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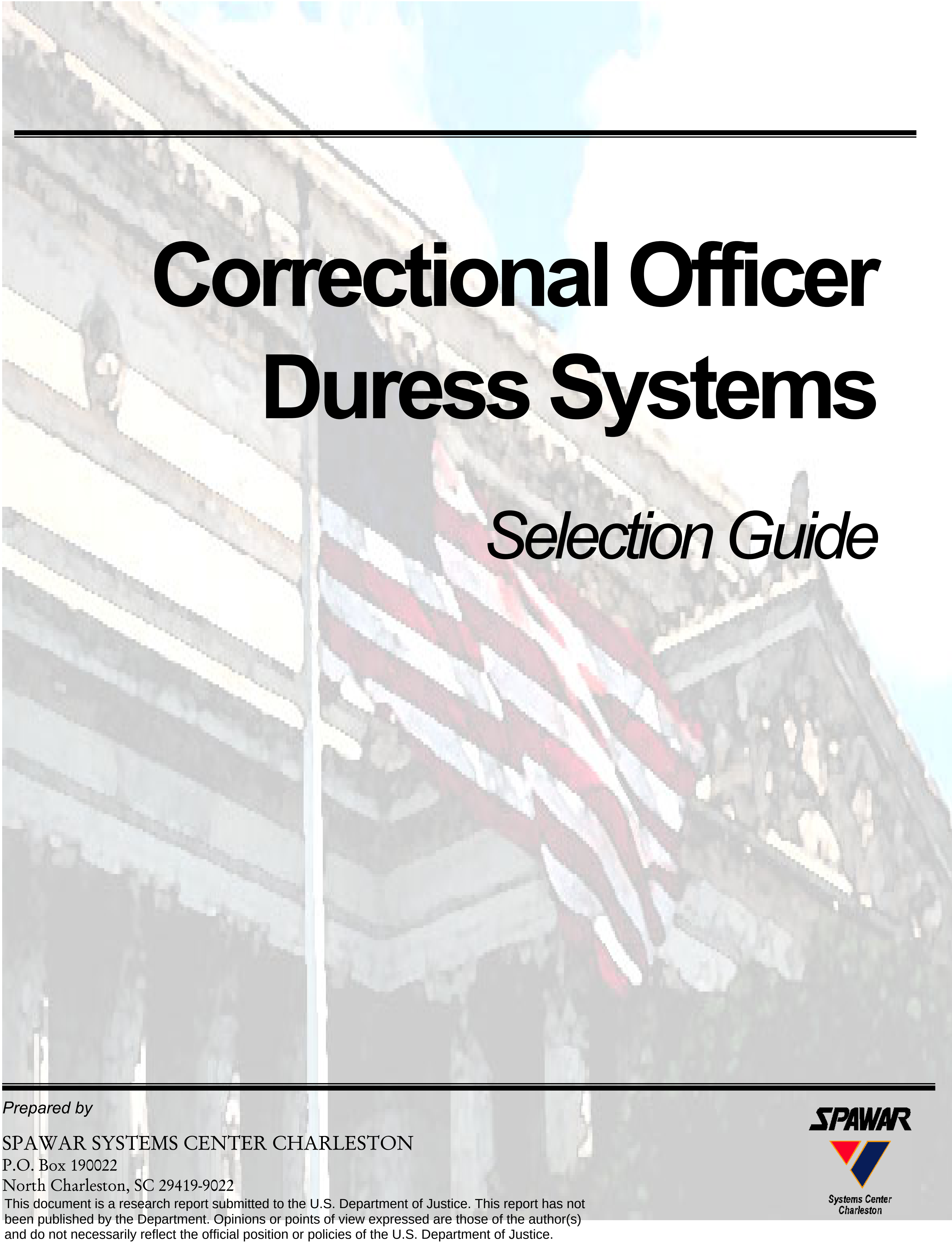

Correctional Officer Duress Systems

Selection Guide

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SPAWAR
Systems Center Charleston

Correctional Officer Duress Systems Selection Guide

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Foreword

This document is intended to assist those within the corrections community with the process of identifying, selecting, and deploying duress alarm systems. To enhance officer and staff security within a correctional facility, duress systems permit alarm signals to be rapidly distributed in the event of impending threats. The real-time nature of the alarm notification permits central control to coordinate an effective response to a given duress situation.

The typical duress system considered in this guide consists of a network of transmitters and receivers (fixed or portable) strategically distributed throughout the facility and linked to a central command alarm and control point.

In order to select the appropriate system for a given facility, those involved in the selection process should understand several key issues. This document addresses these issues by introducing i) a scheme for classifying guard duress systems, ii) a simplified duress system model, iii) basic issues to address during the selection process, and iv) an overview of relevant (current and emerging) technologies.

Fundamental issues relevant to the duress system selection process are introduced and discussed. These fundamental issues cover topics such as cost, installation issues, alarm activation, and system scalability, to name just a few. A major element of this document considers duress systems that are currently available from various vendors.

Relevant technologies, including ultrasonic, infrared, and radio frequency communications, are described with an emphasis on their advantages and disadvantages in the context of personal alarm systems. Additionally, emerging technologies that may influence future alarm systems are identified and described.

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Executive Summary

This document is intended to assist those within the corrections community with the process of identifying, selecting, and deploying personal duress alarm systems. To enhance officer and staff security within the correctional facility, personal duress systems permit alarm signals to be rapidly distributed in the event of impending threats. The real-time nature of the alarm notification permits central control to coordinate an effective response to a given duress situation. The ability to provide comprehensive alarm coverage throughout a correctional facility is made possible by wireless communication technologies. The typical duress system considered in this guide consists of a closed network of transmitters and receivers (fixed or portable) strategically distributed throughout the facility and linked to a central command alarm and control point.

In order to select the appropriate system for a given facility, those involved in the selection process should understand several key issues. This document addresses these issues by introducing i) a scheme for classifying guard duress systems, ii) a simplified duress system model, iii) basic issues to address during the selection process, and iv) an overview of relevant (current and emerging) technologies.

The classification scheme is introduced to identify the fundamental capabilities offered by each type of duress alarm system: Type I – panic button alarms, Type II – identification alarms, and Type III – identification / location alarms. Where Type I systems provide only alarm notification capabilities, Type II and Type III systems identify the correctional staff member involved in a duress situation when an alarm is activated. Additionally, Type III systems provide localization capabilities, identifying the location of activated alarms. An alarm / locator / control model is introduced as a framework for discussing the common functional capabilities offered by various duress systems.

Fundamental issues relevant to the duress system selection process are introduced and discussed. These fundamental issues cover topics such as cost, installation issues, alarm activation, and system scalability, to name a few. The underlying technologies used in available systems include ultrasonic, infrared (IR), and radio frequency (RF) communications. Each technology is described with an emphasis on its advantages and disadvantages in the context of a personal alarm system. In addition, emerging technologies that may directly impact future alarm systems, including ultra wideband RF, global positioning system (GPS), biometrics, and body-implantable microchips are identified and described.

A major element of this document considers duress systems that are currently available from various vendors. The following currently available products are discussed:

Ultrasonic-based systems with alarm and location capabilities:

- Perimeter Products PAS-120
- Sentry Products Sentry Communication System

RF-based systems with alarm and identification capabilities:

- Grace Industries GEM System™

RF-based systems with alarm, identification, and location capabilities:

- Ascom Tateco AB telePROTECT 900 Personal Alarm System
- Bosch Security Systems Security Escort®
- Dominion Wireless Flare™ Personal Emergency Locator System
- Technology Systems International TSI PRISM™

Dual-technology RF+IR systems with alarm, identification, and location capabilities:

- Actall® PALS 9000
- Visonetix SpiderAlert®

Each of these solutions is discussed in terms of the generic alarm / locator / control model, with product-specific characteristics noted and the underlying hardware and software components identified.

1 Introduction

Correctional facilities at all levels (local, state, and federal) face a number of significant problems, such as overcrowding, that affect correctional personnel safety. Because the safety of correctional personnel is paramount, the ability to respond quickly to the correct location when a correctional staff member is in trouble is crucial to the welfare of the individual, the inmates, and the facility. Although the development of advanced correctional officer duress notification systems previously lagged behind other programs, recent technological advancements offer new solutions that meet or exceed the ongoing safety needs of correctional personnel.

1.1 About This Document

The U.S. Departments of Defense (DoD) and Justice (DOJ) have agreed to jointly develop and demonstrate emerging technologies of mutual interest to both the law enforcement community and the military. The National Institute of Justice (NIJ), DOJ's lead agency in this effort, sponsors a special Staff Alarm and Inmate Tracking (SAINT) Program that is managed at the Department of the Navy's Space and Naval Warfare (SPAWAR) Systems Center in Charleston, South Carolina.

The SAINT Program researches products and technologies for correctional institutions and provides guidelines for acquiring and implementing these systems. SAINT is based on a defined need to maintain maximum correctional personnel and inmate safety through reliable systems that provide both precise location and identification of correctional personnel and inmates within a facility.

On October 28, 2000, SPAWAR Systems Center, Charleston released a request for information (RFI) focusing on improved correctional personnel safety through accurate and reliable duress notification systems. The primary emphasis of the RFI was to solicit input from the vendor community concerning products for correctional officer duress systems. The responses to that RFI were brought together to form the basis for this document[1].

This guide is partitioned into several sections that progress from basic issues related to correctional officer duress systems in general to vendor-specific system information. The current section (Section 1) is intended to familiarize the reader with the general layout of the document and to introduce notation and nomenclature used throughout the remainder of the guide.

Section 2 provides an overview of basic considerations that must be addressed during the selection of a correctional officer duress system. Details related to specific technologies and implementations are deferred until later sections.

[1] No approval or endorsement by the National Institute of Justice (NIJ), the Space and Naval Warfare (SPAWAR) Systems Center or the authors for any company or commercial product is intended or implied.

Section 3 provides information about technologies currently used in correctional officer duress systems and emerging technologies that may be integrated into systems in the near future.

Section 4 uses a three-component model (Alarm / Locator / Control) of a generic correctional officer duress system to discuss sub-system functionality and implementation issues.

Section 5 presents information from a variety of alarm system vendors and provides details concerning implementations of specific correctional officer duress systems.

Section 6 provides concluding remarks and a brief synopsis of the guide.

Section 7 contains a glossary of terms and acronyms used in this document, and Section 8 contains document reference information.

1.2 Classification of Correctional Officer Duress Systems

Throughout this guide, the following three categories are used to classify duress systems and sub-systems.

1.2.1 Type I – Panic Button Alarm

The panic button is the most basic duress alarm available. The simplest application includes strategically distributed panic buttons located, for example, on walls, desks and ingress / egress points. When activated, a panic button transmits a dedicated signal via wiring or radio frequency to a central alarm console. Using visible and / or audible annunciators, the alarm console identifies the general location of the alarm event. However, Type I systems are not capable of identifying the individuals involved in a duress situation.

Advantages:

- Simple and effective for many types of emergencies
- Minimal installation and deployment requirements, particularly when integrated during the initial construction of a facility

Disadvantages:

- Panic button may not be accessible in a duress situation (the alarm button may be blocked or across the room from the correctional staff member)
- Such systems lend themselves to nuisance alarms triggered by inmates

1.2.2 Type II – Identification Alarm

Type II alarms typically include portable transmitting devices worn by correctional personnel, with push buttons and / or pull-pins for activation. In a duress situation, the correctional staff member activates the alarm. When the alarm is triggered, the transmitting device broadcasts a wireless alarm signal to the nearest wireless sensing unit, which forwards it to the alarm console. The console also receives information uniquely identifying the officer or staff involved.

Advantages:

- Ability to identify personnel involved in the duress situation
- Portable devices allow individuals to trigger alarms anywhere within a coverage area

Disadvantages:

- Inability to localize alarms within a facility

1.2.3 Type III – Identification / Location Alarm

Systems capable of identifying, locating, and tracking the correctional staff member who triggered an alarm are classified as Type III systems. As with Type II systems, an individual initiates the alarm transmitter, which broadcasts a wireless signal to a sophisticated sensing unit. The sensing unit then forwards the signal to the alarm console. Additionally, an extensive wireless infrastructure identifies, localizes, and tracks the transmitting device. The electronics and software of such a system may produce a positioning symbol on a console panel or map-like display at a central alarm location.

Advantages:

- Ability to identify and localize correctional personnel under duress
- Better coordination of response to duress situations using officers in close proximity

Disadvantages:

- Higher acquisition costs

The majority of vendors who responded to the RFI use a combination of Type II and III components for their correctional officer duress alarm systems. Vendor-specific details and products are presented in Section 5.

1.3 Prototypical Model of a Correctional Officer Duress System

A correctional officer duress system is typically composed of a closed network of portable and mounted transmitters and receivers strategically distributed throughout a correctional institution and linked to a command center alarming point. When a correctional staff member senses a threat, an alarm can be activated on the portable transmitter carried by the individual or on a hard-mounted alarm point located within the facility. This forwards a distress alarm to the central alarm console, notifying others of an emergency condition.

Each vendor's duress system uses different components. To identify common sub-system functionality for typical correctional officer duress systems, the following Alarm / Locator / Control model is employed throughout this document:

1.3.1 Alarm Sub-System

For the purpose of this selection guide, the alarm sub-system consists of the devices used to i) signal the occurrence of a duress situation, and ii) identify the officer / staff involved. As noted above, only Type II and Type III systems provide unique identification capabilities. Alarm sub-systems may consist of hard-mounted panic alarms, wireless transmitter–receiver pairs, and wireless transceivers. Wireless technologies currently used in alarm sub-systems may incorporate ultrasonic, radio frequency (RF), and infrared (IR) signals.

1.3.2 Locator Sub-System

For Type III systems, the locator sub-system consists of devices used to localize alarm events within a correctional facility. Two fundamental localization methodologies are typically employed: i) a tracking / logging approach, and ii) a dynamic localization approach. By gathering information as correctional personnel perform their duties, a tracking / logging-based sub-system determines the most likely location of an alarm based on the logged history of officer movements. In contrast, a dynamic localization-based sub-system uses information received by a network of wireless receivers to ascertain a correctional staff member's location at the time an alarm is activated.

1.3.3 Control Sub-System

The control sub-system contains the underlying infrastructure required to process incoming alarm events and coordinate a directed response. The systems described later in this guide typically centralize control sub-system functionality. It should be noted that, although this selection guide focuses on the use of new duress system technologies that have had the greatest impact on alarm and locator sub-systems, the control sub-system is of fundamental importance

2 Basic Considerations for Selecting Correctional Officer Duress Systems

A broad range of issues must be addressed when selecting a duress system for a correctional facility. Since the significance of each issue must be determined on a case-by-case basis, this section is intended solely to introduce the wide range of issues that exist. Details concerning technologies, systems, and vendor-specific information are addressed in subsequent sections of this document.

2.1 Cost

As with any major project, cost plays a significant role in the selection of a duress system. In addition to the initial costs associated with installing and integrating the system into the facility, additional costs such as operational and maintenance costs must be considered over the life of the system. All factors that can impact the total life-cycle costs of a system should be addressed during the selection process.

Issues to address:

- What are the anticipated installation and integration costs for a given correctional officer duress system?
- What operational and maintenance costs are anticipated for the systems?
- What is the anticipated total life-cycle cost for the system?

2.2 Scalability / Flexibility

Regardless of how well a correctional officer duress system is planned it is difficult to predict all future needs the system will be required to meet. To accommodate possible expansions, a system must be both scaleable and flexible. Scalability is primarily concerned with being able to accommodate additional users and or increased coverage areas. Similarly, flexibility allows the system's role to change over time. Such changes may arise due to the need to integrate the correctional officer duress system with other systems (e.g., CCTV, access control, biometrics) that may be deployed in the future. Flexibility also allows for configuration changes and customizations that may be needed.

Issues to address:

- How many users are expected to use the system immediately following deployment?
- What is the total number of users supported by the system?
- What will be required to add users to the system in the future?
- How easily is the system customized?

- Will the system be able to integrate new and emerging technologies as they mature?
- Does the system use proprietary or open technologies and standards?

2.3 Size and Weight

Size and weight issues must be addressed at each level of the Alarm / Locator / Control model. For Type II and Type III systems, the portable alarm transmitters should be sized so they do not interfere with the day-to-day operations of the staff. Likewise, the hard-wired components (e.g., receivers, signposts) should be easily deployed throughout the facility without interfering with other mechanical and electrical equipment. Finally, for systems with centralized control, the control sub-system should be easily integrated into a control room.

Issues to address:

- What are the size and weight requirements for transmitters?
- What are the size and weight requirements for receivers?
- What are the size and space requirements for the control sub-system?

2.4 Installation

For a duress system to be useful, it must be successfully integrated into the correctional facility. With this in mind, those involved in the selection process must be aware of specific facility issues. For example, an IR-based system may not be feasible in older facilities where line-of-sight issues introduce excessive "dead zones". Detailed facility drawings, including electrical, HVAC, and plumbing details, are essential for identifying the proper locations for equipment / services required by the design.

Issues to address:

- Into what kind of facility (e.g., new or existing construction, campus type or multiple building) will the system be integrated?
- Does the facility have special issues (e.g., electrical supply, noise)?
- What are the installation requirements for the facility?

2.5 Reliability / Maintainability

When the safety of correctional personnel is at stake, reliability is of primary concern. The system and all ancillary equipment must perform as required in the field. Non-functional units must be easily identified and easily repaired or replaced. Likewise, maintainability should also be considered during the selection process. A system that is difficult to maintain may end up draining a facility of many valuable resources (e.g., dollars, man-hours). Preventative and repair maintenance on any of the systems should be carefully planned during the system acquisition process.

Issues to address:

- What is the Mean Time Between Failure (MTBF)?
- What are anticipated failure mechanisms for components?
- How are operators made aware of non-functional equipment?
- Are operators able to test components in the field?
- What are the system life requirements?
- What maintenance costs are anticipated for a given system?
- What level of logistical support is required for the system?
- What are the details of the manufacturer's warranty?
- What training is available from the manufacturer for facility staff?
- What are typical and worst-case technician response times?

2.6 Integration with Existing Systems

Often a correctional officer duress system must be integrated with other existing systems (e.g., communication systems, CCTV, entry-control systems). All parties involved with the design of the new system (e.g., facility managers, system designer, installers) must be cognizant of the architecture of the new system and how it impacts any existing infrastructure. In addition, ample consideration must be made for space in the control room for new and existing electronic equipment.

Issues to address:

- What is the ease of integration with existing systems?
- What type of system architecture will be implemented?
- What resources will be shared between systems?
- Will factory technicians be onsite for installation, start-up, and / or debugging?

2.7 Alarm Activation

Positive alarm activation is an essential part of a correctional officer duress system. Several methods of activating duress alarms often employed in correctional officer duress systems include i) manually depressing pushbuttons (panic buttons) on transmitting devices or fixed alarming points, ii) detaching a cord or strap from the transmitter (lanyard pull), iii) removing the device from a holster, and iv) man-down sensors. Man-down functionality is included in alarm systems to detect when an individual has been knocked down (using tilt switch sensors) and / or remains motionless for a set amount of time (using on-board accelerometers). In a duress situation, a correctional staff member should have full confidence in the alarm system. Adequate operator training of alarm activation is required. Operational procedures may need to be modified in order to fully and accurately utilize the new correctional officer duress system.

Issues to address:

- How is the alarm activated (e.g., push-button, pull-pin, man-down)?
- What are the operating procedures for emergency notification?
- How will the system operation integrate with facility operations?

2.8 Positive Identification

Positive identification, a feature where the duress system identifies the individual who triggered an alarm, is found only in Type II and Type III duress systems. The method by which a system accomplishes positive identification is vendor-specific. Typically, the ID information is dispatched to a central control system for dissemination.

Issues to address:

- How does the system ensure positive identification?
- Does the system support a sufficient number of unique identifiers for all correctional personnel?

2.9 Location Determination / Staff Tracking

Type III duress systems are capable not only of identifying alarms but also of localizing the alarm within the facility. This location information may be determined by various means. Some systems localize alarms by tracking correctional personnel as they perform their duties. This logged tracking information may be gathered by periodically querying each alarm device, or by recording timestamp and location information as the correctional staff member passes system checkpoints. These systems then merge the logged tracking information to determine the most likely location of an alarm event. Other systems dynamically localize individuals at the time an alarm is activated using the distributed alarm receivers.

Issues to address:

- How are activated alarms localized for a specific correctional officer duress system?
- Does the system localize alarms based on tracking data or dynamic information?

2.10 Tracking Accuracy

For systems capable of localizing alarms events (Type III systems), tracking accuracy must be considered during the selection process. Tracking accuracy can be affected by i) the technology employed by a given system, ii) the distribution density of receivers and / or signposts, and iii) environmental interference. A duress system using log-based tracking may be able to localize events only to a given zone, the size of which may be dictated by the number and distribution of signposts and receivers in the facility. Similarly, systems that dynamically localize alarms are limited by the inherent resolution of the technology employed and the density with which receivers are distributed. Environmental effects, such as line-of-sight limitations for infrared (IR) systems, environmental noise for ultrasonic systems, and electromagnetic interference (EMI) for radio frequency (RF) systems, must be considered for all tracking technologies.

Issues to address:

- What level of tracking accuracy is required?
- How many tracking devices are required to achieve the desired accuracy?
- What tracking resolution can be expected from a given tracking device?
- How do building type and layout affect tracking accuracy?

2.11 Power Supply

In terms of the Alarm / Locator / Control model, each sub-system and component has its own power requirements. Type II and III portable transmitters are typically battery-powered to allow for mobility. Fixed transmitters and receivers are typically hard-wired into the walls and ceilings.

Issues to address:

- What are typical power requirements for a duress system?
- What are typical power requirements for individual components?
- Is an uninterruptible power supply (UPS) required to ensure continuous power?
- How are users alerted to low-battery conditions?
- What reliability issues exist for the transmitter batteries?
- How are devices reset after power surges or outages?

2.12 Operational Environment

Every deployed correctional officer duress system must function within a specific operational environment. In many cases, facility layout and construction impose specific requirements on the systems. The system should also be capable of operating within defined temperature and humidity ranges. Other environmental concerns may include noise and electromagnetic interference (EMI).

Issues to address:

- What is the operational environment of the facility?
- Are there any special factors that must be considered (e.g., extreme temperatures, humidity)?
- Is the operational environment expected to vary over the life of the system?

2.13 Operator Usage

In selecting a duress system, it is important to consider the needs of those who use the equipment on a daily basis. Officers and staff members working in the field have different requirements than those operating the control sub-system. If different technologies are merged for the duress system, this should be transparent to the operator, who should be able to perform multiple functions from one computer. Navigation through the screens should be easy to follow for basic operations. The benefits of well-integrated, user-friendly systems include improved ease of use, reduced manpower, and reduced training time. Before any decisions are made about correctional officer duress systems, agencies should familiarize themselves with the advantages and disadvantages of each option and compare these considerations to the needs of their own facility.

Issues to address:

- What is the learning curve for operating the system?
- What are the training requirements for a given system?
- Does the system present an intuitive and easy-to-use interface?

2.14 Coverage

Vendors use prediction programs to identify the areas within a facility where a readable signal can be obtained, and they guarantee coverage only within those areas. Before selecting a system, all areas where coverage is essential must be identified. A complete survey of the facility will aid the system designer with creating the coverage design.

Issues to address:

- What are the required coverage areas for a given facility?
- Are potential “dead spots” introduced for a given design?
- After a system is deployed, how are coverage dead spots identified and corrected?

2.15 Diagnostics / Testing

Because a correctional officer duress system is primarily reactionary, periodic testing of the system is essential to ensure the equipment is working properly. The system must be operational at all times due to the unpredictable nature of emergency situations.

Issues to address:

- Does a given system use built-in diagnostics?
- Do individual components perform periodic self-tests?
- How are system-wide tests performed?
- Do the system and its components require periodic re-calibration? If so, what is the time between re-calibration and what are the associated costs?

3 Review of Relevant Technologies

This section describes the technologies used in correctional officer duress systems. Specifically, the technologies used for routing alarm and location information from the field to the central control point, namely ultrasonic, radio frequency (RF) and infrared (IR) systems, are introduced. Additional emerging technologies identified during the compilation of this report are also introduced.

3.1 Current Technologies

A typical duress system is composed of a network of portable and permanently mounted transmitters and receivers strategically placed throughout the correctional institution and linked to a central network. This section focuses on technologies that are currently used in correctional officer duress systems for providing the communications link between the distributed transmitters and receivers. In particular, three technologies that enable this communication to occur - ultrasonic, infrared, and radio frequency - are introduced.

3.1.1 Ultrasonic

The term ultrasonic refers to sounds at frequencies above the hearing range of the average human. Where the normal human hearing range for audible sounds lies between 20 Hz and 20 kHz, ultrasonic signals occur in the range above 20 kHz. Ultrasonic devices are used in many technical applications, including nondestructive testing of materials, degasification of liquids, echo sounding, industrial cleaning, medical imaging, automatic door openers, and alarm systems.

Several characteristics of ultrasonic signals make them useful for transmitting alarm signals. Ultrasonic waves tend not to penetrate structural barriers such as walls, ceilings or windows. Instead, these high frequency waves are readily reflected by hard surfaces such as concrete block and glass, and to a lesser degree by soft surfaces such as carpet and drapes. Based on these propagation characteristics, ultrasonic alarm signals tend to stay localized to the room in which they are broadcast. For duress alarm systems, this characteristic can be exploited to provide localization that is based on the known location of alarm receivers.

Within the context of a duress alarm system, a generic transmit / receive model may be used to explain the role played by ultrasonic technologies. The correctional staff member carries an ultrasonic transmitter while performing his duties. In the event of an impending threat, the individual activates the transmitting device, which broadcasts an ultrasonic signal. Arrays of passive ultrasonic receivers distributed throughout the facility sense ultrasonic acoustic energy levels. The receivers analyze deviations from normal acoustic conditions to identify alarms. Due to the highly reflective nature of ultrasonic signal propagation, signals can often find multiple paths to nearby receivers. In the event that a transmitter is covered (e.g., the correctional staff member falls on the transmitter before activating the alarm), the alarm signal may be completely blocked and therefore not detected by the receivers.

ADVANTAGES	DISADVANTAGES
Measures and detects distances to moving objects	Subject to interference from other like sounds (mitigated by using modulated alarm signals)
Resistant to external disturbances such as vibration, IR radiation, and ambient noise	Ease to intercept / distort signal
Not affected by dust, dirt, or high-moisture environments	

Table 3-1 Characteristics of Ultrasonic-Based Alarm Systems

Ultrasonic technology relies on signals that readily reflect off hard surfaces, making this technology suited for indoor applications but not conducive to an open environment. In the past, ultrasonic systems were plagued with a large number of nuisance alarms. The nuisance alarms were often caused by acoustic signals similar to the ultrasonic signal used by alarm systems. These signals can be generated by other ultrasonic equipment within the facility, such as automatic door openers, or by noisy mechanical equipment. Newer designs often use modulation schemes that require the alarm signals to contain certain patterns before the system will accept the alarm.

3.1.2 Infrared (IR)

The term "infrared" (IR) refers to electromagnetic (EM) radiation between the visible light and microwave portions of the EM spectrum. IR waves have frequencies lower than visible light and higher than microwaves (see Figure 3-1). IR devices are used in many technical applications, including motion detection, scanning, remote control, imaging, wireless computer connectivity, and alarm systems.

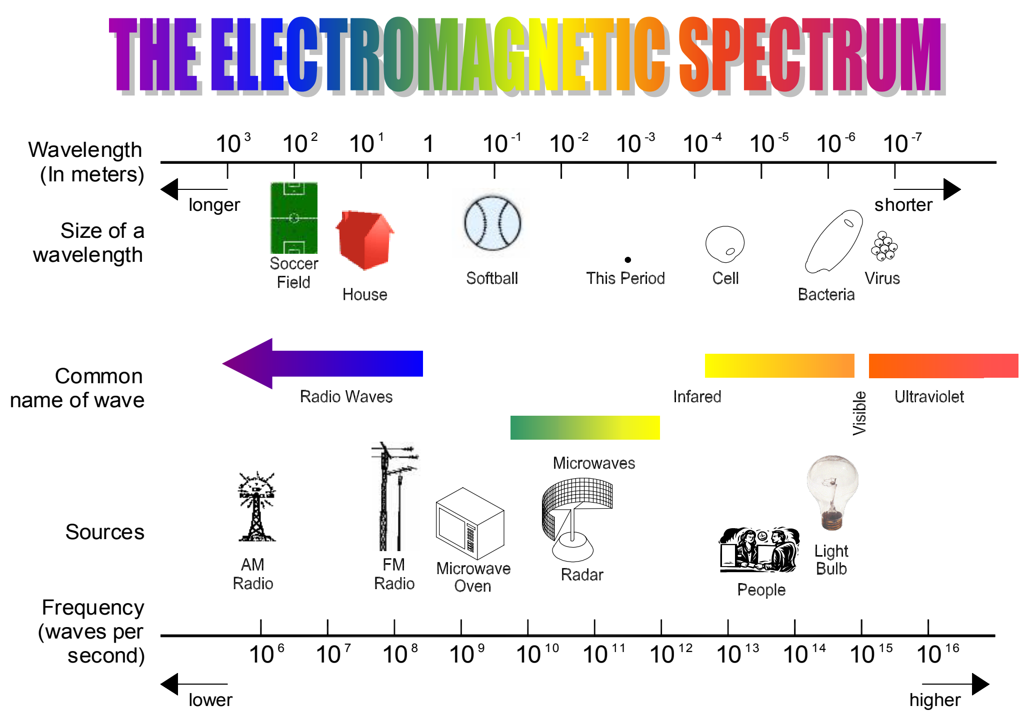


Figure 3-1 Electromagnetic Spectrum

Several characteristics of IR signals make them useful in indoor alarm system applications. Although IR signals cannot be seen by the naked eye, electronic devices can detect them. Infrared waves tend to readily reflect from smooth surfaces. However, physical barriers obstructing the propagation path easily block IR signals. For this reason, IR devices are primarily considered as line-of-sight (LOS) devices. Moreover, IR communications can be sensitive to ambient lighting and atmospheric conditions. IR technologies are not typically used for outdoor applications or other situations with high ambient natural lighting.

In the context of a duress alarm system, a generic transmit / receive model may be used to explain the role played by IR technologies. IR communications are fairly reliable and relatively inexpensive to install into an existing facility. A major limitation of IR communication is that it is a line-of-sight technology. A clear path must exist between the transmitter and receiver in order to achieve proper communication. For this reason, IR is typically not used as the primary technology for transmitting alarm signals. Instead, IR provides supplemental alarm location information in conjunction with some other technology.

For example, the IR signal can be incorporated into the wireless device carried by correctional personnel (with fixed IR receivers distributed) or into the fixed devices distributed throughout the facility (with portable IR receivers carried by the correctional staff member). In either configuration, the IR signals are responsible for updating discrete location information (i.e., recognizing when a correctional staff member has left one operational zone and entered another). Please refer to individual vendor / product descriptions for additional information.

ADVANTAGES	DISADVANTAGES
Measures and detects distances to moving objects	Signals can be obstructed by physical barriers
Increased accuracy	Dependent on atmospheric conditions
Invisibility to human eye	Limited penetration power

Table 3-2 Characteristics of Infrared-Based Alarm Systems

3.1.3 Radio Frequency (RF)

The term "radio frequency" (RF) refers to electromagnetic radiation that lies below the microwave portion on the EM spectrum (see Figure 3-1). The frequencies cover a wide portion of the electromagnetic spectrum, extending from 9 kHz to hundreds of gigahertz (GHz). RF signals are widely used for communication systems throughout the world.

The RF spectrum is divided into several ranges, or bands. With the exception of the lowest-frequency segment, each band represents an increase of frequency corresponding to an order of magnitude (power of 10). Table 3-3 depicts the eight bands in the RF spectrum. The SHF and EHF bands are commonly referred to as the microwave spectrum.

DESIGNATION	ABBREVIATION	FREQUENCIES
Very Low Frequency	VLF	9 kHz – 30 kHz
Low Frequency	LF	30 kHz - 300 kHz
Medium Frequency	MF	300 kHz - 3 MHz
High Frequency	HF	3 MHz - 30 MHz
Very High Frequency	VHF	30 MHz - 300 MHz
Ultra High Frequency	UHF	300 MHz - 3 GHz
Super High Frequency	SHF	3 GHz - 30 GHz
Extremely High Frequency	EHF	30 GHz - 300 GHz

Table 3-3 Frequency Ranges for RF Communications

The following sections identify some of the frequency bands and modulation techniques used by various vendors for using RF signals for alarm systems: spread spectrum, 800 MHz, and 900 MHz. It should be emphasized that the issues considered here are chosen to suit the purposes of this selection guide. Please refer to a basic communications reference for detailed information regarding RF technology.

The characteristics of radio communications in the 800 and 900 MHz frequency ranges have many similarities. The wavelength of these signals is approximately 13-14 inches. The propagation characteristics of such signals can be quite complicated in indoor environments. An RF signal that is broadcast within a given location provides comprehensive coverage due to the signal's ability to be reflected by or transmitted through walls, ceilings, and other physical barriers with little appreciable attenuation. The steel and concrete construction typical of many correctional facilities creates a complicated environment for radio communications, requiring comprehensive site surveys to ensure adequate coverage.

RF-based technology is advancing at a rapid pace. As a result, vendors developing wireless RF systems must use a mixture of frequency bands and various modulation techniques to comply with Federal Communication Commission (FCC) regulations. The following modulation techniques are widely used in the industry today:

CDMA (Code Division Multiple Access) uses spread-spectrum technology to transmit a frequency according to a defined pattern (code). The coded transmission can only be intercepted by a receiver whose frequency response is programmed with the same code. There are trillions of possible frequency-sequencing codes, which enhances privacy and makes cloning difficult.

FDMA (Frequency Division Multiple Access) is the most common modulation technique. It allows users to share the same physical channel by multiplexing the transmissions in space, separating the channels by putting them on different frequencies

TDMA (Time Division Multiple Access) allows users to share a frequency band. Transmissions are grouped as packets and transmitted according to controlled time slots. Where FDMA separates channels by putting them on different frequencies, TDMA separates them by allocating different time-slots on the same frequency to a sender and receiver.

Many of the products described in Section 5 use RF communications based on spread-spectrum technology. Spread spectrum, in which the frequency of the transmitted signal is deliberately varied based on a specified modulating code, is specific to RF technology. The result is a wider bandwidth than the signal would have if its frequency were not varied. Most spread-spectrum signals use a digital scheme called "frequency hopping". The transmitter frequency changes abruptly, or hops, many times each second. A few spread-spectrum circuits employ continuous frequency variation, which is an analog scheme.

Another RF-based technology being incorporated in a variety of industrial applications is radio frequency identification (RFID). RFID can be thought of as a technology that takes barcode reading to the next level. The primary function of an RFID system is to receive and send data over a wireless communication network via tags. The major components of an RFID system include an antenna, a transceiver with a decoder, and a transponder (tag). Antennas are available in a variety of shapes and sizes and operate over a large spectrum.

Three frequency ranges – low, intermediate, and high - are generally distinguished for RFID systems. Low-frequency (30 kHz to 500 kHz) systems have short reading ranges and lower system costs. They are most commonly used for security access and asset tracking. Intermediate-frequency systems (10 MHz to 15 MHz) are primarily found in access control and proximity card systems. They are relatively short range and are comparable in price to the low-frequency application. High-frequency systems (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) offer superior coverage ranges (> 90 feet) with higher data rates. However, these increased capabilities are costly.

Though typically not used for alarm activation / notification, RFID does provide a means for ensuring access control and tracking capabilities, as the data in the tag may identify an individual in transit or a location.

3.1.4 Summary

Ultrasonic, infrared, and radio frequency technologies are used by a variety of vendors to implement guard duress systems. Each technology has distinct advantages and disadvantages as discussed above. Table 3-4 provides a brief overview of the characteristics of each technology, and how these technologies are used in available duress systems. Additional details on how these technologies are used within the Alarm / Locator / Control model are provided in Section 4. Details for vendor-specific implementations are provided in Section 5.

Technology	Indoor	Outdoor	Location	Alarming	Line of Sight
Ultrasonic	✔		✔	✔	
Infrared	✔		✔		✔
RF	✔	✔	✔	✔	

Table 3-4 Summary of Current Technology Usage in Duress Alarm Systems [Summer, 2001]

3.2 Emerging Technologies

Several emerging technologies have the potential to directly impact future personal duress alarm systems. The following emerging technologies are discussed: Global Positioning System, Ultra Wideband RF Technology, Biometrics, and Body Implantable Microchips. These technologies represent ideas or early products that have been developed but in most cases have not been integrated into duress alarm systems.

3.2.1 Global Positioning System - GPS

Global positioning systems (GPS) combine navigation and communications capabilities in a single package. Satellites transmit signals that are used for extremely accurate three-dimensional (latitude, longitude, and elevation) global navigation (position determination), and for the dissemination of precise time. GPS-derived position determination is based on the arrival times, at an appropriate receiver, of precisely timed signals from the satellites that are above the user's radio horizon. One of the most significant shortcomings of GPS is its inappropriateness for most indoor applications. These systems are very useful outdoors, but are ineffective indoors due to blocking of the GPS transmission signals.

3.2.2 Ultra Wideband (UWB) Technology

Ultra wideband (UWB) refers to RF-based technology that operates across a broad frequency range at FCC-restricted low power levels. This technology, which has recently been approved by the FCC for commercial sales and development, works by emitting short pulses that exhibit a wide spectrum. These RF pulses can penetrate walls and cement and can provide both obstructed and unobstructed local tracking capabilities with a resolution that is in general better than GPS. The FCC has placed emission level restrictions in the vicinity of frequencies used by GPS and the Industrial, Scientific, and Medical (ISM) band to preclude interference.

Emerging applications that use UWB include higher data rate wireless networks, tracking, and security and sensing systems. The signals are "time-modulated" or coded to provide an abundance of channels. This provides a capacity for many users in a small space. Due to the nature of these systems, one emission can be used to both determine location and send data, such as the identity of the individual originating the alarm. This evolving technology has been demonstrated and used in limited applications for safety, law enforcement and rescue situations.

3.2.3 Biometrics

Biometrics is the science of positive personnel identification using an individual's unique physical characteristics. Authentication may be activated using various features including facial identification, facial thermographs, voice / speech recognition, fingerprint identification, and iris recognition. The uniqueness and accessibility of these features make them ideal for security purposes. These devices are primarily used for access control systems (entry and exit); however, with advancements in technology, they may be integrated into a duress system.

- **Facial identification:** Converts a video image of the face to a digital template, which can then be compared with a recorded image. Facial recognition provides a non-obtrusive means for identity verification.

- **Facial thermographs:** Uses an infrared camera to capture heat emission patterns. The underlying vascular system of the human face produces a unique signature when heat passes through the facial tissue.
- **Voice / Speech Recognition:** The sound waves generated by a person saying a given phrase or password are used to create a voiceprint, which can then be compared with recorded voiceprints. More modern systems also include speech recognition devices that can identify a speaker on either side of a telephone line in as little as four seconds. Automatic voice-recognition technology determines the identity of a speaker solely from a speech sample. Identification decisions can be made on as little as one word or one-third of a second.
- **Fingerprints:** Minute variations in the loops, whorls, and arches on fingers are converted to a digital template that can be compared with database records or a person. These variations are compared to the access control point database.
- **Iris Recognition:** A video image of the colored portion of the eye is mapped by computer to create a digital code based on the individual pattern of the iris. In these systems, low-intensity infrared light is reflected and recorded from numerous checkpoints on the retina. The reflected pattern can then be converted to a digital template.

Biometric systems are less susceptible to compromise or defeat. They do not require the knowledge or possession of codes, cards, or keys for activation. The negatives of biometric systems include enrollment time, high cost, and variations in a person's physical characteristics (e.g., changes due to aging, fatigue, illness, and trauma.). The application of biometrics may also raise some legal issues. Prior to the implementation of biometrics, the advice of legal counsel should be solicited.

> *The California Department of Corrections has used biometrics for years to track the comings and goings of guards. The system uses a "blacked-out" barcode, invisible to the naked eye, on an ID card, in combination with a fingerprint reader. Alarms are tripped if a guard fails to check in with the system after a given time.* [Glave, 2001]

3.2.4 Body-Implantable Microchips

Body-implantable microchips can be placed under the skin of correctional personnel to aid in location and tracking. The microchips are about the size of a grain of rice and coated with biocompatible glass. They contain vital data and other identifying information. The chip is a passive transponder, and can be activated by low frequency radio waves. This type of microchip is capable of carrying a set of alarm information that can emit status via a tracked radio signal. One glaring drawback of this type technology is the invasion of privacy. End users must weigh the benefits of continual tracking versus staff safety.

3.2.5 Summary

GPS, UWB, biometrics, and body-implantable microchip technologies are just a few of the technologies currently under consideration for integration into future correctional officer duress systems. Each technology has distinct advantages and disadvantages as discussed above. Table 3-5 provides a brief overview of the characteristics of each technology, and how these technologies can be used in duress systems.

Technology	Indoor Application	Outdoor Application	Location	Alarming	Line of Sight
UWB	✔	✔	✔	✔	
GPS		✔	✔		✔
Biometrics	✔	✔	✔	✔	
Body Implantable	✔	✔	✔		

Table 3-5 Summary of Emerging Technology Usage in Duress Alarm Systems

4 Overview of System / Component Functionality

The primary components of a duress system are shown in Figure 4-1, along with the role that each component plays within the Alarm / Locator / Control model. In this section, the Alarm, Locator, and Control sub-systems for a prototypical correctional officer duress system are considered in detail.

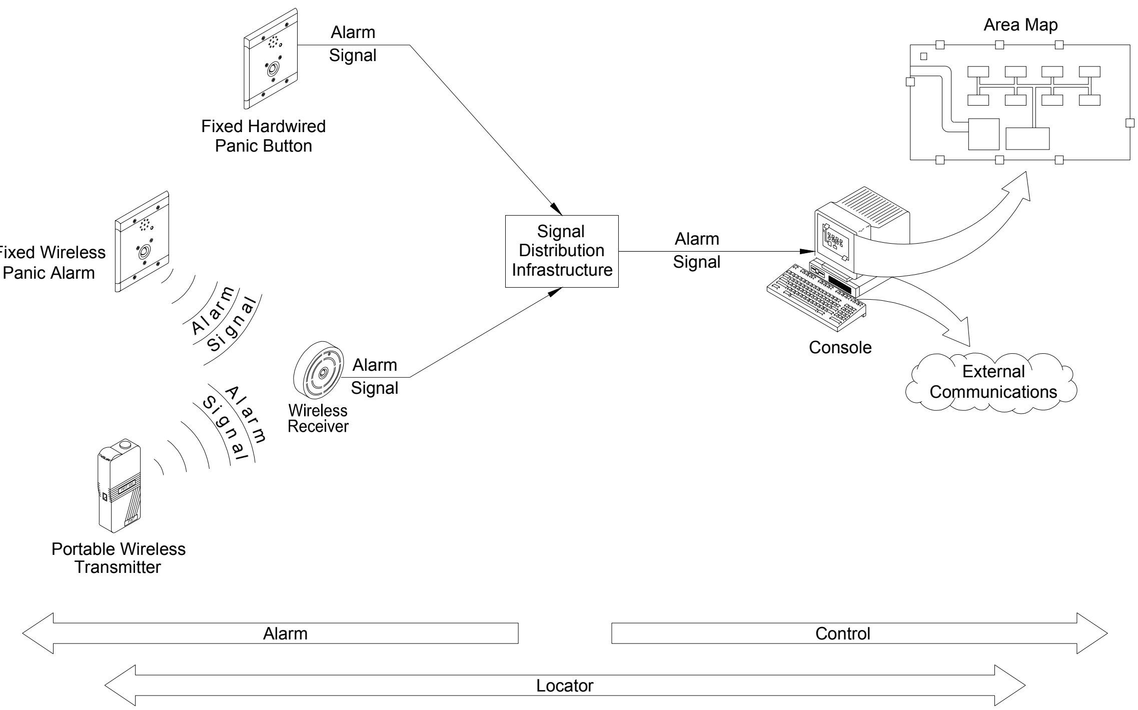


Figure 4-1 Generic Alarm / Locator / Control Model

4.1 Alarm Sub-System

For the purpose of this selection guide, an alarm sub-system consists of those devices used to i) signal the occurrence of a duress situation, and ii) identify the correctional staff member involved. As noted earlier, only Type II and Type III duress systems provide unique identification capabilities. Typical components that are utilized within a generic alarm sub-system, including hard-mounted panic alarms, wireless transmitter-receiver pairs, and wireless transceivers, are shown in Figure 4-2. Wireless technologies currently used in alarm sub-systems may incorporate ultrasonic, radio frequency (RF), or infrared (IR) signals.

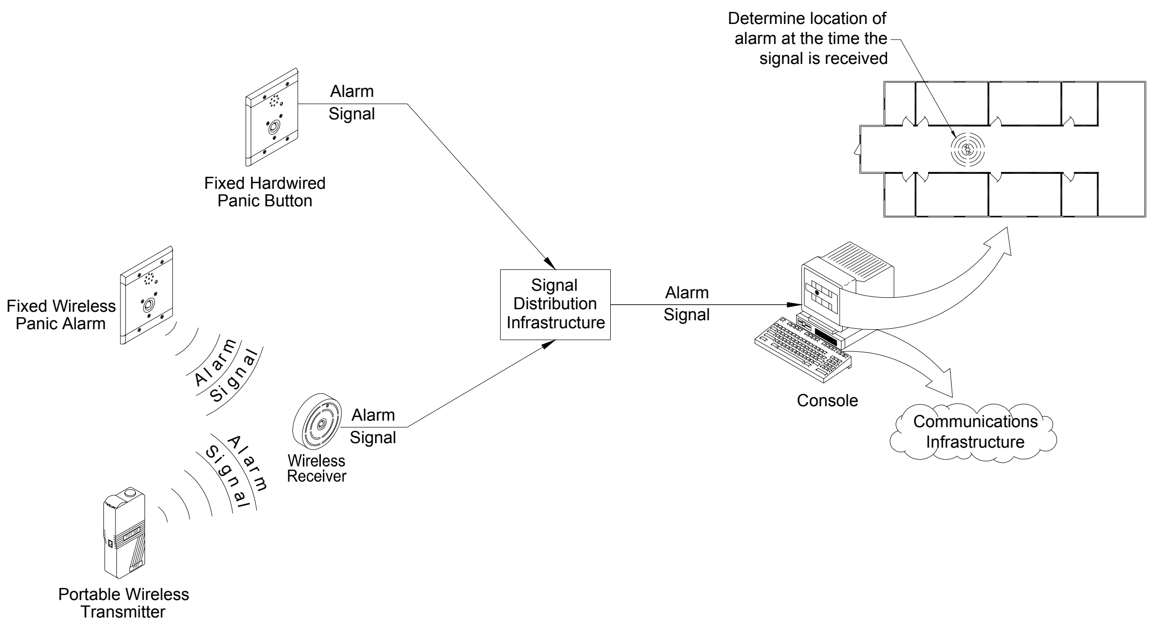


Figure 4-2 Generic Alarm Sub-System – Fixed vs. Portable

4.1.1 Description

Based on the duress system classifications introduced earlier, two primary components may be used to signal alarms: fixed panic button alarms (Type I) and portable wireless alarms (Type II / III). The basic functionality of each of these device classifications is described below.

4.1.1.1 Panic Button Alarms

Panic button alarms are by far the simplest alarming method utilized in a correctional officer duress system. Classified as Type I devices, panic buttons are typically hard-mounted (fixed) pushbuttons that are strategically located throughout the facility. In the event of a potentially dangerous situation, the correctional staff member must move to the fixed alarm in order to activate a duress signal. This assumes that the individual is free to move within the area, and is able to manually activate the alarm. Once the alarm button is depressed, a dedicated signal is forwarded to a control console for distribution. Though panic buttons are typically easy to deploy and are often very effective for many types of emergencies, they are associated with several distinct disadvantages. In particular, panic alarms may not be accessible during a duress situation. For example, the correctional staff member may be immobilized and therefore unable to move across a room to the alarm button. Additionally, panic buttons lend themselves to nuisance alarms triggered by inmates. In most current duress systems, panic buttons may be used in conjunction with more advanced alarming sub-systems.

4.1.1.2 Portable Identification Alarms

Portable identification alarms, classified as Type II / III devices, typically include portable transmitting devices that may be either worn or carried by correctional personnel. Basic functionality for a typical portable identification alarm is shared between a transmitter and one or more receivers.

4.1.1.2.1 Transmitters

A transmitter is a battery-powered device, typically worn or carried by correctional personnel, which is responsible for transmitting an alarm signal (RF or Ultrasonic) when activated. A personal identification code is often encoded within the alarm signal to uniquely identify the activated transmitter, thereby identifying the individual under duress. Location information may also be encoded in the alarm signal, depending on how a particular vendor implements its localization services (please refer to the discussion on the Locator Sub-System in Section 4.2).

Depending on the particular device, the alarm may be activated by one of several means, including pushbuttons and lanyard pulls. Additionally, some devices feature man-down capabilities wherein a duress signal is automatically transmitted when the correctional staff member is in a prone position. In addition to the alarm signal, the transmitter may also be capable of transmitting test signals for system-wide testing and / or status signals for correctional staff member tracking.

4.1.1.2.2 Receivers

Receivers are strategically distributed throughout a protected area and are responsible for detecting duress alarms emitted by wireless transmitters. When a duress alarm signal is detected, the receiver typically decodes the signal for identification and location information, and forwards a message to the control sub-system for processing. The means by which these signals are distributed are vendor-specific, varying from hard-wired distribution channels to wireless channels.

Indoor receivers are typically mounted on inside walls or ceilings for concealment and to deter tampering. These receivers often have a set of colored LEDs to indicate operational status. Outdoor receivers are typically contained in small weatherproof boxes mounted on the sides of buildings or on light posts. Outdoor receivers typically do not have colored LEDs and often rely on other means (e.g., strobe lights) for indicating successful tests.

4.1.2 Technologies Utilized

Current duress systems use many of the technologies introduced in the previous section. The role of these technologies in implementing effective alarm sub-systems is discussed in this section.

4.1.2.1 Ultrasonic Alarms

Several vendors provide duress systems that utilize ultrasonics for transmitting alarm signals. For these systems, portable transmitters produce high-frequency acoustic alarm signals, which are received by one or more fixed receivers. To reduce the likelihood of nuisance alarms, which often plagued older ultrasonic-based systems based on single-frequency signals, current systems typically utilize multiple-frequency, modulated alarm signals. Due to the tendency of ultrasonic signals to reflect readily off any hard, smooth surface, these signals are not limited to line-of-sight operations. Moreover, since ultrasonic signals do not penetrate walls or other barriers, they can provide accurate location information where the location of a duress event is based on the location of the responding receiver. Two disadvantages of ultrasonic-based systems are i) possibility of blocked alarm signals (e.g., an individual falls on top of the transmitter before activating the alarm), and ii) difficulty associated with providing the ability to uniquely identify users.

4.1.2.2 RF-Based Alarms

Many currently available duress systems rely on radio frequency (RF) signals for transmitting alarm signals. As discussed in the previous section, vendors may utilize a variety of transmission protocols for RF-signal distribution. Vendor-specific information is provided in Section 5. To respond to wireless alarm signals, RF-based duress systems use an array of RF receivers that are strategically distributed throughout the facility to ensure adequate coverage. Most systems require coverage testing and calibration as part of the installation and maintenance of the system. In addition to duress alarm signals, RF-based transmitters often broadcast other messages, such as status, fault detection, and location.

Recall that for Type II alarm systems, the transmitter / receiver pairs must be capable of uniquely identifying the transmitter, and thus the individual, associated with a given alarm. For systems offering identification alarms, each transmitter is assigned a unique identification code. When activated, the transmitter ID is encoded within the alarm signal. Based on the received transmitter ID, which is decoded within the wireless receivers and forwarded to the control sub-system, the system is able to identify the individual involved based on a one-to-one association between correctional personnel and transmitters.

4.1.3 Additional Features

Each vendor's product provides a mix of features and extra functionality. Some of these features are briefly described here, with additional details provided in the next section.

4.1.3.1 Alarm Activation

Most portable alarm transmitters provide one or more means for signaling a duress event. Some of the activation mechanisms include push buttons, where the correctional staff member activates an alarm simply by depressing a button on the transmitter, or lanyard pulls, where the duress alarm is activated when the person under duress pulls a lanyard, a cord or strap that is attached to the device, from the transmitter. For situations in which an individual may be incapacitated and unable to manually activate an alarm, some transmitters provide man-down functionality. For these systems, an alarm is automatically activated when the device detects that the correctional staff member has been knocked down or immobilized. The man-down functionality is typically implemented using tilt switches, which activate an alarm when the individual is no longer in an upright position, or motion detectors, which activate an alarm when the correctional staff member fails to move within a specified amount of time.

4.1.3.2 Fault / Low-Power Indicators

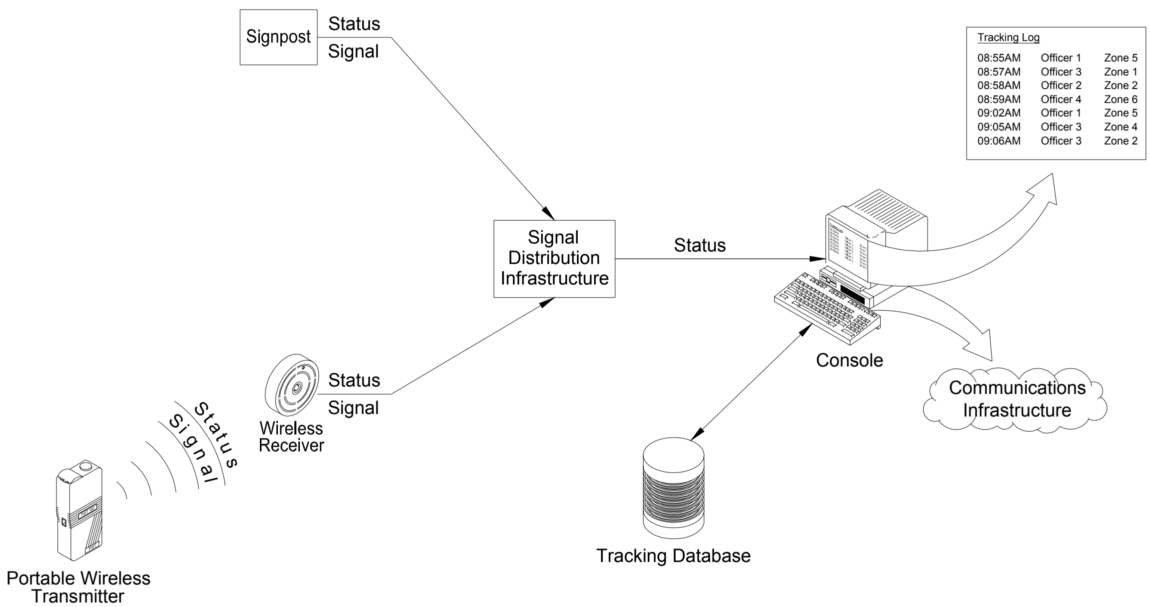
To ensure that alarm transmitters function properly, the correctional staff member should be made aware of any faults or error conditions that may adversely affect his ability to activate a duress alarm. To this end, transmitters should provide visible and / or audible feedback to the correctional staff member by way of low-battery and fault-condition alarms. Additionally, individual receivers should be periodically tested to ensure that they are functioning properly. This testing may be performed as part of either self-tests for the individual components or system-wide testing performed under the automatic or manual direction of the central control.

4.1.3.3 Size and Weight

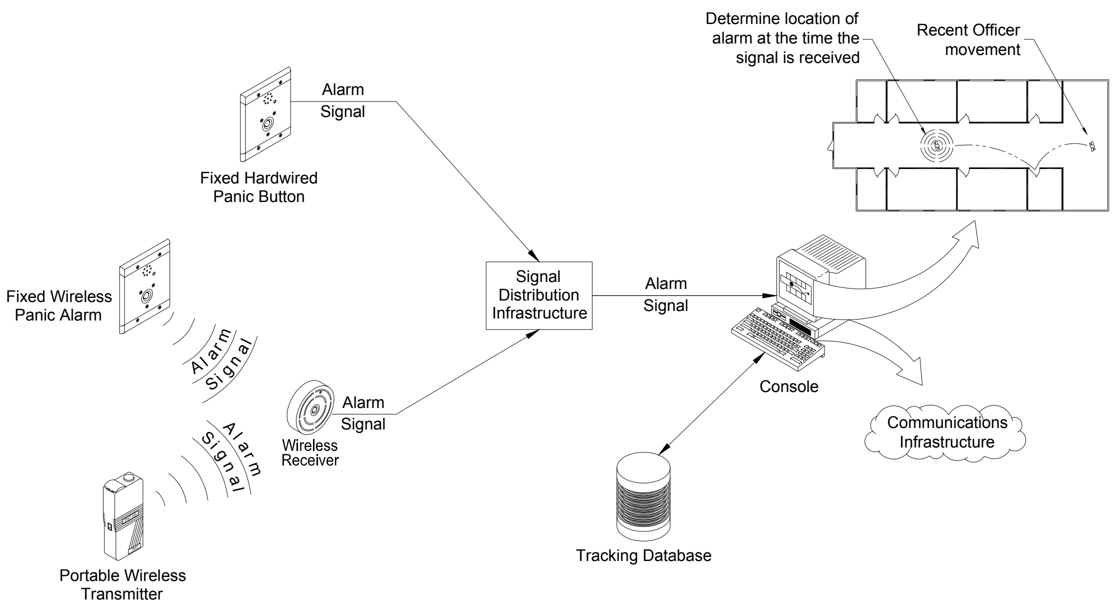
Size and weight are important issues for portable alarm transmitters. The transmitter should be small enough to not interfere with the normal operations of the individual, yet be large enough to easily manipulate and activate in the event of a duress situation.

4.2 Locator Sub-System

For Type III duress systems, the locator sub-system consists of devices used to localize alarm events within a correctional facility. Rapidly localizing a duress situation within a correctional facility is critical to maintaining a safe environment for correctional personnel. For the typical officer duress system, the facility is divided into multiple zones. In the event of a duress alarm, the system attempts to determine the zone in which the alarm was triggered. Some systems also provide finer-grained localization capabilities that can determine not only the zone in which an alarm was activated, but also the location of the correctional staff member within the zone. Based on this information, a coordinated response to the emergency may be initiated. Although the details concerning how a given duress system localizes alarms are vendor-specific, this section attempts to briefly describe the principal techniques utilized.



Logging and Tracking



Log-based Tracking System

Figure 4-3 Generic Locator Sub-System

4.2.1 Description

Two fundamental localization methodologies are typically employed: i) a tracking / logging approach, and ii) a dynamic localization approach.

4.2.1.1 Tracking / Logging-Based Locators

A generic log-based locator sub-system is depicted in Figure 4-3. By continuously gathering location information as individuals perform their duties, a tracking / logging-based sub-system determines the most likely location of an alarm based on the logged history of staff movements.

In duress systems that implement this localization technique, the system periodically updates the location of each correctional staff member. By combining the tracking information for all deployed personnel, central control maintains situational awareness over the entire facility. Additionally, when a duress alarm is received, the comprehensive view of correctional staff member locations allows a dispatcher (either man-in-the-loop or computer controlled) to review the last few known locations and coordinate an effective response.

Tracking information may be obtained by one of several means. One common implementation uses signposts that record the times at which an individual moves from one zone to another. Other implementations use status signals from the various wireless transmitters to periodically provide location information.

4.2.1.2 Dynamic Localization

Dynamic localization uses information transmitted at the time an alarm is signaled to determine the location of the activated transmitting device (as depicted previously in Figure 4-2). Several methods are available for dynamic localization.

One method uses the alarm transmitter to encode location or zone information within the alarm signal. In this case, the transmitter must constantly detect its current location. This is typically accomplished using location receivers on the alarm transmitter itself. The location receiver continually receives and stores location codes broadcast by an array of locator transmitters. When an alarm is activated, the transmitter then sends the stored location codes and identification codes as part of the alarm signal. Some systems that utilize this technique can also provide continuous tracking capability wherein the transmitter periodically transmits a status signal with encoded identification and location information. This information can then be stored and tracked by the control sub-system. By doing so, central control remains aware of all staff locations, allowing a more effective coordinated response to an emergency situation.

A second localization method is based on simply associating the location of a duress event with the fixed location of the receiver(s) involved. In systems utilizing this method, the facility is typically sub-divided into well defined "coverage zones". When a duress event occurs within a given zone, a correctional staff member activates an alarm. Wireless receivers that receive the transmitted alarm are responsible for forwarding the alarm message to the control sub-system. Based on zone information associated with the receiver that forwarded the alarm message, the system is able to identify the location of the given event. The coverage area within a given zone is generally determined when the system is designed based on the facility layout and the propagation characteristics of the wireless technology utilized.

Alternate duress systems may dynamically localize alarms using triangulation and / or signal-propagation models. Such systems are often difficult to implement, due to complicated signal propagation characteristics when operating indoors and the need to accurately synchronize multiple receivers to a common clock. Moreover, such systems require accurate calibration information in order to capture the signal characteristics within the given correctional facility. This technique, however, is often used to localize alarms in outdoor environments, where the coverage area is greater and the environment may not adversely affect the alarm signals.

4.2.2 Technologies Utilized

Multiple components are currently available for implementing the above localization methodologies.

4.2.2.1 Signpost-Based Locators

Signposts are typically used in conjunction with a tracking / log-based approach to localization. Signpost-based systems require personnel to periodically "check in" at well-defined stations (signposts) as they perform their duties. These periodic check-ins may utilize swipe-card readers, RFID-based proximity sensors, or some other means for time stamping a correctional staff member’s known location. The signpost information is then forwarded to the control sub-system for logging and display purposes.

When a duress alarm is received by the alarm sub-system, central control can query tracking logs to determine the last known locations for that identified correctional staff member. Based on this information, the system can localize the duress event and coordinate an appropriate response. The ability to resolve a duress event to a precise location is based on the number and distribution of signposts used within the facility.

4.2.2.2 IR-Based Locators

Two types of IR-based locator methodologies are currently available from various vendors. In the first method, the wireless alarm transmitters are responsible for transmitting an IR signal. In such systems, IR receivers are distributed throughout the facility, often deployed in dual technology RF / IR receivers.

A second method incorporates an IR reader into the wireless alarm transmitter. In these systems, an array of IR transmitters is distributed throughout the facility in well-defined coverage zones. As an individual moves in and out of these coverage zones, the alarm transmitting device continuously receives updated location ID codes from the fixed IR transmitters (where the location IDs are uniquely associated with a given zone / IR locator combination).

When a duress event occurs, the current location ID (stored onboard the transmitter) is encoded within the alarm signal and broadcast to nearby alarm receivers. This location ID is then decoded by the receiver (possibly along with other transmitter information, such as identification, status, and alarm type), then forwarded to the control sub-system for notification and response coordination.

4.2.2.3 RF-Based Locators

Several RF-based location techniques are available in correctional officer duress systems. Two methods used in products presented in Section 5 include i) localizing a duress event based on which receivers (well-known, fixed locations) respond to the alarm, or ii) localizing alarms using response information from multiple receivers via triangulation, receiver strength, or computer-based propagation models.

The first method uses well-defined mappings between receiver ID codes and fixed receiver locations to determine the zone within which a duress alarm was activated. The second methodology provides finer alarm resolution at the expense of additional sensor coordination by using information from multiple receivers.

Due to the complicated propagation environment presented by the steel and concrete composition of correctional facilities, RF-based localization systems require accurate coverage and calibration at the time the system is installed and periodically throughout the life of the alarm system. In addition, facility renovations and modifications may significantly alter the propagation characteristics of alarm signals and subsequently require a re-calibration of the system.

4.3 Control Sub-System

The third component of the prototypical correctional officer duress system is the control sub-system. The basic functionality and services provided by the control sub-system are discussed below.

4.3.1 Description

The control sub-system consists of those components required to i) process alarm events and ii) coordinate a directed response. The systems described here typically centralize control sub-system functionality. It should be noted that, although this selection guide focuses on the use of new technologies that have the greatest impact on alarm and locator sub-systems, the control sub-system is of fundamental importance.

4.3.2 Functionality

The control sub-system is typically responsible for i) maintaining situational awareness over the entire facility, and ii) coordinating a directed response to emergency situations. Additional responsibilities may include providing interfaces for software upgrades and a mechanism for integration with other systems within the correctional facility.

4.3.2.1 Central Alarm Point

The control sub-system often centralizes many alarm functionalities in order to provide adequate safety coverage and situational awareness. Centralizing the alarming points for the system allows for a security operator to maintain a system-wide view of staff status, permitting an effective response to be coordinated when a duress event occurs. Some of the newer systems have an "accountability of assets" feature by which the system can automatically coordinate the nearest available field correctional staff member to respond to a duress alarm.

4.3.2.2 Mapping

Situational awareness for the security dispatcher is typically achieved using graphical-based mapping functions within the control sub-system. Digitally captured floor plans and building drawings allow the central control staff to readily and accurately view where the guard duress alarm was initiated.

4.4 System Infrastructure

In the context of this selection guide, the system infrastructure is intended to include all the components required to fully integrate the Alarm / Locator / Control sub-systems. Such components may include alarm signal distribution channels (which may be hardwired and / or wireless), network protocols, auxiliary alarming components, and facility-specific components, to name just a few. Each of these components either supports the functionality of one of the three primary sub-systems or crosses the boundaries separating the individual sub-systems. For example, the alarm distribution infrastructure provides the underlying communication paths over which information is passed among each of the primary sub-systems. Since these issues vary significantly amongst the various vendors, please refer to Section 5 for additional information.

5 Products / Vendors

In response to the October 2000 Request for Information, several vendors submitted information on commercially available correctional officer duress alarm systems. These systems are described in this section. For additional information on a given vendor and / or product, the reader is encouraged to contact the vendors directly (contact information is provided in Section 8 of this document).

5.1 Actall® Corporation – PALS 9000

Actall Corporation distributes the patented PALS 9000 Personal Alarm Locating Systems (PALS). The PALS 9000, a Type III duress system, utilizes RF and IR technologies for alarm activation, correctional staff member identification, and localization. Making extensive use of wireless transmitters, locators, and repeaters, this system is designed to require a minimum amount of wiring, conduits, and labor for deployment.

Figure 5-1 PALS 9000 Components

5.1.1 Alarm Sub-System

The PALS 9000 system utilizes 900 MHz spread spectrum RF technology for transmitting alarm signals. For mobile operations, the system utilizes small, portable Personal Mobile Transmitters (PMTs) to broadcast alarm signals in the event of a duress situation.

The PMTs are powered by 3.6 V lithium batteries with an expected life of six to twelve months under standard operating conditions. In the event that a low-battery condition is detected, the PMT automatically forwards a fault condition to the control sub-system. Even with a low-battery fault, however, the PMT remains fully operational for approximately fifteen days.

An alarm may be activated by one of three means: a panic button (pushbutton), a lanyard pull, or a man-down alarm that is activated whenever the PMT detects that the individual is no longer in an upright position.

Up to 65,532 different PMT units can be supported by the PALS 9000 system. Each PMT is identified by a unique system ID. The system IDs, which are transmitted within an activated alarm signal, may then be mapped to individual users to identify the personnel involved in a duress situation.

The PMTs may also be re-programmed on-site for expanded functionality. The PALS 9000 system may also include fixed, RF-based wireless panic button alarms (Emergency Call Boxes) for situations which only require hard-mounted, Type I alarm activation.

Within the PALS 9000 system, Serial Receivers are used to receive alarm signals. Once a Serial Receiver detects an alarm signal, an alarm message is forwarded to the control sub-system over an RS-232 link. Using Actall's Line Driver capability, the receivers may be deployed up to 5 miles.

To increase the transmission range of a PMT and other fixed wireless transmitters, the facility may need to deploy wireless repeaters. In systems utilizing many transmitters, wireless repeaters amplify the signals from all transmitters within their range. The repeaters utilize proprietary protocols and signal synchronization to amplify alarm signals from any Actall 900 MHz transmitter (portable or fixed), while rejecting noise.

Each receiver and repeater is continuously monitored by the control sub-system for low-battery conditions, faults, tampering, and inactivity. An extensive RF site survey should be conducted to ensure satisfactory coverage from transmitters to receivers.

5.1.2 Locator Sub-System

Although the PALS 9000 relies on RF technologies for broadcasting alarm signals, it uses a combination of RF and IR technologies for alarm localization. For indoor operations, the system utilizes IR Transmitters (IRTs) that are distributed throughout a facility in user-defined zones. Each IRT emits specified location codes (IDs) that are received by the PMTs using integrated IR readers. A PMT needs to receive a location ID only once to store location information, and it stores both current and previous location IDs. When an alarm is activated, this location information is encoded within the alarm signal and transmitted to the alarm receiver units, then forwarded to the control sub-system.

Each IRT may be programmed with one of over 65,000 possible location IDs. For coverage of large areas / zones, “slave” IRTs can be connected to “master” locators, with each locator transmitting the same location ID and covering distances up to 400 feet between the furthest “slave” and “master” locator. For situations in which a PMT's IR reader may inadvertently be blocked (e.g., covered by a jacket), an optional IR Lapel Reader is available from Actall.

Testing of location ID codes and analysis of fluorescent lighting frequencies for adverse conditions within a facility may be performed using an IRT Locator Test Unit, a portable device powered by a standard 9 V lithium battery. For outdoor operations, where use of IR signals face severe limitations, the PALS 9000 uses RF-based locators. Location sensitivity can range from 40 feet to 150 feet, dependent on environment and weather conditions.

Each RF locator is responsible for forwarding location information (based on a unique ID associated with the specific locator) to the control sub-system when it detects an alarm signal. Extensive RF / IR site surveys should be conducted to ensure coverage requirements are satisfied.

5.1.3 Control Sub-System

The PALS 9000 system utilizes Actall Corporation’s patented Crisis Controller©™ software, a wireless Windows-based monitoring system, to support advanced monitoring and control features. The software continuously supervises all transmitting devices (PMTs, RF locators, repeaters, and receivers) for faults, malfunctions, and low-battery conditions.

Location IDs associated with individual IRT locators may be loaded in the Crisis Controller software. Using this information along with graphical representations of the correctional facility, the software can overlay alarm information onto a facility map to enhance situational awareness and support response coordination.

The Alert Monitoring Center utilizes an open architecture, allowing other security systems (e.g., CCTV, audio intercoms, biometrics devices, sounders) to be easily integrated into the system using a 32-port Input / Output (I / O) Module. Additionally, the Alert Monitoring Center may be used for custom on-site programming of individual PMTs using Alert Programmer and a standard RS-232 interface.

5.1.4 Additional Features

The functionality of the PALS 9000 system can be enhanced with several optional features. The Real-Time Staff Tracking option provides a means to track or update in real time the movement of correctional personnel within the facility. The selection of this feature incorporates tracking-based localization into the Crisis Controller, allowing the control sub-system to display a correctional staff member's current position within the facility.

With the optional Guard Tour feature, the PALS 9000 can be used not only to monitor staff movements, but also to compare them with pre-defined tours (programmed within the control sub-system as routes and expected time frames to reach specified destinations). Whenever the system detects deviations from a specified tour (e.g., officer movement beyond a specified route), an alarm is automatically forwarded to the Alert Monitoring Center. With both the Real-Time Staff Tracking and Guard Tour options, the PMTs periodically transmit a status signal encoded with location and user identification to the control sub-system in order to update displays, log information, and compare with pre-defined tours.

A third optional feature of the PALS 9000 system is the Page Alert system. Using RF-based paging technology, the Page Alert system allows for coordinated responses to duress events by notifying response teams, staff, and supervisors when an alarm is received. Finally, the optional "Follow Me Audio" and "Follow Me Video" features integrate with the facility's audio intercom and CCTV systems to follow an individual correctional staff member as new location information is forwarded to the Crisis Controller. When a new location ID is received, the monitoring systems within the new zone are activated and the control operator can monitor activities within the zone.

5.1.5 Hardware / Software

Some of the modules and components that constitute a PALS 9000 system are listed below, along with brief descriptions of component functionality. Actall Corporation can be contacted directly for additional information.

20131 Emergency Call Box – RF-based panic button alarm

60011 Personal Mobile Transmitters (PMT) – mobile transmitter with location, push button, breakaway pull cord, and man-down features

60110 IR Lapel Reader – device used to improve the reception of IRT Locator signals

60115 PMT Nylon Holster – holster to protect a PMT without interfering with IRT Locator signal reception

60201 Serial Receiver – receiver that accepts RF transmissions and relays information to the Crisis Controller software

60220 RF Repeater – repeats RF transmissions to extend operational range

60320 Alert Monitoring Center – computer workstation, with Crisis Controller software installed, used for duress alarm monitoring and response coordination

60401 / 60402 IRT Locators – IR-based transmitters that continuously transmit location codes to the PMTs

60405 Wireless RF Locators – used in large areas and outdoor zones where IRT Locators cannot be used

60420 IRT Protective Guards – used to protect IRT Locators from damage and / or tampering

60530 Page Alert Paging Module – used for alarm notification

60610 I/O Alarm Module – provides 32 I/O ports for integrating new or existing systems into the PALS Alert Monitoring Center

60650 Hand-held Barcode Scanner – used to assist operators with recording and identifying security units and users

60701 PALS Alert Programmer – used to program options and features into the PMTs

60703 IRT Test / Programmer – used to program IRT Locators, test ID codes from the IRT Locators, and analyze fluorescent lighting frequencies for adverse conditions

60850 Solar Power Kit – used to supply power to Wireless Repeaters and / or Wireless RF Locators in remote areas where standard 110 / 120 VAC lines may be difficult to run

69500 Repeater / Locator Enclosure Box – weatherproof enclosure that provides extra protection and security to wireless serial receivers, repeaters and RF locators

90149 Motorola Advisor Gold Pager – used in conjunction with 91901 Page Alert Transmitters to forward alarm messages to response teams or staff personnel

91901 Page Alert Transmitter – allows immediate alarm notification of security personnel

91919 Dipole Antenna – extends the coverage area of the 91901 Page Alert Transmitter

The PALS 9000 system from Actall Corporation has minimal maintenance requirements. All installed hardware components, including Transmitters, Repeaters, RF Locators, and Receivers, are fully supervised by the Crisis Controller software for malfunctions and low batteries. Each PMT is powered by a 3.6 V lithium battery with a life of six to twelve months under normal operating conditions. Low battery conditions are forwarded to the Alert Monitoring Center for replacement, but the PMT can operate for approximately fifteen days under low battery conditions. Locally instituted operational procedures should require that users check their alarm transmitter at the test station (less than thirty seconds to perform the test) before the start of each workday in order to ensure proper operations.

5.2 Grace Industries, Inc. – GEM System™

The GEM System™, manufactured and distributed by Grace Industries, Inc., utilizes two basic components for duress alarm and identification: the PA 1000 or PA 2000 Personal Alarm Transmitter, and the SM 1000 Command Receiver. GEM System is an enhanced version of a system that was originally designed for fire fighting and industrial use. The system provides notification and personnel identification in the event of a duress alarm, and is therefore classified as a Type II duress system.

Figure 5-2 GEM System Components

5.2.1 Alarm Sub-System

The GEM System uses spread spectrum radio transmitters and receivers. The PA 1000 and PA 2000 devices are small (2" x 3 ¼" x 1 1/8", 8 oz. with battery) portable transmitters powered by 9 V alkaline batteries. Alarm signals may be activated by one of several means: pushbutton, man down (using solid state accelerometers to sense lack of movement), and an automatic alarm that is activated if the transmitter is removed from its holster.

The transmitters encode unique identification tags within the alarm signals to identify the correctional staff member under duress. In addition to transmitting a duress / identification alarm when activated, the PA 1000 and PA 2000 transmitters also have outputs capable of emitting loud (95+ dBA) audio alarms with "attention getting sound signatures". Whereas the PA 1000 transmitter is limited to one-directional alarm notification (from transmitter to receiver), the PA 2000 provides transceiver capabilities, permitting bi-directional signaling to distribute notifications from the Command Receiver to officers in the field.

The spread-spectrum radio receivers are fully integrated in the SM 1000 Command Receiver. The PA 1000 / 2000 transmitter - SM 1000 Command Receiver pair is capable of responding to alarms broadcasted within a range of up to 1 ½ miles depending on limiting factors such as topography, building construction features and other environmental conditions. To provide wider coverage, Grace Industries, Inc. also provides Remote

Enhanced Radio Receivers and Transparent Signal Repeaters. Since control functionality is fully integrated into the Command Receiver unit, additional features of the receiver unit are discussed below.

5.2.2 Locator Sub-System

As a Type II duress system, the GEM System does not provide an integrated locator sub-system. The ability to localize alarm events within a facility is therefore dependent upon compliance with a well-established local Standard Operating Procedure (SOP).

5.2.3 Control Sub-System

The GEM System SM 1000 Command Receiver integrates receiver and control functionality into a single portable unit. This unit may be powered either internally (12 V NiCad batteries providing up to twelve hours of continuous operation) or externally (120-240 VAC). The base unit automatically displays current status information on all users. Alarms are annunciated using vocal messages and alarm warning lights. The base unit can identify up to 800 users (optional upgrade to 1,584) using unique identifiers (e.g., personnel name, unit number, ID number) containing eleven alphanumeric characters.

In addition, the unit may interface with other computer applications using communications and signaling within a terminal emulation program (e.g., HyperTerminal). It should be noted that the GEM System Base Receiver is also available from Grace Industries, Inc. for use as an integrated receiver and control unit for smaller facilities or situations requiring local operations within a larger facility.

5.2.4 Hardware / Software

Some of the modules and components that constitute a GEM System duress alarm system are listed below, along with brief descriptions of component functionality. Grace Industries, Inc. can be contacted directly for additional information.

PA 1000 Personal Alarm Transmitter – 900 MHz spread spectrum radio transmitter

PA 2000 Personal Alarm Transmitter – 900 MHz spread spectrum radio transceiver

SM 1000 Command Receiver – integrated receiver and control unit

Base Receiver – receiver and integrated control unit intended for smaller facilities or localized operations within a large facility

Transparent Signal Repeater – used to extend the range of transmitters and receivers

Remote Enhanced Radio Receiver – used to extend the range of the transmitters and receivers

Automatic Telephone Dialer – permits automatic telephone notification to remote locations in the event of a distress situation

The GEM System components have minimal maintenance requirements. The life of the 9 V battery used in the PA 1000 or PA 2000 transmitter is typically two to three months, depending on its operational duty cycle. The 12 V NiCad battery in the SM 1000 Command Receiver provides power for up to twelve hours of continuous operation and has an expected life of three to four years. In addition, the SM 1000 may periodically require software upgrades, which are made available through Grace Industries.

5.3 Perimeter Products inc.– PAS-120

The Personal Alarm System PAS-120 from Perimeter Product, inc. (PPi) is an ultrasonic-based emergency notification / communication system. The PAS-120 system does not provide an identification capability, focusing instead on forwarding alarm and location information. This hybrid system, offering only the alarm and localization features of a Type III system, has been installed and is currently operating in over 200 criminal justice facilities in the United States.

Figure 5-3 PAS-120 Components

5.3.1 Alarm Sub-System

The alarm sub-system of the PAS-120 uses proprietary dual-frequency ultrasonic transmissions to broadcast duress alarm signals. The use of dual-frequency signals is intended to reduce the number of nuisance alarms that plague earlier ultrasonic-based alarm systems.

The PAS-120 system provides two basic alarm-transmitting devices: the PAT/C and the PAT/S. The PAT/C is a compact, rugged transmitting device that provides either pushbutton or pull-pin alarm activation. A 9 V lithium battery with an operating life of approximately one year powers the PAT/C.

The PAT/S is a portable transmitter that provides man-down functionality (activated when the wearer is in a prone position for more than a few seconds) in addition to pushbutton activation (pull-pin activation is optional). The PAT/S is powered by a 9 V lithium battery, which provides up to 100 hours of continuous transmit time or several years of normal operations.

Both types of transmitters provide low-battery indicators. Once an alarm is activated, the PAT/C and PAT/S devices provide continuous alarm transmission intended to ensure positive reception. Alarms persist until the alarm button is pressed again to reset. The operation of individual transmitters may be tested using a simple plug-in tester from PPi. Perimeter recommends that this unit testing be performed on a daily basis.

The PAR 03RM Receiver (or one of its variants) is used to receive the ultrasonic duress alarm signals. This receiver, based on a rugged, tamperproof design, is typically mounted on the ceiling or wall in standard double-gang electrical boxes. When an alarm signal is detected at the receiver, an integrated red LED alarm light is illuminated and the alarm signal is forwarded to a PARC-3 Receiver / Communicator. Each 03RM receiver contains built-in self-test circuitry and is configurable via jumper settings to activate other local alarm devices by way of an auxiliary alarm relay contact. The receivers are individually powered by the PARC-3 unit, and contain integrated microphones for audio verification of local activities. Optional video input for visual verification of alarm events is available with the 03RM/IV receiver.

The third basic component in the PAS-120 alarm sub-system is the PARC-3 Receiver / Communicator. The PARC-3 is responsible for responding to alarm signals (from 03RM receivers) by forwarding formatted digital signals to the control sub-system. The PARC-3 uses a multiplexed communication network for distributing alarm messages. The PARC-3 units also i) supervise alarm inputs from up to four receiver zones, ii) provide power for the connected 03RM receivers and iii) conduct functionality tests of itself and all connected receivers. Auxiliary outputs are available to integrate local alarm annunciators. Using an audio switcher, the PARC-3 permits an operator to listen-in on any zone. A video switcher is available with the PARC-3/IV module.

5.3.2 Locator Sub-System

Localization within the PAS-120 is based on a one-to-one relationship between a receiver and its fixed location within the facility. A receiver responds to an activated alarm by forwarding an alarm message to the control sub-system. The identity of the responding receiver is mapped to a pre-defined location within the facility, allowing for precise alarm localization (relying on the inability of ultrasonic to penetrate walls, ceilings, or other barriers).

As discussed above, the system utilizes dual-frequency ultrasonic signals using a preset modulation pattern to reduce the likelihood of nuisance alarms. The PAS-120 system locates correctional personnel only when a duress alarm is activated, and does not support tracking functionality (i.e., the system provides location information only if and when an alarm is activated). Alarm notification is performed using Local Annunciation Panels (LAPs), which are powered by the PARC-3 units. The LAPs permit correctional personnel in the vicinity to be notified of an emergency situation and therefore respond appropriately.

5.3.3 Control Sub-System

The PAS-120 uses two fundamental components for control functionality: the MX-2000 Multiplex Control Center and PSYCON/IV control unit.

The MX-2000 Multiplex Control Center operates as a stand-alone unit or within the context of a larger system. It de-multiplexes alarm signals from the Receiver / Communicators and performs most of the primary control functionality. The MX-2000, which is able to monitor and control up to 120 zones, utilizes standard RS-232 and RS-422 output to interface with other systems. Covering up to a 20,000-foot limit, which can be extended with optional repeaters, the MX-2000 integrates audio and visual functionality in order to switch automatically to an activated alarm receiver. The control units permit remote testing of other alarm components on either an individual or system-wide basis.

The second basic component of the PAS-120 control sub-system, PSYCON/IV, is a PC-based control unit that provides a simple interface to the MX-based controller units. The PSYCON/IV uses a touch screen display and integrated video to provide facility mapping, customizable interfaces, and an easy-to-use control interface to the full set of MX-2000 functionality. PSYCON/IV operates as a command center for one or more MX-2000 controllers, expanding the coverage area to a large number of zones.

5.3.4 Additional Features

Several additional components and options are available with the PAS-120 system for expanded functionality. The Roving Alarm Notification System (RANS-VOICE) is an optional paging system that permits wide-area distribution of digitized voice messages. The paging system can be configured to work with i) RANS-Audio portable alarm receivers, ii) third- party pagers, iii) walkie-talkie radio systems, iv) paging amplifier and loudspeakers, and v) intercom systems.

Other optional features include the Alarm Relay Interface (ARI), the Remote Display Unit (RDU), and the Remote Map Interface (RMI). The ARI permits the MX-Control unit to interface with other security systems using up to forty-eight relay contacts. The RDU permits alarm information to be remotely distributed by repeating the information that is displayed in the MX-Series Control Units. The RMI is also intended to distribute alarm information to remote locations. In this case, the RMI is used to repeat LED display information from the control display onto wall-mounted map displays. Each RMI can drive up to thirty zones of displays, where each zone consists of a red and green LED.

5.3.5 Hardware / Software

Some of the modules and components that constitute a PAS-120 system are listed below, along with brief descriptions of component functionality. Perimeter Products inc. can be contacted directly for additional information.

PAT/S Portable Transmitter – portable ultrasonic duress alarm transmitter with optional man- down feature

PAT/C Portable Transmitter – compact, portable ultrasonic duress alarm transmitter

PAT Tester Unit – device for testing PPi Personal Alarm Transmitters (PAT/S, PAT/C)

PAR 03RM Receiver – ultrasonic receiver

PAR 03RM/WP – waterproof version of the 03RM receiver

PAR 03RM/WPH – waterproof version of the 03RM receiver, with a thermostatically controlled heater for low temperature applications

PAR 03RM/IV – variant of 03RM receiver with integrated miniature CCD video camera

PARC-3 Receiver / Communicator – device that i) receives alarm and audio signals from a group of receiver units and ii) forwards alarm and audio information to the central control

MX-2000 Multiplex Control Center – unit that monitors and controls up to 120 alarm zones

LAP (Local Annunciation Panel) – notification device used to annunciate alarms in up to four personal alarm zones

PSYCON/IV – a PC-based control unit that provides a simple interface to MX-2000 units

RANS-VOICE (Roving Alarm Notification System) – optional paging system providing wide-area distribution of digitized voice messages

ARI (Alarm Relay Interface) – unit that interface MX-2000s to 3rd party security systems

RDU (Remote Display Unit) – distributes MX-Series control unit display information

RMI (Remote Map Interface) – repeats LED display information from a control unit onto wall-mounted map displays

Instituting a regular testing program is important to ensure the operational integrity of the PAS-120 system. Low battery conditions for the portable transmitters are indicated via audible low battery tones. Transmitter functionality should be tested (using the PAT Tester Unit) periodically (e.g., per-shift, daily, weekly) as dictated by local testing procedures. Receiver functionality should be tested periodically by performing a walk-through of the entire system with a reference transmitter. The PARC-3 Receiver / Communicator, however, has built-in self-test capabilities.

5.4 Visonetix – SpiderAlert®

The SpiderAlert® duress alarm system, a Type III duress system from Visonetix, utilizes both RF and IR technologies for alarm, identification, and location functionality. RF-based communications are used to transmit / receive alarm signals and provide general location information, while IR-based technologies are used to precisely localize alarm events within the facility.

Figure 5-4 SpiderAlert® Components

5.4.1 Alarm Sub-System

The SpiderAlert system, which utilizes RF duress alarm signals, is compatible with multiple portable wireless transmitters from Visonetix, ranging from inexpensive Type II transmitters to full-featured Type III transmitters with man-down functionality. Each transmitter utilizes a unique 24-bit ID code for identifying personnel involved in a duress situation. This ID is encoded within transmitted alarm signals and forwarded to the control sub-system. Designed for correctional facilities, the MDT-122 S transmitter is a dual technology RF + IR Man-Down transmitter. Twin-pushbuttons, pull-cord, or man-down detection (using a tilt-switch to recognize when the device is tilted beyond 60º from vertical) may activate alarm signals.

The transmitting devices are powered by long-life internal batteries with an expected life of five years, and battery usage is supervised by the system. Each MDT-122 S transmitter can transmit multiple event messages (e.g., panic, pushbutton, pull-cord, pre-tilt, low-battery), each using a separate 24-bit ID. Transmitters may be tested from any location within a facility using a simple single-button test. Numerous hardwired (Type I) panic buttons can also be connected into the SpiderAlert system as required.

Within the SpiderAlert system, alarm signals are received by SR-500 receivers (wireless RF receiver intended for outdoor use) and / or SR-520 receivers (wireless, dual technology RF + IR receivers intended for indoor use). After receiving an alarm signal from the portable transmitting devices, the receivers forward transmitter and receiver IDs to the control sub-system using the SpiderBus network. The SR-500, relying solely on RF signals for alarm, identification, and location functionality, is intended for use in either single-level indoor or outdoor operations. For multi-floor facilities, the SR-520 augments the RF-received event information with IR-based signals to pinpoint alarm events within a given zone. For operations requiring extended broadcast ranges, optional Wireless Repeaters are also available from Visonetix.

5.4.2 Locator Sub-System

As described above, the SpiderAlert system uses dual technology RF + IR transmitters and receivers to localize alarms within a facility. The RF-based signals transmit the duress alarm signal and provide general location information. The IR-based components are responsible for localizing alarms using line-of-sight detection. In contrast with other systems that utilize IR technologies to store location IDs within the wireless transmitters, the SpiderAlert RF + IR transmitters broadcast both RF signals and IR signals which are received by combined RF / IR receivers (SR-520s).

5.4.3 Control Sub-System

The SpiderAlert system utilizes several basic components for implementing control sub-system functionality. The SLC-5 SpiderAlert Controller provides primary network control, data collection, and computer interface. For widely distributed networks, an installation may require one or more SRD-51 SpiderBus Repeaters. The SAM-5 SpiderAlert Manager software is an MS-Windows application that runs on industry-standard PCs. This software package is responsible for handling alarm and event messages, providing updated event information to the operator, and transferring command messages to SLC-5 controllers for distribution over the SpiderBus. The software provides graphical presentations of event signals (e.g., alarms overlaid onto facility maps), automated log management, and systems database management. The SAM-5 software also permits an unattended mode of operation when used in conjunction with an integrated paging system.

The SpiderAlert system emphasizes an open architecture, allowing the system to be easily expanded or integrated with other systems. When a duress alarm is received, the control center can, if configured appropriately, respond by locking doors within the facility, activating CCTV cameras, and activating strobe lights, sounders, and voice modules. The controller coordinates these operations using one of several Input / Output Interface Units (SI-540, SI-544, and SI-561).

5.4.4 Additional Features

The SpiderAlert system offers several optional features for enhanced functionality. An optional paging system, including software, paging transmitters, and alphanumeric pagers, may be incorporated into a deployed SpiderAlert system for alarm notification. When a duress alarm is received by the control sub-system, the paging system may be used to notify response teams, staff, and supervisors as part of a coordinated response to the emergency. Additionally, the system may incorporate activity / inactivity reporting into the control sub-system. This reporting mechanism allows the system to be programmed for expected activities (e.g., pre-defined facility tours, scheduled door checks) and inactivity (e.g., no activity in specified zones within certain times), and then automatically respond to deviations from these schedules.

5.4.5 Hardware / Software

Some of the modules and components that constitute a SpiderAlert system are listed below, along with brief descriptions of component functionality. Visonetix, Inc. can be contacted directly for additional information.

Wireless Portable Transmitters

MCT-101 S – single channel handheld transmitter

MCT-102 S – two-channel handheld transmitter

MCT-104 S – four-channel handheld transmitter

MCT-201 S – miniature pendant transmitter

MCT-201 WP S – waterproof pendant transmitter

MCT-201 AT S – airtight pendant transmitter

MCT-211 S – waterproof wristband transmitter

Dual Technology (UHF and IR) Transmitters

MCT/IR-201 S – miniature, dual RF+IR transmitter

MCT/IR-201 WP S – waterproof version of the MCT/IR-201 S

MDT-122 S – dual RF+IR transmitter with man-down functionality

System Components

SAM-5 – SpiderAlert Manager software program

SLC-5 UPS – SpiderAlert controller

SRP-51 UPS - repeater

SR-500 – interface unit between various SpiderAlert RF transmitters and the SpiderBus

SR-500 ER – extend range version of SR-500

SR-520 – dual RF+IR receiver

SI-540 – 8-output interface unit

SI-544 – 4-input / 4-output interface unit

SI-561 – 6-input / 1-output interface unit

HK-2 – heated enclosure for wireless receivers

SK-1 – protective enclosure for single and dual technology receivers

Paging System – optional paging system for alarm notification

The SpiderAlert system from Visonetix has minimal maintenance requirements. Since the system performs self-diagnostic testing, a regular maintenance schedule is not required. Full system-wide self-tests, including dynamic load testing of batteries, are performed on each component every ninety seconds. Component faults and low battery messages are forwarded to the central controller for future corrective action.

5.5 Dominion Wireless, Inc. – Flare™ Personal Emergency Locator System

The Flare™ Personal Emergency Locator System is manufactured and distributed by Dominion Wireless, Inc. This system provides alarm, identification, and localization functionality, and is based solely on RF-technology. It should be noted that Dominion Wireless also distributes the Flash™ Portable Personal Alarm System which provides only alarm and identification capabilities (Type II functionality), but which may be expanded to a Flare system as required. For this discussion, we will focus on the Type III functionality provided by the Flare system.

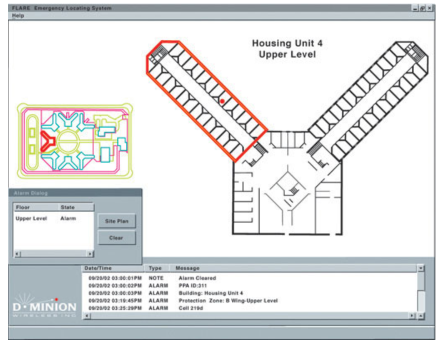


Figure 5-5 Flare Components

5.5.1 Alarm Sub-System

The Flare system utilizes RF-based transmitters and receivers for communicating duress alarm signals. In the Flare system, each correctional staff member uses a miniature belt-worn Personal Protection Device (PPD) that transmits duress alarm signals. An individual may activate a duress alarm with either a pushbutton or lanyard pull. Alarm signals are broadcast between 425 and 470 MHz, the particular frequency used being field programmable. The PPDs are powered by 6 V lithium batteries. Over 64,000 unique identification codes may be used with the PPDs, the particular value being programmable on individual devices. In addition to duress alarm signals, the PPDs can report diagnostic alarms to the control sub-system, identifying low-battery condition, failures, or other faults.

The Flare system utilizes an array of sensors (Receivers) and hubs (Data Concentrators and Controllers) for receiving and forwarding duress alarm signals. The sensors and hubs are powered by 120 VAC, with a trickle charge battery backup. The battery backup is designed to provide a minimum of four hours of operation in the event of a power failure. Up to sixteen individual sensors may be connected to a single hub. The hub is responsible for managing its collection of sensors and forwarding activated alarm signals to the control sub-system using Interface Units.

Communication among a collection of sensors, hubs, and interface units is based on the CEBus™ protocol for spread spectrum modem communication. The use of this communication protocol allows the system to communicate over existing AC power lines and / or spare telephone lines, potentially resulting in reduced installation costs. The system utilizes automatic self-testing and diagnostics in order to maintain an overall awareness of system functionality (from individual PPDs through the receiver and distribution channels).

5.5.2 Locator Sub-System

The Flare system provides an RF-based alarm localization capability, providing an accuracy of up to 12.5 feet inside steel and concrete facilities. The system is able to resolve received alarm signals to particular floors (for multi-floor facilities) and between indoor / outdoor operation. The locator sub-system relies on the same network of RF sensors that are utilized as part of the alarm sub-system. Using the sensor system that is installed within the buildings, the system is able to locate an activated alarm to within 25 feet outside the building, and can monitor activities up to 300 feet from the building's perimeter. The system provides continuous coverage of the correctional facility and does not use signposts as part of the locator sub-system.

The locator sub-system utilizes a patented method based on a computerized propagation model for radio signals. The model is customized for each facility as part of the system deployment. In this regard, test transmitters are activated at known locations within the facility, and the responses from all sensors (receivers) are recorded. Based on this calibration information, the parameters of the localization algorithm are updated specifically for the facility. Due to this facility-specific model, it should be noted that sensors cannot be re-located within the facility without requiring a new system-wide calibration, and any facility renovations must be closely monitored.

5.5.3 Control Sub-System

The Flare Head End, Windows NT-based software runs on a personal computer, providing control functionality for a deployed Flare system. The controller can be operated as a stand-alone unit, or may be integrated into existing security consoles. The Head End provides an easy-to-use point-and-click interface, and audio and visual alarm indicators. The system also utilizes automated self-test and diagnostics for fault detection and reporting. The control sub-system is also responsible for identifying the locations of activated alarms using alarm messages forwarded from multiple sensors (receivers) in conjunction with the customized localization model / algorithm. The system can handle over 4000 unique Personal Duress Transmitters, and can monitor activities in up to 2400 distinct facility zones.

5.5.4 Hardware / Software

Some of the modules and components that constitute the Flash / Flare systems are listed below, along with brief descriptions of component functionality. Dominion Wireless can be contacted directly for additional information.

Personal Protection Device (PPD) – belt-worn, RF transmitter

Sensor Unit – RF-based receiver

Flare Sensor Relay Unit (Hub) – interface between sensors (up to sixteen) and the Interface Unit

Interface Unit – provides communication between the hubs (CEBus™ protocol) and the central computer (via RS-232 protocol)

Head End – Windows NT-based system providing monitoring and control functionality

Test Unit – RF transmitter used in conjunction with periodic, system-wide self-tests

The Flare system from Dominion Wireless has minimal maintenance requirements. Automated diagnostics and self-tests are performed regularly on all installed hardware and software components, including full sensor recalibrations, without operator intervention. Faulty components identified via these self-tests are reported to maintenance staff for corrective action. Sensor redundancy ensures that system performance is not degraded in the case of sensor failures. Backup internal batteries are incorporated into all sensors and hubs to ensure a minimum of four hours of operation in the event of power failure. Firmware and software upgrades are made available from Dominion Wireless via dial-up modems, and propagated to remote components over the data network (eliminating the need to physically access the device for firmware updates).

5.6 Technology Systems International, Inc. – TSI PRISM™

The TSI Prison Inmate & Safety Management (PRISM™) system, a Type III duress system from Technology Systems International, Inc., offers a wide-range of alarm, identification, and localization capabilities. Although the information presented here focuses on the safety and security features offered by the TSI PRISM system for officers and staff, the system also permits the identification, localization, and tracking of the inmate population. The TSI PRISM system is an RF-based system that was designed and developed using technologies available under an exclusive license for the criminal justice market from Motorola, Inc.

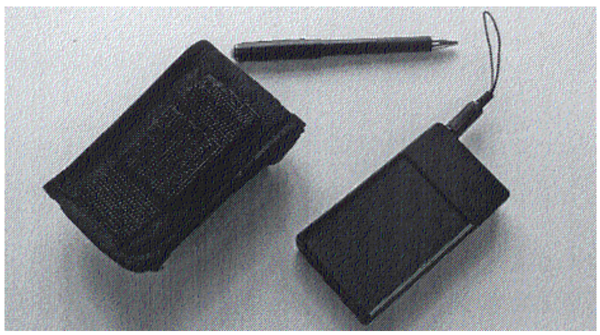


Figure 5-6 TSI PRISM Components

5.6.1 Alarm Sub-System

The TSI PRISM system relies solely on 900 MHz spread spectrum RF technology for alarm, identification and localization functionality. Correctional personnel wear Personal Alarm and Locator (PAL) transmitting devices on their belts. Each PAL is able to transmit up to six unique signals: Identification & Location Supervisory (periodically transmitted for tracking purposes), Duress (activated by the staff member via pushbuttons), Person Down (activated when a tilt-switch detects that the wearer is beyond 60º from vertical), Lanyard Pull (activates by a pull cord), Low Battery (transmitted to indicate a low battery condition), and Self-Test (transmitted to verify that the device is functioning properly). The PAL device also emits a loud audible alarm when activated. For tracking inmates, wrist-worn Personal Activated Security Sensor (PASS) transmitters are assigned to each inmate within the facility.

AP-Nodes (receivers) and C-Nodes (summing nodes) are utilized for receiving and forwarding event signals to the control sub-system. These nodes, typically connected to a network of antennas that are distributed throughout the facility, are responsible for converting RF alarm signals to digital signals that are then transmitted to a Server Computer (part of the control sub-system) over a Local Area Network (LAN).

5.6.2 Locator Sub-System

Alarm localization in the TSI PRISM system is based on data transmission timing characteristics, as measured at the AP- and C-Nodes. Typical location accuracy of 8-10 meters may be obtained by the system. Using the transmitting devices' Identification & Location Supervisory signal, the system is able to update a location database every two seconds and display continuous tracking information on demand. In the event of an alarm, the system identifies and tracks the individual who activated the alarm. Additionally, the system can identify and track a limited number of transmitters (e.g., those assigned to correctional personnel, prisoners or visitors) in close proximity to the duress event.

5.6.3 Control Sub-System

The TSI PRISM system utilizes a Client / Server model for distributing computer resource within the control sub-system. The server computer is the primary distribution and collection point for alarm signals. Alarms that have been forwarded by the AP- and C-Nodes are further distributed to client computers as required for display and response coordination. The Server, which maintains database information, is also responsible for maintaining history and event logs. The Client computers, the number of which is determined by the needs of each facility, are Windows-based systems.

In a typical installation, one computer is utilized as the Alarm Monitoring Console and one or more additional computers are utilized for managing inmate enrollment (if using the inmate tracking functionality), system administration, and other functions. The Alarm Monitoring Console can display multiple alarm events simultaneously. Alarms may be prioritized within the system, with priorities indicated by color on the console. The console includes mapping functionality with overlaid alarms and events. The entire system is self-monitoring to ensure correct operations, and any problems or faults are logged by the Server and forwarded to the Alarm Monitoring Console for display. Up to 24,000 unique user identifications (IDs) may be used within the TSI PRISM system, consisting of any combination of officers and other staff, visitors, and inmates.

5.6.4 Additional Features

Several features should be noted for the TSI PRISM system as a whole. All key components utilize uninterruptible power supplies that allow at least fifteen minutes of operation during a complete power failure. In addition, the system is able to perform self-diagnostics and automatic calibration to identify malfunctions or faults and, if detected, report these conditions to the control sub-system.

As noted above, the TSI PRISM system offers a wide range of advanced functionality beyond the correctional personnel safety and security features. In particular, the system can be used to identify and track inmate and visitor movements within the facility. For tracking inmates, wrist-worn transmitters (PASS) are assigned to each inmate within the facility. Alarms may be activated if tampering is detected. The health and operation of each PAL and PASS transmitter is continuously supervised as part of the Automated Head Count system, and activates alarms if malfunctions or faults are detected. Other features may be used to ensure inmate separation, control egress points, and schedule inmate activities.

5.6.5 Hardware / Software

Some of the modules and components that constitute a TSI PRISM system are listed below, along with brief descriptions of component functionality. Technology Systems International, Inc. can be contacted directly for additional information.

Transmitters

PAL (Personal Alarm and Locator) – belt mounted transmitter for officers and staff

PASS – wireless, wrist-mounted transmitter for inmates

System Components

AP-Node – RF receiver

C-Node – unit that converts RF signals to digital signals, which are then forward to the Server Computer via a local area network (LAN)

CAL-Node – fixed point transmitter that transmits periodic calibration signals

Server Computer – Unix or Linux based computer that serves as the primary distribution and collection point for alarm signals

Alert Monitoring Console – Windows based client computer that provides central monitoring point for the duress alarm system

Software

TSI SOS™ (Staff and Officer Safety) – provides duress alarm monitoring and control

TSI OMNI™ (Prison Inmate and Alarm Management) – inmate management system

PHILS™ (Prisoner Headcount Identification & Location System) – provides inmate identification, location and tracking functionality

The TSI PRISM system has minimal maintenance requirements. It is a self-supervisory system that performs system-wide diagnostics on a regular basis. Portable and fixed (CAL-Node) transmitters broadcast signals every two seconds to ensure transmitter / receiver operational integrity. Faults are presented on the monitoring station screen and noted for future corrective action. The estimated lifespan of a portable transmitter is five to seven years. Software updates periodically become available from TSI for system upgrades. Most software upgrades are coordinated through the local TSI officer and are applied via dial-up services from TSI servers to the local machine.

5.7 Sentry Products, Inc. – Sentry Communication System (SCS)

The Sentry Communication System (SCS) is an ultrasonic-based duress alarm system from Sentry Products, Inc. SCS is designed to provide instant, location discrete (i.e., zone-based) emergency communication between mobile personnel and central control. This hybrid system focuses on alarm notification and localization, and does not provide an identification capability.

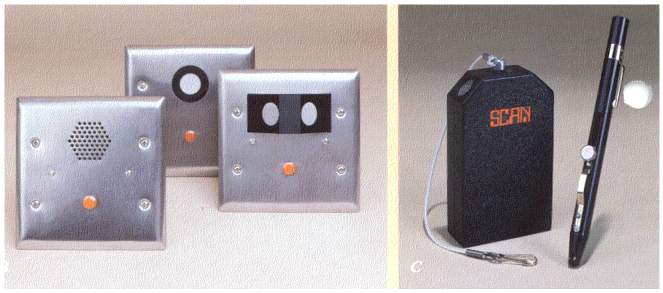


Figure 5-7 Sentry Communication System

5.7.1 Alarm Sub-System

Sentry Products, Inc. offers three basic alarm-transmitting devices: the P-105, the LC-110 and the LC-210. The P-105 is a pen-shaped mechanical transmitter that emits short, non-continuous alarm signals when activated. In contrast, the LC-110 and LC-210 transmitters are battery-powered devices that continuously transmit an alarm signal once activated.

Though any of the three transmitters may be used within SCS, the LC-210 is intended for use in correctional facilities. The LC-210 is a rugged, belt-worn device that is activated via a lanyard pull. In addition, the LC-210 offers a man-down feature that activates an alarm if the transmitter is tipped beyond 45º from vertical for more than fifteen seconds. (To reduce the occurrence of nuisance alarms, an audible warning is annunciated, giving the individual fifteen seconds to return the transmitter to an upright position.) The LC-210 is powered by standard 9 V batteries, offering up to 250 hours of continuous operation when using lithium batteries (and up to seventy hours of operation when using alkaline batteries). The LCS-210 provides low-battery indicators. The operation of individual transmitters may be tested using a PRT-45 tester.

Sentry Products, Inc. offers a wide variety of receiver options depending on the particular needs of a given facility. The receivers are responsible for i) detecting when an alarm has been activated, ii) illuminating a LED to acknowledge the alarm, and iii) forwarding the alarm signal to the control sub-system. The signals forwarded from up to twenty receivers within a single zone are multiplexed together using either an integrated multiplexer (available on some receivers) or a standalone MUX-100 zone communicator / multiplexer. Receivers / multiplexers utilize the RS-485 protocol to communicate with a control unit, limited to communication paths of less than 4000 feet. A transmitter / receiver pair provides an operational range of at least 50 feet within which all activated alarms should be detected. Once an alarm is detected, the responding receiver illuminates a red LED on its faceplate, which should be visible within up to 50 feet. Several of the receivers available from

Sentry, particularly those intended for use within a correctional facility, incorporate relays for annunciating local alarms and / or operating auxiliary equipment.

5.7.2 Locator Sub-System

Alarm localization within an SCS duress system is based on identifying which receiver reports an alarm message. The various receivers are distributed throughout the facility in well-defined zones. A receiver responds to an activated alarm by forwarding an alarm message to the control sub-system. The identity of the responding receiver is mapped to a well-defined location / zone, permitting precise alarm localization. Remote alarm notification / annunciation may be incorporated via the optional ROC-10 (alarm relay output board), ROC-30 (30-zone relay output board), and LDC-30 (30-zone LED driver board) products from Sentry Products, Inc.

5.7.3 Control Sub-System

Within an SCS duress alarm system, primary control is provided via MPA 30/60 Annunciation and Control Units. Covering up to thirty (MPA 30) or sixty (MPA 60) zones, Annunciation and Control Units communicate with various receivers and multiplexers across RS-485 cables within a range of 4000 feet. For small facilities with less than sixty operational zones, a single MPA may be used as a standalone control unit. For larger facilities, multiple units may be combined to obtain wider coverage. Each multiplexer attached to a given MPA is polled four times per second to determine operational status and check for fault conditions. The status of each zone is individually displayed on a flat panel using multiple LEDs.

In addition to receiving forwarded alarm messages from multiplexers, MPAs can accept sensor inputs for monitoring doors, windows and limited access spaces. System management of the distributed receivers is maintained via simple, two-button acknowledge / reset action. MPA control units are programmable via a single dipswitch, allowing each unit to be configured for the particular needs of the facility.

5.7.4 Additional Features

Several additional components and options are available with the SCS duress system for expanded functionality. For data logging, standard personal computers can be integrated with the Annunciation and Control Units using the RS-232 communication protocol. Audio may be integrated into the alarm sub-system using optional Amplifier Speaker Units. This feature requires extra twisted-pair wiring, but permits audio to be distributed to up to two receivers per zone.

For localized alarm operations within a larger facility, Sentry Products, Inc. also offers the SCAN and Mark-10 modular systems. These systems utilize the same transmitters and receivers, offering varying levels of functionality through different annunciation and control units.

5.7.5 Hardware / Software

Some of the modules and components that constitute a SCS system are listed below, along with brief descriptions of component functionality. Sentry Products, Inc. can be contacted directly for additional information.

LC-210 – ultrasonic man-down transmitter with fifty (50) foot range

LX-220 – ultrasonic man-down transmitter with sixty-five (65) foot range

LC-110 – ultrasonic transmitter that generates a continuous alarm signal when activated

P-105 – pen-shaped, mechanical device that generates an ultrasonic signal when activated

RS-100 – ultrasonic receiver

RS-120 – dual-head version of the RS-100 receiver

RS-140 – quad-head version of the RS-100 receiver

MS-100 – ultrasonic receiver with fire-retardant faceplate

HS-100 – vandal resistant, water resistant ultrasonic receiver

RM-100-RS – ultrasonic receiver with integrated signal multiplexer

RMX-100 – ultrasonic addressable receiver with remote device switch and programmable address

RMX-120 – dual-head version of the RMX-100 receiver

RMX-140 – quad-head version of the RMX-100 receiver

MPA 30/60 – 30 or 60 zone control and annunciation unit

MUX-100 – standalone units for multiplexing signals from up to twenty receivers

ROC-01 – alarm relay output board

ROC-30 – 30 zone relay output board

LDC-30 – 30 zone LED driver board

PS-103 – power supply that satisfies all SCS 30/60 system power requirements

PRT-45 – ultrasonic receiver with automatic reset capability; used to test ultrasonic transmitters

Instituting a regular testing program is required to ensure proper operation of the Sentry Communication System (SCS). The man-down transmitters are powered by 9 V batteries (either lithium or alkaline), with a yellow LED used to indicate low battery conditions. Regular testing of the transmitter and receiver component should be incorporated into a facility's standard operating procedures (SOPs). Sentry Systems recommends that component functionality be tested periodically: on a per-shift basis for portable transmitters, and monthly for fixed receivers (via a facility walk-through using a reference transmitter). For systems that utilize the MUX-100 and / or RMX, components are periodically self-tested (four times per second) to ensure signal integrity on the system's data network.

5.8 Bosch Security Systems – Security Escort®

The Security Escort Personnel and Asset Tracking System is developed and distributed by Bosch Security Systems. Security Escort is an RF-based, Type III duress system that provides alarm, identification, and localization functionality.

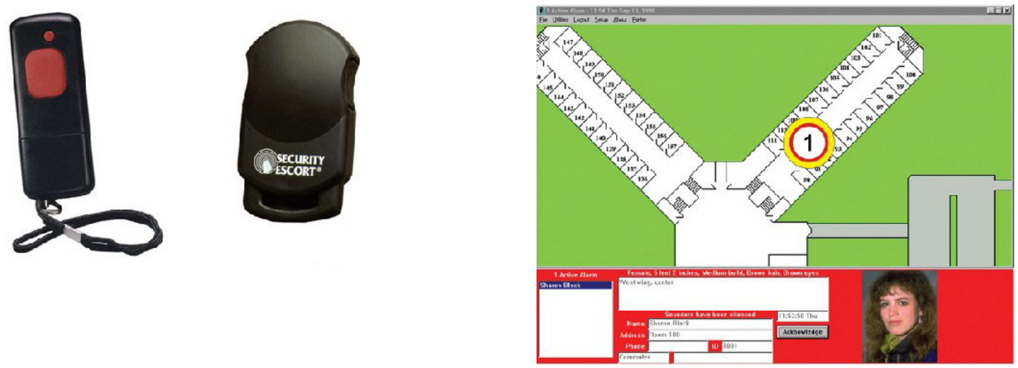


Figure 5-8 Security Escort Components

5.8.1 Alarm Sub-System

The Security Escort system utilizes RF signals, centered at 304 MHz, for transmitting alarm, test, and tracking signals. Three transmitting devices are available from Bosch Security Systems for use within Security Escort: the SE3401, the SE3, and the SE2. Each transmitter is assigned a unique identification code (minimum of 16 million), and over 60,000 transmitters may be used per system. A replaceable lithium battery with four-year life powers each transmitter, and low-battery indicators are incorporated into each device.

Designed specifically for use as a personal duress alarm transmitter, the SE2 Transmitter provides man-down alarm activation (an alarm is transmitted if the device is tipped beyond 60º from vertical), manual test capability, optional lanyard pull alarm activation, and an optional silent manual alarm. When an alarm, test, or tracking signal is transmitted, the transmitter's ID code is forwarded in order to identify the user. During a duress alarm, the SE2 Transmitter provides an Auto-Tracking feature wherein alarm signals are repeated every few seconds to continuously update location information at central control. The SE2 Transmitter also includes a push button that permits the device to be easily tested in the field. Several models of the SE2 Personal Duress Alarm Transmitter are available from Bosch Security Systems, each providing a unique set of features and options. The vendor can be contacted for additional information.

Security Escort utilizes an array of EA102 Receivers to receive and decode transmissions (alarm, test, and tracking signals) from the portable transmitters. Several receiver enclosures are available for the EA102, allowing it to be used in either indoor or outdoor locations. Indoor enclosures use green and red LEDs to indicate test and alarm conditions, respectively. In contrast, outdoor, weatherproof enclosures utilize sounders and / or strobes to acknowledge successful tests and annunciate alarms (optional). The EA102, powered by 12 VDC, monitors itself for tampering or fault conditions, and notifies central control when problems are detected. Using the Buddy Check system, any EA102 can test the operational status of nearby receivers by transmitting test messages via an internal radio transmitter. Results of the Buddy Check tests are reported to central control, which compares information with previous results to identify faults.

When an EA102 Receiver detects an alarm or test event, the information is forwarded to an EA500 Transponder. Transponders are responsible for controlling Receivers and Alert Units (devices that provide alarm annunciation through a Siren / Strobe device or other third party devices) and providing a communication link via either wire or ProxLink radios, to the control sub-system. Up to 255 transponders may be used within a Security Escort system, each with up to 64 devices (any combination of receivers and alert units) per transponder. EA500 Transponders, which must be mounted indoors, are powered by 18 VAC with 12 V battery backups. Using commands from the control sub-system, each transponder (and any device connected to it) can be tested remotely.

5.8.2 Locator Sub-System

The Security Escort system is designed to provide computed alarm location information, with typical accuracy of less than 25 feet indoors and 50 feet outdoors. Moreover, the system provides floor-to-floor location capability, allowing it to be used in multi-story facilities. Using alarm signals from multiple EA102 receivers, the control sub-system calculates alarm location via one of five user-selectable location algorithms.

Due to the complicated propagation environment presented by a typical correctional facility, care must be taken during the design and installation phases. The system requires receivers to be distributed throughout the facility in an evenly spaced grid and away from large metal objects that could adversely affect signal propagation. For indoor operations, the receivers should be spaced with no more than 80 feet between receivers. For multi-floor applications, the receivers are also required to be vertically aligned (i.e., receivers on one floor must be mounted directly above corresponding receivers on the floors below them). For outdoor operation, receivers are spaced according to proximity to surrounding buildings. For operation beyond 100 feet of a building, the receivers must be evenly spaced with no more than 300 feet between receivers. For operations within 100 feet of a building, the spacing requirements are the same as for indoor operations.

5.8.3 Control Sub-System

The Central Console Software, which runs on standard Windows-based personal computers, provides a simple, easy-to-use interface for managing and controlling the Security Escort system. The Central Console Software receives alarm, test, and tracking information data from the Transponders that are distributed throughout the facility (via either a wired or wireless link). When an alarm is received, the software is responsible for identifying the individual involved (by matching the transmitter's ID with an assigned correctional staff member) and calculating the alarm location (via one of five location algorithms). The identity and location information is then graphically displayed.

Other responsibilities of the Control Console package include: i) controlling individual devices, ii) managing system-wide testing and diagnostics, iii) monitoring system status, iv) reporting system and component faults, and v) managing multiple operational databases (e.g., event logging and subscribing uses). To enhance alarm notification and response coordination capabilities, the system provides support for wireless pagers. The Control Console Software is also easily modified, allowing it to be customized for the needs of a particular facility.

5.8.4 Additional Features

Several additional components and options are available with a Security Escort system for expanded functionality. As mentioned above, the Central Console Software provides wireless pager support to enhance alarm notification and response coordination capabilities. In addition, the software supports multiple databases that provide additional functionality. Some of these databases include a Subscriber Database, which manages data for individual users (e.g., current status, low battery conditions, most recent test results), an Alarm Reports Database, which records alarm activities, and a History Database, which manages a complete chronological history of all service actions, tests, and alarms.

Other information managed through the databases includes equipment configurations (installation sites, connectivity, etc.) and authorized operators. The Security Escort system also provides a Supervision Tracking feature for monitoring and tracking the movements of correctional personnel as they perform their duties. With this feature enabled, the SE2 transmitters periodically broadcast tracking signals to the Central Console in order to constantly update location information.

5.8.5 Hardware / Software

Some of the modules / components that constitute a Security Escort® system are listed below, along with brief descriptions of component functionality. Bosch Security Systems can be contacted directly for additional information.

SE2 Personnel Transmitter – RF transmitter intended for personal duress alarm activation with man-down, lanyard pull and silent alarm features

SE3 Subscriber Transmitter – RF transmitter with identification, location and test features

SE3401 Point Tracking Transmitter – RF transmitter for asset tracking

EA102 Receiver – indoor / outdoor RF receiver

SE2000 – Central Control Software that provides monitoring and control functionality

- **SE2005** – Central Control Software supporting up to 500 users
- **SE2010** – Central Control Software supporting up to 1,000 users
- **SE2050** – Central Control Software supporting up to 5,000 users
- **SE2100** – Central Control Software supporting up to 10,000 users

SE485 – interface between Transponders (RS485 protocol) and Central Console (RS232 protocol)

EA120 Alert Unit / Output Control Module – devices providing alarm annunciation through a Siren / Strobe device or other third party devices

EA500 Transponder – interface between Receivers and Alert Units and Central Console

The Security Escort system has moderate maintenance requirements. The distributed set of hardwired components is fully supervised by the control sub-system. Receiver functionality is tested by performing a facility walk-through with a reference maintenance transmitter. Transmitter functionality testing should be conducted periodically by the individual user (a quarterly test of each transmitter is recommended). Local test procedures should be instituted in order to ensure full system integrity.

5.9 Ascom Tateco AB – telePROTECT 900 Personal Alarm System

The telePROTECT 900 Personal Alarm System, a Type III duress system from Ascom Tateco AB, utilizes dual technologies for alarm, identification and location functionality. RF signals (UHF or VHF) are used for alarm notification and identification, and IR or LF (low frequency magnetic field) signals are used for alarm localization.

Figure 5-9 telePROTECT Components

5.9.1 Alarm Sub-System

The telePROTECT 900, utilizing RF-based (UHF or VHF) communications, is compatible with three basic types of wireless alarm transmitters. The Mini Alarm Transmitter offers Type II duress capabilities with alarm and identification functionality. The Pocket Alarm Transmitters and Pocket Alarm Transceivers from Ascom Tateco AB provide Type III duress capabilities, offering alarm, identification and location capabilities. This section focuses on the Pocket Alarm Transmitters and Transceivers. When activated, an alarm signal is transmitted that contains the transmitter identification code (for alarm identification), alarm type (push button, pull cord, man-down or no-movement), and location code (if the system includes locator equipment). An optional automatic supervision functionality may be used in a telePROTECT 900 system, wherein each mobile transmitter periodically transmits a verification code to central control.

The Pocket Transmitters are battery powered, with expected battery life varying between six months and two years, depending on usage and the presence of location functionality. Low battery conditions are indicated via a short audible beep once per minute. The Pocket Alarm Transceiver provides the same capabilities as the

Transmitter, plus integrated alphanumeric paging capabilities. The Pocket Transceivers are powered by rechargeable batteries, with typical charges lasting between one and four days. Between uses, the Pocket Transceivers are placed in recharging storage racks. In addition to a periodic audible beep, low battery conditions are indicated in the Transceiver's display.

Ascom Tateco AB offers several products for receiving and responding to alarm signals. Fixed Mini Receivers, with three outputs (one activated for test alarms, the second activated for duress alarms, and the third activated for malfunctions) for lamps and / or relays, are available for localized alarm notification. For larger distributed duress systems, Fixed Receivers and Receiver Interface are also available. Up to four Receivers may be connected to each Receiver Interface.

When an alarm signal is received, the Fixed Receiver forwards the signal to its corresponding Receiver Interface, which then converts the signal into a data block that is sent out on the system's data bus to an Alarm Module, Alarm Interface, or Output Module. Each Receiver Interface is also responsible for performing fault monitoring and reporting detected faults.

The Alarm Module, a programmable unit that accepts up to sixty-four inputs, is responsible for a variety of activities, from forwarding alarm messages to the Alarm Computer (control sub-system) to generating pages for distributed alarm notification. Each Alarm Module input is individually programmed in the Alarm Computer that activates, acknowledges, or resets alarms accordingly.

The Output Module, with sixteen programmable outputs (for lamps or relays) and one input (for alarm acknowledgement or reset), provides distributed alarm notification capabilities. Communication between the telePROTECT 900 system and an Alarm Computer is managed by an Alarm Interface via a standard RS232 serial interface. For extended coverage areas, Repeaters are available for the telePROTECT 900 system.

5.9.2 Locator Sub-System

A telePROTECT 900 Personal Alarm System utilizes one of two technologies, IR or LF (low frequency magnetic fields), to localize duress alarms within a correctional facility. The system utilizes a distributed network of fixed locators to continuously transmit location codes to mobile Pocket Alarm Transmitters and Transceivers. The transmitters / transceivers, which store the two most recently received location codes, are responsible for encoding the location codes within any transmitted alarm signal. The system does not attempt to determine exact alarm locations. Instead, the two most recently received locator codes, along with the elapsed time since they were received, are used to estimate the location and direction of movement of the correctional staff member under duress.

Up to 65,535 different locator codes are available for use within a system, with each fixed locator's unique code programmed via dipswitches. Slave locators may be connected to a “master” locator (up to three IR Slave Locators for each IR Locator or a single LF Slave Locator for each LF Locator), resulting in multiple locators transmitting the same locator code and thus increasing the coverage area for a given zone.

Other issues affecting coverage areas for IR Locators include output power, physical layout of the surrounding area, and whether the device will be used for indoor or outdoor operation. For LF Locators, the presence of external electromagnetic interference, nearby metallic structures, and the walking speed of personnel within the generated magnetic field may adversely affect coverage area. Fixed locators within a telePROTECT 900 system have internal fault monitors for self-testing and output connectivity for reporting fault conditions to Alarm Modules. For situations in which the demands on geographical accuracy are not as strict, alarm location can also be determined using the network of fixed receivers. Using a T940AI Alarm Interface Module, alarm data can be converted into location codes, wherein an alarm's point of origin is derived from the location of the receiver responding to the alarm. For situations in which multiple fixed receivers detect an alarm, the estimated alarm location is based on the location of the receiver detecting the alarm with the best signal quality.

5.9.3 Control Sub-System

A telePROTECT 900 system utilizes two basic components for implementing control sub-system functionality: the Alarm Interface and the Alarm Computer. The Alarm Interface uses a standard RS232 serial interface to the Alarm Computer to the system's data bus. The Alarm Interface is responsible for forwarding alarm information (transmitter identification code, alarm type, and locator codes), operational status, and fault conditions to the Alarm Computer. In addition, the Alarm Computer can pass signals to the Output Modules and generate pages in response to alarms via the Alarm Interface.

The Alarm Computer is an industry-standard PC running the PCPRO software package from Ascom Tateco AB. PCPRO provides multiple capabilities for managing and controlling the telePROTECT 900 system. In the event of a duress situation, the PCPRO application receives, displays, and acknowledges alarms. To facilitate a coordinated emergency response, the PCPRO software provides the ability to illuminate lamps and actuate relays via Output Modules and to generate pages (automatically or manually) for alarm notification. The PCPRO software also provides the ability to monitor system fault messages, perform automatic supervision of Pocket Alarm Transmitters and Transceivers, and perform radio coverage tests.

5.9.4 Additional Features

Several additional components and options are available with a telePROTECT 900 system for expanded functionality. The telePROTECT 900 can be integrated with cordless telephone systems, such as the CTS 900 or Ascom 9d system from Ascom, or paging systems, such as the teleCOURIER 900 system from Ascom as well as third party systems. This close integration can provide enhanced alarm notification capabilities.

Optional software applications are also available for use with the Alarm Computer's PCPRO control software. Guard Route provides the ability to monitor individual guards as they perform their duties. Routes are programmed into the software specifying which locators the guard must pass at specified time intervals. An alarm is generated in the event that the system detects deviations from the specified route.

The optional Supervised Alarm Transmitters capability provides the ability to automatically check and monitor the function of mobile alarm transmitters. The WinBK, WinBKS, and WinBKP suite of PC-based software is also available for programming and configuring the various components of a telePROTECT 900 system. Ascom Tateco AB should be contacted directly for additional information concerning these and other optional components.

5.9.5 Hardware / Software

Some of the modules / components that constitute a telePROTECT 900 system are listed below, along with brief descriptions of component functionality. Ascom Tateco AB can be contacted directly for additional information.

U922 – alarm transmitter with 6-button keypad

U922K – two-way speech alarm transceiver with 15-button keypad

U970 – pocket-sized, personal alarm transmitter

U970I – enhanced version of the U970 transmitter with alarm location functionality

U971 – wrist-watch sized alarm transmitter

U980 / V980 – UHF and VHF alarm receivers

U981 – small UHF alarm receiver

P940AI – alarm interface module used to communicate with external equipment

P940AM/8 / P940AM/32 – programmable alarm module with up to 64 alarm inputs

P940C / P941C – central unit that controls all communications on the system bus and monitors all installed modules

P940OM – output module that provides up to sixteen outputs for external control

P950L – IR-based locator that continuously transmits coded location information to U970I units

P950LP/LSP – location transmitter utilizing low frequency magnetic field transmissions to send coded location information to portable alarm units

P980RI – receiver interface used to connect up to four U980 receivers to a central unit

T930PS1 – power supply for the various telePROTECT 900 modules

T938D / T938S / T938BC2 – modems used to extend the data and speech buses

T941AM8 / T941AM32 – alarm module that is used in conjunction with an on-site paging system

T941OM – programmable output module used for controlling and monitoring indicator lamps or similar loads

T942C – central unit that monitors and controls all communications within an alarm system

T962E / T962M / T963 – racks used for storing and recharging U922 and U922K transceivers

T981RI – receiver interface for connecting up to four fixed receivers to the central unit

MHB-5 – unit used to program personal alarm transmitters

MIR-1 – receiver used to test locator units (verify transmitted location codes)

PCPAR – PC-based application used to customize software for the fixed equipment with a system

PCPRO – PC-based control software used to monitor and control a telePROTECT 900 system

The telePROTECT 900 system has minimal maintenance requirements. Low power conditions on portable transmitters are detected when a battery life drops below forty percent. When a low-battery condition is detected, an audible chirp is activated, a light is illuminated on the transmitter device, and a message is forwarded to the system controller. Diagnostics on all hardwired components in the system are performed every ninety seconds, with malfunctions noted and forwarded to the system controller for corrective action. Portable transmitters also perform periodic self-tests, with the period between tests established by the customer. Additionally, the system operator can request a status on all body alarms directly from the controller. Regular testing of each body alarm should be incorporated into a facility's standard operating procedures.

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6 Concluding Remarks

This document is intended to assist those within the corrections community with the process of identifying, selecting, and deploying personal duress alarm systems. In order to select the appropriate system for a given facility, those involved in the selection process must first identify their specific requirements. This document addresses relevant issues by introducing i) a scheme for classifying guard duress systems, ii) a simplified duress system model, iii) fundamental issues that should be addressed, and iv) an overview of relevant (current and emerging) technologies.

A classification scheme was introduced to identify the fundamental capabilities offered by each type of correctional officer duress alarm system: Type I – panic button alarms, Type II – identification alarms, and Type III – identification / location alarms. Fundamental issues relevant to the duress system selection process were introduced and discussed, including cost, installation issues, alarm activation, and system scalability, to name a few. The particular needs for a given facility should be taken into account when considering these fundamental issues.

The underlying technologies used in currently available systems include ultrasonic, infrared (IR), and radio frequency (RF) communications. Each technology was described with an emphasis on its advantages and disadvantages in the context of personal alarm systems. Emerging technologies that may directly impact future alarm systems, including ultra wideband (UWB) RF, global positioning system (GPS), biometrics, and body-implantable microchips were identified and described.

Provided within this document are several duress systems that are currently available from various vendors, including:

Ultrasonic-based systems with alarm and location capabilities:
- Perimeter Products PAS-120
- Sentry Products Sentry Communication System

RF-based systems with alarm and identification capabilities:
- Grace Industries GEM System™

RF-based systems with alarm, identification and location capabilities:
- Ascom Tateco AB telePROTECT 900 Personal Alarm System
- Bosch Security Systems Security Escort®
- Dominion Wireless Flare™ Personal Emergency Locator System
- Technology Systems International TSI PRISM™

Dual-technology RF+IR systems with alarm, identification and location capabilities:
- Actall® PALS 9000
- Visonetix SpiderAlert®

For further information on specific products, the reader is encouraged to contact the vendor directly (contact information is provided in Section 8).

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7 Glossary of Terms

Bandwidth	The width of the range of frequencies found within the electromagnetic spectrum that an electronic signal occupies on a given transmission medium.
Biometrics	The science of positive identification using an individual's unique physical characteristics.
CCTV	Closed circuit television that is primarily used for monitoring specific areas. Typical camera locations are at entrances and sally-ports in visiting areas and along a facility's perimeter.
CDMA	Code Division Multiple Access uses spread-spectrum technology to transmit a frequency according to a defined pattern (code). The coded transmission can only be intercepted by a receiver whose frequency response is programmed with the same code. There are trillions of possible frequency-sequencing codes, which enhances privacy and makes cloning difficult.
CPU	CPU (central processing unit) is an older term for processor and microprocessor, the central unit in a computer containing the logic circuitry that performs the instructions of a computer's programs.
DoD-	Department of Defense
DOJ	Department of Justice
EMI	Electromagnetic Interference
FCC	Federal Communications Commission
FDMA	Frequency Division Multiple Access, the most common modulation technique. It allows users to share the same physical channel by multiplexing the transmissions in space, separating the channels by putting them on different frequencies.
GHz	gigahertz - A unit of frequency denoting one billion (10^9) Hz.
GPS	Global Positioning System
ID	Identification
Infrared sensors	Interior devices that generate a multiple beam pattern of modulated energy and react to a change in the modulation of the frequency or an interruption in the received energy
IR	Infrared electromagnetic (EM) radiation between the visible light and microwave portions of the EM spectrum
IRT	IR Transmitter
ISM	Industrial, Scientific, and Medical
kHz	kilohertz – A unit of frequency denoting one thousand (10^3) Hz.
LOS	Line of Sight
MHz	megahertz – A unit of frequency denoting one million (10^6) Hz.

Motion detectors	Devices that use infrared light waves, radio frequency transmission, ultrasound or microwaves to detect changes that occur in a previously empty space when a human body enters
MTBF	Mean Time Between Failure – An indicator of expected reliability calculated on a statistical basis from known failure rates
Ni-Cd	The Nickel Cadmium (Ni-Cd) battery is a type of battery commonly used in portable small battery-powered devices, having an effective and even power discharge
NIJ	National Institute of Justice
PMT	Personal mobile transmitter; wireless transmitting device carried by individual that sends emergency signals or location information when activated
RF	Abbreviation for radio frequency. Refers to alternating current used for wireless broadcasting extending from 9 kHz (the lowest allocated wireless communications frequency, within the range of human hearing), to thousands of gigahertz
RFI	Request for Information
RFID	Radio Frequency Identification
RS-232	RS-232 is the interface that allows communication and data exchange with modems and other serial devices
SAINT	Staff and Alarm and Inmate Tracking
SOP	Standard Operating Procedures
SPAWAR	Space and Naval Warfare Systems Center
TDMA	Time Division Multiple Access, which allows users to share a frequency band. Transmissions are grouped as packets and transmitted according to controlled time slots. Where FDMA separates channels by putting them on different frequencies, TDMA separates them by allocating different time-slots on the same frequency to a sender and receiver.
UHF	Ultrahigh frequency range of the radio spectrum is the frequency band extending from 300 MHz to 3 GHz. The wavelengths corresponding to these limit frequencies are 1 meter and 10 centimeters
Ultrasonic	Sounds at frequencies above the human audible limit (i.e., above 20,000 Hz)
UPS	Uninterruptible power supply
UWB	Ultra-Wide Band
V	Voltage, also called electromotive force (EMF), is an expression for electric potential or potential difference. The common symbol for voltage is the uppercase letter V or E. The standard unit is the volt, symbolized by V. One volt is the EMF required to drive one coulomb of electrical charge (6.24 x 1018 charge carriers) past a specific point in one second

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8.3 Vendor Contact Information

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Ascom Wireless Solutions 598 Airport Blvd., Suite 300 Morrisville, NC 27560 919-861-6600 - phone 919-861-6626 - fax www.ascomwireless.com	
Bosch Security Systems 130 Perinton Parkway Fairport, New York 14450 (800) 289-0096 – phone (585) 223-9280 – fax http://www.boschsecurity.us	
Dominion Wireless Inc. 22611 Markey Court, Unit 110 Sterling, Virginia 20166 (703) 421-2086 – phone (703) 421-2149 – fax http://www.dominionwireless.com	
Grace Industries, Inc. P.O. Box 1225 Owings, Maryland 20736 (800) 204-7277 / (410) 286-2401 – phone (410) 286-2410 – fax http://www.gracesales.com	

Sentry Products, Inc. 2225 Martin Avenue, Suite J Santa Clara, CA 95050 (800) 899-1940 / (408) 727-1866 – phone (408) 727-2129 – fax http://www.sentryproducts.net	
Technology Systems International, Inc. P.O. Box 12038 Scottsdale, AZ 85267-7600 (480) 998-7700 – phone (480) 998-7600 – fax http://www.tsilink.com	
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Visonetix 10 Northwood Drive Bloomfield, CT 06002-1911 860-243-0833 860-242-8094 http://www.visonetix.com	