



# Radio Frequency Systems (RFS) and SOLiD Participate in DAS Feasibility Study in Nuclear Facility: EPRI Evaluates Connectivity Alternatives to Wi-Fi

High Performance Radiating Cable Improves LTE-based Wireless Coverage



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## Summary

The implementation of wireless networks within nuclear power plants could allow for greater process efficiency and enhance safety by enabling mobile work management with online connectivity. Nuclear power plants, however, have had limited success installing conventional wireless networks (Wi-Fi) inside the power block due to radio frequency (RF) coverage issues and the extensive backhaul required, driving the need for alternate solutions.

The Electric Power Research Institute (EPRI) has been exploring one potential solution – a distributed antenna system (DAS) network – through a demonstration at a currently decommissioning nuclear plant. The demonstration included testing in the 700 MHz and 2.1 GHz LTE bands to evaluate RF propagation by a DAS using radiating cables.

## Introduction

Nuclear power plants are complex facilities with thousands of components. Maintenance at these sites can be challenging. Procedures are layered with multiple checks and balances – and redundancies – to meet safety and security requirements. Maintenance workers typically carry procedural guides in three-ring binders into the field, and paperwork must be completed and signed off during the process. This analog process is inefficient and does not capitalize on digital technology advances.

Mobile work management could provide numerous advantages, but it is difficult to outfit a nuclear plant with the necessary communications infrastructure to support reliable connectivity.

A successful wireless network would enable on-site consultation with



*Photo supplied by EPRI*

**Wireless network installation and operation are extremely challenging in nuclear plants due to forbidding conditions such as high temperatures, radiation, metallic pressure vessels and piping, multiple elevations, and thick concrete walls reinforced with rebar.**

procedural guidance, data entry by workers in the field using tablets, and communications with managers whose signatures are needed to approve and close out work packages. Online data would also enable remote, real-time monitoring of equipment operations and calibrations. The resultant digital workflow guidance could improve productivity and work quality while reducing costs.

Nuclear plants have had limited success with conventional Wi-Fi inside the power block. Installations are costly due to a large number of hot spots and the infrastructure needed to provide adequate coverage. The higher temperature and radiation environment also proves challenging for the wireless infrastructure, resulting in reliability concerns and frequent component replacements.



*Photo supplied by SOLiD*

**SOLiD provided a modular, hot-swappable DAS solution designed to withstand harsh environments. The SOLiD platform allows additional services to be added on a similar network, and modules can be readily replaced to ensure high network uptime.**



Signal performance is also challenging due to the presence of metallic pressure vessels and piping, multiple elevations with various components and equipment, and thick concrete walls reinforced with rebar.

## The Solution

To address these issues, EPRI investigated how other industries were transmitting data wirelessly, including the mining industry, underground transportation, military, and the shipping industry. These investigations identified a distributed antenna system built for the Boston subway system's complex underground tunnel network that exhibited favorable performance.

EPRI researchers believed such a DAS system could be adapted into a nuclear environment to provide more reliable coverage and capacity with less overall power and maintenance. While there has been some historical use of DAS systems for niche applications in the nuclear industry, a DAS network had not been systematically tested and evaluated inside a nuclear plant for coverage performance at the critical LTE RF frequencies. To prove the concept, EPRI

obtained approval to conduct field testing at a nuclear plant. The site is currently in the early stages of decommissioning, which enabled installation and testing, but imposed a tight schedule. EPRI worked with Radio Frequency Systems and SOLiD to design and test the system.

In developing the system, RFS supplied the cabling technology and support, and SOLiD provided the platform with the DAS equipment. SOLiD helped determine hardware requirements in a site walk of the station prior to field testing; they generated software models to design the system and estimate signal coverage. SOLiD ensured the testing conducted would not interfere with existing technologies essential to running the plant, such as the two-way radios used for communications between workers. The modeling exercise helped SOLiD estimate the power, length and type of cable needed. Those calculations were then tested against reality in the on-site pilot.

The SOLiD solution components are designed to withstand harsh environments that include high temperatures, water and dust. The



“ The advantage the RFS radiating cable provided was a uniform distribution of RF energy over the entire distance of the cable. ”

Suzanne Kasai  
Radio Frequency Systems

### About EPRI

The Electric Power Research Institute, Inc. (EPRI, [www.epri.com](http://www.epri.com)) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, affordability, health, safety and the environment. EPRI's members represent approximately 90 percent of the electricity generated and delivered in the United States, and international participation extends to more than 30 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, NC; Knoxville, Tenn.; and Lenox, Mass.

### About SOLiD

SOLiD (<http://www.solid.com>) helps people stay connected and safe in a rapidly-changing world through a portfolio of RF Amplifier, RF Radio and Optical Transport solutions. SOLiD enables indoor and outdoor cellular and public-safety communications at some of the world's best-known and most challenging venues including leading hospitals; professional, and college sports venues; government, university and Fortune 500 corporate buildings and campuses; international airports and metropolitan subways. For further information on SOLiD DAS, Small Cell Backhaul and C-RAN Fronthaul solutions, go to [www.solid.com](http://www.solid.com) or call 888-409-9997.

## Radio Frequency Systems (RFS) and SOLiD Participate in DAS Feasibility Study in Nuclear Facility: EPRI Evaluates Connectivity Alternatives to Wi-Fi



Photo supplied by EPRI

**RFS and SOLiD were able to coordinate and deploy products for field testing on a very tight schedule before the plant was fully decommissioned.**

platform is also modular and hot-swappable so that additional services such as wireless carriers and public safety systems, including plant security two-way radios and outside agency Land Mobile Radios (LMRs), can be quickly added on a single network; similarly, modules are easily replaceable to ensure high network uptime. Lastly, the SOLiD solution supports a flexible “mix-and-match” architecture whereby a common head-end can feed any combination of 1W, 5W and 20W amplifiers so the network can be optimally designed to enable coverage in numerous buildings in the

most efficient manner, including the containment building, offices and cafeteria.

Even the best signaling power is only as good as the cable that carries it. SOLiD worked with RFS to supply the optimal conduit for distributing a clear signal throughout the facility. The two companies have a proven track record working together on projects for various environments. This project needed a radiating cable solution without stop bands to accommodate a high-performance, future-proof design and

fewer shadow areas. RFS’ RADIAFLEX® “leaky feeder” coaxial cable solution made it possible to enable LTE technology for data management. Its patented higher-order mode suppression technique allows some cable variations to have no stop band from 698-2700 MHz. RADIAFLEX radiating cables act as distributed antennas, allowing operators to scale and tailor RF coverage in even the most challenging metro, rail and road tunnels and indoor environments.

EPRI wanted the system to achieve the same threshold standard as cellular companies, aiming for 95 decibel-milliwatts (dBm) or higher signal strength. Data transmissions were tested at 730 MHz and at 2130 MHz frequencies to compare performance differences at high and low frequencies. At 730 MHz, an acceptable signal was generated with ~80% coverage at the target level, through as many as three walls in the plant. On the 2130 MHz test, signal strength only reached about ~35% at the target level. This proved that penetration of signal strength at lower frequencies is significantly better than the higher frequencies, at an acceptable coverage level. Additionally, results of the study indicate that 100% coverage is possible given rerouting of cable and/or use of antennas to boost signal strength in the low coverage areas. The advantage the radiating cable provided was a uniform distribution of RF energy over the entire distance of the cable.

“ Successful DAS deployment in the power industry can be widely beneficial to utilities. The ability to have connectivity for mobile work management and continuous online monitoring of components could increase productivity at nuclear, coal, and natural gas facilities. ”

**Nick Camilli**  
Electric Power Research Institute, Inc.



## Conclusion

The tests demonstrated that a DAS utilizing high-performance radiating cable can substantially improve LTE-based wireless coverage within dense concrete and steel facilities when utilizing the low frequency bands. EPRI is producing a detailed technical report to share the results of this field test with its nuclear members so they can utilize the findings to expand their mobile workforce capabilities.

Future deployment of similar DAS systems could allow nuclear power plants to identify maintenance needs proactively through support of both data and voice applications on a single network platform. This would further enhance the reliability of these facilities, enabling identification of potential problems before they reach a failure point.

This information can also be used to assess this communications technology for use in other power plant environments, including coal and natural gas-fired facilities. This technology could open the doors to other applications, such as continuous online monitoring and mobile work management.



*Photo supplied by EPRI*

**A wireless network can support productivity gains and reduced costs for power and utility plants by enabling on-site consultation, data entry, and communications as well as remote equipment monitoring.**

## About RFS

Radio Frequency Systems (RFS) is a global designer and manufacturer of cable, antenna and tower systems, as well as active and passive RF conditioning modules, providing total-package solutions for outdoor and indoor wireless infrastructure. RFS serves OEMs, distributors, system integrators, operators and installers. Its customers currently include the four largest wireless carriers, the majority of tier 2 and 3 wireless carriers in North America and many of the top wireless and microwave OEMS worldwide.

For more than 70 years, RFS has provided its customers world-class service that today is backed by a global presence of nine manufacturing facilities worldwide and sales and technical support centers in 23 countries. RFS offers advanced engineering capabilities, superior field support, and expert technical assistance and training to provide scalable, flexible, future-proof and lightweight end-to-end solutions optimized across the entire RF chain. As an ISO-compliant organization, RFS solutions offer proven longevity, premium performance and unrivalled quality.

For more information visit [www.rfsworld.com](http://www.rfsworld.com), or follow us on Twitter: [www.twitter.com/RFSworld](https://www.twitter.com/RFSworld).

# RADIAFLEX: The optimal confined-coverage solution



## A unique broadband solution, ensuring the most future-proof confined coverage installation

### Wireless has made the move indoors – RADIAFLEX® is an important part of the solution

**RADIAFLEX®** is the world's leading, 'leaking feeder' cable solution. Designed to provide contoured RF indoor coverage, RFS RADIAFLEX® cable provides a scalable and practical means of tailoring RF coverage in even the most challenging of confined spaces.



### Future-proof confined coverage

**RADIAFLEX®** is a unique broadband solution, ensuring the most future-proof confined coverage installation.

**Broadband solution** – RADIAFLEX® supports all major services from 75 MHz to 6 GHz and is therefore optimally suited for multi-operator and multi-band applications.

**Flame and fire retardancy** – RADIAFLEX® cable is a low-smoke and halogen-free cabling solution that meets all major international flame- and fire-retardancy standards.

**Low loss** – Featuring low longitudinal and coupling losses, RADIAFLEX® is available with optional vario coupling loss configurations for longer installation runs.

**Comprehensive range** – With diameters spanning 1/2-inch to 1 5/8-inch, the RADIAFLEX® family is available in a broad selection of jacketing, coupling losses and bending radii.

### RADIAFLEX® is available in eight distinct series:

**ALF/RLF series** – Heavy-duty wideband radiating cable for multi-use applications in tunnels of all kinds

**RLK series** – Low coupling loss radiating cable for tunnel and building applications

**RLV (VARIO) series** – Variable or staged coupling loss radiating cable that provides for nearly constant system loss and low amplitude variation

**RAY series** – Optimized for high-frequency and digital in-building and tunnel applications, where low coupling loss is required

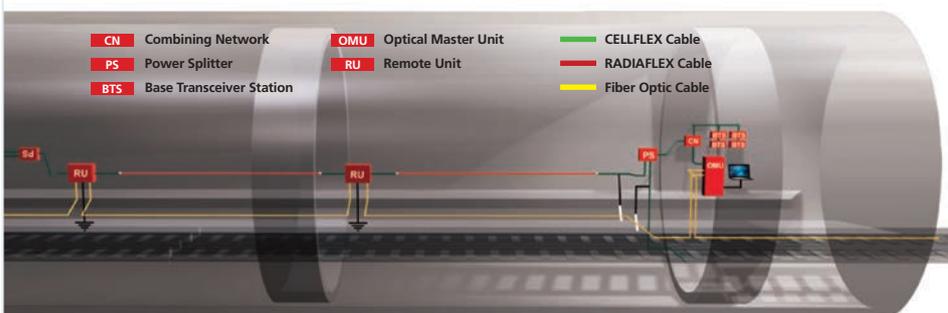
**RCF series** – Small bending radii, corrugated outer radiating cable for heavy-duty applications in buildings and underground mines

**RSF series** – Flexible, corrugated outer radiating cable solution for in-vehicle applications

**RE60 series** – Worldwide unique RE60 radiating waveguide which is the leading edge solution for in-tunnel wireless applications in the 5-6 GHz band

**RHCA series** – Plenum-rated air-dielectric radiating cable for use in buildings where the highest standard of flame- and fire-retardance

**Tailor-made Cables** – Cables engineered to meet new or special customer requirements



# Why RFS?



**Radio Frequency Systems (RFS) is a global designer and manufacturer of cable, antenna and tower systems, as well as active and passive RF conditioning modules, providing total-package solutions for outdoor and indoor wireless infrastructure. RFS serves OEMs, distributors, system integrators, operators and installers. Its customers currently include the four largest wireless carriers, the majority of tier 2 and 3 wireless carriers in North America and many of the top wireless and microwave OEMS worldwide.**

## Serious about services

Customers know they can count on RFS for comprehensive logistical capabilities, flawless execution and outstanding technical skills and support. The company's dedicated shipment coordinators, hotline staff and on-site engineers go well beyond mere technology, striving to offer tailored solutions to meet even the most complex site engineering and delivery challenges.

RFS' value-added services match the exact needs of business partners large and small.

## Ever-present quality guarantee

From design to manufacture, ISO 9001 and ISO 14001 certification standards encompass all aspects of RFS' business worldwide. Every product RFS ships has stood up to the most stringent technical, environmental and quality control tests, continuously meeting and surpassing the expectations of a long list of wireless carriers, transportation and utility operators, and broadcasters.

RFS backs every product bearing its name with a quality guarantee that is unrivaled in the market.

## A tradition of innovation

For over a century, RFS has been at the forefront of the wireless communication industry through its unwavering commitment to design and develop the world's most advanced technology in the field. Dedicated R&D teams, along with a privileged partnership with Bell Labs, are at the source of breakthroughs that are ensuring the mobility of an increasingly wireless world.

RFS is at the frontier of wireless technology innovation, sustaining the boldest ventures to enhance the way people communicate and live.

## A truly global company

With on-the-ground personnel in more than 20 countries and on every continent, RFS always delivers on its commitments, providing a comprehensive range of premium products, systems and services. Its clients benefit from all the advantages of a global supplier, while relying on dedicated support from RFS' local engineering, manufacturing and shipping teams.

RFS' products, systems and personnel can be found in every corner of the planet. As a global group, RFS is committed to upholding the most stringent environmental, health and safety standards, and seeks to integrate green initiatives in every aspect of its business.

**For more information about this project:**

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