

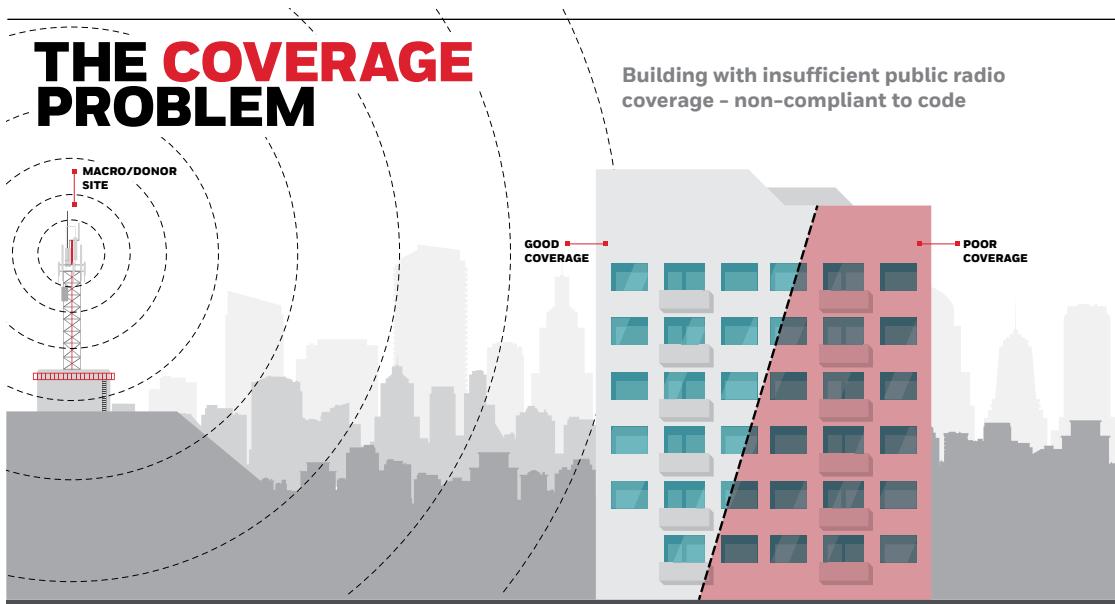
EMERGENCY RESPONDER COMMUNICATION ENHANCEMENT SYSTEMS CODES

Emergency Responder Communication Enhancement Systems (ERCES)
/Bi-Directional Amplifier (BDA) and Fiber DAS Systems

Honeywell

BACKGROUND

An Emergency Responder Communication Enhancement System (ERCES) or commonly referred to as a Bi-Directional Amplifier (BDA) system is a Life Safety System similar to a fire alarm system. Emergency Responders - Firefighters, Police and Emergency Medical Services (EMS) rely on two-way radios operating on public safety frequencies for communications in every day operations. When radio signals going into and out of buildings are weakened by structures such as concrete, Low-E glass windows, metal, underground, and additional materials impacting radio propagation, emergency radio communications can become unreliable with lack of in-building public safety radio coverage. Codes require an approved level of radio coverage which can be achieved by enhancing the in-building radio frequency signal coverage with an ERCES which comprises of a BDA / Signal Booster and Distributed Antenna System (DAS). For the benefit of those considering an ERCES / BDA, this article explains origins and requirements of applicable codes and standards, the importance of the emerging product performance listings and standards (UL 2524), and the current certified offerings that are available.



Recommendation 22

NIST recommends the installation, inspection, and testing of emergency communications systems, radio communications, and associated operating protocols to ensure that the systems and protocols: (1) are effective for large- scale emergencies in buildings with challenging radio frequency propagation environments; and (2) can be used to identify, locate, and track emergency responders within indoor building environments and in the field.

Affected Standards

FCC, SAFECOM, NFPA Standards on Electronic Safety Equipment, NFPA 70, NFPA 297, and NFPA 1221. Model Building Codes: The standards should be adopted in model building codes by mandatory reference to, or incorporation of, the latest edition of the standard.

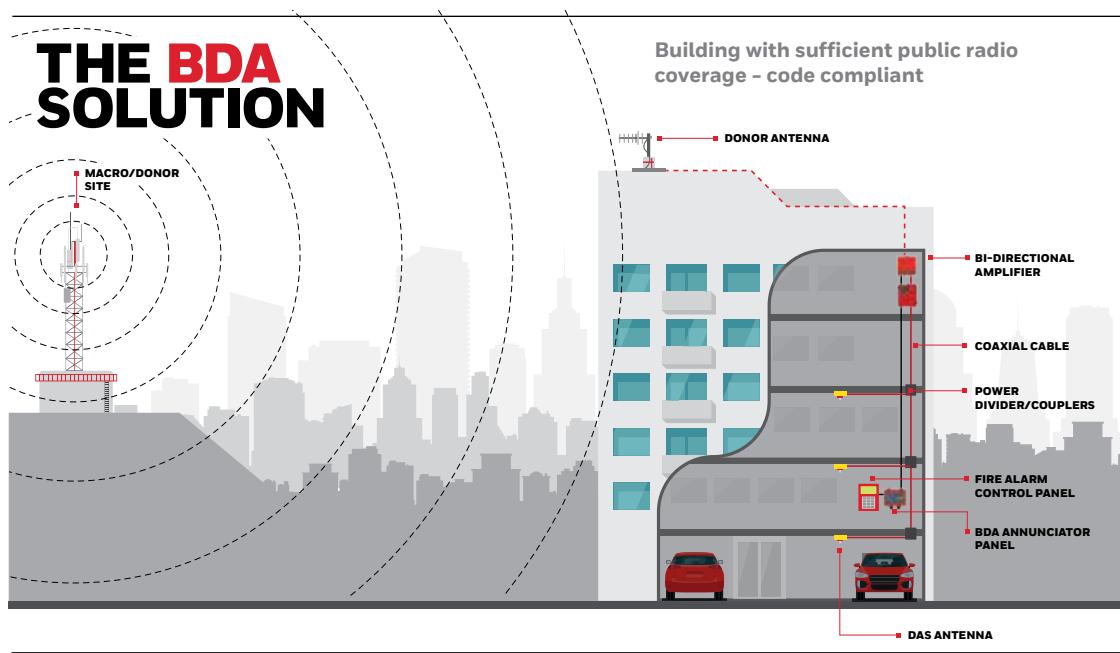
ORIGINS OF ERCES CODES

Emergency Responders rely on two-way radios for communication in everyday operations and during an emergency, reliable communication is critical in saving lives. Shortly after the attacks on the World Trade Center on September 11, 2001, the National Institute of Standards and Technology's (NIST), with support and funding from the U.S. Congress through FEMA, conducted a building and fire safety investigation. NIST's World Trade Center report (<http://wtc.nist.gov/>), provides a summary of their findings and recommendations. Among their recommendations, Recommendation 22 provided the impetus for updates to the Codes.

The NIST efforts resulted in new section 510 being added to the 2009 edition of the International Fire Code (IFC) that requires all buildings to have approved radio coverage for emergency responders within buildings. Approved is a defined term in the IFC which means acceptable to the fire code official. Section 510.2 provided the minimum acceptable signal criteria that must be achieved and maintained throughout 95 percent of all areas on each floor of a building, as indicated in Sections 510.2.1 and 510.2.2. Section 510.2.1 requires that a minimum signal strength of -95 dBm be

received by radios inside the building. However, section 510 provided no requirements for designing, installing, testing and maintaining an ERICES. Instead Appendix J provided the technical guidance. The provisions of Appendix J are not mandatory unless specifically referenced in the adopting ordinance. The design, installation, testing and maintenance requirements for the ERICES moved from Appendix J to the body of the code for the 2012 edition of the IFC. New Section 915, titled "Emergency Responder Radio Coverage" was added to the 2009 edition of the International Building Code (IBC) and requires emergency responder radio coverage in all new buildings in accordance with Section 510 of the IFC. For the 2015 edition of the IBC, Section 915 was moved to section 916.

New section 6.10.2 was added to the 2007 edition of the NFPA 72, National Fire Alarm Code, that permits the installation of two-way in-building radio communications enhancement systems and these systems are permitted to be monitored by the building fire alarm system. The requirements in the 2010 and 2013 edition of NFPA 72 were greatly expanded over the 2007 edition. General requirements that the installation of the ERICES be coordinated with the AHJ, a permit for the installation of the ERICES is required, critical areas shall be provided with 99 percent floor area radio coverage and general building areas shall be provided with 90 percent floor area radio coverage were added. It should be noted that the provisions of the IFC do not address critical areas. Examples of critical areas are fire command centers, the fire pump rooms, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by the authority having jurisdiction.



APPLICABLE CODES

Most current adopted Fire and Building Codes require Emergency Responder Radio Signal strength and coverage to be measured in all new and some existing construction. ERCES are required by IBC, IFC and NFPA 1. These codes require ERCES to be installed, serviced and maintained in accordance with NFPA 1221 and NFPA 72.

IBC

IBC Section 916 (2021 edition) and IBC Section 915 (2012 edition) dictate that radio coverage shall be provided in all new buildings in accordance with Section 510 of the IFC.

IFC*

Section 510 in 2021, 2018, 2015, 2012, 2009 editions dictate that all new and existing buildings shall have approved radio coverage for emergency responders. Approval is based upon the existing coverage levels of the public safety communication systems utilized by the jurisdiction and measured at the exterior of the building. 2021 edition requires 95% coverage of all areas on each floor of the building and the same signal strength as outlined in NFPA. BDA components should be contained in NEMA-4 type enclosure and the battery backup should be contained in NEMA 3R or higher-rated cabinet (2021 edition) or NEMA 4-type cabinet. The system requires a battery backup of 12 hours (2021 edition) or 24 hours. Under all system operating conditions, requires isolation be maintained between the donor antenna and all inside antennae to not less than 20dB greater than the system gain under all operating conditions (2021 edition). It also requires oscillation prevention circuitry for the BDA. FCC certification is required for the BDA and BDA status should also be monitored by the fire alarm system with a supervised communication link. BDA equipment required to provide emergency responder radio coverage shall be listed in accordance with UL 2524 (2021 edition).

IFC requires system designer and lead installation personnel have both valid FCC-issued General Radio Operators License (GROL) and certified in-building system training by the equipment manufacturer or approved organization or approved school. IFC also requires inspection and annual testing of ERCS or where structural changes occur that could materially change the original field performance tests.

NFPA 1*

NFPA 1 Section 11.10 dictates in all new and existing buildings, minimum radio signal strength for emergency services department communications shall be maintained at a level determined by the AHJ. Where required by the AHJ, two-way radio communication enhancement systems shall comply with NFPA 1221. 2021 edition requires in-building emergency responder communication enhancement systems installed within buildings shall be listed and labeled in accordance with UL 2524, in-building 2-Way Emergency Radio Communication Enhancement Systems.

NFPA 1225, 1221 and 72*

NFPA 1225 Chapter 18 (2022 edition) dictates that radio coverage shall be provided with 95% floor area in general building areas and 99% floor area in critical areas (Critical areas include command centers, fire pump rooms, exist stairs and passageways, elevator lobbies, sprinkler section values, and other areas required by an AHJ). For signal strength or quality of audio delivered, NFPA 1225 2022 Edition requires the system to provide a Minimum Delivered Audio Quality (DAQ 3.0) and NFPA 72 requires minimum inbound and outbound signal strength of -95 dBm. NFPA requires the system must be capable of all radio system frequencies assigned by AHJ. 2022 NFPA 1225 Section 18.12.1.3 requires In-building

emergency responder communication enhancement systems installed within buildings shall be listed and labeled in accordance with UL 2524, In-building 2-Way Emergency Radio Communication Enhancement Systems.

To meet code, NFPA 1225, 1221 and 72* include system component requirements. Signal Boosters / BDA units should have FCC certification prior to installation and should be compatible with both analog and digital communications simultaneously at the time of installation. BDA components should be contained in NEMA-4 or 4X type enclosure(s). The system requires a battery backup of 12 hours. Isolation should be maintained between the donor antenna and all inside antennae to ensure non-interference and Public Safety System non-degradation. A dedicated annunciator panel is required within the emergency command center to annunciate the status of any signal booster(s). The monitoring panel should provide visual and labeled indication of the following for each signal booster: (1) Normal AC power, (2) Signal booster trouble, (3) Loss of normal AC power, (4) Failure of battery charger, (5) Low-battery capacity and Antenna failure. The BDA status should be also monitored by the fire alarm system with a supervised communication link.

Local Ordinances

Many cities and counties have additional ordinances requiring ERCS / BDA systems. These ordinances are defined by the Authority Having Jurisdiction (AHJ). Specifications set by the AHJ are required and must be met.

FCC, IC

Federal Communications Commission (FCC) rules apply to all RF (Radio Frequency) Emitters (any device that emits RF energy), including BDAs / Signal Boosters. All BDAs must be FCC certified to be legally sold in the USA. Furthermore, all systems must be installed in accordance with applicable FCC rules and regulations. Similarly, in Canada Industry Canada (IC) certification is required.

* Refer to Appendix for summary of key requirements in IFC and NFPA

PRODUCT PERFORMANCE LISTINGS AND STANDARDS

UL 2524 Timeline

December 2017:	UL 2524 published as an Outline of Investigation
December 2017:	Product testing begins
Spring 2018:	Standards Technical Panel (STP) formed for US/CAN
June – July 2018:	UL 2524 proposal balloted
August 2018:	STP meets to review negative ballots and public comments
August – October 8:	Recirculation of revisions to proposal
October 2018:	Published 1st edition on October 18th
January 2019:	2nd edition published - Bi-National Standard

Product performance listings and standards were only recently introduced for ERICES. Prior to the new standards, AHJs, Architects and Engineers (A&Es), and building owners could not be certain that systems were code compliant and whether they would perform as claimed by manufacturers. Today, code regulates performance standards and listings provide all necessary parties the certainty that installed BDA systems will provide reliable communications for emergency responders.

2021 IFC Section 510.4, 2021 NFPA 1 Section 11.10.3.1 and 2022 NFPA 1225 Section 18.12.1.3 requires In-building emergency responder communication enhancement systems installed within buildings shall be listed and labeled in accordance with UL 2524, In-building 2-Way Emergency Radio Communication Enhancement Systems. NFPA 72 Section 10.3.1, IFC Section 907.1.3 and NEC Section 110.2 & 110.3 require the products to be listed for the purpose for which they are installed. This conformity assessment provision provides a means of ensuring the products or systems have the required performance characteristics, and these characteristics are consistent from product to product. Conformity assessment also requires an OSHA accredited, independent third-party organization to sample, test and inspect products to a performance standard.

Absence of product performance standards combined with absence of independent testing and verification of product performance to an operational standard, AHJs, A&Es and building owners could not be 100% certain that ERICES performed as claimed by the manufacturer, or if they were code compliant. Ultimately, there was no guarantee systems would work as described in an emergency. Therefore, AHJs have historically been reluctant to enforce

ERCES regulations, and A&Es have been reluctant to specify BDAs in their building designs due to the uncertainty regarding ERICES operational performance.

UL 2524

UL 2524 for In-building 2-Way Emergency Radio Communication Enhancement systems was introduced as an Outline of Investigation (OOI) on December 21, 2017. An OOI is essentially a draft version of a product standard.

UL 2524 covers the products (e.g., repeater, transmitter, receiver, signal booster components, external filters, and battery charging components) used for ERICES/BDA systems installed in a location to improve wireless communication at that location. It does not cover passive RF components which includes antennas, splitters, couplers, coaxial cable and connectors.

UL 2524 addresses the following areas:

- Safety (risk of fire and risk of shock) requirements – construction and testing
- Compliance with specific performance requirements in accordance with the IFC-2018 and NFPA 1221-2016 (2019)
- Reliability performance requirements applicable for life safety systems – construction and testing
- Product marking and installation documentation

Refer to Appendix for summary of UL 2524 key technical requirements.

Product assessment is done by an OSHA accredited, independent third-party organization and successful investigation results in product listing for the purpose.

ERCES – KEY STAKEHOLDER CONCERNS AND SOLUTIONS

ERCES / BDA system is a Life Safety System similar to a fire alarm system. Improper design and installation of ERCES / BDA system is one of the key concerns of AHJs and other stakeholders. For example, an improperly designed and installed system in a single building can impact the reliability and operation of an entire public safety radio network in a jurisdiction.

Standardized design process from manufacturers and installers using industry standard indoor radio propagation prediction software which can model the system and coverage even before construction is required to address the concerns with improper design.

IFC Section 510 requires Manufacturer-Certified Training on BDA system design, installation, troubleshooting, and service—in addition to acquiring an FCC General Radio Operators License (GROL) for the designing and certifying BDA technicians. Manufacturers requiring and providing in-depth manufacturer training of their ERCES/BDA in addition to requiring FCC GROL License for all their installers in compliance with IFC codes are required to address the concerns with improper installation.

Standardized manufacturer training, standardized survey & test tools, standardized manufacturer provided design process, manufacturers and installers with in-depth knowledge of fire life safety codes combined with UL 2524 listed products independently tested against performance standards will enable ERCES / BDA Solution Providers to provide AHJs, A&Es and Building Owners the 100% assurance and confidence required to adapt these life safety systems and enable reliable in-building public safety radio coverage for emergency responders and save lives.

APPENDIX

Most current adopted Building Codes and Installation Standards require Emergency Responder Radio Signal strength and coverage to be measured in all new and some existing construction. This Reference Guide summarizes the key requirements in the national consensus model codes and installation standards that govern the installation, testing, and maintenance of in-building emergency responder radio enhancement systems. Always consult with your local fire jurisdiction to determine if other local specifications or ordinances are followed, which could be more stringent than those listed below.

CODE REQUIREMENTS**	NFPA*		NFPA 1221 - 2019	IFC		
	NFPA 72 - 2013	NFPA 1221 - 2016		IFC 510 - 2015	IFC 510 - 2018	IFC 510 - 2021
In-Building Solution Required	Section 24.5.2	Section 9.6	Section 9.6	Section 510.1	Section 510.1	Section 510.1
Pathway Survivability for Coaxial Cable Required	2 Hour for Riser Coaxial Cable Section 24.3.6.8.1	2-Hour for Riser Coaxial Cable Section 9.6.2.1.1	Backbone Cable Routed Through Enclosure Matching Bldgs. Fire Rating Section 9.6.2.3	Not Addressed in Section 510. Referenced in 24.3.6.8.1 of NFPA 72-2013	Yes, Section 510.4.2. Reference to NFPA 1221***	Yes, Section 510.4.2. Reference to NFPA 1221
Plenum Rated Coaxial Cable Required	Yes, Riser & Feeder Coaxial Cable Section 24.3.6.8.1.1	Yes, Riser & Feeder Coaxial Cable Section 9.6.2.1.1.1	Yes, Backbone & Antenna Distribution Cables Section 9.6.2.1	Not Addressed in Section 510. Referenced in 24.3.6.8.1.1 of NFPA 72-2013	Yes, Section 510.4.2. Reference to NFPA 1221	Yes, Section 510.4.2 Reference to NFPA 1221
Lightning Protection Required	Not addressed in Section 24.5.2	Yes, In accordance with NFPA 780 Section 9.6.3	Yes, Section 9.6.3 Installed per NFPA 780	Not Specifically Addressed in Section 510	Yes, Section 510.4.2 Per NFPA 780 as Referenced in NFPA 1221	Yes, Section 510.4.2 Per NFPA 1221 Section 9.6.3 Installed per NFPA 780
Isolation of Donor Antenna Required	Yes, 15 dB Section 24.5.2.3.3	Yes, 20 dB Section 9.6.9	Yes, 20 dB Above System Gain Section 9.6.9	Not Specifically Addressed in Section 510	Yes, 20 dB Section 510.4.2.4 (4)	Yes, 20 dB Section 510.4.2.4 (4)
Battery Backup Required	12 Hours Section 24.5.2.5.5.2	12 Hours Section 9.6.12.2	12 Hours Battery or Generator Section 9.6.12.2	24 Hours Section 510.4.2.3	12 Hours Section 510.4.2.3 or 2-Hours Battery with Emergency Generator	12 Hours Section 510.4.2.3 or 2- Hours Battery with Emergency Generator
Signal Strength and Area Coverage Required	-95 dBm Section 24.5.2.3 90% General Section 24.5.2.2.2 99% Critical Section 24.5.2.2.1	DAQ 3.0 Section 9.6.8 90% General Section 9.6.7.5 99% Critical Section 9.6.7.4	DAQ 3.0 Section 9.6.8 90% General Section 9.6.7.4 99% Critical Section 9.6.7.3	-95 dBm Section 510.4.1 95% General Section 510.4.1 99% Critical - Not Specifically Addressed in Section 510	DAQ 3.0 Section 510.4.1.1 95% General Section 510.4.1 99% Critical Section 510.4.2 Ref. to NFPA 1221	DAQ 3.0 Section 510.4.1.1 95% General Section 510.4.1 99% Critical Section 510.4.1
Monitoring by Fire Alarm Required	Yes, Section 24.5.2.6	Yes, Section 9.6.13	Yes, Section 9.6.13 & Chapter 10 of NFPA 72	Yes, Section 24.5.2.6 NFPA 72-2013	Yes, Section 510.4.2.5	Yes, Section 510.4.2.5
Cabinets for Equipment and Battery Backup Required	Yes, NEMA 4/NEMA 4X Section 24.5.2.5.2	Yes, NEMA 4/NEMA 4X Section 9.6.11.2	Yes, NEMA 4/4X & NEMA 3R for Batteries Section 9.6.11.2	Yes, NEMA 4 Section 510.4.2.4 (1)&(2)	Yes, NEMA 4/NEMA 3R Section 510.4.2.4 (1)&(2)	Yes, NEMA 4/NEMA 3R Section 510.4.2.4 (1)&(2)
Monitor Antenna Malfunction Required	Yes, Donor Antenna Section 24.5.2.6(2)(a)	Yes, Donor Antenna Section 9.6.13.1(2)(a)	Yes, Donor Antenna Section 9.6.13.2.1(5)	Yes, Section 24.5.2.6(2)(a) NFPA 72-2013	Yes, Donor Antenna Section 510.4.2.4(4)	Yes, Donor Antenna Section 510.4.2.4(4)
System Acceptance/Testing	Section 24.5.2.1.2 & 14.4.10	Section 9.6.4, 11.3.9 & 11.3.9.1	Section 9.6.4, 11.3.9 & 11.3.9.1	Section 510.5.3	Section 510.5.3	New Section 510.5.4 Annual Section 510.6.1
Listing of Equipment	Not specifically addressed	Not specifically addressed	Specific Listing Requirement TBD by the AHJ	Not Required by Section 510	Not Required by Section 510	Yes, Section 510.4 (UL2524)
Mounting of Donor Antenna	Not specifically addressed	Not specifically addressed	Not specifically addressed	Not specifically addressed	Not specifically addressed	Section 510.5.1

* **2021 NFPA 1 Section 11.10:** In all new and existing buildings, minimum radio signal strength for emergency services department communications shall be maintained at a level determined by the AHJ. Where required by the AHJ, in-building emergency responder communication enhancement systems shall comply with Section 9.6 of NFPA 1221 and 11.10.3.1 through 11.10.5 of 2021 NFPA 1; shall be listed and labeled in accordance with UL 2524, In-building 2-Way Emergency Radio Communication Enhancement Systems.

** Also See NFPA 1221 TIA 16-2

UL 2524 IN-BUILDING 2-WAY EMERGENCY RADIO COMMUNICATION ENHANCEMENT SYSTEMS – TECHNICAL REQUIREMENTS

Areas Addressed by UL 2524

- Safety (risk of fire and risk of shock) requirements
 - construction and testing
- Compliance with specific performance requirements in accordance with the IFC-2018 & NFPA 1221-2016 (2019)
- Reliability performance requirements applicable for life safety systems – construction and testing
- Product marking and installation documentation

Scope

- Cover products (e.g. repeater, transmitter, receiver, signal booster components, remote annunciators and operational consoles, power supply, and battery charging system components) used for in-building 2-way radio emergency radio communication enhancement systems installed in a location to improve wireless communication at that location.
- Does not cover passive RF components which are defined in UL 2524 as “any device that RF passes through that does not have an active electronic component that requires external power. This includes, antennas, splitters, couplers, coaxial cable and connectors. Passive components cannot amplify RF signals.”

For more information

<https://hwll.co/BDA>

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Performance - Operation:

- Normal AC power
- Visual & audible annunciation within 200 secs of fault for Loss of normal AC power, Battery charger failure, Loss of battery capacity (to 70% depletion), Donor antenna disconnection, Active RF emitting device malfunction, System component malfunction other than passive RF component which affects system performance,
- Visual & audible annunciation within 24 hrs. of fault for Donor antenna malfunction

Construction:

- NEMA Type 4 or 4X for all repeater, transmitter, receiver, signal booster components, external filters, and battery system components. Note: Rechargeable standby batteries are permitted to be contained in enclosures that comply with the requirements for a Type 3R.
- The system shall be sufficiently modular to have the capability to support revised and/or additional system frequencies within the same frequency band of the bi-directional amplifier supplied to maintain radio system coverage as it was originally intended without the need to replace the system.

Reliability:

- Variable Voltage Operation Test
- Variable Ambient Temperature and Humidity Tests
- Component Temperatures Test
- Charging Current Test
- Transient Testing