technical note technical note

DEVELOPMENT OF A GENERIC GMCC SIMULATOR INTERIM REPORT

Todd R. Truitt, Ph.D., ACT-530
Vicki Ahlstrom, M.S., ACT-530

DOT/FAA/CT-TN02/04

November 2001

U.S. Department of Transportation
Federal Aviation Administration

William J. Hughes Technical Center
Atlantic City International Airport, NJ 08405

NOTICE

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof. The United States Government does not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the objective of this report. This document does not constitute FAA certification policy.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN02/04		

4. Title and Subtitle	5. Report Date
Development of a Generic GMCC Simulator Interim Report	November 2001
	6. Performing Organization Code ACT-530
7. Author(s) Todd R. Truitt, Ph.D. and Vicki Ahlstrom, M.S.	8. Performing Organization Report No. DOT/FAA/CT-TN02/04
9. Performing Organization Name and Address Federal Aviation Administration William J. Hughes Technical Center Atlantic City International Airport, NJ 08405	10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Federal Aviation Administration Office of the Chief Scientific and Technical Advisor for Human Factors 800 Independence Ave., S.W. Washington, DC 20591	13. Type of Report and Period Covered Technical Report 14. Sponsoring Agency Code AAR-100

15. Supplementary Notes

16. Abstract

This document describes the development and current status of a high fidelity, human-in-the-loop simulator for Airway Facilities Maintenance Control Centers and Operations Control Centers. Applications include Event Manager, Maintenance Automation System Software, and a weather display. The simulator, based on existing airspace used in Air Traffic Control simulations, is self-contained and generic in nature. We discuss the advantages and uses for such a simulator and present maps, standard operating procedures, and scenarios.

17. Key Words	18. Distribution Statement
Airway Facilities Human-in-the-Loop Simulation Maintenance Control Center Operational Control Center	This report is approved for public release and is on file at the William J. Hughes Technical Center, Atlantic City International Airport, New Jersey 08405. This document is available to the public through the National Technical Information Service, Springfield, Virginia, 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	51	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Table of Contents

LIST OF ILLUSTRATIONS

EXECUTIVE SUMMARY

The National Plan for Civil Aviation Human Factors identifies human performance assessment as a necessary consideration in order to achieve the expected level of National Airspace System (NAS) safety. Airway Facilities (AF) is an integral part of the NAS. The goal of the current project is to develop a means to improve our understanding of human performance in AF. In particular, the project addresses the goals set forth by developing a high fidelity, human-in-the-loop simulator to examine human performance in Maintenance Control Centers (MCCs) and Operations Control Centers (OCCs).

Human Factors Specialists from the NAS Human Factors Branch (ACT-530) of the William J. Hughes Technical Center are developing the simulator as a generic, self-contained system. It will be able to be used as a platform for scientific research in human factors, testing and validation of behavioral and performance measures, and as a potential training mechanism within the AF domain. The simulator encompasses Event Manager, Maintenance Automation System Software, and a weather display. The simulator also includes associated databases, maps, and standard operating procedures. The generic nature of the simulator allows for increased experimental control of research and extended applicability of results. Because the system is self-contained, it can be set up and used at any desired location.

Similar research has been conducted in the realm of Air Traffic Control. However, such a simulator for use in the AF domain has never been built, and the finished product would be one-of-a kind. For the first time, human factors researchers will have a realistic platform to conduct a systematic program of study regarding human performance capabilities and limitations in the MCC/OCC environment.

This document provides an overview of the system components that comprise the simulator and their current development status. We propose various performance and behavioral measures and present potential uses of the simulator.

1. Introduction

Human performance assessment is one of the five major research thrusts identified in the National Plan for Civil Aviation Human Factors. These thrusts are considered necessary to achieve expectations for National Airspace System (NAS) safety and productivity. Human performance assessment transcends domain and organizational boundaries and is as important to the Airway Facilities (AF) domain as it is to the Air Traffic Control (ATC) domain. The goal behind this thrust is to improve the understanding of human performance capabilities and limitations and to develop measurement techniques.

In the realm of ATC research, human performance has been measured using computerized high fidelity simulations. These human-in-the-loop simulations have been used successfully to study the impact of numerous proposed changes such as dynamic resectorization, shared separation, and the use of new automation tools. The prior ATC research serves as a foundation for the growth of research in AF, promoting a better understanding of performance capabilities and limitations of AF system specialists.

1.1 Background

Current research in ATC uses a generic airspace in order to generalize simulation results. There are several advantages to using a generic domain in both ATC and AF research. Most importantly, the generic domain provides a set of standardized and controlled conditions. Controlled conditions are important to be able to apply the results of our experiments to the AF domain in general. It is difficult to extrapolate findings and recommendations from an experiment that focuses on operations and procedures at a particular facility.

A generic domain allows researchers to control or even eliminate the unwanted effects of confounding variables that are associated with real General National Airspace System Maintenance Control Centers (GMCCs). Real GMCCs vary in many ways. Idiosyncrasies associated with GMCCs such as the number and type of facilities, type and size of geography, weather, and procedures all can be considered as confounding variables or factors that may affect the results of an experiment.

Another potential confounding variable is the amount of experience specialists have with a GMCC domain. More experienced specialists may possess knowledge that provide them with workload, performance, or situation awareness advantages. A generic GMCC domain ensures that all specialists acting as participants in an experiment have the same level of experience with the domain. The generic domain may reduce specialists' ability to use knowledge or strategies particular to their domain, but the results of a realistic simulation can be generalized to the GMCC population at large with greater confidence (the specialists are still experts, even in a generic environment). The generic domain eliminates effects of facility-specific experience by providing a new, easy-to-learn domain that becomes equally familiar to all participants. Furthermore, using a generic domain provides a larger population from which to draw participants.

1.2 Purpose

The primary goal of the current project is to develop a generic GMCC simulator. This document provides a high-level summary of the simulator components and its development to date.

Human Factors Specialists from the NAS Human Factors Branch (ACT-530) of the William J. Hughes Technical Center are developing the simulator so that its operation is completely

contained within the Research Development and Human Factors Laboratory (RDHFL). Such a self-contained simulator will allow complete experimental control of simulation activity without sacrificing usefulness or flexibility. Experimental control will also be bolstered by the generic nature of the simulator. A simulator contained within the RDHFL will eliminate the need for large, expensive equipment such as the Tandem Maintenance Processor System (MPS) that is currently used in the field. It will also eliminate the need to rely on outside personnel in order to run the simulations. Furthermore, a self-contained simulator would be portable and could be implemented at any location desired.

2. Simulator Components Description

The simulator components are representative of GMCCs nationwide. The main components include software applications, a generic domain, and associated materials. Subcomponents comprise each of the main components. Software applications used in the simulator are the Event Manager (EM), Maintenance and Automation System Software (MASS), and a weather display. Figure 1 shows a photo of the participant workstation. The generic domain also includes two maps and a standard operating procedure (SOP). Other materials associated with the generic domain include databases to populate the EM, MASS, and numerous scenarios.

Figure 1. GMCC simulator participant specialist workstation (showing the weather display, EM, and MASS from left to right).

2.1 Software Applications

Both the EM and MASS applications will obtain data from a Microsoft® Structured Query Language (SQL) server located in the RDHFL. However, each application will obtain and record data using a separate database.

2.1.1 Event Manager

GMCC Specialists use the EM software application to schedule, track, and coordinate all events of concern. The EM processes events such as unscheduled outages, preventative maintenance, radio frequency interference, aircraft accidents and incidents, and flight checks. It is also linked to the Maintenance Management System (MMS) that provides record keeping and national reporting capabilities.

We are constructing the GMCC simulator to emulate the capabilities of both EM (Version 1.3.0.0) and the associated MMS. The design of the EM will emulate field operations as realistically as possible. Therefore, EM will be fully functional with only a few exceptions. EM contains numerous functions but only the primary ones will be mentioned in this document. EM comprises six main pages: Events Display, Interruption Entry Form, Event Coordination Form, Coordination Info, Facility Info, and Phone Book Sheet. All of the pages rely on one or more databases. The Databases section of this document discusses databases used by EM. We describe the primary functions of each of the pages in turn.

The Events Display page shows a list of each event that is entered into EM. For each event, the information identifies the facility name, facility type, start and end date and time of the event, status, log interrupt report (LIR) category and condition, reporting level, a brief summary, and the group assigned to perform the event. The Events Display can be sorted and filtered as needed. The Events Display page also allows the user to set refresh and alarm latencies. The refresh function determines how often the Events Display updates to reflect any new events that are created or any updates to existing events. The alarm function alerts the user whenever a scheduled event is about to occur but final coordination has not been performed.

Users can create or update an existing event ticket by using the Interruption Entry Form. Users can specify information such as the facility of concern, event information (e.g., MMS LIR code category, start and end date and time, event impact, and event status), assign a specialist to the event, and record written information about the event. Users can also send an electronic page to the assigned specialist as a means of communication about a specific event.

Users enter the Event Coordination Form to assist them in performing event coordination and to record information about the coordination. Once the user provides a facility identification and type, the Event Coordination Form will present the appropriate points of coordination and telephone numbers to the user. The user can indicate if it is an initial, final, or return to service coordination. They can also record the initials of the person with whom they coordinated and the time the coordination was performed for each point of coordination. The user can call each point of coordination by clicking on the telephone number provided.

Users enter the Coordination Info page to establish new services and points of coordination for each facility. The user may create both outage coordination points and general coordination points. Once created, the coordination points and their telephone numbers appear in the Event Coordination Form.

The Facility Info Form provides two important functions. First, it provides a database for facility-specific comments. Users can edit and search this database, as needed. Second, it provides a facility relationship table. Users can gain information from this table to learn what facilities are related. This is a very important function because users can take note of redundant and backup facilities and services that should not be taken out of service while the primary

system is out of service. The Facility Info page also provides buttons to obtain street map and weather information near a specified facility. The weather and map functions are not available in the simulator because they rely on real, as opposed to generic, locations.

The Phone Book Sheet provides a list of points of contact and technicians. The Phone Book Sheet provides primary and alternate phone numbers (when available) for each listing. Users can sort the data by point of contact name or by point of contact type (e.g., flight service station, power company, and air traffic control tower). Users can also search the data by service name or by technician last name to help locate needed information.

In addition to the EM application, support contractors at the RDHFL have developed "event recorder" software code that can be integrated with the EM software code. Once integrated, the event recorder will allow researchers to measure the frequency and duration of participant interaction with the EM and its various components. The event recorder will also provide summary information that is amenable for data analysis.

The EM software will also measure communication activity. Participants will make and receive calls using a telephone communications system. The participant will click on the phone number to be dialed and a message will appear on a remote computer monitor being watched by a Subject Matter Expert (SME). The message will notify the SME of whom the participant is calling. The SME, simulating points of contact, will then answer the phone as the appropriate person being called. A telephone line will be opened to allow voice communication. Participants will also be able to send text page messages to the SME using the EM. The SME and experimenter will also place calls to the participant using this communications system. The communication system software will collect data regarding the number of calls made, how long it took the participant to answer each call, and the duration of each call.

2.1.2 Maintenance and Automation System Software

AF Specialists use the MASS application to remotely monitor and control facilities and subsystems that are integrated into the FAA Remote Maintenance Monitoring System (RMMS). The MASS displays alarms, alerts, and status changes of subsystems. Using MASS, a specialist can acknowledge alarms and alerts and monitor subsystem status, configuration, performance, and environmental data. A specialist can also use MASS to remotely adjust subsystem states and diagnose subsystem problems. Subsystem states can be viewed and remote commands can be issued to alter those states. The simulated version of MASS is being constructed so that scenario scripts can be implemented to simulate data being sent and received from remote facilities. Scenario scripts will contain time-based events that result in changes to the MASS database, thereby simulating changes to a facility that result in alarms, alerts, or status changes.

The MASS application is somewhat more complicated than EM both in terms of operation and simulation because it accepts real-time data from remotely monitored facilities. Data are sent to the MASS from an MPS. Third party, proprietary software lies in between the MPS and the MASS application for data translation. MASS is also more difficult to simulate because participants must be able to send commands from the MASS to the simulated field sites where affected changes occur.

2.1.3 Weather Display

Weather can adversely affect the operation of AF and hinder the ability of field technicians to perform preventative maintenance and repairs. One might expect that AF Specialists would use

weather information to inform them when to take preventative measures and to make decisions about dispatching field technicians in severe conditions. However, it is not clear how AF Specialists actually use weather information. The experiment, using the simulator under development, will incorporate weather into some of the scenarios to gain a better understanding of how weather may affect AF Specialist performance. Weather can also constitute area-specific knowledge that may allow a specialist to take more effective and timely steps to avoid or repair an outage.

Researchers will create a display to examine the specialists' use of weather information. It will be similar in appearance to the current Weather and Radar Processor application. The display will provide past and current (i.e., trend) information about weather affecting the generic domain. A "looping" display of simulated weather superimposed over a map of the GMCC domain will provide weather trend information.

2.2 Generic Domain

After consultation with an SME, we developed the generic GMCC domain to contain elements that are typical of a GMCC. One may think of the generic domain as a prototypical GMCC in that it represents many GMCCs in general and none in particular. Researchers based the generic domain on existing generic airspace (see Appendix A) that has been in use at the RDHFL for several years in ATC simulations (Guttman & Stein, 1997; Guttman, Stein, & Gromelski, 1995). The generic AF domain (see Appendix B) used identical geographical boundaries. Researchers made some modifications to the existing airspace to increase realism for the AF Specialists who will serve as participants. For example, we changed three-letter identifiers for long-range radars to begin with the letter "Q" and correspond with the nearest airport or facility (e.g., radar near CAL airport is QCA). We maintained radar locations from the original airspace. We added facilities such as Flight Service Stations (FSSs), an Air Route Traffic Control Center (ARTCC), and navigational aids that did not exist in the airspace.

The generic ATC and the generic GMCC domain simulations are similar in many ways. Both rely on scripts to run real-time scenarios. Simulation personnel such as pilots or ATC or AF technicians act as points of contact. Communication is an essential part of both tasks. An AF simulation differs from an ATC simulation in that telephones replace radio transmissions. AF Specialists use the telephone to contact numerous personnel in widespread geographical locations. The AF environment demands the construction of well-populated databases containing facility and callback information and a highly functional telephone system. We developed materials, procedures, and performance measures particularly for use in the generic GMCC simulator, as described in the following subsections.

2.2.1 Maps

We developed two maps for the GMCC domain. The primary map (Appendix B) depicts locations of airports or ATC towers, FSSs, radars, navigational aids, and an ARTCC. The second map depicts the locations of primary and backup communications sites and frequencies. Appendix C shows the communication sites map.

2.2.2 Standard Operating Procedure

We developed an SOP in consultation with an SME (see Appendix D). We based it on drafts of the Operating Procedures in the NIM Environment. We designed the SOP to be as short as

possible while including all of the essential procedures. The SOP will help ensure that participants follow the same basic procedures during the experiment.

2.3 Materials

We developed the materials specifically for the pending experiment regarding situation awareness in the GMCC environment (Truitt & Ahlstrom, 2000). However, these materials can be modified or reused for other experiments, simulations, or training. We will develop additional materials as research progresses.

2.3.1 Databases

Both EM and MASS require three databases to operate. The databases contain all facility, equipment, and callback information for the generic domain. All databases reside on a Microsoft® SQL server located in the RDHFL and can be modified as necessary.

2.3.2 Scenarios

SMEs wrote seven scenarios to focus on two areas of technical expertise. Four scenarios concern radar systems and three concern Instrument Landing Systems (ILSs). Each scenario is about 1-hour long and focuses on one problem in particular. Scenarios also contain secondary tasks to ensure realism and maintain taskload. SMEs wrote the scenarios based on their personal experience and training as AF Specialists. Participants' responses to questionnaire items regarding the realism of the simulation will provide feedback on each scenario. Appendix E shows seven scripted scenarios. Each scenario contains four columns of information. The first column indicates the time that an event will occur. Times are based on scenario time with each scenario beginning at time zero (i.e., 00:00: zero hours, zero minutes). The second column describes events that occur external to the GMCC. External events are executed either by the AF simulator software or by the SME. The third column indicates likely actions that the participant will take. Participant actions are expected to vary and so the associated times and activities are only hypothetical. How a participant responds to any given external event may affect subsequent events. The fourth column indicates how or where an activity will take place. For example, activities may occur via the telephone, MASS, EM, and so on.

3. Metrics and Experimental Approach Using the Simulator

Currently, there are no established methods for measuring participant behavior, workload, task performance, or situation awareness in AF simulations. The development of a GMCC simulator allows researchers to develop valid and reliable measures that can be used to examine current and future maintenance concepts. The current project begins the development process by implementing numerous measures in a high-fidelity simulation. Table 1 shows a list of candidate measures sorted by type.

Researchers will measure taskload several ways based on the number of actions that are performed during a given period. A count of the number of incoming and outgoing telephone calls will provide an estimate of taskload. We will also measure taskload by recording participant interaction with the EM and MASS via integrated event recorder software. The number of alarms and alerts that participants receive via MASS will also serve as an indication of taskload.

TABLE 1. CANDIDATE METRICS

	Subjective	Objective	Performance	Taskload	Workload	Situation Awareness
SME Rating	X		X			X
Time to contact field technician		X	X			
Time to rectify MASS alarm		X	X			
Time to rectify MASS alert		X	X			
No. of telephone calls made		X		X		
No. of telephone calls received		X		X		
No. of MASS alarms		X		X		
No. of MASS alerts		X		X		
Duration of telephone calls made		X		X		
Duration of telephone calls received		X		X		
ATWIT rating	X				X	
Post-scenario questionnaire	X		X		X	X
Time to answer incoming telephone calls		X			X	
Situation Present Assessment Method		X				X
Time to acknowledge MASS alarm		X	X			X
Time to acknowledge MASS alert		X	X			X

Subjective ratings of workload will complement objective taskload measures. Participants will provide measures of workload during and after each scenario. During each scenario, participants will respond to the Air Traffic Workload Input Technique (ATWIT) to provide a subjective measure of workload (Stein, 1985). The ATWIT is a touch panel display that prompts participants for a categorical workload rating at a fixed time interval. Participants will also estimate workload by responding to a Likert-type questionnaire at the end of each scenario.

Researchers will measure performance using a number of objective metrics. We will record performance metrics automatically by event recorder software embedded in the EM and MASS applications. We will record and analyze time-based measures such as mean time to acknowledge an alarm or alert, mean time to call a technician, and mean time to complete an event ticket.

An SME will complete subjective performance ratings to provide additional performance data. They can also record errors, which are indicators of degraded performance because SMEs are the most likely person to notice when an error occurs. Error analysis can be used to further examine maintenance concepts and performance limitations.

Although there is no direct relationship between performance and situation awareness, some performance measures can also be considered as secondary indicators of situation awareness. For example, the time it takes a participant to acknowledge an alarm or alert may predict situation awareness. We can use a more direct measure of situation awareness, as well. We will use the Situation Present Assessment Method (SPAM) to collect an objective measure of situation awareness (Durso et al., 1998; Willems & Truitt, 1999). The SPAM operates by posing yoked queries and then measuring response time to those queries. Queries will focus on present visual data, present conceptual data, and likely future occurrences. We will develop all queries with the assistance of an SME to ensure that items refer to information and relationships that are relevant to simulated events. Participants will also provide subjective ratings of their situation awareness after each scenario. We will then consider all of these objective, subjective, and secondary measures.

We will gain information regarding the usefulness, reliability, and validity of these measures as they are implemented. We can identify the "best" measures or modify measures for use in the AF environment. An understanding of the measures will emerge as they are used over a number of studies. The GMCC simulator provides a means through which researchers can develop and test these measures over time.

4. Simulator Components Status

4.1 Software Applications

4.1.1 Event Manager

The EM application, including MMS, is operational within the RDHFL. We have integrated the event recorder software. An SME will conduct complete tests of the event recorder and EM. We have developed the communication system and are awaiting an SME evaluation.

4.1.2 Maintenance and Automation System Software

In order to realistically simulate the MASS, we have essentially simulated the MPS and all necessary intermediary processes. The MASS application is functional within the self-contained RDHFL environment. To date, MASS has been completely severed from the MPS connection. An SQL server, located in the RDHFL, has replaced the MPS. The SQL server has been programmed to simulate the necessary functions of the MPS. Additional MPS functions will be simulated on the SQL server as needed pending SME input. Currently, the MASS will perform initialization procedures upon start up and will also import all available data from the SQL server. We are able to create and store MASS scenarios on the SQL server and then run them as simulation scripts. The scripts trigger time-based events in MASS such as changes to facility parameter that result in alarms and alerts. We are currently in the process of fully developing scripts for each scenario. The MASS can also send remote commands to a facility. We have implemented only a limited subset of remote commands to date. We need SME assistance to decide which commands will have to be fully developed and to determine how each command affects the facility subsystem screens. Because there are hundreds of commands that could be issued for each particular type of facility, we will only implement those commands that would be used based on our existing scenarios. We will develop additional commands as needed to implement future scenarios.

4.1.3 Weather Display

We are currently developing the weather display using Macromedia® (1997) and custom software. We are capturing snapshots of actual weather patterns from the Internet. We have developed custom software to extract only the weather information by removing any background information such as geography and text from these snapshots. We then use Macromedia® software to superimpose the extracted weather patterns on a map of the GMCC domain for each scenario, as appropriate.

4.2 Generic Domain

4.2.1 Maps

Map development is complete. Two SMEs have reviewed and modified both maps as necessary.

4.2.2 Standard Operating Procedure

We have completed the SOP development. Two SMEs have reviewed and approved the SOP as shown in Appendix D.

4.3 Materials

4.3.1 Databases

We have populated the EM databases with the exception of parts of the callback data. The callback data associates field technicians to each facility in the generic domain. We created these databases by transforming copies of real databases into generic data. We still need an SME to verify the realism of the databases as they are used in EM. We have acquired the necessary MASS databases. We still need to modify the MASS databases to reflect the generic information and facilities that are represented in the EM databases.

4.3.2 Scenarios

We have completed all radar scenarios and three of the four ILS scenarios. An SME is currently writing the final ILS scenario. Appendix E shows the completed scenarios.

5. Conclusion

To our knowledge, neither measures of subjective workload nor situation awareness have been collected in the GMCC domain. Performance and taskload measures are also scarce or have not been used. Furthermore, a fully functional GMCC simulator does not exist. Once the simulator is functional, research scientists can examine and develop behavioral measures for use with the simulator. They can validate measures in the simulator and identify reliable measures for use in subsequent experiments. The simulator would be useful for various programs of research including developing and testing operational concepts and procedures, training for current procedures, error analysis, and simulating future concepts such as an Operations Control Center (OCC).

Connecting multiple operator stations to the SQL server would allow the simulation of OCC operations. Connected operator stations would share data from the same source while filtering information on individual displays, as necessary. Researchers could examine concepts of communication, teamwork, and distributed decision making in such a multi-operator simulation. Understanding how specialists behave while using the simulator could be extended into the real world through the development of training programs. Single or multiple workstations could

serve as training devices to teach specialists new functions or tools for upgraded software applications.

The GMCC simulator could be effective as a training device because it is portable and customizable. The simulator does not require the use of an expensive and sometimes distant MPS. All operations can be controlled on a local SQL server containing the proper databases and scripts.

Overall, the GMCC simulator will provide a flexible platform that researchers can use to examine AF concepts and procedures in a controlled environment. The development of a standardized, easy-to-learn generic domain enables results to be generalized beyond the scope of the simulation. Uses for the simulator can also be extended beyond simulation and into the realm of training. The self-contained nature of the simulator allows the system to be set up anywhere for training or simulation purposes.

ACRONYMS

AF	Airway Facilities
ARTCC	Air Route Traffic Control Center
ATC	Air Traffic Control
ATWIT	Air Traffic Workload Input Technique
EM	Event Manager
FSS	Flight Service Stations
GMCC	General National Airspace System Maintenance Control Centers
ILS	Instrument Landing Systems
LIR	Log Interrupt Report
MASS	Maintenance and Automation System Software
MCC	Maintenance Control Centers
MMS	Maintenance Management System
MPS	Maintenance Processor System
NAS	National Airspace System
OCC	Operations Control Centers
RDHFL	Research Development and Human Factors Laboratory
RMMS	Remote Maintenance Monitoring System
SME	Subject Matter Expert
SOP	Standard Operating Procedure
SPAM	Situation Present Assessment Method
SQL	Structured Query Language

REFERENCES

Durso, F. T., Hackworth, C. A., Truitt, T. R., Crutchfield, J. M., Nikolic, D., & Manning, C. A. (1998). Situation awareness as a predictor of performance for en route air traffic controllers. *Air Traffic Control Quarterly, 6,* 1-20.

Guttman, J. A., & Stein, E. (1997). *En route generic airspace evaluation* (DOT/FAA/CT-TN97/7). Atlantic City International Airport, NJ: DOT/FAA William J. Hughes FAA Technical Center.

Guttman, J. A., Stein, E., & Gromelski, S. (1995). *The influence of generic airspace on air traffic controller performance* (DOT/FAA/CT-TN95/38). Atlantic City International Airport, NJ: DOT/Federal Aviation Administration Technical Center.

Macromedia® Director 6 [Computer software]. (1997). San Francisco, CA: Macromedia, Inc.

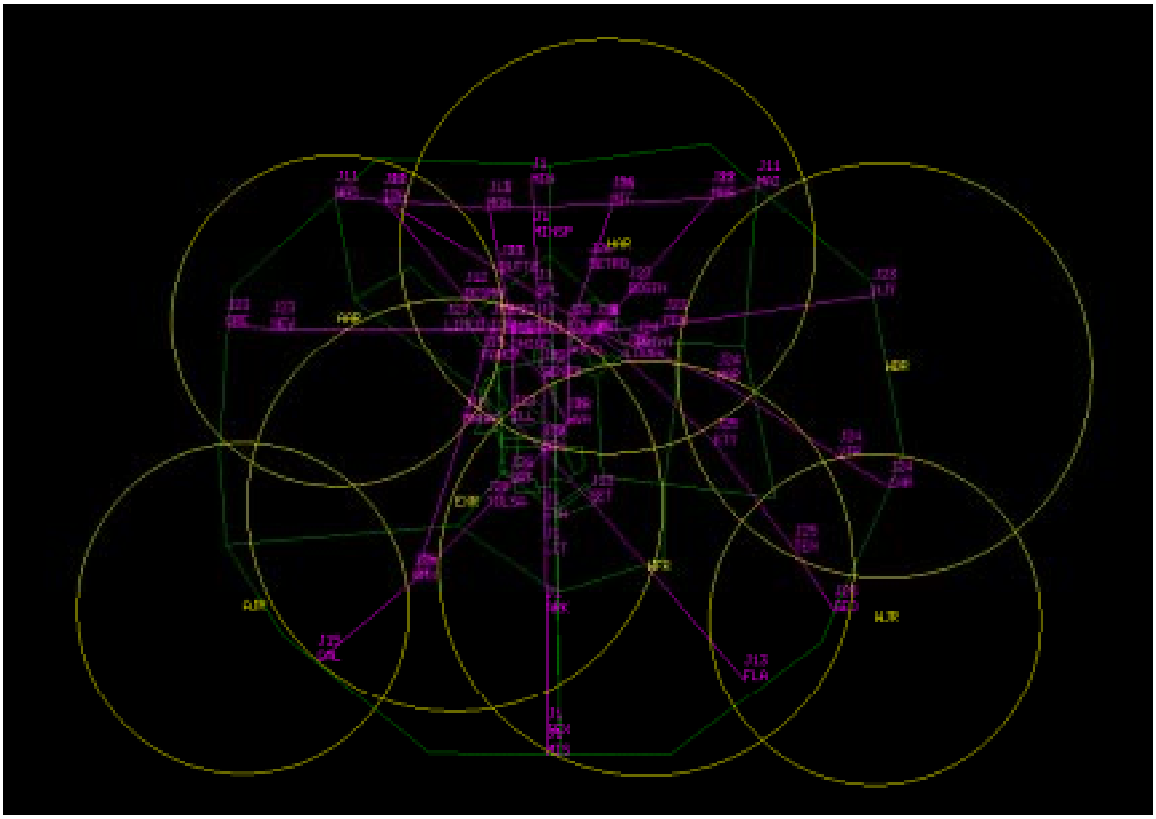
Stein, E. S. (1985). *Air traffic controller workload: An examination of workload probe* (DOT/FAA/CT-TN84/24). Atlantic City International Airport, NJ: U. S. Department of Transportation, Federal Aviation Administration Technical Center.

Truitt, T. R., & Ahlstrom, V. (2000). *Situation awareness in Airway Facilities: Replacement of maintenance control centers with operations control centers* (DOT/FAA/CT-TN00/09). Atlantic City International Airport, NJ: DOT/FAA William J. Hughes Technical Center.

Willems, B., & Truitt, T. R. (1999). *Implications of reduced involvement in en route air traffic control* (DOT/FAA/CT-TN99/22). Atlantic City International Airport, NJ: DOT/FAA William J. Hughes Technical Center.

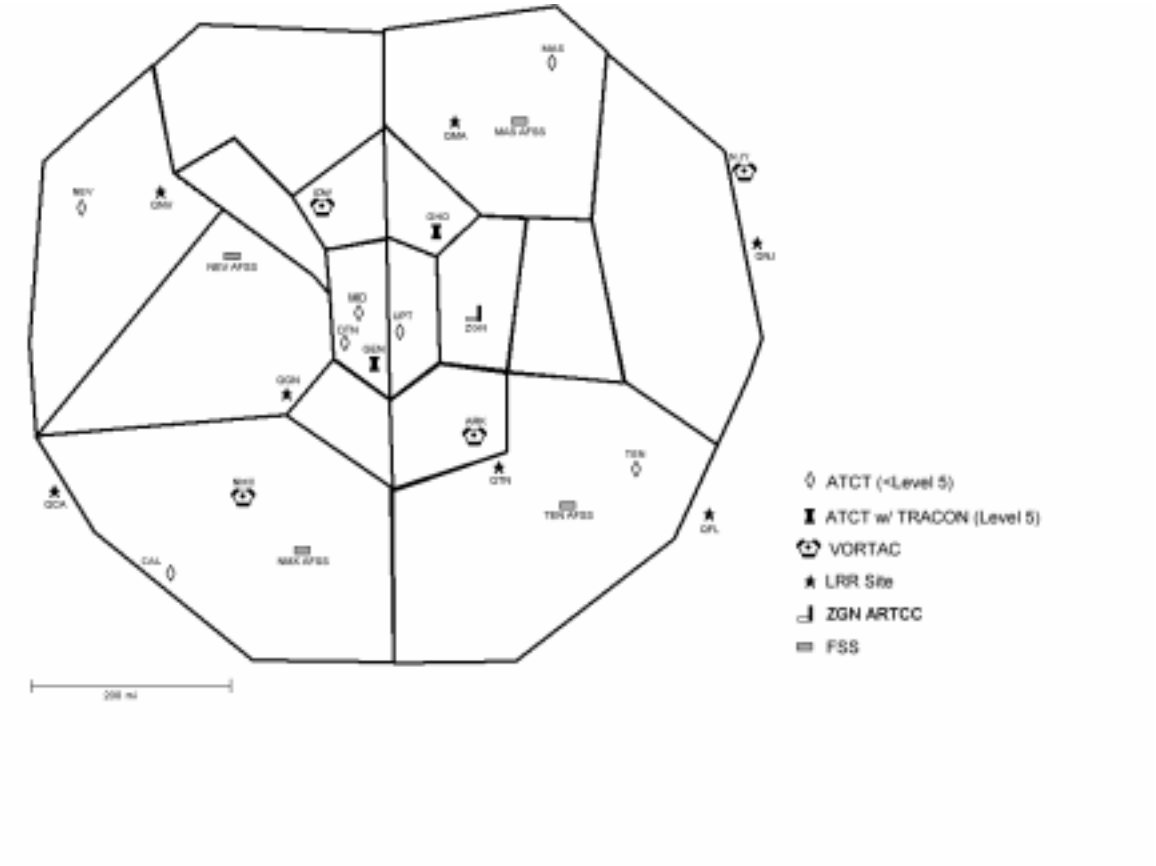
Appendix A

Generic Airspace Used at the RDHFL



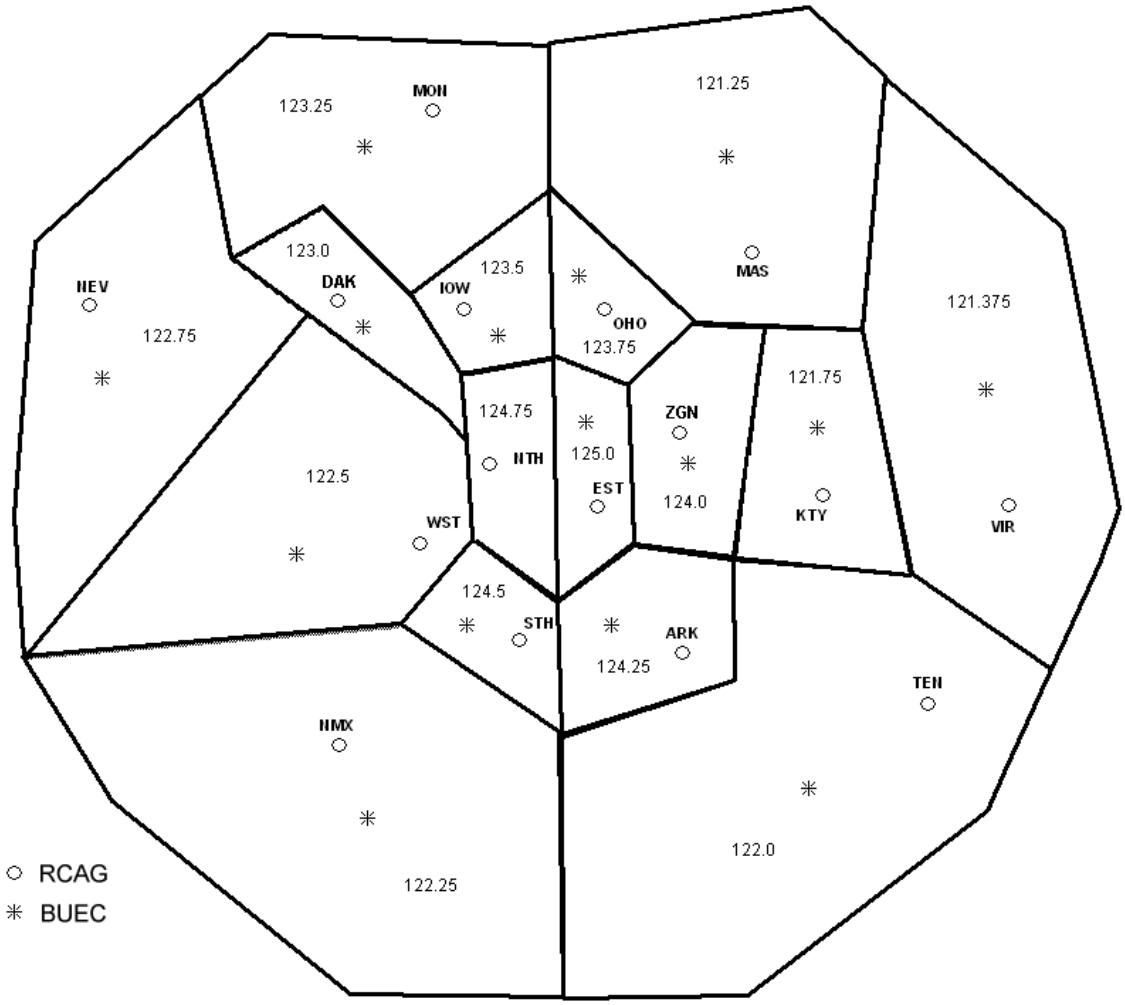
Appendix B

GMCC Domain Map



Appendix C

Primary and Backup Communication Sites Map



Appendix D

GMCC Standard Operating Procedures

Standard Operating Procedures for the Generic Maintenance Control Center (GMCC)

Key Roles and Responsibilities:

- Serve as the single point of contact for SER(s), notification, coordination and providing information and status to the NOCC, Ros, other GMCCs, SOCs, SMOs, and SSCs/WCs.
- Serve as the single point of contact for facility restoration.
- Prioritize AF's response to unscheduled events.
- Track all events in the Event Manager (EM) that impact services/systems/equipment.
- Request NOTAM initiation upon notification of system/service degradation.
- Track and request cancellation of NOTAMs issued by the GMCC.
- Assist SOC/SSC/WC Specialists in obtaining needed resources (*e.g.*, special test equipment, parts).
- Create, update, and close all LIR(s).
- Use available RMM features/procedures to determine cause of alarm condition and initiate necessary remote equipment resets.
- Coordinate with AT in assessing the impact of an unscheduled event for equipment and services.

Unscheduled Events

1. Notify and Assess Event

1.0 The GMCC Specialist shall be responsible for opening a new *Interruption Entry Form* in the *EM* upon notification of an event.

1.1 The GMCC Specialist, with the proper RMM equipment training, shall execute initial reset/mitigation for systems with RMM control capability. If the service is restored via RMM, the GMCC Specialist shall be responsible for clicking the "RMM Save" checkmark and documenting the action taken within the EM Interruption Entry Form, Comments field.

1.2 The GMCC Specialist shall be responsible for documenting equipment status in the *EM, Interruption Entry Form, Comments field.* Also, the GMCC Specialist shall enter a brief description in the *EM, Interruption Entry Form, Summary field.*

1.3 The GMCC Specialist shall be responsible for completing the *EM, Interruption Entry Form, Event Info* section prior to creating an LIR.

1.4 The GMCC Specialist shall be responsible for accessing MMS to create an LIR by selecting the "create" button in the *EM, Interruption Entry Form, LIR Operations* section.

1.5 The GMCC Specialist shall be responsible for obtaining impact and potential delays from local AT.

2. Coordinate Dispatch

2.1 The GMCC Specialist shall be responsible for notifying organizations as listed in the *EM, Outage Event Coordination Form.* The GMCC Specialist may also contact organizations listed on the *EM, Coordination Info Form, General Coordination Points* field, as needed.

2.2 The GMCC Specialist shall be responsible for documenting all information in the *EM, Interruption Entry Form Comments Field.*

3. Track and Document Event Status

3.0 The GMCC Specialist shall be responsible for tracking and documenting event status within their area of responsibility. All event status shall be tracked in the *EM, Interruption Entry Form, Comments* field.

3.0.1 The GMCC Specialist shall be responsible for notifying AT, NOCC, SOC/SSC/WCs, and other organizations as listed in the *EM, Outage Event Coordination Form.*

3.0.2 The GMCC Specialist shall be responsible for upward reporting to the NOCC all events that are causing, or have the potential for causing air traffic delays. Any impact on operational services provided to AT facilities or the flying public shall be reported as soon as possible after initial awareness.

3.0.3 The GMCC Specialist shall be responsible for documenting initials and time of all contacts made in the *EM, Interruption Entry Form, Comments* field.

4. Request Initiation/Update NOTAM Information

4.0 The GMCC Specialist shall be responsible for performing procedures associated with requesting the initiation or update of equipment NOTAMs within their domain.

5. Coordinate Return to Service Activities

5.0 Upon restoration of the system/equipment, the GMCC Specialist shall coordinate/confirm user acceptance. Upon user acceptance, the GMCC Specialist shall complete the following procedures.

5.0.1 After verifying event accuracy with SSC/WC Specialist, complete, validate, and close the LIR in the *EM, Interruption Entry Form, Event Info Field* and *LIR Operations* sections (include end date, time, comments, and change Event Status to “returned”).

5.0.2 Notify SSC/WC Specialist, if applicable.

5.0.3 Inform other organizations as listed in the *EM Event Coordination Form*.

Scheduled Events

1. Assess/Coordinate Scheduled Event

1.2 The GMCC Specialist shall be responsible for conducting initial assessment and coordination of scheduled events.

1.1.1. The GMCC Specialist shall be responsible for creating a new *Interruption Entry Form* in the *EM* upon notification of an event.

1.1.2. The GMCC Specialist shall be responsible for reviewing coordination and notification data in the *EM, Event Coordination Form.*

1.3 The affected GMCC Specialist shall be responsible for contacting other GMCCs and the SOC in the domain when equipment/service(s) are shared through mutual boundaries within their domain.

1.3.1 If the reportable equipment and services are in the GMCC's area of responsibility, the GMCC Specialist shall be responsible for creating an event ticket and LIR for each.

1.3.2 If the service(s) is only in the GMCC's area of responsibility, the GMCC Specialist shall be responsible for creating an event ticket and LIR(s) for each affected service in their area of responsibility.

2. Complete Initial Coordination Activities

2.1 The GMCC Specialist shall be responsible for coordinating initial release with organizations identified on the *EM, Outage Event Coordination Form,* for events within their domain.

2.1.1 The GMCC Specialist shall be responsible for identifying possible conflicts that may impact the release for a scheduled event. Conflicts identified shall be noted in the *EM, Interruption Entry Form, Comments field.*

2.1.2 The GMCC Specialist shall be responsible for issuing event notification to the NOCC, if applicable.

2.1.2.1 If applicable, the GMCC Specialist shall identify as "*National Reporting Level*" on the *EM, Interruption Entry Form, Reports section.*

2.2 The GMCC Specialist shall be responsible for contacting, on an as-needed basis, other organizations identified in the *EM, Coordination Info Form, General Coordination Points section,* to obtain initial approval/concurrence (*e.g.* sheriff, fire dept., telco, etc).

2.3 The GMCC Specialist shall be responsible for coordinating alternate times when conflicts exist pertaining to the initial request.

3. Request Initiation/Update NOTAM Information

3.0 The GMCC Specialist shall be responsible for performing procedures associated with requesting the initiation or update of equipment NOTAMs within their domain.

4. Final Assessment/Release Coordination

4.1 The GMCC Specialist shall be responsible for conducting final event assessment and coordination.

4.2 The GMCC Specialist shall utilize the risk management process by obtaining weather, traffic flows, special events, adjacent facility status, and unscheduled event information from available sources. This should be done to determine whether current conditions would preclude final approval to release.

4.3 The GMCC Specialist shall be responsible for contacting impacted organizations to obtain final release for the scheduled events contained in the *EM, Event Coordination Form*.

5. Accomplish Event

5.1 The GMCC Specialist shall be responsible for completing the *EM, Interruption Entry Form, Event Info section*, prior to creating an LIR after receiving a final approval from all organizations contained within the *EM, Event Coordination Form*.

5.2 The GMCC Specialist shall be responsible for accessing MMS to create an LIR by selecting the "create" button in the *EM, Interruption Entry Form, LIR Operations section*.

5.2.1 The GMCC Specialist shall be responsible for verifying MMS information on the LIR screen prior to adding the LIR.

5.2.2 The GMCC Specialist shall be responsible for documenting information received from SSC/WC Specialist on the *EM, Interruption Entry Form, Comments field, Events Status field*.

6. Coordinate Return to Service Activities

6.1 Upon restoration of the system/equipment, the GMCC Specialist shall coordinate/confirm user and/or customer acceptance. Upon user and/or customer acceptance, the GMCC Specialist shall complete the following procedures:

6.1.1 Complete, validate, and close the LIR in the *EM, Interruption Entry Form, Event Info* and *LIR Operations sections,* after verifying event accuracy with the SSC/WC Specialist. This should include end date/time, comments, and the Event Status being changed to "*returned*".

6.1.2 Coordinate return of equipment/service into the NAS.

6.1.2.1 Request cancellation of NOTAM and place initials/date obtained from the AFSS in the *EM, Interruption Entry Form, NOTAM section, Canceled field,* if applicable.

6.1.2.2 Inform other organizations as listed in the *EM, Event Coordination Form*.

6.1.2.3 The GMCC Specialist shall be responsible for contacting the NOCC when return-to-service activities are completed.

6.1.2.4 Ensure the LIR is closed properly by using the "*closed*" button in the *EM, Event Entry Form, LIR section*.

6.2 The GMCC Specialist shall be responsible for logging and validating all information concerning the event, from event notification through return to service. The GMCC Specialist shall be responsible for verifying all entries associated with each event prior to closing.

6.3 The GMCC Specialist shall be responsible for closing a scheduled event after verification of completion of all activities in the *EM, Interruption Entry Form, Event Info section,* by changing the Event Status to "*closed*".

Appendix E

GMCC Scenarios

Radar Scenario #1

ASR-9 Failure – Technical-Specific Problem

Scenario info:

1. QGN LRR is operational
2. The ZGN ARTCC Host is operational and GEN CENRAP Triggers on
3. The GEN ARTS switches to CENRAP operation

Time	External to the GMCC	GMCC	Technology/Info
00:00	GEN ASR-9 fails: GEN ATC observes loss of radar and beacon data on displays.	Monitoring all facilities. MASS shows loss of radar and beacon at GEN.	MASS
00:01	GEN ATC calls GMCC.	Acknowledge MASS alarm. Receive call from GEN ATC. From monitoring, the GMCC knows the ZGN Host and QGN LRR are operational. Ask the GEN ARTS to switch to CENRAP operation.	MASS Telephone
00:03	ZGN ARTCC gets call from GMCC.	Call ZGN ARTCC and ask for GEN CENRAP Trigger to be turned on.	Telephone
00:04	GEN ARTS gets call from GMCC.	Call GEN ARTS to determine if CENRAP is operational and if there are any delays or other impacts.	Telephone
00:05	GEN AF gets call from GMCC.	Call GEN AF to insure they are aware of the problem and get preliminary restoration estimate. Open event ticket for GEN ASR-9.	Telephone EM
00:07		Open LIR on GEN ASR-9.	EM MMS

Time	External to the GMCC	GMCC	Technology/Info
00:10		Upward report GEN ASR-9 failure according to Event Manager (EM). Enter coordination.	EM
00:15	ATC from OHO departure control reports interference on freq 123.75.	Receive call from OHO ATC. Open event ticket for RFI.	Telephone EM
00:16	OHO AF gets call from GMCC.	Call OHO AF and asks them to investigate interference on freq 123.75.	
00:17	NOCC calls GMCC to request info on GEN ASR-9 failure.	Receive call from NOCC. Provide requested info from EM.	Telephone EM
00:18	MID ATCT calls GMCC to advise that the VASI (West side) for rwy 18 is OTS.	Receive call from MID ATCT.	Telephone
00:19		Open event ticket for MID rwy 18 VASI.	EM
00:20	Specialist at GEN ASR-9 calls GMCC to advise outage due to commercial power interruption. EG went to overcrank condition. Commercial power is now stable, EG is in bypass search and beacons are certified. Request RTS and Environmental Tech for EG restoral.	Receive call from Specialist at GEN ASR-9.	Telephone
00:25	GEN ARTS gets call from GMCC.	Update event ticket for GEN ASR-9. Call GEN ARTS to advise GEN ASR-9 RTS.	EM Telephone
00:27	ZGN ARTCC gets call from GMCC.	Call ZGN ARTCC to request CENRAP Triggers be turned off. Close LIR for GEN ASR-9.	Telephone MMS
00:30	No Environmental Tech on site – callout required.	Initiate callout for Environmental Tech to GEN ASR-9.	EM, Work Force Mgr., Telephone, Pager
00:35	No MID Environmental Tech on site – callout required.	Initiate callout for MID VASI rwy 18 Environmental Tech.	Work Force Mgr., Telephone, Pager

Time	External to the GMCC	GMCC	Technology/Info
00:37	NOCC gets call from GMCC.	Call NOCC to upward report GEN ASR-9 RTS.	Telephone, EM/MMS
00:40	OHO AF calls GMCC to advise that no problem was found with OHO transmitters or receivers. Interference appears to be external.	Receive call from OHO AF.	Telephone
00:41		Update event ticket for OHO RFI.	EM
00:42	RO Frequency Management gets call from GMCC.	Call RO Frequency Management to advise of problem at OHO.	Telephone EM
00:45	Environmental Tech for GEN ASR-9 calls GMCC to advise he is enroute to site.	Receive call from Environmental Tech. Update event ticket for GEN ASR-9.	Telephone EM
00:49	Environmental Tech for the MID VASI calls GMCC to advise he is enroute to site.	Receive call from Environmental Tech. Update event ticket for MID VASI.	Telephone EM
00:50	RO Frequency Management calls GMCC to advise RFI is result of a welding crew working on a tower next to the RTR. The welding is complete. Interference should be gone.	Receive call from RO Frequency Management. Update event ticket for OHO RFI.	Telephone EM
	OHO AF gets call from GMCC.	Call OHO AF to advise that RFI problem has been resolved and corrected.	Telephone
	OHO AT gets call from GMCC.	Call OHO AT to advise of resolution to RFI problem. Ask for radio check. If good, RTS. Close event ticket for OHO RFI.	Telephone EM
00:55	Environmental Tech for GEN ASR-9 calls GMCC to advise he is on site.	Receive call from Environmental Tech. Update event ticket for GEN ASR-9.	Telephone EM

Time	External to the GMCC	GMCC	Technology/Info
00:58	Environmental Tech for MID VASI calls GMCC to advise he is on site.	Receive call from Environmental Tech. Update event ticket for MID VASI.	Telephone EM

Radar Scenario #2

Radar Reflections – Area-Specific Problem

Area-Specific Database:

Trailers parked close to the QNV radar site cause reflections.

Time	External to the GMCC	GMCC	Technology/Info
00:00	Air Traffic (AT) from ZGN ARTCC calls GMCC to report false targets north of the QNV radar site (no outage).	Receive call from ZGN AT. Open event ticket.	Telephone EM
00:02	QNV gets call from GMCC.	The GMCC knows this reflection problem was most likely caused by parking trailers too close to the site. Call QNV radar to investigate.	Telephone, EM Facility Info database
00:05	TEN calls GMCC to report ILS RWY 27 is RTS after a scheduled shutdown.	Receive call from TEN. Update EM for TEN ILS.	Telephone EM
00:07	ZGN and TEN AFSS get a call from GMCC.	Complete appropriate coordination, close NOTAM, close LIR, and close TEN ILS event ticket.	Telephone, EM/MMS
00:10	NMX AFSS calls GMCC to report loss of monitoring capability for the NMX VORTAC.	Receive call from NMX AFSS regarding NMX VORTAC.	Phone
00:11		Observe loss of comm. to the NMX VORTAC.	MASS
00:12		Open event ticket on NMX VORTAC monitoring.	EM
00:14	ZGN ARTCC gets a call from GMCC.	Call ZGN to request an aircraft check on the NMX VORTAC.	Telephone
00:15		Update event ticket on NMX VORTAC.	EM

Time	External to the GMCC	GMCC	Technology/Info
00:16	QNV radar supervisor calls the GMCC to report that several trailers have been parked ½ mile west of the radar. AT wants the problem resolved but wants to continue using the site. QNV SSC supervisor takes responsibility to move trailers or modify BFTC masks to cover the problem.	Receive call from QNV radar supervisor. Update event ticket on QNV radar.	Telephone EM
00:17	ZGN AT calls GMCC to report aircraft check on NMX VORTAC was ok.	Receive call from ZGN AT. Update event ticket on NMX VORTAC.	Telephone EM
00:20	ZGN Comm gets call from GMCC.	Contact ZGN Comm unit to request check on end-to-end (phone lines, modems, tandem) for monitoring of the NMX VORTAC. Update event ticket.	Telephone EM
00:22	IOW VORTAC Tech calls GMCC to inform RTS after scheduled maintenance.	Receives call from IOW VORTAC Tech.	Telephone
00:23	ZGN & NEV AFSS get call from GMCC.	Call ZGN & NEV AFSS to complete appropriate coordination, close NOTAM, close LIR, close event ticket for IOW VORTAC.	Telephone, EM/MMS
00:25	QNV Supervisor calls GMCC to inform he was able to get the trailers moved to an area that shouldn't interfere with the QNV radar.	Receive call from QNV supervisor. Update event ticket on QNV radar.	Telephone EM
00:27	ZGN AT gets call from GMCC.	Call ZGN AT to request check of QNV radar for reflections. Update EM.	Telephone EM
00:30	ZGN Comm calls GMCC to inform they were unable to loop the line from ZGN to NMX. Referred to telco ticket # 1213000296.	Receive call from ZGN Comm and update EM accordingly.	Telephone EM

Time	External to the GMCC	GMCC	Technology/Info
00:34	DTN ATCT calls GMCC to report no heat in the tower cab. No Envrion Tech on site.	Receives call from DTN ATCT and initiates callout according to facility mgr listing. Opens event ticket.	Telephone EM
00:36		Contacts specialist at home and instructs to respond to DTN ATCT heating problem.	Telephone
00:40	Specialist en route to DTN ATCT.	Update EM to show specialist en route to DTN ATCT.	EM
00:42	ZGN Comm calls GMCC to inform telco was able to reset the circuit for monitoring of the NMX VORTAC.	Observe the NMX RMM monitors return to normal.	Telephone MASS
00:45	NMX AFSS & ZGN AT get call from GMCC.	Contact NMX AFSS & ZGN ARTCC for RTS of NMX VORTAC and close of NOTAM. Close event ticket for NMX VORTAC.	Telephone EM
00:48	ZGN ARTCC calls GMCC to advise that there is no longer a problem with reflections at the QNV radar	Receive call from ZGN ARTCC regarding QNV radar status.	Telephone
00:50	QNV radar gets call from GMCC.	Advise specialists at QNV radar that moving the trailers appears to have solved the reflection problem. Close event ticket for QNV radar.	Telephone EM
00:50	Environ Tech arrives at DTN ATCT and calls GMCC to advise of finding a burned out heater coil. Tech knows part is available at the MID ATCT and leaves to get the part.	Receives call from Environ Tech at DTN ATCT.	Telephone
00:53		Update event ticket for DTN ATCT status.	EM
00:59	Environ Tech at DTN ATCT calls GMCC to inform heater coil was retrieved from MID ATCT and placed in DTN ATCT, RTS.	Receives call from Environ Tech at DTN ATCT. Update EM.	Telephone EM

Radar Scenario #3

Mode C Altitudes Off by up to 1000’ – Technical-Specific Problem

Note: This scenario includes the effects of weather.

Time	External to the GMCC	GMCC	Technology/Info
00:00	OHO ATCT calls GMCC to advise that a severe storm just passed through. Gusting winds broke tie downs on several aircraft. One aircraft rolled across the field and is resting on the ILS antenna.	Receive call from OHO ATCT. Open event ticket for OHO ILS.	Telephone EM
00:02	OHO Airport Mgr gets call from GMCC. Airport Mgr advises he is inspecting the field for damage. His first priority will be to move the aircraft away from the ILS antenna.	Call OHO Airport Mgr for status report on ILS. Update event ticket for OHO ILS.	Telephone EM
00:05	OHO SSC gets call from GMCC. OHO SSC Supervisor advises he will meet with the OHO Airport Mgr to inspect damage to OHO Rwy 36R localizer antenna. Also advises Rwy 36R is not in use and should be NOTAMed OTS until inspection and certification is completed (if required).	Call OHO SSC Supervisor for status report on ILS. Update event ticket for OHO ILS.	Telephone EM
00:07	PEN AFSS gets call from GMCC.	Call PEN AFSS to initiate NOTAM for OHO Rwy 36R localizer – 36R ILS OTS UFA.	Telephone
	NOCC gets call from GMCC.	Call NOCC (and other upward-reporting contacts) due to possible significant impact on a level-5 facility. Update event ticket for OHO ILS.	Telephone EM
00:10	NJY VORTAC calls GMCC to advise that due to heavy wx NJY VORTAC will not shut down for PMs, cancel request.	Receive call from NJY VORTAC regarding cancellation of PMs.	Telephone

Time	External to the GMCC	GMCC	Technology/Info
00:10	All coordination points get call from GMCC.	Contact all Air Traffic POCs according to EM. Close event ticket (NOTAM was closed by adjacent MCC).	Telephone EM
00:16	ZGN ARTCC calls GMCC to report that enroute aircraft below FL180 are indicating Mode-C altimeter readings are off by as much as 1000'.	Receive call from ZGN. Open event ticket.	Telephone EM
00:20	TMU from ZGN ARTCC calls GMCC to advise they have placed altitude restrictions on aircraft in the affected area (in trail and reroutes). No delays so far.	Receive call from ZGN TMU. Update event ticket. Page appropriate contacts for upward reporting.	Telephone EM Paging system
00:25	ZGN Flight Data get call from GMCC.	Call ZGN Flight Data to report problem may be due to a rapidly falling altimeter following the frontal passage. Request check of current altimeter compared to the hourly updated altimeter for the closest mandatory reporting station. Update altimeter as required.	Telephone
00:28	OHO ILS specialist calls GMCC to request a 30-min shutdown of rwy 36R/18L for further inspection and testing to restore rwy 36R localizer.	Receive call from OHO ILS specialist.	Telephone
00:30	PEN AFSS, OHO AT, and ZGN AT get call from GMCC.	Call POCs to coordinate requested shutdown of OHO rwy 36R. NOTAM rwy 36R OTS. Update event ticket for OHO ILS.	Telephone EM
00:33	OHO ILS specialist gets call from GMCC.	Call OHO ILS specialist to report rwy 36R/18L has been approved for shutdown 0045-0115Z. Update event ticket for OHO ILS.	Telephone EM
00:35	OHO ATCT calls GMCC to report water dripping from tower cab.	Receive call from OHO ATCT. Open event ticket for OHO ATCT.	Telephone EM

Time	External to the GMCC	GMCC	Technology/Info
00:38	OHO SSC gets call from GMCC. OHO SSC advises GMCC that all specialists are busy restoring the ILS and other weather related problems. A specialist will be redirected to the OHO ATCT after restoration activities are completed on rwy 36R localizer.	GMCC calls OHO SSC regarding OHO ATCT leaking tower cab and receives information. Update event ticket on OHO ATCT in accordance with information received. Advise OHO AT regarding latest information.	Telephone EM Telephone
00:40	ZGN AT calls GMCC to report that following updating altimeter inputs, Mode C altitude reporting returned to normal – all enroute and reroute restrictions removed.	Receive call from ZGN AT. Close event ticket. Complete all upward reporting.	Telephone EM Telephone or EM?
00:45	OHO ILS Specialist calls GMCC to get final approval to enter rwy 36R/18L for ILS restoration. At this time the Environmental Specialist has completed his work on the ILS.	Receive call from OHO ILS Specialist. Update event ticket.	Telephone EM
00:50	OHO ILS Specialist calls GMCC to report he has completed visual checks and measurements, cleared the rwy and returned rwy 36R localizer to service.	Receive call from OHO ILS Specialist. Redirect Environmental Specialist to the OHO ATCT water drip.	Telephone MASS indicates RTS for OHO rwy 36R ILS
00:55	OHO/ZGN AT, PEN AFSS, Page all AF, and NOCC are contacted by GMCC.	Make all appropriate contacts for OHO ILS RTS, close LIR, close NOTAM for rwy and localizer, close event ticket.	Telephone/Pager EM

Radar Scenario #4

Excessive Search Targets – Area-Specific Problem

Time	External to the GMCC	GMCC	Technology/Info
00:00	QNV LRR malfunctions.	Acknowledge MASS alarm indicating half-scan inhibit at QNV. Open event ticket for QNV.	MASS EM
00:02	ZGN gets call from GMCC. Confirms that there are excessive search targets within 100nm of QNV and targets have dropped out twice for 10 seconds on each occurrence.	Call ZGN to validate MASS alarm for QNV.	Telephone
00:04		Determines that the problem at QNV is recurring and due to heavy A.P. The site is set up with one channel better adapted to handle A.P. Perform remote switch of CD channels. Update event ticket for QNV.	MASS MASS EM
00:05	ZGN AT calls GMCC to advise that QNV display is better – no more lost targets but requests further improvements.	Receive call from ZGN AT. Switch from STC 1 to STC 2 via RMM. Update event ticket for QNV.	Telephone MASS EM
00:07	Specialist on site at NMX VORTAC calls GMCC to report failure of a blower motor. Requests shutdown of NMX VORTAC for 1.5 hrs to perform corrective maintenance.	Receive call from Specialist at NMX VORTAC and open event ticket.	Telephone EM
00:10	ZGN AT gets call from GMCC.	Call ZGN AT to coordinate shutdown of the NMX VORTAC.	Telephone
00:12	NMX AFSS gets call from GMCC.	Call NMX AFSS to request NOTAM for the NMX VORTAC.	Telephone

Time	External to the GMCC	GMCC	Technology/Info
00:15	NMX VORTAC gets call from GMCC.	Call NMX VORTAC to report shutdown is approved. Open LIR and update event ticket.	Telephone EM
00:16	USAF ELT Center calls GMCC to report and ELT signal in the vicinity of the DTN airport.	Receive call from USAF ELT Center. Open event ticket.	Telephone EM
00:17	DTN AF gets call from GMCC.	Calls DTN AF to request if their personnel trained in ELT detection will investigate the reported signal. Update event ticket.	Telephone EM
00:22	Specialist at NMX VORTAC calls GMCC to report he found faulty power supply (PS-9) possibly due to overheating. May require and extension. Enroute to SSC for parts.	Receive call from Specialist at NMX VORTAC. Update event ticket.	Telephone EM
00:25	Specialist at DTN ATCT calls GMCC to advise the talked to the FBO. An instructor with student made a "hard" landing that set off the ELT. The ELT was reset.	Receive call from Specialist at DTN ATCT.	Telephone
00:26	USAF ELT Center gets call from GMCC.	Advise USAF ELT Center of resolution. Close event ticket.	Telephone EM
00:27	ZGN AT calls GMCC to report QNV search count is now at an acceptable level.	Receive call from ZGN AT. Relay message to Radar Tech. Close event ticket for QNV.	Telephone EM
00:30	NMX WC calls GMCC to report Specialist for NMX VORTAC is still enroute to the WC for parts and requests a 30min extension of the outage to 02:15 Z.	Receive call from NMX WC. Update event ticket for NMX VORTAC.	Telephone EM
00:35	ZGN gets call from GMCC. NMX AFSS gets call from GMCC.	Call ZGN to request 30 min extension of NMX VORTAC shutdown. Call NMX AFSS for extension of NMX VORTAC NOTAM.	Telephone Telephone

Time	External to the GMCC	GMCC	Technology/Info
00:40	Specialist at NMX VORTAC gets call from GMCC.	Call Specialist at NMX VORTAC to report extension of shutdown is approved. Update event ticket.	Telephone EM
00:41	Specialist at TEN ATCT calls GMCC to request shutdown of the TEN LOM from 0045Z to 0115Z.	Receive call from Specialist at TEN ATCT. Open event ticket for TEN LOM.	Telephone EM
00:42	ZGN gets call from GMCC.	Call ZGN to request approval for shutdown of TEN LOM.	Telephone
00:43	Specialist at TEN ATCT gets call from GMCC.	Call Specialist at TEN ATCT to report that approval for shutdown was approved. Update event ticket.	Telephone EM
00:44	NMX VORTAC calls GMCC to report Specialist is back on site with required parts and will begin the restoration.	Receive call from NMX VORTAC. Update event ticket.	Telephone EM

ILS Scenario #1

Localizer failure – Technical-specific problem

1. VFR Day.
2. OHO 4R primary operational ILS runway.
3. 4R Localizer fails during operational use.
4. GMCC located at OHO.

Time	External Source	GMCC	Technology/Info
00:00	OHO--4R LOC fails. A/C report lost of signal.	Monitoring all RMMed facilities. MASS indicating OHO Loc monitor in alarm.	MASS
00:01	OHO ATCT calls GMCC	Receive call from OHO ATCT. Pireps indicating Loc is ots.	Telephone
00:01	OHO TRACON (ATC) calls GMCC to ask about Loc status.	Acknowledge MASS alarm & attempt remote reset. Review system parameters screens and determine where the probable cause of the fault interruption occurred.	MASS
00:02	OHO ATCT gets call from GMCC	Call OHO ATCT to update. Loc will not reset remotely via MASS. Via monitoring, the GMCC knows the failure is due to a sharp width alarm of .105 DDM, well below the normal level. Check pwr levels as possible cause; levels normal, as is modulation level. Problem maybe in the recombining unit or in the distribution unit at the array. Loc cannot be used under this condition. Tech will have to be dispatched to site.	Telephone MASS
00:08	OHO ATCT gets call from GMCC	Informs OHO ATCT of Loc status and remove system from service. Inquiry of impact to ATC Operations. (None @ this time).	Telephone
00:09	AF receives call from GMCC.	Call OHO Nav to investigate equipment failure and start restoration efforts. Open Event Ticket for OHO Loc.	FM transceiver EM
00:10	FSS receive call from GMCC	Call FSS and issue Notam on Loc.	Telephone

Time	External Source	GMCC	Technology/Info
00:11		Check OHO ATIS for local Notam.	Select ATIS use Telephone
00:12		Open LIR on OHO Localizer.	MMS via EM
00:13		Upward report OHO LOC failure according to National and Local requirements.	EM Telephone
00:17	UPT ATCT reports lost of BRITE video presentation at LC-1.	Receive call from UPT ATC. Local Control (LC)-1 lost Brite video presentation.	Telephone
00:18	OHO AF ARTS gets call from GMCC.	Call OHO AF ARTS to assume control of UPT LC-1 BRITE and determine fault location. Open event ticket.	Telephone EM
00:22	UPT AF gets call from GMCC.	Call UPT AF and advised them of BRITE's status and that OHO ARTS has taken local control of system to determine location of equipment malfunction. Transfer UPT AF specialist to ARTS specialist.	Telephone
00:23	NOCC calls GMCC for an update on OHO LOC.	Receive call from NOCC and provide requested info from EM.	Telephone EM
00:28	OHO ATCT calls GMCC to advise that visibility is dropping and OHO Loc will be needed.	Receive call from OHO ATCT. ATCT advises Loc may impact operations with the changing wx. Update ticket.	Telephone EM
00:33	Weather monitor reviewed by GMCC.	Check wx forecast and determine estimated time of area wx change. Discuss with ATCT.	WX Monitor Telephone
00:35	OHO AF receive call from GMCC.	Call OHO Nav specialist for estimated RTS time. Update ticket.	Telephone EM
00:37	OHO ARTS specialist calls GMCC.	Receive call from OHO ARTS spec's. UPT BRITE has a bad PS&J box. Site specialist will R&R box. Update event ticket.	Telephone EM
00:40	OHO ATC contacted by GMCC.	Update ATC supervisor on OHO Loc estimated RTS time.	Telephone
00:42	OHO ATC request for Arts specialist at position.	GMCC specialist present at departure position -12. Beacon targets are coasting in NE quadrant.	Telephone

Time	External Source	GMCC	Technology/Info
00:45		Have Arts specialist monitor other positions for same occurrences. Currently operating on channel-b of mode-s.	EM Compliant form
00:46		Check accuracy of compliant form and submit for local AOS review.	Telephone Drop box
00:48	UPT ATCT calls GMCC	Receive call from UPT system specialist; DBrite RTS.	Telephone
00:49		Update UPT ATCT on Brite status.	Telephone
00:50		Update event ticket and close LIR.	EM MMS
00:51	OHO Nav specialist calls GMCC.	Receive call from OHO Nav that OHO 4R Loc RTS. Tech advises that the lightning protection circuit at the DU had a shorted diode component. The width detector was also found to be malfunction. No spare diode ckt on hand, but width detector was R&R.	Telephone
00:52		Advise Specialist to bypass diode ckt in order to restore normal monitoring functions, and place diodes on order.	Telephone
00:53		Update EM and close out LIR.	EM/MMS
00:54		Update OHO ATC.	Telephone
00:55		Contacts FSS and cancel notam on Loc outage.	Telephone
00:56		Verify current ATIS report	Dial up or use transceiver
00:59		Upward report status of OHO Localizer.	Telephone
01:00		Advise NOCC of OHO Loc status and cause of malfunction.	Telephone

ILS Scenario #2

Outer marker failure – Area-specific problem

1. IFR
2. Freezing rain.
3. NEV-09 primary operational runway.
4. GMCC located at OHO.

Time	External Source	GMCC	Technology/Info
00:00	NEV rwy 09 LOM and outer maker fail.	Monitoring all facilities. MASS showing loss of both systems. No RMM for LOM.	MASS
00:01		Review subsystem performance parameters and attempt RMM remote reset on outer marker. Allow marker to cycle through normal automatic resets functions (3 total).	MASS
00:06	NEV ATCT calls GMCC.	Acknowledge MASS alarm. Receive call from NEV ATCT. From monitoring GMCC knows the outer marker has a high vswr level and an exec monitor alarm. Suspect OM monitor antenna and LOM antenna may have iced up. Increasing output power on the LOM can sometime melt the ice. Marker restoration may require site visit if it doesn't auto reset.	MASS Telephone
00:08	NEV AFSS gets call from GMCC.	Call NEV AFSS and issues a notam on outer marker.	Telephone
00:09		Dials up NEV ATIS to check for local notam on marker & LOM.	Telephone
00:10	NEV Nav gets call from GMCC.	Call NEV Nav and request Tech investigate outage. Outer marker has not reset after three auto resets.	Telephone
00:11		Open separate event ticket and LIR for each component.	EM MMS
00:12	Anonymous person calls GMCC.	Receive anonymous call of bomb in NEV ATCT facility.	Telephone

Time	External Source	GMCC	Technology/Info
00:14		Contact Telco to start trace. Attempt to gather info on the bomb and person(s) making the call. Get attention of someone else to assist.	Telephone
00:17	Emergency departments get call from GMCC.	Contact emergency departments for dispatch. Police, fire, FBI, FAA Security.	Telephone
00:19	NEV ATCT gets call from GMCC.	Call NEV ATCT to advise of the bomb threat.	Telephone
00:21		Advise AF personnel assigned NEV ATCT's workload to stand clear of tower.	2 way comm/Telephone
00:22		Verify all AF personnel accounted for and that ATC has accounted for all of their personnel after tower evacuation.	FM radio Telephone
00:23		Advise adjacent GMCC and/or AMCC facility is being evacuated.	Telephone
00:24		Upward report bomb threat.	Telephone
00:26		Open event ticket and LAD on bomb threat.	EM MMS
00:29		Start Significant event report (SER) on NEV tower evacuation.	Admin pc
00:30	NEV AF calls GMCC to advise that one to two inches of ice had built up on monitor ant, and on LOM single wire ant. OM & LOM RTS at this time.	Receive call from NEV AF Nav tech. Update event ticket/close LIR's.	EM MMS
00:31		Verify LOM power level has been return to normal by site tech.	MASS
00:32	NEV AFSS gets call from GMCC.	Call NEV AFSS to cancel notam on outer marker.	Telephone
00:35	NOCC calls GMCC for update on NEV tower evacuation.	Receive call from NOCC. Advise NOCC personnel are still out of the building, awaiting bomb squad clearance.	Telephone
00:37		Update local/Regional Management on NEV ATCT status.	Pager

Time	External Source	GMCC	Technology/Info
00:40	OHO ATC experiences power bump. lights flicker.	Call environmental specialist to determine power source (E/G or commercial).	Telephone
00:41	OHO environmental spec's gets call from GMCC. Spec's advises GMCC facility is on backup power.	Call power company for info on power interruption. Lost primary feeder to ATCT. Secondary feeder online. Repair of primary will take about one hour.	Telephone
00:43		Upward report power interruption at OHO ATCT.	Telephone
00:44	NEV ATCT calls GMCC to advise no bomb found in facility, given clearance to reenter the facility.	Receive call from NEV ATCT.	Telephone
00:45		Broadcast message via fm xceiver to AF personnel. Threat suspended, tower reopen.	FM Xceiver
00:46		Upward report NEV ATCT status.	Telephone Pager
00:47		Close out MMS LAD and update event mgr.	MMS EM
00:49	NEV ATCT gets call from GMCC.	Advise NEV ATCT that NEV outer marker was RTS @ 00:30.	Telephone
00:50		Notice MASS indication of rwy 4 Localizer failure. View subsys monitor for possible cause(s). From MASS monitor GMCC knows loc has ant fault and misalign alarms. Acknowledge alarms.	MASS
00:51	OHO ATCT calls GMCC. A/C landing rwy 4 slide off the end of the rwy and damaged the LOC ant array.	Receive call from OHO ATCT. A/C ran off end of rwy 4. Rwy closed.	Telephone
00:52	NOCC calls GMCC about the A/C incident at OHO.	Receive call from NOCC. Advise NOCC of possible damage to FAA equipment, and other info relating to incident.	Telephone
00:56		Upward report A/C incident	Telephone

Time	External Source	GMCC	Technology/Info
00:58	OHO Nav gets call from GMCC.	Advise Nav of possible antenna array damage.	Telephone
00:59		Open event ticket and MMS LAD, and LIR on 4R Loc.	EM MMS
01:00		Complete first version of bomb threat SER.	Admin PC
01:15	OHO Nav spec's calls GMCC.	Receive call from OHO Nav. Two elements of the array are damage. Starting restoration efforts.	Telephone
01:16	Power company calls GMCC	Receive call from power co. Primary feeder restored and they need to switch back to primary feeder.	Telephone
01:17		Upward report Nav spec's findings on 4R ant damage.	Telephone Pager
01:19		Update event ticket	EM
01:21	470 Operations calls GMCC.	Receive call from 470 Ops. Need version one of the bomb threat SER. Submit same.	Telephone

ILS Scenario #3

Erratic localizer signal – Area-specific problem

Database info:

1. TEN ATCT landing 9's and 4's
2. WX clear and dry.
3. Area specific knowledge is located at time 00:30

Time	External Source	GMCC	Technology/Info
00:00	TEN ATCT receive Pireps indicating erratic Loc signal at 5 miles out from touchdown zone.	Reviewing MASS and other systems monitors for alarms and/or abnormal indications.	MASS
00:01	TEN ATCT calls GMCC to report Pirep reports.	Receive call from TEN ATCT. Pilots reporting the 4R LOC signal is erratic. Check system status via MASS and review parameters screen for any fluctuation of readings. Perform a global status or status check to refresh the monitor screen time stamp to ensure current data is being displayed.	Telephone EM
00:02		Determine via TEN ATCT if all arriving aircraft are experiencing this occurrence.	Telephone
00:03	TEN AF receive call from GMCC.	Call TEN AF to request tech investigate erratic indication reports.	Telephone
00:05	TEN AF ESU calls GMCC.	Receive call from TEN ESU Tech. Tech reports runway 22 VASI ots Due to damage of the upwind box.	FM xceiver Telephone
00:06		Open event ticket on VASI outage. Upward report to SOC/SSCM Mgr's.	EM Pager
00:08		Issue Notam via flight service station at TEN AFSS.	Heli Line (2 digit direct dial)
00:10		Call TEN ATCT and determine what impact they are experiencing without the services of the VASI.	Telephone

Time	External Source	GMCC	Technology/Info
00:12	TEN AF Nav Tech calls GMCC.	Received call from TEN Nav Tech. Tech reviewed all system parameters, and found no system readings abnormal. Line entry completed on system parameters.	Telephone
00:13		Call TEN ATCT and determine if the A/C are still experiencing the erratic Localizer signal. Elevate problem to SSCM.	Telephone
00:15	Nav unit SSCM called by GMCC.	Call Nav unit SSCM and advise no problems were discovered by the site tech. Further investigation may be required.	Telephone
00:17		Conference site tech into call with Nav's SSCM. Question tech on bird activity around the antenna array. Request tech monitor aircraft and determine if they are taxing off near the array or exiting at the high speed taxiway. If aircraft's are taxing to the very end of the runway, the erratic signal could possibly be due to reflections as the aircraft turns off in front of the array. If aircraft are turning parallel to the array at a close proximity reflections or scoffing are occurring due to objects in the signal path (aircraft). The next approaching aircraft on final would see this as a momentary lost of signal. Advise ATCT that aircraft exiting rwy 4R at the approach end of 22L may be the cause of the erratic signal, they should ensure aircraft are exiting the runway at the high speed taxiway or greater separation on final may be required. Verify with the next three to four aircraft.	Telephone

Time	External Source	GMCC	Technology/Info
00:22	TEN ATCT receive call from GMCC.	Call TEN ATCT and verify if there are any additional erratic indication of 4R Loc signal. If not, advise SOCM/SSCM and update event ticket. If A/C are now using the highspeed turn off and the erratic condition still exist, perform the following: Advised ATCT that the Loc signal is unreliable and the system is no longer usable. Notam system ots with local AFSS station. Open a new event on the Loc as an unscheduled event. Contact both the Tracon and Tower ATC to determine what if any impact this will create. Upward report the problem. Complete LIR as required by order 6000.48A.	Telephone
00:27	TEN AFSS calls GMCC.	Receive call from TEN AFSS. AFSS has lost all monitoring of the ARK VORTAC. Pilot reports (Pireps) indicate VORTAC is operational. GMCC attempt to log on to VORTAC via MASS. Loss of communication indicated, GMCC unable to access FCPU.	Telephone MASS
		Notify ZGN ARTCC AMCC that ARK VORTAC is unmonitored and Pireps have verified equipment signal is radiating without error. Open an event ticket and annotate Specialist notified initials.	Telephone EM
		Notify Telecommunication service provider of the circuit failure. Annotate service provider ticket # and initials in the open EM ticket.	Telephone EM
00:32	ZGN calls GMCC.	Receive call from ZGN AMCC, BUEC freq 122.75mhz at NEV has failed. ATC is requesting immediate restoration.	Telephone
		Open event ticket and contact SSC responsible for restoration of equipment. Call NEV AF. No answer at SSCM office--leave msg.	Telephone EM

Time	External Source	GMCC	Technology/Info
00:34	TEN ATCT calls GMCC.	Receive call from TEN ATCT. Water over- flowing from the Urinal in the third floor restroom. Open event ticket	Telephone EM
00:35		Call TEN ESU specialist for correction of malfunctioning Urinal. Update event ticket.	Telephone EM
00:38	TEN AF calls GMCC.	Receive call from TEN AF COMM SSCM. No qualified Technician available to respond to NEV BUEC freq outage, Certified tech is currently in Oklahoma for training.	Telephone EM
		Determine when a certified tech will be available and advise ZGN AMCC that a delay in restoration will be incurred until the next day with ATC's concurrence	
00:43	ZGN AMCC calls GMCC.	Receive call from ZGN AMCC. ATC agreed to the delay in restoration of the NEV BUEC.	Telephone
00:44	TEN AF ESU calls GMCC.	Receive call from TEN AF ESU. VASI up- wind box repaired. Replaced broken lens.	Telephone
00:45		Update event manger, close-out LIR Advise TEN ATCT, and upward current status.	EM/MMS Telephone
00:47		Cancel Notam with AFSS.	Telephone
00:50	Telecommunication service provider calls GMCC.	Receive call from Telecom service Provider. Access to the NEV VORTAC is required. Determine an ideal time frame to meet at site.	Telephone
00:53		Call SSCM and schedule an AF Specialist to meet with Telecom Rep at the NEV VORTAC. If time is different, call Telecom svc provider and change time. Annotate EM.	Telephone EM
01:00	TEN ESU specialist calls GMCC.	Receive call from TEN ESU spec. Third floor restroom urinal repaired. Update event ticket.	Telephone EM