1/2 or more of the sky is covered (approximately 60-90 percent).
- **Overcast**. Sky is totally covered by clouds or other materials; that is., fog, blowing snow, blowing sand, or smoke.

Determining Sky Cover

A-139. The total cloud amount is determined by considering the sky above as a celestial dome divided into eight equal parts. For example, the observer is standing at point X in figure A-54. There are three different cloud layers above you. There is 7/8 cloud cover, but the cirrus and the altocumulus overlap by about 1/8, so the total cloud amount is reported as 6/8, or a broken condition. Table A-19 indicates amount of cloud cover codes.

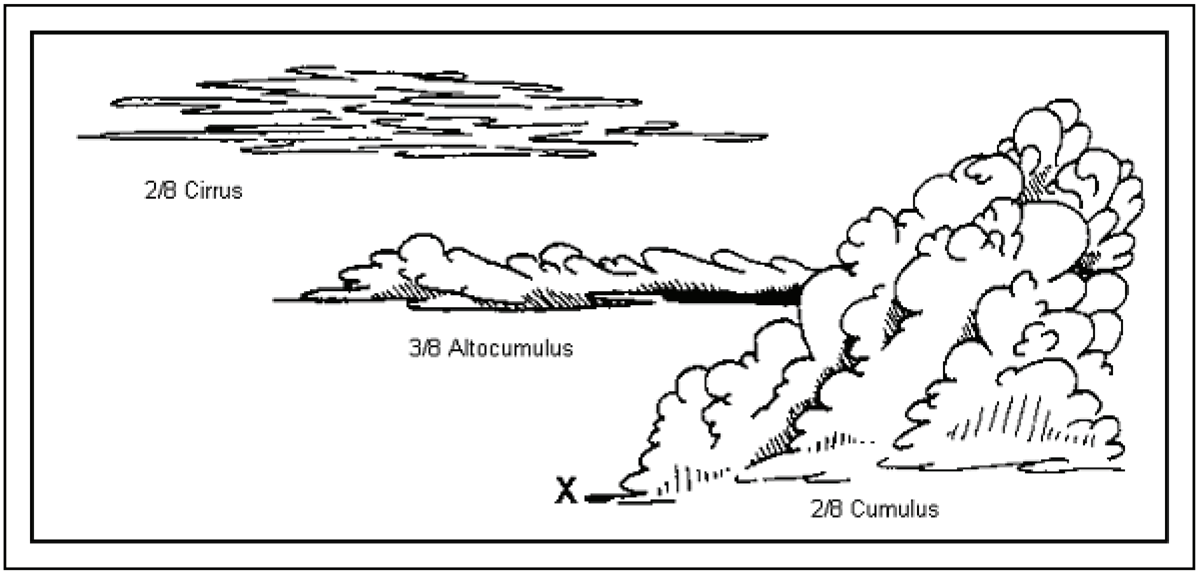

Figure A-54. Cloud cover

Table A-19. Na-Total Amount of Cloud Cover

Code Figure	*Explanation*	*For Work Sheet Abbreviation*
0	Clear (no clouds)	CLR
2	Scattered (1/8 - 4/8)	SCTD
3	Scattered (hills in clouds)	SCTD II
5	Broken (5/8 - 7/8)	BRKN
6	Broken (hills in clouds)	BRKN
7	Overcast (8/8)	OVC
8	Overcast (hills in clouds)	OVC II

Additional Codes

A-140. Very often, significant features of sky cover cannot be explained simply by scattered, broken, and so forth. Explanations for hilly or mountainous stations are included in the code and must be used. These codes, which are extremely important to aircraft operations, are listed in table A-20.

Table A-20. Additional Codes

Code	*Description*
3 - Scattered	(Hills in clouds)
6 - Broken	(Hills in clouds)
8 - Overcast	(Hills in clouds)

WIND DIRECTION AND SPEED (D F)

A-141. Wind speed and direction are necessary in forecasting weather, especially in locations where weather is often associated with frontal systems. Wind direction and speed can be used to locate these fronts and to determine their movement. Frequently, the combination of wind direction and terrain produces significant variation in wind speed over very short distances. Local variations in wind speed can also produce deviations in weather conditions.

Direction (D)

A-142. Wind direction is defined as the direction from which the wind is blowing. Wind may be read from an anemometer. Table A-21 lists the codes for wind direction.

Table A-21. D-Direction From Which Surface Wind is Blowing

Code Figure	*Explanation*	*Degrees*
0	Calm	
1	NE	023-067
2	E	068-112
3	SE	113-157
4	S	158-202
5	SW	203-247
6	W	248-292
7	NW	293-337
8	N	338-022
9	Variable	

Speed (F)

A-143. Wind speed may also be read from an anemometer. If no wind equipment is available, the speed may be estimated by using table A-22.

Table A-22. F-Force of Surface Wind (Beaufort Scale)

Code Figure	*Description*	*Specifications*	*Approximate Knots*
0	Calm	Smoke rises vertically	Less than 2
2	Light Breeze	Wind felt on face and leaves rustle	3-8
4	Moderate breeze	Dust and loose paper fly about; small branches move	9-18
6	Strong breeze	Large branches in motion, whistling in wires	19-29
8	Gale	Twigs broken off trees; progress of person walking generally impeded	30-42

VISIBILITY (V)

A-144. Visibility is an important limiting factor in flying operations. Poor visibility restricts visual surveillance and flying observations. Visibility is the greatest distance an object can be seen and identified by the normal eye without the aid of optical devices such as binoculars and starlight scopes. In actual practice, visibility is the greatest distance that prominent objects such as trees, buildings, water towers, or natural landmarks (hills) can be seen clearly enough to be identified. Visibility is reported in meters, to the nearest hundred meters, as listed in table A-23. The visibility that is reported must be representative of at least half of the horizon circle. In making this determination, the horizon circle is normally divided into quadrants as shown in figure A-55. Any two quadrants may be used to determine the prevailing visibility. Quadrant visibility may be reported as a remark at the end of the observation. If the observer feels that the visibility in one quadrant is significantly different from the prevailing visibility, he should include a remark, for example, Visibility N, meters. Any quadrant or direction may be used for this remark.

Table A-23. V-Visibility at Surface

Code Figure	*Explanation*
0	Less than 50 meters
1	50-200 meters
2	200-500 meters
3	5000-1,000 meters
4	1-2 km
5	2-4 km
6	4-10 km
7	10-20 km
8	20-50 km
9	50 km or more

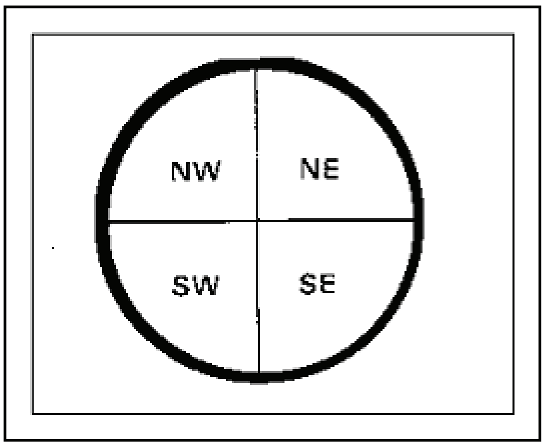

Figure A-55. Quadrant visibility

Daytime

A-145. In daytime, any building, water tower, telephone pole, road, hill, clumps of trees, and others that can be seen under ideal conditions may be used as a visibility marker if the distance to the object is known.

Night

A-146. At night**,** the above objects can be used if their silhouettes can be identified. However, the best nighttime marker is an unfocused light at a known distance from the observation point. This does not include searchlights, airport rotating beacons, or automobile headlights aimed directly at you.

PRESENT WEATHER AND OBSTRUCTIONS TO VISION (W)

A-147. The important effect visibility has on operations has already been mentioned. It would not be logical to report a reduction in visibility without describing it in terms of the weather phenomena upon which the visibility depends. These weather phenomena are divided into two main groups, weather and obstructions to vision. They are discussed separately in detail in the following paragraphs. Table A-24 lists the codes for present weather.

Table A-24. w-Present Weather and Obstructions to Vision

Code Figure	*Explanation*
0	No significant weather
1	Smoke or haze
2	Fog in valley
3	Sandstorm, dust storm, or blowing snow
4	Fog
5	Drizzle
6	Rain
7	Snow or rain and snow mixed
8	Shower(s)
9	Thunderstorm(s) with or without precipitation

Smoke

A-148. Smoke is fine ash particles suspended in the air. When smoke is present, the disk of the sun appears very red at sunset and sunrise and has a reddish tinge throughout the day. Smoke at a distance, such as from a forest fire, usually has light grayish or bluish color.

Haze

A-149. Haze is dust and other material too small to be seen individually by the unaided eye. Haze reduces visibility and resembles a uniform veil over the landscape that subdues the colors. Haze appears bluish against a dark background but dirty or orange against a bright background such as the sun. In contrast, fog appears grayish and feels damp on the skin.

Fog

A-150. Fog is very small drops of water suspended in the air that reduce visibility.

Blowing Sand and or Dust

A-151. Blowing sand or dust is dust or sand raised by the wind to such an extent that visibility is impaired.

Blowing Snow

A-152. Blowing snow occurs when there is no appreciable amount of falling snow, but snow from the ground is carried into the air by the wind and visibility is reduced.

Precipitation

A-153. Precipitation includes all forms of moisture that fall to the earth's surface, such as rain, snow, and hail. All forms of precipitation can be classified as liquid, freezing, or frozen. Of special importance are the freezing types of precipitation that present a great hazard to aviation. Precipitation is reported as amplification of phenomenon reported by w. Table A-25 contains the appropriate codes.

Table A-25. A'-Amplification of Phenomenon Reported by w

Code Figure	*Explanation*
0	No precipitation occurring
1	Light
2	Heavy
3	In the past hour, but not at the time of observation
4	Precipitation within sight
5	Freezing precipitation
9	Hail or ice pellets

Liquid Precipitation

A-154. There are two forms of liquid precipitation, drizzle and rain. Drizzle is very small water droplets that seem almost to float in the air and visibly follow air motion. Drizzle falls from fog or very low clouds. Rain is precipitation that reaches the earth's surface as relatively large drops. Rain can be classed as light, moderate, or heavy, depending upon the rate of fall.

Freezing Precipitation

A-155. There are two forms of freezing precipitation, freezing rain and freezing drizzle. Freezing rain is precipitation in the form of very cold raindrops, a portion of which freezes and forms a smooth coating of ice upon striking an exposed surface. Freezing drizzle is precipitation in the form of very cold drizzle that freezes in the same manner as freezing rain.

Frozen Precipitation

A-156. There are four forms of frozen precipitation: ice pellets, hail, snow, and snow grains. Ice pellets are frozen raindrops formed by rain falling through a layer of cold air. Ice pellets may adhere to any exposed surface, forming an uneven layer of ice. Hail is precipitation in the form of balls or irregular lumps of ice. Hail results when water drops are repeatedly carried aloft to the colder air by the violent air currents usually associated with thunderstorms. Snow is precipitation composed of ice crystals. Snow grains are small grains of snow that are soft and opaque and lack the six-sided appearance of the ordinary snowflake.

Thunderstorms

A-157. A thunderstorm may or may not be accompanied by rain or hail.

Tornado

A-158. A tornado is a circular whirl or wind of great velocity and small horizontal diameter. The horizontal diameter of a tornado varies from a few feet up to a mile, and the wind speeds often exceed 200 miles per hour. Tornadoes are short-lived, usually not lasting more than an hour or two. If a tornado is sighted, the observer should call his reporting station immediately and give its location and direction of movement. Speed in reporting the sighting is of the utmost importance to all concerned.

STATE OF ROAD IN VICINITY OF OBSERVATION POINT (R)

A-159. Table A-26 lists the codes for road conditions.

Table A-26. R-State of Road in Vicinity of the Observation Point

Code Figure	*Explanation*
0	Dry
1	Wet
2	Flooded
3	Slush
4	Ice patches
5	Glazed Ice
6	Snow depth 1 to 19 cm
7	Snow depth 20 cm or more
8	Snow drift

STATE OF TERRAIN IN VICINITY OF OBSERVATION POINT (T)

A-160. Table A-27 lists the codes for terrain conditions.

Table A-27. T-State of Terrain in the Vicinity of the Observation Point

Code Figure	*Explanation*
0	Dry
1	Wet
2	Pools of water on surface;
3	Flooded
4	Ground frozen 0 to 4 cm
5	Ground frozen 5 cm or more
6	Snow depth 0 to 4 cm
7	Snow depth 5 to 24 cm
8	Snow depth 25 to 44 cm
9	Snow depth 45 cm or more

STATE OF WATER SURFACE (A)

A-161. Table A-28 lists the codes for water surface conditions.

Table A-28. A-Sate of Water Surface

Code Figure	*Explanation*
0	Water level normal
1	Water level much below normal
2	Water level high, but not overflowing
3	Banks overflowing
4	Floating ice (more than half)
5	Thin ice, complete cover, impassable for persons, 0-4 cm thick
6	Ice, complete cover, passable for persons,

Table A-28. A-Sate of Water Surface

Code Figure	*Explanation*
	depth unknown
7	Ice, complete cover, depth 5-9 cm
8	Ice, complete cover, depth 10-24 cm
9	Ice, complete cover, depth 25 cm or more

TEMPERATURE (TT)

A-162. Temperature is indicated in whole degrees Celsius. Negative temperatures are encoded by adding 50 to the absolute value of the temperature; that is., -20 degrees is coded as 70.

PRESSURE (PPPP)

A-163. The surface pressure to the nearest tenth of a millibar is encoded. When pressure is over 1,000 millibars, the thousands' digit is dropped.

WIND DIRECTION (DD)

A-164. In this portion of the code, the wind direction (in tens of degrees) is reported in two digits. This data is used to further amplify wind information reported in the fourth six-digit group. These two digits will be encoded as 99 when the wind speed is less than 5 knots.

WIND SPEED (FF)

A-165. The wind speed is reported in knots and in two digits.

AMOUNT OF LOW CLOUD (NH)

A-166. The lowest cloud is determined for the amount of cover in eighths. For encoding, see table A-29.

Table A-29. Nh-Amount of Cloud Reported at Height ha

Code Figure	*Explanation*
0	0
1	1/8 or less, but not 0
2	2/8
3	3/8
4	4/8
5	5/8
6	6/8
7	7/8 or more, but not 8/8
8	8/8
9	Sky obscured or cloud amount cannot be estimated

HEIGHT OF LOW CLOUD (HA)

A-167. The height of the lowest cloud above the observing point is estimated. For encoding, see table A-30.

Table A-30. ha-Height of the Lowest Cloud Layer Above the Observation Point

Code Figure	*Explanation*
0	0-99 meters
1	100-199 meters
2	200-299 meters
3	300-399 meters
4	400-499 meters
5	500-599 meters
6	600-699 meters
7	700-799 meters
8	800-899 meters
9	900 meters or more or no clouds

INDICATOR FOR SURF DATA (99)

A-168. When the unit is located at a seacoast area, it is important to give surf conditions. The 99 group indicates that surf data will follow. The surf data includes average height of breakers, time breakers last, direction of waves' approach to beach, and the width of the surf zone. For estimation and encoding of these variables, see tables A-31, A-32, A-33, and A-34. When surf data is not available, the message will end with height of low cloud plus any remarks on weather elements that might seem appropriate. Thus, the message includes seven 6-digit groups when surf data is not included. Any data or weather element that is missing is represented by a slash (/).

Table A-31. Hs-Average Height of Breakers

Code Figure	*Explanation*
0	0 to 10 seconds
1	10 to 20 seconds
2	20 to 30 seconds
3	More than 30 seconds

Table A-32. Ps-Period of Breakers (Seconds) Time Required for Successive Breakers to Pass a Given Point

Code Figure	*Explanation*
0	Less than 1 meter
1	1-2 meters
2	2-3 meters
3	More than 3 meters

Table A-33. Dw-Direction of Approach of Waves To Beach (Observers Back to Sea)

Code Figure	*Explanation*
0	Waves approaching from right side
1	Waves approaching directly from rear

Table A-33. Dw-Direction of Approach of Waves To Beach (Observers Back to Sea)

2	Waves approaching from lift side

Table A-34. Ws-Width of Surf Zone (Distance from Edge of Water to the Point Seaward that the White Caps of the Surf Begin to Appear)

Code Figure	*Explanation*
0	1 to 10 meters
1	10 to 20 meters
2	29 to 30 meters
3	More than 30 meters

PLAIN LANGUAGE REMARKS

A-169. Any remark that the observer considers beneficial or explanatory may be listed at the bottom of the message. Some examples include—

- The direction of a thunderstorm from your location and the approximate direction it is moving toward; for example, thunderstorms E moving NE.
- The direction of lightning from your location; for example, lightning overhead and SW through NW.
- Obscuring phenomena at a distance from your location but not occurring at your location; for example, fog bank NE through SE.

DA FORM 5033-R LIMITED SURFACE OBSERVATION

A-170. Figure A-56 is a DA form to be completed for each limited surface observation.

SECTION V MET MESSAGE CHECKING PROCEDURES

A-171. MET section personnel perform quality control checks of all data and MET messages. However, anyone receiving MET messages should question any peculiarities noticed on their copy. Anytime there is doubt about the timeliness or validity of a MET message, the MET section should be consulted. MET section personnel are qualified to explain and correct message variations or transmission errors. Voice dissemination of messages often induces copying errors, especially when other than the standard MET message forms are used to copy the messages.

A-172. All MET messages are processed automatically. Once the instrument is released, MET section personnel can monitor the raw data but cannot edit it. If any peculiarities appear on the final message, the MET station leader can extract the flight data and look for any abnormal conditions that could explain the peculiarity. If the MET station leader has any doubts, another sounding can be made to verify data. Consecutive soundings should show a trend unless weather conditions have changed because of rain, snow, a rapid increase or decrease in cloud cover, the passage of a front, or a sunrise or sunset transition period.

MET MESSAGE PARTS

A-173. MET messages are divided into the message heading and message body. The message heading identifies the MET station location, the area of validity of the message, and the time of the message. The message body contains the MET data element of the specific message.

CHECKING THE MESSAGE HEADING

A-174. In general, the procedures for checking the heading of the MET message are the same for all types of messages. These procedures are discussed below.

Location

A-175. The location of the MET station and the octant is a check to ensure it is valid for your area of operation.

Date and Time

A-176. The date and time entries are checked to ensure that the MET data in the message are current. If the message is over 4 hours old, verify the validity of the message with the MET section or obtain an updated message from them.

NOTE: The date and time are Greenwich Mean Time, not local standard time.

Altitude

A-177. The altitude of the MET section should be checked on the map. An altitude error of 50 meters or more can affect temperature and density accuracy.

Pressure

A-178. The pressure on the ID line should be the same as the pressure on line 00. This does not apply to ballistic messages since all lines except the heading are reported in density percentage of standard.

CHECKING THE MESSAGE BODY

A-179. The procedures for checking the message body vary with each type of message. Procedures for checking the message body of specific types of MET messages are discussed below.

Computer MET Message

A-180. The computer MET message is a record of actual measured weather conditions. Therefore, it is more likely to show abrupt changes not noticed on the ballistic MET message.

A-181. Wind speeds and directions should be fairly uniform with proportional changes in altitude. Large changes in wind direction (1,000 mils when wind speeds are above 10 knots) or abrupt increases or decreases in wind speeds (10 to 15 knots) are suspect and should be investigated.

NOTE: Large changes in wind direction are not uncommon with wind speeds less than 10 knots.

A-182. Temperature accuracy is hard to evaluate because of natural erratic changes. Any severe increase or decrease in temperature (for example, +/- 20°K) is suspect and should be investigated.

A-183. Atmospheric pressure always decreases from line to line. Pressure never increases with height. Transposed figures are the most common errors in pressure values. If errors in pressure are suspected, the MET section must provide the corrected values.

BALLISTIC MET MESSAGE

A-184. Ballistic wind directions should remain fairly constant from line to line. Drastic changes (greater than 1,000 mils) or sudden reversals in direction should be questioned, particularly if the wind speeds on those lines are greater than 10 knots. Ballistic wind speed changes greater than 15 knots from line to line should be questioned.

A-185. Ballistic temperatures and densities should trend smoothly with no drastic changes between zones. Normally, as density increases, temperature decreases. Rarely will both temperature and density change in the same direction. If they do, those lines are suspect and should be verified by the MET section. Drastic changes in density or temperature (2.0 percent or more) should be verified by the MET section.

OTHER MET MESSAGES

A-186. The data in each of the other types of MET messages are not easily checked by the user. If the message heading has been checked for each of these messages, the data provided should be considered correct without further checking.

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Appendix B

World Meteorological Organization Cloud Codes

This appendix provides the necessary tables and specific instructions to record cloud phenomena for the surface "41414 $N_hC_LhC_MC_H$" group. This guidance assumes minimal previous knowledge of synoptic code procedures; however, a basic understanding of clouds is necessary. For those already familiar with synoptic codes, some departure from conventional World Meteorological Organization coding procedures will be noticed. By simply observing the elements requested and reporting them according to tables provided in this text, the intent of the cloud entry will be fully met.

CLOUDS GROUP FORMAT

B-1. The clouds entry is a five-digit, mandatory group as shown in figure B-1.

IDENTIFICATION-POSITION (Section 1)							
TTBB	TTGG/	IIiii					
SIGNIFICANT LEVELS WITH RESPECT TO TEMPERATURE AND/OR HUMIDITY (Section 5)							
$00P_oP_oP_o$	$T_oT_oT_{ao}D_oD_o$	TTPPP	TTT_aDD	22PPP	TTT_aDD	33PPP	TTT_aDD
44PPP	TTT_aDD	55...ETC.					
DATA ON SEA-SURFACE TEMPERATURE AND SOUNDING SYSTEM (Section 7)							
31313	$s_rr_ar_as_as_a$	8GGgg	$9s_aT_wT_wT_w$				
CLOUD DATA SYMBOLIC LETTERS AND DEFINITIONS (Section 8)							
41414	$N_hC_LhC_MC_H$						
CODE GROUPS TO BE DEVELOPED REGIONALLY (Section 9)							
51515	$101A_{df}A_{df}$						

Figure B-1 Format for part B (TTBB) of WMO MET message

B-2. All five digits must be entered, regardless of the presence or absence of clouds. The WMO format for entry of clouds has been modified to meet National Climatic Data Center requirements. All stations should follow this modified format, regardless of location. A description of the five-digit format follows.

B-3. **N_h**. N_h is the amount (in oktas) of the sky covered by all low clouds (C_L) observed or the amount of sky covered by all the middle clouds (C_M) observed. In no case will the amounts of the low and middle clouds be combined to report N_h. Use table B-1 to report the amount of low or middle cloud coverage.

Table B-1. Amount of Low/Middle Cloud, N_h

Code Figure	*Cloud Amount in oktas (eighths)*	*Cloud Amount in Tenths*
0	0	0
1	1 okta or less, but not zero	1/10 or less
2	2 oktas	2/10 - 3/10
3	3 oktas	4/10
4	4 oktas	5/10
5	5 oktas	6/10
6	6 oktas	7/10 - 8/10
7	7 oktas or more, but not 8 oktas	9/10 or more, but not 10/10
8	8 oktas	10/10
9	Sky obscured by fog and/or other meteorological phenomena	
/	Cloud cover is indiscernible for reasons other than fog or other meteorological phenomena	

NOTE: If there are any breaks in the sky at all, such as an overcast with a mackerel sky (altocumulus pelucidus or stratocumulus pelucidus), N_h would be encoded as 7. If there are only a few patches of low or middle cloud in the sky, N_h cannot be encoded as 0, but is encoded as 1. A partial obscuration does not affect the coding of N_h. A total obscuration is coded as 9, not 8 (overcast sky).

B-4. **C_L**. C_L is the type of low cloud, based on the priority given in table B-2. This table presents the specifications for type of low cloud, C_L, in order of priority. Go down the table and use the first applicable code figure. A slash (/) is reported if C_L clouds are not visible owing to fog or similar obscuring phenomena.

Table B-2. Coding of Low Cloud, C_L

Code Figure	*Reportable Heights (ft)*
CUMULONIMBUS PRESENT, WITH OR WITHOUT OTHER C_L CLOUDS	
CL = 9	If the upper part of at least one of the cumulonimbus clouds present is clearly fibrous or striated, use CL = 9.
CL = 3	If the upper part of none of the cumulonimbus clouds present is clearly fibrous or striated, use CL=3.
NO CUMULONIMBUS PRESENT	
C_L = 4	If stratocumulus formed by the spreading out of cumulus is present, use C_L = 4.
C_L = 8	If the C_L code figure 4 is not applicable and if cumulus and stratocumulus clouds with bases at different levels are present, use C_L = 8.

Table B-2. Coding of Low Cloud, C_L

Code Figure	***Reportable Heights (ft)***
C_L = 1	If the C_L code figures 4, 8, and 2 are not applicable, use C_L = 1, if the C_L clouds present are predominantly (NOTE 1) cumulus with little vertical extent and seemingly flattened or ragged cumulus other than of bad weather (NOTE 2), or both.
C_L = 5	Use C_L = 5, if among other C_L clouds present, stratocumulus other than that formed by the spreading out of cumulus of predominant.
C_L = 6	Use C_L = 6, if the C_L clouds present are predominantly stratus in a more or less continuous sheet or layer, or in shreds (stratus of bad weather), or both.
C_L = 7	Use C_L = 7, if the C_L clouds present are predominantly pannus (ragged shreds of stratus of bad weather or ragged cumulus of bad weather), or both.
0	No C_L clouds - No cumulus, cumulonimbus, stratocumulus, or stratus.
/	C_L clouds not visible owning to fog or similar obscuring phenomena.
NOTE 1: Consideration of predominance is restricted to the clouds corresponding to C_L code figures 1, 5, 6, and 7, which have the same priority. Clouds of any one of these four specifications are said to be predominant when their sky cover is greater than that of the clouds of any of the other three specifications.	
NOTE 2: Bad weather denotes the conditions which generally exist during precipitation and a short time before and after.	

NOTE: Clouds are divided into three families, and classified as low, middle, or high. The general height ranges for these are surface to 6,500 feet for low, 6,500 feet to 20,000 feet for middle, and above 20,000 feet for high. Remember, these ranges are not absolute, but given as a guide only. More consideration may be given to the cloud form than the height in many cases. Each cloud family is coded with a single digit, 0 through 9. The code figure 0 is used to indicate that clouds are not present for a given family.

B-5. **h.** h = Height of the base of the lowest cloud seen. The height reported is with respect to the surface. The height is coded as a solidus (/) if there is a total surface-based obscuration that prevents an observation of the clouds. Use table B-3 for the cloud base height.

Table B-3. Height of Cloud Base Above Ground

Code Figure	***Reportable Heights (ft)***
1	200 or 300
2	400 or 600*
3	700 to 900*
4	1000 to 1900*
5	2000 to 3200*
6	3300 to 4900*
7	5000 to 6500**

Table B-3. Height of Cloud Base Above Ground

Code Figure	*Reportable Heights (ft)*
8	7000 to 8000**
9	8500 or higher or no clouds
/	unknown or base of clouds below surface of station
*	reported in 100-foot increments
**	reported in 500-foot increments
NOTE 1: This group is used to report the height of the base of the lowest cloud seen, regardless of cloud amount. The height reported is with respect to the surface.	
NOTE 2: The lowest cloud height is coded with a solidus (/) if there is a total surface-based obscuration that prevents an observation of the clouds.	

B-6. C_M. C_M is the type of middle cloud, based on priority given in table B-4. This table presents the specifications for type of middle cloud, C_M, in order of priority. Go down the table and use the first applicable code figure. A solidus (/) is reported if C_M clouds are not visible owing to fog or similar obscuring phenomenon, or because of a continuous layer of lower clouds.

Table B-4. Coding of Middle Cloud, C_M

Code Figure	*Coding Criteria*
	ALTOCUMULUS PRESENT
C_M = 9	If the sky is chaotic, use C_M = 9.
C_M = 8	If the C_M code figure 9 is not applicable and if altocumulus with sprouting in the form of turrets or battlements or altocumulus having the appearance of small cumuliform tufts is present, use C_M = 8.
C_M = 7*	If the C_M code figures 9 and 8 are not applicable and if altostratus or nimbostratus is present together with altocumulus, use C_M = 7.
C_M = 6	If the C_M code figures 9, 8, and 7 are not applicable and if altostratus formed by the spreading out of cumulus or cumulonimbus is present, use C_M = 6.
C_M = 5	If the C_M code figures 9, 8, 7, and 6 are not applicable and if the altostratus present is progressively invading the sky, use C_M = 5.
**There are several definitions of C_M = 7 and each has a different priority; therefore, C_M = 7 appears several times in this code table.	
C_M = 4	If the C_M code figures 9, 8, 7, 6, and 5 are not applicable and if the altostratus present is continually changing in appearance, use C_M = 4.
C_M = 7	If the C_M code figures 9, 8, 6, 5, and 4 are not applicable and if the altostratus present occurs at two or more levels, C_M = 7.
C_M = 7, 3	If the C_M code figures 9, 8, 6, 5, and 4 are not applicable and if the altocumulus present occurs at one level, use C_M = 7 or 3 depending on whether the greater part of the altocumulus is respectively opaque or semi-transparent.
	NO ALTOCUMULUS PRESENT
C_M = 2	If nimbostratus is present or if the greater part of the alto stratus present is opaque, use C_M = 2.
C_M = 1	If there is no nimbostratus and if the greater part of the altostratus present is semi-transparent, use C_M = 1.
C_M = 0	No C_M clouds - No altocumulus, altostratus, or nimbostratus.
/	C_M clouds not visible owing to fog or similar obscuring phenomena or because of a continuous layer of lower clouds.

B-7. **C_H.**= C_H is the type of high cloud, based on priority given in table B-5. This table presents the specifications for type of high cloud, C_H, in order of priority. Go down the table and use the first applicable code figure. A solidus (/) is reported if C_H clouds are not visible owing to fog or similar obscuring phenomenon, or because of a continuous layer of lower clouds.

Table B-5. Coding of High Cloud, C_H

Code Figure	***Coding Criteria***
	ALTOCUMULUS PRESENT
C_H = 9	If cirrocumulus is present alone or is more than the combined sky cover of any cirrus and cirrostratus present, use C_H = 9.
	CIRROSTRATUS PRESENT
C_H = 7	If the cirrostratus covers the whole sky, use C_H = 7.
C_H = 8	If the cirrostratus does not cover the whole sky and is not invading the celestial dome, use C_H = 8.
C_H = 6	If the cirrostratus is progressively invading the sky and if the continuous veil extends more than 45 degrees above the horizon but does not cover the whole sky, use C_H = 6.
C_H = 5	If the cirrostratus is progressively invading the sky but the continuous veil does not reach 45 degrees above the horizon, use C_H = 5.
	NO CIRROSTRATUS PRESENT
C_H = 9	Not applicable.
C_H = 4	If the cirrus clouds are invading the sky, use C_H = 4.
C_H = 3	If the C_H code figure 4 is not applicable and if dense cirrus which originated from cumulonimbus is present in they sky, use C_H = 3.
C_H = 2, 1	If the code figures 4 and 3 are not applicable:
	Use C_H = 2, if the combined sky cover of dense cirrus, of cirrus with sprouting in the form of small turrets or battlements, and of cirrus of tufts is greater than the combined sky cover of cirrus in the form, of filaments, strands, or hooks. Use C_H = 1, if the combined sky cover of cirrus in the form of filaments, strands, or hooks is greater than the combined sky cover of dense cirrus, of cirrus with sprouting in the form of small turrets or battlements, and of cirrus in tufts.
C_H = 0	No C_H clouds - No cirrus, cirrostratus, or cirrocumulus.
/	C_H clouds not visible owing to fog or similar obscuring phenomena or because of a continuous layer of lower clouds.

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Appendix C

MET Support Request Procedures

MMS equipped sections normally distribute MET messages digitally to all users by broadcasting them on a specific schedule (push method). Some users, especially firing units, may have an immediate need for MET data before being placed on automatic distribution. All MET messages from MMS–P equipped sections using 220C Protocol are requested (pull method) by users. Users can request MET support by using the procedures in this appendix.

SUBMISSION OF MMS MET SUPPORT REQUESTS

C-1. All requests for MET support should be forwarded through the operations officer to the appropriate MET section. Requests should state who should eventually receive the MET data. To ensure receipt of appropriate MET information, the unit requesting MET support should state specifically in the initial request what information is needed, the delivery time, and the method of delivery. The number of lines requested should be no greater than the number required for the maximum ordinate expected to be fired. Requests for MET should be submitted as far in advance as possible. Also units must realize MET messages are provided on time schedules based on GMT, not local time. The structure for a request for MET support is shown in figure C-1. The standard format for MET requests provides the following:

- Type of message.
- Intervals between messages.
- Lowest and highest lines required.
- Time request is terminated.

Group 1	METRKQ
Group 2	$L_aL_aL_aL_oL_oL_o$ or XXXXX
Group 3	$Y_oY_oG_oG_oG_1G_1$
Group 4	$Z_oZ_oZ_1Z_1J_oJ_1$

Figure C-1. Message request structure

C-2. The symbols in the message request for MET support are defined in table C-1 in the order in which they appear. The Q code for octant of the globe is defined in table C-2. Table C-3 lists the line codes for the type 2 or 3 ballistic MET message. Table C-4 lists the zone number codes for a TA MET message. Table
C-5 lists the zone codes for a computer MET message. Figure C-2 shows an example and provides an explanation of a request for a MET message.

Table C-1. Symbols in Message Request for MET Support

Symbol	*Definition*
MET	Designates message category-met.
R	Designates request.
K	Designates type of message as follows: 2-surface to air (type 2 ballistic). 3-surface to surface (type 3 ballistic).

Table C-1. Symbols in Message Request for MET Support

Symbol	*Definition*
	6-target acquisition. 9-computer.
Q	Designates octant of the globe in which requesting unit is located. (See Table C-2.)
$L_aL_aL_a$	Designates latitude of requesting unit to the nearest tenth of a degree.
$L_oL_oL_o$ XXXXXX	Designates longitude of requesting unit to the nearest tenth of a degree. For longitudes of 100° and greater, the hundreds digit is dropped. or Location of the center of the area of applicability in code.
Y_oY_o	Designates day of month (GMT) on which delivery of first message is required.
G_oG_o	Designates time (GMT) to the nearest hour of day (Y_oY_o) at which delivery of the first message is required.
G_1G_1	Designates time (GMT) to the nearest hour on the last day on which final message is required. (See J_o to determine date.)
Z_oZ_o	Designates lowest line required in the message is 00 (surface) for all messages.
Z_tZ_t	Designates highest line code required. See Tables C-3, C-4, or C-5 for the type message requested by K.
J_o	Designates the number of days from 0 to 9 that must be added to Y_oY_o to find the last day for which MET message support is required. The hour of the last day is determined by G_1G_1 above.
J_1	Designates time interval, in hours, between messages. Numbers 1 through 8 indicate hourly intervals, and 9 indicates a 12-hour interval. When only one message is required, G_1G_1 is the same as G_oG_o and J_o and J_1 are 0.

Table C-2. Q Code for Octant of the Globe

Q Code	*Octant Locations*
0	North latitude-0° to 90° west longitude
1	North latitude-90° to 180° west longitude
2	North latitude-180° to 90° east longitude
3	North latitude-90° to 0° east longitude
4	Not used
5	South latitude-0° to 90° west longitude
6	South latitude-90° to 180° west longitude
7	South latitude-180° to 90° east longitude
8	South latitude-90° to 0° east longitude
9	To be used when the location of the MET station is not indicated by latitude and longitude

Table C-3. Line Codes for Ballistic MET Messages (Type 2 or 3)

Line-Code ***Z_tZ_t***	***Meters***	***Line-Code*** ***Z_tZ_t***	***Meters***
00	0	08	5,000
01	200	09	6,000
02	500	10	8,000
03	1,000	11	10,000
04	1,500	12	12,000
05	2,000	13	14,000
06	3,000	14	16,000
07	4,000	15	18,000

Table C-4. Zone Number Codes for Target Acquisition MET Message

Z_tZ_t	***Height Of Midpoint Of Zone Above MDP (Meters)***	***Height Above MDP Of Zone (Meters)***	
		Base	***Top***
00	0	-	-
01	25	0	50
02	75	50	100
03	150	100	200
04	250	200	300
05	350	300	400
06	450	400	500
07	550	500	600
08	650	600	700
09	750	700	800
10	850	800	900
11	950	900	1,000
12	1,050	1,000	1,100
13	1,150	1,100	1,200
14	1,250	1,200	1,300
15	1,350	1,300	1,400
16	1,450	1,400	1,500
17	1,550	1,500	1,600
18	1,650	1,600	1,700
19	1,750	1,700	1,800
20	1,850	1,800	1,900
21	1,950	1,900	2,000
22	2,050	2,000	2,100
23	2,150	2,100	2,200
24	2,250	2,200	2,300

Table C-4. Zone Number Codes for Target Acquisition MET Message

Z_tZ_t	*Height Of Midpoint Of Zone Above MDP (Meters)*	*Height Above MDP Of Zone (Meters)*	
25	2,350	2,300	2,400
26	2,450	2,400	2,500
27	2,550	2,500	2,600

Table C-5. Zone Number Codes for Computer MET Messages

Z_tZ_t	*Height Above MDP Of Midpoint Of Zone (Meters)*	*Height Above MDP From Base To Top Of Zone (Meters)*
00	0	0
01	100	0 to 200
02	350	200 to 500
03	750	500 to 1,000
04	1,250	1,000 to 1,500
05	1,750	1,500 to 2,000
06	2,250	2,000 to 2,500
07	2,750	2,500 to 3,000
08	3,250	3,000 to 3,500
09	3,750	3,500 to 4,000
10	4,250	4,000 to 4,500
11	4,750	4,500 to 5,000
12	5,500	5,000 to 6,000
13	6,500	6,000 to 7,000
14	7,500	7,000 to 8,000
15	8,500	8,000 to 9,000
16	9,500	9,000 to 10,000
17	10,500	10,000 to 11,000
18	11,500	11,000 to 12,000
19	12,500	12,000 to 13,000
20	13,500	13,000 to 14,000
21	14,500	14,000 to 15,000
22	15,500	15,000 to 16,000
23	16,500	16,000 to 17,000
24	17,500	17,000 to 18,000
25	18,500	18,000 to 19,000
26	19,500	19,000 to 20,000

EXAMPLE	
The following is an example of a request for a met message.	• **Group 2**. Location of the requesting unit is 34°30' N and 90°18'W.
METR31 345903 050816 000624	• **Group 3**. Delivery of the first message is required on the fifth day of the month at 0800 GMT. Delivery of the last message is required at 1600 on the seventh day of the month. (To determine the seventh day, see group 4 below.)
An example of the request for met support is as follows: • **Group 1**. Ballistic met message is requested for surface-to-surface fire applicable to the Northern Hemisphere between 90°W and 180°W. The octant code is explained in Table C-2.	• **Group 4**. The lowest line requested is 00, and the highest line requested is 06. In addition to day Y_oY_o, the message is required for 2 additional days. (In this message, met information is requested for the fifth [original day], sixth, and seventh days [2 additional days].) The time interval between messages is 4 hours.

Figure C-2. MET message request

SUBMISSION OF MMS–P MET SUPPORT REQUESTS

MET REQUEST REQUIREMENTS

C-3. All requests for MET message generation, except for the upper air message (which is automatically generated at the termination of a sounding), require the following entries:

- Gun location.
- Target location.
- Specific type of MET message desired.
- The requestor's universal resource locator (URL).

NOTE: The MET messages (except for the TAM) generated by the MMS–P are based on the mid-point between the gun location and target location grids.

Computer MET Message

C-4. The requestor should use his grid for gun location and an estimated center grid of the target area for the target location.

Target Area MET Message

C-5. The requestor should use his grid for gun location and the actual grid of the target area you need data on for the target location.

NOTE: Even though the profiler will ignore the gun location and only use the target location, both fields must be entered to generate the MET message.

Target Acquisition MET

C-6. Since the MMS–P generates a TA MET for the location midpoint between the entered gun location and target location grids, the radar should use his grid for gun location and the nearest suspected enemy artillery location, along the radar's center sector of search, for the target location.

Basic Wind Report

C-7. Since the profiler generates a basic wind report for the location midpoint between the entered gun location and target location grids, the requestor should use his grid for gun location and the grid of the suspected CBRNincident (CBRN 1 Report) for the target location (if known). If no grid for a suspected CBRN incident is known then select a grid down range in the direction of the enemy as the target location.

MET REQUEST GUIDANCE

C-8. In theory, MET data for both the local and target area could be requested and sent for each fire mission, or every 30 minutes, to assist in fire mission accuracy. A MET every 30 minutes has been shown to dramatically increase the lethality of munitions. This however may be impractical and could slow the responsiveness of the shooter as well as tie up the digital communications net. Instead, examples of when it would be critical for a firing unit to request and receive a MET message are—

- Upon entering its initial fighting position. (Along with his unit update, the battery FDC sends a request for a computer MET message to the profiler. (MLRS will also request a target area MET.)
- Anytime a firing unit moves more than 4 kilometers, but the target area remains the same. (Request a computer MET.)
- Anytime the target area grid changes by more than 5 kilometers; that is, if the battery is told to lay its guns on a new engagement area (EA). (Request both a computer MET and a target area MET.)
- Anytime direction of fire is more than 800 mils from the original target location. (Request a new computer MET.)
- When smart munitions are expected to be used in the target area. (Request a target area MET.) (MLRS only.)
- Anytime there is a significant change in weather; that is, a storm front comes through or the temperature increases or decreases. (Request both a computer MET and a target area MET.)
- As directed by the firing unit commander.

NOTE: Although the profiler system was developed to allow for automated MET message requests using the information request message format, this message format will not be available until the next version AFATDS message set is fielded. Since the 188/220A protocol with revision 3 message set does not support the information request message format, the requestor must request MET messages using a free text message.

Appendix D

Example MET Plan

The MET plan contains the information needed to understand how MET assets will be employed. This appendix shows an example of a MET plan. Table D-1 lists acronyms and abbreviations for the example MET plan.

Table D-1. Acronyms and Abbreviations

Acronym/Abbreviation	***Definition***
admin	Administrative
Intel	Intelligence
Log	Logistics
Mech	Mechanized
PSY	Psychological
PSYOP	psychological operations

EXAMPLE MET PLAN

(Classification)

The classification is a header and footer that will appear on the top and bottom of each page.

TAB F (MET PLAN) TO APPENDIX 3 (FA SUPPORT PLAN) TO ANNEX C (FIRE SUPPORT) TO OPORD 06-3, 1st Brigade Combat Team.

REFERENCE: Map, series JWT 128, MONROVIA, sheet 3 (DURIEN), edition 2, 1:50, 000.

Time Zone Used Throughout the Order: BRAVO.

1. SITUATION

   a. Enemy Forces. Annex A (Intelligence) to OPORD 06-3.

   b. Friendly Forces

   (1) 1st Brigade Combat Team attacks to secure crossings over the RAMUZZA River and destroys enemy in zone.

   (2) Attachments and detachments are as follows:

   (a) Section-1 is attached for admin and log support to 1-12th FA.

2. MISSION

The MET section of the 1st Brigade Combat Team controlling headquarters will provide MET data support to U.S. and allied forces (artillery) and to the USAF.

3 EXECUTION

a. Concept of Operation. MET support will be provided on a continuous basis.

(1) The MET Section will provide automatic MET messages for artillery fires. Direct coordination with firing batteries is required for special operations. Unless otherwise requested, flights will be 3,000 meters altitude (line 6 [type 3 ballistic] and line 7 [computer]). Coordination with allied sound and/or artillery units require direct coordination for both receipt and delivery of MET data for artillery fires and allied sound ranging.

(2) The MET Section will provide high-altitude MET data for radiological fallout forecasts and MET messages for USAF as requested by the using G2, S2, or staff weather offices. MET messages for artillery firing and sound data and TA data will be generated from the same sounding (ballistic type 2 and type 3, computer, and sound). Additional MET data for artillery firing will be required at other times, as scheduled by individual units (U.S. and allied) through controlling headquarters S3. Special limited surface observations will be provided for smoke and chemical operations, as requested directly by the USAF.

(3) Controlling Headquarters operations officer will coordinate all MET section displacements and other movements by echelons to provide uninterrupted flow of MET data.

(4) Target acquisition MET data will be developed as required. It will be generated at the same time as ballistic data.

(5) Special MET data requests will be processed through controlling headquarters operations officer for PSYOP units.

(6) Controlling Headquarters operations officer will establish liaison with any adjacent allied artillery units and/or MET sections to provide a receipt of ballistic, computer, and fallout data whenever similar data are not available from organic MET section.

b. Coordinating Instructions

(1) Priority of MET is 7 lines computer and 6 lines ballistic, up to 3,000 meters for howitzer and 11 lines computer and 8 lines ballistic, up to 5000 meters for rockets. These messages will be provided on a 2-hour basis unless otherwise coordinated with firing units. USAF support and radiological fallout will be provided in addition to firing MET data.

(2) All firing elements within the sector of operations and spatial validity of MET section locations will be provided MET support.

(3) There will be direct coordination between the MET section, the firing battalion, and, the controlling headquarters operations officer regarding radiosonde frequencies, radio frequencies, and movements of MET section.

(4) The controlling headquarters operations officer will position the MET section to provide optimum coverage for all firing units (U.S. and allied) radar, unmanned aircraft system (UAS), smoke units, USAF, Intel sections, and other MET users.

4. SERVICE SUPPORT

a. All MET-specific Class IX parts and expendable items will be routed from the controlling headquarters S4 through artillery battalions down to the requesting MET section. Organizational maintenance will be performed by on-hand unit maintenance personnel. Direct support maintenance will be provided by the direct support battalion.

b. Controlling Headquarters S4 will monitor low-density, met-specific parts and expendable items and cross-level between MET sections, as required.

5. COMMAND AND SIGNAL

a. Command. 1st BDE Combat Team controlling headquarters operations officer will direct all MET operations.

b. Signal

(1) Current SOI in effect.

(2) Automatic direct radio data link will be established for all firing units.

(3) FM voice (secure) alternate.

(4) Landline in effect when MET sections collocate with firing units.

(Classification)

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Appendix E

Global Positioning System (GPS)

The MMS and the MMS–P systems use the GPS system to track the movement of balloon borne radiosondes giving the systems wind finding capability.

GPS SYSTEM

E-1. The GPS is a continuous, worldwide, space-based radio positioning and time-transfer navigational system maintained by the U.S. Department of Defense (DOD). The GPS provides position, velocity, and time (PVT) data that is highly accurate and continuous to an unlimited number of suitably equipped ground, sea, air, and space users.

E-2. The system is unaffected by weather and provides a worldwide common grid reference system based on an earth fixed coordinate system. For its earth model, GPS uses the World Geodetic system of 1984 datum.

E-3. The GPS consists of three main segments. They are the space segment, control segment, and user segment. These are defined as follows:

- The space segment consists of a constellation of 24 low orbit satellites transmitting military and civil navigational signals. Each satellite broadcasts radio frequencies (RF) ranging codes and a navigation data message.
- The control segment consists of a network of monitoring and control facilities that are used to manage the satellite constellation and update the satellite navigation data messages.
- The user segment consists of a variety of radio navigation receivers specifically designed to receive, decode, and process the GPS satellite codes and navigation data messages.

SPACE SEGMENT

E-4. The GPS space segment consists of 24 satellites deployed in semi-synchronous (approximately 12-hours) orbit. The satellites are positioned in orbital planes that provide a good geometric relationship allowing four or more satellites to be viewed from any location on earth. Each satellite broadcasts two RF signals. Each signal is modulated with a unique code sequence that allows the navigational set to identify the satellite. Each satellite is also modulated with a navigational data message that gives the navigational information about the operation of the satellite.

E-5. A minimum of four satellites are normally required to be simultaneously “in view” of the receiver. The satellites provide the receiver four range measurements. Three of the measurements are used to calculate a three-dimensional location of the receiver. The fourth parameter represents the user clock error. Treating the user clock error as an unknown parameter enables most receivers to be built with an inexpensive crystal oscillator rather than an expensive precision oscillator or an atomic clock.

Figure E-1. GPS satellite constellation

CONTROL SEGMENT

E-6. The control segment of the GPS system consists of ground stations monitoring and controlling the satellites by performing the following tasks:

- Track the satellites.
- Check and control satellite orbits.
- Update the satellite navigational message.

E-7. The control segment primarily consists of a master control station located in Colorado Springs, Colorado, and monitor stations and ground antennas at various locations around the world.

E-8. The master control station is the central processing facility for the control segment and is responsible for monitoring and managing the satellite constellation.

USER SEGMENT

E-9. The user segment is utilized by both military and civilian personnel. The primary intended use for GPS is for military purposes. The Department of Defense (DOD) determines who has authorization to use the GPS. The civilian code is limited by a selective availability program also called spoofing. Though civilians are able to access the GPS, access is controlled by cryptographic techniques.

MMS AND MMS–P GPS OPERATIONS

E-10. The MMS and MMS–P systems have the capability to determine wind speed and direction using the GPS system. The GPS receiver in the radiosonde transmits frequency and phase measurements to the ground station for processing. These measurements are processed by the ground station to determine wind speed and direction.

E-11. The ground stations in the MMS and MMS–P differ in configuration and capabilities. The Marwin in the MMS contains a built-in GPS receiver that processes the signals from the GPS radiosonde allowing the Marwin to determine wind speed and direction. The MMS–P system GPS radiosonde signals are received by the PLGR II and passed to the Marwin III for GPS wind finding. Using the PLGR II to process signals, allows the system to utilize the Precise Positioning Service (PPS) signal and allows future compliance with Selective Availability Anti-Spoofing Module compliance. This results in the MMS–P producing more accurate wind finding data.

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Appendix F

NAVAID Coverage Charts and Tables

This appendix provides charts for the selection of optimum coverage. Section I contains an overview of the long-range aid to navigation coverage charts. Section II contains a map depicting very low frequency and Omega station locations. Apply the procedures outlined in chapter 4 to enter the charts in this appendix.

LORAN COVERAGE CHARTS

F-1. The U.S. Department of Defense requirement for foreign LORAN-C coverage ended December 31, 1994. The Coast Guard has either closed or turned over the foreign stations to the host country. As a result, predictability of coverage availability is no longer possible. Some chains no longer have the requisite three stations operating, whereas others are completely off the air. MET personnel should consult with local authorities when selecting optimum LORAN-C coverage. Those chains operational as of the publication date are contained in. Table F-1 as a quick reference for the LORAN chains' master and secondary stations. See figures F-1 through F-24 for the specific master and secondary stations for each chain.

Table F-1. LORAN Chains' Stations

Chain Name	***Stations***	***Latitude/Longitude***
5543 Calcutta		
	Master / Baleshwar	021˚ 29' 08.000" N 086˚ 55' 18.000" E
	Whiskey / Diamond Harbor	022˚ 10' 18.000" N 088˚ 12' 25.000" E
	X-ray / Patpur	020˚ 26' 48.000" N 085˚ 49' 47.000" E
5930 Canadian East Coast Chain		
	Master / Caribou	046˚ 48' 27.305" N 067˚ 55' 37.159" W
	X-ray / Nantucket	041˚ 15' 12.046" N 069˚ 58' 38.536" W
	Yankee / Cape Race	046˚ 46' 32.286" N 053˚ 10' 27.606" W
	Zulu / Fox Harbor	052˚ 22' 35.252" N 055˚ 42' 27.862" W
5980 Russian-American Chain		
	Master / Petropavlovsk	053˚ 07' 47.584 N 157˚ 41' 42.900" E
	Whiskey / Attu Island	052˚ 49' 44.134"N 173˚ 10' 49.528" E
	X-ray / Alexandrovsk	151˚ 04' 42.800" N

Table F-1. LORAN Chains' Stations

Chain Name	***Stations***	***Latitude/Longitude***
		142˚ 42' 04.950" E
5990 Canadian West Coast Chain		
	Master / Williams Lake	051˚ 57' 58.876" N 122˚ 22' 01.686" W
	X-ray / Shoal Cove	055˚ 26' 58.876" N 131˚ 15' 19.094" W
	Yankee / George	047˚ 03' 48.096" N 119˚ 44' 38.976" W
	Zulu / Port Hardy	050˚ 36' 29.830" N 127˚ 21' 28.489" W
6042 Bombay Chain		
	Master / Dhrangadhra	023˚ 00' 14.000" N 071˚ 31' 39.000" E
	Whiskey / Veraval	020˚ 57' 07.000" N 070˚ 20' 13.000" E
	X-ray / Billamora	020˚ 45' 40.000" N 073˚ 02' 17.000" E
6731 Lessay Chain		
	Master / Lessay	049˚ 08' 55.224" N 001˚ 30' 17.029" W
	X-ray / Soustons	043˚ 44' 23.099" N 001˚ 22' 49.584" W
	Zulu / Sylt	054˚ 48' 29.975" N 008˚ 17' 36.856" E
6780 China South Sea		
	Master / Hexian (Babu)	023˚ 58' 03.847" N 111˚ 43' 10.298" E
	X-ray / Raoping (Huanggang)	023˚ 43' 25.941" N 116˚ 53' 44.826" E
	Yankee / Chongzuo (Taiping)	022˚ 32' 35.452" N 107˚ 13' 21.665" E
7001 Bo		
	Master / Bo	068˚ 38' 06.847" N 111˚ 43' 10.298" E
	X-ray / Jan Mayen Island	070˚ 54' 51.478" N 008˚ 43' 56.525" W
	Yankee / Berlevag	070˚ 50' 43.014" N 029˚ 12' 15.980" E
7030 Saudi Arabia South Chain		

Table F-1. LORAN Chains' Stations

Chain Name	*Stations*	*Latitude/Longitude*
	Master / Al Khamasin	020˚ 28' 02.025" N 044˚ 34' 52.894" E
	Whiskey / Salwa	024˚ 50' 01.631" N 050˚ 34' 12.574" E
	X-ray / Afif	023˚ 48' 36.952" N 042˚ 51' 18.184" E
	Yankee / Ash Shaykh Humayd	028˚ 09' 15.997" N 034˚ 45' 40.544" E
	Zulu / Al Muwassam	016˚ 25' 56.028" N 042˚ 48' 04.844" E
7270 Newfoundland East Coast		
	Master / Comfort Cove	049˚ 19' 53.570" N 054˚ 51' 42.570" W
	Whiskey / Cape Race	046˚ 46' 32.286" N 053˚ 10' 27.606" W
	X-ray / Fox Harbor	052˚ 22' 35.252" N 055˚ 42' 27.862" W
7430 China North Sea		
	Master / Rongcheng (Yatou)	037˚ 03' 51.765" N 122˚ 19' 25.954" E
	X-ray / Xuancheng	031˚ 04' 07.937" N 118˚ 53' 09.635" E
	Yankee / Helong	042˚ 43' 11.562" N 129˚ 06' 27.213" E
7499 Sylt		
	Master / Sylt	054˚ 48' 29.975" N 008˚ 17' 36.856" E
	X-ray / Lessay	049˚ 08' 55.224" N 001˚ 30' 17.029" W
	Yankee / Vaerlandet	061˚ 17' 49.435" N 004˚ 41' 46.618" E
7950 Eastern Russia Chayka		
	Master / Aleksadrovsk	051˚ 04' 42.805" N 142˚ 42' 04.952" E
	Whiskey / Petropavlovsk	053˚ 07' 47.584" N 157˚ 41' 42.900" E
	X-ray / Ussuriisk	044˚ 31' 59.702" N 131˚ 38' 23.403" E
	Yankee / Tokachibuto	042˚ 44' 37.214" N 143˚ 43' 09.757" E

Table F-1. LORAN Chains' Stations

Chain Name	***Stations***	***Latitude/Longitude***
	Zulu / Okhotsk	059˚ 25' 02.050" N 143˚ 05' 22.916" E
7960 Gulf of Alaska Chain		
	Master / Tok	063˚ 19' 42.884" N 142˚ 48' 31.346" W
	X-ray / Narrow Cape	057˚ 26' 20.301" N 152˚ 22' 10.708" W
	Yankee / Shoal Cove	055˚ 26' 20.940" N 131˚ 15' 19.094" W
	Zulu / Port Clarence	065˚ 14' 40.372" N 166˚ 53' 11.996" W
7980 Southeast United States Chain		
	Master / Malone	030˚ 59' 38.870" N 085˚ 10' 08.751" W
	Whiskey / Grangeville	030˚ 43' 33.149" N 090˚ 49' 43.046" W
	X-ray / Raymondville	026˚ 31' 55.141" N 097˚ 49' 59.539" W
	Yankee / Jupiter	027˚ 01' 58.528" N 080˚ 06' 52.875" W
	Zulu / Carolina Beach	034˚ 03' 46.208" N 077˚ 54' 46.100" W
7990 Mediterranean Chain		
	Master / Sellia Marina	038˚ 52' 20.707" N 016˚ 43' 06.713" E
	X-ray / Lampedusa	035˚ 31' 20.912" N 012˚ 31' 30.799" E
	Yankee / Kargabarun (off air)	040˚ 58' 21.066" N 027˚ 52' 02.074" E
	Zulu / Estartit (off air)	042˚ 03' 36.629" N 003˚ 12' 16.066" E
8290 North Central United States		
	Master / Havre	048˚ 44' 38.589" N 109˚ 58' 53.613" W
	Whiskey / Baudette	048˚ 36' 49.947" N 094˚ 33' 17.915" W
	X-ray / Gillette	044˚ 00' 11.305" N 105˚ 37' 23.895" W
	Yankee / Williams Lake	051˚ 57' 58.876" N 122˚ 22' 01.686" W

Table F-1. LORAN Chains' Stations

Chain Name	***Stations***	***Latitude/Longitude***
8830 Saudi Arabia North Chain		
	Master / Afif	023˚ 48' 36.952" N 042˚ 51' 18.184" E
	Whiskey / Salwa	024˚ 50' 01.631" N 050˚ 34' 12.574" E
	X-ray / Al Khamasin	020˚ 28' 02.025" N 044˚ 34' 52.894" E
	Yankee / Ash Shaykh Humayd	028˚ 09' 15.997" N 034˚ 45' 40.544" E
	Zulu / Al Muwassam	016˚ 25' 56.028" N 042˚ 48' 04.844" E
8970 Great Lakes Chain		
	Master / Dana	039˚ 51' 07.658" N 087˚ 29' 11.586" W
	Whiskey / Malone	030˚ 59' 38.870" N 085˚ 10' 08.751" W
	X-ray / Seneca	042˚ 42' 50.716" N 076˚ 49' 33.308" W
	Yankee / Baudette	048˚ 36' 49.947" N 094˚ 33' 17.915" W
	Zulu / Boise City	036˚ 30' 20.783" N 102˚ 53' 59.487" W
9610 South Central United States Chain		
	Master / Boise City	036˚ 30' 20.783" N 102˚ 53' 59.487" W
	Victor / Gillette	044˚ 00' 11.305" N 105˚ 37' 23.895" W
	Whiskey / Searchlight	035˚ 19' 18.305" N 114˚ 48' 16.881" W
	X-ray / Las Cruces	032˚ 04' 18.130" N 106˚ 52' 04.388" W
	Yankee / Raymondville	026˚ 31' 55.141" N 097˚ 49' 59.539" W
	Zulu / Grangeville	030˚ 43' 33.149" N 090˚ 49' 43.046" W
9930 East Asia		
	Master / Pohang	036˚ 11' 05.450" N 129˚ 20' 27.440" E
	Whiskey / Kwang Ju	035˚ 02' 23.996" N 126˚ 32' 27.295" E

Table F-1. LORAN Chains' Stations

Chain Name	***Stations***	***Latitude/Longitude***
	X-ray / Gesashi	026˚ 36' 25.038" N 128˚ 08' 56.920" E
	Yankee / Niijima	034˚ 24' 11.943" N 139˚ 16' 19.473" E
	Zulu / Ussurisk (off air)	044˚ 31' 59.702" N 131˚ 38' 23.403" E
9940 United States West Coast Chain		
	Master / Fallon	039˚ 33' 06.740" N 118˚ 49' 55.816" W
	Whiskey / George	047˚ 03' 48.096" N 119˚ 44' 38.976" W
	X-ray / Middletown	038˚ 46' 57.110" N 122˚ 29' 43.975" W
	Yankee / Searchlight	035˚ 19' 18.305" N 114˚ 48' 16.881" W
9960 Northeast United States Chain		
	Master / Seneca	042˚ 42' 50.716" N 076˚ 49' 33.308" W
	Whiskey / Caribou	046˚ 48' 27.305" N 067˚ 55' 37.159" W
	X-ray / Nantucket	041˚ 15' 12.046" N 069˚ 58' 38.536"W
	Yankee / Carolina Beach	034˚ 03' 46.208" N 077˚ 54' 46.100" W
	Zulu / Dana	039˚ 51' 07.658" N 087˚ 29' 11.586" W
9990 North Pacific Chain		
	Master / Saint Paul	057˚ 09' 12.350" N 170˚ 15' 06.245" W
	X-ray / Attu Island	052˚ 49' 44.134" N 173˚ 10. 49.528" E
	Yankee / Port Clarence	065˚ 14' 40.372" N 166˚ 53' 11.996" W
	Zulu / Narrow Cape	057˚ 26' 20.301" N 152˚ 22' 10.708" W

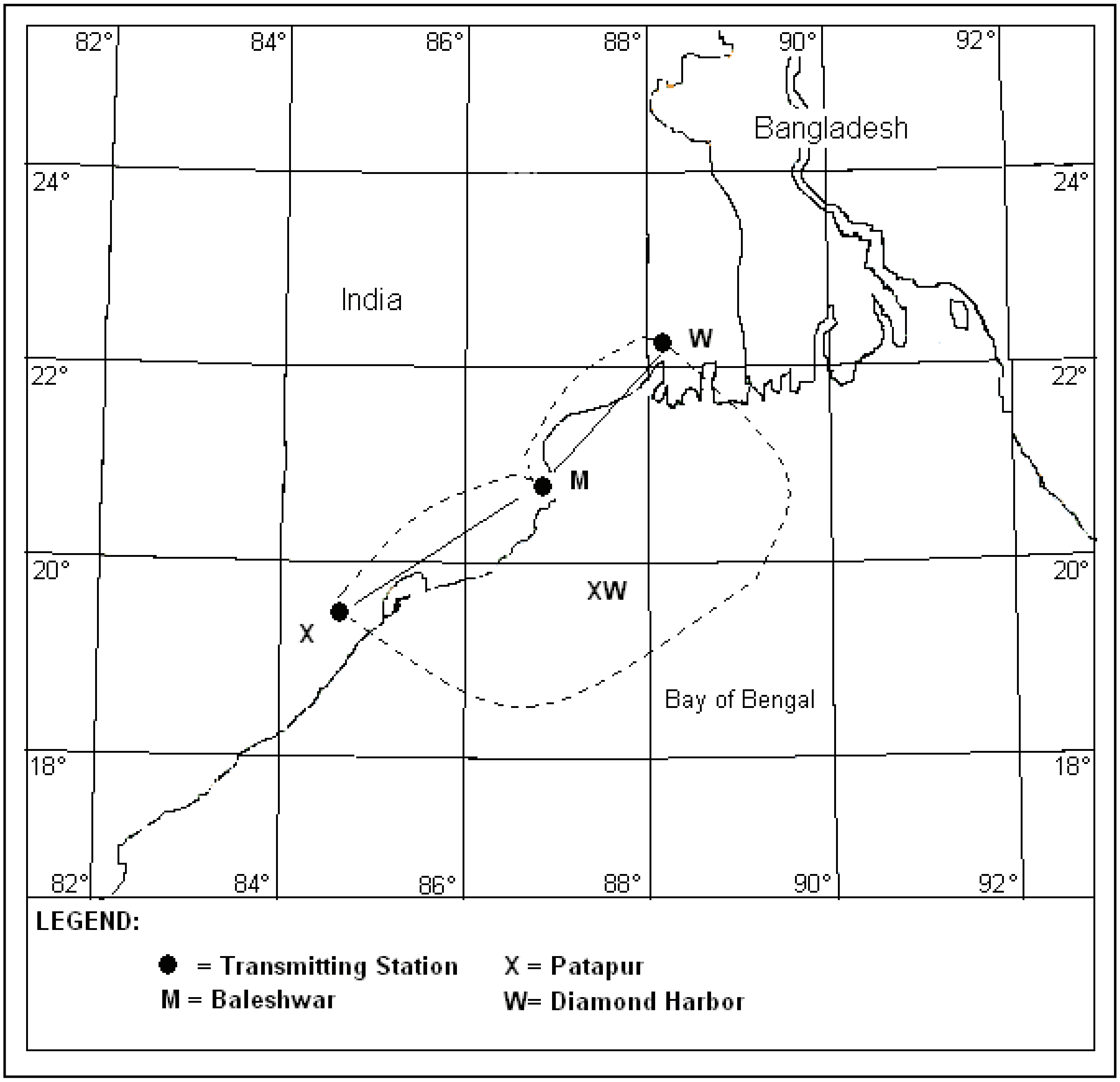
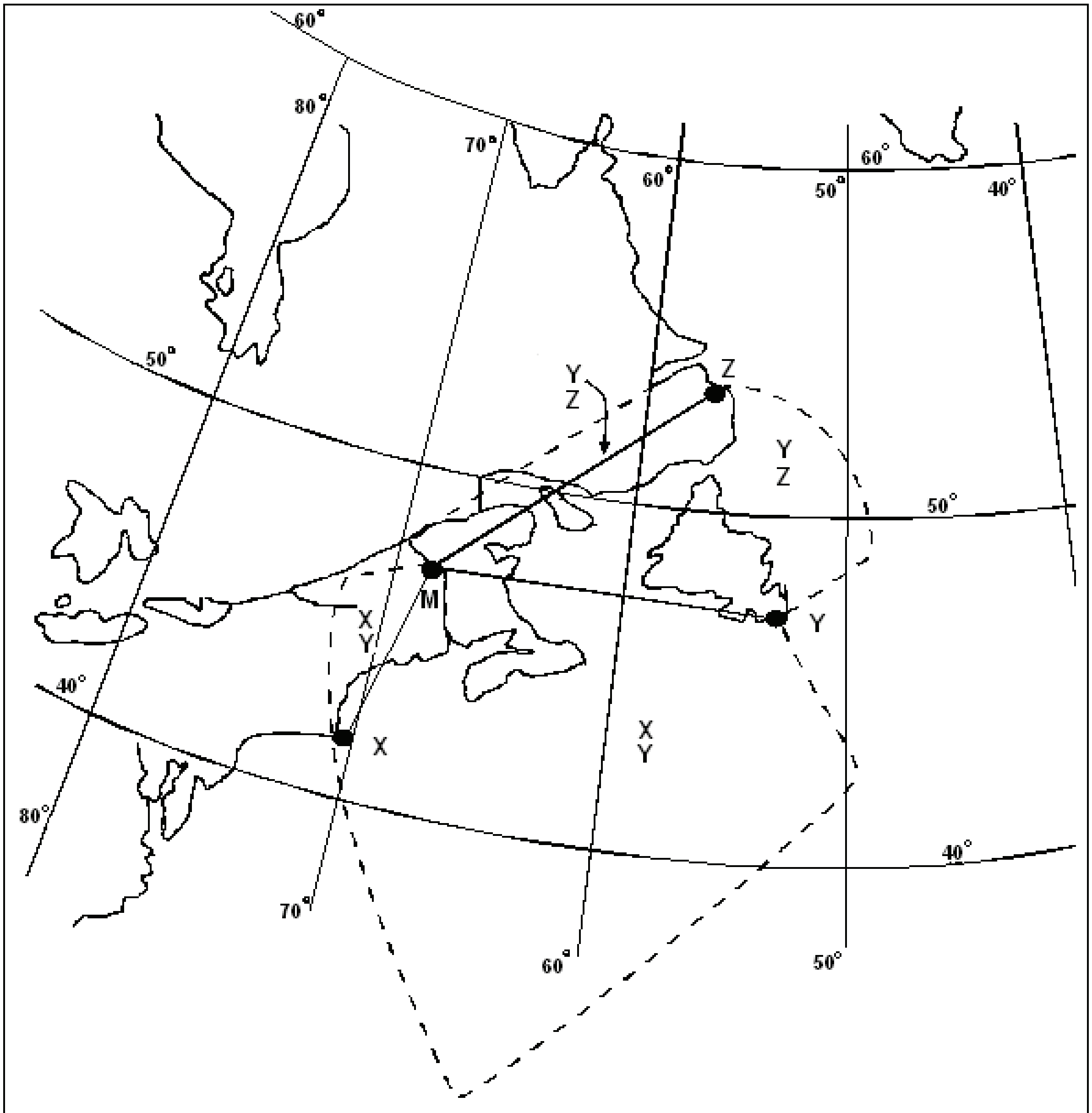


Figure F1. LORAN-C, Calcutta chain GRI 5543



LEGEND:

•	=	Transmitting Station	X	=	Nantucket, Massachusetts
M	=	Caribou, Maine	Y	=	Cape Race
Z	=	Fox Harbour			

Figure F-2. LORAN-C, Canadian east coast Chain GRI 5930

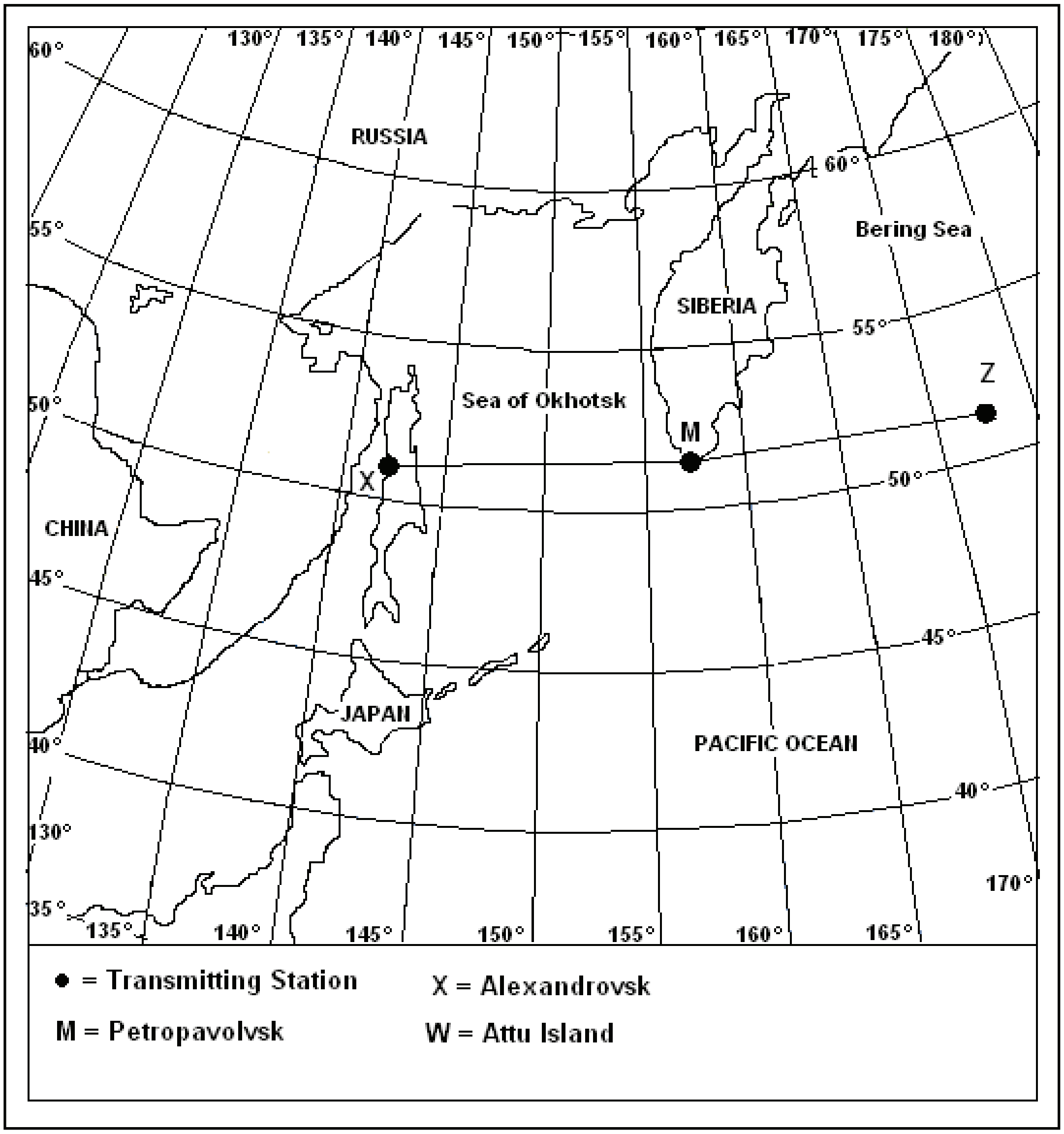
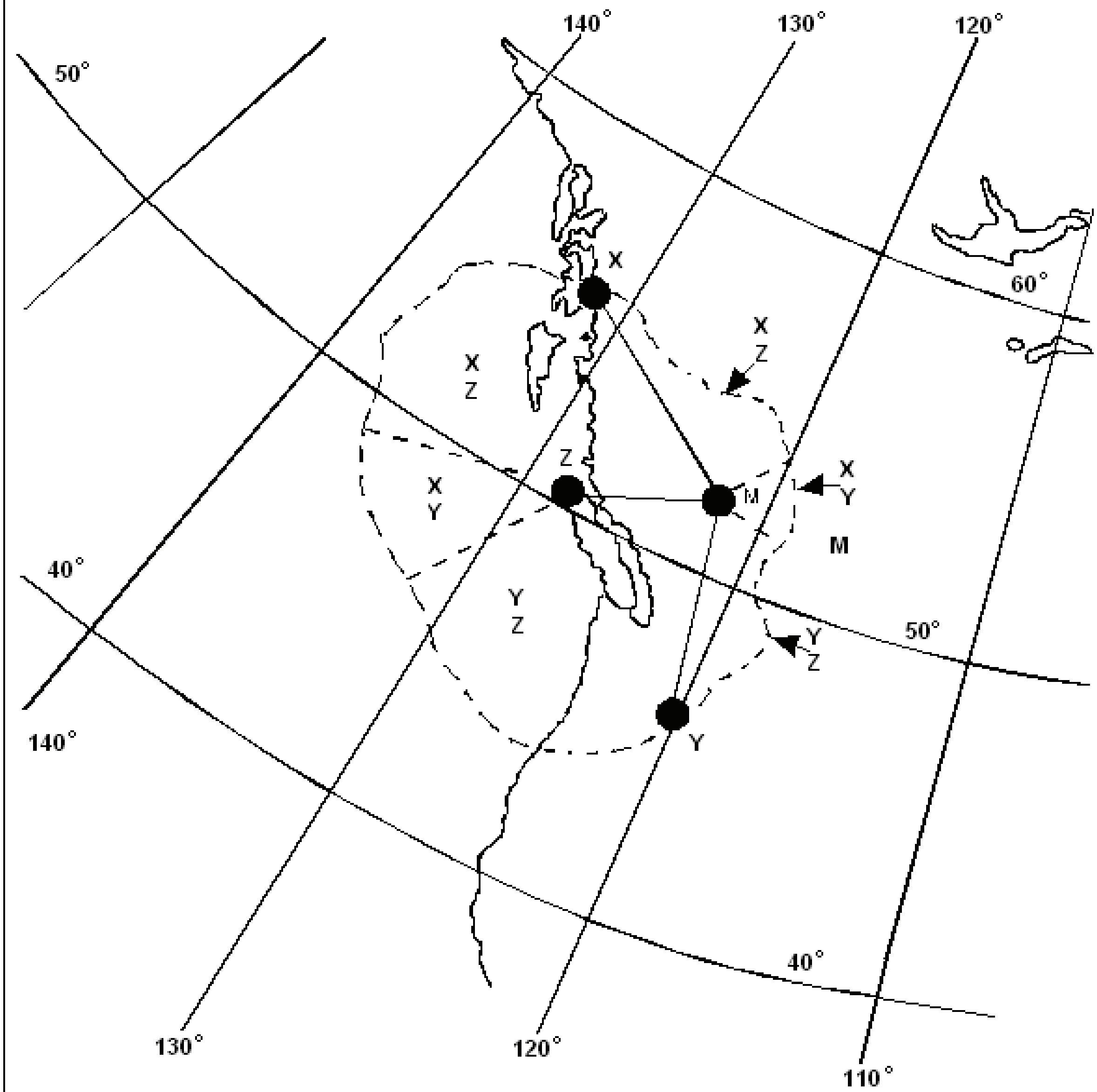


Figure F3. LORAN-C, Russian-American chain GRI 5980



LEGEND:
• = Transmitting Station
M = Williams Lake
X = Shoal Cove
Y = George, Washington
Z = Port Hardy

NOTE: This diagram reflects observed data.

Figure F4. LORAN-C, Canadian west coast chain, GRI 5990

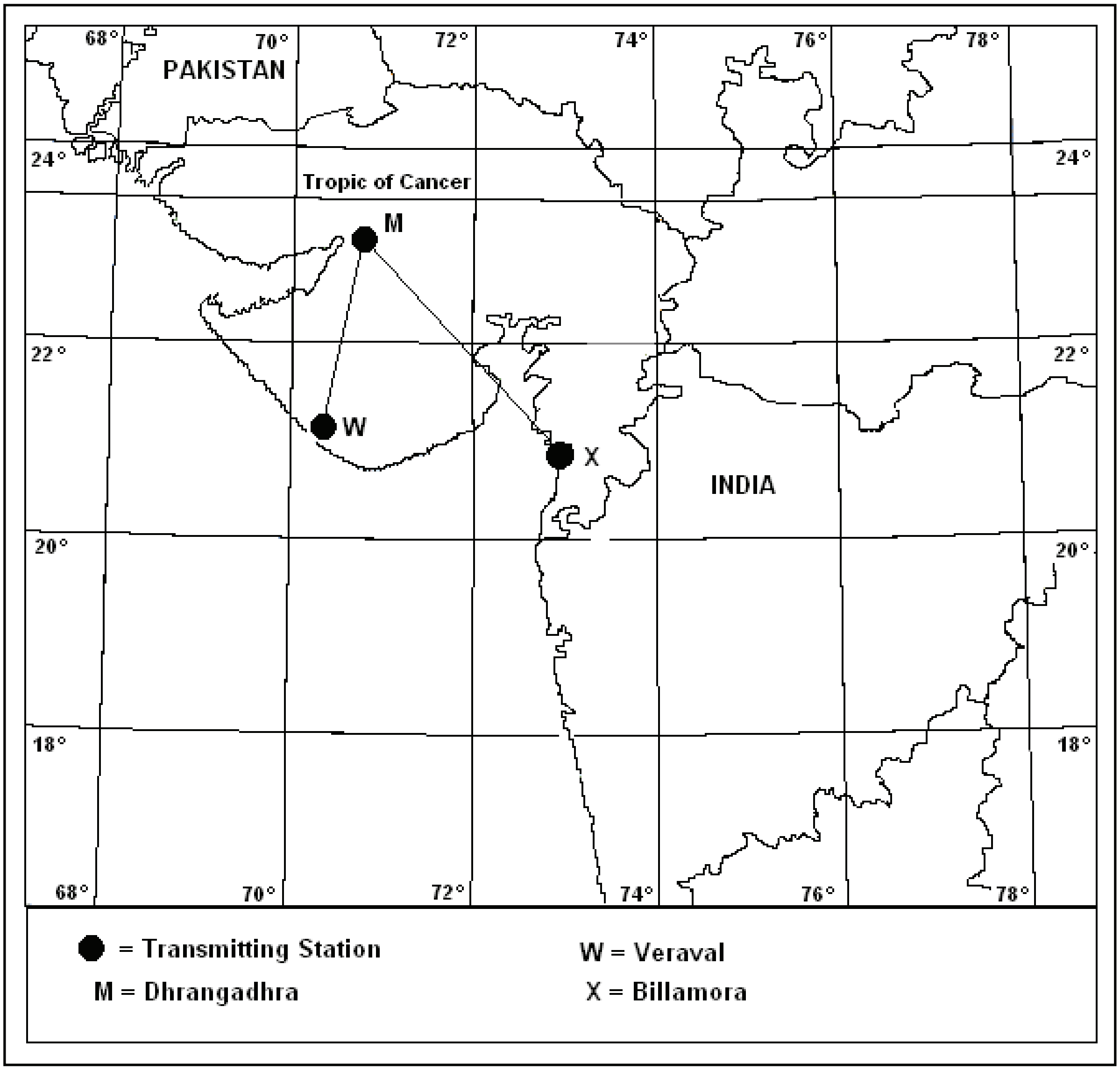


Figure F5. LORAN-C, Bombay chain GRI 6042

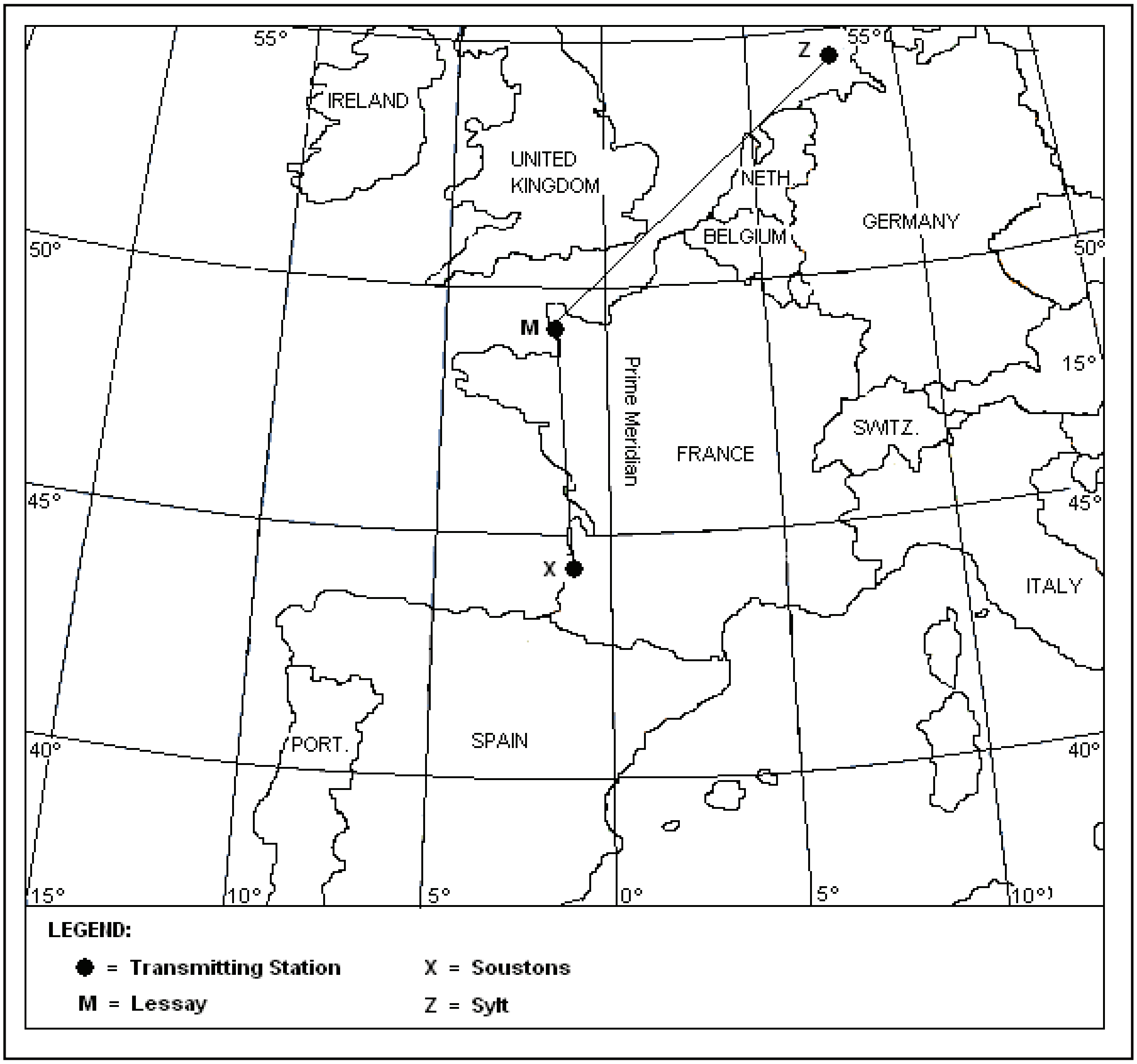


Figure F6. LORAN-C, Lessay chain GRI 6780

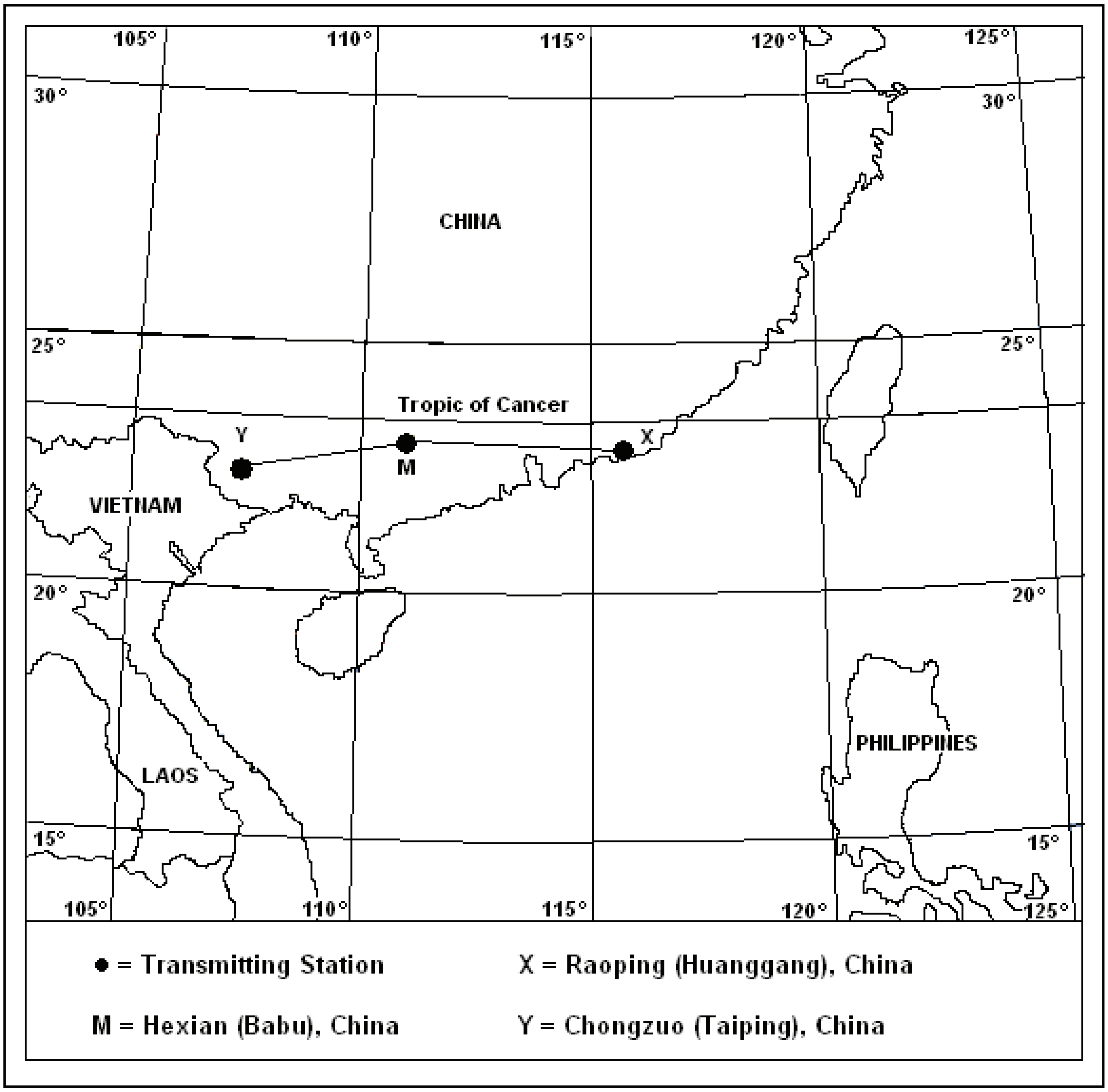


Figure F7. LORAN-C, China south sea GRI 6780

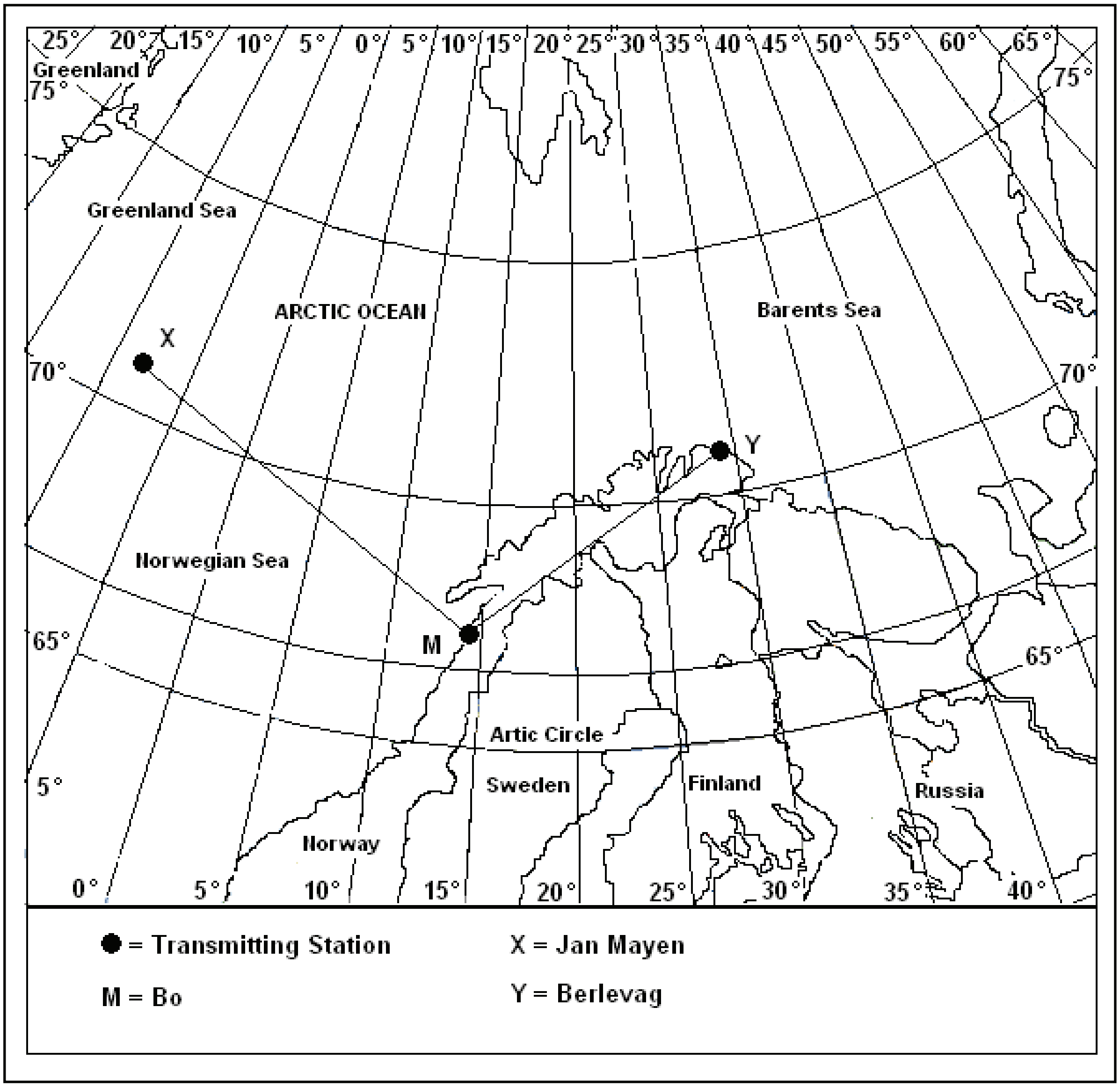
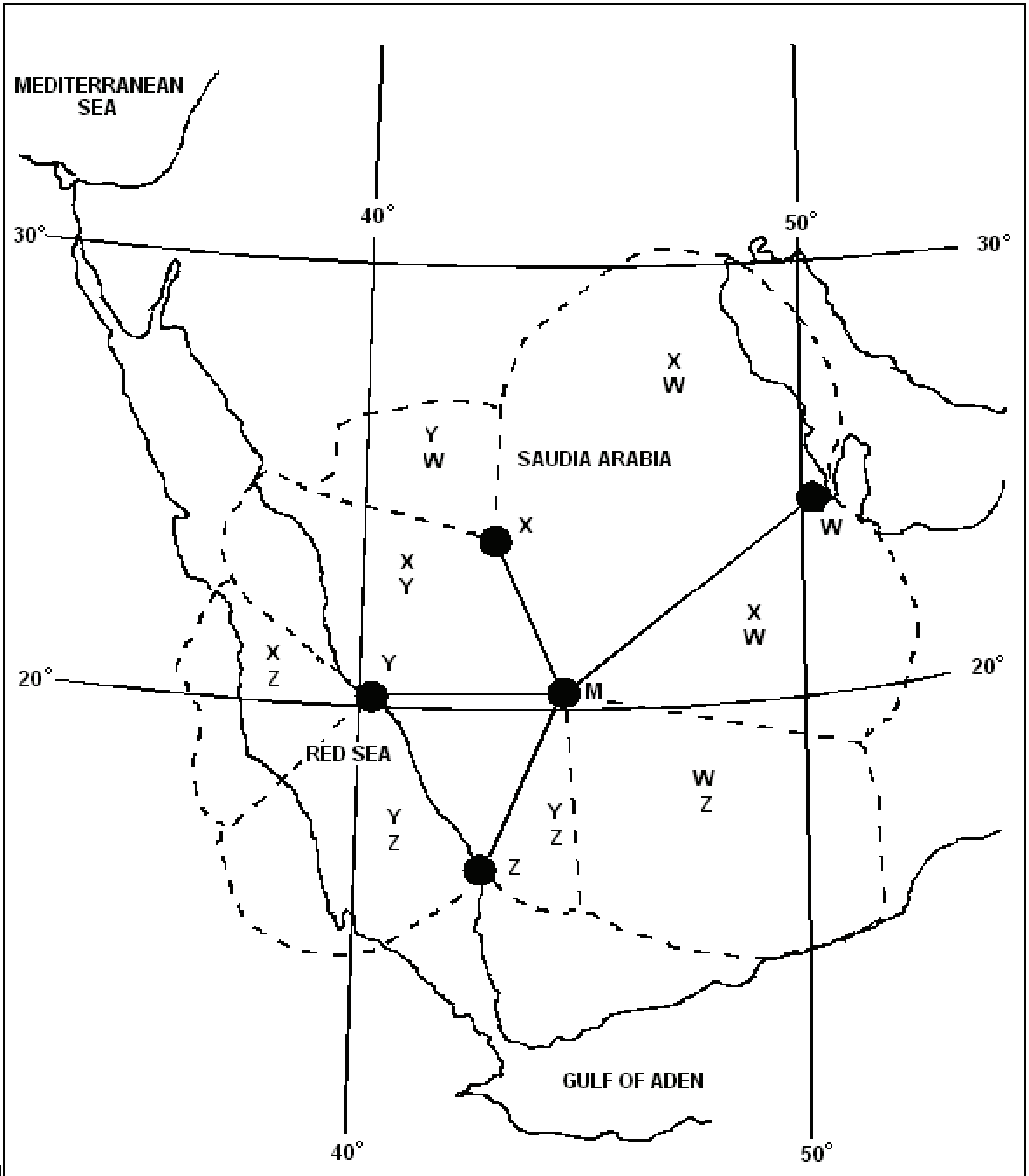


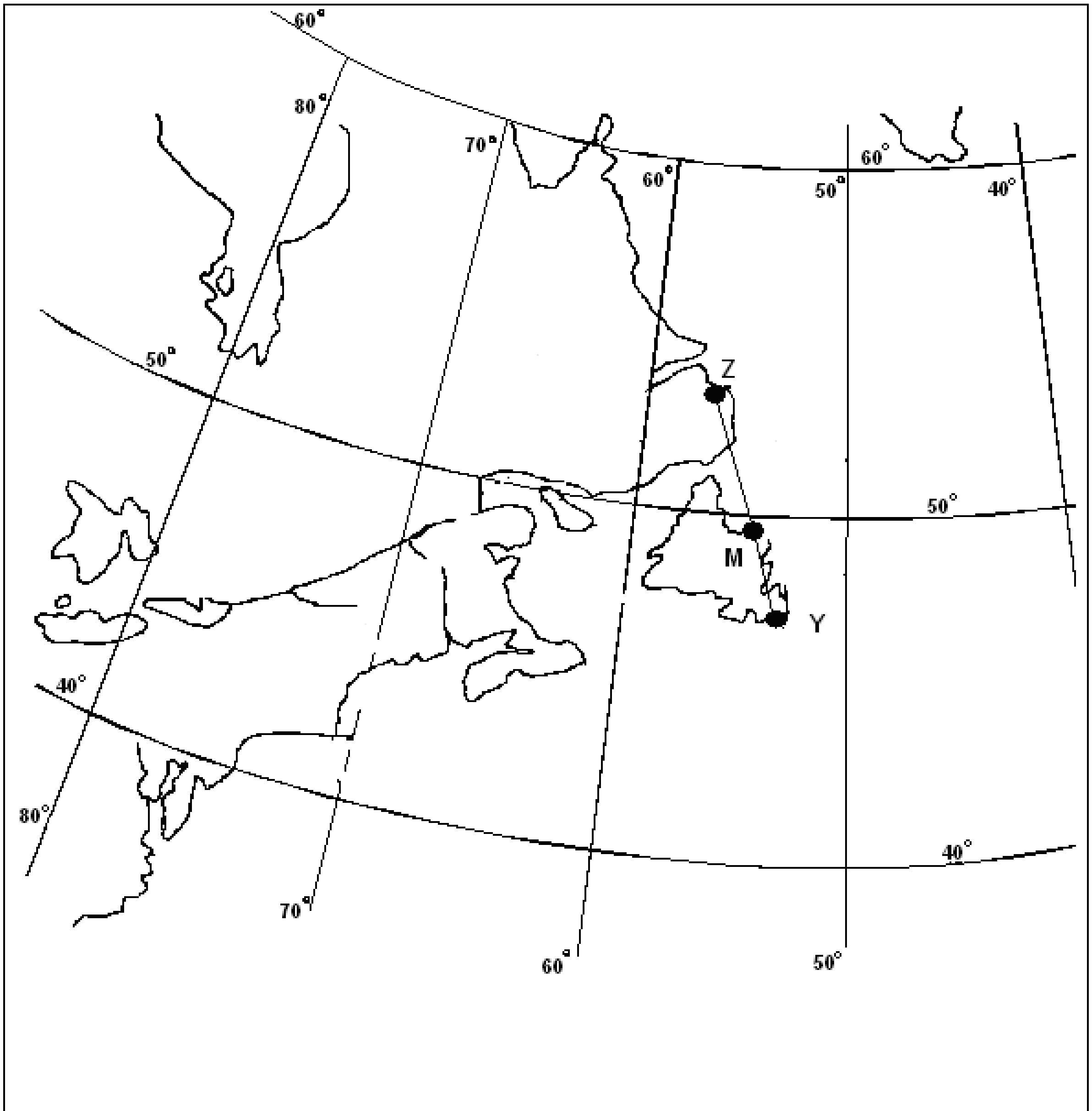
Figure F8. LORAN-C, Bo chain GRI 7001



LEGEND:

•	=	Transmitting Station	W	=	Salwa	Y	=	Ash Shaykh
M	=	Al Khamasin	X	=	Afif	Z	=	Al Muwassam

Figure F-9. LORAN-C, south Saudi Arabian chain, GR 7030



LEGEND:

•	=	Transmitting Station
M	=	Comfort Cove
Z	=	Fox Harbour
Y	=	Cape Race

Figure F10. LORAN-C, Newfoundland east coast GRI 7270

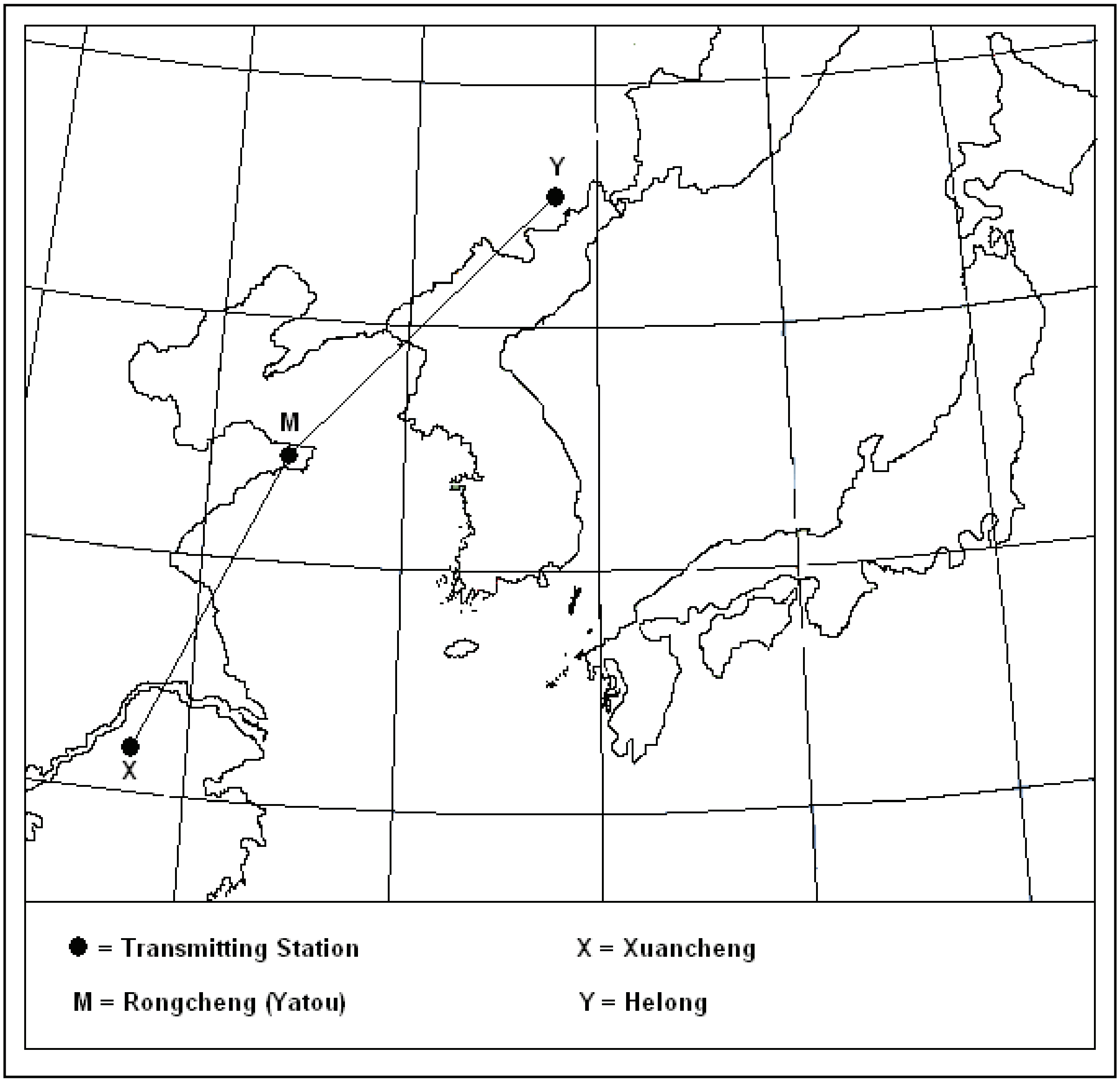


Figure F11. LORAN-C, China north sea GRI 7430

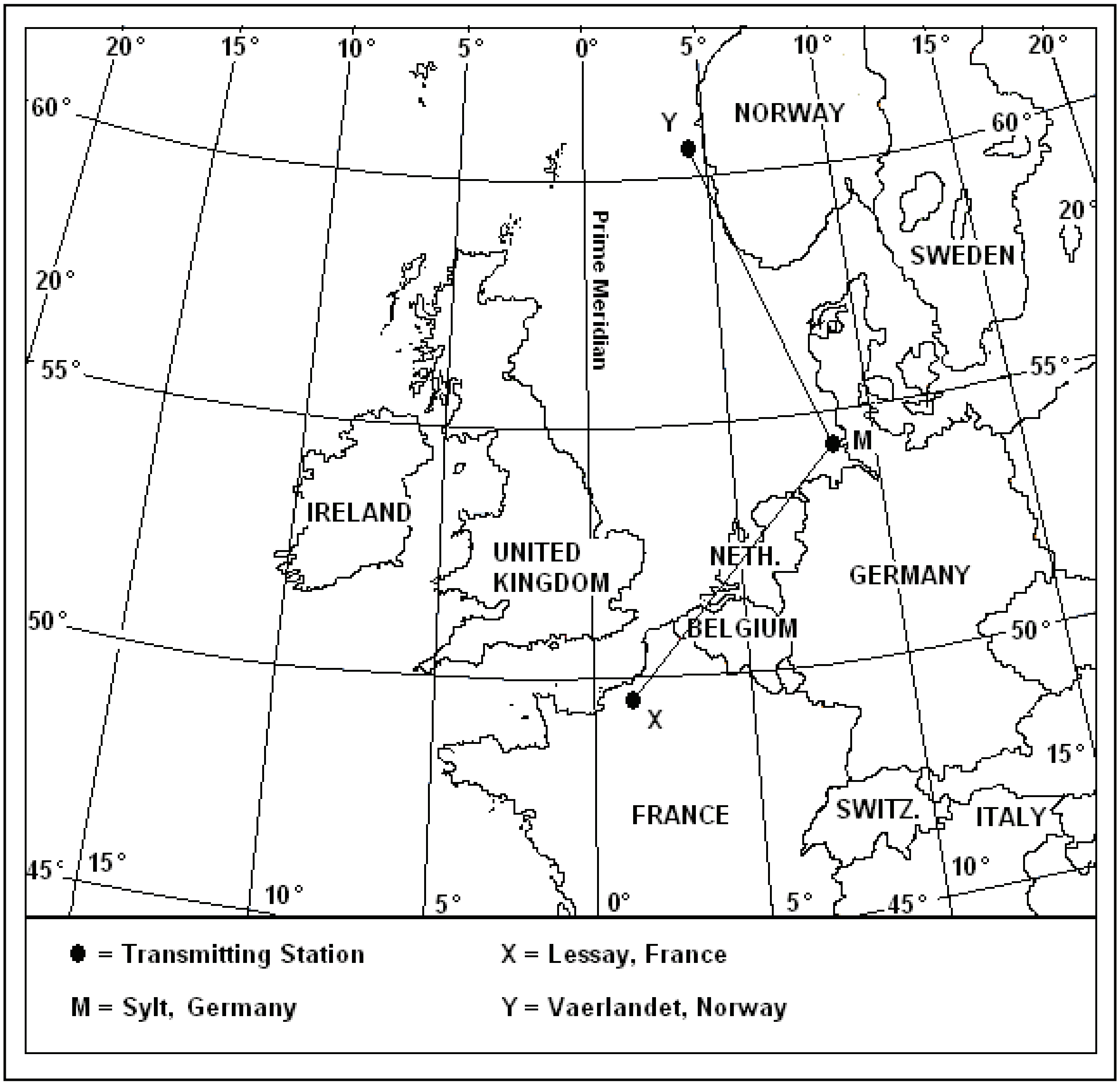


Figure F12. LORAN-C, Sylt chain GRI 7499

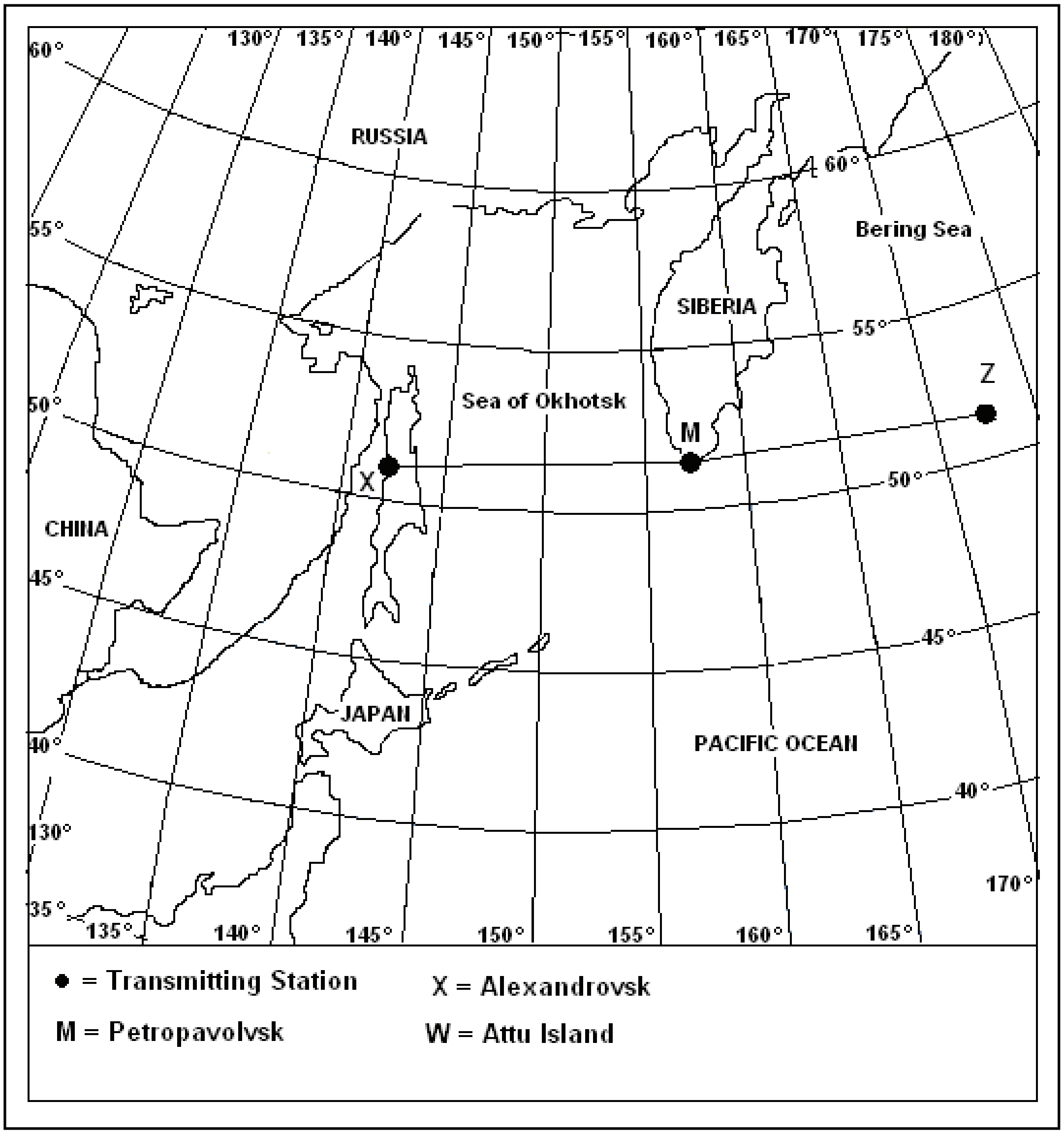
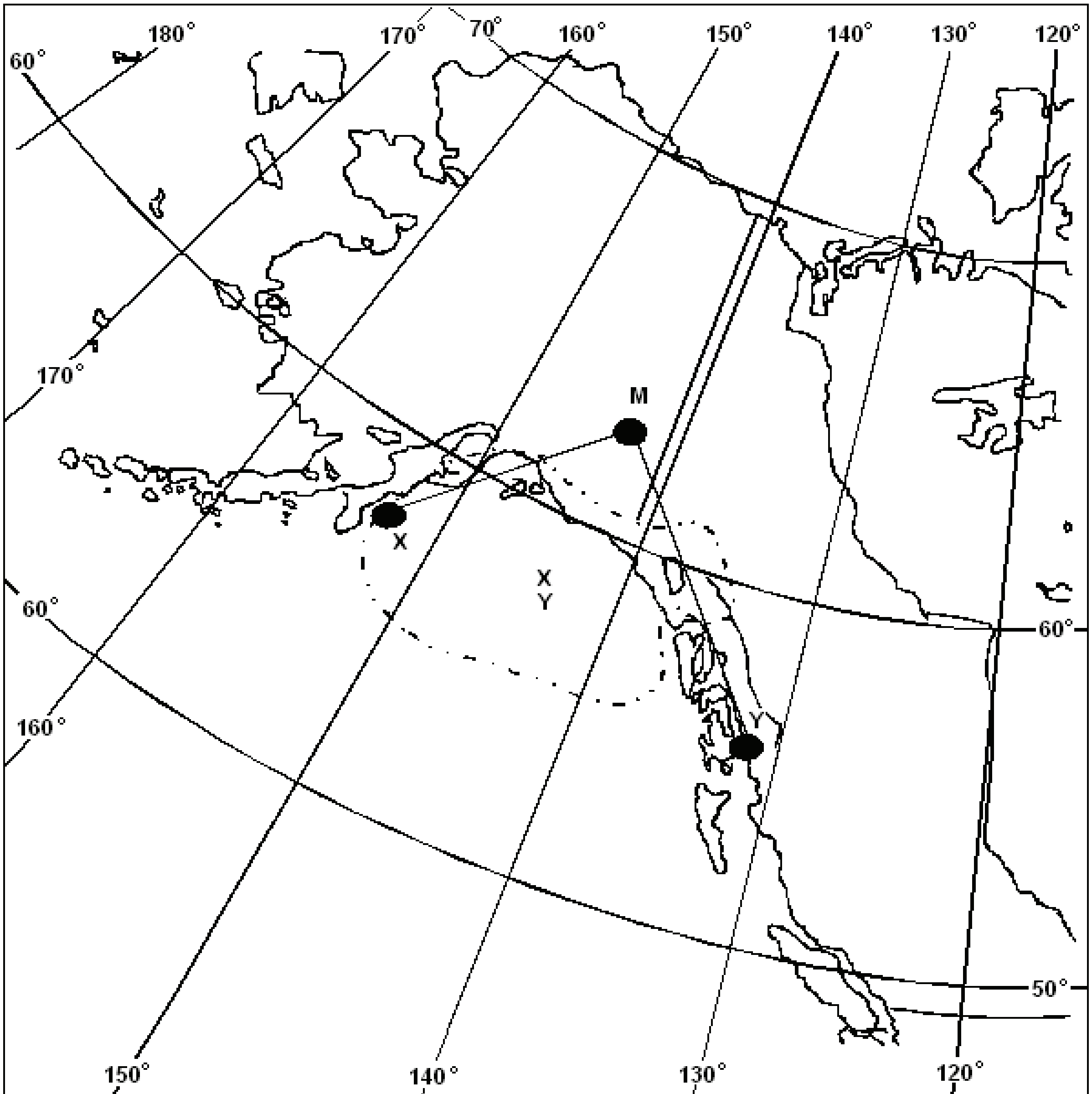


Figure F13. LORAN-C, eastern Russia Chayka chain GRI 7950

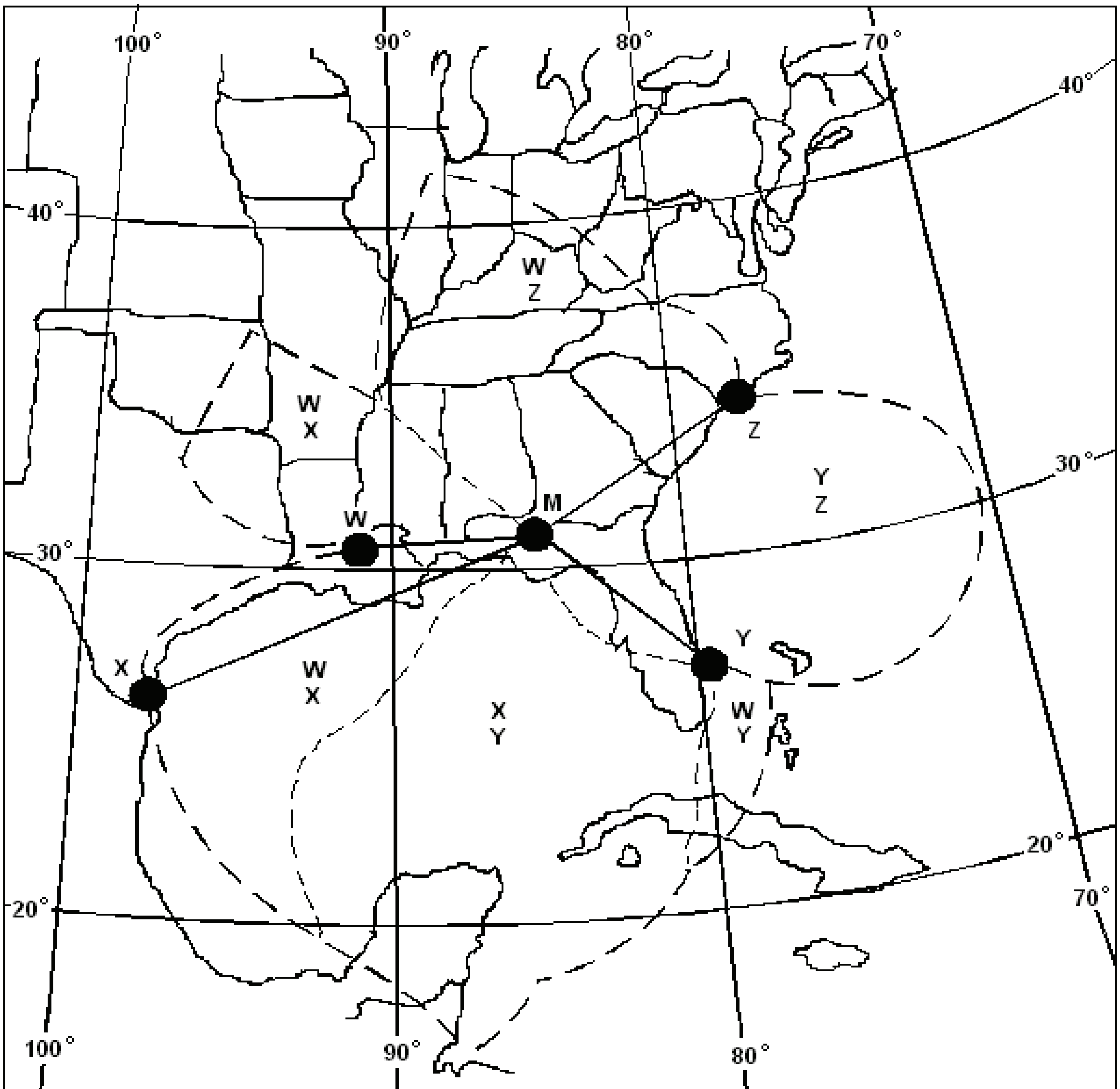


LEGEND:

• = Transmitting Station
M = Tok
X = Narrow Cape
Y = Shoal Cove

NOTE: This diagram reflects observed data.

Figure F-14. LORAN-C, Gulf of Alaska chain, GRI 7960



LEGEND:

•	=	Transmitting Station	W	=	Grangeville, Louisiana
M	=	Malone, Florida	X	=	Raymondville, Texas
Y	=	Jupiter, Florida	Z	=	Carolina Beach, North Carolina

Figure F-15. LORAN-C, southeast United States chain, GRI 7980

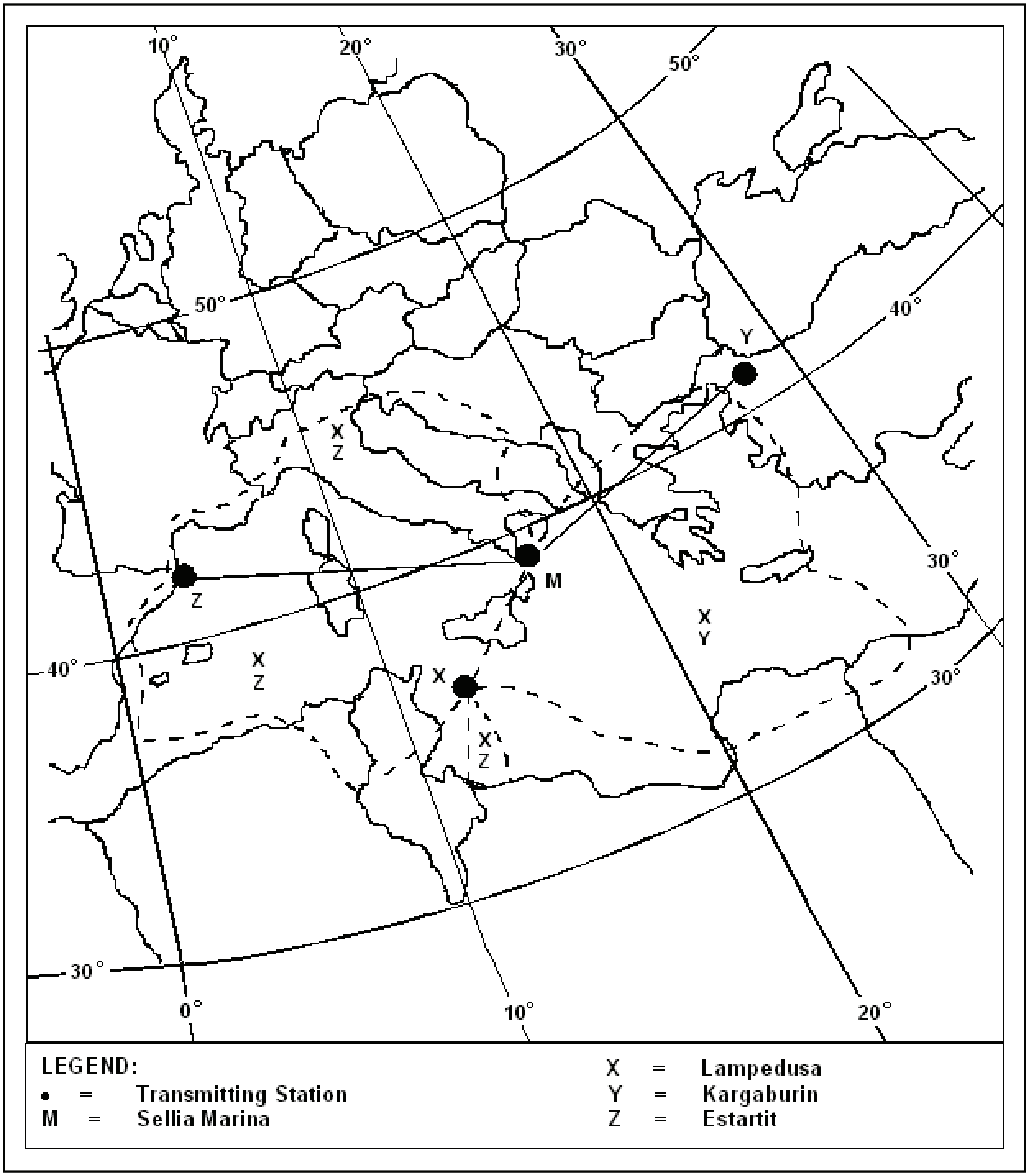
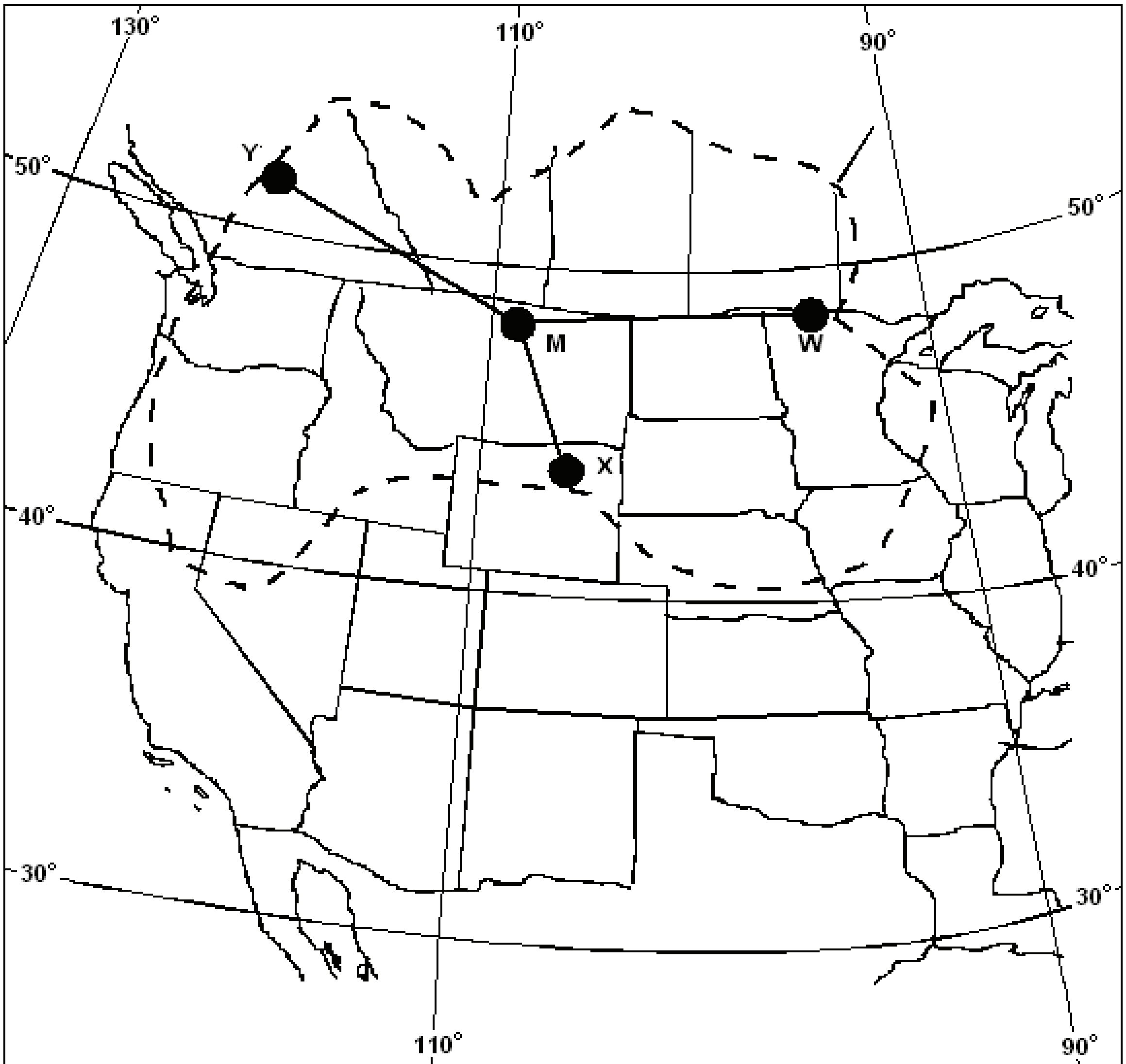


Figure F-16. LORAN-C, Mediterranean chain, GRI 7990



LEGEND:

•	=	Transmitting Station	W	=	Baudette, Minnesota
M	=	Harve, Montana	X	=	Gillette, Wyoming
			Y	=	Williams Lake, British Columbia

Figure F-17. LORAN-C, north central United States chain, GRI 8290

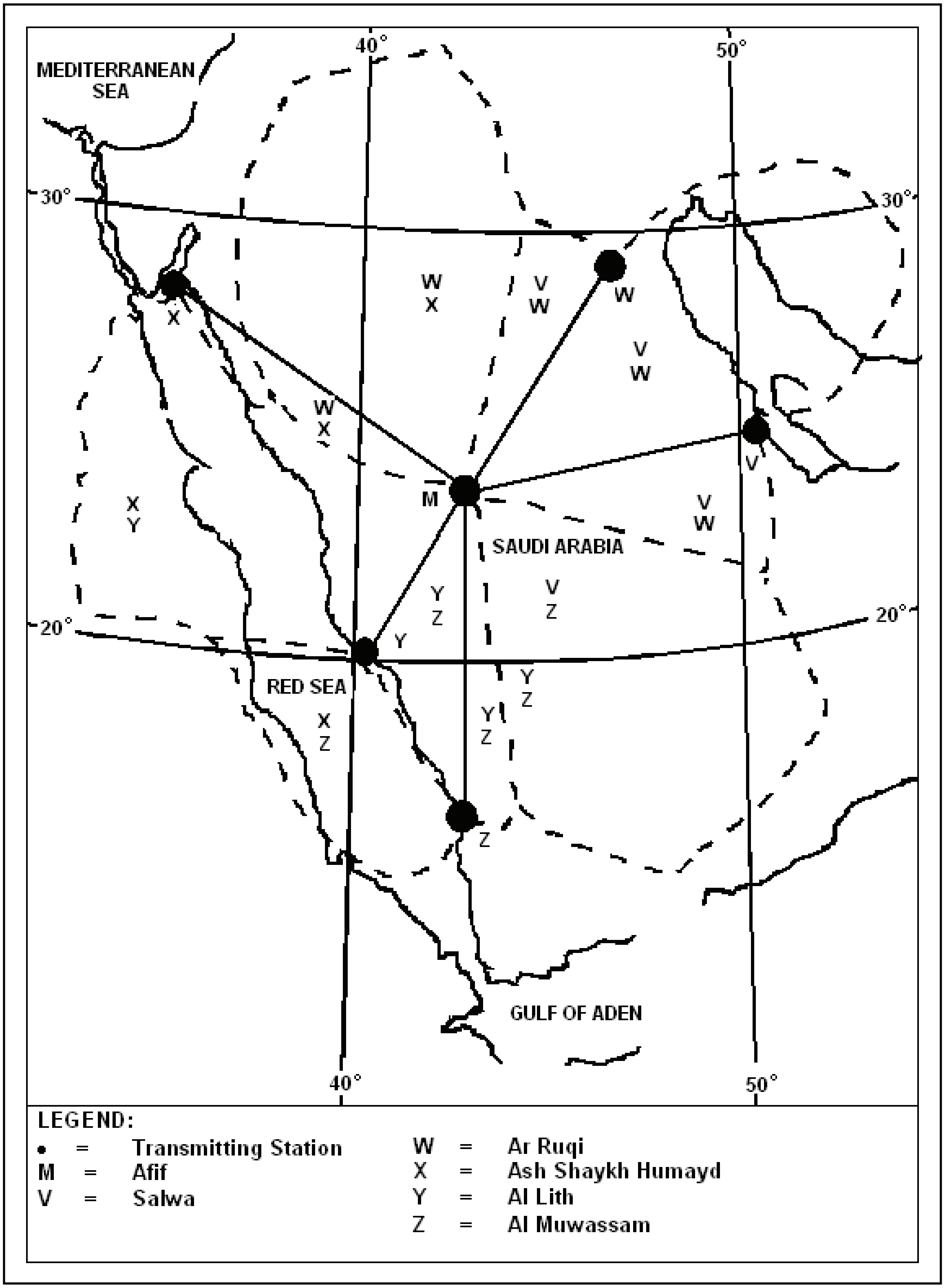
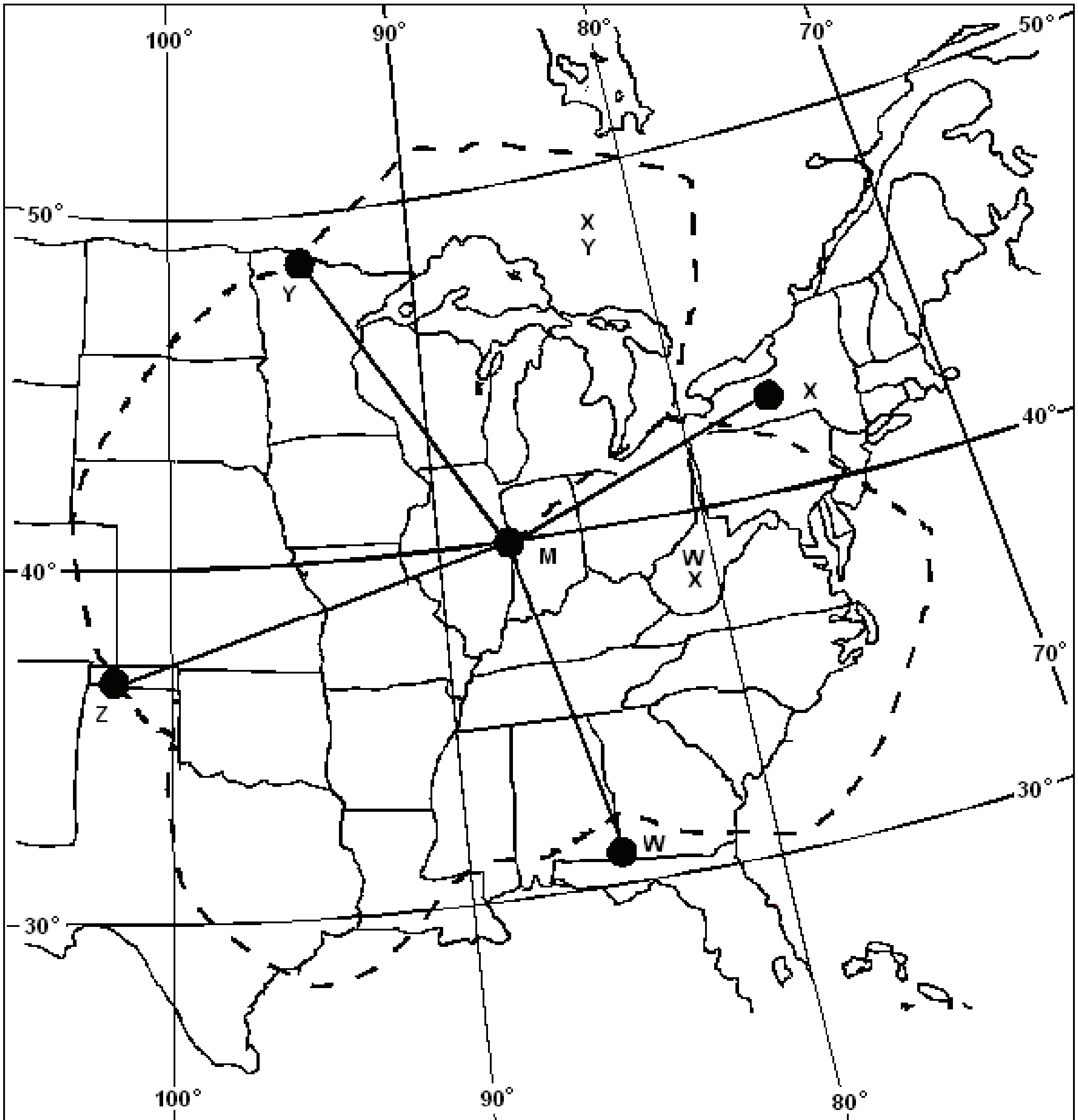


Figure F-18. LORAN-C, north Saudi Arabian chain, GRI 8830



LEGEND:

•	=	Transmitting Station	W	=	Malone, Florida
M	=	Dana, Indiana	X	=	Seneca, New York
Y	=	Baudette, Minnesota	Z	=	Boise City, Oklahoma

Figure F-19. LORAN-C, Great Lakes chain, GRI 8970

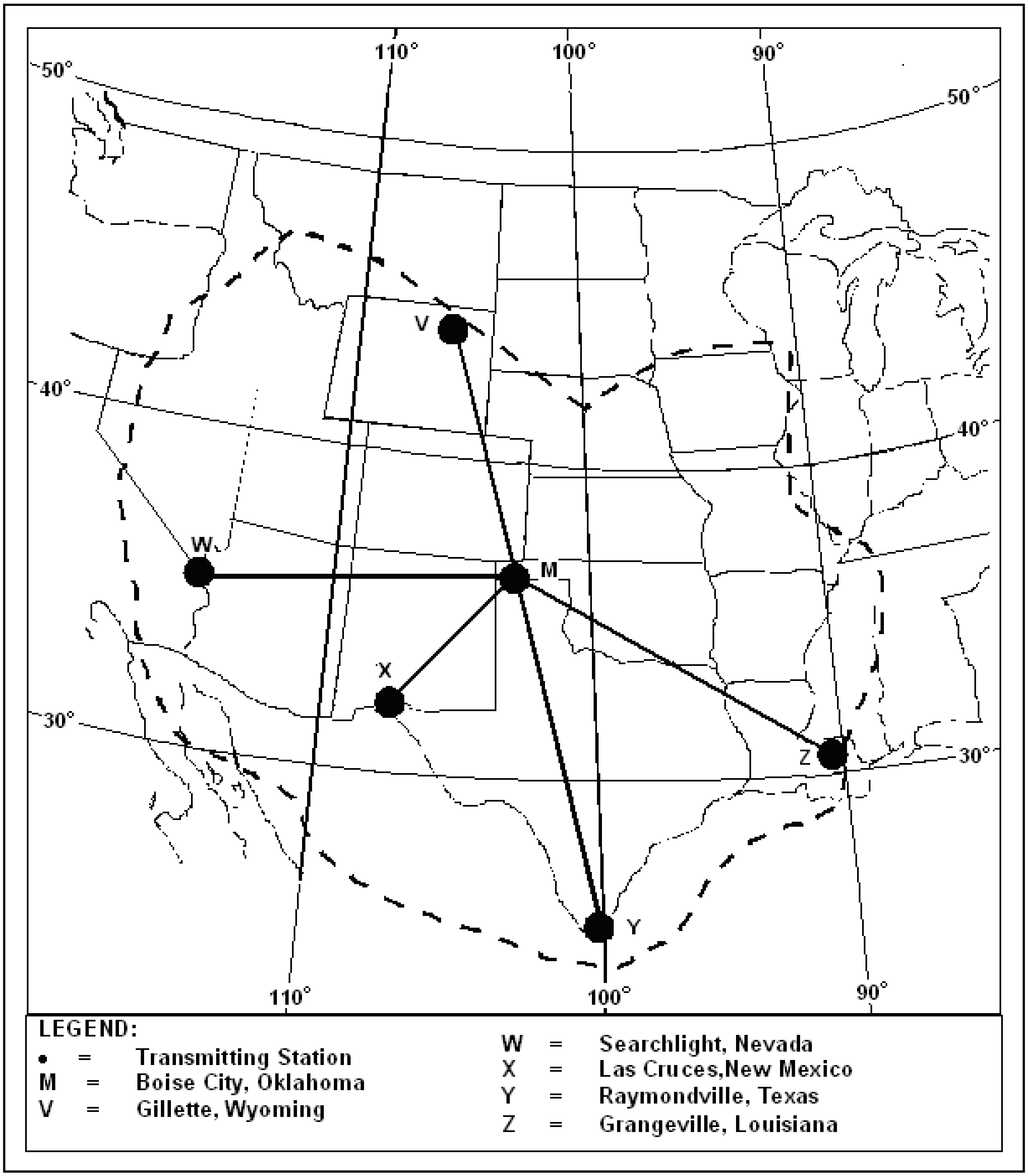


Figure F-20. LORAN-C, south central United States chain, GRI 9610

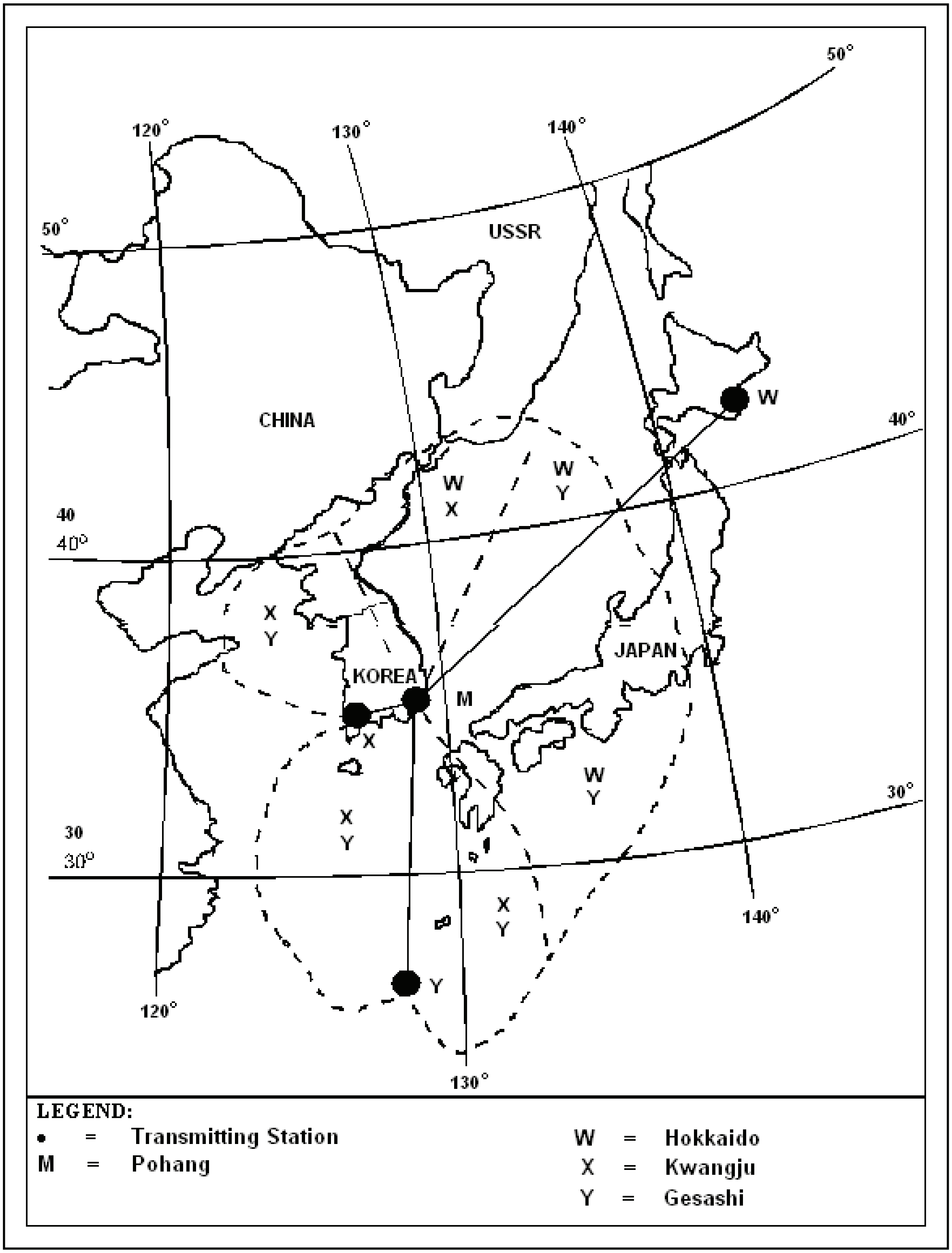


Figure F-21. East Asia GRI 9930

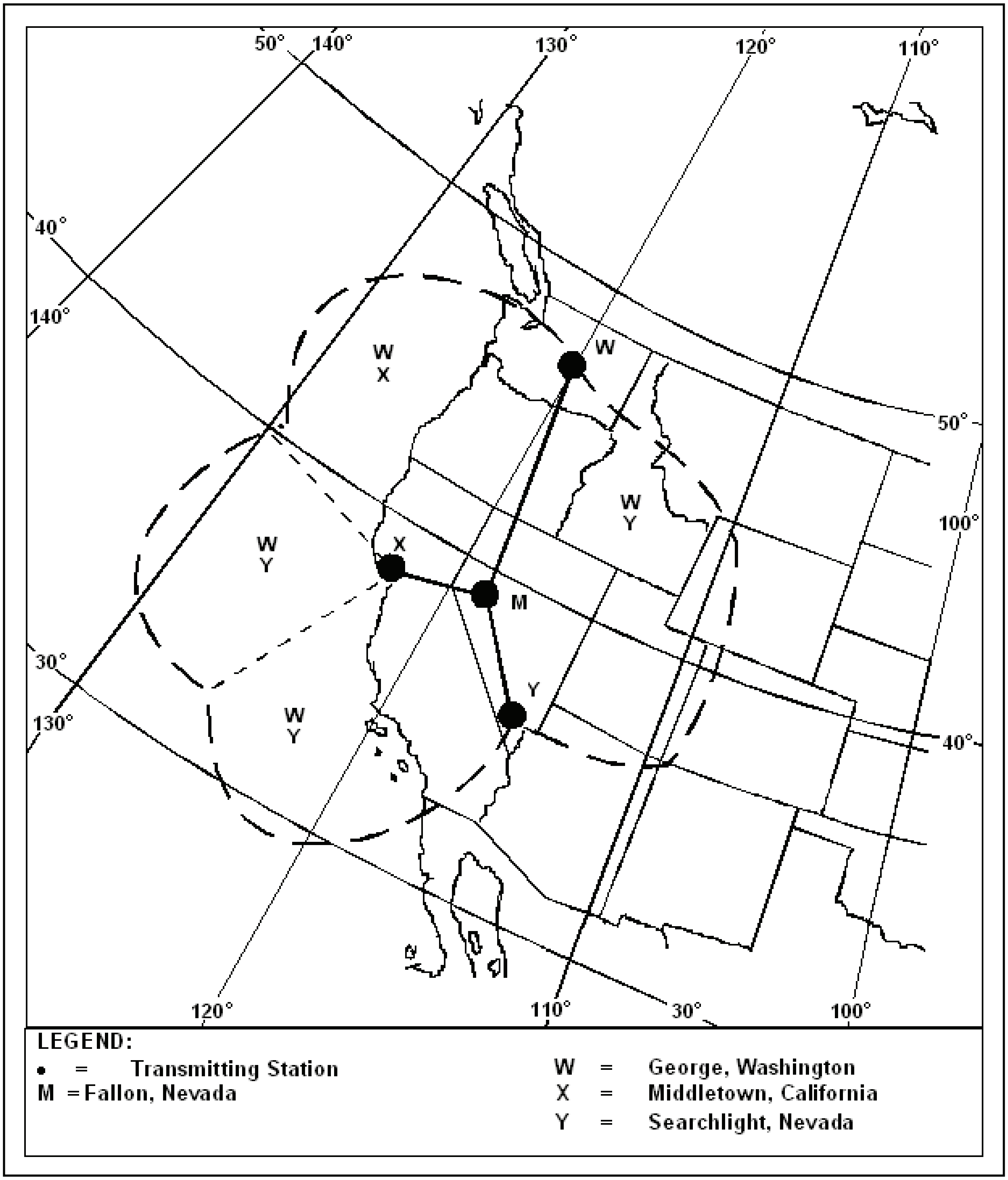


Figure F-22. LORAN-C, United States west coast chain, GRI 9940

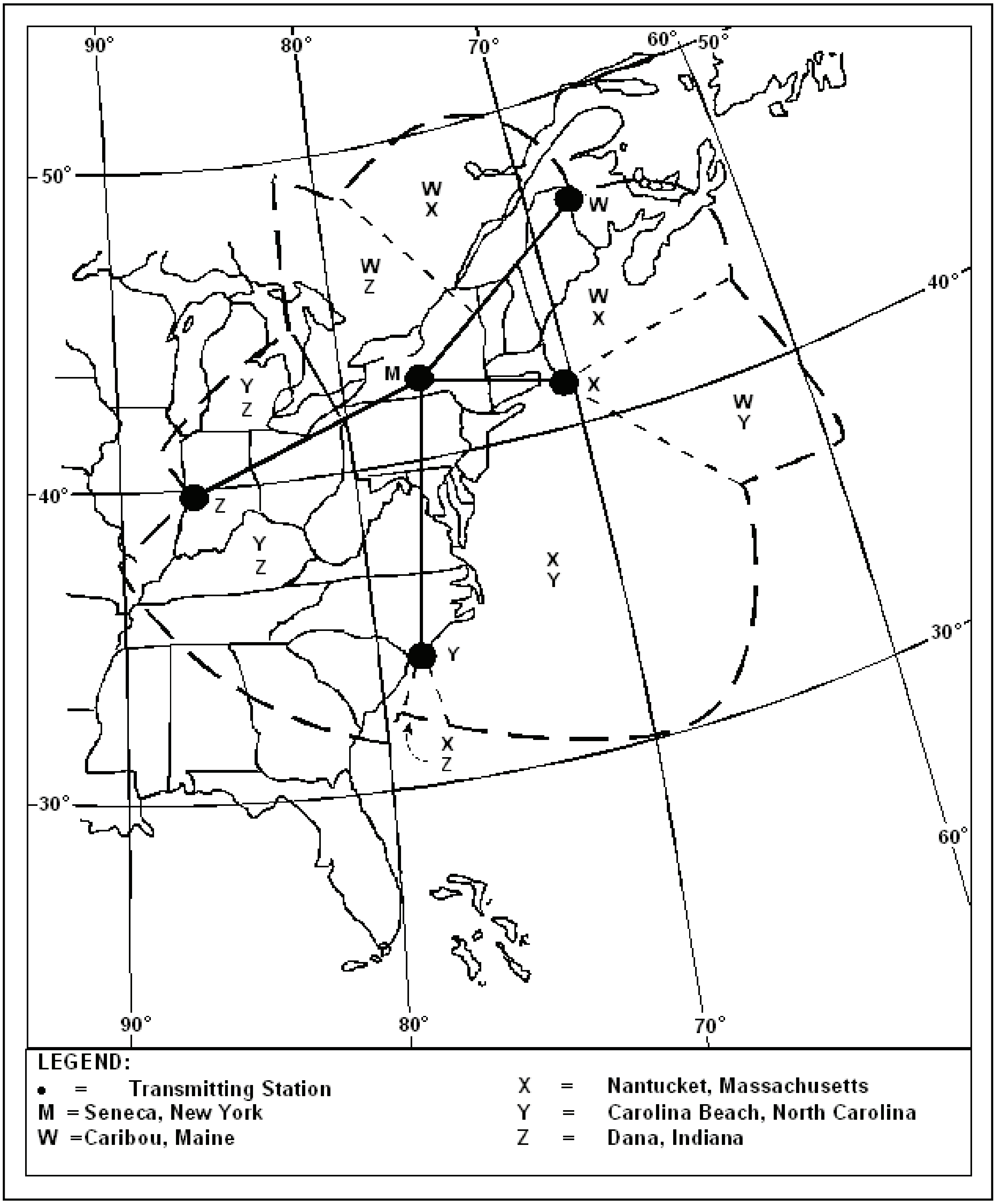


Figure F-23. LORAN-C, northeast United States chain, GRI 9960

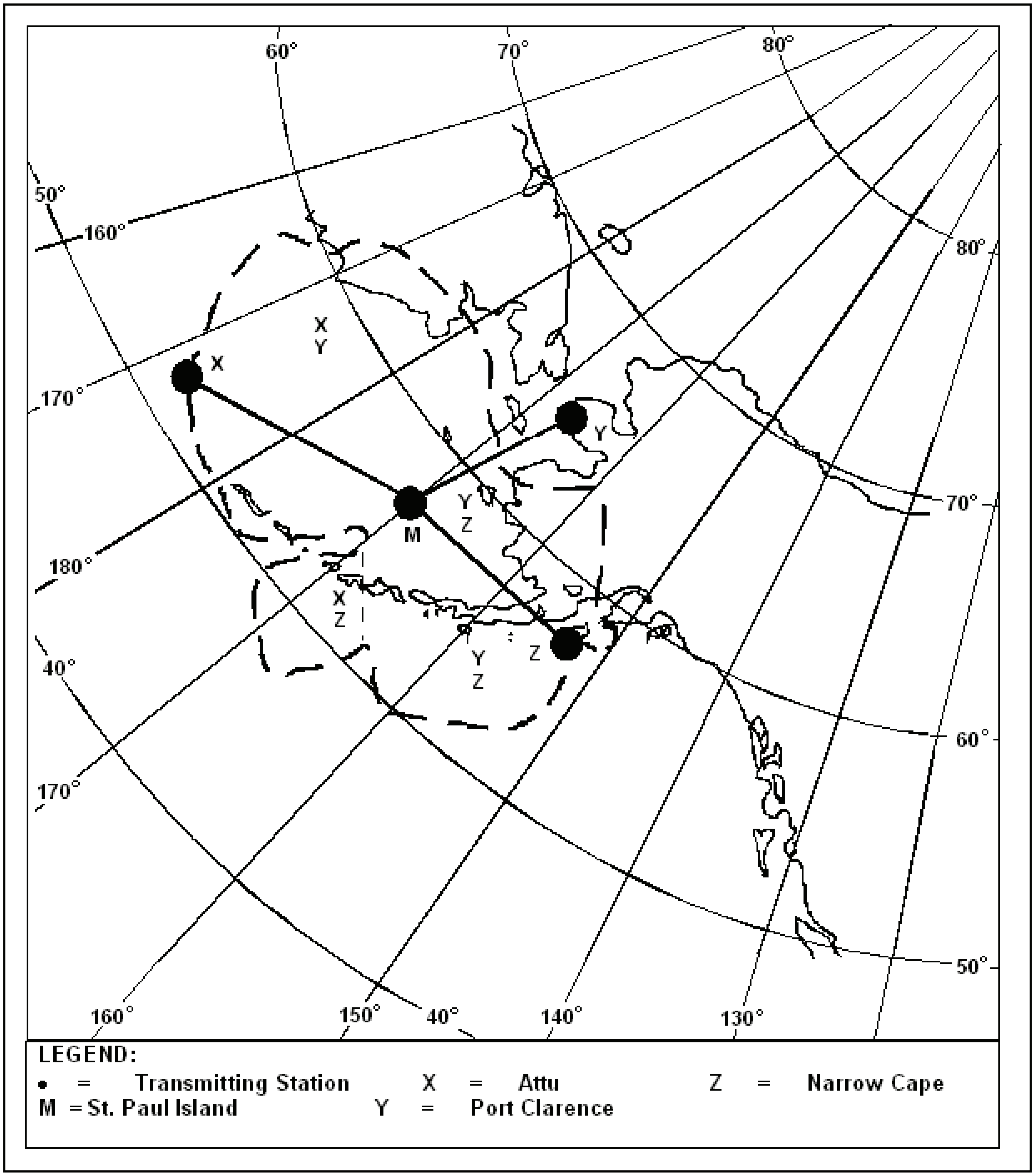


Figure F-24. LORAN-C, north Pacific chain, GRI 9990

Appendix G

Safety and Environmental Requirements

Safety is always a primary consideration of Soldiers and trainers at all levels. Often, the implementation of safety and environmental procedures becomes counterproductive, preventing units from conducting realistic training. Units must be able to conduct realistic training while meeting all safety and environmental requirements. This appendix addresses these requirements.

GENERAL

G-1. The first rule of safety is: "Do Not Take Chances." Hydrogen gas is extremely flammable. Special care in handling, storing, and disposing of waste is required to prevent injury or environmental hazards.

HYDROGEN

G-2. Mixtures of hydrogen and air can be highly explosive. Personnel using commercial hydrogen must remove all possible sources of flames and sparks. Hydrogen burns with an almost invisible flame that is difficult to extinguish. If hydrogen ignites, use powder fire extinguishers only.

Storage

G-3. Warning signs must be posted in all areas where hydrogen is stored. The hydrogen cylinders should not be exposed to extreme heat or the direct rays of the sun. The area should be well ventilated and at least 50 feet (15 meters) away from ignition sources. Material safety data sheets (MSDS) must be kept on file at each location.

Handling

G-4. All sources of static electricity must be provided a path to ground. All personnel and equipment must be grounded when using or generating hydrogen. Fire extinguishers must be readily available. Personnel must adhere to the detailed safety requirements outlined in chapter 7.

Disposal

G-5. Commercial hydrogen produces no harmful waste. When using the hydrogen generator set, AN/TMQ-3, a cloudy substance, calcium hydroxide, is released into the water during the process. This by-product is an environmental hazard. Before disposing of this deposit and the calcium hydride containers, MET personnel must check with local agencies and comply with their procedures.

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Appendix H

Environmental Awareness

Commanders, unit leaders, and Soldiers have specific duties and responsibilities concerning protection of the environment. Soldiers are expected to do what is right in the absence of specific guidance. Unit leaders and commanders must be competent and confident in the area of environmental stewardship. Not all leaders are required to be environmental experts; however, they must be aware and responsive to compliance and prevention issues required during the execution of their duties. The information contained herein is considered an overview of expected duties and responsibilities in order to build a foundation of basic environmental awareness. Throughout is reference to material for further reading; research of these documents provides a complete explanation of legal and ethical responsibilities.

NOTE: Equivalent U.S. Marine Corps guidance documents include MCO P1200.7S and MCO P5090.2A.

SECTION I-ARMY ENVIRONMENTAL AWARENESS

GENERAL POLICY STATEMENTS

H-1. The Army's environmental vision states: "The Army will be a national leader in environmental and natural resource stewardship for present and future generations as an integral part of our mission". To achieve this vision, the Army's environmental strategy places a high priority on sustained compliance with all environmental laws; takes into account the restoration of previously contaminated sites; focuses on pollution prevention; and accounts for the conservation and preservation of natural resources.

H-2. The Army environmental ethic calls for the chain of command to establish and support a stewardship climate that supports *compliance*; obeying the law; *prevention*; the concept of reduce, reuse, recycle; *conservation*, control and protection of natural resources; and *restoration*, the cleanup of contaminated areas. This ethic supports caring for the environment while conducting realistic training.

H-3. All Army personnel should become familiar with these policy statements; they are established so that our natural environment will be available for present and future generations. Complete information regarding these polices can be obtained in section II of *The Field Artillery Guide to Environmental Considerations.*

SECTION II-METEOROLOGY ENVIRONMENTAL CONSIDERATIONS

FIELD ACTIVITIES

H-4. The meteorological (MET) section provides accurate and timely meteorological data to both artillery and other tactical units. This data is gathered via highly mobile, automated data processing and MET data acquisition systems. In order to obtain this data, various processes are used to launch and track a balloon-borne radiosonde. These processes apply and produce substances that have the potential to cause serious damage to the environment. This section will identify and address the various preventive measures that can be utilized in order to decrease possible environmental damage while conducting realistic training from the met section, associated vehicles, and personnel involved in training and operations.

H-5. Key field environmental considerations include, but are not limited to, the following:

- Vehicles should stay on established roads, trails, firing points, and firebreaks, unless conducting specific cross-country maneuver exercises.
- Follow land contours rather than driving up and down hills or along creeks.
- In order to minimize siltation of streams; use bridges or low water crossings when crossing permanent streams. If crossing through a stream becomes necessary, then do so by the most direct route (90-degree angle).
- Establish refueling and maintenance areas away from wetlands, drainage areas, and near or over water sources.
- Federal law prohibits the removal of artifacts from federal property. Do not excavate, remove, damage, or otherwise alter or deface any archaeological resource located on a military reservation.
- Avoid off-limit areas for known archaeological sites during military training exercises. Penalties can be up to $250,000 for knowingly disturbing a site.
- Be aware of and avoid nesting, bedding, and habitats of all species of birds and animals.
- Use radar-scattering camouflage netting as outlined in the field manual; not live vegetation.
- When planning training activities, conform to installation and community noise-abatement regulations. Identify, mark, and abide by off-limit boundaries.
- Open fires, such as burning of garbage, refuse, and rubbish is not allowed on range areas.
- Conform to field sanitation and medical standards when using soakage pits for wash water, liquid kitchen wastes, and grease traps per FM 21-10.
- Establish field satellite-accumulation site and procedures.
- Police field locations and establish field trash-collection point and procedures. Remove materials packed into training area on departure from the training area.
- When the training exercise is complete, repair any field damage such as ruts from vehicles and other emplacements.
- Conduct all training with a concern for conservation and future use of range training areas.

HAZARDOUS MATERIAL AND HAZARDOUS WASTE

H-6. The Resource Conservation Recovery Act (RCRA) of 1976 is the framework for managing hazardous waste and has established standards for identifying, classifying, and storing of these wastes. RCRA regulations require those involved in managing hazardous substances to be properly trained, and the training to be properly documented.

H-7. Key hazardous material and hazardous waste environmental considerations include, but are not limited to, the following items:

- Personnel dealing with hazardous materials should be trained in proper handling, containment, cleanup, and reporting procedures.
- A material safety data sheet (MSDS) must be on file, and made available to all personnel regarding hazardous material.
- .Battery electrolyte (acid) from damaged batteries should be drained and disposed of through turn-in via installation policy and maintenance SOP. Refer to TB 43-0134 for complete procedures regarding battery handling and disposal.
- Never allow the accumulation of more than 55 gallons of a hazardous waste, or 1 quart of acutely hazardous waste, at the satellite accumulation point. Process all hazardous waste in a timely manner.
- Hazardous waste containers should be kept closed when not in use, kept free of rust and leaks, and stored separately from incompatible wastes.
- Incompatible wastes must never be transported on the same vehicle.

- Ensure that all U.S. Department of Transportation (DOT) and hazardous waste transportation requirements are met prior to transporting hazardous material or hazardous waste on public highways.
- Check with local environmental office for transportation procedures within the installation boundary.
- For complete information regarding storing and handling of hazardous materials refer to TM 38-410.

MATERIAL SAFETY DATA SHEET

H-8. A MSDS is a summary of information on a given chemical identifying material, health and physical hazards, exposure limits, and precautions. A MSDS describes the hazards of a material and provides information on how the material can be safely handled, used, and stored. Insist on receiving a copy of a MSDS when receiving a hazardous chemical from supply, and retain it for when or if you turn in the material. Periodically review each MSDS pertaining to your unit. This will assure a quick response when identifying symptoms and handling emergencies.

H-9. Unfortunately, there is no specified format for a MSDS, and it doesn't contain all known data of a chemical, but there are typical components. These are outlined in 29 CFR 1910.1200. Use the following information in table H-1 as a guide toward what to expect on most MSDS forms.

Table H-1 Material Safety Data Sheet

Section/Topic	***Contents***
Section 1 - General Information	Manufacturers' name and address Trade or common name of product
Section 2 - Hazardous Components	NIOSH and/or CAS Number Chemical name and percentage
Section 3 - Physical Properties	Boiling point, freezing point, water solubility, etc. Appearance and odor under normal conditions
Section 4 - Fire & Explosion Hazard	Fire-fighting equipment Any unusual fire and explosion hazards
Section 5 - Health Hazard	Routes of entry into the body Emergency and first aid procedures
Section 6 - Reactivity Data	Conditions to avoid Incompatibility with other materials
Section 8 - Control Measures	Recommended respiratory and ventilation Personal protective equipment, if needed
Section 9 – Special Precautions	Handling and storing precautions
Section 10 – Transportation	Applicable regulations Hazards class and required labeling

MAINTENANCE

H-10. The MET station leader assigns a hazardous material/hazardous waste (HM/HW) spill coordinator. This person ensures the accountability, proper storage, and disposal of all HM/HW, and ensures that HM/HW spills are immediately contained and reported.

H-11. Key maintenance environmental considerations include, but are not limited to, the following:

- Refueling operation SOPs should address practices to minimize spills.

- Implement preventive maintenance on all heavy equipment to ensure petroleum products will not be released from the belly pan.
- Ensure pollutants are not discharged into storm or wash rack drains or poured on the ground or along fence lines. Some common pollutants are oil, solvents, soap, diesel, gasoline, battery acid, chemicals, waste antifreeze, paint, and grease.
- Parts containing asbestos, such as brake shoes, clutch plates, and equipment insulation should be removed, collected, and disposed according to installation policy.
- The least hazardous or preferably, nonhazardous material to perform a function should be used, unless previous research of options clearly indicates otherwise. The Defense Logistics Agency (DLA) produces a manual, *Environmental Products*, to assist in this process.
- Do not mix fuel, oil, or antifreeze together. This is considered a mixed waste.

SUPPLY

H-12. The MET section is required to have a complete inventory of HM/HW generated by the section. The MET station leader must know what chemicals the unit requires, where and how they are stored, how much hazardous waste is generated, and necessary spill response procedures. He/she should coordinate with the unit operations officer or environmental control officer (ECO) to ensure this information is incorporated into the unit SOP.

H-13. Key supply environmental considerations include, but are not limited to, the following items:

- Requisition only supplies needed and authorized, avoid excessive stockpiling of materials.
- Maintain an accurate inventory in SOP of hazardous waste used by the MET section. This listing should include waste by volume, type, generating process, and location.
- Use of used oil tanks for disposal of solvents, antifreeze, or other HM/HW is against regulation. Storage of hazardous material must be in clearly marked DOT-approved containers.
- Actively support a unit-recycling program.
- Ensure tires and batteries are properly turned in for recycling.
- Ensure used batteries are turned in on a one-for-one basis.

SPILL RESPONSE

H-14. Generally, only persons specifically trained to respond to a spill should handle unit spills. However, all personnel should, at a minimum, report the spill, and be aware of the following four basic steps to spill response:

- Protect yourself. Use personal protective equipment (PPE) specified in the MSDS.
- Stop the flow. This may be as simple as placing the container upright or closing a valve.
- Contain the spill. Place absorbent material around the spill, and protect drains and ditches.
- Report the spill. Notify supervisor, and other key personnel.

H-15. Each unit is responsible for the cleanup of their own spills, as long as no personnel are put in danger. After the above four steps are completed, take the necessary steps to cleanup the spill. Information on cleanup procedures can be found on the MSDS, unit SOP, or contact installation environmental staff for guidance. Turn in the spilled material and absorbent to the Defense Reutilization Marketing Office (DRMO), or another designated point if a DRMO is not available. Also, ensure adequate spill supplies are on-hand for future use.

H-16. Key spill prevention, response, and cleanup considerations include, but are not limited to, the following items:

- A spill prevention and response section should be included in the unit SOP outlining installation spill plan requirements.
- Maintain a spill cleanup kit near any satellite-accumulation area, or where a potential for spill exists. The kit should contain, at a minimum, absorbent material, shovel, brooms, gloves, and

appropriate containers. Units who have a potential for release or spill that may impact streams should also maintain booms for containment.

- Drip pans should be used under vehicles and equipment where spills are likely to occur.
- Spills of oil, fuel, or other hazardous pollutants over 5 gallons (18.9 liters) in volume, 100 square feet (9.3 square meters) in area, or in any waterway should be reported immediately to the chain of command.
- All topsoil contaminated with oil should be removed, properly disposed, and replaced by the unit. While awaiting disposal, keep the excavated soil covered to prevent runoff in case of rain.

SECTION III-REGULATORY REQUIREMENTS

LAWS AND REGULATIONS

H-17. Military facilities are subject to federal, state, local, and host nation environmental laws. When the requirements differ, the most stringent applies. Ignorance of environmental laws is not an excuse for noncompliance, and it will not protect commanders, Soldiers, or the military services from civil and criminal liability. Table H-2 lists the federal and military laws and regulations that are frequently encountered by Army personnel; however, it is not inclusive of all requirements.

H-18. Additionally, environmental law varies with differing countries, states, and cities. What is legal in one area may be illegal in another. Each installation environmental office knows the laws for that locality, and should be consulted on environmental considerations during the planning and execution of training.

H-19. Army units outside the United States (OCONUS) that are not subject to federal environmental regulations decreed by the Environmental Protection Agency (EPA) should comply with the final governing standards (FGS) of the host nation (HN). In areas where a HN has minimal or no environmental laws and regulations, comply with the *Overseas Environmental Baseline Guidance Document (OEBGD)* provided by the Department of Defense*,* AR 200-1, and AR 200-2. Refer to Table H-2 for a listing of applicable Army regulations, executive orders, and federal laws.

Table H-2. Environmental Laws and Regulations

Army Regulations	***Federal Laws***
AR 200-1. Environmental Protection and Enhancement	Archaeological Protection Act of 1979
AR 200-2. Environmental Effects of Army Actions	Clean Air Act of 1970
AR 200-3. Natural Resources	Clean Water Act of 1972
AR 200-4. Historic Preservation	CERCLA of 1980
AR 420-49. Solid and Hazardous Waste Management	EPCRA of 1986
AR 420-76. Pest Management	Endangered Species Act of 1973
	Federal Facilities Compliance Act of 1992
Executive Orders	Haz. Materials Transportation Act of 1975
EO 11989. Use of off-road vehicles on public land	National Environmental Policy Act of 1969
EO 11990. Wetland protection	National Historic Preservation Act of 1966
EO 12114. Effects of federal actions abroad	Noise Control Act of 1972
EO 12196. OSHA Compliance for federal employees	Oil Pollution Act of 1990
EO 12580. CERCLA duties and powers	RCRA of 1976
EO 13101. Pollution prevention and recycling	Toxic Substances Control Act of 1976

H-20. Regulatory agencies exist which require environmental training. This training may be general designed for all personnel in the unit, or may be specialized training targeted at specific personnel. The installation Environmental and Safety Offices can best assist in determining your training requirements and who to contact for additional information. Table H-3 is provided as a reference of possible training requirements for the MET section personnel.

Table H-3. Regulatory Training Requirements

NOTE: The depth or level of training will vary between target audiences. For example, K and E will need in-depth training, while A will only require broad overviews. The letters K, E, N, or A denotes target audience, and are listed below:

Knowledge	Personnel who administer, implement, or comply with contents of regulations such as program manager and technicians in the environmental field. Also includes organizations that need in-depth knowledge of the environmental laws/regulations/programs, such as Staff Judge Advocate.
Executors	All personnel who supervise or actually handle responsibilities dealing with environmental programs, to include ECOs, technicians, and workers. Also includes unit personnel required to execute responsibilities with environmental ramifications as part of their mission.
Need to Know	Personnel who may encounter environmental issues as part of their mission. This may include personnel within the following activities: Engineers; Designers; Emergency Personnel; Safety; Reserve Components; First-line Supervisors; Crew Chiefs; NCO's; and various unit personnel as identified by the installation Environmental Office and their supervisors
Awareness	Public Affairs Office, Reserve Components, other unit personnel.

Training Topic	***Regulatory Reference***	***K***	***E***	***N***	***A***
Hazardous Materials/Waste Compliance Training	29 CFR 1200; 40 CFR 262.34, 264.16, 265.16; 49 CFR 172	*	*	*	*
Hazardous Waste Operations (HAZWOPER) for IR	29 CFR 1910.120	*	*		
Hazardous Waste Operations (HAZWOPER) for TSDF	29 CFR 1910.120	*	*		
Emergency Response to Hazardous Materials Incidents/Hazardous Material Technician	29 CFR 1910.120	*	*	*	
National Environmental Policy Act (NEPA)	NEPA of 1969	*			*
National Historic Preservation Act (NHPA)	36 CFR part 800, 36 CFR part 63, NHPA of 1966	*			*
Archaeological Resources Protection Act (ARPA)	43 CFR 7.7 (4) ARPA of 1979	*			
Native American Graves Protection and Repatriation Act (NAGPRA)	NAGPRA of 1990	*			
Emergency Planning and Community Right-to-Know (EPCRA)	EPCRA/SARA 1986 Title 3, Executive Order 12856	*	*	*	*
Lead Based Paint	Lead Based Paint Exposure Reduction Act of 1992, 24 CFR 35	*	*	*	*
Asbestos	40 CFR part 763, 40 CFR 61 part M	*	*	*	*
Endangered Species Act (ESA)	ESA 1973 as amended, 50 CFR par 402	*			*
Clean Water Act (CWA)	CWA S 311	*	*		*
Storm Water Pollution Prevention Planning	CWA S 319	*	*	*	
CFC/Halon Refrigerants	EO 11051, 40 CFR 82.40, 40 CFR 282, 58 FR 92 (p. 28660)		*	*	*
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	FIFRA of 1972, 40 CFR 265.16, SARA of 1986		*		

Table H-3. Regulatory Training Requirements

NOTE: The depth or level of training will vary between target audiences. For example, K and E will need in-depth training, while A will only require broad overviews. The letters K, E, N, or A denotes target audience, and are listed below:					
Solid Waste Management	40 CFR 240-257/RCRA Subtitle D	*			*
Underground Storage Tanks	40 CFR part 280, RCRA Subtitle I	*			
National Pollutant Discharge Elimination System (NPDES)	CWA of 1990, 40 CFR 122-129	*	*		*
Confined Space Entry	29 CFR 1910.146	*	*	*	*
Occupational Respiratory Protection	29 CFR 1926.58, 29 CFR 1910.134	*	*		
Occupational Exposures to Bloodborne Pathogens	29 CFR 1910.1030	*	*	*	*
Storm Water Compliance	40 CFR 122-129, WPCA S 319	*	*		
Hazard Communication Standard	29 CFR 1910.1200	*	*	*	*
Department of Transportation	49 CFR172.704	*	*	*	*

ENVIRONMENTAL COMPLIANCE OFFICER RESPONSIBILITIES

H-21. Field artillery battalions will appoint an environmental compliance officer (ECO)/hazardous waste coordinator. This individual is an excellent source for guidance with regards to environmental regulations and procedures. Appointed personnel—

- Should receive formal training and act as an advisor on environmental regulatory compliance during training, operations, and logistics functions.
- Will be the commander's eyes and ears for environmental matters, as the safety officer/NCO is for safety matters.
- Should function as the liaison between the unit and higher headquarters regarding environmental matters such as training requirements, equipment, or supplies that unit personnel need.
- Should inspect HM/HW accumulation sites, and ensure that Soldiers handling these materials are properly trained.
- Ensure the unit's SOP covers environmental considerations, conservation, natural resources, pollution prevention, HM/HW, and spill procedures.
- Support the Army's pollution prevention/recycling program.
- Report hazardous material and waste spills immediately.
- Conduct environmental self-assessments or internal environmental compliance assessments, and meet with key installation environmental points of contact, as necessary, to remain updated on any regulatory changes.

SECTION IV. ENVIRONMENTAL RISK MANAGEMENT

ENVIRONMENTAL RISK MANAGEMENT

H-22. Leaders at all levels are required to make timely and appropriate decisions regarding the environment. The failure to do so may negatively impact the training environment, which could then lead to personal liability of individuals directly involved, the chain of command, and the U.S. Army. Therefore, leaders must have a method of managing, assessing, and reducing environmental risks.

H-23. Risk management is a five-step process designed to provide leaders a methodology for the identification, assessment, control, and evaluation of environmental risks. The following is a summary of these steps from FM 20-400 and FM 100-14; refer to them for detailed information.

H-24. **Step 1.** Identify Hazards - Environmental hazards include all activities that may pollute, create negative noise-related effects, degrade archeological/cultural resources, or negatively affect threatened or endangered species habitats. A select listing of common environmental hazards is located in table H-4.

Table H-4. Common Environmental Hazards

Media Area	***Common Environmental Hazards***
Air	Equipment exhaust, convoy dust, range fires, open-air burning, pyrotechnics/smoke pots/smoke grenades, part-washer emissions, paint emissions, air-conditioner/refrigeration CFCs, HM/HW release, pesticides, other toxic industrial chemicals or material.
Archeological and cultural	Maneuvering and digging in sensitive areas, disturbing or removing artifacts, demolition/munitions effects, HM/HW spills.
Noise	Low-flying aircraft (helicopters), demolition/munitions effects, nighttime operations, operations near post/camp boundaries and civilian populations, vehicle convoys/maneuvers, large-scale exercises.
Threatened and/or endangered species	Maneuvering in sensitive areas, demolition/munitions effects, especially during breeding seasons, disturbing habitat or individual species, HM/HW spills or releases, poor field sanitation, improper cutting of vegetation, damage to coral reefs,
Soil (terrain)	Over use of maneuver areas, demolition/munitions effects, range fires, poor field sanitation, poor maneuver-damage control, erosion, troop construction effect, refueling operations, HM/HW spills, maneuver in ecologically sensitive areas such as wetlands and tundra, industrial waste runoff, pesticide accumulation in soil, vegetation, and terrestrial organisms.
Water	Refueling operations near water sources, HM/HW spills, erosion and unchecked drainage, amphibious/water-crossing operations, troop construction effects, poor field sanitation, washing vehicles at unapproved sites.

H-25. **Step 2.** Assess Environmental Hazards to Determine Risk - A risk assessment is a tool used for evaluating the most pressing or most hazardous potential environmental damage. It considers two factors: probability, how often a hazard is likely to occur; and severity, the effect in degrees a hazard will have on personnel, equipment, environment, and mission. Unit leaders should conduct risk assessments before conducting any training, operations, or logistical activities that are not previously addressed in the SOP, or when conditions differ significantly from the SOP. Complete information on risk assessments can be obtained from FM 20-400 for procedures on how to perform an environmental risk assessment.

H-26. **Step 3.** Develop Controls and Make a Decision - This step is designed to reduce the probability or severity of each hazard, which in turn lowers the overall risk. Control types fall in the categories of educational, physical, or avoidance. Table H-5 outlines examples of environmental controls, and section II above contains the specifics pertinent to the MET section.

Table H-5. Examples of Environmental Controls

Control Type	***Environmental-Related Examples***
Educational	Conducting unit environmental-awareness training Conducting an environmental briefing before deployment Performing tasks to environmental standards Reviewing environmental considerations in AARs Reading unit's environmental SOPs and policies
Physical	Providing spill-prevention equipment Establishing field satellite-accumulation site and procedures Policing field locations Practicing good field sanitation Posting signs and warnings for off-limit areas
Avoidance	Maneuvering around historical/cultural sites Establishing refueling and maintenance areas away from wetlands and drainage areas Crossing streams at approved sites Preventing pollution Limiting noise in endangered and threatened species habitats

H-27. **Step 4.** Implement Controls - Leaders must inform subordinates of risk-control measures, state how each control is to be implemented, and assign responsibilities. They must also ensure these controls are in place prior to the operation. This is accomplished by using the *before*, *during*, and *after* checklists and the environmental risk-assessment process. Examples of checklists can be obtained from TC 5-400, or from the field artillery environmental handbook referenced in section I, in order to determine the environmental considerations that may effect MET section training and operations.

H-28. **Step 5.** Supervise and Evaluate - Leaders should monitor controls to ensure effectiveness and whether controls require modification. They should ensure the after action review (AAR) process includes an evaluation of environmental-related hazards, controls, Soldier performance, and leader supervision.

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Appendix I

Time Zones, Octants, and Regions

To establish a common time and location, MET messages are reported in Greenwich Mean Time while locations are prefaced with an octant of the globe code. Figure I-1 is a world map divided into time zones, global octants, and climatic regions

TIME ZONES

I-1. Time is calculated from the Greenwich meridian. The middle of the zero time zone passes through Greenwich with its east and west limits 7° 30' on each side. Each 15-degree zone east and west of the initial zone represents 1 hour of time. The number of hours that must be added to or subtracted from local standard time to give GMT is indicated for each zone. Political boundaries in the various countries have caused modifications of the time zones. The vertical lines and clear sections are used to show which zones these divisions belong. Where a half-hour difference is legal, horizontal lines are used. Where no zone system has yet been adopted, the area is represented by small dots. Where no legal time has been established, the larger dots are used. Variations from zone time are given in hours and minutes. Enter the map with the section location and extract the time correction.

GLOBAL OCTANTS

I-2. Global octants are indicated by bold N-S, E-W lines and octant identifications. Determine the section location on the map and extract the appropriate octant number.

CLIMATIC REGIONS

I-3. The seven climatic regions of the Northern Hemisphere are indicated and identified by the large black numbers 1 through 7.

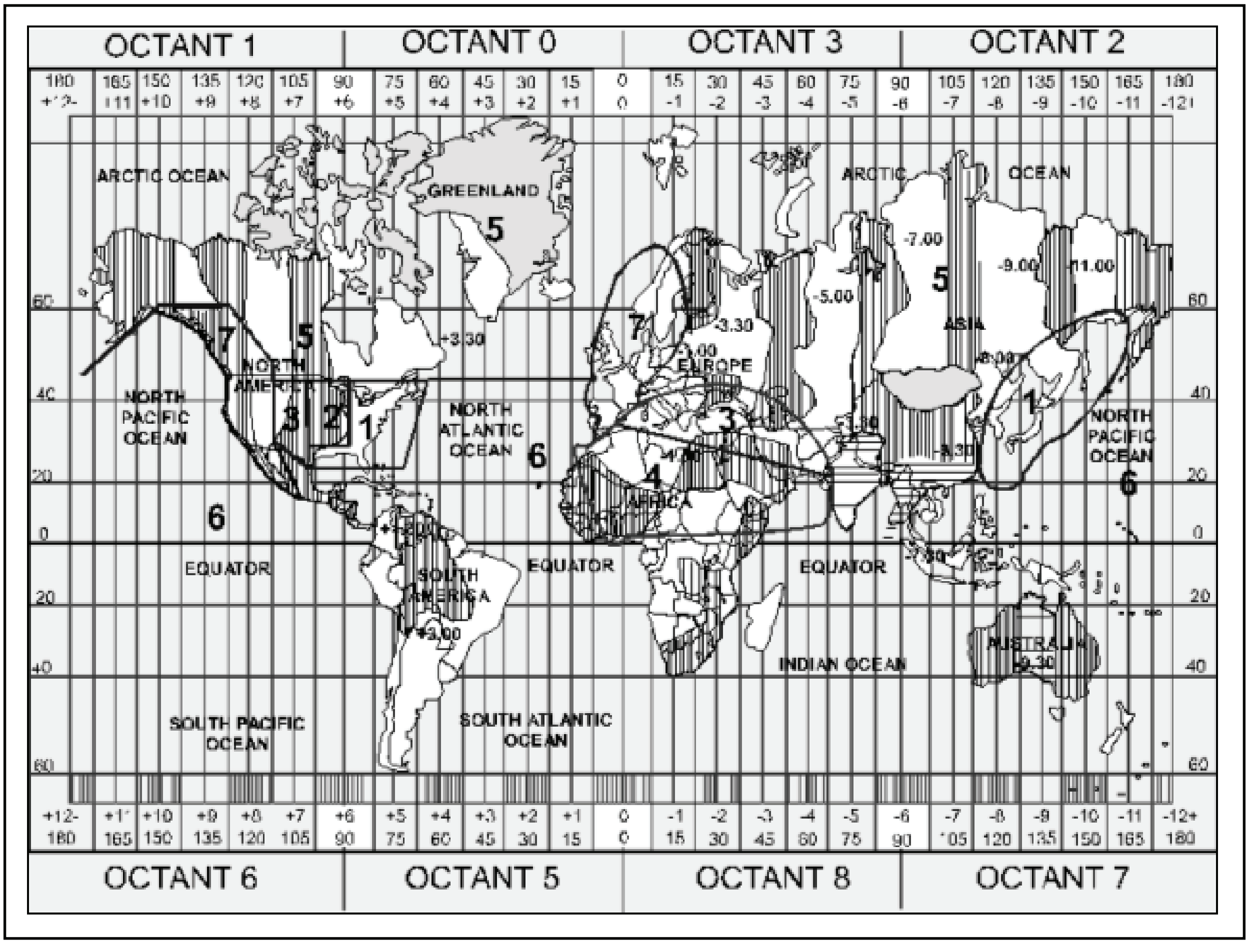

Figure I-1. Time zones, octants, and regions

Glossary

SECTION I. ACRONYMS AND ABBREVIATIONS

AFATDS	Advanced Field Artillery Tactical Data System
AFW	Air Force weather
AFWA	Air Force Weather Agency
AI	area of interest
ALSO	artillery limited surface observation
AMV	area of meteorology validity
AO	area of operation
AR	Army regulation
ARTEP	Army Training and Evaluation Program
ASI	additional skill identifier
BCT	brigade combat team
BITE	built-in test equipment
BN	Battalion
C2	command and control
C	Celsius
CBRN	chemical, biological, radiological, and nuclear
CECOM	Communications-Electronics Command
CMP	common message processor
comm	Communications
COSCOM	corps support command
corr alt	corrected altitude (Table 2 computation work sheet)
CPL	Corporal
DA	Department of the Army
DDT	digital data terminal
DISCOM	division support command
DOD	Department of Defense
DOT	Department of Transportation
DP	dew point
DRMO	Defense Reutilization Marketing Office
DS	direct support
DTED	Digital Terrain Elevation Data
ECO	Environmental Control Officer
F	Fahrenheit
FA	field artillery
FATDS	Field Artillery Tactical Data System
FC	Fires Cell

FCE	fire control element
FDC	fire direction center
FLOT	forward line of own troops
FM	field manual
FMH	federal meteorology handbook
FOMET	fallout met
FSCL	fire support coordination line
FSC	federal supply catalog
FSCOORD	fire support coordinator
GMT	Greenwich Mean Time
GPS	Global Positioning System
GRI	grid repetition interval
GS	general support
GUI	graphical user interface
HAZMAT	hazardous materials
HM/HW	hazardous material/hazardous waste
HMMWV	high-mobility multipurpose wheeled vehicle
HN	host nation
Hz	Hertz
ICAO	International Civil Aviation Organization
IMETS	Integrated Meteorological System
IP	internet protocol
IPB	intelligence preparation of the battlefield
JAAWIN	Joint Air Force and Army Weather Information Network
JVMF	joint variable message format
K	Kelvin
kHz	Kilohertz
km	Kilometer
kw	kilowatt
LCPL	lance corporal
log	logistics
LORAN	long-range aid to navigation
LORAN-C	Long-range aid to navigation commercial
LRU	line replaceable units
m	meter
MAC	maintenance allocation chart
mb	millibar
MDP	meteorological datum plane
mech	mechanized
MET	meteorology

METCM	meteorology computer message
METT-TC	mission, enemy, terrain and weather, troops and support available, time available, civil considerations
MHG	meteorological hydrogen generator
Mhz	megahertz
MLRS	Multiple Launch Rocket System
MOS	military occupational specialty
MSDS	material safety data sheet
MSE	mobile subscriber equipment
MSL	mean sea level
MM5	mesoscale model (fifth generation)
MMS	meteorological measuring set
MMS–P	meteorological measuring set-profiler
MUL	master unit list
NATO	North Atlantic Treaty Organization
NAVAID	navigational aid
NCO	noncommissioned officer
NIPRNET	Non-Classified Internet Protocol Network
NOGAPS	Naval Operational Global Atmospheric Prediction System
NOTAM	notice to airmen
OIC	operator interface computer
OPORD	operation order
PFC	private first class
PIBAL	pilot balloon
PMCS	preventive maintenance checks and services
POL	petroleum, oils, and lubricants
PPS	Precise Positoning Service
PSI	pounds per square inch
PSY	Phychological
PSYOP	psychological operations
PTM	plaintext message
PTU	pressure temperature humidity
OPORD	operations order
QSTAG	quadripartite standardization agreement
RAOB	Radiosonde Observation
RCRA	Resource Conservation Recovery Act
RDF	radio direction finding
RF	radio frequencies
RH	relative humidity
RPV	remotely piloted vehicle
SAASM	Selective Availability Anit-Spoofing Module

S3	operations officer
SF	standard form
SFC	sergeant first class
SGT	Sergeant
SINCGARS	single-channel ground and air-borne radio system
SIPRNET	Secret Internet Protocol Routing Network
SOI	signal operating instructions
SOP	standard operating procedure
SPC	Specialist
SOWT	special observation weather team
SSG	staff sergeant (Army)
SSGT	staff sergeant (USMC)
STANAG	standardization agreement
SWO	staff weather officer
TA	target acquisition
TACMET	tactical metorology
TAM	target area metorology
TB	technical bulletin
TC	training circular
TCIM	tactical communications interface module
TM	technical manual
TRN	transmission repeat number
TSOP	tactical standing operating procedure
T-VSAT	Tactical-Very Small Aperture Terminal
UAV	unmanned aerial vehicle
UPPS	Unified Post Processing System
URL	Universal Resource Locator
URN	unit reference number
U.S.	United States
USAF	United States Air Force
USMC	United States Marine Corps
V	Volt
VAC	volts alternating current
VDC	volts direct current
VLF	very low frequency
VMF	variable message format
WB	white bag
WLR	weapons-locating radar
WMO	World Meteorological Organization
Z	ZUZU time zone

SECTION II-TERMS AND DEFINITIONS

air mass

An extensive body of air within which the conditions of temperature and moisture in a horizontal plane are essentially uniform.

air pressure

The weight of the air per unit of volume.

all-weather

The ability to be functional without regard to weather.

ambient temperature

The temperature of the immediate surrounding medium, such as a gas or liquid.

Anemometer

The general name for instruments designed to measure the speed (or force) of the wind.

aneroid

A kind of barometer which contains no liquid.

area observations

Meteorological observations that come in via messages over the radio network from other MMS–P or metorological measuring set systems in the current theater of operations.

azimuth

The horizontal angle, measured clockwise by degrees or mils between a reference direction and the line to an observed or designated point. There are three base (reference) directions or azimuths: true, grid, and magnetic azimuth.

ballistic meteorology

The study dealing with the phenomena of the atmosphere and its effect upon the motion of projectiles.

ballistics

The science of the motion of projectiles.

ballistic temperature

An assumed temperature that would have the same total effect on a projectile during its flight as the varying temperatures actually encountered; reported as a percent of standard.

ballistic wind

An assumed constant wind that would have the same total effect on a projectile during its flight as the varying winds actually encountered.

barometer

An instrument for measuring atmospheric pressure.

baroswitch

A pressure-operated switching device used in a radiosonde.

built-in test equipment (BITE)

Circuits built into an item of equipment to test certain functions.

climatological information

Information that deals with weather conditions and variations from normal for a particular place or area, during a specified period of a year.

critical angle

The limiting angle at which angular data may become invalid.

cursor

An indicator on a computer.

datum

A mathematical model of the earth used to calculate and specify geographic locations.

density

The mass per unit volume, measured in grams per cubic meter.

deviation

A departures from accepted policies or standards. Ballistic densities and temperatures are reported as deviations from the standards that were used to develop the weapons firing tables.

domain

A square geographic area with a center point selected by the system operator.

downwind

The direction toward which the wind is blowing (with the wind).

dry-bulb temperature

The temperature measured by the dry bulb of a psychrometer; ambient air temperature.

elevation

The vertical distance of a point or level on or affixed to the surface of the Earth measured from mean sea level.

elevation angle

Elevation angle is the angle between the horizon and objects above the horizon measured along the arc which passes through the zenith and the object in question.

equation of state

An equation relating temperature, pressure, and volume of a system in thermodynamic equilibrium.

fallout

Fallout is the precipitation to earth of particulate matter from a nuclear cloud; also applied to the particulate matter itself.

free lift

Refers to the net upward force required for a balloon to rise at a given rate. Free lift corresponds to the specific balloon (sounding or pilot balloon) being used and is a portion of total lift.

fronts

A transition zone between air masses of different densities and temperatures.

geopotential height

The height of a given point in the atmosphere in units proportional to the potential energy of unit mass (geopotenital) at this height, relative to mean sea level.

horizontal distance

The arc distance or the distance traveled by a balloon as projected to the earth's curved surface.

hydrostatic equation

The basic force equation which states that the change of pressure with respect to height is equal to the negative product of density and the acceleration of gravity.

hygristor

The hygristor is a humidity-sensing element or device; a resistor whose resistance varies according to the amount of moisture in the air.

inversion

An increase of air temperature with increase in altitude (the ground being colder than the surrounding air). When an inversion esists, there are not convection currents an dwind speed apre below 5 knots. The atmosphere is stable and normally is considered the most favorable state for ground release of chemical agents.

isobar

A line of constant pressure.

isobaric

Means of equal or constant pressure.

isotherm

A line of constant temperature.

isothermal

Means of equal or constant temperature.

kelvin scale (°K)

An absolute temperature scale with a freezing point of 273.16°K and a boiling point of 373.16°K.

lapse rate

The rate at which temperature changes with altitude.

Local observations

Meteorological observations gathered at the current shelter location. Also referred to as local data or local met.

low-level winds

Winds in the friction layer of the atmosphere.

magnetic declination

The angle between the magnetic and geographical meridians at any place, expressed in degrees east or west to indicate the direction of magnetic north from true north. In nautical and aeronautical navigation, the term magnetic variation is used instead of magnetic declination and the angle is termed variation of the compass or magnetic variation.

mandatory level

One of several constant-pressure levels in the atmosphere for which a complete evaluation of data derived from upper air observation is required.

mean sea level

The average height of the surface of the sea for all stage of the tide; used as a reference for elevations.

mean sea level pressure

The station pressure reduced to mean sea level pressure.

meteorological datum plane

The altitude of the met station from which all met computations are based.

meteorological day

A 24-hour day divided into three periods - night, afternoon, and transition.

meteorological data

Meteorological facts pertaining to the atmosphere, such as wind, temperature, air density, and pressure an other phenomena that affect military operations.

meteorology

The study of the earth's atmosphere.

millibar

A unit of atmospheric pressure.

modulator

The part of a radiosonde which contains the sensing elements and baroswitch.

N unit

A mathematically simplified unit of refraction; designed to replace complex numbers involved in the values of the index of refraction.

NOGAPS data

Worldwide forecast model data for the next 72 hours produced by the Navy Operational Global Atmospheric Prediction System (NOGAPS).

nowcast

A weather forecast for "now," meaning a very short term forecast.

nowcast segment

The 30-minute period in which an iteration of modeling is done by the MM5.

observations

Actual measurements of meteorological conditions, as opposed to predicted or interpolated values. Also referred to as real-time meteorological observations.

offset

The difference in distance and azimuth from a tracking point to the point of release of a sounding or pilot balloon.

operational response

The data entered during the operation of the flight.

optical-electrical bearing clock

A check performed to ensure that the optical axis of the telescope is parallel to the electrical axis of the radio direction finding antenna.

orographic

Means of, pertaining to, or (frequently in meteorology) caused by mountains.

parameter

A quantity to which arbitrary values may be assigned, such a temperature, density, or pressure values.

pilot balloon

A small balloon whose ascent is followed by a theodolite to obtain data for computing speed and direction of winds in the upper air.

precipitation

The form of water, either liquid or solid, that falls from the atmosphere, and which reaches the ground.

pressure gradient

The spacing between lines of constant pressure, or isobars.

pressure gradient force

The initiating force which produces wind.

projectile

Any object projected by exterior force and continuing in motion by its own inertia.

psychrometer

An instrument used for measuring atmospheric humidity that consists of a dry-bulb thermometer and a wet-bulb thermometer.

radioactive fallout

The eventual descent to the earth's surface of radioactive matter placed in the atmosphere by atomic or thermonuclear explosion (also called radiological fallout).

radio direction finder

A component of the MMS that tracks the radiosonde signal.

radiosonde

A balloon-borne instrument (radio) that measures and transmits meteorological data.

rawin

Rawin is a method of winds aloft observation; that is, the determination of wind speed and direction in the atmosphere above the station by using radar or a radio direction finder; a contraction of radio winds.

rawinsonde (radiosonde and wind sounding, combined)

A method of winds aloft observation that determines wind speed and direction in the atmosphere above the station by using radar of a radio direction finder. [Note: the term is a contraction of "radio winds"].

relative humidity

The ratio of the actual vapor pressure of the air to the saturation vapor pressure, usually expressed in percent.

sounding

Upper-air meteorological data gathered by sensors and transmitted to a ground receiver by the radiosonde carried aloft by a balloon.

sounding balloon

A free, unmanned balloon carrying a radiosonde to sound the upper air.

sound ranging (sound locating)

The method of locating the source of a sound, such as that of a gum report or a shell burst, by calculations based on the intervals between the reception of the sound at various previously oriented microphone stations.

spatial validity

The space, or distance, from the location of the met section that is estimated or determined to be within the valid limitation of the MET sounding.

standard ballistic density

The density of the air as defined by the ICAO standard atmosphere; density of 100 percent.

standard height

The height above surface to the top of a prescribed standard zone.

station pressure

Surface pressure at the observing station; the atmospheric pressure computed for the level of the station elevation.

surface wind

The wind speed and direction as measured at the surface with an anemometer.

temperature element

A thermistor which is a resistor that reacts to temperature changes.

theodolite

An optical instrument which consists of a sighting telescope and graduated scales to read angles of azimuth and elevation.

thermistor temperature

The temperature measured by the temperature element (thermistor) on a radiosonde.

total lift

The weight (grams) of the balloon with attachments that must be balanced by the gas volume in the inflated balloon for the balloon to rise at a desired rate of ascent.

trajectory

The path of a projectile in the earth’s atmosphere.

true north

The direction from any point on the earth’s surface toward the geographic north pole.

virtual temperature

In a system of moist air, the temperature of dry air having the same density and pressure as the moist air. The virtual temperature is always greater than the actual temperature.

visual technique

The determination of upper air conditions from PIBAL observations and the measurement of surface temperature, pressure, and relative humidity.

weather forecast

A prediction of expected weather conditions at a point, along a route, or within an area, for a given time or specific period of time in the future.

weather information

Information concerning the state of the atmosphere, mainly with respect to its effects on the military; data and information concerned with forecasts, summaries, and climatology.

weighing off

A balloon inflation procedure when using an inflation shelter which involves inflating the balloon with attached weights in the inflation shelter until it just lifts off the ground and remains suspended in air.

weighting factor

A factor used in weighting the effects of met conditions in each artillery zone.

wet-bulb depression

The difference in degrees between the dry-bulb temperature and the wet-bulb temperature.

wet-bulb temperature

The temperature measured by the wet bulb of a psychrometer; used to determine wet-bulb depression.

wind chill

That part of the total cooling of a body caused by air motion.

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BALLISTIC MESSAGE

For use of this form, see FM 3-09.15; the proponent agency is TRADOC.

IDENTIFICATION METB	TYPE MSG K	OCTANT Q	LOCATION $L_aL_aL_a$ or xxx / $L_oL_oL_o$ or xxx	DATE YY	TIME (GMT) $G_oG_oG_o$	DURATION (HOURS) G	STATION HEIGHT (10s M) hhh	MDP PRESSURE % OF STD PPP
METB								

ZONE HEIGHT (METERS)	LINE NUMBER ZZ	BALLISTIC WINDS		BALLISTIC AIR	
		DIRECTION (100s MILS) dd	SPEED (KNOTS) FF	TEMPERATURE (% OF STD) TTT	DENSITY (% OF STD) ΔΔΔ
SURFACE	00				
200	01				
500	02				
1000	03				
1500	04				
2000	05				
3000	06				
4000	07				
5000	08				
6000	09				
8000	10				
10000	11				
12000	12				
14000	13				
16000	14				
18000	15				

REMARKS

DELIVERED TO: RECEIVED FROM:	TIME (GMT)	TIME (LST)

MESSAGE NUMBER	DATE
RECORDER	CHECKED

COMPUTER MET MESSAGE IS ENCODED AS FOLLOWS

1. The message is arranged in groups to be conveniently transmitted by radio or teletypewriter.

2. Information data: In the first group, the first five letters denote that the message is a computer message and the digit denotes the Q code of the global octant of the met station. The next group of six digits denotes the location of the met station in degrees and tenths of degrees. When 9 of the Q code is used, the six digits denote the clear or coded location of the met station. The third group digits denotes the day of the month, time of commencement of validity in hours and tenths of hours(Greenwich mean time), and duration of validity in hours from 1 to 8; code figure 9 indicates 12 hours. (Note: US forces will always use 0, since period of validity is not predicted.) The first three digits of the fourth group denote the height of the met station (met datum plane) above sea level in multiples of 10 meters. The succeeding groups of eight digits are zone values, two groups of each line of the message.

3. The following specimen message was transmitted by radio:

```
METCM1    347983    081450    123903
00451025  29310903
01454027  29200892
...........
```

EXPLANTATION:

Group 1	Computer message. Met station located in global octant 1 (N latitude, 90°-180° longitude W.)
Group 2	Center of the area of applicability of the message (station location) is 34°42'N; 98°18'W.
Group 3	8th day of the month. Valid time commences at 1430 hours GMT. Period of validity is not predicted by US units.
Group 4	Met station is 1,230 meters above MSL. The MDP pressure is 903 millibars.
Group 5 & 6	At the surface (line 00), the wind direction is 4,510 mils and the wind speed is 25 knots. The surface temperature is 293.1 K°, and surface pressure is 903 millibars.
Group 7 & 8	For line 01 (0-200 meters), the zone wind direction is 4,540, mils and wind speed is 27 knots. Zone temperature is 292.0 K°, and zone pressure is 892 millibars.

Q Code for Octant of Globe

0 -	North latitude	0 - 90 west longitude
1 -	" "	90 - 180 west "
2 -	" "	180 - 90 east "
3 -	" "	90 - 0 east "
4 -	Not used	
5 -	South latitude	0 - 90 west longitude
6 -	" "	90 - 180 west "
7 -	" "	180 - 90 east "
8 -	" "	90 - 0 east "
9 -	Used when the location of the meteorological station is not indicated by latitude and longitude.	

FALLOUT MESSAGE

For use of this form, see FM 3-09.15; the proponent agency is TRADOC.

IDENTIFICATION	OCTANT	LOCATION		DATE	TIME (GMT)	DURATION (HOURS)	STATION WEIGHT (10s M)
METFM	Q	$L_aL_aL_a$ or xxx	$L_oL_oL_o$ or xxx	YY	GGG	G	hhh
METFM							

ZONE HEIGHT (METERS)	LINE NUMBER ZZ	TRUE WIND		ZONE HEIGHT (METERS)	LINE NUMBER ZZ	TRUE WIND	
		DIRECTION (10s MILS) ddd	SPEED (KNOTS) FFF			DIRECTION (10s MILS) ddd	SPEED (KNOTS) FFF
SURFACE	00			16000	08		
2000	01			18000	09		
4000	02			20000	10		
6000	03			22000	11		
8000	04			24000	12		
10000	05			26000	13		
12000	06			28000	14		
14000	07			30000	15		

REMARKS

RECEIVED FROM:

DELIVERED TO:

DATE AND TIME (GMT)

RECORDER

CHECKER

THE FALLOUT MESSAGE IS ENCODED AS FOLLOWS

1. The fallout MET message is arranged in groups to be conveniently transmitted by radio or teletypewriter.

2. Information data:

- The first five letters denote that the message is a fallout message and the digit denotes the Q code of the global octant of the MET station.
- The next group of six digits denotes the location of the MET station in degrees and tenths of a degree. When a Q code of 9 is used, the six digits denote the clear or coded location of the MET station.
- The third group of digits denotes the day of the month, time of commencement of validity in hours and tenths of an hour (Greenwich Mean Time), and duration of validity in hours from 1 to 8; code figure 9 indicates 12 hours.
- The three digits of the fourth denote the height of the MET station (MET datum plane) above sea level in multiples of 10
- All succeeding groups of eight-digit groups are true zone wind data.

3. The following specimen message was transmitted by radio:

```
METFM1    623465    290200    025
00026015  01030021
02046023
```

EXPLANATION:

Group 1	Fallout message. Met Station located in global octant 1 (N latitude, 90°-180° W longitude).
Group 2	Center of the area of applicability of the message (station location) 62°18'N, 146°30'W.
Group 3	29th day of the month. Valid time commences at 0200 hours GMT. Period of validity is not predicted by US units.
Group 4	Met station is 250 meters above mean sea level.
Group 5	For line 00 (surface), the true wind direction is 0260 mils and wind speed is 15 knots.
Group 6	For line 01 (0-2000 meters), the true wind direction is 0300 mils and the wind speed is 21 knots.
Group 7	For line 02 (2000-4000 meters), the true wind direction is 0460 mils and the wind speed is 23 knots.

Q CODE FOR OCTANT OF GLOBE

0 – North latitude 0 –90 west longitude
1 – North latitude 90 –180 west longitude
2 – North latitude 180 –90 east longitude
3 – North latitude 90 –0 east longitude
4 – Not used
5 – South latitude 0 – 90 west longitude
6 – South latitude 90 – 180 west longitude
7 – South latitude 180 – 90 east longitude
8 – South latitude 90 – 0 east longitude
9 – Used when the location of the meteorological station is not indicated by latitude and longitude.

COMPUTER MET MESSAGE

For use of this form, see FM 3-09.15; the proponent agency is TRADQC

IDENTIFICATION METCM	OCTANT Q	LOCATION $L_aL_aL_a$ or xxx	$L_oL_oL_o$ or xxx	DATE YY	TIME (GMT) $G_oG_oG_o$	DURATION (HOURS) G	STATION HEIGHT (10's M) hhh	MDP PRESSURE MB $P_dP_dP_d$
METCM								

ZONE HEIGHTS METERS	LINE NUMBER ZZ	ZONE VALUES			
		WIND DIRECTION (10s M) ddd	WIND SPEED (KNOTS) FFF	TEMPERATURE (1/10 °K) TTTT	PRESSURE (MILLIBARS) PPPP
SURFACE	00				
200	01				
500	02				
1000	03				
1500	04				
2000	05				
2500	06				
3000	07				
3500	08				
4000	09				
4500	10				
5000	11				
6000	12				
7000	13				
8000	14				
9000	15				
10000	16				
11000	17				
12000	18				
13000	19				
14000	20				
15000	21				
16000	22				
17000	23				
18000	24				
19000	25				
20000	26				

FROM TO	DATE AND TIME (GMT)	DATE AND TIME (LST)
MESSAGE NUMBER	RECORDER	CHECKED

COMPUTER MET MESSAGE IS ENCODED AS FOLLOWS

1. The message is arranged in groups to be conveniently transmitted by radio or teletypewriter.

2. Information data: In the first group, the first five letters denote that the message is a computer message and the digit denotes the Q code of the global octant of the met station. The next group of six digits denotes the location of the met station in degrees and tenths of degrees. When 9 of the Q code is used, the six digits denote the clear or coded location of the met station. The third group digits denotes the day of the month, time of commencement of validity in hours and tenths of hours(Greenwich mean time), and duration of validity in hours from 1 to 8; code figure 9 indicates 12 hours. (Note: US forces will always use 0, since period of validity is not predicted.) The first three digits of the fourth group denote the height of the met station (met datum plane) above sea level in multiples of 10 meters. The succeeding groups of eight digits are zone values, two groups of each line of the message.

3. The following specimen message was transmitted by radio:

METCM1	347983	081450	123903
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01454027	29200892		
....			

EXPLANATION:

Group 1	Computer message. Met station located in global octant 1 (N latitude, 90°-180° longitude W.)
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Group 3	8th day of the month. Valid time commences at 1430 hours GMT. Period of validity is not predicted by US units.
Group 4	Met station is 1,230 meters above MSL. The MDP pressure is 903 millibars.
Group 5 & 6	At the surface (line 00), the wind direction is 4,510 mils and the wind speed is 25 knots. The surface temperature is 293.1 K°, and surface pressure is 903 millibars.
Group 7 & 8	For line 01 (0-200 meters), the zone wind direction is 4,540, mils and wind speed is 27 knots. Zone temperature is 292.0 K°, and zone pressure is 892 millibars.

Q Code for Octant of Globe

0 - North latitude	0 - 90 west longitude	5 - South latitude	0 - 90 west longitude
1 - " "	90 - 180 west "	6 - " "	90 - 180 west "
2 - " "	180 - 90 east "	7 - " "	180 - 90 east "
3 - " "	90 - 0 east "	8 - " "	90 - 0 east "
4 - Not used		9 - Used when the location of the meteorological station is not indicated by latitude and longitude.	

LIMITED SURFACE OBSERVATION

For use of this form, see FM 6-16-2; the proponent agency is TRADOC.

DATE:

	IDENTIFIER	OCTANT O *a*	LATITUDE LaLaLa *b*	LONGITUDE LoLoLo *c*	DATE (GMT) YY *d*	TIME (GMT) GGgg *e*	TOTAL AMOUNT OF CLOUD COVER Na (Table 4-1) *f*	WIND DIRECTION D (Table 4-2) *g*	WIND SPEED F (Table 4-3) *h*	VISIBILITY V (Table4-4) *i*
1	ACTUAL CONDITIONS									
2	SUPRP									

	IDENTIFIER	PRESENT WEATHER w (Table 4-5) *j*	AMPLIFICATION OF PRESENT WEATHER A' (Table 4-6) *k*	STATION HEIGHT HHH *l*	ROAD CONDITIONS R (Table 4-7) *m*	TERRAIN CONDITIONS T (Table 4-8) *n*	STATE OF WATER SURFACE A (Table 4-9) *o*	AIR TEMPERATURE TT *p*	PRESSURE PPPP *q*	WIND DIRECTION dd *r*
3	ACTUAL CONDITIONS									
4	SUPRP									

	IDENTIFIER	WIND SPEED ff *s*	AMOUNT OF LOWEST CLOUD Nh (Table 4-10) *t*	HEIGHT OF LOWEST CLOUD ha (Table 4-11) *u*	INDICATION FOR SURF DATA 99 *v*	AVERAGE HEIGHT OF BREAKERS (Meters) Hs (Table 4-12) *w*	PERIOD OF BREAKERS (Seconds) Ps (Table 4-13) *x*	DIRECTION OF WAVES Dw (Table 4-14) *y*	WIDTH OF SURF ZONE Ws (Table 4-15) *z*
5	ACTUAL CONDITIONS				99				
6	SUPRP				99				

REMARKS:

DA FORM 5033-R, Dec 81

MESSAGE #:	TIME AT TOP OF ZONE				30 GRAM/100 GRAM	MILS/DEGREES
STATION DATA	ZONE HEIGHT METERS	ZONE LINE NUMBER	30 GRAM	100 GRAM	ELEVATION ANGLE	AZIMUTH ANGLE
OCTANT:	SUR	00	0:15	0:10		
LOCATION:	200	01	1:05	0:41		
GMT DATE:	500	02	2:43	1:41		
LST TIME:	1000	03	5:26	3:23		
GMT TIME:	1500	04	8:09	5:05		
HEIGHT (10's M):	2000	05	10:52	6:47		
SURFACE PRESS:	2500	06	13:34	8:28		
DRY TEMP:	3000	07	16:17	10:10		
WET TEMP:	3500	08	19:01	11:52		
DEPRESSION:	4000	09	21:43	13:34		
VIRTUAL TEMP:	4500	10	24:26	15:15		
RELEASE DIST:	5000	11	27:09	16:56		
OFFSET AZIMUTH:	6000	12	32:35	20:19		
EXPENDABLES USED:	7000	13	38:01	23:43		
	8000	14	43:27	27:06		
	TEAM CHIEF:				OPERATOR:	

REMARKS:

ML 373 NOZZLE EQUALS 132 GRAMS

1. TOTAL LIFT REQUIRED FOR 100 GRAM BALLOON IS 515 GRAMS.
2. TOTAL LIFT REQUIRED FOR 30 GRAM BALLOON IS 139 GRAMS.

PIBAL(Worksheet)

FM 3-09.15
25 October 2007

By Order of the Secretary of the Army:

GEORGE W. CASEY, JR.
General, United States Army
Chief of Staff

Official:

JOYCE E. MORROW
Administrative Assistant to the
Secretary of the Army
0727701

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