Smart Fire Protection Systems Improve Overall Reliability and Decision Making

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Abstract

If you can check your home security system via an app on your smart phone from anywhere in the world, shouldn’t you be able to do the same for your facility’s fire pump and other fire protection systems? What if we could collect and visualize fire protection system information in such a way that we’re not only alerted that we need to take action, but also gain insight to the overall health of these safety-critical systems?

This presentation will include the evolution of smart fire pump systems and their related developments within codes and standards (NFPA and FM). Additionally, using case studies, we will highlight how cloud-based technology enables smart emergency response, helps identify potentially serious system performance issues earlier than conventional methods, ensures regulatory compliance and can even reduce water usage through real-time data tracking and analysis.

Potential examples to highlight:

- Peace of mind that the fire pump system will operate when needed
- Instead of calling the fire department, call the diesel fuel delivery truck
- Prevent fire systems from freezing
- Identify system leaks and water savings opportunities
- Incident Command – sound decision making based on live data

Lastly, the presenter will review potential barriers to using smart fire systems, discuss new and emerging developments for smart fire protection systems, and provide overall insight to the value that fire system data provides in improving loss prevention and emergency response.

Keywords
Smart Fire Pump, IOT, Remote Monitoring, ITM, Remote Testing, Proactive Monitoring
Introduction

Smart fire protection systems are a constantly evolving technology. With the advent of cloud-communicating alarm panels, smart sprinkler heads, wired flow switches, wireless valves, and more, fire protection has begun to slowly move toward the “smart” category. However, the fire pump system has been left behind as most of the information and data has historically been locked in the fire pump room requiring on-site personnel to review in person. Until recently.

New developments have brought the fire pump system online and into the cloud, providing extremely valuable system information and monitoring, pump performance data, Inspection, Testing and Maintenance (ITM) efficiencies and more.

**WHAT IS A SMART FIRE PROTECTION SYSTEM?**

*Enabled by a Smart Fire Pump System via hardware and cloud-based software*

![Diagram of smart fire protection system](image)

**Fig 1: What is a smart fire protection system?**

**What is a smart fire pump system?**

A smart fire pump system proactively shares fire pump system data through a gateway device, up to the cloud and is output in a consumable manner, such as via a User Interface or via notifications during state changes.

The main and jockey fire pump controllers are typically the center sources of data for a fire pump system – connected via Modbus TCP/IP or RTU RS485 to the gateway and up to the cloud, these systems can provide more than just the standard alarms on the panel. Over 70 points of data are captured and sent to the cloud, including things like battery voltage, system pressure, electric amps, number of jockey pump starts, pump run time and so much more.
Moving beyond the fire pump controllers, additional items, which typically must be visually inspected, can be viewed remotely by digitizing them. Adding a suction pressure transducer allows for remote monitoring suction pressures but also can give a sound estimate on remaining supply in a water storage tank. Similarly for diesel fuel level, the same can be accomplished on the fuel tank. Adding a digital output test loop flowmeter provides simplified annual flow testing, captured remotely in the cloud. Adding a suction side ultrasonic flowmeter enables monitoring of fire pump flow, whether during a live event or just a test. Utilizing suction pressure and system pressure, along with the fire pump test curve, Estimated Flow can be calculated. Pump room temperature sensors alert if the room temperature goes above or below your set threshold, creating an actionable notification to save your fire pump system and accessories.

Additional smart fire protection solutions, such as hydrant monitoring and riser gauge monitoring, can be tied in with the smart fire pump system, allowing the user to diagnose leaks in a fire loop, or to help simplify riser gauge inspection in a large building.

**Evolution of Smart Fire Pump Systems**

The beginnings of smart fire pump systems really started in earnest with the advent of the microprocessor-based fire pump controller, around 2003. These controllers paved the way for significant data collection and began the conversations of finding ways to extract that data via communication modules. Around 2005 several manufacturers began adding optional
communication modules that could be networked to a desktop PC. This PC could view the current alarm states of the controller but was not yet pulling further data beyond the alarms. By 2010 municipal and industrial markets are already making significant headway in remote monitoring pump systems, while the fire market segment lags behind. The Fire Protection Research Foundation commissioned a study titled *Fire Pump Field Data Collection and Analysis* where recommendations for a standardized data collection framework, remote testing, testing frequency and more were presented. (Pennel, et. al 2012). The report began to drive the idea that more visibility into the fire pump systems was needed as most data was housed on individual hard copies in remote fire pump rooms. The idea of bringing fire pumps to the cloud was born.

Private companies such as Grundfos (who already had other pump monitoring solutions) began to commission pilot projects to get data from the pump and fire pump controllers up to the cloud, with the goal of providing enriched data from fire pump testing. Around the same time an NFPA 20 task group kicked off developing the “Connectivity” chapter that can be found in Annex C of the Appendix. In 2014 Grundfos and Peerless Pump design a more robust pilot using Modbus connectivity and external sensors to go beyond the fire pump alarms and useful data in the cloud via a cellular connection.

By the end of 2020 fire pump remote monitoring is being discussed frequently. Versions of NFPA 20 and 25 are being updated to encompass remote testing based on remote monitoring as the COVID-19 Pandemic makes it nearly impossible for buildings to keep up with their weekly and monthly fire pump testing due to skeleton crews.
Case Studies

1) **Fire pump system monitoring ensures your system is in an always ready state when needed, going beyond standard code-mandated alarms**

Remote monitoring gives peace of mind that the fire pump is ready to operate when needed through proactive notifications and alerts along with easy to access system overviews.

- Ensuring pump is ready to operate in “auto”, and is not in “hand/off”
- If water and fuel supply levels are not sufficient, automatic notifications are sent
- Jockey pump is running and functional
- Weekly/monthly churn tests are being completed as required by local code and performance data automatically logged
- Global overview of “in compliance” and “out of compliance” fire pumps across your entire installation base
- Proactive vs Reactive – data is available at any time, not just when an alarm sounds

Fig 3: Smart fire pump system remote monitoring dashboard

Source: Peerless FireConnect User Interface
2) Identifying system leaks and providing the necessary data to justify CAPEX for system repairs

Monitoring a jockey pump over time gives a very strong indicator of overall fire protection system health

- The more a jockey pump runs, the more water you’re losing in a system
- Historically very difficult to identify jockey pump usage
- Run time and cycles give an indication of when it’s time to consider replacing a jockey pump
- Smart systems can alert when status changes, i.e. when a jockey pump runs more than it historically has on average, signifying a potential leak
- Daily water loss estimates utilized for CAPEX justifications

Fig 4: Daily jockey pump starts – jockey pump monitoring dashboard

Source: Peerless FireConnect User Interface
3) **Prevent Unattended fire pump systems from freezing**

Low pump room temperature alarms are typically displayed in a remote alarm panel as a *Common Trouble* or *System Trouble* alarm

- Fire pump controllers can provide an alarm to the fire alarm panels when pump room temperature goes below a user-defined threshold, however they are often displayed as *Common Trouble* or *System Trouble*
  - If these alerts go unaddressed equipment in pump rooms can freeze leading to easily $100K+ damages, plus an impaired fire pump
- Monitoring live temperature in a pump room along with early warning SMS notifications can save a system before it is too late
- Harsh, unpredictable winters, such as the surprise freeze February 2021 in Texas, leading to many pump rooms becoming impaired due to frozen systems
- Remote monitoring of the pump room saved a remote pump house at a West Virginia construction site during an unattended weekend period

Fig 5: Pump room temperature live and daily readings – temperature monitoring dashboard

*Source: Peerless FireConnect User Interface*
4) **Instead of calling the fire department, call the diesel fuel delivery truck**

Fire Pump Controllers have a wealth of data available, but usually only basic alarms display in the fire alarm panel

- **What does Common Trouble actually mean?**
  - Until we are physically in the Fire Pump room and looking at the controller we don’t know what’s driving the Common Trouble alarm
- **Fuel Tank Level Low** displays as a Common Trouble alarm, requiring someone to head on-site to diagnose the problem (problematic if you’re in bed at 2 in the morning)!
- Remote monitoring of diesel fuel level can reduce visits to only critical and urgent items. In this case it would be more important to call the diesel fuel delivery company right away as opposed to an incident response team.

![Fig 6: Low Fuel level alarm triggering common trouble alarm – diesel fire pump controller monitoring](source: Peerless FireConnect User Interface)
5) *Incident Command monitoring enables smarter decision making during a fire incident*

- An incident command dashboard in a one-stop tool providing critical fire pump performance information during a live event
- It can tell you that not only the pump is on, but that it’s flowing water, and even more importantly how much water it is flowing
  - If water flow is increasing over time, assume the fire is spreading
  - If water flow is steady over time (plateau on a time horizon chart), then the fire may very well be contained as no new sprinkler heads are opening
- Fire Alarm Control Panels may show that sprinkler(s) have activated, but do not indicate overall water flow
- Incident Command will display remaining water supply in a storage tank, including a “Time to Empty” based on refill rate and pump performance

Fig 7: Incident Command – remote monitoring dashboard

Source: Peerless FireConnect User Interface
**Codes and Standards Development**

NFPA 20 and 25 currently have sections related to recognizing new technologies, including those that enable automated inspection, testing and distance monitoring. NFPA 20 (2019 Edition) allows for automated churn testing of the fire pump via the fire pump controller’s scheduled weekly test function plus automatic shutdown feature, where allowed by the Authority Having Jurisdiction (AHJ). NFPA 20 (2022 Edition) will further define and allow automated inspection and testing so long as the remote equivalent is as effective as an in-person test and examination.

NFPA 25 (2020 Edition) also allows for remote inspection of equipment if it is as good as, or better than, in person viewing. Additionally, the current version says that on-site personnel must respond within 5 minutes during remote testing if an issue arises, effectively requiring someone to be on-site. It appears that the next iteration of NFPA 25 (2023 Edition) will change the “time to response” to 4 hours (from 5 minutes) truly opening the door for remote weekly/monthly pump testing.

COMING SOON: NFPA 915: Standard on Remote Inspections, along with a new standard on remote monitoring from Factory Mutual, with more information in the coming months.

**Potential Barriers to Installing Smart Fire Protection Systems**

Cost is the number one barrier to installing smart fire protection systems. Smart enabled devices can add up in cost quickly when you realize how many components are part of a fire protection system. Additionally, adding building infrastructure such as wiring, cabling and networking can become burdensome. Dealing with different smart components from different manufacturers leads to a disjointed experience, subjecting your site to many different monitoring fees.

Disjointed individual devices on individual platforms not talking to each other adds additional complexity and lessens the value proposition of an interconnected smart system. Thinking of a smart home system, the value is when all systems are available on one app, providing an overview of the whole system. Standardization in the fire protection market will be critical to achieve a similar experience.

Security Concerns are critical, especially regarding life safety equipment and protecting against the potential for malicious intent. Large corporations are often hesitant to bring external hardware into their networks, behind their firewalls. Utilizing Bluetooth, LORA and cellular-based systems helps alleviate several of these network concerns.
Using Data to Improve Loss Prevention and Emergency Response

Having an overall global picture of the fire protection systems throughout your buildings helps improve readiness and safety by understanding the risk level across all sites.

- Remote monitoring can inform, across your entire network of fire pumps, which are impaired (or in hand/off) versus those are ready to perform. Similarly critical data points such as diesel fuel level and water supply can be monitored across the network to ensure the pumps can be actively supplied if required.
- Leaks can be identified when they occur and not weeks later
- Proactive maintenance for repair and replacement parts based on performance data from weekly/monthly fire pump tests, along with daily jockey pump runs
- Code Compliance is ensured by making weekly/monthly fire pump run tests automatically available (and automatically logged)
- Incident Command gives real performance data during a live event to improve decision making
- Adding in other smart fire tech, such as iHydrant and RiserConnect to view fire loop and riser data
- Future state uses Artificial Intelligence to analyze equipment performance and to auto-order spare parts, make system recommendations and more. Moving further into proactive versus reactive.

New and Emerging Developments in Smart Fire Protection

Smart Fire Protection is gaining traction in the industry with new developments on the horizon. Groups such as Smart Firefighting Community, which is a coalition of academia, fire departments/chiefs, and manufacturers, have the goal of raising fire protection further into the IOT enabled space. This combination of “users, makers and thinkers” enables robust, thought-provoking, and sometimes downright radical ideas to help drive the industry forward.

Remote Testing will become more popular as the Codes & Standards are updated accordingly to enable widespread use. The hardware and monitoring software already exists so the biggest challenge is to drive industry acceptance of this practice. Industry and end-user buy-in will help push this capability forward.

Systems will eventually be able to order their own parts, or at least alert when its time based on run-cycles and overall condition changes, such as performance degradation over time of a fire pump. Similarly for system leaks – helping to identify when it occurred and eventually where the leak is in the system.

Eventually, Incident Command will tie-in with the fire department, providing live pump and system performance data to the truck before it even arrives on-site so that the first responders arrive fully informed.
Notes:

The mention of “alarms” in relation to communication between fire pump controllers and cellular gateways / User Interfaces / notifications is more closely resembled to a Supervisory Condition, compared to a Trouble or Alarm Condition. For ease of explanation “alarms” are used generally to reference an “alert” and should not be construed as an Alarm Condition as defined in NFPA 72.

Reference:


