

Comparison of Tritium Component Failure Rate Data

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Experimental fusion facilities have used, and others will use, tritium fuel. Because tritium is a radioactive fuel with unusual characteristics, such as its ability to become water, combustibility, and its ability to permeate many materials, there are safety issues with its storage and use. A number of experimental tritium laboratories have been built and operated to answer fusion-specific questions about tritium, including storage, isotope separation, and handling. Several of these tritium laboratories, including the Tritium Systems Test Assembly (TSTA) in the US, the Tritium Process Laboratory (TPL) in Japan, and the Tritium Laboratory Karlsruhe (TLK) in Germany, have recorded the component failures that have occurred. With these data sets and the operations information from each facility, component failure rates have been calculated and published. These failure rates are used in fusion safety assessment to model similar tritium systems and estimate the rate of adverse events, such as leaks. These data can also be used for estimating tritium system availability; that is, to model detrimental system events such as failure to provide tritium when required.

TSTA failure rates were first published in the late 1980's and early 1990's. The TSTA failure event data reports through the mid-1990's have also been collected and used to update the initial component failure rates. The failure event reporting was discontinued in the mid 1990's as the TSTA emphasis shifted after exhibiting over a decade of safe operations and the facility experienced reductions of funding. The TSTA was closed and decommissioned in the early 2000's, so this is the final update of the TSTA component failure rates. The other tritium facilities are continuing operation and will be able to periodically update their failure rate data values.

For this paper, the updated TSTA data are compared to the published failure rate data from the TPL, the TLK, and the Joint European Torus Active Gas Handling System. This comparison is on a limited set of components, but there are a variety of data sets to compare. The most reasonable failure rate values are recommended for use on next generation tritium handling system components, such as those in the tritium plant systems for the International Thermonuclear Experimental Reactor (ITER) and the tritium fuel systems of inertial fusion facilities. These data and the comparison results are also shared with the International Energy Agency cooperative task on fusion component failure rate data.

The data sets compared here generally show favorable agreement between values. Consensus failure rate values are recommended in this paper for some types of components. The variety of data available for comparison shows that these data are important for safety since several countries have devoted ongoing effort to collect the data and analyze it, and the variety of data also allows consensus, or average, values to be reached for some components. These consensus values can be used for safety assessment of next-generation fusion experiments.

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