

Emergency Alarm: Project 25 Inter-RF Subsystem Interface and Console Subsystem Interface Features and Functions

This document is part of a series of Project 25 (P25) Inter-Radio Frequency (RF) Subsystem Interface (ISSI) and Console Subsystem Interface (CSSI) Features and Functions write-ups designed to increase awareness of P25 features, terminology, and implementation considerations learned during ongoing discussions within the Federal Partnership for Interoperable Communications (FPIC) ISSI/CSSI Focus Group. This document uses vendor neutral P25 Standards terminology, but the reader should be aware that different manufacturers and user communities often use different terms to describe these features.

FEATURE OVERVIEW

Problem Statement

P25 users and the FPIC ISSI/CSSI Focus Group have identified operability and interoperability concerns when using the *emergency alarm*, *emergency call*, *emergency alarm cancel*, and *emergency call cancel* features across the ISSI/CSSI, especially in a multi-vendor environment.

What are these features?

The *emergency alarm* feature alerts other users and dispatchers of an emergency condition, and the *emergency call* feature grants a responder in peril the highest-priority access to P25 system(s) resources via mobile or portable radio. The *emergency alarm cancel* and *emergency call cancel* features resolve *emergency alarms* and *calls*, respectively. These are primarily trunking features within the context of the ISSI/CSSI; however, they are also available on many conventional systems.

Why is this feature important?

The ability to alert telecommunicators and other first responder personnel of an emergency condition and its resolution in a timely manner can be the difference between life and death. Conversely, the inability to confidently establish or cancel an emergency condition – whether for a trapped firefighter, a law enforcement officer under duress, or an injured transportation or utility worker – is a risk that most agencies are unwilling to accept. The user expectation is that these features work seamlessly across the ISSI/CSSI even with multiple manufacturers involved; however, the operational and functional reality does not always match this expectation.

What are the primary ISSI/CSSI concerns?

With ISSI/CSSI connections, voice and data messages related to these features are sometimes routed between multiple P25 systems (i.e., RF subsystems, including console subsystems). As such, differences in configurations, implementation, and how each manufacturer's system handles these messages may result in the emergency alarm, emergency call, emergency alarm cancel, or emergency call cancel messages not working across the ISSI/CSSI. These issues have led to tough decisions to disable these features in situations where problems may occur.

What is being done about this?

For prospective users, it is important to be aware of potential interoperability concerns that may occur across the ISSI/CSSI. Robust features testing can identify emergency alarm, call, and cancel issues across different manufacturer systems, software revisions, and configurations.¹

SECTION 1: INTRODUCTION

Features related to the declaration and resolution of user emergencies – referred to as “emergency condition” or “emergency status” in the P25 Standards – represent a critical and lifesaving P25 user need. Emergency conditions constitute the highest priority voice and data communications transmissions (typically for the affected talkgroup and/or user). Whether the emergency is a trapped firefighter, a law enforcement officer under duress, an injured transportation or utility worker, or another life-safety situation, the ability to alert dispatch and other first responder personnel in a timely manner can be the difference between life and death. In these situations, a typical emergency condition unfolds in the following steps:

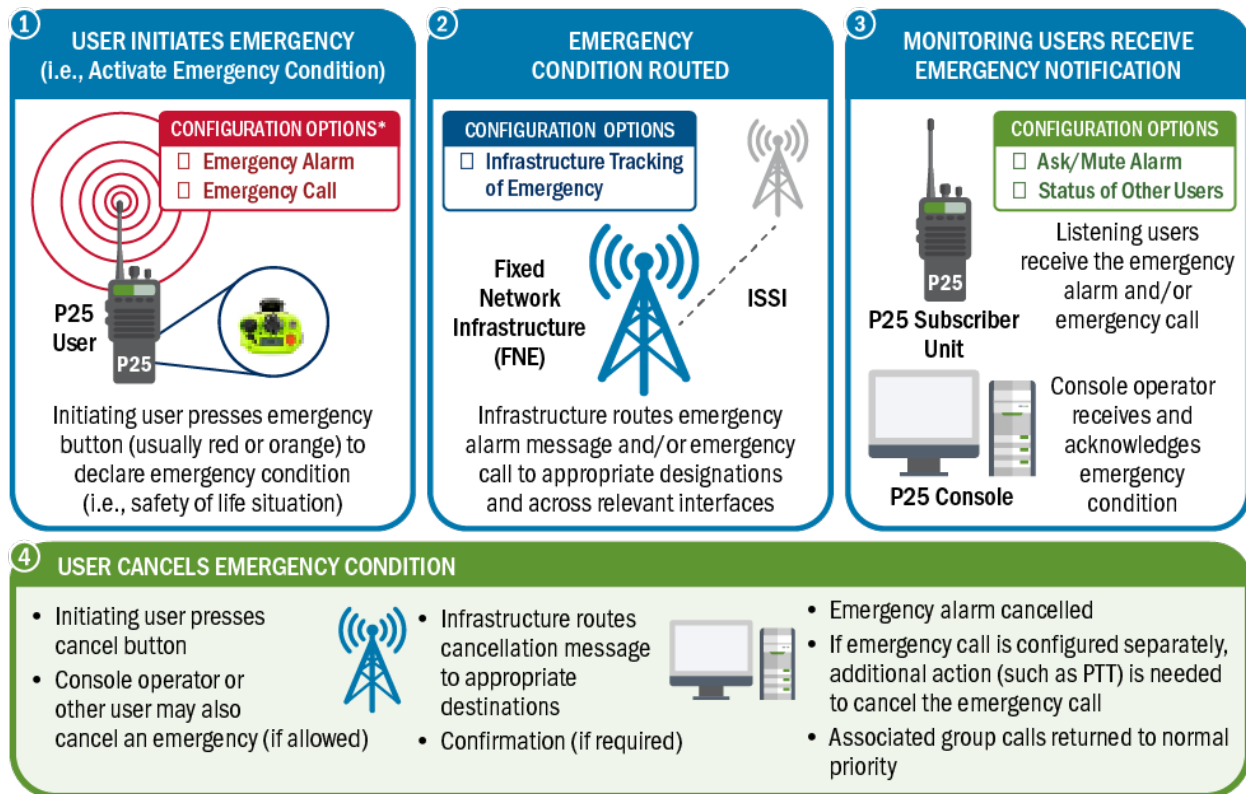


Figure 1 - Emergency Condition Overview

*Emergency Alarm and Emergency Call are explained in the next section. These are distinct services, handled differently by the P25 Standards and implemented uniquely by the manufacturers.

¹ Interoperability testing of P25 features and functions is on the Project 25 Compliance Assessment Program (CAP) roadmap. Currently, interoperability testing is conducted by manufacturers as either a part of their product development or during system implementation.

Defining the Terms

When an end user activates an emergency (i.e., presses the emergency button on his or her subscriber unit [SU]), it does not matter to him or her how an emergency condition is conveyed across the system infrastructure or ISSI/CSSI interfaces. Operationally, terms such as “emergency alarm,” “emergency alert,” “emergency call,” and “group emergency” are often used interchangeably to describe the ability for an end user to declare an emergency condition. As such, these terms are commonly misconstrued as a single feature.

However, within the context of P25 Standards and cross-manufacturer interoperability, these terms represent complementary yet distinct features that are handled differently by P25 systems. When addressing interoperability and operability challenges, it is important to understand the differences among these terms. When initiating an emergency condition, the two primary terms used by the P25 Standards are:

- **Emergency Alarm (Emergency Alert)** – the supplementary data feature for transmitting an alarm/alert message to a dispatcher (or infrastructure) indicating an emergency status for a user or talkgroup
- **Emergency Call (Group Emergency Call, or Emergency Group Call)** – a voice transmission intended for a group of users in a radio system during an emergency condition. In an emergency group call, a talkgroup is granted the highest priority (including ruthless preemption if enabled) on the P25 system, but otherwise follows standard group call procedures

Similarly, terms such as “emergency alarm cancel” or “group emergency cancel” may be used to describe the cancellation, “clearing,” or “knock down” of an emergency condition:

- **Emergency Alarm Cancel** – clears the emergency alarm/alert notification of the SU and/or associated group. There is a separate feature called the “*group emergency cancel*” that applies to trunked systems; however, in most situations, this feature is synonymous with *emergency alarm cancel*
- **Emergency Call Cancel** – clears the emergency status of group calls. The *emergency call cancel* is often tied to the *emergency alarm cancel*, but this is not always the case because emergency calls and emergency alarms are separate features

SECTION 2: EMERGENCY CONDITION BEHAVIORS AND IMPLEMENTATION VARIABLES

The P25 Standards define general procedures and messaging formats for each of these features. However, the standard allows implementation variations that result in different behaviors of standard services between manufacturers. If what the standard allows and how equipment from different manufacturers operates is unknown or unclear to the system operator/users, this could lead to interoperability challenges in a multi-manufacturer ISSI/CSSI environment. As such, it is up to system administrators to understand and configure those options. This section describes general emergency alarm behaviors and identifies areas where system and SU configurations and manufacturer design decisions could lead to different behaviors (i.e., implementation variables). **Due to these variations, regular testing is needed to establish and maintain functionality of desired P25 features and functions across ISSI/CSSI connections.**

1. Declaring an Emergency Condition

Most, if not all, P25 SUs have a physical emergency button for users to indicate that they – or someone around them – are in peril. By pressing the button, the initiating user is indicating an emergency condition to all pertinent SUs and consoles.

This emergency condition is sent as an *emergency alarm*, an *emergency call* with the emergency bit set to “1,” or during unit registration and group affiliation using an emergency bit. The emergency alarm triggers alarms/alerts for all relevant users; the emergency call ensures talkgroup priority and even preemption in some cases; and the unit registration/group affiliation allows a user to use systems they otherwise may not access in normal conditions. It should be noted that if the emergency call feature is configured separately from the emergency alarm feature, then additional action(s) may be needed to trigger an emergency call.

IMPLEMENTATION VARIABLES²

- **Method for triggering emergency status**
 - What is the form factor of the emergency button?
 - Does there need to be a physical button?
- **Relationships between the emergency call and emergency alarm feature**
 - Are emergency calls and alarms tied together?
 - Does pressing the emergency button also initiate an emergency call?

2. Routing the Emergency Condition

The *emergency alarm* allows a mobile or portable radio user to assert an emergency condition and raise a direct alarm for the awareness of system administrators, telecommunicators, and/or other radio users. On the system backend, the *emergency alarm* is transmitted as a standardized supplementary data message alerting the P25 infrastructure (fixed network equipment [FNE]) of an emergency state. Upon receiving the *emergency alarm*, the system associates the user and related talkgroup(s) with an emergency state until the emergency is cleared by some other action.

The term *emergency call* refers to the voice transmission itself, which follows routine group call procedures. The only difference between an *emergency call* and a routine call is the presence of an active emergency bit indicating that the talkers are in an emergency state and shall be granted the highest system priority. It is important to note that the term *emergency call* generally refers to group calls and not individual calls (also known as unit-to-unit or subscriber-to-subscriber calls).

This distinction between *emergency alarm* and *emergency call* becomes important when they are used in conjunction with the *emergency alarm cancel* and *emergency call cancel* features across the ISSI or CSSI. Although these two features are often tied together, they are different features that can be configured separately in some systems. This can lead to instances where an alarm is triggered or canceled, but not the emergency call, or vice versa.

In general, *emergency calls* follow routine P25 Common Air Interface (CAI) voice procedures and maintain emergency status across every talk spurt (i.e., across system endpoints) while being routed to the appropriate destinations. An *emergency alarm* is routed as a supplementary data message and should follow appropriate supplementary data procedures. **In a multi-manufacturer ISSI/CSSI**

² The term “implementation variables” refers to different operational elements or configurations that should be considered when planning or implementing features and functions to be used across the ISSI/CSSI.

environment, differences in the routing of emergency calls and alarms and how they are handled by different manufacturer's system infrastructures can lead to interoperability concerns.

IMPLEMENTATION VARIABLES

- **Emergency Condition Setup and Tracking**
 - Does the FNE track the emergency state of users or groups?
 - Can an SU with an emergency condition register on previously non-approved systems/sites?
- **Emergency Call**
 - Should all talkgroup users or just the initiating user receive priority?
 - If the talkgroup has been dynamically regrouped (also called "group regrouping"), should everyone inherit the emergency?
 - Should ruthless preemption be enabled for emergency calls?

3. Receiving an Emergency Alarm or Call

Once an *emergency call* or *emergency alarm* is sent to the appropriate destination, it can trigger visual and/or audible indications on all interested consoles and SUs and grant priority talkgroups to those in the emergency condition. Acknowledgement and notification of the emergency condition can vary based on implementation and operational needs. These operational procedures should be discussed and agreed upon by all system owners to ensure operability and interoperability.

IMPLEMENTATION VARIABLES

- **Emergency Alarm Acknowledgement**
 - Who should be notified of the emergency condition in a complex system environment (e.g., multiple console systems, RF Subsystems (RFSS), FNE)?
 - What kind of acknowledgement, and by whom, is required for an emergency alarm?
 - What permission should be granted to dispatch operators from connected systems (or home/foreign systems for an ISSI/CSSI)?
 - What is the mechanism for dispatch operators (or others) to acknowledge an emergency condition?
 - How is an emergency condition displayed on listening SUs (and consoles)?
 - Is the unit alias (and other important information) conveyed to listening users and dispatchers?
- **Emergency Call**
 - Should the emergency condition (i.e., emergency bit active) apply to subsequent group call transmissions?
 - Does the emergency condition apply to all members of a group?
 - Are there situations where an emergency call is needed, but an emergency alarm is not?

4. Cancelling Emergencies

Once an emergency state has ended, the *emergency alarm cancel* and *emergency call cancel* features alert the system infrastructure of a need to switch users back to a normal state and allows system operators, telecommunicators, and other users to act accordingly. An *emergency alarm cancel* initiated from a mobile SU or console should be relayed to the appropriate endpoints using supplementary data procedures. The *emergency call cancel* occurs in the CAI voice message. Because *emergency alarm* and *emergency call* are distinct features, they may need to be canceled separately depending on implementation.

IMPLEMENTATION VARIABLES

- Who should be able to clear an emergency alarm in a complex system environment (e.g., multiple console systems, RFSSs, FNE)?
 - Should the cancel come from the initiating user, or can an operator cancel an emergency condition?
 - What permission should be granted to dispatch operators/administrators from connected systems (should they be able to cancel an emergency under any circumstances, including situations where a user is roaming)?
- Who needs to receive acknowledgment or notification of the emergency alarm cancel?
- What are the procedures for silencing an alarm, and does that account for inappropriately cleared alarms?

Emergency Across the ISSI/CSSI

As noted in the implementation variables, emergency across the ISSI or CSSI requires system administrators to consider a new set of behaviors for how each connected RFSS addresses *emergency alarms* and *emergency calls*. Roaming SUs and the need for a RFSS (i.e., system infrastructure and console subsystems) to interact with foreign SUs and talkgroups add operational complexity. Additionally, optionality in the standards, including manufacturer interpretation of the standards and design choices to serve user needs/preferences, can lead to differing behaviors and expectations on each side of the ISSI/CSSI connection, especially if different manufacturer systems are involved.

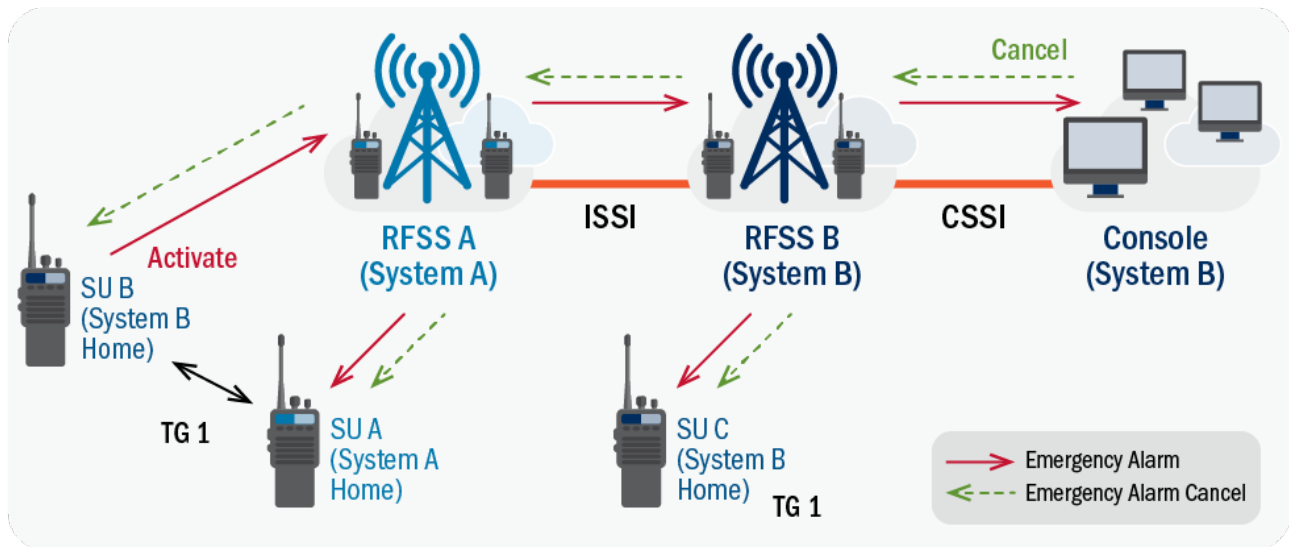


Figure 2 – ISSI/CSSI Emergency Example

In the graphic above, SU B triggers an *emergency alarm* and may attempt to establish an *emergency call* with its home System B. The conveyance of this emergency across an ISSI/CSSI involves multiple RFSSs and call spurts and can be addressed to multiple console subsystem(s), talkgroup(s), or to a general system infrastructure node. The *emergency alarm* message is acknowledged by the second system, but how (or if) the second system resolves the alarm can differ from manufacturer to manufacturer. For example, System B may be configured to automatically trigger an emergency

condition for all talkgroup 1 SUs, whereas System A may not. The systems may also differ in how they trigger and treat *emergency calls* and their associated talkgroups.

Differences in implementation may lead to missed *emergency alarms* or *emergency calls* and *emergency alarm cancels* where some users are not granted system priority. For example, users have experienced issues where an emergency acknowledgement on a CSSI-connected console is not passed back to the home core. Additional complexities arise when audio patching, encryption, roaming, multiple ISSI/CSSI connections, and/or non-P25 systems are introduced.

To ensure true interoperability across the ISSI, connected systems must test each feature across all permutations of home, registered, and talkgroup RFSSs to understand expected behaviors across the ISSI.

Table 1 - ISSI Testing Permutations

Note: This is not a real test plan, but a list of permutations meant to show the complexity of ISSI/CSSI testing.

| Initiating SU | Home RFSS | Registered RFSS | Talkgroup Home | Destination SU |
|-------------------|--------------|-----------------|----------------|-------------------------------------|
| Radio and Console | RFSS A and B | RFSS A and B | RFSS A and B | Radio and Console (on RFSS A and B) |

Summary of Implementation Variables

In summary, while the P25 Standards address some implementation variables, they do not dictate how *emergency alarm*, *emergency call*, *emergency alarm cancel*, or *emergency call cancel* messages should be addressed within each manufacturer’s P25 infrastructure or RFSS. Additionally, legacy preferences and differing user expectations can lead to variations in how these features are implemented. Table 2 provides a breakdown of elements found in the P25 Standards and elements where implementation differences can exist.

Table 2 - Emergency Alarm and Call in the P25 Standards (includes both ISSI and non-ISSI Standards)

| In Standard | In Standard, but with Optionality | Not in Standard |
|--|---|--|
| Emergency Alarm messages and procedures | What happens when resources are limited. Ruthless preemption vs. top of queue for emergency calls | End user (and device) ergonomics to trigger and cancel an emergency condition |
| Emergency Call procedures | Whether the system infrastructure should track the emergency status of a group call | Method for dispatch operators (or other users) to acknowledge or cancel an emergency condition |
| Mechanisms (emergency bit, control message formats) for alerting the FNE of an emergency condition | If the emergency condition applies to subsequent group call transmissions | How an emergency condition is displayed on listening SUs (and consoles) |
| Mechanism for auto-triggering of emergency alarms | Whether the emergency condition applies to all members of a group | |
| Emergency alarm cancellation messages and procedures | Ability to register SU on previously non-approved systems/sites | |
| Emergency call cancellation procedures | | |

Other Considerations

The rising popularity of long-term evolution (LTE) and land mobile radio (LMR) interconnections necessitates an extension of the *emergency alarm* and *emergency call* features to LTE users connected to an LMR system. A joint Alliance for Telecommunications Industry Solutions (ATIS) and the Telecommunications Industry Association (TIA) working group is currently defining an interworking function (IWF) between LMR and LTE systems.

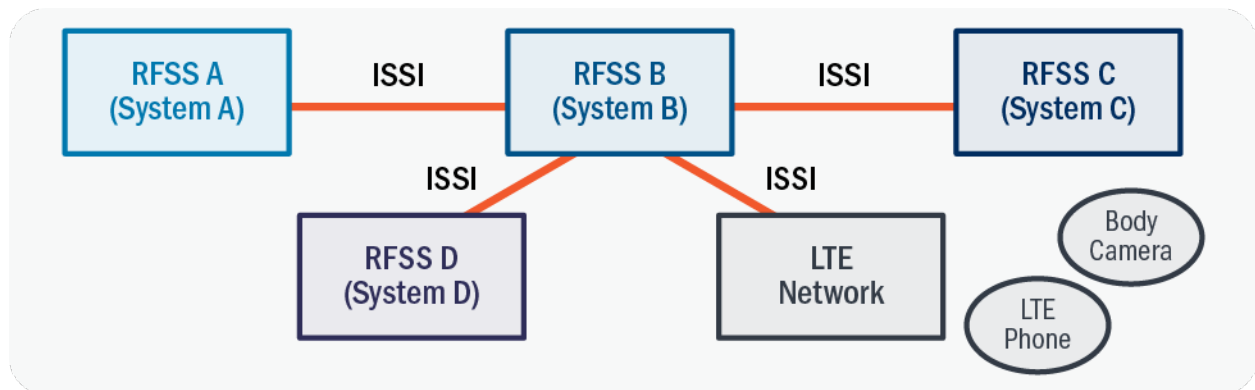


Figure 3 - Complex ISSI/CSSI and LMR/LTE Considerations

Addressing Emergency Challenges

Various efforts have been taken or are underway to address this topic:

- **P25 Standards: P25 Trunking Procedures updated** to include more detailed procedures for *emergency alarm*, *emergency alarm cancel*, *emergency call*, and *emergency call cancel*
- **Compliance Assessment Program (CAP): ISSI/CSSI conformance testing** for *emergency call* and supplementary data features, such as *emergency alarm*, over an ISSI/CSSI. The CAP does not currently perform interoperability testing of these features, but that could be a next step if P25 interoperability testing procedures are developed
- **FPIC: ISSI/CSSI Focus Group activities** to discuss and share ISSI/CSSI implementation best practices³

Conclusion

The public safety user community views these well-established features as critical to life safety and have expressed their concerns to the manufacturer community. Because these concerns occur only in specific combinations of manufacturers and in specific conditions, they are difficult to identify and resolve due to their level of complexity and the number of permutations that exist. Additionally, existing implementations conform with P25 standards; as such, issues can only be identified through extensive interoperability testing and/or during live operations.

³ Through these efforts, FPIC has developed ISSI/CSSI documents such as ISSI/CSSI Best Practices Volume 1 and Volume 2. These documents can be found at cisa.gov/safecom/fpic

From the user perspective, it is important to communicate ISSI/CSSI user needs to all involved manufacturers and be aware of potential interoperability challenges. For example, a user looking to implement these features and functions will need to work with their manufacturers to understand if the *emergency alarm* and/or *emergency call* (depending on implementation) is able to pass through the ISSI and be acknowledged, and that the *emergency alarm* can be seamlessly cleared across all systems, regardless of manufacturer.

Additional Resources⁴

- TIA-102.BACA-B, Inter-RF Subsystem Interface Messages and Procedures for Voice Services, Mobility Management, and RFSS Capability Polling Services
- TIA-102.AABD-B, Trunking Procedures
- TIA-102.AABB-B, Trunking Control Channel Format
- TIA-102.AABC-E, Trunking Control Channel Messages
- TIA-102.BAAD-B, Conventional Procedures and TIA-102.AABG, Conventional Control Messages

⁴ P25 Standards are published by TIA and can be found at standards.tiaonline.org/standards/technology/project_25/index.cfm