



New York State Technology Enterprise Corporation

presents its

**Public-Safety Communication Needs  
Analysis Report**

for the

**Tompkins County Radio System Project**

February 28, 2001

Version 2

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## **1. SURVEY AND INTERVIEW ANALYSIS**

This section details the analysis performed on both the written survey and the interview process that followed.

### **1.1 Data (Information) Collection**

The NYSTEC team worked with Tompkins County (TC) Public Safety (TCPS) to determine the current status of the Tompkins County Public Safety communications network, including the work flow through the system (how the end user uses it) and the infrastructure that supports it. The team documented multi-jurisdictional, multi-disciplinary interfaces to achieve a high-level understanding of issues and needs. To obtain the necessary information, the team:

- Reviewed existing materials — Discussed known requirements with Tompkins County Public Safety technical personnel. NYSTEC also reviewed industry and commercial publications to see where Public Safety organizations were going and the technologies that are currently being employed (see Appendix A, Bibliography).
- Surveyed users — The County Planning Department, in conjunction with County Public Safety, selected a cross section of Tompkins County Public Safety users (Members), and NYSTEC surveyed them to document their use of (and needs for) the system. Two-hundred and forty (240) surveys were mailed. One-hundred and ninety-nine (199) completed surveys were returned.
- Conducted interviews — NYSTEC interviewed a subset of the Members that received a survey, and interviewed others on an availability basis. Thirty-eight (38) Members were interviewed.
- Determined existing interoperability requirements — The County's Public Safety communications system must support the interoperation of a number of organizations: 1) TC law-enforcement agencies (TC Sheriff's Department, local PDs), 2) New York State law enforcement (New York State Police, New York State Park Police), 3) Fire and EMS agencies, 4) commercial ambulance service providers (Bangs Ambulance, Guthrie Air (helicopter evacuation), 5) university/college safety organizations (Cornell University and Ithaca College), and 6) other TC organizations (Health Department, County and local Highway and Public Works Departments). NYSTEC collected the information needed about these organizations from its Member survey and subsequent interviews.

#### **1.1.1 Existing Materials**

Several Public Safety Communication reports were significant sources of material that provided valuable insight into communication needs and issues. These reports were:

- New York Statewide Law Enforcement Telecommunications Committee (NYSLETC) reports provided by Mr. Robert F. Schlieman (Radio Engineer, NYSP Communications Section), the Technical Advisor. These papers (and

discussions with Mr. Schlieman on intent) were the baseline concept for NYSTEC's study. They are:

- “Twenty-First Century Statewide Communications Project, A Concept Paper,” August 1994.
- “A Survey of NY State Agency Radio Communication Systems,” February 1996.
- PSWAC — The Public Safety Wireless Advisory Committee (PSWAC) was established by the Federal Communications Commission (FCC) and the National Telecommunication and Information Administration (NTIA) to evaluate the wireless communications needs of federal, state, and local Public Safety agencies through the year 2010 and to recommend possible solutions. The PSWAC final report, dated September 11, 1996, included reports from subcommittees on operational requirements, technology, interoperability, spectrum requirements, and transition. The NYSTEC process-modeling team studied and used the Operational Requirements Subcommittee Report Summary.<sup>1</sup> This report was used as a baseline upon which to proceed on the collection of requirements for TCPS.

### 1.1.2 Survey

A personalized, twenty-two-page survey was mailed to the Tompkins County Planning Department for distribution to two-hundred-forty Public Safety personnel (Members) selected by County Planning staff members in conjunction with staff members from Tompkins County Public Safety agencies. The Members selected provided a good cross section of jobs, ranks, and geographic locations. Every Public Safety organization considered a potential user of the TCPCS (Tompkins County Public Safety Communications System) was represented.

#### 1.1.2.1 *Purpose of the Survey*

Some high-level aspects need to be determined early in the development of a public-safety communications system. Based on the NYSTEC experience with the SWN requirements as well as with PSWAC, these high-level requirements — as they apply to Tompkins County — were addressed by the survey and interview task. Public-safety communications has three high-level aspects that need to be considered throughout the process of system development. These are:

- *System Coverage* What are the coverage requirements, what level of coverage is needed to service what types of equipment (i.e., mobiles, portables, and/or mobile computers)? Is coverage to include use in buildings, in tunnels, or just outdoors?
- *System Capacity* Who will be using the system when or what will be the traffic load? What grade of service will the users need, can they be tolerant of call blockage, and to what extent?

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<sup>1</sup> “The general charter of the Operational Requirements Subcommittee (ORSC) was to identify the wireless communication needs of the Public Safety community through the year 2010. The subcommittee was also tasked to examine current operational requirements that are unmet or suffer reliability, quality, or coverage deficiencies.” Also: “The subcommittee’s report provides a snapshot of operational capabilities that Public Safety providers require, now and in the future, in order to fulfill their mission of protecting lives and property. The subcommittee analyzed the needs of a broad range of Public Safety entities according to the type of service (voice, data, image, and video) and quantity of service (number of channels) required.”

- *System Capabilities* What are the operational needs of the user community and how will those need to map into the system? Are there features that need to be included in the system design that respond to operational demands, like call preemption for a person in a life-threatening situation (like being under gunfire or trapped in a burning building)?

The surveys were conducted to help better understand these high-level issues of public safety communications and how they apply to Tompkins County. This understanding was to be acquired through the survey and interview process by:

- Introducing the candidates to what the NYSTEC team was doing, both on the project and during the upcoming interviews.
- Giving the candidates information in preparation for the interviews.
- Obtaining feedback for NYSTEC so that it could prepare for the interviews. (If a candidate raised an issue, NYSTEC could address it in all the interviews.)
- Providing an initial perspective on the baseline of requirements.
- Identifying key personnel with the interest and background to assist in the analysis-definition of a needs effort.

#### *1.1.2.2 Description*

Appendix B provides a copy of the survey, along with a copy of the cover letters sent to the Members. Two cover letters were included: the first cover letter outlining the purpose of the survey and instructing Members to return the completed survey to the Tompkins County Planning Department, and the second cover letter stating that the surveys are to be returned to John Miller of the Tompkins County Fire & EMS Service.

The survey consisted of several sections. The first section consisted of 5-point Likert Scale questions to which respondents were asked to mark — 1 Strongly Disagree, 2 Disagree, 3 Neither Agree or Disagree, 4 Agree, 5 Strongly Agree — how closely the statement corresponded to their experiences or views regarding the current Tompkins County Public Safety Communications System (TCPSCS). If the statement was not applicable or the respondent did not know, the respondent was asked to mark the Not Applicable/Don't Know choice. In another section, using 5-point Likert Scale questions, Members were surveyed on their mobile and portable radio operational needs. Other sections of the questionnaire consisted of a variety of questions and formats. Some questions limited responses to Yes, No, or Not Applicable; other questions asked the respondent to choose from a list of ranges; and yet other questions asked the respondent to provide lists or short answers. The questionnaire also afforded each respondent the opportunity to provide additional comments. Members were surveyed on coverage problems, interoperability requirements, and equipment and infrastructure issues. In addition, Members were asked to describe their radio usage as well as problems associated with that usage. Another section surveyed Members on mobile and portable radio operational needs, as well on answering-point (dispatching support) requirements.

#### *1.1.2.3 Survey Process*

The survey instrument was mailed on 22 November 2000 to the Tompkins County Planning Department where the cover letter from the Tompkins County Planning Department explaining

the purpose of the survey was attached. The survey was then distributed by the Planning Department to 240 County Public Safety Members. Respondents were asked via another attached cover letter to return their completed surveys by 7 December 2000 to John L. Miller, of the Tompkins County Fire & EMS Service. Returned surveys were then turned over to the Tompkins County Planning Department on 8 December 2000. One-hundred ninety-nine (199) surveys were returned, and all were found to be usable — giving about an 83% response rate. This is considered an excellent return rate for such surveys. Table 1 shows the distribution of surveys mailed and completed by Tompkins County Public Safety Organizations.

**Table 1, Questionnaire Distribution and Response**

<b>Tompkins County Public Safety Organization</b>		<b>Surveys</b>		
		<b>Distributed</b>	<b>Returned</b>	<b>Response Rate</b>
<b>I. Fire/EMS</b>				
<b>A. Career</b>				
	Ithaca	6	5	83%
<b>B. Volunteer</b>				
	Brooktondale	5	4	80%
	Cayuga Heights	6	6	100%
	Danby	6	4	67%
	Dryden	15	1	7%
	Enfield	10	9	90%
	Etna	3	3	100%
	Freeville	3	3	100%
	Groton	7	7	100%
	Lansing	10	6	60%
	McLean	9	6	67%
	Newfield	9	7	78%
	Slaterville	12	8	67%
	Speedsville	4	4	100%
	Trumansburg	10	10	100%
	Varna	6	5	83%
	West Danby	4	4	100%
<b>II. Commercial Ambulance</b>				
	Bangs Ambulance	8	7	88%
<b>III. Law Enforcement</b>				
<b>A. Local PD</b>				
	Cayuga Heights PD	4	4	100%
	Dryden PD	5	5	100%
	Groton PD	2	2	100%
	Ithaca PD	13	12	92%
	Trumansburg PD	4	4	100%
<b>B. Sheriff</b>				
	Tompkins County Sheriff's Department	15	13	87%
<b>C. NYS Law Enforcement Agencies</b>				
	NYS Park Police	6	4	67%

Tompkins County Public Safety Organization		Surveys		
		Distributed	Returned	Response Rate
	NYSP at Ithaca	14	13	93%
<b>IV. E-911</b>				
	E-911 Operations Committee	3 (15)*	3 (14)*	100% (93%)*
	E-911 Dispatch/Operations	16	12	75%

<b>V. Other TC Organizations</b>				
	Health Department	1	1	100%
	County Highway	1	1	100%
	Groton Highway	1	1	100%
	TCAT	1	1	100%
	Ithaca	1	1	100%
	Enfield	1	0	0%
	Tompkins County Fire, Disaster & EMS Advisory Board	1	1	100%
	TC Airport Rescue	1	1	100%

<b>VI. University Safety</b>				
	Cornell University - Police	8	8	100%
	Cornell University - Environmental Health and Safety	4	4	100%
	Ithaca College - Campus Safety	5	5	100%

<b>TOTAL</b>		<b>240</b>	<b>195</b>	<b>81*</b>
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\*Here there are occasions in which persons were both part of E-911 Operations Committee and part of a survey response from another public-safety department in the county. For the purposes of this table, the lower number denotes E-911 Operations Committee members that were not part of (and therefore not included in the results of) other Public Safety organizations, i.e., Fire, EMS, Law Enforcement. The number in parenthesis represents the total number of E-911 Operations Committee members who were surveyed and returned a completed survey from some department within the county.

#### 1.1.2.4 Respondent Groupings

The survey responses and interviews are grouped according to the unique functional requirements of that group (e.g., law enforcement, fire, or EMS). The Law Enforcement Category contains three sub-categories: Local Police Departments, Sheriff, and NYS Law Enforcement Agencies. The Local PD sub-category includes all PDs that are associated with a particular jurisdiction within Tompkins County (e.g., a city, a town, or a village). The Sheriff’s subcategory only includes the Tompkins County Sheriff’s Department, which is the only Tompkins County county-wide law-enforcement organization. The NYS Police and the NYS Park Police were included in their own category (NYS Law Enforcement Agencies), primarily because they are part of a larger organization and their parent organization has its own radio system upon which they

chiefly rely. They interoperate with County agencies on an as-needed basis using the Tompkins County Public Safety radio.

The Fire Department/EMS category is divided into two sub-categories — Career and Volunteer. While both sub-groups provide professional services and have the same radio requirements when travelling to a scene, or at the scene, they do have a fundamentally different pre-arrival communications requirement — dealing with the notification by dispatch that an incident has occurred. The Career members when on duty are generally located in a fire station and, thus, dispatch needs only to contact a fixed location. In the case of the Volunteers, dispatch needs to contact Volunteers that may be located anywhere in the County and in a myriad of building types via paging. Furthermore, Volunteer Fire/EMS departments operate in fire districts that are geographically larger than that serviced by the Ithaca Fire Department.

The Commercial Ambulance category covers the Bangs Ambulance, a commercial ambulance service (the only known commercial ambulance service in the county). Interoperability between the Law Enforcement and Fire/EMS categories and Bangs Ambulance is critical. The surveys and interviews revealed that Guthrie Air's helicopter is used to air transport critically injured people to major medical centers.

The University category covers the Public Safety organizations associated with Cornell University and Ithaca College. Each school has its own communications system. However, when an incident occurs on campus, the pertinent school's Public Safety organization needs to communicate with Law Enforcement, Fire/EMS, and Commercial Ambulance.

The Other Tompkins County Organizations category covers those organizations with which Tompkins County Public Safety agencies need to communicate on an infrequent basis. For example, communications with highway departments (both county and local) were cited by all the Tompkins County Public Safety agencies as important to their operations.

### 1.1.3 Interviews

To complement the surveys, group interviews were planned for a subset of the individuals who received a survey. The interviewees were selected by the Tompkins County Planning Department in conjunction with representatives from Tompkins County Public Safety agencies. Interviews were somewhat dependent upon availability. Based on the comments made by respondents in the survey results, NYSTEC requested that additional individuals representing other organizations and job functions be included. The purposes of the interviews were to:

- Clarify information that was received on the surveys.
- Gather additional information that might be missing from the surveys.
- Better understand the context of the replies on the surveys.
- Help get feedback on what portions of the survey might have not been understood or which might have asked for the wrong type of information.

Additionally, the interviews were seen as an excellent way to have face-to-face contact with members of various county public-safety agencies to help explain the project, and to help them better understand NYSTEC and its role.

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The actual interview process was planned to include 5-10 minutes of introducing the interviewers, NYSTEC, and the TCPSCS project, and of thanking the interviewees for their survey participation. To encourage frankness in the interviews, NYSTEC made it clear that all comments made would be held in confidence and not be attributed to any one individual or organization. All results would be reported in aggregate form.

Then the interviewees would take about 5 minutes to explain their job and how they were currently using the communication system. The remaining time was planned to be spent in an informal dialogue that would go into any detail or clarification of the actual survey responses. Clarifications or additional information from the interviews were to be entered into the database and/or spreadsheet as appropriate.

During the period of 20 through 22 December 2000, NYSTEC interviewed Tompkins County Public Safety personnel. Table 2 summarizes which Tompkins County Public Safety Organizations were interviewed during the week

**Table 2, Interviews by Organization**

Organization		Members Interviewed
<b>I. Fire/EMS</b>		
<b>A. Career</b>		
	Ithaca	5
<b>B. Volunteer</b>		
	Brooktondale	1
	Dryden	1
	Enfield	1
	Groton	1
	McLean	2
	Newfield	1
	Slaterville	1
	Trumansburg	2
<b>II. Commercial Ambulance</b>		
	Bangs Ambulance	2
<b>III. Law Enforcement</b>		
<b>A. Local PD</b>		
	Cayuga Heights PD	2
	Dryden PD	1
	Groton PD	1
	Ithaca PD	2
	Trumansburg PD	1
<b>B. Sheriff</b>		
	Tompkins County Sheriff's Department	3
<b>C. NYS Law Enforcement Agencies</b>		
	NYS Park Police	1
	NYSP at Ithaca	3
<b>IV. E-911</b>		
	TC Fire & EMS Service	2
	E-911 Dispatch/Operations	2
<b>V. Other TC Organizations</b>		
	County Highway	1
	TC Search & Rescue	1
<b>VI. University Safety</b>		
	Cornell University - Police	1
<b>Total Interviewed</b>		
<b>38</b>		

### 3. RADIO SITE AUDITING

This section details the conditions associated with the County's current radio sites.

#### 3.1 Technical Overview

Every RF (radio frequency) site usually has associated with it a shelter and a tower. The shelter's main purpose is to house the RF (and associated) equipment, and the tower is there for antenna mounting. Associated with every site is all the equipment (auxiliary power; heating, ventilation and air conditioning (HVAC); alternating current (AC) power, etc.) needed to ensure continual operation of the RF equipment. Sites also require access roads and security measures. Depending on the initial standards (construction, safety, reliability, etc.) used to construct a site, the age of the site, and the maintenance of the site, the site can exhibit high standards and be in excellent condition, or can be substandard and be in a condition of total disrepair.

When a site does not meet the audit criteria, it will be more prone to interruption of service and higher maintenance costs and will possibly pose personnel-safety hazards. For these reasons, the New York State Technology Enterprise Corporation (NYSTEC) has formulated procedures for determining the general condition of RF sites. These procedures are part of a standards process the NYSTEC is tasked to follow for the Statewide Wireless Network (SWN) project. This Tompkins County Site Audit Report is based on that effort. The site audit investigated the eight categories listed in subsection 3. After a site audit is completed, information gathered from the audits can be used to:

- assess if any problems in service can be attributed to site conditions,
- determine an upgrade and maintenance plan,
- assess the level of surge and lightning protection provided,
- assess the grounding system, and
- determine the future viability of the site.

The Note and annotations at the end of each site review can often be very telling. For example, a site may statistically tabulate poorly, but the auditor will report that the site is undergoing remodeling or construction<sup>4</sup>. That notation may offer insight into the reason for an individual site's condition.

##### 3.1.1 Scope

The site audits were limited to a visual inspection. A great deal can often be gleaned from a visual inspection. The visual inspection will reveal the presence or absence of entire systems, e.g., auxiliary power, surge suppression, grounding, and security measures. It will also reveal the overall condition of the shelter, access road, and tower. What can not be determined from the visual audit is the physical condition of equipment (RF, generators, HVAC, surge suppressors, etc.) or the apparent condition of the ground system if one is in place. This can be done for future site development, but, given that this entails a significant level of effort, it needs only be

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<sup>4</sup> Note that very poor practices used on a Public Safety radio site during construction are not considered acceptable.

done when the site is identified as needed in future development, not when the site is identified as a potential site for development. Tompkins County's existing sites all had relatively good-to-excellent soil conditions, none of the existing sites are on rock substratum, so this approach entails little risk that a site will experience any significant grounding problems.

General fixed-site requirements can be found in Motorola R-56 for fixed-site operations. Information regarding proper grounding, bonding, and shielding can be found in military handbook MIL-HDBK-419A, 29 December 1987, "Grounding, Bonding, and Shielding for Electronic Equipment and Facilities." Information regarding grounding, site construction, shelter construction, and tower specifications can be found in publications LBI-39067B, LBI-39148, LBI-39179A, LBI-39184A, and LBI-39185, by Com-Net Ericsson Inc.

#### *3.1.1.1 Pre-Site Audit Checklist*

Before an audit is performed, the following information must be known:

- Location of site,
- Directions to site,
- Whether it is accessible by ground and, if so, if a 4-wheel-drive vehicle is necessary,
- Personnel to contact,
- Is a key or combination needed to access site and shelter, and
- Is the site shared with other providers (if so, how can their antenna and equipment be identified?).

#### *3.1.1.2 Site Audit Checklist*

The site audit checklist consist of eight sections and a site diagram section. The eight sections are as follows:

- Site location,
- Site Conditions,
- Shelter Construction and Layout,
- Installation of Equipment,
- Auxiliary Power,
- Surge/Lightning Protection,
- Inside Grounding, and
- Outside Grounding.

The top of the checklist contains an area for the site name, site location, GPS coordinates, date of audit, time of audit, and auditor's name. The checklist itself contains seven columns. The first column indicates the section number; the second column is a description of the parameter to be audited; the third, fourth, and fifth columns indicate the condition of the

parameter; the sixth column is for comments; and the seventh column is for indicating if an image was taken of that particular parameter.

### 3.1.2 Applicable Documents

The site auditing performed under the SWN project acted as the basis for much of the site auditing done for this report for Tompkins County. Also, a number of standards, handbooks, and documents were referred to in order to generate the audit segments for this report and the site standards that NYSTEC has developed for the SWN project. Table 25 lists these documents.

**Table 25, Applicable Documents**

Document	Description
AC 70/7460-H1	Federal Aviation Administration (FAA) Advisory Circular (AC) for Obstruction Marking and Lighting
AC 150/53545-43E	FAA AC specification for obstruction lighting equipment
AC 150/5390-2A	Heliport design
ANSI TIA-568-A	Cabling standards
ANSI RP-7-91	Lighting standards for industrial workplaces
EPA SPCC Section 112.1	U.S. Environmental Protection Agency (EPA) regulations for spill-prevention countermeasures control
EPA Emission Standards	Emission standards for backup power generators
EIA/TIA 222F	Tower construction minimum standards
FAA-STD-019B	FAA Standard for lightning protection, grounding, and bonding
FCC OET Bulletin 56 97-01	Safe RF-emission levels for humans
FCC WT Docket 95-5	Antenna structure registration
IEEE STD-C95.1, 1999 Edition	IEEE Standards for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
ISO/IEC 1180	Cabling standards
ISO/IEC 11801:1995	Standards for Fiber-Optic Cables
MIL-STD-188	U.S. Military Standard
MIL-HDBK-419A	Grounding, Bonding, and Shielding for electrical equipment
MIL-STD-461	Electromagnetic susceptibility and emissions
NFPA	National Fire Protection Agency Codes
NYS DEC Part 598	New York State Department of Environmental Conservation regulations governing handling and storage of hazardous substances
NYS DEC 613	New York State Department of Environmental Conservation regulations governing storage of petroleum
NYS DEC 614	New York State Department of Environmental Conservation Regulations governing standards for new and substantially modified petroleum storage facilities
OSHA 1926.57 and subparts	Emission levels for backup power generators operated in confined spaces
OSHA CP 2-1.29	Directive for interim inspection procedures during communication tower construction
OSHA 1924.541 and 1910.97	Safe exposure-level limits
OSHA 1910.268g	Regulations governing safety harnesses for climbing
OSHA 1910.110	Standards for storage and handling of liquefied petroleum gas
OSHA 1910.151	Medical Services and First Aid
OSHA 1917.156	Handling of hazardous and flammable materials
UL 752	Requirements for bullet-proof shelters
UL 1449	Transient protection standards
UL 142	Standards for fuel-storage containers

## **3.2 Audit Procedures**

This section details the specifics of the site audit, which consists of completing the eight functional parameters of the site audit checklist. The Audit Segments correspond to the SWN site audit standards document, “Statewide Network Fixed Site Standards Rev. 2.5,” that is still being developed for the New York State SWN Program Office. In this report for Tompkins County, the general descriptions that were used follow.

Appendix D is the site audit checklist used.

### 3.2.1 Audit Segment 1: Site Location

This is a brief section and only contains four parameters that have to be checked. This section in actuality could be filled in before the site is even visited, since most questions would be answered in the pre-site audit checklist. However, additional comments should be added concerning the condition of the access road and whether modifications in the directions to the site are necessary. With this section and all sections, note (in the Image column) if an image was taken of any parameter.

### 3.2.2 Audit Segment 2: Site Conditions

This section contains ten parameters and gives an indication of how well the outside environment has been maintained and how well the outside environment was considered in the site design. It also indicates the cleanliness of the interior of the shelter, whether there is a fence installed, and whether falling trees, if present, can damage the shelter or overhead power lines. All parameters should be supplied with a “yes” or “no” answer and comments if needed. In this section the requirement for FCC license posting is checked. At this point, images should be taken showing the shelter, surrounding environment, and the antenna and tower.

### 3.2.3 Audit Segment 3: Shelter Construction and Layout

The first four parameters of this section concern the shelter construction and condition. Comments should be made indicating the condition of the parameters, and images should be taken to reflect the conditions. Concerning Parameter 3.5, make a judgment call as to whether the HVAC equipment that is present is adequate. Since this is a one-time visual audit, you will not know how well the inside environment temperature is maintained at other times. If possible, ask someone responsible for maintaining equipment how well the HVAC system performs. Parameters 3.6 – 3.11 concern the adequacy of the AC wiring in terms of sufficient circuits, sufficient outlets (and how well they are mounted), and labeling of circuit breakers and outlets. Where appropriate, supply comments and images for these parameters. Parameter 3.12 concerns cable support. It is not necessary to have a cable tray, but the cable or cables should be supported and held securely in place. Parameter 3.13 concerns the lighting within the shelter, and a simple “yes” or “no” answer will suffice. Parameters 3.14 – 3.17 concern safety issues. Check the appropriate “yes” or “no,” depending on whether the parameter is present, and comment on the condition. If a fire extinguisher is present, check to see if it is charged. For Parameter 3.18, check for any obvious signs of disrepair, damage, or insufficiencies regarding the utilities (AC, phone, etc.). Make appropriate comments and take pictures if warranted.

### 3.2.4 Audit Segment 4: Installation of Equipment

Parameter 4.1 concerns the adequacy of spacing around equipment. Equipment racks should have approximately three feet of clearance in front and back. Equipment that only needs to be accessed from one side should have three feet of clearance. All equipment should also have adequate space to ensure proper cooling. Parameters 4.2 – 4.4 require a “yes” or “no” answer and image if necessary. Parameter 4.5 is an important one and should not be overlooked. The potential for batteries to explode is real. Parameters 4.7 and 4.8 require a “yes” or “no” answer. For parameter 4.8, check to see if the antenna is straight and approximately at the height it should be. An image should be taken of the antenna and, if possible, include in the picture some reference so the height of the antenna can be estimated.

### 3.2.5 Audit Segment 5: Auxiliary Power

Parameter 5.1 should be given a “yes” or “no” answer, and comments should be made concerning the condition of the generator if one is present. An image of the generator should also be taken. Concerning parameter 5.2, if a generator is not present, are there provisions for installing one? Look for adequate space to locate a generator; is a transfer switch is present; are fuel tanks present, is there an outlet provided for exhaust, etc.? Parameters 5.3 – 5.6 require a “yes” or “no” answer and an image should be taken for parameter 5.4 if applicable.

### 3.2.6 Audit Segment 6: Surge/Lightning Protection

Category 6, Surge/Lightning Protection, contains only three parameters, but they are very important to protection of the equipment. Besides noting if surge protection is present, note if the equipment appears operational and take images. Surge protection on the AC can be provided by a main service protector (Type 1 or Type 2) or by individual outlet protectors. Note which is present and take images if applicable.

### 3.2.7 Audit Segment 7: Inside Grounding

Grounding is very important to the safety of personnel and equipment. This category should be thoroughly checked, comments made, and images taken. Parameters 7.1 and 7.2 concern the internal ground window. An internal ground window should be installed, be of adequate size, and be directly grounded to the external grounding system using adequate-size copper straps or cable. Parameter 7.3 requires you to check for the presence of an interior ground halo. The halo should begin and terminate at the ground window. It should be of solid copper AWG #2. All ancillary equipment should be attached to the halo using AWG #6. As required in parameter 7.4, check for proper bonding between dissimilar metals. Parameter 7.5 requires that proper bonding procedures be followed, note “yes” or “no” and provide comments. Parameter 7.6 requires that you note whether all ground-conductor-bending radii are less than 8 inches. Parameters 7.7 – 7.10 concern the grounding of cable trays, equipment cabinets, and surge-protection devices. Provide “yes” or “no” answers to those parameters, comments, and images if applicable.

### 3.2.8 Audit Segment 8: Outside Grounding

An outside ground window is a very important part of a ground system. Parameters 8.1 and 8.2 concern the ground window and the grounding of transmission lines to the window. Always

take an image of where the transmission lines enter the shelter. This will capture whether a ground window is installed or not installed, and whether the outer conductors of the transmission lines are properly grounded. Parameters 8.4 – 8.16 concern items that should be grounded to the external earth electrode subsystem. In these parameters, if there is no external ground window, look to see if metal in the shelter gets to earth ground some way. It is acceptable in parameters 8.4 through 8.16 if metal devices go to ground through an internal ground window that is grounded to the outside earth ground directly.

In general, any metal object must be grounded. The object should either be directly grounded or be grounded via the external ground window. For example, for ice bridges, if they have posts, the posts should be grounded directly to the external earth electrode subsystem. If the ice bridge does not have posts, it should be grounded to the external ground window.

Parameter 8.15, main electrical ground (AC), should be grounded at the entry point to the shelter. Also notice if the neutral wire of the AC is grounded at the same point. The AC neutral should only be grounded at this point and no other. Parameter 8.17 can only be checked if you have the equipment to do so. It is a very important parameter and should be checked if at all possible. A quick check can be done utilizing an AEMC Instruments clamp-on ground resistance tester. Other, more-elaborate tests can be done, and should be done if warranted. Parameter 8.18 concerns an exterior fence. If one is present, it should be grounded every fifty feet, or be grounded to the earth electrode subsystem if within six feet of it. For Parameters 8.19 and 8.20, check that each tower leg is grounded and that all guy wires are grounded. If the tower is a monopole, it should have at least four ground rods installed. All outer conductors of the transmission lines should be grounded at the base of the tower and at the top of the tower at minimum.