FIRE PUMPS:

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TIME TO CHANGE NFPA 25 WEEKLY CHURN TESTING

APPA, through its Code Advocacy Task Force (CATF), is active with code organizations such as the National Fire Protection Association (NFPA). This article reviews some of the recent work on NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, by the CATF and some members of the NFPA 25 Technical Committee.

The current (2008) NFPA 25 requires weekly tests of fire pump assemblies to be conducted without flowing water, sometimes referred to as a "churn test." During the current review cycle of NFPA 25 we submitted several proposals to decrease the "no-flow" test frequency for all fire pumps from weekly to monthly, and one proposal to decrease the churn test frequency for electric motor driven fire pumps. As of this writing, the latter proposal has made it through several processes to final balloting, although we remain unsure of the final outcome of the proceedings.

This CATF work continued an effort begun by Mike Anthony, a senior electrical engineer at the University of Michigan, whose goal is reducing testing cost without compromising safety. We believe that weekly testing is an undue burden while providing no appreciable benefit. Indeed, weekly testing might be so frequent as to cause a decrease in system reliability. It should be abandoned for the reasons discussed below.

RELIABILITY OF ENGINE DRIVEN PUMPS

Reliability testing of components is commonly done by suppliers, whether for electronic devices for space craft or for mechanical parts on construction machinery. Predictions concerning the reliability of an engine driven fire pump, or any assembly, are related to the reliability of the individual components when new. The reliability of the system is no greater than the reliability of the least reliable critical component. In addition, the reliability is related to the product of the individual component reliabilities, expressed as a fraction of one.

For example, a machine comprising two parts, each with a 90 percent chance of surviving for the life of the product, will have an 81 percent chance of performing without failure. The probability of failure is 19 percent. With an engine driven fire pump that is already in service, many other factors must be considered. The number of starts, the hours of operation, the load on the engine during operation, the speed of the engine, the characteristics of the environment where the system is installed, the corrosive and erosive effects of the water, the age and condition of the battery, the knowledge and skill of the maintenance personnel, and the quality of the fire pump's controls all affect reliability.

PREDICTIONS CONCERNING THE RELIABILITY OF AN ENGINE DRIVEN FIRE PUMP, OR ANY ASSEMBLY, ARE RELATED TO THE RELIABILITY OF THE INDIVIDUAL COMPONENTS WHEN NEW.

Frequent testing has both beneficial and negative consequences. A key benefit is the opportunity to find equipment that is malfunctioning on a schedule that corresponds to the testing, at least weekly in the case of NFPA 25. Another advantage is that the engine cylinder walls and bearings are likely to have thicker coatings of lubricant with weekly operation. However, this latter benefit probably is a stronger factor in the life of the equipment rather than the likelihood of the pump starting when needed.

There are some problems with frequent testing, too. The probability of failure with many components tends to increase with the hours of use and the number of starts. Examples are fatigue failures of cyclically loaded metal parts, wear failure of moving parts, catastrophic failure of bearings, and arcing failures of magnetic solenoids. We have searched for reliability data for fire pumps without success. It is likely that reliability data for fire pumps are proprietary, owned by the manufacturers, and not available to the public.

In the absence of concrete data, you might ask why the Code Advocacy Task Force and some Technical Committee members have advocated reduced testing frequencies. Some of the reasons are:

- We found no data supporting the testing intervals established in NFPA 25 when it was first issued in 1992. Our evidence today indicates that the original testing protocols were merely based on the judgment of the Technical Committee. Yet, changing the current weekly test frequency to monthly appears to require new data to justify the change based on published comments of the current Technical Committee.
- The Technical Committee has favored short testing intervals. Possible reasons are a reluctance to change long established requirements and the fact that many committee members in the fire protection and insurance industries are not directly impacted by the cost of frequent testing.
- NFPA standards are by definition minimum standards. As currently written, the weekly test requirement appears to deviate from this rule and represents a near maximum requirement. Even if the test frequency is increased to monthly, property owners, AHJs (Authorities Having Jurisdiction), and insurers will continue to have the option of increasing requirements, if warranted.
- In communities that have adopted NFPA 25, owners wishing to reduce the testing frequency required by NFPA 25 may not often do so, even after following a documented formal alternative pump testing program. AHJs don't generally permit deviations to existing standards, perhaps to avoid the potential liability.
- According to a casing relief manufacturer, poorly set casing relief valves can cause irreparable damage to gaskets and o-rings such that excessive pump testing can actually be more detrimental to a pump than less frequent testing.
- Many owners have redundant fire pumps, each capable of sustaining the design load. Redundant system design is an accepted engineering solution for critical systems. The capital expense of redundant systems improves reliability, and can prevent the replacement of functioning components during the life of the equipment, lowering preventive maintenance costs. An example can illustrate the design benefit. If the probability of a fire pump failing is 2 percent, two redundant pumps each have a 98 percent chance of starting and operating. The chance that neither starts is the product of the two failure rates, (0.02) (0.02) or 0.04 percent. There is a 99.96 percent chance that at least one of the engines will start. This example uses a low reliability for the individual pumps to illustrate the remarkable benefit of redundant design. NFPA 25 should at least consider the effect of redundancy on test frequencies. It does not.
- The U.S. Department of Defense (since 2001) permits monthly testing of diesel engine and electric motor fire pumps; Australia (since 2005) permits electric motor fire pumps to be tested monthly.

DIFFERENCES IN RELIABILITY BETWEEN ENGINE AND MOTOR DRIVEN FIRE PUMPS

The reliability differences between electric driven and engine driven pumps has not been acknowledged in NFPA 25. A weekly churn test is required for both, despite the greater complexity of the engine driven systems. Electric motor driven pumps can fail due to bearing failures, winding defects, and starter failures. However, most engineers and operators understand the inherent greater reliability of an electric motor driven system.

NON-COMPLIANCE WITH STANDARDS AND REGULATIONS THAT OWNERS AND LOCAL ENFORCEMENT PERSONNEL DEEM UNREASONABLE OR ONEROUS

Large universities, research facilities, and government facilities can have dozens or hundreds of fire pumps. We have found, through informal polling of several colleges and universities, that none were in compliance with NFPA 25. This suggests that fire marshals and others who enforce the NFPA 25 may consider the testing excessive, or have decided that their efforts are better expended on issues with greater nexus between their efforts and the safety of building occupants and the public generally.

Noncompliance with a national standard fosters a general lack of respect for standards and regulations affecting building operators, with managers and owners deciding what should and should not be done. Noncompliance creates an effective tool for plaintiffs' counsel to argue negligence in the event of loss, despite the fact that the standard was not established scientifically or based on actual field data.

SUMMARY

The NFPA provides an excellent service by producing consensus standards. The codes it publishes represent the collection of many industry experts using a fundamentally democratic process replete with due process protections including public comment to arrive at codes that promote safety. The codes also provide national uniformity and quality in fire standards.

In addition, the codes are instructive to the reader and user. This is a great help to young engineers who are called upon to design systems for which they may understand the fundamental principals of operation but are completely naïve about the current standards in the industry for the solution to their design problem. This educational function of the codes, in helping train the next generation of designers and mechanics, is an important ancillary benefit of NFPA's work.

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