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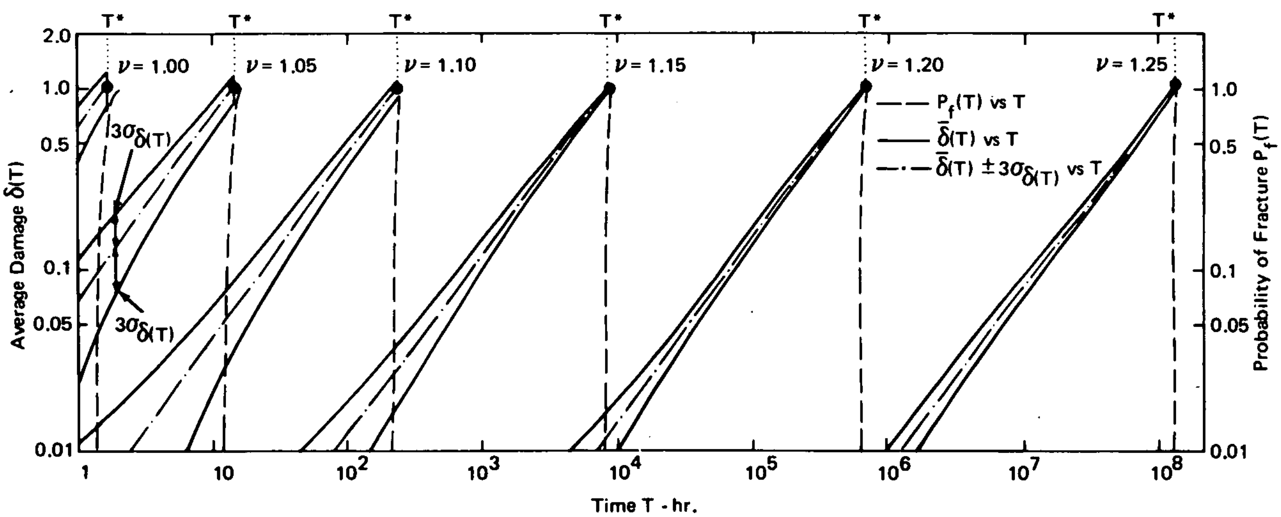
# NASA TECH BRIEF
## *NASA Pasadena Office*



## Probability of Stress-Corrosion Fracture Under Random Loading




Probability of Structural Fracture as a Function of Time and Average Damage as a Function of Time

Pressure vessels (such as rocket-propellant storage tanks, fuel and water tanks, undersea pressure vessels, and submerged structures) occasionally fail at relatively-low stress levels, after being subjected to sustained loading much below the critical level. Such failures often result from stress-corrosion crack propagation.

A mathematical method has been developed for evaluating the probability of stress-corrosion fracture under random loadings. The formulation is based on a cumulative-damage hypothesis and experimentally-determined stress-corrosion characteristics. Under both stationary and nonstationary random loadings, the mean value and the variance of the cumulative damage are obtained. The probability of stress-corrosion fracture is then evaluated, using the principle of maximum entropy. It is found that, under stationary random loadings, the standard deviation of the cumulative damage increases in proportion to the square root of time, while the coefficient of variation (dispersion) decreases in inverse proportion to the square root of time.

The solutions are based on a linear structure, which is related to the excitation g(t) as follows:

$$\ddot{Y}(t)+2\zeta\omega_0 \dot{Y}(t)+\omega_0^2 Y(t) = g(t)$$

where $\zeta$ and $\omega_0$ are, respectively, the damping coefficient and the natural frequency of the structure, and Y(t) is the displacement response, assuming that the cumulative damage is essentially due to stress corrosion.

The probability of fracture then can be computed as a function of time, T, as shown in the figure. It is observed that T*, the average time to failure, increases rapidly with respect to the increasing safety factor, $\nu$. Additional information presented in the figure is the average damage, $\bar{\delta}(T)$, as a function of time, and $\bar{\delta}(T) \pm 3\sigma_{\delta(T)}$, as a function of time, where $\sigma_{\delta(T)}$ is the standard deviation.

(continued overleaf)

**Note:**

Requests for further information may be directed to:

Technology Utilization Officer
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Reference: TSP73-10453

**Patent status:**

NASA has decided not to apply for a patent.

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