Inspection, Testing, and Maintenance (ITM) Data Exchange Model

Victoria Hutchison
Fire Protection Research Foundation, Quincy MA, USA

Bart van Leeuwen
Netage B.V., Linschoten, The Netherlands

Abstract

In recent years, there has been interest in using ITM activity data to inform decisions related to system reliability, risk acceptability and ITM frequencies. This data is being captured in thousands of different formats, through hundreds of different approaches, and by thousands of different groups but one key thing has been lacking to date – standardization. This void has restricted the ability to determine sound performance-based inspection frequencies and prevents stakeholders from exchanging and analyzing data that can influence safety and efficiencies. To address this need, the Research Foundation and Netage B.V. have taken a novel approach to standardizing ITM data using concepts of linked data and graph modelling. Instead of requiring everyone to comply with a single data model or format, the developed model enables stakeholder's data to be accepted "as is" and the output is standardized to enable diverse data to be shared, consolidated, and broadly understood for evidence-based decision making. This paper presents a proof-of-concept comprehensive, scalable, and extensible ITM data exchange model that can facilitate data sharing from diverse data sources to support reliability analyses and predictive analytics. Guided by the concepts of fair data principles, this case study shows how graph-modelling and other cutting-edge techniques are being leveraged to collect and consolidate data to enable further analysis, reporting and sharing of ITM data for the needs of various stakeholder groups.

Keywords: inspection, testing, maintenance, fire protection systems, data model, vocabulary, ontology, class, properties

Introduction

Many NFPA codes and standards establish minimum frequencies for periodic inspection, testing, and maintenance (ITM) for fire protection systems, including for example, NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, and

NFPA 72, National Fire Alarm and Signaling Code. These frequencies are often historical requirements that are often not based on empirical ITM data or observed deficiencies. In recent years there has been growing interest in risk/occupancy-based and performance-based ITM frequencies; however, to be effective there is a need for a more data-based approach to ITM frequencies. While the use of digital ITM data collection software are evolving, there remains great variation in the format that ITM data is collected, stored, and analyzed. Due to the inconsistency in ITM data collection methodologies, it is difficult to implement data-informed decision-making regarding system reliability, ITM frequencies, and risk acceptability.

The Fire Protection Research Foundation (FPRF) has previously lead projects on ITM Data Collection and Analytics that have concluded that additional work needs to be done in order to evaluate and correlate fire protection equipment reliability with code requirements. Some of the identified gaps were the lack of standardization of ITM data format, collection, and submission processes, as well as unresolved issues regarding data access, ownership, security parameters, and others.

Data from the Inspection, Testing, and Maintenance of Fire Protection Systems have value to a large variety of stakeholder groups including Contractors (i.e. inspectors), Building Owners/Facility Managers, Authorities Having Jurisdiction, Equipment Manufacturers, Insurance companies, NFPA Codes and Standards Technical Committees, Consultants, and others. Despite the widespread appreciation of the importance of ITM data, there is currently no universally adopted data model, or standardized data format, that all stakeholders utilize to share and compare data. This lack of standardization not only limits the ability to determine sound performance-based inspection frequencies, but it also limits the abilities of all stakeholder groups to exchange and analyze data to inform decisions for their own local needs.

To address this need, the ITM data exchange project aimed to develop and pilot test a comprehensive, scalable, and extensible data exchange model to facilitate ITM data sharing from diverse ITM data sources.

Data Model

A data model is an abstract domain model which describes how data elements are connected and which properties these elements possess. Data models help organizations connect and collaborate because there is a consensus about the structure of the data.

It is important to understand that a data model reflects a common understanding of how elements and properties within a certain domain are related, the model follows the domain, not the other way around. The data model facilitates the exchange of information between SME's in a specific domain, based on a consensus within that domain. It is up to the users, the SME's, of the data model to maintain and update the

model to reflect changes and new insights within their domain. A good data model describes the exact constraints the elements and properties should meet, e.g. pressure is recorded in PSI. By following these constraints, it is possible to exchange information without loss of meaning or misunderstanding.

Data Modeling Methodology

By acknowledging that the variations in the data may exist for good historical reasons or to differentiate between various vendors or companies, this modeling approach can change the narrative from, 'everyone should comply to a single model' to 'explain the properties of your model for others to use'. When the various formats have been described, the data can be automatically processed and injected into a central repository.

NFPA 25, *Standard for the Inspection, Testing and Maintenance of Water Based Fire Protection Systems,* NFPA 72, *Fire Alarm and Signaling Code* and other relevant standards define the core requirements for ITM reporting, while standards such as NFPA 950, *Standard for Data Development and Exchange* and NFPA 951, *Guide to Building and Utilizing Digital Information* help define data and file formats. Therefore, these standards can inform the development of a core data model from which all the end-user supplied models are variations.

To allow easy adaptations of the variations supplied by vendors and stakeholders, a methodology known as a RDF Graph Data Model was applied to the data, which is agile by design and allows extension without interfering with previously submitted data. This process informs how to model the data, in addition to providing validation, reasoning, taxonomies, transformation, and transport of the data.

Results

The preliminary data model developed for this project essentially organizes ITM data elements, standardizes how they relate to one another and defines the items or equipment being described. Although much of the sample data had great variability, disparate data like this can be easily combined from different sources and exported in a standardized way, since this methodology is agile by design. The data model can be changed or expanded incrementally, new data types can be added or deleted, without affecting the rest of the model or previously submitted data. Because the properties of the model are defined upfront and the data elements are referenced by unique identifiers, variations in facilities ITM data can be adapted to a standardized structure.

Summary

This project showcases how the developed ITM data models can enable data standardization and facilitate data sharing across the fire protection industry. To be able to make informed decisions around fire protection

system reliability and risk acceptability, the fire protection community needs to have a role in this process to enable further data collection and analytic capabilities. The results of this project are available at www.nfpa.org/foundation.

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