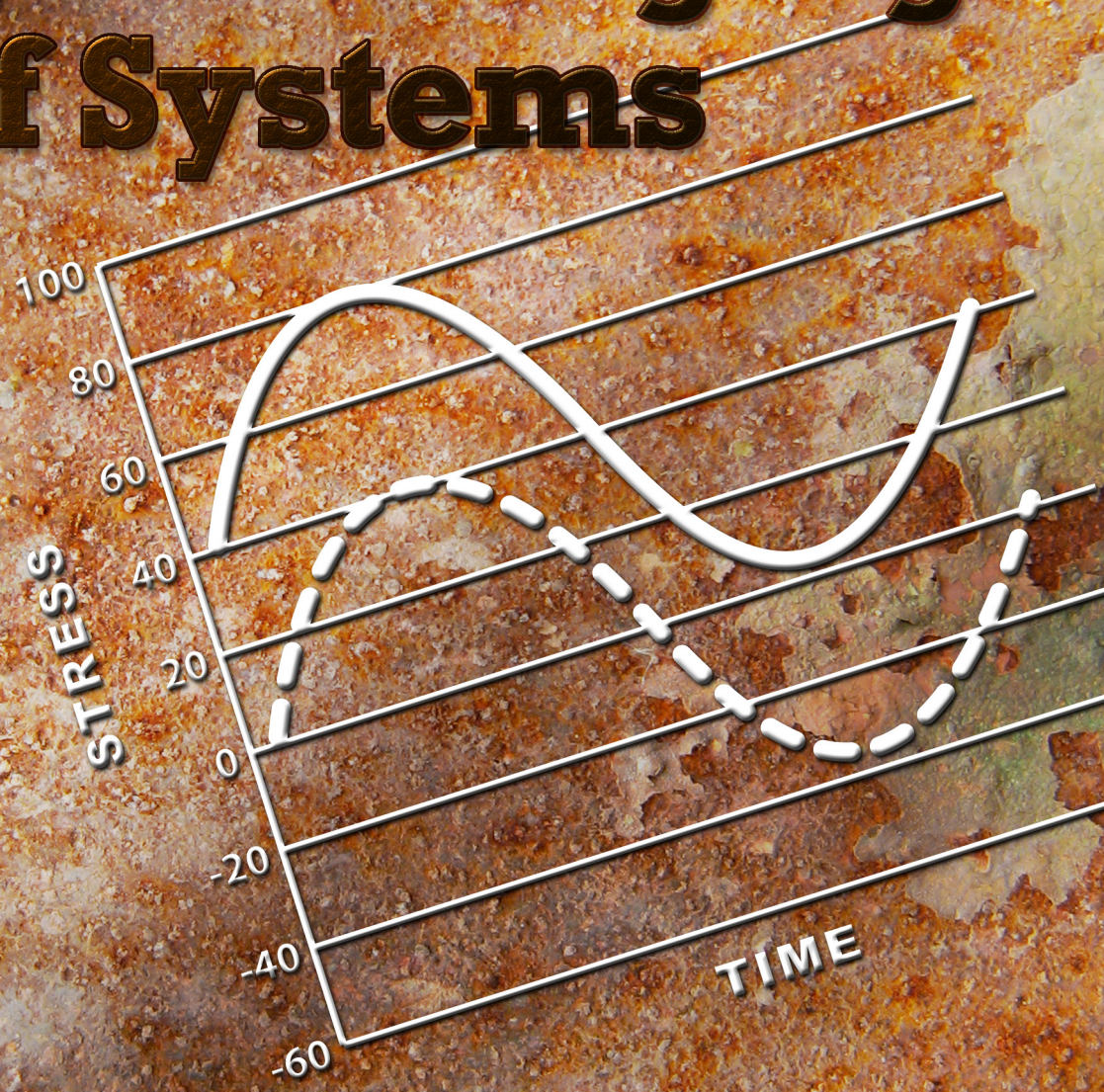
Techniques to Evaluate Long-Term Aging of Systems



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The RIAC was the DoD Information Analysis Center (IAC) Center of Excellence for the reliability, maintainability, quality, supportability and interoperability (RMQSI) technical disciplines from 2005-2014. To broaden the former Center's User Community, Quanterion offers this publication to facilitate the design & development of more robust products and systems.

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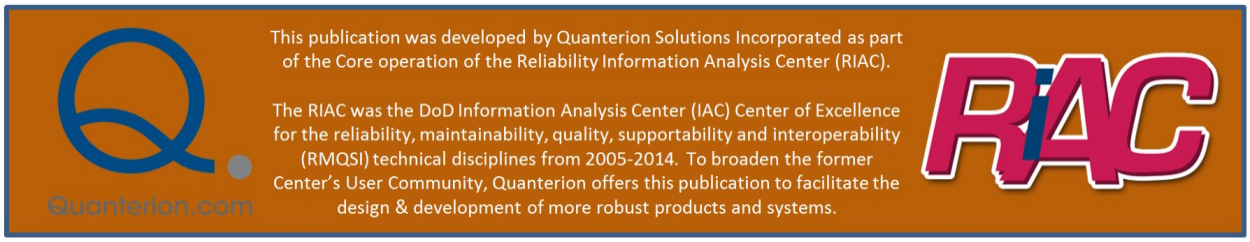

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1. INTRODUCTION

The Reliability Information Analysis Center mission has continued to evolve over the years (including its years as the Reliability Analysis Center (RAC)) with the greater recognition that reliability, maintainability, and quality are critical military system and commercial product attributes. Coincident with the evolution has been the recognition that these attributes have much more encompassing impacts than their specific attained metrics. For example, where at one time the measure of reliability called mean-time-between-failure (MTBF) was of interest in itself, now management and system planners have expanded their interest because of how that MTBF impacts such issues as sustainability and total ownership costs. Part of the refocusing of reliability-related needs is the concern over long-term aging effects on systems in operation and in storage brought about by systems having to last longer.

The objective of this report is to highlight the impact of long-term aging effects on parts, assemblies and equipments by investigating characteristics of aging as they impact specific material classes.

The report is broken down into the following sections:

- Section 2 addresses general environmental design considerations for aging during in-service conditions
- Section 3 discusses aging factors as they relate to ferrous and non-ferrous metals
- Section 4 provides an overview of aging as it applies to polymer materials
- Section 5 covers general reliability design considerations and appropriate tasks/techniques

2. GENERAL DESIGN CONSIDERATIONS FOR IN-SERVICE CONDITIONS

Various environmental extremes can accelerate material failure mechanisms, thereby affecting the aging of designs in which they are used. Some environments may introduce peculiar stress conditions that may not be of major concern in any of the other environments.

Although the following sub-sections address individual components of environmental stress parameters (temperature, humidity, UV, etc.) it must be recognized that many of these components may act in concert with one-another. ***A failure to consider the potential combined effects of these parameters can lead to a serious underestimation of their overall effect on material aging.***

In the sections related to environment, the terms desert, arctic and tropical are used to identify major, non-temperate terrestrial environments on earth that present extreme environmental conditions that may impact material selections for a design.

The word ‘desert’ usually brings to mind the hot deserts such as the Sahara. Technically, however, a desert is any land area that has an annual moisture deficit. Accordingly, the polar and tundra land areas are also deserts and, in fact, constitute the majority of all desert area. In addition, the term hot desert and ‘tropical desert’ are often used synonymously.

Due to the potential confusion of terms, and because the environments cannot be definitely associated with boundaries, this guideline will loosely define the three environments as follows:

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