Material Integrity Solutions, Inc.

PROJECT BULLETIN

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High-Energy Piping Integrity Program

BACKGROUND

In the increasingly competitive utility industry, accurate and timely information about equipment condition is vital for optimizing inspection, repair, and replacement schedules. High-energy piping (HEP) systems are some of the most critical and costly systems to maintain due to their susceptibility to catastrophic failures (*Fig. 1*) and high cost of inspections and repairs. Most utilities have developed HEP inspection programs that use calculations for estimating safe inspection intervals. However, such calculations generally consider design conditions and are usually conservative. Due to the economic importance of timely inspection and the need to prevent failures, MIS developed the High-Energy Piping Integrity Program (HEPIP) .

Figure 1: A major HEP failure

DISCUSSION

The accumulation of creep and fatigue damage can lead to initiation and growth of cracks in a plant's HEP systems. The rate of creep and fatigue damage depends on the component's actual temperature and stress time histories and its material properties. HEPIP considers these and other variables that are needed for accurate and useful estimation of damage and crack growth of the component.

HEPIP was originally based on a PG&E/EPRI computer program (CFPro) whose development was lead by MIS staff. HEPIP comprises four modules—a data collection module (DCM), a calculation module (CM), a user interface module (UI), and a decision analysis module (DAM). The DCM (located either on-site or across a network) interfaces with plant instruments and collects pressure, temperature, and flow data for locations of interest. These data are used by the CM to calculate stress and temperature time histories at selected locations and estimate creep and fatigue damage and crack growth. The CM performs deterministic and probabilistic (*Fig. 2*) analyses and estimates the remaining life probabilistically. Creep and fatigue damage and crack growth accumulation are continuously monitored, updated, and stored in data files for review. The UI module accesses the files and allows the user to review on-line results such as damage accumulation and crack sizes. The UI can also simulate different operating conditions off-line and includes an automatic reporting system to identify damaging events and critical locations easily and rapidly *(Fig. 3)*. The DAM uses probabilistic remaining life results and a decision analysis model to determine the most economical time for inspection of the monitored HEP components.

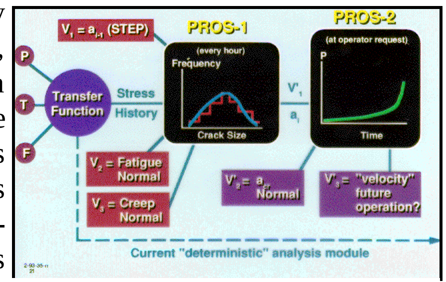

Figure 2: HEPIP's probabilistic module

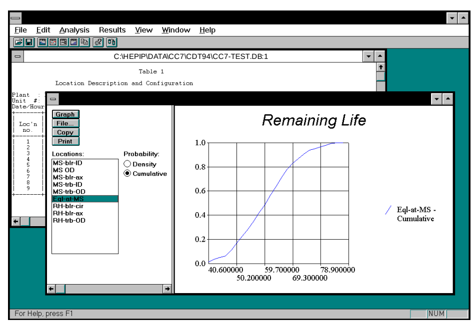

Figure 3. HEPIP's user interface

CONCLUSION

Development and testing of HEPIP has shown that this system is operationally feasible and can extend estimated reinspection intervals, thereby realizing major savings. Key features of HEPIP include its use of existing plant instrumentation, its large-scale data reduction capability, and its simulation module, which permits engineers to assess various operational modes off-line. Overall, HEPIP is a useful tool for assessing HEP system and for making the optimum maintenance decision considering economics