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MAYOR**



**DEPARTMENT OF FINANCE
INTERNAL AUDIT SECTION**

**METROPOLITAN
GOVERNMENT OF NASHVILLE
AND DAVIDSON COUNTY**

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December 20, 2005

Nancy Whittemore, Director
Department of General Services
222 3rd. Ave. N, Suite 350
Nashville, TN 37201

Report of Internal Audit Section

Dear Ms. Whittemore:

We have recently completed a performance audit of Radio Communication Services Division of the Department of General Services. *Government Auditing Standards* issued by the Comptroller General of the United States define performance audits as follows:

Performance audits entail an objective and systematic examination of evidence to provide an independent assessment of the performance and management of a program against objective criteria as well as assessments that provide a prospective focus or that synthesize information on best practices or cross-cutting issues. Performance audits provide information to improve program operations and facilitate decision-making by parties with responsibility to oversee or initiate corrective action, and improve public accountability.

A performance audit is different than a financial statement audit, which is limited to auditing financial statements and controls, without reviewing operations and performance. In performing this audit, we retained Matrix Consulting Group to work under our direction. Their final report dated December 20, 2005, *Performance Audit of the Radio Communication Services Division*, accompanies this report and is hereby submitted to you.

Radio Communication Services is a division of the Department of General Services. The purpose of the Radio Communication Services program is to provide installation, repair and infrastructure products to radio system users so they can have reliable and functional equipment.

Radio Communication Services Division operates as an internal service fund with a total of 24 budgeted positions for FY 2004 and the audited FYE 6/30/2004 can be summarized as follows:

Operating Revenues:

Charges for Services	\$ 4,520,245
Other Revenue	<u>0</u>
Total Operating Revenues	<u>\$ 4,520,245</u>

Operating Expenses:

Personal Services	\$ 1,034,841
Contractual Services	1,226,241
Other	<u>765,867</u>
Total Operating Expenses	<u>3,026,949</u>
Operating Income (Loss)	<u>\$ 1,493,296</u>

Objectives, Scope, and Methodology

The primary objectives of this performance audit were as follows:

- Develop a profile of the Radio Communication Services Division.
- Develop an in-depth understanding of the key issues impacting the Radio Communications Services Division.
- Benchmark the performance of the Radio Communication Services Division to industry best practices and peer cities using the same radio technology.
- Evaluate operations and staffing levels.
- Evaluate organizational issues including the organizational placement of Radio Communications within the Metropolitan Government.
- Evaluate the adequacy of management systems utilized by the Radio Communication Services Division.

This audit focused primarily on fiscal years 2003 and 2004 budgeted and actual financial balances, transactions, performance outcomes, and on the processes in place during the time of the audit. Certain analyses required the consideration of financial results, performance and operations outside of that time period.

The methodology employed throughout this audit was one of objectively reviewing various forms of documentation, including written policies and procedures, financial information and various other forms of data, reports and information maintained by Radio Communication Services. Management, administrative and operational personnel, as well as personnel from other Metro departments, and other stakeholders, were interviewed, and various aspects of Radio Communication Services operations were directly observed. Data obtained from various sources were analyzed, and various aspects of performance, cost and practices were compared to those of peers and to best practices.

We performed the audit procedures in accordance with generally accepted government auditing standards.

Findings and Recommendations

The Matrix Consulting Group report addresses the Radio Communication Services operation and the resulting findings and recommendations in detail. The following is an overview of some of the more significant findings and recommendations included in their report.

Finding

A review of the coverage maps for the 800MHz radio system indicates that there are coverage gaps in the 800MHz radio system in areas such as Hermitage and Green Hills, and in important buildings such as schools.

Recommendation

The Radio Communication Services Division should evaluate the adequacy of coverage, discuss with its customers particular problem areas in terms of coverage, and develop capital budget proposals for consideration of the Finance Department to address these coverage problems. The estimated capital outlay to develop one site would be approximately \$500,000.

Finding

The Radio communication Services Division charges a fee for replacement of radio equipment. This amounts to \$28.16 for each subscriber unit regardless of whether it is a high-tier radio, an analog radio, control station, etc., and results in Metro departments paying \$122,890 each month or \$1,474,683 annually. Given this annual revenue collected for replacement, the Radio Communications Division should have a fund balance approximating \$2.1 million at the end of 2003-04. The fund is undercapitalized, and these fees would have to be increased significantly to redress this problem. The replacement charges are not separated into a separate sub-fund, and it is difficult to determine if sufficient revenue is currently being accrued to replace subscriber equipment or if replacement revenue is underwriting operating and maintenance costs or vice-versa. As indicated in the comparative survey, not one of the other local governments charges their participants a replacement charge for subscriber equipment.

Recommendation

Metropolitan Nashville and Davidson County should not charge a replacement or subscriber fee for radios. When departments need to replace subscriber equipment, the Department of General Services should budget for the replacement within the annual capital budget. The elimination of the replacement charge would reduce annual operating costs by \$1,474,683.

Finding

While staff assigned to the Radio Communication Services Division can be underutilized given the seasonality of workload and the amount of the workload, the Division contracts with Motorola for technical support in the maintenance and repair of the 800MHz backbone. This is in addition to another contract with Motorola for system management of the 800 MHz radio system.

Recommendation

The Radio Communications Services Division should develop the in-house capacity for the provision of a backbone system technician capacity. This can be accomplished by filling the vacant Radio Technician 3 position, sending this technician to Motorola training for backbone system maintenance, repair, diagnosis, and teaming the Radio Technician 3 with the system technician from Motorola for twelve to eighteen months for field training. Upon completion of the classroom and field training, the contract with Motorola for technical services should be utilized as a back-up resource called upon only in cases where the Metro technical staff cannot properly address the immediate needs of the system within an acceptable time-frame. This change should result in a reduction in annual operating costs of \$173,550.

The Matrix Consulting Group also evaluated the adequacy of the maintenance of the 800MHz radio system backbone, and the transmission sites. A number of recommendations were developed as a result of this evaluation. These recommendations were discussed separately with management of the Radio Communication Services Division.

In addition to the Matrix Consulting Group work, Internal Audit staff reviewed procedures and controls surrounding financial and other operations and discussed those issues with Radio Communications management.

Additional findings and recommendations can be found in the Matrix Consulting Group report in chapters 6 through 9 accompanying this report.

December 20, 2005
Ms. Whittemore
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Management's response to the audit recommendations is attached to this report.

We appreciate the cooperation and help provided by all Radio Communication Services staff.

This report is intended for the information of the management of the Metropolitan Government of Nashville and Davidson County. This restriction is not intended to limit the distribution of this report, which is a matter of public record.

Internal Audit Section

Don Dodson
Internal Audit Manager

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December 20, 2005

Mr. Don Dodson
Metro Department of Finance
Internal Audit Division
222 Third Avenue North, Suite 401
Nashville, TN 37201

Dear Mr. Dodson:

This letter is acknowledgement that the Department of General Services has received the radio communication performance audit report recently completed by Matrix. After thorough review of the report, the Department of General Services is in agreement with its findings.

We are determined to work diligently to address the issues raised in the report, and are committed to implementing its recommendations.

Sincerely,

A handwritten signature in cursive script that reads "Nancy Whittemore".

Nancy Whittemore, Director
Department of General Services

Performance Audit of the Radio Communication Services Division

METROPOLITAN NASHVILLE AND DAVIDSON COUNTY, TENNESSEE



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November 15, 2005

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1. INTRODUCTION AND EXECUTIVE SUMMARY

1. INTRODUCTION AND EXECUTIVE SUMMARY

The report, which follows, presents the results of the Performance Audit of the Radio Communication Services Division conducted by the Matrix Consulting Group for Metropolitan Nashville and Davidson County (Metro).

This first chapter introduces the analysis - outlining principal objectives and how the analysis was conducted, and an executive summary of the report.

1. PROJECT SCOPE OF WORK

The analysis by the Matrix Consulting Group of the Radio Communication Services involved the following steps.

- **Develop an in-depth understanding of the key issues impacting the Radio Communication Services Division.** To develop an understanding of the issues impacting and shaping service requirements, the consulting team conducted interviews with the General Services Director, key staff of the Radio Communication Services Division, and other managers and supervisors of Metropolitan Nashville and Davidson County.
- **Develop a Profile of the Radio Communication Services Division.** The consulting team conducted a number of tasks to document how the Radio Communication Services Division is organized and delivers services. This included the interview of all staff in the Division, review of workload and work order data for the Division, the allocation of labor hours by activity, and the scope of services provided by the Division.
- **Benchmark the performance of the Radio Communication Services Division.** The consulting team reviewed the performance of the Radio Communication Services Division in the context of best management practices and also a comparative survey with other local governments. The consulting team developed best management practices for the Division based upon the experience of the consulting team and practices developed by other organizations such as the Public Safety Wireless Network *Operational Best Practices for Managing Trunked Land Mobile Radio Systems*. The consulting team conducted a comparative survey of other local governments utilizing the same radio technology as Metropolitan Nashville and Davidson County.
- **Evaluate the operations and staffing levels of the Radio Communication Services Division.** This included evaluating the adequacy of major work

practices, the extent of work planning and scheduling, the level of staffing in comparison to work output guidelines, the adequacy of service levels for the 800 MHz radio system, the balance between outsourced and in-house work, and other key operational aspects of the Division.

- **Evaluate organizational issues associated with Radio Communication Services Division.** This included a review of the location of the Radio Communication Services Division within the organization of Metropolitan Nashville and Davidson County, and the organizational structure of the Divisions.
- **Evaluate the adequacy of various management systems utilized by the Radio Communication Services Division.** The consulting team conducted a review of the policies and procedures, adequacy of strategic planning, network security, network planning, and adequacy of goals and objectives.

The following section presents a brief discussion of the project methodology.

2. PROJECT METHODOLOGIES

The processes utilized in developing this study are described below:

- Interviews were conducted with key staff from Metropolitan Nashville and Davidson County and the Radio Communication Service Division. The purpose of these interviews was to develop an understanding of potential issues with performance and operations of the Radio Communication Services Division.
- Conducted interviews with all of the staff of the Radio Communication Services Division to document operations and work practices.
- Through interviews, data collection and discussion with key staff, the consulting team documented the organization, operation, management systems, and staffing of the Radio Communication Services Division.
- Workload, work order, and actual expenditure data was reviewed and analyzed to determine labor hour allocation by activity to document actual costs and to up to date service charges.
- The consulting team utilized data, including workload, best management practices and comparative survey information to assess the organization, operations and staffing of the Radio Communication Services Division.

The following section presents the executive summary, which includes the findings, conclusions and recommendations developed by the Matrix Consulting Group.

4. EXECUTIVE SUMMARY

The Matrix Consulting Group has prepared a summary of the findings, and key recommendations contained in the attached report. This summary is presented in the table below.

NO.	RECOMMENDATION	PRIORITY	ANNUAL BUDGETARY IMPACT
Chapter 6 – Organization and Staffing			
6.1.1	The General Services Division Manager position should be reclassified	High	20,000
6.1.2	The three Communication Analyst 2 positions should be reclassified	High	\$39,000
6.2	Metropolitan Nashville and Davidson County should evaluate the appropriate organizational location for the Radio Communication Services Division.	Low	N/A
6.3	The Radio Communication Services Division should develop a formal agreement for consideration and adoption by the MRAM.	High	N/A
6.4	<p>The Radio Communication Services Division should balance the level of staffing with routine ongoing workload. The Division should take the following actions to address peak workload and bring staffing in balance with the routine, ongoing workload:</p> <ul style="list-style-type: none"> • The Radio Communication Services Division should outsource peak installation workload • The responsibility for providing technician support for the 800 MHz backbone should be insourced and the contract with Motorola for maintenance and repair of the 800 MHz backbone should be eliminated approximately 12 – 18 months after the vacant Radio Technician 3 position has been filled. • The number of authorized staff should be reduced by four vacant radio technician positions. • The vacant Radio Technician 3 position assigned to microwave backbone maintenance and repair should be reclassified and filled. 	<p>High</p> <p>High</p> <p>High</p> <p>High</p>	<p>\$30,000</p> <p>(\$173,550)</p> <p>(\$155,000)</p> <p>\$15,000</p>

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Performance Audit of the
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NO	RECOMMENDATION	PRIORITY	ANNUAL BUDGETARY IMPACT
Chapter 7 – Management Practices			
7.1	User fees should be updated in FY 2005/06	High	Unknown
7.2	A replacement fee should not be charged for subscriber equipment.	High	(\$1,474,683)
7.3	The MRAM should develop and adopt a policy and procedure for the annual updating of service fees by the Radio Communication Services Division	Medium	N/A
7.4	The Radio Communication Services Division should fully develop policies and procedures for the 800 MHz radio system.	High	N/A
7.5	The managers and supervisors of the Radio Communication Services Division should conduct a formal skills assessment of the knowledge and skills of each employee in the Division to ensure that training dollars are spent effectively, and develop minimum training standards for the Radio Technicians in the Division. The Radio Technicians assigned to the maintenance and repair of the microwave backbone should be provided with the full range of Motorola factory training.	High	\$5,000
Chapter 8 – Customer Services			
8.1	The routine, ongoing training of end users of the 800 MHz radio system needs to be upgraded significantly.	High	N/A
8.2	The Director of the OEM should design and provide training for major events or disasters including the effective use of the 800 MHz radio system.	High	N/A
8.3	The Radio Communication Services Division should conduct user surveys to assess the adequacy of training and the understanding of the 800 MHz radio system by end users.	Medium	N/A
8.4	The Radio Communication Services Division should establish service level agreements with its major customers.	Medium	N/A
8.5	The Radio Communication Services Division should be assigned responsibility for the review of requests for radio equipment, an assessment of the needs of the customer, and the development of recommendations for the tier of radio that should be provided to that customer. This role should be clarified in a policy developed by the Radio Communication Services Division.	Medium	Unknown

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NO.	RECOMMENDATION	PRIORITY	ANNUAL BUDGETARY IMPACT
Chapter 9 – Asset Management			
9.1	<p>A number of the practices used in the maintenance, repair, and operation of the 800 MHz backbone should be modified to enhance the reliability of the system</p> <ul style="list-style-type: none"> • The medical channels should be moved off the 2 GHz microwave at Cane Ridge, Sullivan Ridge and Joelton and relocated from the old site to the new 800 MHz sites as soon as possible. • The annual tower inspections should be expanded • All microwave tower sites should have copies of the FCC authorizations posted in the tower building for equipment that are installed at the site. • The GPS antenna be relocated inside the microwave backbone site buildings 	<p style="text-align: center;">High</p> <p style="text-align: center;">Medium</p> <p style="text-align: center;">Medium</p> <p style="text-align: center;">High</p>	<p style="text-align: center;">N/A</p> <p style="text-align: center;">\$5,000</p> <p style="text-align: center;">\$100 (One-Time)</p> <p style="text-align: center;">N/A</p>
9.2	The MRAM should adopt a policy assigning responsibility to the manager of the Radio Communications Services Division for approval and management of the installation of all equipment in the 800 MHz communication sites	High	N/A
9.3	The Radio Communication Services Division should acquire a computerized maintenance management system (CMMS).	Medium	\$30,000 (One-Time) \$5,000 annual licensing fees
9.4	The Division should develop a maintenance management system using the CMMS.	Medium	N/A
9.5	Radio Technicians should charge not less than 1,450 hours annually to work orders to assure the productivity of its staff and competitive hourly labor rates.	High	N/A
9.6	An additional compact pickup truck should be acquired for the Microwave Backbone and Repair Section	High	\$15,000 – One Time \$1,200 Ongoing
9.7	The Radio Technicians assigned to the Installation and Maintenance Section should be utilized to perform installations in the field or to perform subscriber unit maintenance and repair in the field when workload allows.	Medium	N/A

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NO.	RECOMMENDATION	PRIORITY	ANNUAL BUDGETARY IMPACT
Chapter 9 – Asset Management (Cont'd)			
9.8	The Radio Communication Services Division should develop an accurate inventory of subscriber equipment by reconciling these three inventories. The billing inventory and the inventory on the zone controller should be reconciled monthly.	Medium	N/A
9.9	The Radio Communication Services Division should address the limitations in fleet mapping for the 800 MHz radio system.	Medium	N/A
9.10	Metro should conduct a needs assessment to identify and document the mobile computing needs of the Police Department.	High	N/A
9.11	The Water Services Department convert to the 800 MHz radio system rather than use the Nextel system.	High	\$525,000 One-Time \$83,000 Ongoing
9.12	The Office of Emergency Management should provide the leadership in the development of a formal, written interoperability plan.	High	N/A
9.13	The Radio Communication Services Division should evaluate the adequacy of coverage, discuss with its customers particular problems areas in terms of coverage, and develop capital budget proposals for consideration of Metro to address these coverage problems.	High	\$500,000/site

The Matrix Consulting Group also evaluated the adequacy of the maintenance of the 800 MHz radio system backbone, and the transmission sites. A number of recommendations were developed as a result of this evaluation. These recommendations were discussed separately with management of the Radio Communication Services Division.

The chapters, which follow, present the findings, conclusions, and recommendations developed as a result of the performance audit of the Radio Communication Services Division.

2. PROFILE

2. PROFILE

The chapter presents a descriptive profile of the Radio Communication Services Division of Metropolitan Nashville and Davidson County. Information presented in the profile was collected through interviews with Division staff, as well as data provided by the Division. The profile is organized into sections that present information relating to budget, staffing and organization, and workload levels. The recommendations within this report are presented in chapters 6 through 9.

1. FISCAL YEAR 2003-04 EXPENDITURES FOR THE RADIO COMMUNICATION SERVICES DIVISION AMOUNT TO ALMOST \$3.1 MILLION.

The table below contains the audited statement of revenues and expenses for the Radio Communication Services Division for fiscal year 2003-04 from the fiscal year 2003-04 Comprehensive Annual Financial Report.

CASH FLOWS FROM OPERATING ACTIVITIES	
Revenue from operations	\$4,320,676
Payments to suppliers	2,090,447
Payments to employees	978,578
Net cash provided by operating activities	\$1,251,651
CASH FLOWS FROM NON-CAPITAL FINANCING ACTIVITIES	
Transfers in	\$214,320
Transfers out	(300)
Net cash provided in non-capital financing activities	\$214,020
CASH FLOWS FROM CAPITAL AND RELATED FINANCING ACTIVITIES	
Acquisition of capital assets	\$(85,728)
Proceeds from the sale of capital assets	0
Interest paid	0
Net cash used in capital and related financing activities	\$(85,728)
CASH FLOWS FROM INVESTING ACTIVITIES	
Purchase of investments	\$(5,908,678)
Proceeds from the sale and maturities of investment securities	5,101,049
Interest on investments	50,137
Net cash used in investing activities	\$(757,492)
NET CHANGES IN CASH AND CASH EQUIVALENTS	\$622,451
CASH AND CASH EQUIVALENTS AT THE BEGINNING OF YEAR	\$1,537,078
CASH AND CASH EQUIVALENTS AT END OF YEAR	\$2,159,529

As the data in the table indicate, the Radio Communications Division internal service fund is in a healthy financial position.

2. THE RADIO COMMUNICATIONS DIVISION INTERNAL SERVICE FUND IS IN GOOD FINANCIAL POSITION.

Data from the fiscal year 2003-04 Comprehensive Annual Financial Report for the Radio Communications Division internal services fund was analyzed to assess the financial position of the internal services fund. Important points to note concerning the financial position of the Radio Communications Division internal services fund are as follows:

- The current assets amounted to \$5,343,507 with the largest asset being investments (in the amount of \$2,538,395);
- The current liabilities amounted to \$325,997 with the largest liability being accrued payroll;
- The current ratio amounts to a healthy 16.32;
- The cash and cash equivalents at the beginning of the fiscal year amounted to \$1,537,078 at the beginning of the fiscal year and \$2,159,529 at the end of the fiscal year or a growth of \$622,451 or 40.5%; and
- The net cash provided by operating activities amounted to \$1,251,651.

Altogether, the Radio Communications Division internal service fund is in a healthy position. However, as will be noted later in this report, if the City wishes to utilize replacement funds within the internal service fund to replace subscriber equipment when it begins to reach the end of a standard lifecycle, the fund is significantly undercapitalized.

3. THE RADIO COMMUNICATION SERVICES DIVISION IS AUTHORIZED 22 STAFF.

The Radio Communication Services Division is assigned to the General Services

Department. The Division is authorized 22 staff, but there were six vacant positions at the commencement of this study including five radio technicians and the division-head position.

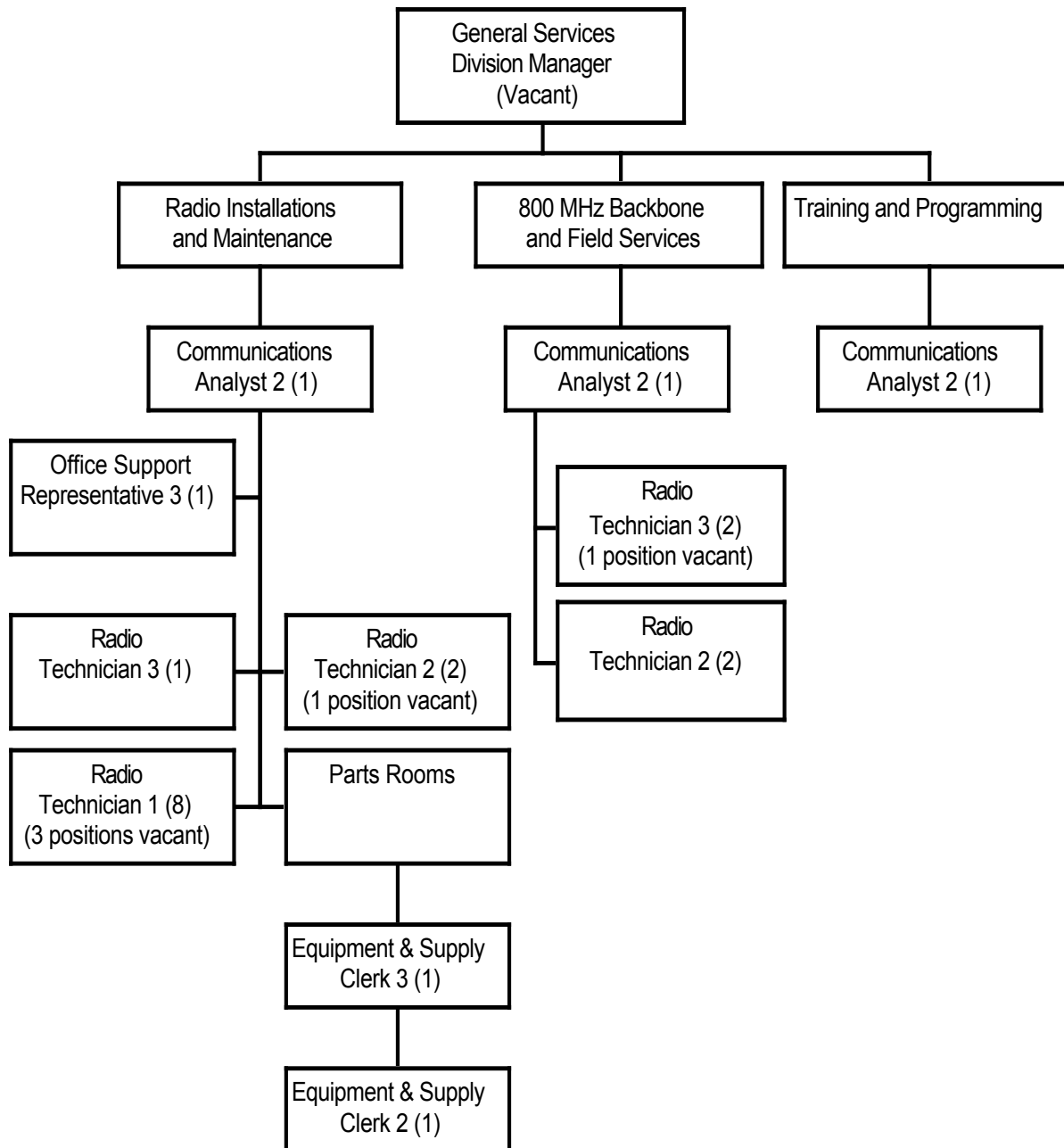
The division maintains and repairs the UHF, VHF, and 800 MHz radio systems for Metropolitan Nashville and Davidson County. This includes the following:

- Repair and maintenance of the backbone; and
- Maintenance, repair and installation of all communications and safety equipment in vehicles such as radios, light bars, cages, automatic vehicle locator devices.

The Radio Communication Services Division is organized into three sections. The plan of organization is presented in the exhibit following this page. This plan of organization reflects authorized and actual levels of staffing. Points to note regarding the plan of organization for the Radio Communication Services Division are presented below.

- **The Programming/Training Section was authorized one position: a Communication Analyst 2.** The Communication Analyst 2 is responsible for designing and maintaining templates for talk groups, maintaining the Federal Communication licenses for the UHF, VHF, and 800 MHz channels, maintaining the security groups within the zone controller, and provides end user training for the 800 MHz subscriber equipment. Approximately 13% of the available work hours of the Communication Analyst 2 were charged to work orders in 2003-2004. All of these work hours were charged to programming.
- **The Installation and Maintenance Section was authorized fifteen staff.** Staff are responsible for the installation of radios, cages, light bars, mobile computing terminals, sirens, maintaining and issuing parts, and maintaining, repairing and replacing this equipment when brought to the shop for repair. Based on an analysis of work orders in 2003- 2004, the technicians assigned to this section allocate 13% of the work hours allocated to work orders to maintenance and repair of the end user subscriber equipment, 84% to installation of end user subscriber equipment, and 3% of their work hours to programming. Approximately 57% of the available work hours of these technicians were charged to work orders in 2003-2004.

Current Plan of Organization Radio Communication Services Division



- **The Microwave Backbone Maintenance and Repair Section was authorized five staff.** This section is responsible for the maintenance and repair of the backbone, the field repair and maintenance of radios and other end user subscriber equipment, and the installation in the field of end user subscriber equipment. This staff is based at the Emergency Communication Center. Based upon an analysis of work orders in 2003- 2004, the technicians assigned to this section allocate 44% of the work hours allocated to work orders to maintenance and repair of the backbone, 33% of their work hours to maintenance and repair of end user subscriber equipment, 17% to installation of end user subscriber equipment, and 6% of their work hours to programming. Approximately 50% of the available work hours of these technicians were charged to work orders in 2003- 2004.

This staff works 7:30 a.m. to 4:00 p.m. Monday through Friday.

4. THE RADIO COMMUNICATION SERVICES DIVISION COMPLETED 5,453 WORK ORDERS IN 2003- 2004.

Installations represent a small proportion of the work orders completed by the Radio Communication Services Division, but installations represent more than one-half of the labor hours associated with these work orders (see the table below).

Cost Centers	Backbone		Radio Communications Division		Programming		Total	
	Hours	%	Hours	%	Hours	%	Hours	%
Backbone	1,024	41%	2	0%	0.00	0%	1,026	9%
Radio Maintenance and Repair	1,058	42%	2,916	33%	0.00	0%	3,974	34%
Installation	265	11%	5,661	64%	0.00	0%	5,925	51%
Program	152	6%	255	3%	234.95	100%	642	6%
Total	2,499	100%	8,833	100%	234.95	100%	11,567	100%

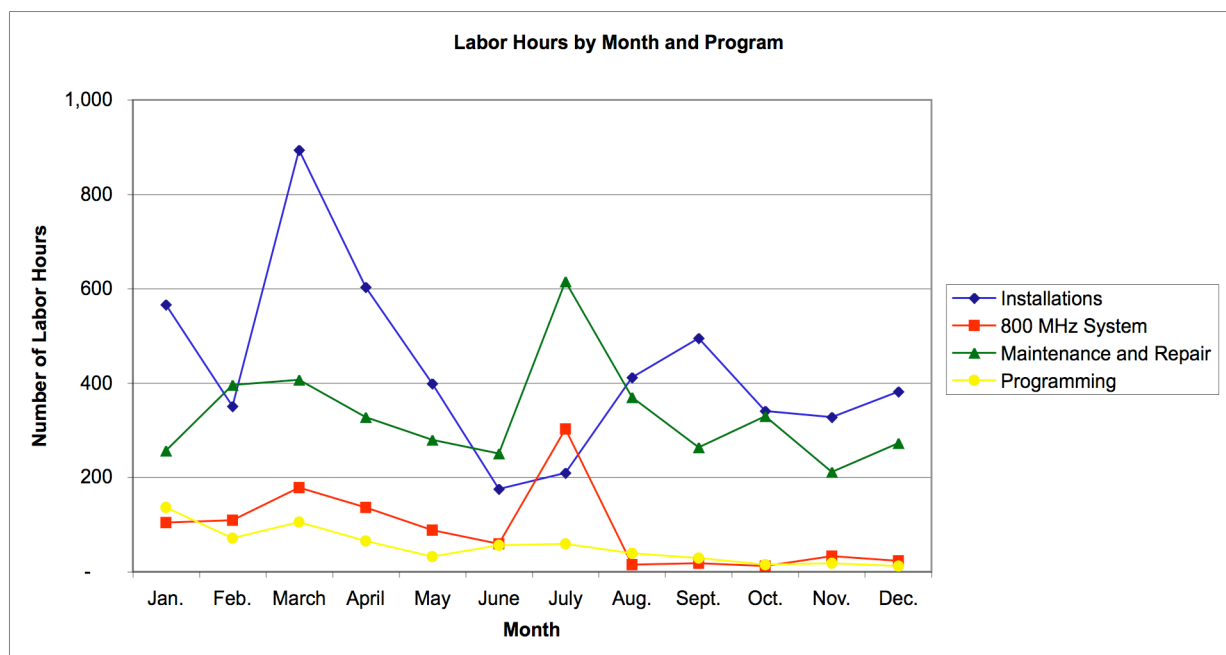
Important points to note concerning the data contained within the table are as follows:

- The labor hours associated with installation of radios, light bars, cages, etc. consumed 51% of the total labor hours in 2003-04;
- Maintenance and repair of radios consumed 34% of the total labor hours in 2003-04;
- The technicians allocated to maintenance and repair of the backbone allocated more of their labor hours in 2003-04 to maintenance and repair of radios, installation of radios, and programming of radios than to the maintenance and repair of the backbone;

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- While not indicated within the table, the annual hours charged by technicians to work orders varied considerably ranging from a low of 476 hours to a high of 1,485 hours with a median of 1,130 labor hours per technician for 2003-04;
- The amount of labor hours shown as charged to installations is not based upon actual labor hours, but rather a “flat rate” charged by the Division for the various types of installs; and
- The talents and skills of the Communication Analyst 2 assigned to Programming/Training appear to be underutilized as the Communication Analyst 2 charged almost 235 hours to work orders in 2003-04.

While the labor hours allocated to installation of radios consumed a little more than half the labor hours charged to work orders in 2003-04, this tends to be seasonal workload as the chart below indicates.



As the chart indicates, the labor hours charged to installation work orders peaked in March 2004, and required 400 hours a month or less for seven of the twelve months, including February, May, June, July, October, November, and December. In these seven months, an average of 311 labor hours were required for installation or the

equivalent of two and one-half technicians. The peak workload for installations – March – required a little more than seven technicians.

5. THE 800 MHz SYSTEM HAS SIGNIFICANT CAPACITY FOR GROWTH.

The current 800 MHz trunked public safety radio system was accepted by Metropolitan Nashville and Davidson County in April 2000. Federal Engineering (FE) completed a capacity study of this system in 2004. FE recommended that Metropolitan Nashville and Davidson County and NES proceed with the transition of voice units to data units. Even with the conversion of two voice channels to data, FE concluded that the voice system was lightly loaded and should accommodate the five-year growth, the agencies FE recommended for transition in their “Metro Nashville VHF/UHF Mobile Radio Assessment” report, and the agencies that expressed a desire to be transitioned to the 800 MHz voice system since the publishing of the FE report. Important points to note regarding the 800 MHz trunked public safety radio system are presented below.

- **There are a total of 45 channels allocated to the 800 MHz radio system.**
 - Thirty-six (36) simulcast voice channels divided into two subsystems A and B. The subsystems are networked with the Motorola Smartzone network manager.
 - Four (4) 19.2 Kbps RD-LAP data channels per site.
 - Two (2) AVL data channels at five sites.
 - Fire alerting MOSCAD system.
- **There are a total of seven microwave backbone tower sites.** The microwave backbone is a 6 GHz digital loop system. The backbone is capable of voice/data, analog/digital, conventional/trunked, wide/narrowband operation.
- **There are approximately 4,900 portable radios, mobile radios, and control or base stations owned by Metropolitan Nashville and Davidson County that utilize the 800 MHz radio system.** The five largest users of the 800 MHz system are as follows:

Department/Division	Number of Subscriber Units
Police	2,555
Fire	888
Public Works	269
Radio Communication Services	260
Sheriff's	200

These five departments/divisions represent almost 90% of all of the portable radios, mobile radios, and control stations within Metropolitan Nashville and Davidson County. The number of portable and mobile radios and control stations excludes mobile data terminals (MDT's), automatic vehicle locators (AVL), and Motorola supervisory control and data acquisition (MOSCAD) units. It should be noted that the Matrix Consulting Group was provided with three different inventories for the radio system from three different sources and that there were minor variances (3%) between these inventories in terms of the total number of radios.

- **Only 16% of the portable and mobile radios assigned to the Police Department are encrypted.** The Police Department has a total of 254 encrypted portable radios (out of a total of 1,361), and 164 encrypted mobile radios (out of a total of 1,175).
- **There are other public agencies that utilize the 800 MHz radio system.** These other agencies utilize approximately 1,400 mobile and portable radios and control stations. (These units are in addition to the 4,900 units mentioned previously). 70% of these 435 mobile and portable radios and control stations are assigned to Nashville Electric Service, and the Airport. The other agencies range from the media to Tennessee Highway Patrol to the Tennessee Bureau of Investigations.
- **The 800 MHz radio system has significant capacity for growth.** The analysis completed by Federal Engineering, dated July 2004, show that the peak utilization for System A and System B were 30% and 6.5% respectively.
- **The NES and the Police Department are utilizing the 800 MHz radio system for mobile data.** This system consists of a 19.2 Kbps RD-LAP (Radio Data Link Access Protocol) data system with 4 separate data channels: 1 for NES and 3 for the Police Department. This system capacity is available at all seven microwave tower sites. The Police Department has 600 mobile data terminals (MDT's).

Motorola manages the system under contract with Metropolitan Nashville and Davidson County. The Motorola system manager has a number of roles including the following:

- Manage the preventive maintenance of the 800 MHz microwave backbone by staff of the Radio Communication Services Division;
- Manage microwave backbone site maintenance including monthly inspections of all of the sites and the issuance of corrective work orders;
- Manage system emergency repair efforts and escalation response procedures;
- Review system demand information and quality reports generated by the system service database;
- Conduct regular, ongoing meetings with MRAM to review system performance and address technology and operational issues that arise;
- Manage and evaluate available system hardware and software upgrades and make recommendations to Metropolitan Nashville and Davidson County;
- Manage the implementation of all system upgrades performed by Motorola to insure total continuity and minimal system impact.

In addition, Motorola dedicates a technician to Metropolitan Nashville and Davidson County 800 MHz radio system on a full-time basis.

3. COMPARATIVE SURVEY

3. COMPARATIVE SURVEY

As part of the performance audit of the Radio Communications Services Division of Metropolitan Nashville and Davidson County (Metro), the Matrix Consulting Group conducted a comparative survey focusing on operations, staffing, and workload. The recommendations within this report are presented in chapters 6 through 9.

The consulting team developed a list of communities with which to compare the operations, staffing and workload of the Radio Communication Services Division. The table below presents the agencies, which participated in the comparative survey.

Agency	FY 05 Operating Budget	Number of End Users	Extent of Backbone	Number of Push to Talks
City of Charlotte, North Carolina	\$2,234,994	10,500	8 sites 33 channels	1.7 million per month and an additional 575,000 console calls per month
City of Memphis, Tennessee	N/A	5,810	5 sites / Simulcast 31 Channels	Not logged
Metropolitan Nashville and Davidson County	\$2,863,849	6,300*	7 sites 34 channels	1.6 million per month, plus an additional 548,337 console per month
Montgomery County, Maryland	\$2,400,000	8,000	11 Simulcast Sites, each with 20 trunked and 4 conventional channels	N / A
Orange County, Florida	\$2,000,000	6,500	11 sites 28 Channels	2.6 million per month
San Diego County, California	\$6,235,326	17,242	67 sites 18 site simulcast 167 800 MHz channels	Average 3 million per month

* The number of end users for Metro includes NES, Vanderbilt, the Airport and other local governments whose end user equipment are not maintained by the Radio Communications Division

These agencies were selected because (1) they utilize Motorola 800 MHz radio equipment, (2) several of these agencies had systems of comparable size to Metro such as Memphis, Montgomery County, Maryland, and Orange County, Florida, or (3) the

organizations had reputations as being well managed such as Charlotte, North Carolina and San Diego County, California.

The sections, which follow, provide an analysis of the results of the survey.

1. MOST LOCAL GOVERNMENTS USE A BALANCE OF IN-HOUSE STAFF AND CONTRACTORS FOR INSTALLATION OF SUBSCRIBER EQUIPMENT AND HAVE IN-HOUSE CAPACITY FOR SYSTEM ADMINISTRATION.

The survey requested information regarding the scope of services provided by these radio communication services divisions. This included areas such as the types of services provided for maintenance and installations and system and backbone maintenance. The table, which follows, provides the results.

Service	In – House	Does not Provide / Contract Out	Combination of In-House/Contract
Maintenance and Repair of Radios	City of Charlotte City of Memphis Montgomery County Orange County (FL) San Diego County Metro Nashville		
Maintenance and Repair of Backbone	City of Charlotte City of Memphis Montgomery County San Diego County	Orange County (FL)	Metro Nashville
Installations of Mobile Radios	Memphis Orange County (FL) Metro Nashville	Montgomery County	Charlotte San Diego County
Installation of Light Bars	Memphis Metro Nashville	Montgomery County Orange County (FL) San Diego County	Charlotte
Installations of Cages in Patrol Cars	Metro Nashville	Memphis Montgomery County Orange County (FL) San Diego County	Charlotte
Manage / Serve as system administrator for the 800 MHz System	City of Charlotte City of Memphis Orange County (FL) San Diego County	Montgomery County	Metro Nashville
Does the Division purchase extended warranties for mobile and portable radios?	City of Charlotte City of Memphis Montgomery County Orange County (FL) San Diego County Metro Nashville		

The trends in practices evident from these other governmental agencies as it pertains to Metropolitan Nashville and Davidson County are presented below.

- **Almost All of the Local Governments That Participated in the Comparative Survey Maintain and Repair their Portable and Mobile Radios and Their Microwave Backbone with In-House Staff.** With the exception of Orange County, Florida, all of the agencies perform the maintenance and repair of the radio subscriber equipment and backbone with in-house staff. Orange County, Florida contracts out the maintenance and repair of the infrastructure.
- **Almost All of These Local Governments “Depot” the Significant Maintenance and Repair of Their Portable and Mobile Radios With the Exception of San Diego County.** In essence, these local governments “triage” their subscriber equipment. If the repair is simple, the repair is performed with in-house staff. This would include such repairs as the battery, a knob, flash upgrade, or programming change, etc. Repairs more significant than that are shipped to Motorola for repair as part of the extended warranty program. Only San Diego County appears to be making board repairs to any extent.
- **Three of the Five Local Governments Contract Out All or A Portion of the Installation of their Mobile Radios.** Montgomery County is the only local government that contracts out all of the installations of portable and mobile radios. However, San Diego County and the City of Charlotte contract out portions of their installations focusing on peak workload.
- **None of These Local Governments Utilize Their Radio Technicians To Install Cages in Patrol Cars.** Metro performs all of these services in-house (and by the Radio Communication Services Division staff). Similarly, most of these local governments do not utilize their radio technicians to install light bars with the exception of Charlotte and Memphis. Charlotte, however, also uses contractors to perform approximately one-half of the light bar installations.
- **Staff in all of these local governments, except for Montgomery County, serve as the system administrator / manager for the 800 MHz Systems.** All of these local governments, with the exception of Montgomery County, have developed an in-house capacity for system management.

There are a number of implications for the work practices utilized by the Radio Communication Services Division that can be drawn from these local governments.

These implications are presented below.

- The staff of the Radio Communications Division should maintain and repair the portable and mobile radios owned and operated by Metro;

- The Radio Communications Division should ““triage” their subscriber equipment and, If the repair is simple (battery, a knob, flash upgrade, or programming change, etc.), perform the repair with in-house staff, and if the repair is more complex, ship the subscriber unit to Motorola for repair as part of the extended warranty program;
- The Radio Communications Division should purchase extended warranties for subscriber equipment;
- The Radio Communications Division should contract out a portion of the installation of mobile radios, MDT’s etc., focusing on peak workload; and
- The Radio Communications Division should develop an in-house capacity over the long-term for system administration and management of the 800 MHz radio system.

The Radio Communications Division meets all of these work practices with three exceptions. It does not contract peak installation workload. It is utilizing a radio technician to perform repairs of subscriber equipment that exceed simple repairs. The Radio Communications Division does not have the capacity for system administration and management at the present time.

2. NONE OF THE LOCAL GOVERNMENTS UTILIZE A REPLACEMENT FUND FOR RADIO EQUIPMENT.

The local governments that participated in the comparative survey were asked to provide information relating to replacement cycles and replacement funds. The following table presents the summary of the responses.

Question	Yes	No
Does the division have established replacement cycles for end user equipment?	Montgomery County	City of Charlotte City of Memphis Metro Nashville Orange County (FL) San Diego County
Does the division have a replacement fund?	Metro Nashville, but the capital replacement fund is too low.	City of Charlotte City of Memphis Montgomery County Orange County (FL) San Diego County

The points below present a discussion of the information presented in the table.

- **None of the Other Local Governments Charge a Fee for Replacement of Their Subscriber Equipment.** All of the responding local governments indicated that they do not have a replacement fund for radio equipment.
- **With the Exception of Montgomery County, None of the Local Governments Have Established Replacement Guidelines for End User Equipment.** Montgomery County replaces end user equipment on an 8 to 10 year cycle. San Diego County recommends a seven-year replacement cycle, but does not have a formal guideline.

There are a number of implications for the work practices utilized by the Radio Communication Services Division that can be drawn from these local governments.

These implications are presented below.

- Metro should not charge a fee for replacement of subscriber equipment (particularly given the significant undercapitalization of replacement requirements), but should budget for replacement as the needs arise;
- Metro should not establish formal replacement guidelines for subscriber equipment. The Radio Communications Division and the customer should make the decisions regarding replacement of subscriber equipment and on a case-by-case basis based upon the frequency of breakdowns and the expense of repairs. Equipment manufactured by Motorola has proven to highly reliable. This includes instances in which radios have fallen in the river, been dried, and continued to function.

The Radio Communications Division does, in fact, charge a replacement fee, but has not developed formal replacement guidelines.

3. THE LOCAL GOVERNMENTS HAVE A HIGHER RATIO OF RADIO SUBSCRIBER EQUIPMENT PER TECHNICIAN THAN THE RADIO COMMUNICATIONS DIVISION.

On average, the number of radios per radio technician assigned to installs, maintenance and repair of subscriber equipment for these six local governments is 1,170. This excludes technicians assigned to the maintenance and repair of the backbone. The chart below presents a comparison to Metro.

METROPOLITAN NASHVILLE & DAVIDSON COUNTY
Performance Audit of the
Radio Communication Services Division

Local Government	No. of Subscriber Units	Number of Staff	Subscriber Units/Staff	Notes
Charlotte	10,500	4	2,625	Excludes supervisor
Metro Nashville	4,900	11	445	Excludes supervisor
Memphis	5,810	11	528	
Montgomery County	8,000	5	1,600	
Orange County (FL)	6,500	3	2,167	Excludes supervisor
San Diego County	17,242	18	958	

As the chart indicates, Metro Nashville has significantly fewer subscriber units per radio technician when compared to the other local governments. More specifically:

- The City of Charlotte allocates four electronic technicians to the maintenance, repair, and installs of radios for 10,500 radios or 2,625 radios per technician;
- The City of Memphis allocates 7 shop technicians and 4 installers to the maintenance, repair and installs of radios for 5,810 radios or 528 radios per technician;
- Montgomery County allocates an estimated 5 technicians to the maintenance and repair of 8,000 radios or 1,600 radios per technician;
- Orange County, Florida allocates 3 technicians to the maintenance, repair and installation of radios or 2,167 radios per technician;
- San Diego County allocates 18 technicians to the maintenance, repair, and installation of radios or 958 radios per technician; and
- Metropolitan Nashville and Davidson County allocates 11 technicians to the maintenance, repair, and installation of 4,900 radios or 445 radios per technician. However, this includes 4 authorized, but unfilled, positions. If only filled positions were considered, the ratio would be 700 radios per technician.

The median for staffing of installs, maintenance and repair of subscriber equipment for these six local governments is 1,170 radios per technician. While these comparisons do not constitute a workload analysis, the comparisons do indicate that the level of staffing Radio Communications Division exceeds these other cities and counties, even considering the vacant positions. If the level of staffing within the Radio Communications Division was comparable to these other cities and counties, it would

be allocated four radio technicians or seven fewer than authorized and three fewer than currently filled. These other local governments have achieved this benchmark through greater reliance on contractors.

4. THE RADIO COMMUNICATIONS DIVISION’S EXPENDITURES PER RADIO ARE HIGHER THAN THESE OTHER LOCAL GOVERNMENTS.

One of the questions within the comparative survey was operating budget for each Radio Communications Division in each local government. The Radio Communication Services Division for Metro Nashville spends more per radio than these other local governments as indicated in the table below.

Local Government	04/04 Budget	Subscriber Equipment	Budget/Subscriber equipment
Charlotte	\$2,234,994	10,500	\$213
Metro Nashville	\$3,000,000	6,300*	\$481
Montgomery County	\$2,400,000	8,000	\$300
Orange County (FL)	\$2,000,000	6,500	\$308
San Diego County	\$6,235,326	17,242	\$362

* The number of end users for Metro includes NES, Vanderbilt, the Airport and other local governments whose end user equipment are not maintained by the Radio Communications Division

There are a number of implications for the work practices utilized by the Radio Communication Services Division that can be drawn from these local governments. These implications are presented below.

- **The Higher Ratio of Staffing in the Radio Communication Services Division In Comparison To These Other Local Governments Increases the Expenditures Per Radio for Metro.** If the Radio Communications Division met the benchmark of these local governments, it would have seven fewer radio technicians than authorized and three fewer than currently filled.
- **The contracts with Motorola for system management and technical assistance impacts the expenditures per radio for Metro.** These contracts are not insignificant expenditures. These contracts were absolutely necessary at system acceptance and at the present time given the present skills and capacity of the Radio Communications Division. As noted previously, however, all of the five local governments, with the exception of Montgomery County, have developed an in-house capacity for system management.

If the Radio Communications Division was spending at the average for these other local governments, it would be spending approximately \$1.25 million less annually than it is currently (given the current number of subscriber equipment).

5. RADIO INSTALLATION FEES FOR METROPOLITAN NASHVILLE AND DAVIDSON COUNTY ARE HIGHER THAN OTHER LOCAL GOVERNMENTS.

A comparison of the 800 MHz radio system user fees for the local governments that participated in the comparative survey indicates that Metro Nashville charges comparable rates for maintenance and 800 MHz radio system access, but higher rates for installations. The Radio Communications Service Division in Metro Nashville charges higher fees for maintenance and access than these other local governments.

However, the Radio Communications Service Division of Metro Nashville charges higher fees for installation than these other local governments. The chart, below, presents a comparison of the installation rates for patrol cars. (Note: this excludes some of the charges by the Radio Communications Division such as the light bar, cage, etc. since these other local governments contract for this service).

Agency	Patrol Car
Charlotte	\$575
Metro Nashville	\$971
Montgomery County	\$650
San Diego County	\$420
Median	\$613
Difference	58%

The cost to provide the installation services in Metro Nashville is higher than these other local governments. The median cost is \$613 per installation for patrol cars. Metro Nashville charges \$971.

There are a number of implications for the work practices utilized by the Radio Communication Services Division that can be drawn from these local governments.

These implications are presented below.

- **These Other Local Governments Contract Entirely Or Contract Out Peak Workload For Installations.** The Radio Communications Division has relied exclusively on in-house staff for installation of radios, sirens, light bars, cages, etc. These other local governments in the table above utilize contractors or a mix of in-house staff and contractors.
- **These Other Local Governments That Use A Mix of In-House Staff and Contractors Rely On A Staffing Philosophy That Authorizes Staff For the Average and Not The Peak Installation Workload.** Both Charlotte and San Diego County largely balance the workload between in-house staff and contractors for installation of mobile radios.

The Radio Communications Division does not meet these work practices. It has relied exclusively on in-house staff for peak installation workload. The Radio Communications Division has staffed for peak workload.

4. CUSTOMER SATISFACTION SURVEY

4. CUSTOMER SATISFACTION SURVEY

This chapter presents a review of the data contained in the customer satisfaction questionnaire. The recommendations within this report are presented in chapters 6 through 9.

A sample of staff within the Police and Fire Departments completed a customer satisfaction questionnaire regarding the 800 MHz radio system. The table below presents the number of responses received.

Department	Number of Questionnaires Received
Police Department	161
Fire Department	54
Total	215

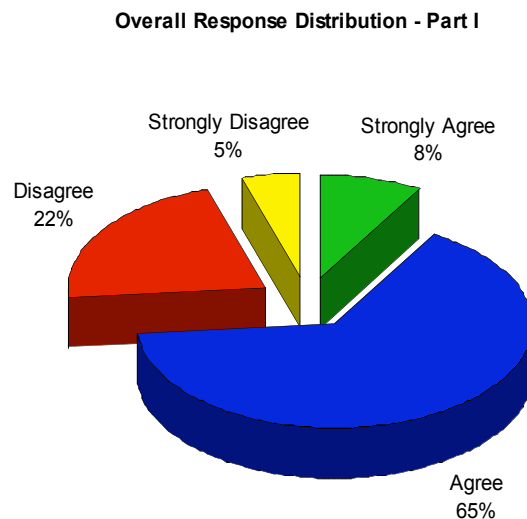
The survey was organized into two sections. The first section asked respondents to select a response to a series of statements regarding the 800 MHz radio system (such as “the initial training I received in the use of operation of my 800 MHz radio was adequate). Respondents were asked to select ‘strongly agree,’ ‘agree,’ ‘neutral,’ ‘disagree,’ or ‘strongly disagree’ to these statements.

The second section of the questionnaire presented a list of potential improvements that may or may not make the 800 MHz radio system more useful and effective. Respondents were asked to select a number from one to ten to rate the importance of these improvements ranging from ‘not important’ (one) to ‘extremely important’ (ten).

The sections that follow present a discussion of the responses for each of the sections.

1. THE POLICE DEPARTMENT STAFF VIEW THE 800 MHZ SYSTEM POSITIVELY.

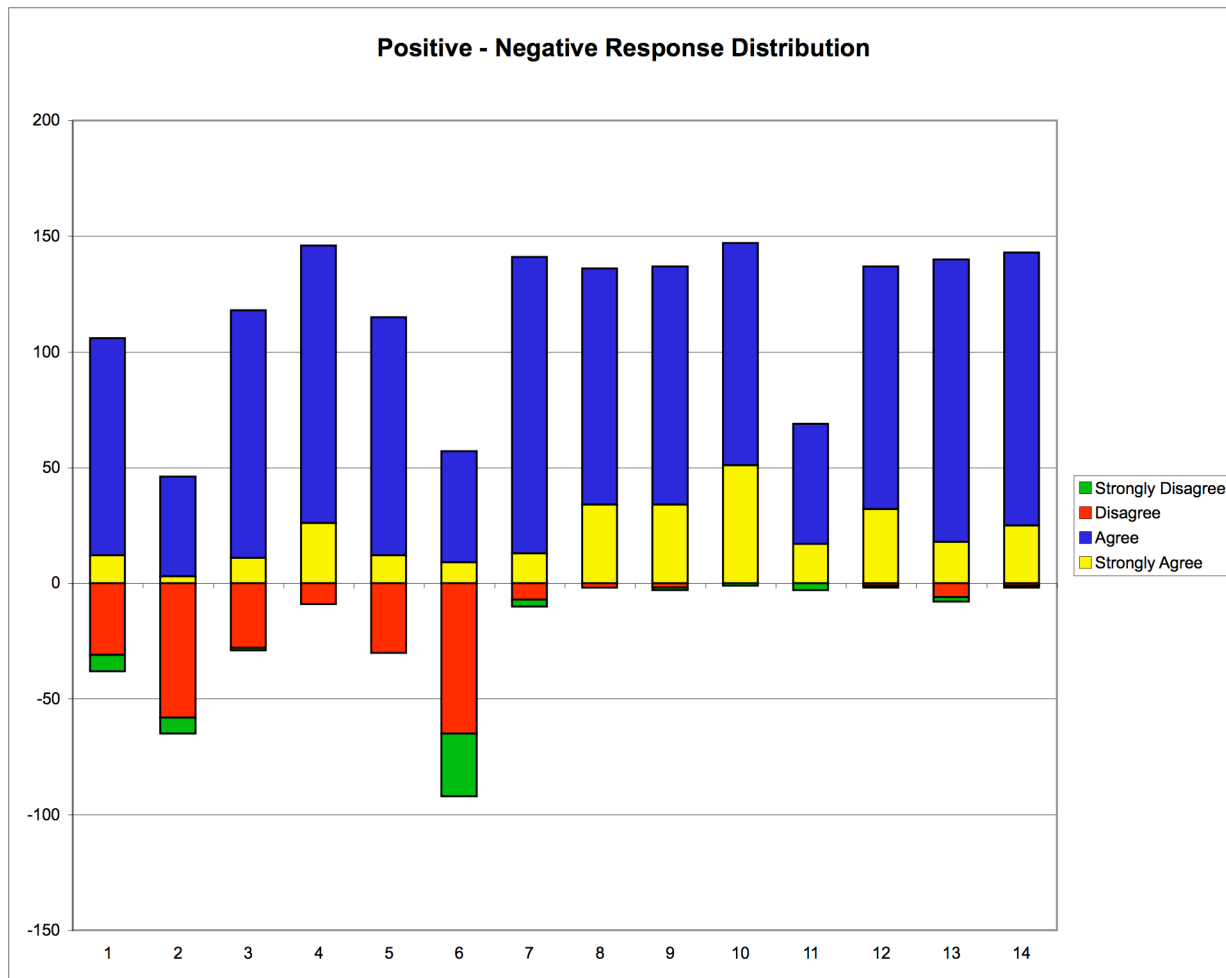
Responses were reviewed to determine the overall percentage of positive and negative responses. The chart below presents the results for the first section of the questionnaire. It should be noted that 'neutral' responses were excluded from the chart below.



The response to the questions in the first part of the customer satisfaction questionnaire indicates a high degree of satisfaction by these customers with the 800 MHz radio system. As the chart illustrates, the 73% of the respondents provided positive responses to the statements by selecting either 'strongly agree' or 'agree.' 27% of respondents provided negative responses by selecting 'disagree' or 'strongly disagree.'

To gain a more detailed sense of the responses from the first section of the customer satisfaction questionnaire, it is useful to look in more detail at the statements that elicited the strongest positive and negative responses. The chart, found below, plots the actual number of positive and negative responses for each statement.

Statement numbers from the questionnaire are shown along the bottom of the chart.
Neutral responses are excluded.



As the chart shows, respondents in the Police Department generally had a positive perspective regarding the 800 MHz system in Metropolitan Nashville and Davidson County. The specific questions posed in this survey, in numerical order, are presented below.

1. The initial training I received in the use and operation of my 800 MHz radio was adequate.
2. I have access to additional ongoing training in the use of the 800 MHz radio system if I need it.

3. I have a good understanding of how to use most of the features of my 800 MHz radio.
4. Under normal conditions, I am able to use the 800 MHz radio system without delay.
5. During major incidents or events, I am able to use the 800 MHz radio system without delay.
6. The coverage provided by the 800 MHz radio system is adequate. There aren't any "dead spots" in the 800 MHz radio system that prevent me from communicating with the communications center or other staff
7. Overall, the 800 MHz radio system meets my needs.
8. The Radio Shop does a good job of diagnosing and fixing the problems with my 800 MHz radio when I bring my radio in for repair.
9. The Radio Shop is effective at completing repairs to my radio without the necessity to bring the radios back a second time to fix the same problem
10. The staff of the Radio Shop is courteous and helpful in working with us to resolve problems with our 800 MHz radios.
11. The response by the Radio Shop to emergency calls is responsive and timely.
12. I am satisfied with the turnaround time for completion of repairs by the Radio Shop.
13. The 800 MHz radio system is reliable.
14. The services provided by the Radio Shop meet my expectations.

The points that follow, present the results for these questions by theme or topic area.

(1) While Initial Training Was Perceived as Adequate, Concerns Were Expressed Regarding the Adequacy of Ongoing Training.

Three statements within the questionnaire focused on the adequacy of training: the initial training, ongoing training and the extent that staff of the Police Department

understands how to use the features of their 800 MHz radio. The responses by the employees of the Police Department to the statements are presented below.

- 66% of the respondents agreed or strongly agreed that the initial training they received in the use and operation of my 800 MHz radio was adequate. 24% of the respondents disagreed. (Question #1)
- 40% of the respondents did not agree that they have access to additional ongoing training in the use of the 800 MHz radio system if they needed it. 29% of the respondents agreed that they had that access to additional ongoing training, while 31% of the respondents indicated that they were neutral. (Question #2)
- 74% of the respondents indicated that they had a good understanding of how to use most of the features of my 800 MHz radio. However, 18% of the respondents indicated that they did not have a good understanding. (Question #3)

Overall, a high preponderance of the respondents indicated that they had a good understanding of how to utilize the features of their 800 MHz radio. The concern is that almost one out of five (18%) of the employees of the Police Department that disagreed with this statement.

(2) The Respondents Indicated that They Are Able To Use The 800 MHz Radio System Without Delay.

The ability to use the 800 MHz radio system without delay or “busies” is a critical design and performance component of a public safety radio system such as the 800 MHz radio system. A variety of material indicates that Metropolitan Nashville and Davidson County’s 800 MHz radio system has significant capacity and that the extent of “busies” is minimal. For example:

- Federal Engineering in 2002 completed an analysis of the capacity of the 800 MHz radio system to accommodate growth in the number of subscriber units and end users over a five-year period. Federal Engineering recommended that Metropolitan Nashville and Davidson County and NES proceed with the transition of voice units to the 800 MHz system. Even with the conversion of two voice channels to data, Federal Engineering concluded that the voice system was lightly loaded and that the 800 MHz radio system should accommodate the five-year growth, the agencies Federal Engineering recommended for transition in

“Metro Nashville VHF/UHF Mobile Radio Assessment” report, and the agencies that expressed a desire to be transitioned to the 800 MHz voice system since the publishing of the Federal Engineering report.

- An analysis of the extent of system busies for the month of July 2004 found that there were 52 busies out of a total of 1,059,500 calls during that month.

The response by the staff of the Police Department supported that the 800 MHz radio system is a robust system. This is evident in the statements and the responses by the employees of the Police Department as noted below.

- 91% of the respondents agreed with the statement that under normal conditions, they are able to use the 800 MHz radio system without delay. (Question #4)
- 71% of the respondents agreed with the statement that during major incidents or events, they are able to use the 800 MHz system without delay. 10% of the respondents had no opinion and 19% disagreed with the statement. (Question #5)

While the respondents agree that the system under normal conditions is capable of meeting their needs without delay, 19% of the respondents indicated that there were problems using the system during major incidents or events.

(3) The Respondents Indicated That the 800 MHz Radio System Met Their Needs With the Exception of Coverage.

A number of statements in the questionnaire asked respondents how well the 800 MHz radio system met their needs. Overall, most respondents indicated that the 800 MHz radio met their needs with the exception of the adequacy of radio coverage.

The responses to these statements are presented below.

- 35% of the respondents agreed with the statement that the coverage provided by the 800 MHz radio system was adequate, and that there were not any ‘dead spots’ in the 800 MHz radio system that prevented them from communicating with the communications center or other staff. However, 57% of the respondents disagreed with that statement, while 7% of the respondents had no opinion. (Question #6)

- 88% of the respondents agreed with the statement that, overall, the 800 MHz radio system meet their needs. Only 6% of the respondents disagreed with that statement. (Question #7)
- 88% of the respondents agreed with the statement that the 800 MHz radio was reliable. Only 5% of the respondents disagreed with that statement. (Question #13)

A high proportion of the respondents believe the radio system meets their needs and is reliable, but are concerned regarding the adequacy of radio coverage.

(4) The Respondents Indicated That the Radio Communication Services Division Provided Responsive Customer Service.

A number of statements within the questionnaire focused on the responsiveness of the customer service provided by the Radio Communication Services Division. These statements and the response to these statements are provided below.

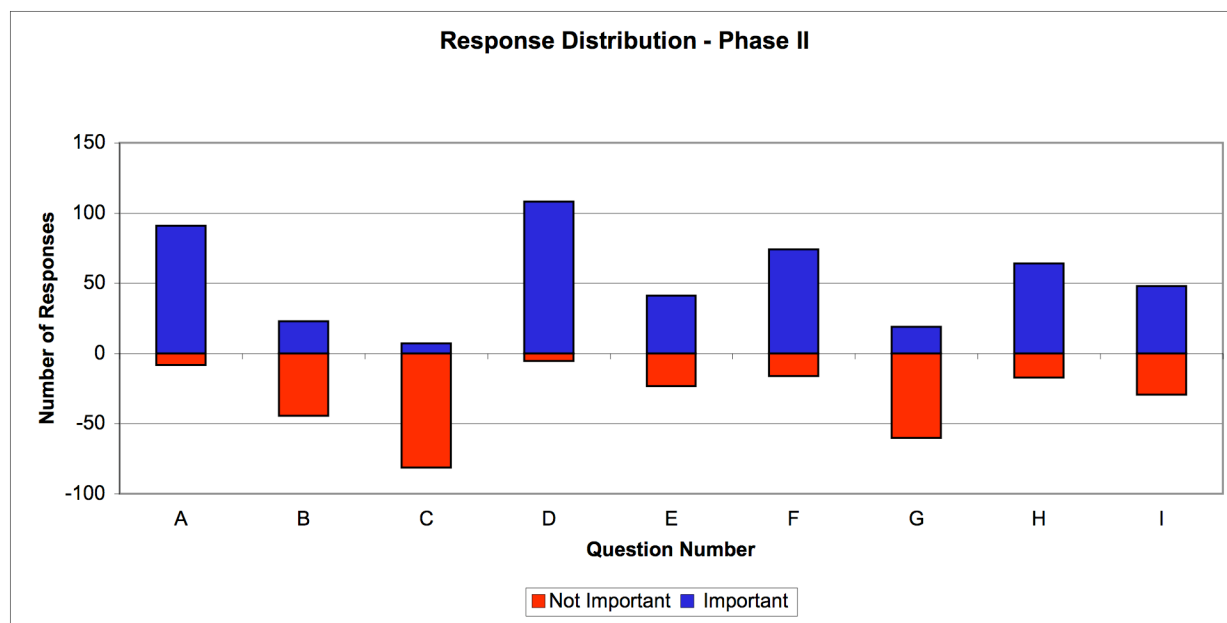
- 84% of the respondents agreed with the statement that the Radio Communications Division did a good job of diagnosing and fixing the problems with their 800 MHz radio when they brought their radio in for repair. Only 1% of the respondents disagreed with that statement. (Question #8)
- 85% of the respondents agreed with the statement that the Radio Communications Division was effective at completing repairs to their radio without the necessity to bring the radios back a second time to fix the same problem. Only 2% of the respondents disagreed with that statement. (Question #9)
- 91% of the respondents agreed with the statement that the staff of the Radio Communications Division is courteous and helpful in working with us to resolve our problems. Only 1% of the respondents disagreed with that statement. (Question #10)
- 43% of the respondents agreed that the response by the Radio Communications Division to emergency calls was responsive and timely. 55% of the respondents were neutral to the statement. (Question #11)
- 85% of the respondents agreed with the statement that they were satisfied with the turnaround time for completion of repairs by the Radio Communications Division. Only 1% of the respondents disagreed with that statement. (Question #12)

- 89% of the respondents agreed with the statement that the services provided by the Radio Communications Division meet their expectation. Only 1% of the respondents disagreed with that statement. (Question #14)

As the points above show, the Police Department respondents maintained overall positive perceptions and attitudes.

(5) Elimination of Dead Spots Was Identified as an Important Opportunity for Improvement.

The second section of the questionnaire presented a list of potential improvements that may or may not make the 800 MHZ radio system more useful and effective. Respondents were asked to select a number from one to ten to rate the importance of these improvements ranging from 'not important' (one) to 'extremely important' (ten). The chart below presents the responses for each statement. Statement numbers from the questionnaire are shown along the bottom of the chart.



The points, which follow, present the statements associated with each letter (A, B, C, D, etc.) on the x-axis, as well as the percentage (%) of respondents selecting important as the response for that statement.

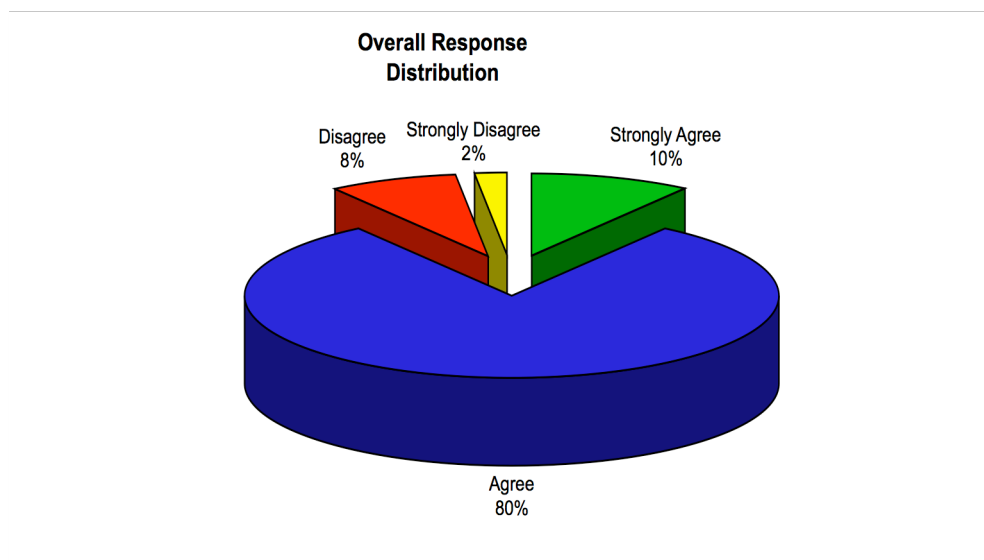
- 59% of the respondents agreed with statement A: reduce the extent of busies (those times when you push-to-talk and get a busy signal). 36% of the respondents were neutral, while 5% of the respondents indicated that this was not important.
- 15% of the respondents agreed with statement B: add to the number of talk groups. 56% of the respondents were neutral, while 29% of the respondents indicated that this was not important.
- 5% of the respondents agreed with statement C: reduce the number of talk groups. 42% of the respondents were neutral, while 42% of the respondents indicated that this was not important.
- 70% of the respondents agreed with statement D: reduce radio dead spots where the 800 MHz radio system does not work. 27% of the respondents were neutral
- 26% of the respondents agreed with statement E: provide additional training in the use of the 800 MHz radio system. 59% of the respondents were neutral, while 15% of the respondents indicated that this was not important.
- 48% of the respondents agreed with statement F: provide the ability to talk with agencies that I cannot talk with today using the 800 MHz radio system. 42% of the respondents were neutral, while 10% of the respondents indicated that this was not important.
- 13% of the respondents agreed with statement G: Provide additional radio equipment. 47% of the respondents were neutral, while 40% of the respondents indicated that this was not important.
- 42% of the respondents agreed with statement H' provide / enhance mobile data capability. 47% of the respondents were neutral, while 40% of the respondents indicated that this was not important.
- 31% of the respondents agreed with statement I: develop formal procedures for radio use during major incidents or emergencies. 50% of the respondents were neutral, while 19% of the respondents indicated that this was not important.

As these points demonstrate, there were several key areas that were important to the respondents from the Police Department. Those key areas included reduction of radio dead spots where the 800 MHz radio system doesn't work, providing the ability to talk with agencies that they cannot talk with today using the 800 MHz radio system,

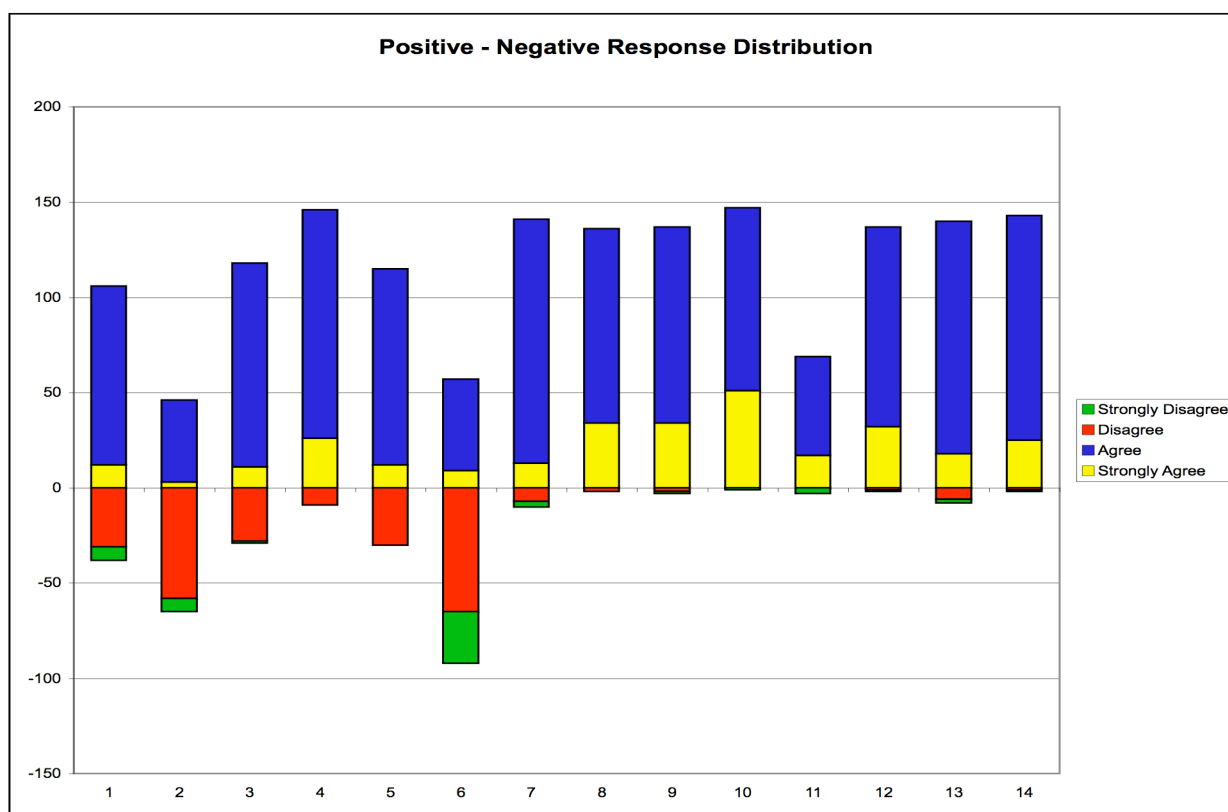
reduction of busies (those times when you push-to-talk and get a busy signal), providing/enhancing mobile data capability, and formal procedures for radio use during major events or incidents. Conversely, there were a number of areas that the respondents indicated were not important. These include reducing the number of talk groups, and providing additional radio equipment.

2. THE FIRE DEPARTMENT STAFF VIEW THE 800 MHz SYSTEM POSITIVELY.

Responses were reviewed to determine the overall percentage of positive and negative responses. The chart below presents the results for the first section of the questionnaire. It should be noted that 'neutral' responses were excluded from the chart below. The response to the questions in the first part of the customer satisfaction questionnaire indicates a high degree of satisfaction by these customers with the 800 MHz radio system. As the chart illustrates, the 90% of the respondents provided positive responses to the statements by selecting either 'strongly agree' or 'agree.' 10% of respondents provided negative responses by selecting 'disagree' or 'strongly disagree.'



To gain a more detailed sense of the responses from the first section of the customer satisfaction questionnaire, it is useful to look in more detail at the statements that elicited the strongest positive and negative responses. The chart, found below, plots the actual number of positive and negative responses for each statement. Statement numbers from the questionnaire are shown along the bottom of the chart. Neutral responses are excluded.



As the chart shows, respondents in the Fire Department generally had a positive perspective regarding the 800 MHz system in Metropolitan Nashville and Davidson County. The specific questions posed in this survey, in numerical order, are presented below.

1. The initial training I received in the use and operation of my 800 MHz radio was adequate.

2. I have access to additional ongoing training in the use of the 800 MHz radio system if I need it.
3. I have a good understanding of how to use most of the features of my 800 MHz radio.
4. Under normal conditions, I am able to use the 800 MHz radio system without delay.
5. During major incidents or events, I am able to use the 800 MHz radio system without delay.
6. The coverage provided by the 800 MHz radio system is adequate. There aren't any "dead spots" in the 800 MHz radio system that prevent me from communicating with the communications center or other staff
7. Overall, the 800 MHz radio system meets my needs.
8. The Radio Shop does a good job of diagnosing and fixing the problems with my 800 MHz radio when I bring my radio in for repair.
9. The Radio Shop is effective at completing repairs to my radio without the necessity to bring the radios back a second time to fix the same problem
10. The staff of the Radio Shop is courteous and helpful in working with us to resolve problems with our 800 MHz radios.
11. The response by the Radio Shop to emergency calls is responsive and timely.
12. I am satisfied with the turnaround time for completion of repairs by the Radio Shop.
13. The 800 MHz radio system is reliable.
14. The services provided by the Radio Shop meet my expectations.

The points that follow, present the results for these questions by theme or topic area.

(1) While Initial Training Was Perceived as Adequate, Concerns Were Expressed Regarding the Adequacy of Ongoing Training.

Three statements within the questionnaire focused on the adequacy of training: the initial training, ongoing training and the extent that staff of the Fire Department

understands how to use the features of their 800 MHz radio. These two statements and the responses by the employees of the Fire Department to the statements are presented below.

- 87% of the respondents agreed or strongly agreed that the initial training they received in the use and operation of my 800 MHz radio was adequate. 9% of the respondents disagreed. (Question #1)
- 28% of the respondents did not agree that they have access to additional ongoing training in the use of the 800 MHz radio system if they needed it. 46% of the respondents agreed that they had that access to additional ongoing training, while 26% of the respondents indicated that they were neutral. (Question #2)
- 70% of the respondents indicated that they had a good understanding of how to use most of the features of my 800 MHz radio. However, 15% of the respondents indicated that they did not have a good understanding. (Question #3)

Overall, a high preponderance of the respondents indicated that they had a good understanding of how to utilize the features of their 800 MHz radio. The concern is that almost one out of seven (15%) of the employees of the Fire Department that disagreed with this statement.

(2) The Respondents Indicated That They Are Able to Use the 800 MHz Radio System Without Delay.

The response by the staff of the Fire Department supported that the 800 MHz radio system is a robust system.

This is evident in the statements and the responses by the employees of the Fire Department as noted below.

- 94% of the respondents agreed with the statement that under normal conditions, they are able to use the 800 M Hz radio system without delay. (Question #4)
- 69% of the respondents agreed with the statement that during major incidents or events, they are able to use the 800 MHz system without delay. 4% of the respondents had no opinion and 27% disagreed with the statement. (Question #5)

While the respondents agree that the system under normal conditions is capable of meeting their needs without delay, 27% of the respondents indicated that there were problems using the system during major incidents or events.

(3) The Respondents Indicated That the 800 MHz Radio System Met Their Needs With the Exception of Coverage.

A number of statements in the questionnaire asked respondents how well the 800 MHz radio system met their needs. Overall, most respondents indicated that the 800 MHz radio met their needs with the exception of the adequacy of radio coverage. The responses to these statements are presented below.

- 64% of the respondents agreed with the statement that the coverage provided by the 800 MHz radio system was adequate, and that there were not any 'dead spots' in the 800 MHz radio system that prevented them from communicating with the communications center or other staff. 34% of the respondents disagreed with that statement, while 2% of the respondents had no opinion. (Question #6)
- 91% of the respondents agreed with the statement that, overall, the 800 MHz radio system meet their needs. Only 2% of the respondents disagreed with that statement. (Question #7)
- 81% of the respondents agreed with the statement that the 800 MHz radio was reliable. Only 9% of the respondents disagreed with that statement. (Question #13)

Clearly, a high proportion of the respondents believe that the 800 MHz radio system meets their needs and is reliable. Equally as clearly, there are clear concerns regarding the adequacy of radio coverage.

(4) The Respondents Indicated That the Radio Communication Services Division Provided Responsive Customer Service.

A number of statements within the questionnaire focused on the responsiveness of the customer service provided by the Radio Communication Services Division (or the

Radio Communications Division). These statements and the response to these statements are provided below.

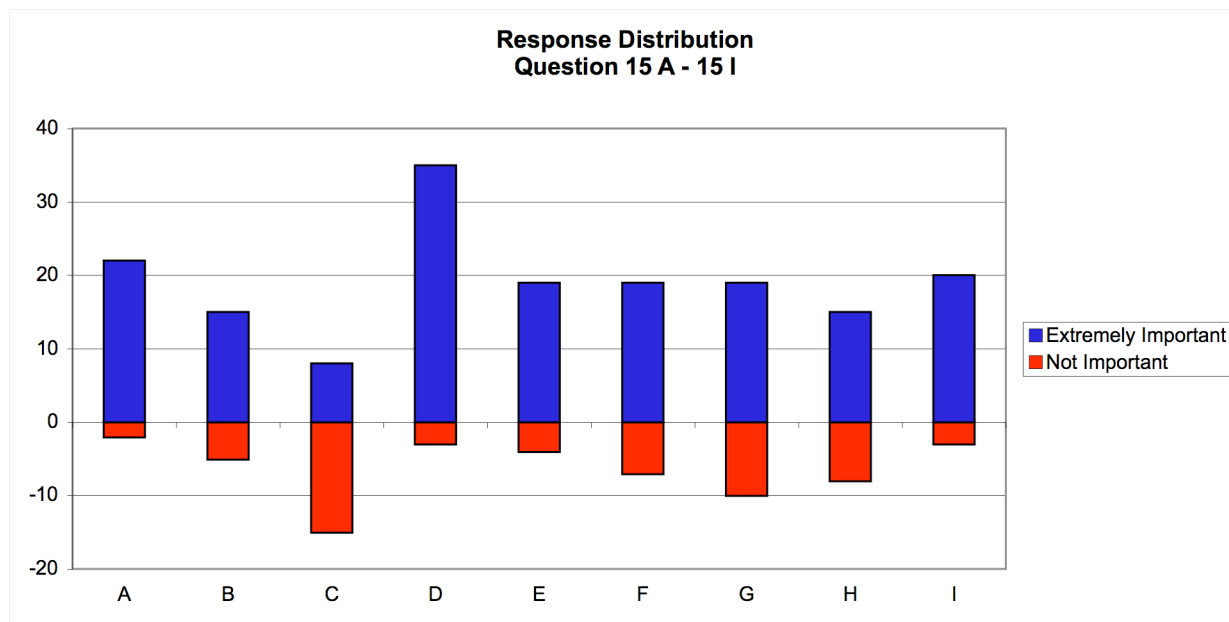
- 91% of the respondents agreed with the statement that the Radio Communications Division did a good job of diagnosing and fixing the problems with their 800 MHz radio when they brought their radio in for repair. Only 2% of the respondents disagreed with that statement. (Question #8)
- 91% of the respondents agreed with the statement that the Radio Communications Division was effective at completing repairs to their radio without the necessity to bring the radios back a second time to fix the same problem. Only 2% of the respondents disagreed with that statement. (Question #9)
- 91% of the respondents agreed with the statement that the staff of the Radio Communications Division is courteous and helpful in working with us to resolve our problems. None of the respondents disagreed with that statement. (Question #10)
- 64% of the respondents agreed that the response by the Radio Communications Division to emergency calls was responsive and timely. 30% of the respondents were neutral to the statement. (Question #11)
- 89% of the respondents agreed with the statement that they were satisfied with the turnaround time for completion of repairs by the Radio Communications Division. None of the respondents disagreed with that statement. (Question #12)
- 89% of the respondents agreed with the statement that the services provided by the Radio Communications Division meet their expectation. None of the respondents disagreed with that statement. (Question #14)

As the points above show, while Fire Department respondents maintained overall positive perceptions and attitudes with respect to the services provided by the Radio Communications Division.

(5) The Respondents from the Fire Department Identified a Number of Opportunities for Improvement.

The second section of the questionnaire presented a list of potential improvements that may or may not make the 800 MHz radio system more useful and effective. Respondents were asked to select a number from one to ten to rate the

importance of these improvements ranging from 'not important' (one) to 'extremely important' (ten). The chart below presents the responses for each statement. Statement numbers from the questionnaire are shown along the bottom of the chart.



The points, which follow, present the statements associated with each letter (A, B, C, D, etc.) on the x-axis, as well as the percentage (%) of respondents selecting important as the response for that statement.

- 46% of the respondents agreed with statement A: reduce the extent of busies (those times when you push-to-talk and get a busy signal). 50% of the respondents were neutral, while 4% of the respondents indicated that this was not important.
- 31% of the respondents agreed with statement B: add to the number of talk groups. 58% of the respondents were neutral, while 10% of the respondents indicated that this was not important.
- 17% of the respondents agreed with statement C: reduce the number of talk groups. 52% of the respondents were neutral, while 31% of the respondents indicated that this was not important.
- 70% of the respondents agreed with statement D: reduce radio dead spots where the 800 MHz radio system does not work. 24% of the respondents were neutral

- 39% of the respondents agreed with statement E: provide additional training in the use of the 800 MHz radio system. 53% of the respondents were neutral, while 8% of the respondents indicated that this was not important.
- 40% of the respondents agreed with statement F: provide the ability to talk with agencies that I cannot talk with today using the 800 MHz radio system. 46% of the respondents were neutral, while 15% of the respondents indicated that this was not important.
- 42% of the respondents agreed with statement G: Provide additional radio equipment. 36% of the respondents were neutral, while 22% of the respondents indicated that this was not important.
- 32% of the respondents agreed with statement H' provide / enhance mobile data capability. 51% of the respondents were neutral, while 17% of the respondents indicated that this was not important.
- 41% of the respondents agreed with statement I: develop formal procedures for radio use during major incidents or emergencies. 53% of the respondents were neutral, while 6% of the respondents indicated that this was not important.

As these points demonstrate, there were several key areas that were important to the respondents from the Fire Department. Those key areas included reduction of radio dead spots where the 800 MHz radio system doesn't work, providing the ability to talk with agencies that they cannot talk with today using the 800 MHz radio system, reduction of busies (those times when you push-to-talk and get a busy signal), providing/enhancing mobile data capability, providing additional radio equipment, and formal procedures for radio use during major events or incidents. Conversely, there were a number of areas that the respondents indicated were not important. These include reducing the number of talk groups, adding to the number of talk groups.

5. BEST MANAGEMENT PRACTICES

5. BEST MANAGEMENT PRACTICES

This section of the report evaluates the practices and performance of the Radio Communication Services Division against industry best management practices. The recommendations within this report are presented in chapters 6 through 9.

The evaluation is based upon a variety of methods including (1) review of documentary material on radio-related policies and procedures; (2) interviews with staff and customers; and (3) analysis of quantitative information on 800 MHz radio system conditions and performance. The consulting team developed best management practices for the Division based upon the experience of the consulting team and practices developed by other organizations such as the Public Safety Wireless Network *Operational Best Practices for Managing Trunked Land Mobile Radio Systems* and based upon the comparative survey of other local governments utilizing the same radio technology as Metropolitan Nashville and Davidson County.

A summary of our findings and recommendations are provided by functional area in the pages that follow.

1. ORGANIZATION AND STAFFING

The organization and staffing of the Radio Communication Services Division has a number of strengths. For example:

- The maintenance, repair and replacement of radios has been administratively centralized within Radio Communication Services;
- The staff assigned to field repair have been decentralized to the E.C.C.; and
- The ratio of supervisory and support staff to technicians is reasonable.

At the same time, there are a number of opportunities for improvement, however.

These opportunities are presented below.

- Technician staffing levels within the Radio Communication Services Division are not consistent with the amount of radios and the extent of backbone.
- The Radio Communication Services Division does not utilize a balance of in-house staff and contractors for installation of mobile radios and other equipment such as light bars, cages, etc.
- The Radio Communication Services Division is reliant on Motorola for system management and administration. The Division does not have the requisite skills to provide the day-to-day management, operation and oversight of the 800 MHz radio system.

The opportunities for improvement within the Radio Communication Services Division pertaining to organization and staffing include the location of the Division within the General Services Department, the level of staffing within the Division, and the ability of the Division to provide system management of the 800 MHz radio system.

2. MANAGEMENT PRACTICES

Radio communication management requires comprehensive, well designed and executed management practices in order for optimal results to be produced. Radio organizations must excel at a host of business management practices such as strategy development and planning, financial management, human resource management, and policy and procedure development.

There are a number of strengths in the Radio Communication Services Division's management practices. These include, for example, the following:

- Some policies and procedures have been developed and adopted by MRAM;
- The training budget for the Division has been increased in FY 2004/05 to \$30,000;
- A charge-back system is in place for the services the Radio Communication Services Division provides to its customers;

- Chargeback rates were developed based upon a cost allocation plan developed by DMG-MAXIMUS in 2000; and
- Metropolitan Nashville and Davidson County retained Federal Engineering (FE) to conduct a capacity assessment of the 800 MHz radio system. FE found that system A has enough capacity to accommodate anticipated growth, and that system B is currently lightly loaded and has more than enough capacity to accommodate the projected growth in the number of units

There are, however, a number of opportunities for improvement. These include the following:

- Policies and procedures have not been completely documented;
- A formal skills assessment has not been conducted of the staff of the Radio Communication Services Division, and minimal training standards have not been set;
- The chargeback rates used by the Division have not been changed since 2000-01;
- The Division charges a replacement fee, when other local governments rely on annual operating budgets to fund ongoing, routine replacement.

The opportunities for improvement pertaining to management practices include policy and procedure development for the 800 MHz radio system, the training of the staff of the Division, and the updating of user fees.

3. CUSTOMER SERVICE

Effective customer service is central to the effective performance of any radio communication organization. Good customer service management stems from an acute sensitivity to the needs and concerns of users, and manifests itself in a set of communication, decision-making, reporting, and feedback processes which encourage users to actively participate in the management of the 800 MHz radio system, and not simply the utilization, of a radio.

The Radio Communication Services Division uses a number of important best

practices for customer service. Governance of the system is provided through MRAM, for example.

There are, however, a number of opportunities for improvement. These opportunities are presented below.

- Annual surveys are not conducted by the Radio Communication Services Division to assess customer satisfaction with the services provided by the Division.
- User specific continuing and remedial training in the use of subscriber equipment is not provided by the Division.
- The Division has not developed service level agreements with its customers.
- The Division has not developed customer service standards to guide its staff.

The opportunities for improvement pertaining to customer service include the ongoing assessment of customer satisfaction, the development of service level agreements and customer service standards, and the enhancement of training provided to users of subscriber equipment.

4. ASSET MANAGEMENT

All 800 MHz radio systems require management, maintenance and repair during their life. Since the Radio Communication Services Division primary mission is to maximize the reliability and performance of the 800 MHz radio system so that its customers can productively do their jobs, the focus of asset management needs to be in developing practices that minimize unscheduled downtime and to increase the ease of use and functionality of the system.

The Radio Communication Services Division uses a number of best management practices pertaining to asset management. Examples of these best practices include the following:

- The system routinely operates between 3 to 5 9's for unplanned downtime;
- Radio coverage is 97% downtown for portable radios and 95% for Metropolitan Nashville and Davidson County as a whole for portable radios when the system was built.
- System A has enough capacity to accommodate anticipated growth, and system B is currently lightly loaded and has more than enough capacity to accommodate the projected growth in the number of units;
- VHF and UHF repeaters have been placed on mutual aid channels for the Police Department. Radio Communication Services is obtaining a state-wide mutual aid channel for the Fire Department;
- The system has a full complement of ITAC mutual aid channels;
- The consoles at E.C.C. have UHF/VHF patch capacity;
- The Airport and Vanderbilt University have access to the 800 MHz radio system;
- Metropolitan Nashville and Davidson County is purchasing an ACU-1000 patch and a portable repeater;
- OEM has a cache of analog radios;
- The Motorola system manager continually monitors the system to gauge and improve the trunked radio system's quality of service;
- Extended warranty is procured for all mobile and portable radios and control stations;
- Motorola has developed a formal maintenance plan for inspection of the backbone;
- The Motorola system manager conducts a monthly inspection of the backbone based upon the plan, and issues corrective work orders as necessary; and
- Towers are inspected annually.

There are a number of opportunities for improvement in asset management, however. These opportunities are presented below.

- The Water Services Department continues to rely on Nextel cellular phones for communication, and not the 800 MHz radio system.

- The microwave backbone is well maintained, but some modifications in maintenance practices are warranted.
- The Radio Communication Services Division lacks a computerized maintenance management system, and a work planning and scheduling system.
- Radio technicians are not accountable for their time in terms of labor hours billed to work orders.
- Fleet maps are not regularly updated.
- The Division has not developed a formal radio communication system interoperability plan with surrounding local governments.
- There are coverage issues within Metropolitan Nashville and Davidson County area that have evolved since the system was accepted in 2000.

There are numerous strengths in the asset management practices utilized by the Radio Communication Services Division. On the other hand, there are opportunities for improvement in continuing to expand the use of the system by Metropolitan Nashville and Davidson County departments, enhancing maintenance management practices, and the development of plans to enhance system coverage and interoperability.

6. ORGANIZATION AND STAFFING

6. ORGANIZATION AND STAFFING

This chapter presents the analysis of the system management for the 800 MHz radio system, the plan of organization of the Radio Communication Services Division, and the levels of staffing.

1. CAPACITY FOR IN-HOUSE SYSTEM MANAGEMENT OF THE 800 MHZ RADIO SYSTEM

The system manager for the 800 MHz radio system is not an employee of Metro Nashville. At present, Metro Nashville contracts with Motorola to provide these services. Motorola provides a full-time system manager to Metro Nashville for the 800 MHz radio system. This contract dates from February 2000. This was an excellent approach for Metro Nashville to make an effective transition from a simple analog, conventional radio system to a complex digital, trunked, simulcast system that relies on computers. The role of the Motorola system manager is specified by contract to include such items as the following:

- Coordinate System Support Center activity including technical support, board repair, and remote monitoring;
- Coordinate the depot program;
- Coordinate the software subscription agreement including updating the system design into the configuration database, reviewing quarterly SSA bulletin information, etc.;
- Manage the Smart Zone, data system, AVL, MOSCAD and console databases;
- Provide device performance report such as fault management integration with other alarm systems;
- Perform quality audits and audit site records.

This system manager service costs Metro Nashville approximately \$225,000

annually.

The system manager for the 800 MHz radio system fills an important role. This role includes responsibility for the day-to-day management, operation and oversight of the system components including monitoring the system and its components for normal operation, leading the diagnosis of system performance problems and the development of corrective action recommendations, dispatching appropriate repair services in the event of a malfunction in the system equipment, etc.

There is a risk to Metro Nashville in continuing to contract for system management with Motorola and not developing that capacity in-house. Metro Nashville is reliant on resources external to its organization to monitor the system, to diagnose the system, to develop corrective recommendations, to dispatch repair services in the event of malfunction. Other agencies that participated in the comparative survey recognized that risk. Only one— Montgomery County, Maryland – contracted with Motorola to provide a system manager

However, the Radio Communication Services Division is in no position to assume this responsibility in the short to mid-term. It is not presently capable of providing the skills and talents necessary to assume this responsibility.

The current division-head for the Radio Communication Services Division is classified as a General Services Division Manager. This is a generic classification that could be utilized in any division within the General Services Department. Specific examples of the generic nature of this classification are presented in the paragraphs below.

- The job objective of this classification is “*performs the managerial and administrative duties involved in directing the daily operations and activities of a division of General Services.*”
- The education and experience requirements of this classification are a bachelor’s degree and five years professional experience in an administrative, technical, or related field;

The licensing required is a Class D driver’s license;

- The performance standards for this classification include knowledge and ability such as:
 - Knowledge of managerial and administrative principles and practices;
 - Knowledge of principles and practices of business and financial management;
 - Knowledge of the goals and objectives of the department;
 - Ability to allocate resources;
 - Ability to communicate effectively; and
 - Ability to keep accurate records and write detailed reports.

RECOMMENDATION 6-1.1

The General Services Division Manager Position in the Radio Communication Services Division should be reclassified to reflect the technical requirements and know-how required of the position. This would be a new classification description. The estimated annual salary and fringe benefit cost would approximate \$15,000 at the first step of the salary range.

The Communication Analyst 2 classification description is the classification utilized for the three managers within the Radio Communication Services Division. The job objective of the classification is to “perform the more complex technical duties involved in designing, implementing, and maintaining communication networks which may include local area network systems, telephone systems, two-way radio and microwave systems and equipment, depending on position location.”

The classification does not indicate the nature of the full-time managerial responsibilities exercised by the three managers within the Radio Communication Services Division. The description describes the supervision exercised by incumbents of

this classification as “depending upon position location, this classification assists in the training of Communication 1 and 2’s or other support personnel, or may lead the work of technicians in the field.”

Metropolitan Nashville and Davidson County should upgrade its capacity to manage the 800 MHz radio system. This can be achieved, in part, by upgrading the division-head position. The next step is to upgrade the three subordinate managers within the Division. This is not unlike the approach utilized in the Office of Fleet Management. The Office of Fleet Management has a Manager of Fleet Operations. It also has a Fleet Manager – Heavy Equipment and a Fleet Manager – Light Equipment. The Radio Communication Services Division should similarly have a manager responsible for supervising the work of the shop and another manager responsible for managing the work of the field.

RECOMMENDATION 6-1.2

The three Communication Analyst 2 positions in the Radio Communication Services Division should be reclassified. A specific classification description should be written for these positions to reflect the skill requirements and technical know-how required for the positions. The estimated annual salary and fringe costs for this adjustment would approximate \$15,000.

2. ORGANIZATIONAL STRUCTURE FOR THE RADIO COMMUNICATION SERVICES DIVISION

Overall, the Radio Communication Services Division basic management and administrative structure is logical and management and supervisory staffing is limited.

The Radio Communication Services Division is one of several divisions within the General Services Department. These other divisions include Printing, Fleet, Mail Services, Security, Photography, and Facility Maintenance. The issue is whether the placement of the Radio Communication Services Division in the General Services

Department adheres to logical principles for organizational structure. These principles include the following:

- **The organizational structure reflects a ‘form follows function’ basis** with a clear, distinct and comprehensive sense of purpose or mission for each functional area. Functions are grouped consistent with their periodic interaction, common planning and scheduling systems, delivery of services which are linked in some way, etc. resulting in functional cohesion.
- **The organizational structure fosters accountability.** The organizational structure foster accountability among management and supervisory staff for delivery of services. The organizational structure facilitates the performance of an organization.
- **The plan of organization enhances communication and coordination.** The number of handoffs/exchanges required among different departments providing service to the public or to internal staff of Metropolitan Nashville and Davidson County is minimized. The structure enhances shared knowledge and understanding among divisions and departments. The channels of communication are clear and consistent.
- **Staff resources are utilized efficiently.** The plan of organization minimizes administrative overhead. Workload can be distributed/shared to maximize the productivity of staff through peaks and valleys and offer cross-functional capabilities. Processes can be standardized to enhance the efficiency and customer responsiveness of services.
- **The potential of human capital is enabled.** The plan of organization enhances career development opportunities, training and recruitment and retention.
- **The quality and responsiveness of services provided to customers is improved.** The plan of organization enables staff to provide better service to the internal customers in terms of response times to work orders, user friendliness, performance management, quality control, and consistency of the application of policies and procedures.

There are a number of alternative approaches to the placement of the Radio Communication Services Division. For example:

- San Diego County has placed its Radio Communication Services Division within the Sheriff’s Office in their Management Services Bureau;
- The City of Dallas has placed its Radio Communication Services Division in the Communication and Information Services Department with responsibility for

radio, telephone, and paging equipment, related maintenance and repair, as well as 9-1-1/ 3-1-1 support services coordination, security, and networks;

- The City of Portland, Oregon has placed its Radio Communication Services Division in its General Services Department with responsibility for telecommunications (telephones, cellular phones, pagers), the 800 MHz system, and other electronic systems.

There clearly is more than one alternative for the organizational placement of the Radio Communication Services Division.

- Information technology departments in Dallas, Texas and Phoenix, Arizona manage their radio systems. The radio systems are viewed as another wireless technology that can be effectively managed by their information technology departments.
- General service departments in Portland, Oregon and Charlotte, North Carolina manage their radio systems. The radio systems are viewed as an internal service that can be effectively managed as a shared business service. In many cases, these general services departments are responsible for managing all telecommunication systems including voice systems.
- Law enforcement departments in San Diego County and Orange County, California manage their radio systems. The radio system is viewed as an emergency communication system that should be managed by emergency service providers.

The diversity of the assignment of responsibility for managing radio systems indicates that the decision has to be made within the context of the circumstances of the local government. However, the Matrix Consulting Group believes there are only two practical alternatives available to Metro Nashville: (1) leave the Radio Communication Services Division within the General Services Department, or (2) reassign the Radio Communication Services Division to the Information Technology Department. The table, below, describes the project team's assessment of issues associated with the current assignment of the Radio Communication Services Division.

Criteria	Issue in General Services?	Issue In ITS?
Organization and Structure		
• Are there clear lines of	Yes	Yes

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Criteria	Issue in General Services?	Issue In ITS?
accountability?		
• Are the spans of control/number of management layers reasonable?	Yes	Yes
• Is there functional cohesion?	Yes, as an internal service	Yes, as a technology
Communication and cohesion		
• Is the number of hand-offs/exchanges (internal/external) of customers a problem?	No. The customers know to come directly to the Radio Communication Services Division for problems with the 800 MHz radio system.	No. This will only become an issue when wireless technologies converge, including public safety communication systems. This is unlikely to any significant extent in the short to mid-term.
• Is the physical/virtual proximity important?	Yes, for installs with the Fleet	Yes, but the ITS is currently located in close proximity to the Radio Communications Division
• Does the structure impede shared knowledge/understanding?	No	No
Resource Utilization (Cost)		
• Does the organization result in unreasonable administrative overhead?	No. The expertise in public safety communication systems would be required regardless of organizational placement.	No. The technology management and expertise within ITS could not be leveraged to avoid duplication of technology and technology expenditures
• Does the organizational structure facilitate workload management (even distribution)?	No, from the perspective of being able to use the shop radio technicians for other duties during non-peak workload	No. The Radio Communications Division technicians and ITS technicians could not be utilized to assist each other in addressing peak workloads given current workload
• Does the organizational structure facilitate process efficiency/standardization?	This will only become an issue when wireless technologies converge, including public safety communication systems. This is unlikely to any significant extent in the short to mid-term.	Yes. This will be a critical issue as wireless technologies evolve to avoid competing solutions
• Does the organizational structure promote resource sharing?	No, from the standpoint of being able to share resources for other wireless applications	No. The Radio Communications Division technicians and ITS technicians could not be utilized to assist each other in addressing peak workloads given current workload

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Human Capital		
• Does the organizational structure enhance career development?	No, from the standpoint of career development into other technology applications	Yes, but it could result in degradation of the skills necessary to maintain the public safety radio system
• Does the organization enhance training?	Yes	Yes
• Does the organizational structure enhance recruitment and retention?	Yes, from the standpoint of a telecommunication specialty	Yes, from a standpoint of widening opportunities for upward mobility in a broader range of classifications
Agility and Flexibility of the Organization		
• Does the organizational structure facilitate the ability to manage peaks and valleys?	No, from the perspective of being able to use the shop radio technicians for other duties during non-peak workload	No. The Radio Communications Division technicians and ITS technicians could not be utilized to assist each other in addressing peak workloads given current workloads
• Does the organizational structure enhance adaptability (cross functional capability)	No, the radio technicians are only utilized for work on the radio system	No, the IT technicians are only utilized for work on the IT systems.
Service Quality and Responsiveness		
• Does the organizational structure promote responsive customer service?	Yes, from the standpoint that it responds directly to a customers concern about a public safety radio systems and just another wireless technology	Yes and no. It will bring a wider set to tools and solutions to customers' technology problems. But it could result in loss of focus on the public safety radio system
• Does the organizational structure enhance performance management	Yes, in that the Radio Communication Services Division is focused exclusively on the 800 MHz radio system and not a host of technologies, one of which is the 800 MHz radio system.	Yes and no. This could enable more productive use of staff across technologies, but it could result in loss of focus on the public safety radio system
• Does the organizational structure aid quality control checks and balances	No, from the standpoint of from the perspective of bringing to bear the technology management expertise resident in ITS	Yes and no. It will bring a greater depth and width of technological expertise and management, but it could result in loss of focus on the public safety radio system
• Does the organizational structure assure consistency of policy/procedure application	Yes, from the standpoint that application of these policies and procedures is focused specifically on the 800 MHz radio system and not a host of technologies.	But it could result in loss of focus on the public safety radio system

There are clearly advantages to the placement of the Radio Communication Services Division in the General Services Department. For example:

- The department was able to cross-utilize some of their staff in the Office of Fleet Management to assist in installations of radio equipment this fiscal year to address the peak workload.
- The 800 MHz radio system is not just another technology, but rather the only technology that the Radio Communication Services Division is assigned responsibility. The Division does not have to balance priorities with other technologies. It is the only technology that it is assigned responsibility.

However, there are also disadvantages to the location of the Radio Communication Services Division in the General Services Department. For example:

- The Information Technology Department has more depth of technology management than does the General Services Department.
- The Information Technology Department could cross-utilize the radio technicians during non-peak workload for other wireless technology workload.
- Wireless technology is clearly a challenge in the near term for the 800 MHz radio system. This is an issue already being addressed by the Information technology Department. It would not be cost-effective for two wireless systems to be constructed for Metropolitan Nashville and Davidson County.
- While there is functional cohesion from the perspective of the Radio Communication Services Division as an internal service, there is not a functional cohesion with the other technology initiatives of Metropolitan Nashville and Davidson County.

Clearly, the placement of the Radio Communication Services Division in a general services department works in other local governments such as Portland, Oregon and Charlotte, North Carolina. It also clearly works in an information technology department in other local governments such as Dallas, Texas and Phoenix, Arizona.

RECOMMENDATION 6-2:

Metro Nashville should evaluate the organizational placement of the Radio Communication Services Division in the mid-to long-term as technology evolves such as programmable radios and the integration of more sophisticated wireless as an integral part of public safety radio systems

3. ROLE OF MRAM

Executive Order #99-06 established the Metro Emergency Radio Management Committee or MRAM. It identified the membership and the mission of the MRAM. The mission of the MRAM was as follows:

- Develop and implement guidelines for the allocation of effective and efficient use of the System, including the loading and development for all users.
- Determine the accurate maintenance and operating costs for the System and then recommend a plan to access each user a fair and proportionate share to recover these costs.
- Develop and recommend guidelines to the Director of Finance and N.E.S. for the creation and maintenance of a reserve fund to cover unanticipated expenses and improvements to the System.
- Provide long-range planning for the ultimate retirement and replacement of the System.

The MRAM meetings are scheduled for the third Thursday of every-other month.

The role of the MRAM has not been clearly defined. The executive order does not address, for example:

- Administration objectives (such as provide a structure that retains administration and fiscal responsibility of the system in the control of the participating agencies);
- The specific responsibilities of the MRAM (such as review and adopt recommendations regarding the establishment of system priorities and talk groups);
- Requirements for attendance at the MRAM meetings;
- The voting requirements of the MRAM; and
- The role of the Radio Communication Services Division in providing staff support to the MRAM and the 800 MHz radio system.

RECOMMENDATION 6-3:

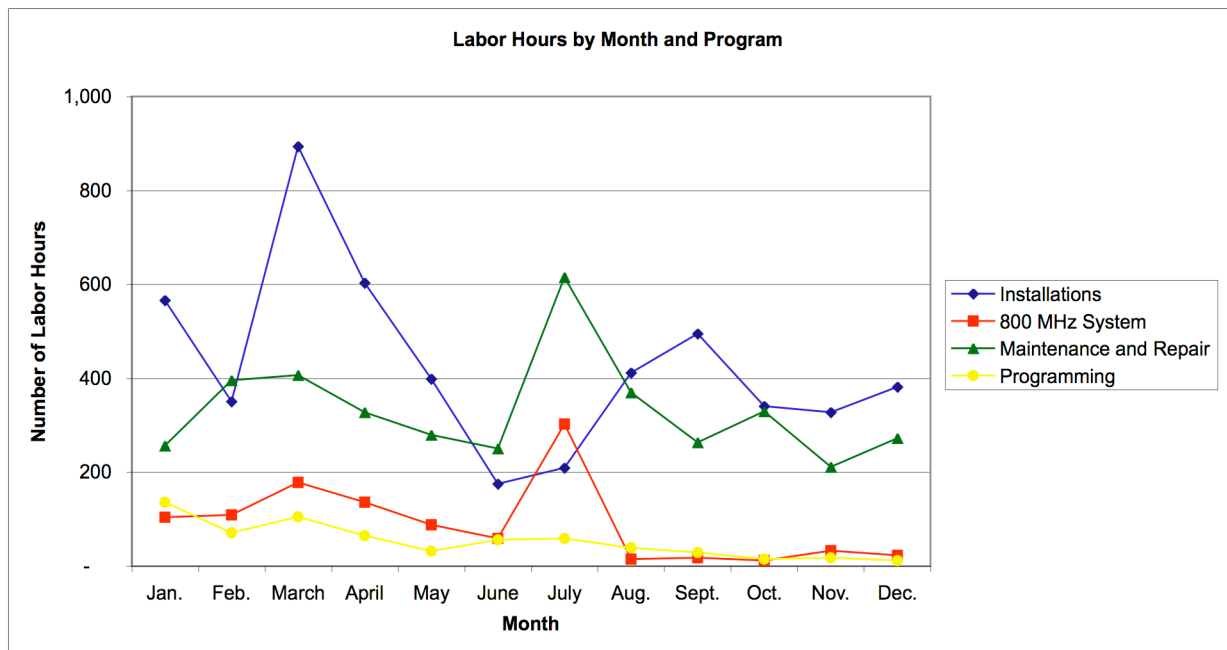
The Radio Communication Services Division should develop a formal agreement for the review and adoption by the MRAM.

4. LEVEL OF AUTHORIZED STAFFING FOR THE RADIO COMMUNICATION SERVICES DIVISION.

There are several findings, conclusions, and recommendations regarding the existing level of staffing for the Radio Communication Services Division. These findings, conclusions, and recommendations are presented in the sections below.

(4.1) The Workload Associated With the Installation of Radios Is Seasonal.

While the labor hours allocated to installation of radios consumed a little more than half the labor hours charged to work orders in 2003-04, this tends to be seasonal workload as the chart below indicates. As the chart indicates, the labor hours charged to installation work orders peaked in March 2004, and required 400 hours a month or less for seven of the twelve months, including February, May, June, July, October, November, and December.



As the chart indicates, the labor hours charged to installation work orders peaked in March 2004, and required 400 hours a month or less for seven of the twelve months,

including February, May, June, July, October, November, and December. In these seven months, an average of 311 labor hours were required for installation or the equivalent of two and one-half technicians. The peak workload for installations – March – required a little more than seven technicians. The consulting team presents recommendations regarding staffing and the use of contractors for peak staffing later in this chapter.

(4.2) The Fees Charged by the Radio Communication Services Division Are Higher Than Other Local Governments Included in the Comparative Survey.

A comparison of the 800 MHz radio system user fees for the local governments that participated in the comparative survey indicates that Metro Nashville charges comparable rates for maintenance and 800 MHz radio system access, but higher rates for installations. The cost to provide the installation services in Metropolitan Nashville and Davidson County is higher than these other local governments. The median cost in these other local governments is \$613 per installation for patrol cars. Metropolitan Nashville and Davidson County charges \$971. (Note: the cost for Metro excludes some of the charges by the Radio Communications Division such as the light bar, cage, etc. since these other local governments contract for this service). The consulting team presents recommendations regarding the evaluation of fees later in this chapter.

(4.3) The Number of Radios Per Radio Technician In Metro Nashville Are Lower Than the Other Local Governments Included in the Comparative Survey.

On average, the number of radios per radio technician assigned to installs, maintenance and repair for these six local governments is 1,200 (the median is 1,050). This excludes technicians assigned to the maintenance and repair of the backbone. In comparison, the Radio Communication Services Division in Metro Nashville has

significantly fewer subscriber units per radio technician when compared to the other local governments. More specifically:

- The City of Charlotte allocates 4 electronic technicians to the maintenance, repair, and installation of radios for 10,500 radios;
- The City of Memphis allocates 7 shop technicians and 4 installers to the maintenance, repair and installation of radios for 5,810 radios;
- Montgomery County allocates an estimated 5 technicians to the maintenance and repair of 8,000 radios;
- Orange County, California allocates 26 technicians to the maintenance, repair, and installation of 15,335 radios;
- Orange County, Florida allocates 3 technicians to the maintenance, repair and installation of 6,500 radios;
- San Diego County allocates 18 technicians to the maintenance, repair, and installation of 17,242 radios; and
- Metropolitan Nashville and Davidson County allocates 11 technicians (authorized, not actual) to the maintenance, repair, and installation of 5,307 radios.

When compared to the responding agencies, Metropolitan Nashville and Davidson County had a higher level of staffing for radio maintenance, repair and installations. The consulting team presents recommendations regarding staffing and the use of contractors for peak staffing later in this chapter.

(4.4) Metro Nashville Expenditures Per Radio Are Higher in Metro Nashville Than The Local Governments Included in the Comparative Survey.

One of the questions within the comparative survey was the annual operating budget for radio communication services for each local government. The Radio Communication Services Division for Metro Nashville spends more than these other local governments. This suggests several issues:

- The higher level of staffing in the Radio Communication Services Division impacts the expenditures per radio for Metropolitan Nashville and Davidson County;
- The contracts with Motorola for system management and technical assistance impacts the expenditures per radio for Metropolitan Nashville and Davidson County; and
- Even with the possible addition of the School Department, Water Services Department, and Metropolitan Transit Authority to the system, the Division should be able to reduce the level of authorized staffing allocated to maintenance and repair of radios, particularly given the use of extended warranties.

The expenditures per subscriber unit are higher in Metropolitan Nashville and Davidson than these other local governments. The consulting team presents recommendations regarding potential cost savings later in this chapter.

(4.5) Metro Nashville Contracts With Motorola For Technical Support in the Maintenance and Repair of the 800 MHz Backbone.

While staff assigned to the Radio Communication Services Division can be underutilized given the seasonality of workload and the amount the workload, the Division contracts with Motorola for technical support in the maintenance and repair of the 800 MHz backbone. (This is in addition to another contract with Motorola for system management of the 800 MHz radio system). The duties associated with technical support and the dedicated system technician for the maintenance and repair of the 800 Mhz radio backbone system includes the following responsibilities and activities:

- Provide a standard 40-hour work week with after hours work in excess of 4 hours per month provided at additional cost;
- Work in concert with Metropolitan Nashville and Davidson County system technicians as needed or as requested by Metropolitan Nashville and Davidson County;
- Evaluate technical issues that are identified via the SmartZone manager terminal and the MOSCAD alarm system so as to create appropriate action steps;

- Respond to any system alarms throughout the day, interrogate equipment to determine if equipment is operating to specifications, and work proactively to catch problems so that end users are not affected and downtime is reduced;
- Perform daily troubleshooting and repair of all fixed network equipment, troubleshooting problems to the defective board, module, or part, and fix or replace the defective unit;
- Order field replacement units;
- Implement various hardware and software upgrades; and
- Perform weekly, monthly, semi-annual, and annual preventive maintenance.

The cost to Metro Nashville for the dedicated system technician amounts to \$173,550 in 2004-05. The consulting team presents recommendations regarding potential cost savings later in this chapter.

(4.6) Even With the Elimination of Four Vacant Radio Technician Positions in the Radio Communication Services Division, the Level of Staffing in the Division Would Be Higher Than Other Local Governments Included in the Comparative Survey.

The level of staffing within the Installation, Maintenance, and Repair Section is higher than the average of the six other local governments that participated in the comparative survey. Eliminating the four vacant technician positions within this section would bring the level of staffing more within the range of these other local governments.

The level of staffing, however, would still be higher than the average of these other local governments. However, with the addition of the School Department (1,091 portable and mobile radios), Metropolitan Transit Authority (an estimated 200 portable and mobile radios), and the Water Services Department (390 portable and mobile radios), this level of staffing within the Radio Communication Services Division would be at the average for these six local governments.

However, the Matrix Consulting Group recommends that the use of outsourcing should enable a further reduction of two to three additional technician positions (excluding supervision) through attrition. The use of outsourcing and temporary employees should enable the Division to address the variances in installation workload more cost effectively than relying on the full-time staff of the Division.

RECOMMENDATION 6-4:

The Radio Communication Services Division should balance the level of staffing with routine ongoing workload. The Division should take the following actions to address peak workload and bring staffing in balance with the routine, ongoing workload:

- **The Radio Communications Services Division should outsource peak installation workload. The estimated annual cost for outsourcing peak workload is \$30,000.**
- **The Radio Communications Services Division should develop the in-house capacity for the provision of backbone system technician capacity by filling the vacant Radio Technician 3 position, sending the Radio Technician 3 to Motorola training for backbone system maintenance, repair, and diagnosis, and teaming the Radio Technician 3 with the system technician from Motorola for twelve to eighteen months for field training. Upon completion of the classroom and field training, the contract with Motorola for technical services should be utilized as a back-up resource called upon only in cases where the Metro technical staff cannot properly address the immediate needs of the system within an acceptable time-frame. This change should result in a reduction in annual operating costs of \$173,550.**
- **The four vacant radio technician positions assigned to the Installation, Maintenance and Repair Section should be eliminated. The elimination of these four positions would generate approximately \$155,000 in cost savings annually in terms of salary and fringe benefits.**
- **The vacant Radio Technician 3 position assigned to maintenance and repair of the microwave backbone should be reclassified and upgraded to enable the Division to upgrade its expertise for maintenance and repair of the backbone. This position should be filled upon being reclassified and upgraded. The upgrading of the vacant Radio Technician 3 position would increase salary and fringe benefit costs by an estimated \$15,000.**

7. MANAGEMENT PRACTICES

7. MANAGEMENT PRACTICES

This chapter presents analysis of the management practices utilized by the Radio Communication Services Division including the following:

- The chargeback system utilized by the Division;
- The extent of written policies and procedures developed by the Division;
- The extent of training provided to the staff of the Division.

1. USER FEES FOR THE 800 MHz RADIO SYSTEM.

In 2000, Metro Nashville and Davidson County hired a consulting firm to develop a cost recovery plan for the Radio Communication Services Division. The cost recovery plan developed as a result of this study is still in place. Rates have not increased since implementation. Due to employee turnover, there was minimal institutional knowledge regarding the development and basis for the cost recovery plan. The following section provides a brief discussion of the user fees used by the Radio Communication Services Division and problems with these fees.

The user fees have not been updated since their adoption in fiscal year 2000-01 either for the increased costs of doing business or for the additional subscriber units that utilize the system.

In reviewing the Excel spreadsheet provided by the Shared Business Office of the General Services Department, it is apparent that some of the work performed by the Division is not charged to customers. In fiscal year 2003-04, there was a total of \$12,000 in parts, \$190,723 in labor, and \$15,091 in outside repairs that were not charged to customers, as per instructions from former management. Approximately one-third of the work orders performed by the Division were “no charge.” Some of this

work was associated with the work included as part of the monthly maintenance fee such as preventive maintenance of MOSCAD. Other labor hours are not billed. These consist of administration such as picking up parts, cleaning the shop, picking up uniforms, etc. However, other work that was not charged includes maintenance and repair of emergency lighting equipment such as traffic backers, wigwags, light bars, shotgun racks, etc. These services appear to be provided primarily for the Police Department, but also include the Sheriff's Department, the Water and Sewer Department, Parks and Recreation Department, OEM, the Drug Task Force, etc. Maintenance and repair of consoles is also not billed.

In fiscal year 2003 – 2004, the Division did not bill for all of the installations it performed. The Excel spreadsheet indicated that the Radio Communications Services Division performed 332 installations. This did not include an additional 137 installations for which departments were not billed. All of the installations should be billed in the month and the year in which the work is performed.

The user fees do not appear, initially, to be supported by analysis of the costs of service delivery. It appears that the charges for maintenance and repair and system access are too high, while the installation charges are too low.

The approach to user fees for the 800 MHz radio system introduces a level of complexity that is unwarranted, unsupported by data, and unlike the approach used by the other public sector agencies that participated in the comparative survey.

The variation in system access fees varies based upon whether the radio is generic, is capable of private interconnect, or is an MDT or AVL. The cost of system

access for these units is the same. The costs of construction of the 800 MHz backbone did not vary based upon the type of unit.

RECOMMENDATION 7-1:

The user fees should be updated in fiscal year 2005-06 to more accurately reflect the costs of providing services in support of the 800 MHz radio system. The following factors should be integrated into the updating of these fees:

- The Radio Communication Services Division should charge a user fee for all of the services that it provides and all of the equipment that it maintains.
- The Radio Communication Services Division should not charge a fee for initial programming; these costs should be included in overhead.
- Nashville Electric Services owns 25% of the 800 MHz microwave backbone. Therefore, it should be allocated 25% of the cost of the 800 MHz microwave backbone.
- The system access fee for the 800 MHz microwave backbone and the maintenance fee should be based on a flat fee reflecting the total number of subscriber units accessing the system excluding those subscriber units in the inventory of the Radio Communication Services Division.
- The maintenance fee for the 800 MHz microwave backbone and the maintenance fee should be based on a flat fee reflecting the total number of subscriber units maintained by the Radio Communication Services Division excluding those subscriber units in the inventory of the Radio Communication Services Division.
- All of the installations performed by the Radio Communication Services Division should be billed in the month and the year in which the work is performed.

2. REPLACEMENT FEES FOR SUBSCRIBER EQUIPMENT.

The Radio Communication Services Division charges a fee for replacement of radio equipment. This amounts to \$28.16 for each subscriber unit regardless of whether it is a high-tier radio, an analog radio, control station, etc.

The table below presents the monthly “subscriber” or replacement fee paid by each of the departments that participate in the 800 MHz radio system. Important points to note concerning the data presented in the table are presented below.

- On the whole, departments in Metropolitan Nashville and Davidson County are paying \$122,890 each month for this “subscriber” or a replacement charge of \$1,474,683 annually.
- The number of radios in this inventory differs from other inventories since not all radio equipment is being charged a replacement charge including, for example:
 - Mobile data terminals within the Police Department and dispatch consoles within the Emergency Communications Center;
 - Some agencies that participate in the 800 MHz radio system do not pay a replacement charge such as Belle Meade; and
 - MTA has purchased radios but has not yet “joined” the 800 MHz radio system and is not yet being charged the subscriber fee.
- Given the annual revenue collected for replacement, the Radio Communications Division internal services fund should have a fund balance approximating \$2.1 million at the end of 2003-04. The fund is undercapitalized, and these fees would have to be increased significantly to redress this problem.
- As indicated in the comparative survey, not one of the other local governments charges their participants a replacement charge for subscriber equipment.

Department	No. of Radios	Subscriber Fee Per Radio	Total Monthly Fee
OEM	123	\$28.16	\$3,463.68
Fleet	27	\$28.16	\$760.32
District Attorney	19	\$28.16	\$535.04
Traffic Violations	6	\$28.16	\$168.96
Juvenile Court	45	\$28.16	\$1,267.20
State Trial Court	39	\$28.16	\$1,098.24
Sheriff	200	\$28.16	\$5,632.00
Police	2,617	\$28.16	\$73,694.72
Medcom	226	\$28.16	\$6,364.16
Fire	627	\$28.16	\$17,656.32
Codes	75	\$28.16	\$2,112.00
Beer Board	7	\$28.16	\$197.12
Health	4	\$28.16	\$112.64
Parks	48	\$28.16	\$1,351.68
Public Works	251	\$28.16	\$7,068.16

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Department	No. of Radios	Subscriber Fee Per Radio	Total Monthly Fee
Taxicab & Wrecker	5	\$28.16	\$140.80
Tennessee State Fair	3	\$28.16	\$84.48
Water Services	6	\$28.16	\$168.96
Emergency Communications Center	24	\$28.16	\$675.84
Lakewood	12	\$28.16	\$337.92
TOTAL	4,364		\$122,890.24

While the user fees include a replacement charge for end user equipment (labeled as subscriber radios in the user fee structure), this charge is the same (\$28.16 per month or \$338 annually) regardless of the type of radio purchased by the customer (high-tier, mid-tier, analog, etc.), and these user fees do not include MDT's or AVL's although it does include MOSCAD's and control stations. The replacement charge recovers \$338 annually. The one-time capital outlay cost for a mid-tier digital portable radio approximates \$2,700. Given the annual replacement charge, this would approximate an eight-year replacement cycle. This is not an unreasonable replacement cycle. However, the capital outlay cost for a low-tier digital radio is approximately \$1,200 less. The replacement charge, in this instance, is recovering a greater amount of revenue than necessary. The capital outlay cost for a high-tier portable radio is approximately \$600 more; the replacement charge is recovering less revenue than necessary.

It is not a prevailing practice for other 800 MHz radio systems to charge a replacement charge for subscriber equipment. For example, this includes San Diego County, California, Montgomery County, Maryland, and the cities of Charlotte, North Carolina, and Memphis, Tennessee.

The Radio Communications Division internal service fund was undercapitalized in terms of replacement funds at the end of 2003-04, and redressing this problem would require a substantive increase in these subscriber fees.

The replacement charges are not separated into a separate sub-fund. As a consequence, it is difficult to determine whether sufficient revenue is being accrued to replacement subscriber equipment or whether replacement revenue is underwriting operating and maintenance costs or vice-versa

RECOMMENDATION 7-2:

Metropolitan Nashville and Davidson County should not charge a replacement or subscriber fee for radios. When departments need to replace subscriber equipment due to wear and tear, the General Services Department should budget for the replacement within the annual capital budget. The elimination of the replacement charge would reduce annual operating costs by \$1, 474,683.

3. ANNUAL UPDATING OF USER FEES.

Internal service funds and enterprise funds should fully recover their costs, unless policies provide direction otherwise. Fully recovering these costs implies that as the cost structure changes as a result of increases in labor costs, service and supply costs, etc. that the service fees should be adjusted to enable the internal revenue fund and enterprise fund to continue to fully recover their costs.

The service or user fees for the Radio Communication System internal service fund have not been updated since their adoption in 2000, either for the increased costs of doing business or for the additional subscriber units that utilize the system.

RECOMMENDATION 7-3:

The Finance Department should develop and adopt a policy and procedure for the annual updating of service fees by the Radio Communication Services Division that should include the following elements:

- **The service fees would be updated annually based upon the recommendation of the Radio Communication Services Division;**
- **The Radio Communication Services Division would present these service fee recommendations to the Financer Department for their December meeting;**
- **The service fees should be designed to recover the operating costs of the Radio Communication Services Division in the maintenance and repair of the radio systems (UHF, VHF, or 800 MHz);**
- **NES, as 25% owner of the backbone, would be charged for 25% of the annual operating costs associated with the 800 MHz backbone; and**
- **The policy should be to develop a rate structure to bill each agency on the basis of the number of subscriber radios deployed. Subscriber radios should be defined as any equipment that accesses the backbone including such equipment as portable radios, mobile radios, control stations, consoles, mobile terminals, etc.**

4. WRITTEN POLICIES AND PROCEDURES.

The Metro Nashville and Davidson County 800 MHz radio communication system is a large system as indicated by the number of channels, the number of sites, and the number of users.

- There are a total of 45 channels allocated to the 800 MHz radio system.
- There are a total of seven microwave backbone tower sites.
- There are approximately 4,900 portable radios, mobile radios, and control or base stations owned by Metropolitan Nashville and Davidson County that utilize the 800 MHz radio system.

Given the complexity of the system and the shared governance structure (MRAM), breadth in the extent of policies and procedures is essential to assure consistency in the direction and in the day-to-day operation of the system.

The Radio Communication Services Division has not fully developed written policies and procedures.

RECOMMENDATION 7-4:

The Radio Communications Services Division should fully develop policies and procedures for the 800 MHz radio system.

- **The Manager of the Radio Communications Services Division should be responsible for the development of the policies and procedures for the Radio Communication Services Division.**
- **Once developed, Metro should approve the policies and procedures.**
- **The policies and procedures, once developed, should be made available on the Division's Intranet.**

5. TRAINING OF RADIO COMMUNICATION SERVICES DIVISION STAFF.

The Balridge National Quality Program utilizes a number of criteria for performance excellence for organizations. One of these criteria is training. The criteria for training state that:

- Employees' success depends increasingly on having opportunities for personal learning and practicing new skills; and
- Organizations invest in employees' personal learning through education, training, and other opportunities for continuing growth.

The General Services Department's fiscal year 2004 – 2005 budget for Radio Communication Services is \$30,000. This is a significant improvement from previous years. However, there are a number of indicators that the training program within the Radio Communication Services Division does not satisfactorily meet these criteria.

- In its *State of the Industry Report*, the American Society of Training and Development reported that expenditures for training per employee approximated \$826, expenditures for training as a percentage of payroll reached 2.2%, and that annual training hours per employee was 28. The fiscal year 2004 – 2005 training budget in the Radio Communication Services Division represents slightly more than 4% of the actual salary costs for the Division. This level of expenditure was necessary to address previous underfunding of this essential need in the Division.

- Minimum training standards have not been established for the Radio Technicians.
- Formal skills assessment and training plans have not been developed to keep Radio Technicians current with changes in the profession.
- Of the three Radio Technicians assigned to the maintenance and repair of the 800 MHz backbone, the Radio Technician 2 has not been provided with any formal training by Metropolitan Nashville and Davidson County. The two Radio Technician 3's received initial system training during the install/warranty phase, but nothing since. The training focused on most of the large components and system management, but data systems and radio networking training was lacking.

The increased level of funding for training in the Division enables enhancements in the amount of training provided to staff. However, the management of the training needs of the staff of the Division needs to be enhanced as well.

RECOMMENDATION 7-5:

The managers and supervisors of the Radio Communication Services Division should conduct a formal skills assessment of the knowledge and skills of each employee in the Division to ensure that training dollars are spent effectively, and develop minimum training standards for the Radio Technicians in the Division. The Radio Technicians assigned to the maintenance and repair of the microwave backbone should be provided with the full range of Motorola factory training.

8. CUSTOMER SERVICE

8. CUSTOMER SERVICE

This chapter presents an analysis of the effectiveness of the support that the Radio Communication Services Division provides to its end users.

1. ROUTINE ONGOING TRAINING OF END USERS

Like any technology, learning how to use portable and mobile radios can be difficult, particularly during emergency incidents. This includes such aspects as procedures in the event of a radio system failure, how to locate talk groups inside a radio, how to move from one zone to another, what to do in a “dead spot,” how to initiate and cancel an emergency alarm, etc.

There are a number of indications that end users in Metro Nashville are not receiving satisfactory training in the use of portable and mobile radios.

- In the customer satisfaction survey for the Police Department administered as part of this audit, 18% of the respondents indicated that they did not have a good understanding of how to use most of the features of their 800 MHz radio. For the customer satisfaction survey for the Fire Department administered as part of this audit, 15% of the respondents indicated that they did not have a good understanding of how to use most of the features of their 800 MHz radio.
- The Communications Analyst 2 in the Radio Communication Services Division assigned to Programming/Training billed approximately 13% of net available hours to programming. There is significant opportunity to expand the use of this position to train end users in the use and operation of radio equipment.

RECOMMENDATION 8-1:

The routine, ongoing training of end users of the 800 MHz radio system needs to be enhanced significantly.

- **The Radio Communication Services Division should develop a policy regarding minimum training requirements for end users for the consideration and adoption by MRAM.**
- **The Communications Analyst 2 responsible for programming of radios, database administration and training should be more effectively utilized for**

the delivery of training for 800 MHz radio system, and the Communications Analyst 2 should allocate not less than one-half of his available work hours to training.

- **The Communications Analyst 2 should (1) develop an on-line training catalog, (2) develop training plans and training material (3) present training regarding the 800 MHz radio system including in-service training for Police and Fire Department staff, and (4) track the personnel being trained.**

2. TRAINING FOR MAJOR EVENTS

APCO International (Association of Public-Safety Communications Officials) recently released its Homeland Security White Paper, which details many of the challenges facing emergency communicators. The top six issues identified as key components of improved emergency response were:

- **Radio Spectrum:** having sufficient spectrum for unfettered and high-quality reliable communications in emergency situations.
- **Interoperability:** getting the necessary communications technologies and systems in place so that different public safety agencies can communicate seamlessly and reliably with each other. Developing the ongoing dialogues with other agencies to allow for joint planning and coordination, which is essential for a coordinated response.
- **Planning:** how to approach planning specific to Homeland Security initiatives.
- **Survivability/Redundancy:** knowing how to plan and having the funding available to build public safety communications systems and communication centers that can withstand significant threats.
- **Security:** instigating processes and procedures to assure that public safety communications systems, centers and staff are protected with substantially increased security to thwart attempts by enemies of the United States to disrupt and destroy our emergency communication capability.
- **Personnel/Training:** providing the necessary training to public safety communications personnel to enable them to plan for any type of terrorist event, to utilize new technology, to be aware of new security systems and procedures, and to deal with the stresses associated with working in an environment characterized by “perpetual anticipation.”

Large events, such as the firestorm in San Diego, CA in October of 2003,

increase the demands on radio systems geometrically and often result in multiple radio systems/frequencies being utilized in response to these major events. Metro Nashville Radio Management Committee, Radio Communication Services Division and Metro Nashville have begun to address interoperability through technology acquisitions. However, an essential part of the response to these major events is disaster planning and training in the application of the plan in coordination with other agencies.

Metropolitan Nashville and Davidson County should routinely design and conduct drills and exercises using a variety of emergency scenarios, and coordinate training for emergency response professionals including the testing of the effective utilization of the 800 MHz radio system. These exercises and training programs should be developed and delivered in conjunction with Metropolitan Nashville and Davidson County partners at the federal, state and local levels, and should occur at least twice a year.

RECOMMENDATION 8-2:

The Director of the Office of Emergency Management should design and conduct drills and exercises twice annually using a variety of emergency scenarios. The disaster or event drills and exercises should include the testing of the effective utilization of the 800 MHz radio system and 800 MHz radio system failure testing.

3. ANNUAL USER SURVEYS

There are a number of benchmarks within the *Baldrige National Quality Program Criteria for Performance Excellence: A Guide to Self-Assessment and Action* that pertain to listening to the customer. These include the following:

- How do you listen and learn to determine key customer requirements and expectations and their relative importance to customers?
- How do customer requirements vary for different customers or customer groups?
- How do you use relevant information from current customers?

- How do you use this information for purposes of service planning, marketing, process improvements, and training development?

This sampling of its customers should be accomplished through the use of a written survey that is administered anonymously.

The Radio Communication Services Division does not conduct user surveys on a routine ongoing basis.

RECOMMENDATION 8-3:

The Radio Communications Services Division should conduct user surveys no less than once every two years to assess how well the 800 MHz system and equipment meets their needs.

4. SERVICE LEVEL AGREEMENTS

It is increasingly common for internal service providers, such as fleet management and facility management to develop service level agreements with their customers. The purpose of service level agreements is to define the responsibilities for doing business with its customers. These service agreements document:

- The services to be provided;
- The funding resources required for acquisitions, maintenance, and repair;
- The terms and conditions under which the customer and the internal service provider will operate in order to properly support Metropolitan Nashville and Davidson County's investment in the infrastructure maintained and repaired by the internal service provider.
- The standard business practices including how compliance with the service agreement will be measured, problem (trouble) reporting protocol, how to request services, emergency service priorities, services provided after hours, etc.
- The services provided and not provided.
- The dispute resolution process.

The service level agreements enhance communication between the internal service provider and its customers, as well as present service level expectations and costs associated with the level of service provided.

The Radio Communication Services Division has not developed service level agreements with its major customers.

RECOMMENDATION 8-4:

The Radio Communication Services Division should establish service agreements with its major customers.

5. TIERS OF RADIO EQUIPMENT TO BE PROVIDED TO VARIOUS END USERS.

The Radio Communications Services Division has taken a perspective that if the customer wants a high-tier portable radio, has sufficient funding, then the customer will be provided with a high-tier portable radio even if the customer's needs could readily be satisfied by a low-tier portable radio.

RECOMMENDATION 8-5:

The Radio Communication Services Division should be assigned responsibility for the review of requests for radio equipment, an assessment of the needs of the customer, and the development of recommendations for that tier of radio that should best meet the needs of that customer most cost-effectively. This role should be clarified in a policy developed by the Radio Communication Services Division and approved by the MRAM.

9. ASSET MANAGEMENT

9. ASSET MANAGEMENT

There are a number of elements to effective asset management of the 800 MHz radio system. These include such elements as the following:

- 800 MHz radio system facilities and equipment are adequate for the provision of effective and efficient services.
- An effective preventive maintenance program is in place to provide regular inspection and servicing of 800 MHz radio system equipment to assure maximum service life, reliability, and operation.
- Work authorization and scheduling procedures have been established that are consistent with the defined role of each section in the Radio Communication Services Division and achieve an equitable distribution of resources. This includes a standardized and meaningful annual work plan, accurate system condition assessment techniques, and a computerized maintenance management system (CMMS).
- An effective system is in place to identify, report, correct, and document substandard conditions and maintenance requirements.
- Work performance standards have been established for all frequently occurring tasks and are used to gauge performance.
- The Radio Communication Systems Division is involved in the planning, modification, and design of 800 MHz radio system facilities including enforcing construction contractor's quality control responsibilities during modifications to any of the 800 MHz microwave sites.

These elements served as the basis for the evaluation of the maintenance management of the 800 MHz radio system.

1. MAINTENANCE OF THE MICROWAVE BACKBONE

As part of the assessment of the 800 MHz radio system, the adequacy of the maintenance and repair of the microwave backbone was evaluated. An inspection of each of the seven microwave tower sites was conducted during the week of July 12, 2004.

The following paragraphs present a description of the approach used by the Radio Communication Services Division in the maintenance of the microwave backbone.

- **Generator Maintenance.** Generator maintenance is contracted. The contract calls for quarterly inspections of all generator systems. All site generators are automatically tested weekly under load for 3 hours, one site per day and verified by maintenance staff and logged on the preventive maintenance board. The exception to this is the prime site. The prime site generators are tested manually each week under load.
- **UPS Maintenance.** Maintenance at all sites except Compton are performed under contract with Powerware. The contract with Powerware has expired and a new contract is under procurement. The UPS is checked yearly, batteries are under separate contract. The prime site Compton's UPS and batteries are under a separate contact from the other sites. Batteries are resistance tested every 6 months with a report submitted to staff indicating defects found and corrective action taken.
- **Tower Maintenance.** Tower maintenance is performed by outside contract. Towers are inspected yearly and a detailed report is developed indicating the condition of the tower, lighting and attachments to the tower. Pictures of all connections are labeled and included in the report that verifies the conditions of all tower attachments.
- **Fire Suppression.** Fire suppression at all sites except Compton are FM-200 systems, and are tested every 6 months. Compton is staffed and monitored 24 x 7. Fire suppression at that site is accomplished via manual fire extinguishers.
- **Preventative Maintenance.** Preventative maintenance of the microwave backbone is provided by the Radio Communication Services Division with assistance from a technical contractor provided by Motorola.
- **Medical Channels.** The medical channels are located on the 2 GHz microwave at Cane Ridge, Sullivan Ridge, and Joelton.
- **Annual Tower Inspections.** The annual tower inspections do not include ground resistance measurement and inspection and cleaning of tower leg weep holes.
- **FCC Authorizations.** Copies of the FCC authorizations for equipment installed at each tower site are not posted in each building.
- **GPS Antennas.** GPS antennas are located on the towers. GPS or the Global Positioning System in the 800 MHz radio system is used as the time base for the

simulcast synchronization. The placement of the GPS antenna in the building will enable faster recovery when lightning damages the GPS antenna, which apparently happens relatively often based on the information provided by the Radio Communication Services Division. If the antenna is located on the building, where it can be replaced by staff, staff will not have to wait for a tower crew to be dispatched to repair the GPS system. There is no need for the antenna to be on the tower from a performance or operational standpoint.

RECOMMENDATION 9-1:

A number of the practices used in the maintenance, repair, and operation of the 800 MHz backbone should be modified to enhance the reliability of the system.

- **The medical channels should be moved off the 2 GHz microwave at Cane Ridge, Sullivan Ridge and Joelton and relocated from the old site to the new 800 MHz sites as soon as possible.**
- **The annual tower inspections should be expanded to include the following:**
 - **Ground resistance measurement to verify condition of tower grounding; and**
 - **Inspection and cleaning tower leg weep holes to ensure proper condensation draining of tower legs.**

The estimated annual costs for expanding this annual inspection amounts to \$5,000.

- **All microwave tower sites should have copies of the FCC authorizations posted in the tower building for equipment that are installed at the site. The estimated one-time cost for providing these copies at each site is \$100.**
- **The GPS antenna should be relocated inside the microwave backbone site buildings**

2. AUTHORITY OF THE MANAGER OF THE RADIO COMMUNICATION SERVICES DIVISION.

The manager of the Radio Communications Services Division does not have the authority to approve and manage installation of all equipment in the 800 MHz communication sites including the communication equipment room at Compton. Metro Nashville and Davidson County is unable to hold the manager of the radio

Communications Services Division accountable for enforcing compliance with good engineering practices and Motorola R56 standards for all microwave backbone installations. The problem with the wireless installation at the Compton site is evidence of the problem with this lack of accountability.

RECOMMENDATION 9-2:

Metro should adopt a policy assigning responsibility to the manager of the Radio Communications Services Division for approval and management of the installation of all equipment in the 800 MHz communication sites.

3. COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM (CMMS).

In all Radio Communications Division s, a tremendous amount of information is recorded and compiled in the normal course of procuring, operating, and maintaining radios and the backbone. With advances in information technology, real-time access to radio repair histories, work order labor time, and perpetual inventory records makes it possible to manage operations and provide services in ways that were literally impossible in the past. The use of such a system also is essential to support a service-based radio charge-back system.

The Radio Communication Services Division relies on a manual maintenance management system. The Division relies on information kept in a hard-copy format, on documents that are manually recorded, compiled, and filed. Extracting key data elements by radio, department, or functional area to support performance evaluation or cost analysis is cumbersome, time consuming, and labor intensive.

RECOMMENDATION 9-3:

The Radio Communication Services Division should acquire a computerized maintenance management system (CMMS). The estimated one-time cost for the system approximates \$30,000 with annual licensing fees of \$5,000.

4. MAINTENANCE MANAGEMENT SYSTEM.

The acquisition of the CMMS is merely a first step. It needs to be supported by effective maintenance management practices as well. These effective practices include:

- The Supervisors need to define in writing all of the critical work activities that consume the majority of staff work hours.
- Performance standards need to be developed. Performance standards should be established for each major work activity to identify the need for the work, required quality of work, the resources necessary to achieve quality and expected rate of productivity, etc. Actual performance should be tracked against these standards.
- Weekly work schedules need to be developed for staff, supported by formal written work orders for all of the work performed by staff.
- An annual work plan needs to be developed. The annual work plan estimates the kind and amount of work to be done in the upcoming fiscal year
- A monthly performance report should be generated. The monthly report should be generated by the automated work order system. It should provide a number of reports such as a comparison of planned versus actual staff hours per work activity for the previous month and year-to-date for each work activity.

The Division does not have a formal maintenance management system that includes activity definitions, performance standards for those activity definitions, formal written weekly work schedules, annual work plans, etc.

RECOMMENDATION 9-4:

The Division should develop a maintenance management system using the CMMS.

5. THE RADIO TECHNICIANS SHOULD CHARGE NOT LESS THAN 1,450 HOURS ANNUALLY TO WORK ORDERS.

The amount of hours that technicians charge to work orders directly affects the hourly shop rate charged to customers for maintenance, repair and installation: it serves as the denominator in the development of a shop labor rate. The fewer hours charged to work orders, the higher the hourly rate to support the cost structure.

The amount of hours charged to work orders during a recent twelve-month work period varied significantly as the table below indicates.

Technician Number	Total Hours	Section
42	117	Installation/Maint.
34	618	Installation/Maint
32	888	Installation/Maint
28	1,029	Installation/Maint
37	1,230	Installation/Maint
41	1,246	Installation/Maint
33	1,284	Installation/Maint
35	1,485	Installation/Maint
40	476	Backbone
39	656	Backbone
20	1,397	Backbone
TOTAL	11,182	

As the table indicates, the number of work hours charged to work orders varied within the Installation, Maintenance and Repair Section from a low of 117 hours for one technician to a high of 1,485 hours for another technician. For the Backbone Maintenance Section, the number of work hours charged to work orders varied from a low of 476 hours for one technician to a high of 1,397 work hours for another technician.

In general, technicians should be capable of charging about 70% of their time to directly billable mechanical work. This equates to 1,450 hours per year. Only one of the eleven technicians within the Radio Communication Services Division met this objective.

RECOMMENDATION 9-5:

Radio Technicians should be fully “billable” to work orders and should charge not less than 1,450 hours annually to work orders.

6. COMPACT PICKUP TRUCKS AVAILABLE FOR MICROWAVE BACKBONE MAINTENANCE AND REPAIR

Crew size is a critical influence in productivity and cost-effectiveness of services. In evaluating crew sizes, each work task must be evaluated to assure an appropriate balance between employee safety versus the complexity and effort required to complete the task.

One of the crews allocated to the maintenance and repair of the microwave backbone is functioning as a two-person crew. This results from the lack of a vehicle for both staff. This staff is not performing work that routinely requires a two-person crew. During the vacancy of the division-head position, the interim division-head reassigned vehicles to enable these staff to each function as a one-person crew. However, when the division-head position is filled, the vehicle will be reassigned and the crew will revert to a two-person crew.

RECOMMENDATION 9-6:

An additional compact pickup truck should be acquired for the Microwave Backbone and Repair Section. The estimated one-time cost for a compact pickup truck approximates \$15,000 with \$1,200 in annual operating and maintenance costs.

7. UTILIZATION OF RADIO TECHNICIANS ASSIGNED TO THE INSTALLATION AND MAINTENANCE SECTION

The ability of an organization to cross-utilize its staff for a wide variety of tasks can significantly influence the cost-effectiveness of services.

The installation workload of the staff allocated to the Installation and Maintenance Section is seasonal. The labor hours charged to installation work orders in 2003-04 peaked in March 2004, and required 400 hours a month or less for seven of the twelve months, including February, May, June, July, October, November, and

December. In these seven months, an average of 311 labor hours were required for installation or the equivalent of two and one-half technicians. The peak workload for installations – March – required a little more than seven technicians.

However, these staff are not utilized to perform installations in the field or to perform subscriber unit maintenance and repair in the field during months when the number of installations is not significant (such as the months of February, May, June, July, October, November, and December). The staff in the Microwave Maintenance and Repair Section performs this work. This diverts these staff from the maintenance and repair of the backbone (although preventive maintenance of the backbone meets manufacturer recommendations).

RECOMMENDATION 9-7:

The Radio Technicians assigned to the Installation and Maintenance Section should be utilized to perform installations in the field or to perform subscriber unit maintenance and repair in the field when workload allows.

8. INVENTORY OF SUBSCRIBER EQUIPMENT.

One of the most important elements of a user fee system is its credibility. That credibility is dependent upon a number of factors. One of these factors is the accuracy of the invoice.

The Radio Communication Services Division provided Matrix Consulting Group with three different inventories of subscriber equipment maintained by three different staff within the Division. Information contained in the inventories was inconsistent with respect to the number of subscriber equipment. Specific information regarding these three different inventories is presented in the paragraphs below.

- One inventory, designated 'the users list', indicated that the Police Department has 1,170 mobile radios and 1,344 portable radios for a total of 2,514. This

inventory reflects the end user or subscriber equipment on the zone controller, which may also include alias's of equipment that was lost or stolen.

- A second inventory, called the 800 MHz Radio Summary, showed the Police Department as having 1,175 mobile radios and 1,361 portable radios for a total of 2,536. This inventory was apparently the number of radios originally distributed to the various departments by type of radio (such as mid-tier portable, high tier portable, etc.).
- A third inventory, which serves as the basis for billing user departments, indicated that the Police Department has 1,160 mobile radios and 1,437 portable radios for a total of 2,597.

While the variance is not significant (an approximate range of 3%), from an internal control perspective this is an indication of errors in the inventory management system. Moreover, as an internal service, which charges its customers for the use and maintenance of subscriber equipment, this could result in billing errors. For instance, using the above example, the Police Department could be paying 3% more than it should for radios not assigned or used by the Department. The Radio Communication Services Division should maintain an accurate inventory of subscriber equipment. Data should be verified monthly to reflect changes (i.e., additions or subtractions to user department accounts), and should be reconciled among the three inventory databases to ensure consistency.

RECOMMENDATION 9-8:

The Radio Communication Services Division should develop an accurate inventory of subscriber equipment by reconciling these three inventories. The billing inventory and the inventory on the zone controller should be reconciled monthly. The Division should develop and utilize a single database of its subscriber units.

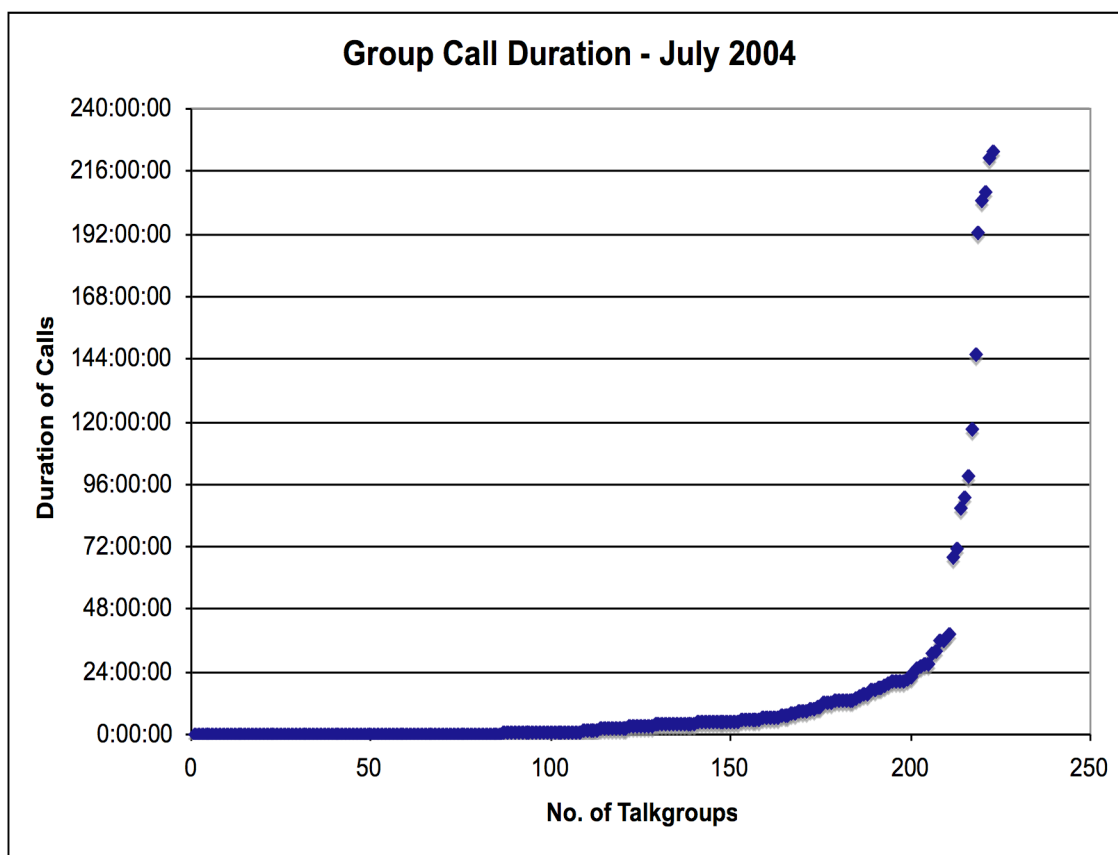
9. FLEET MAPS UTILIZED FOR THE 800 MHz RADIO SYSTEM.

In every step of a voice transmission, radios and the central controller use ID's. The process of assigning ID's is called fleet mapping. One of the greatest challenges in

an 800 MHz system is effective fleet mapping. Fleet mapping involves assigning radio talk groups to departments, giving or denying access to other department's radio groups. These talk groups allow private conversations within that talk group, similar to that of a dedicated channel.

The fleet maps within Metro Nashville have two serious limitations.

- **Talk group naming conventions vary from department-to-department.** In an emergency, if an employee says over the radio “go to Fire 1”, different employees could end up on different talk groups since Fire 1 could be a different talk group to different departments due to variations in naming conventions. Additionally, it is difficult to switch from one zone to another zone.
- **Most of the talk groups within the 800 MHz radio system receive little use.** The chart below presents a distribution chart of the group call duration for the 223 different talk groups in Metro Nashville in hours, minutes, and seconds. This data is based upon the Smart Zone Historical Group Summary Report for the month of July 2004.



Important points to note regarding the group call duration for these 223 talk groups are presented below.

- 48 of the 223 talk groups or 21% had less than one minute group call duration for the month of July 2004.
- 105 of the 223 talk groups or 47% had less than one hour group call duration for the month of July 2004.
- Only 7 of the 223 talk groups had more than 100 hours of group call duration for the month of July 2004. This amounts to 3% of the talk groups.

The fleet maps, as currently defined, can potentially hinder the ability of users to talk to other users in a different zone during events. For example, the transition from the dispatch zone to the tactical zone cannot be accomplished with the knob on the top of the portable radio; that knob enables transitioning from one talk group to another within that dispatch zone. Rather, the user must key the keypad on the front of the radio to make the transition from the dispatch zone to the tactical zone. This can be cumbersome, and unless the user uses this feature frequently or has received ongoing training in its use, it may not be accomplished in a timely fashion.

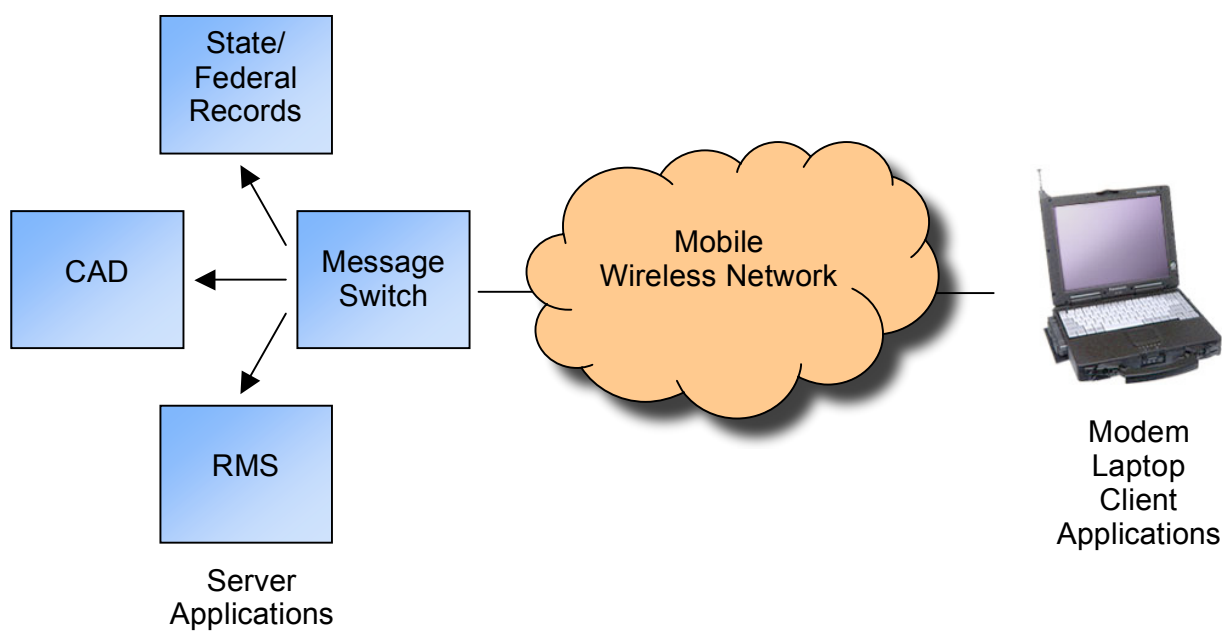
RECOMMENDATION 9-9:

The Radio Communication Services Division should address the limitations in the fleet mapping for the 800 MHz radio system.

- **The Radio Communication Services Division should develop a standardized fleet map across System A and B**
- **The Radio Communication Services Division should evaluate the 800 MHz radio system talk group structure, and develop proposals for the streamlining these talk groups.**

10. OPTIONS AVAILABLE TO PROVIDE THE POLICE DEPARTMENT ENHANCED MOBILE DATA FUNCTIONALITY.

The City operates a Motorola RD-LAP mobile data system to support the Police Department, Fire Department, and NES. This system provides the wireless connectivity between field users and dispatchers, and provides access to data and applications that reside in fixed locations. The system has three separate pieces that work together: applications, a wireless network, and user equipment. This is illustrated below:



The existing mobile data system will not meet the mid to long-term needs of the Police Department. It does not provide sufficient bandwidth for the applications being considered by the Police Department. The existing system can be utilized for license plate checks, criminal records checks, driver's license checks, etc. It cannot be utilized for applications that require significant band-width such as mug shots, fingerprints and photos, GIS crime analysis maps, etc.

Mobile data is important to Police Departments due to the timeliness of access to data (real time) and the accessibility to information databases. Police departments are utilizing a variety of approaches to meet this need.

- Some police departments, such as the Tulsa Police Department, are using private (local government owned) data systems. These systems are one-time capital intensive (expensive) and face spectrum allocation issues. It may be hard to get frequencies or channels in metropolitan areas.
- Many police departments contract for wireless access with major carriers, including Verizon, Sprint, Cingular and T-Mobile. This option would generate new ongoing costs for Metropolitan Nashville and Davidson County Police Department, however.
- Other police departments are beginning to explore 3G (third generation) wireless such as GPRS (general packet radio service) such as the Fremont, California Police Department.
- Other police departments, such as the Arlington, Texas Police Department are using wireless LAN.

Full mobile computing enables a police officer to do in the field what he or she could do in the office.

Without this planning and needs assessment, the risk that this mobile computing project will fail to achieve its potential is significant.

RECOMMENDATION 9-10:

Metro should conduct a needs assessment to identify and document the mobile computing needs of the Police Department.

11. WATER SERVICES DEPARTMENT RADIO SYSTEM

In 2002, Federal Engineering completed an assessment of those departments that were still not utilizing the 800 MHz radio system, the alternatives, and recommended courses of action from both operational and economic perspectives. The firm recommended two courses of action.

- All public safety and public service users (except isolated systems, i.e., jails) should be on the same band with compatible technology to maximize interoperability, and
- Users should not use common carriers (cellular, PCS, or other commercial systems) to avoid lack of service during emergency situations, when priorities are needed most.

The specific departmental recommendations are presented below.

- The Health Department should migrate to the 800 MHz radio system;
- The Water Services Department should migrate to Nextel;
- State Trial Courts should migrate to the 800 MHz radio system;
- The Sheriff's Office should migrate to the 800 MHz radio system;
- Metropolitan Transit Authority should migrate to the 800 MHz radio system;
- Public Schools/Board of Education should upgrade its UHF system; and
- The Public Works Department should migrate to the 800 MHz radio system.

Many of these recommendations have been implemented or will be implemented in the next fiscal year. The Health Department, Public Works Department, and State Trial Courts have converted to the 800 MHz radio system. Metropolitan Transit Authority has the funding necessary to migrate to the 800 MHz radio system (using UHF for data). The Public Schools/Board of Education and the Sheriff's Office plan on converting to the 800 MHz radio system shortly.

The recommendations made by Federal Engineering were, in some cases, based upon the cost of migrating to the 800 MHz radio system. Over a five year period, 25% of the costs associated with an 800 MHz portable radio were attributable to the costs of purchasing an 800 MHz portable radio, while 75% of the costs were attributable

to the operating costs (or the internal service fund service charges) associated with the 800 MHz radio system.

The Matrix Consulting Group has analyzed the 800 MHz service charges associated with the Radio Communications Division internal service fund. The analysis indicates that these service charges can be reduced including the elimination of the replacement charge. While Federal Engineering assumed operating costs of \$679.72 annually for a portable radio, the Matrix Consulting Group believes these service charges for an 800 MHz portable radio should approximate \$240 a year. Rather than facing \$3,398.60 in operating costs over this five-year period, a customer would likely face \$1,200 or 65% less than assumed by Federal Engineering.

While Federal Engineering indicated that the costs of the Nextel units would approximate \$2,500 over a five-year period (capital and operating costs), it presumed an 800 MHz portable radio would cost \$4,540 over this five-year period (capital and operating costs) or \$2,040 more than the Nextel alternative.

However, the analysis by the Matrix Consulting Group indicates that with the revision of 800 MHz service charges and the acquisition of a low-tier digital portable radio (not an analog portable radio as assumed by Federal Engineering), the costs would closely approximate each other. The cost for the 800 MHz portable radio over a five-year period would approximate \$2,700 versus \$2,500 for Nextel. The service charges for the 800 MHz radio system will decrease further with the participation of the Public Schools/Board of Education, the Water Services Department, and Metropolitan Transit Authority. It is estimated that the service charges will decrease by another 20%.

As a consequence, the cost of the 800 MHz portable radio over a five-year period would be less than that of a Nextel system.

While some of the employees that are currently assigned Nextel will continue to need cellular phones, this is likely to be a small proportion of those departmental employees that are currently assigned Nextel phones based upon the performance audit experience of the Matrix Consulting Group in analyzing other large water utilities.

In addition, the participation of water utilities in an emergency response is oftentimes critical.

This was demonstrated in 2001 in an emergency in Baltimore in which a train caught fire in a tunnel near downtown. The 60-car train was carrying wood pulp and large rolls of paper combustibles. Nine cars were carrying chemicals including five acid tank cars. Two tanks held fluorosilicic acid, two carried hydrochloric acid, and one held glacial acetic acid. The City estimated that approximately 60 million gallons of water from the City's water supply were used to assist fire suppression activities. The water supply to the Shock Trauma Hospital had to be maintained and the Water Department had to re-route several pipe channels to ensure water service to the hospital and other businesses. The fire also resulted in several burst water mains immediately above the tunnel.

The Water Services Department is an emergency responder in an event or disaster. Water utility operations affect fire protection, public health, and public safety, as well as most levels of government. It is critical for coordination to take place between water utilities and other departments within Metropolitan Nashville and Davidson County. The ability of the department to participate could be hindered in the extreme

with its reliance on Nextel.

Cell phone service is still a vulnerable technology. When the lights go out for an extended period, chances are the cell phone will, too. The huge power blackouts of 2003 interrupted service over large portions of the country. An AT&T Wireless spokesman said it would be impossible for cellular carriers to engineer networks and backup systems for a "power outage of such massive proportions."

Cellular providers reported that the back up systems they had in place did what they were supposed to do during the blackout. Most back up power supplies, however, are only designed to last six or eight hours.

RECOMMENDATION 9-11:

The Water Services Department should convert to the 800 MHz radio system rather than use the Nextel system. The estimated one-time costs for the radios are \$525,000, and the estimated annual operating and maintenance costs approximates \$83,000 (excluding replacement charges). The cost to the Water Services Department of the 800 MHz portable radio over a five-year period would be less than that of a Nextel system with the reduction of unit charges resulting from the participation of the Public Schools/Board of Education, the Water Services Department, and Metropolitan Transit Authority, the use of a low-tier digital portable radio, and the elimination of the unit replacement charge. The low-tier digital portable radio should replace the Nextel units.

12. DEVELOPMENT OF A FORMAL, WRITTEN INTEROPERABILITY PLAN

Interoperability is the ability of Metropolitan Nashville and Davidson County personnel to communicate by radio with staff from other agencies using other proprietary radio systems or other frequencies, on demand and in real time.

Interoperability is important for a number of reasons:

- Current deficiencies in wireless interoperability put the general public, as well as public safety officials, at significant risk;
- Without coordinated efforts to address interoperability, jurisdictions around the country are developing communications systems at extra expense to taxpayers;

and

- The events of September 11 have highlighted the necessity for effective public safety operations.

Metropolitan Nashville and Davidson County has been addressing the challenges associated with interoperability on many fronts including the following:

- VHF and UHF repeaters have been placed on mutual aid channels for the Police Department. Radio Communication Services is obtaining a state-wide mutual aid channel for the Fire Department;
- The system has a full complement of ITAC mutual aid channels;
- The consoles at E.C.C. have UHF/VHF patch capacity;
- The Airport and Vanderbilt University have access to the 800 MHz radio system;
- OEM has a cache of analog radios;
- A portable repeater is being acquired; and
- Metropolitan Nashville and Davidson County is purchasing an ACU-1000 patch.

Metropolitan Nashville and Davidson County has not developed a formal, written interoperability plan or conducted drills that would apply this plan. This interoperability plan would develop interoperability strategies that address short-term as well as long-term interoperability problems. The final plan would provide Metropolitan Nashville and Davidson County with a clear path towards improving interoperability among emergency responders within the region as well as responders from the state and federal level.

RECOMMENDATION 9-12:

The Office of Emergency Management should provide the leadership in the development of a formal, written interoperability plan.

13. ADEQUACY OF 800 MHz RADIO COVERAGE

A radio network's coverage area refers to the entire area that gets a strong enough signal from the network for a radio in the field to transmit and receive. Once a signal from a network degrades so badly that it is essentially useless, and all transmissions are bad or impossible, then that area is considered to be out of the coverage area. The coverage area is often called the "footprint" of a network.

One of the questions in the customer satisfaction survey administered by the Matrix Consulting Group as part of this performance audit was as follows:

The coverage provided by the 800 MHz radio system is adequate. There aren't any 'dead spots' in the 800 MHz radio system that prevent me from communicating with the communications center or other staff.

For those staff that responded to this question within the Police Department, 58% disagreed with that statement while 42% agreed with the statement.

A review of the coverage maps for the 800 MHz radio system indicates that there are coverage gaps in the 800 MHz radio system in areas such as Hermitage and Green Hills, and in important buildings such as schools.

RECOMMENDATION 9-13:

The Radio Communication Services Division should evaluate the adequacy of coverage, discuss with its customers particular problems areas in terms of coverage, and develop capital budget proposals for consideration of the Finance Department to address these coverage problems. The estimated capital outlay costs to develop one site would approximate \$500,000

APPENDIX

APPENDIX

Technical Glossary

800 MHz

This refers to the range of frequencies that will be utilized in the new radio network. Usually this term is applied to any network that broadcasts on frequencies between 800 and 900 MegaHertz.

Analog

Whenever a person speaks, sound is projected in the form of a sound wave. These waves move at a certain frequency that determines the pitch of the sound. An analog radio network transmits the actual wave of a person's voice over the air by modulating it onto a radio frequency carrier. An analog network operates differently from a digital network, which converts the vocal sound wave into a digital bit stream of ones and zeros. This information is then sent over the air, and eventually converted back into an analog wave to be heard.

APCO

This stands for The Association of Public Safety Communications Officials. This agency is composed of many different public safety employees and representatives from around the world. APCO was one of the lead agencies in the development of the Project 25 Standard on which our new radio system is based.

ASTRO

This is a type of radio communication system developed by Motorola that utilizes narrowband digital technology. This system makes good use of available frequencies, and allows for greater security than older systems. ASTRO can stand alone as a digital network or incorporate analog technology as well.

Backward Compatibility

This term refers to the capability of a piece of equipment (i.e. software program, hardware component) to be compatible with its predecessor in all forms. For instance, Microsoft Word 2000 is backward compatible since it can create documents that will run in Microsoft Word '97.

Base Station (also known as a control station)

This term refers to a stationary radio connected to an antenna. The antenna is located where it can transmit into and receive from a geographic area where mobile and portable radios are being operated. In our system the mobile and portable radios can communicate at extended distances from each other by communicating through the base stations. (See Repeaters) The mobile and portable radios can also communicate with dispatchers at radio consoles.

Common Air Interface (CAI)

This refers to the protocol by which handheld and mobile radios communicate with the radio system infrastructure. In modern radio systems this is typically a proprietary format, however the CAI, defined by the Project 25 Standard, makes this an open protocol. This allows different manufacturers' portable and mobile radios to work together on a single radio system.

Console

A console is used by a dispatch operator to communicate with users in the field, to track radio activity, and to coordinate the efforts of various public safety agencies. A typical dispatch position consists of various types of equipment, which along with the radio console includes several different tracking and communication systems, usually running on anywhere from one to five computers. Dispatchers usually operate in a public safety facility, with consoles set up in their individual work areas.

Conventional

A conventional radio network allocates specific frequencies to specific groups of radio users permanently. If nobody in a particular group is transmitting on their assigned frequency, then that channel remains open. This is in contrast to a trunking network which assigns frequencies to users only when they are needed, which can be more efficient.

Coverage/Coverage Area

A radio network's coverage area refers to the entire area that gets a strong enough signal from the network for a radio in the field to transmit and receive. Once a signal from a network degrades so badly that it is essentially useless, and all transmissions are bad or impossible, then that area is considered to be out of the coverage area. The coverage area is often called the "footprint" of a network.

Digital

The term "digital" refers to the method of expressing information in one of two different electronic states, which are usually designated as ones or zeros. These ones and zeros form a pattern that can be translated into all kinds of information. Relaying digital information through an electrical system is done by transmitting electronic pulses with one of two distinct electrical charges. These pulses are usually referred to as either "1" or "0", with the "1" pulse usually having a higher voltage, or charge, than the "0" pulse. Electronic equipment such as computers can interpret the information by: a) receiving a set of electronic pulses, b) sensing the different voltages of the pulses, therefore determining whether each pulse is a "1" or a "0", and c) combining many of these ones and zeros to form instructions that tell the computer what to do.

Encryption

Digital transmissions can use encryption to secure information that is being transmitted. The reason this security technique is so effective is because the encrypted transmissions can only be deciphered by a radio with the proper decryption key. This key consists of a software application that is programmed into the authorized radios.

FCC

This stands for the Federal Communications Commission. This governmental agency decides how frequencies are to be used, as well as who can transmit on them. The FCC sets aside specific amounts of frequencies for public safety transmissions, commercial wireless carriers, television broadcasts, etc. Traditionally, the FCC grants blocks of frequencies to public safety agencies, while commercial carriers must buy a license to transmit from the FCC.

Frequency

All radio networks broadcast their transmissions through antennas on a certain frequency. The number of the frequency refers to the number of times that an electromagnetic wave repeats in the span of one second. For example, a transmission being sent at 800 MHz means that its wavelength repeats 800,000,000 times per second. With sophisticated electronic equipment, these waves can be engineered to carry large amounts of information over great distances.

Interoperability

This term refers to the capability of separate and independent entities to work together seamlessly.

IP

IP, or Internet Protocol, is a method by which data is transferred over a network. IP is widely used across the Internet. Every computer attached to the Internet is assigned a unique number, called an IP address. Using IP, a data transmission is split electronically into smaller pieces of data called packets. Every data packet contains two IP addresses: one for the sending computer, and one for the receiving computer. These addresses help route the packets of a digital message to its proper destination.

Loading

The FCC awards licenses for frequency usage based on an expectation that there will be a minimum number of users on each channel by a certain time. This amount of users per channel is referred to as loading. For instance, if a wireless network builder purchased licensing for 20 channels from the FCC, then the FCC might stipulate that there must be a certain amount of loading, or users per channel, by a certain time. If the network provider does not meet the loading requirements, their license would be returned to the FCC. The FCC does this to provide incentive for carriers to make good use of their purchased frequencies. In the case of a public safety network, the FCC grants channels to government agencies (as opposed to selling them), but still requires a certain amount of loading. When all the channels that have been provided from the FCC cannot handle any additional radio users, the system is referred to as fully loaded.

A second usage for the term "Loading" refers to the process of providing radios to users for operation on the 800 MHz system. This system loading will be accomplished in steps.

MDC

An MDC, or Mobile Data Computer, is a vehicle-mounted computer that is wirelessly linked to a radio network. An MDC can allow an operator such as a police officer or firefighter to access information from the network, such as missing persons files or driving records. In addition to this, an MDC has all the capabilities of a personal computer, so an operator may use the MDC for storing information or running various applications. This is in contrast to an MDT, which is primarily just for viewing information gathered from the network.

MDT

An MDT, or Mobile Data Terminal, is a vehicle-mounted keyboard and display that is wirelessly linked to a radio network. An MDT can allow an operator such as a police officer or firefighter to access information from the network, such as missing persons files or driving records. MDT's are primarily used to view information from the network and do not have the capability of operating applications independently from the network. This is in contrast to an MDC, which is capable of many other activities.

Mobile

In radio systems, the term mobile is usually used when referring to a vehicle-mounted radio unit. This is different from a portable radio, which refers to a handheld radio.

Narrowband

In radio systems, the term narrowband refers to the size of a channel with regards to frequency.

NPSPAC

This stands for the National Public Safety Planning Advisory Committee. In the 1980's, the FCC reallocated a block of radio channels in the 800 MHz band for public safety communications. NPSPAC was set up by the FCC to determine how these channels were going to be used. NPSPAC developed a usage plan that divided the country into many different regions, and the public safety agencies in these regions would have exclusive use of the NPSPAC frequencies. These regions would then in turn develop a plan for their own respective frequency usage.

PTT (Push to Talk)

This term refers to the button on a radio that a user pushes to transmit. When somebody wants to talk over the air, they depress the PTT on their portable radio, mobile radio, or dispatch console, and if there is an available frequency, they will be able to speak over the network. When a user presses the PTT, that is often referred to as "keying" the radio.

Portable

In radio systems, the term portable usually refers to a handheld radio. This is different from a mobile radio, which would refer to a radio mounted inside a vehicle.

Project 25

Project 25 is a set of guidelines developed by radio system users for the purpose of standardizing the method of designing radio telecommunications networks for public safety agencies. Agencies such as APCO, the Association of Public Safety Communications Officials, the National Association of State Telecommunications Directors (NASTD), the Telecommunications Industry Association (TIA), the International Association of Chiefs of Police, several federal agencies and radio manufacturers have all participated in building this important standard. Project 25 ensures that all systems following this standard will meet its five main objectives: to make efficient use of the limited number of available public safety frequencies; to permit interoperability among other Project 25-compliant agencies; to ensure backward compatibility of the network; to create smooth system migration via upgrades, additions, etc.; and to provide the capability for scalable trunked and conventional networks.

Queue

When a radio user tries to make a call, and there are no available frequencies to transmit on, that user's call gets placed in a queue. For the most part, the first user that gets placed into a queue will get to transmit as soon as a frequency becomes available, and any subsequent users in the queue will transmit when their turn arrives.

Radio

This term takes on multiple meanings when applied to a communications system. When the term radio is used, it can refer to any of the following: a portable device used to transmit audio, a base station at a transmit site that contains electronic equipment, electromagnetic waves in the air which carry a network's information, or any device used to receive and/or transmit information across a medium.

Repeater

A repeater is a piece of equipment that acts as a transmitter and a receiver. In a radio communications system, repeaters are used to extend the coverage of a wireless transmission. The repeater accomplishes this by first receiving a signal that has been transmitted from some other location, then amplifying and re-transmitting that signal from an antenna, thus giving the original transmission a boost.

Simulcast

A radio network that is simulcast transmits information from each of its transmission sites simultaneously. This means that when a radio user transmits from his/her radio, that transmission is rebroadcast from every tower or antenna that is part of the simulcast system. Because of this technique, any radio can pick up any transmission, regardless of its location.

Site

Also called transmit site, cell site, radio site, or antenna site. Any radio network transmits and receives its signals through antennas that are placed strategically in different locations throughout their desired coverage area. These places are called

sites. Usually the antennas at these sites are mounted high above ground on towers or on the sides of buildings.

Talk group

A talk group is a group of radio users that are linked to each other through the radio system. For instance, if any member of a talk group initiates a call, any member of that group will hear that transmission.

Traffic

This term refers to the number of transmissions being made on the network at any given moment. Although most networks are designed to function even when very busy, an excess of traffic on a network may cause some radios to be placed in a queue when trying to transmit.

Trunking

This term refers to a type of communications system that draws from a pool of available frequencies, and assigns them only when they are needed. For example, in the 800 MHz trunked network, when a radio user wishes to talk over the air, they push their transmit button and the system dedicates a frequency to broadcast that user's transmission. After the user lets go of the transmit button, the system can reassign that same frequency to a completely different radio. Trunking is different from a conventional radio network, which assigns one dedicated frequency to a group of radios indefinitely. In a conventional system, if nobody in a particular group is transmitting, their assigned frequency sits unused and is essentially wasted. Trunking can be more efficient, since any available frequency can be used whenever it is needed.

Vocoder

This piece of equipment transforms the sound of a person's voice into a stream of digital information. It also reverses the process converting digital information back to voice. The vocoder is vital to the operation of a digital network, since without it, no audio transmissions could be sent or understood.