

Coexistence and Safety of Wireless Systems In Mining

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Definition of Wireless Coexistence – IEEE/ANSI¹

“Coexistence is the *ability* of one wireless system *to perform a task in a given shared environment where other systems* (in that environment) *have an ability to perform their tasks* and *might or might not be using the same set of rules*, usually in intentional receivers of RF EM energy.”



¹Source: IEEE/ANSI C63.27-2021 American National Standard for Evaluation of Wireless Coexistence

Collaborative Partnership (Interagency Agreement) NIOSH and NIST



Wireless Coexistence Case Study

Wireless Emergency Stops

- **Demonstration of wireless systems' inability to coexist**

- Wireless system with mining application
- Not complex
- High impact on safety



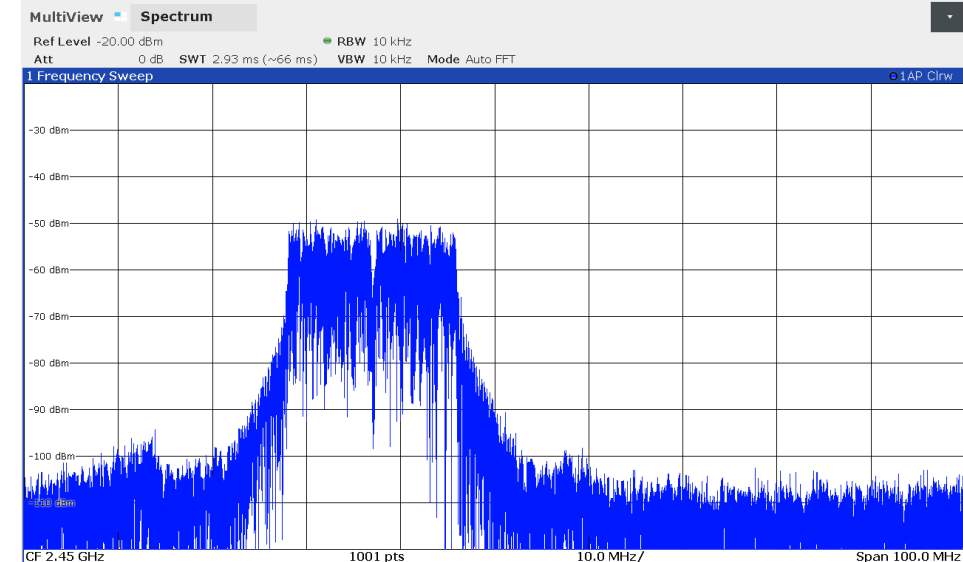
- **Two vendors**

- Vendor A – programmable to improve reliability (latency, hop sequency, etc.)
- Vendor B – no programmability
- Similar technologies
 - Frequency hopping spread spectrum (FHSS)
 - Enhances probability of coexistence
- Four pairs of e-stops
 - Two pairs from each vendor
 - Operating in 915 MHz and 2450 MHz unlicensed frequency bands



Wireless Coexistence Case Study – Initial Findings Susceptibilities

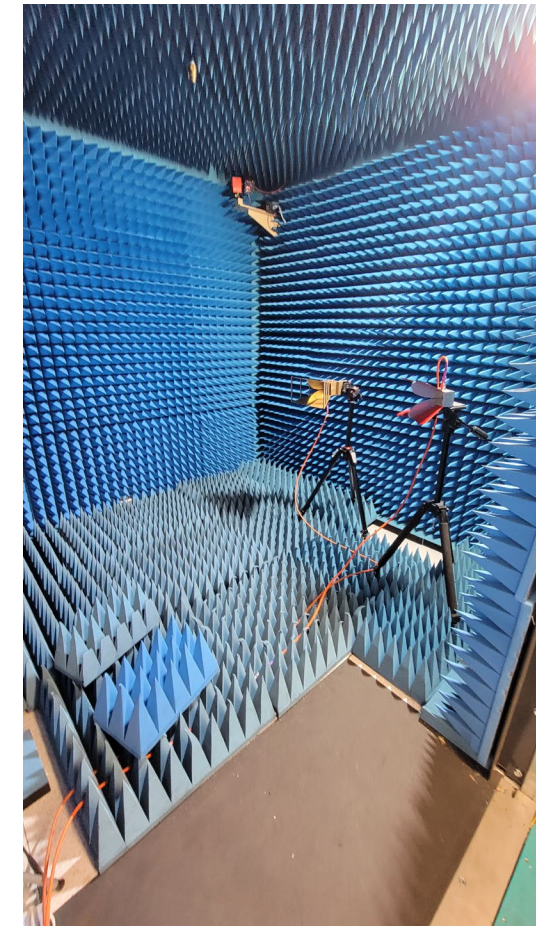
- **2450 MHz system – Vendor A**
 - Can be susceptible to high data rate signal operating in same frequency band
 - Unintended (nuisance) e-stop trips
- **915 MHz system – Vendor B**
 - Can be susceptible to handheld FHSS radio operating in same frequency band
 - Unintended (nuisance) e-stop trips
- **Continued testing**
 - In-band
 - Characterization of susceptibilities
 - 915 MHz system – Vendor A
 - 2450 MHz system – Vendor B
 - Out-of-band



Wireless Coexistence Case Study – Continued Testing

- **Test using different methodologies**

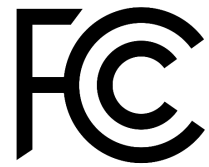
- NIOSH – Conducted testing
 - RF coaxial cables connect devices
 - Tightly controlled
 - Precise data
- NIST – Radiated testing
 - Over-the-air
 - Highly specialized testing environment
 - Real world data



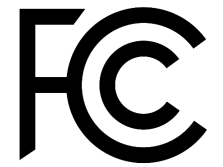
- **Publish case study in 2024**

- **Remember...**

- Simply a demonstration of systems' inability to coexist
- Intent of project is to provide guidance to test for coexistence
- Meanwhile, discuss potential issues with wireless equipment providers

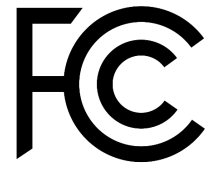


Applicability of 47 CFR Part 15 Regulations in Underground Mines

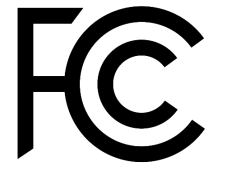


- Impact on probability of wireless coexistence in underground mines
- **47 CFR Part 15 – Radio Frequency Devices**
 - (R)egulations under which an *intentional*, *unintentional*, or *incidental radiator* may be operated *without* an individual license
- **Product scope and devices classification³**
 - “47 CFR Part 15 regulates electronic and electrical devices that can emit radiofrequency energy, and that might cause interference to devices that operate in the radio frequency range of 9 kHz to 3,000 GHz.”
- **47 CFR Part 15 Misconception**
 - Electronic and electrical devices operated underground are exempt from 47 CFR Part 15
 - Clarification – Federal Communications Commission (FCC) Office of Engineering and Technology (OET)

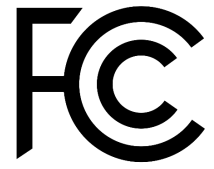




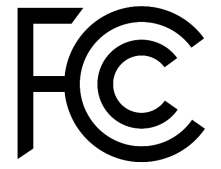
Applicability of 47 CFR Part 15 Regulations in Underground Mines



- **Three exceptions for tunnels, mines or other structures that provide attenuation by means of naturally surrounding earth and/or water**
 - 47 CFR Part 15.211 – Tunnel Radio Systems
 - FCC OET Bulletin No. 63 – Understanding the FCC regulations for low-power, non-licensed transmitters
 - Intentional radiators (*transmitters*) may operate on *any frequency*
 - *Transmitters* are not subject to any *radiation limits*
 - *Transmitters* are not required to be certified, only *verified*
- **Exceptions are *conditional***
 - E.g., Importation, emissions containment, device labeling, authorization, record keeping, etc.
- **No other exceptions noted in 47 CFR Part 15 or 47 CFR in general**



Applicability of 47 CFR Part 15 Regulations in Underground Mines



- **Considerations for tunnel radio systems**

- Per 47 CFR Part 15, OET 63, and 47 CFR Part 1.1310 – Radiofrequency radiation exposure limits
- Frequency and radiated emissions exceptions *apply only to transmitters* operated as part of a tunnel radio system
- Human exposure to radiofrequency (RF) fields *still apply*
- Operation of a tunnel radio system (intentional radiator and all connecting wires) *shall be contained* solely within a tunnel, mine or other structure...
- Operation of an intentional, unintentional, or incidental radiator is subject to the conditions that *no harmful interference is caused* and that *interference must be accepted*
- *Liability lies on operator* to ensure all 47 CFR regulations are followed
- Frequency and radiated emissions exceptions could impact the probability of wireless coexistence
 - Potential unknown radio frequency (wireless) signal environment in underground mines

- **Draft NIOSH paper on findings currently under review by FCC OET**

Literature Review

Standards/Guidelines

- AAMI TIR69:2017(R)2020 – Risk management of radio frequency wireless coexistence for medical devices and systems
- ANSI C63.27-2021 – American National Standard for Evaluation of Wireless Coexistence
- IEC 62657 Wireless Industrial networks Parts 1 to 4
 - Wireless communication networks – Part 1: Wireless communication requirements and spectrum considerations
 - Coexistence of wireless systems – Part 2: Coexistence management
 - Coexistence of wireless systems – Part 3: Formal description of the automated coexistence management and application guidance
 - Coexistence of wireless systems – Part 4: Coexistence management with central coordination of wireless applications

Wireless coexistence is a management process!

Questions?

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NIOSH Mining Program
www.cdc.gov/niosh/mining