

Reliability, Availability, Maintainability, Inspectability (RAMI)

1-page summary

Availability is a primary metric for an attractive power plant, directly affecting the cost of electricity. Reliability (represented here by the mean time between failures, MTBF) and maintainability (represented here by the mean time to repair, MTTR) are two of the most important quantities that influence the availability of a fusion device. The availability resulting solely from random failures is:

$$A = MTBF/(MTBF+MTTR)$$

A goal availability of ~75% typically is assumed for power plant studies, but confidence in our ability to achieve this is low due to many uncertainties associated with a technology still in its infancy. Nevertheless, the importance of availability to an attractive fusion energy source strongly suggests that it should be raised to a higher level of importance in next step options, reactor studies, and emerging concepts development.

Availability improvement depends on both physics *and* technology. For the technology program, the most important near-term need is to vigorously pursue innovation, taking advantage of advances both inside and outside the fusion program. For the physics and confinement side of our program, we need to develop RAMI metrics and apply them as a discriminator in confinement concept development.

Reliability and maintainability programs are well established in many existing industries, such as the automotive, chemical processing, fission power, military equipment, and aerospace industries. Their long history of successes and failures provides a wealth of information for us to draw upon. Expanded efforts to “mine” and utilize existing databases should be supported, in addition to more formal compilation of experience on existing fusion research devices.

The current program of fusion-specific work on “maintenance technologies” in the US is modest or non-existent; much larger program exist in Europe and Japan. Due to the importance of this topic, advanced maintenance techniques (such as “reliability-centered maintenance”) should be applied to

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operating machines and a few common purpose remote maintenance tools and techniques (*e.g.*, remote metrology, remote welding/cutting, advanced motion control) should be identified and developed. Remote inspection, handling and/or repair of selected internal components and/or diagnostics can be demonstrated on existing machines. With such a limited number of sources of fusion-specific data on reliability and maintainability, every opportunity needs to be fully exploited.