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Design Criteria Monograph on Centrifugal Flow Turbopumps

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 engine centrifugal flow turbopumps.

This monograph was written to organize and present, 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.

In rocket engine applications, the requirements for lightweight components and low pump inlet pressures have resulted in many pump problems, some of which arose partially from insufficient background information for application to design analyses. These problems have included impeller rubbing that resulted in oxidizer-pump explosions; bearing failures caused by high axial and radial thrust; excessive cavitation damage; inadequate suction performance; undesirable oscillations in suction and discharge pressure; impeller blade failures; housing ruptures; stress-corrosion cracking; loss of design fit caused by centrifugal or thermal loads; static-seal leakage; and inadequate retention of the components. Additionally, problems have been encountered wherein the structural and dynamic characteristics of the vehicle were involved with those of the pumping system; the solutions to such problems are highly complex.

This monograph presents the useful knowledge gained in the course of successful solution of these and other problems so that similar difficulties may be avoided in future designs. The material within the monograph is organized along the lines of the pump design sequence. The arrangement and treatment of the subject matter emphasize that the basic objective of the design effort is to achieve required pump performance within the constraints imposed by the engine/turbopump system. The

design must provide this performance while maintaining structural integrity under all operating conditions. Such a design depends on simultaneous solutions of hydrodynamic and mechanical problems, as developed in the monograph.

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 state 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 five subject categories: Configuration Selection; Pump Performance (speed, efficiency, flow range); Impeller (hydrodynamic and mechanical design, fabrication, materials); Housing (hydrodynamic, structural, and mechanical design, fabrication, materials); Thrust Balance System (unbalanced forces, methods of thrust balance, materials).

This thorough review of design criteria and practices relating to centrifugal flow turbopumps should be of interest to manufacturers and users of pumps, power drives, turbine drives, and rotary equipment in general.

Notes:

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

NASA SP-8109 (N74-28961), Liquid Rocket Engine Centrifugal Flow Turbopumps

Copies may be obtained at cost from:

Aerospace Research Applications Center
Indiana University

400 East Seventh Street

Bloomington, Indiana 47401

Telephone: 812-337-7833

Reference: B74-10228

(continued overleaf)

2. Specific technical questions may be directed to:

Technology Utilization Officer

Lewis Research Center

21000 Brookpark Road

Cleveland, Ohio 44135

Reference: B74-10228

Source: Lewis Research Center
(LEW-12346)