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Design Criteria Monograph for Metal Tanks and Tank Components

A design criteria monograph has been published which is a summary and a systematic ordering of the large and loosely organized body of current techniques and practices for the successful design of liquid rocket metal tanks and tank components.

This monograph organizes and presents, for effective use in design, the significant experience and knowledge accumulated by NASA in development and operational programs. It reviews and assesses current design practices, and from them establishes firm guidance for achieving greater consistency in design, increased reliability in the end product, and greater efficiency in the design effort.

The incentive to minimize tank weight by use of high-strength, brittle materials operated at a high fraction of yield strength must be balanced against the reliability requirements and economic constraints that are inherent in each particular design situation. Many metal alloys under high stress are sensitive both to small inherent flaws and to the effects of various external environments. Flaw growth induced by stress or by environmental conditions has led to tank rupture even at normal operational pressure. Fracture-control methods based on the recently-developed technology of linear-elastic fracture mechanics provide a means for minimizing such failures.

Failures of tank assembly components, although usually not as ominous as a tank rupture, have just as surely led to mission failures; for example, expulsion devices and standpipes have failed, thereby preventing proper propellant consumption. The designer therefore must employ the same care for components as for tanks in establishing strength margins, selecting material, and allowing for environmental effects.

In the development of a tank, the initial design activity is simply the determination of tank shape or configuration within the constraints of mating vehicle structure or available mounting space. When the basic configuration has been defined, the next activity is material selection. Mechanical properties, fracture toughness, environmental compatibility, cost, availability, and fabrication factors must be considered in material selection. Detail tank and component design follow the material selection. The

objective in detail design is to satisfy the tank volume and shape requirements with the selected material in an optimum manner. The significant elements in detail tank design are wall and end structures, weld joints at bulkhead and attachment junctures, and ports and access openings. Additional design considerations are the influence and effect of fabrication processes on tank and component design, and finally, the testing and inspection that are required to establish confidence in a tank design.

The material in the monograph is organized along the lines of the design and development effort necessary to produce tanks and tank components that satisfy the requirements imposed on them. The monograph comprises two major sections: State of the Art, and Design Criteria and Recommended Practices. References complement the text.

The State of the Art section reviews and discusses the total design problem, and identifies the design elements that are involved in successful design. The Design Criteria states clearly and briefly each rule, guide, limitation, or standard that must be imposed on each essential design element to assure successful design; the Recommended Practices set forth the best available procedures for satisfying the Design Criteria.

Both major sections are divided into seven subject categories: Tank Configuration, Material, Structural Design, Components, Design Analysis, Fabrication, and Testing and Inspection.

This thorough review of design criteria and practices relating to tank and tank components should be of interest to manufacturers and users of tanks.

Notes:

1. This monograph has been published as the following report:

NASA SP-8088 (N70-71628), Liquid Rocket Metal Tanks and Tank Components

(continued overleaf)

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Aerospace Research Applications Center
Indiana University
400 East Seventh Street
Bloomington, Indiana 47401
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Lewis Research Center
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