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UPDATING OF THE

AEROSPACE FLUID COMPONENT DESIGNERS' HANDBOOK

TECHNICAL REPORT AFRPL-TR-67-126

MAY 1967

AIR FORCE ROCKET PROPULSION LABORATORY
RESEARCH AND TECHNOLOGY DIVISION
AIR FORCE SYSTEMS COMMAND
Edwards, California

Project No. 6753, Task No. 675304

[redacted]

[redacted]

AFRPL-TR-67-126 4712.5-67-141

UPDATING OF THE AEROSPACE FLUID COMPONENT DESIGNERS' HANDBOOK

Technical Report AFRPL-TR-67-126

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[redacted]

(Prepared under Contract No. AF04(611)-11316 by TRW Systems, Redondo Beach, California; T. M. Weathers, Author)

FOREWARD

This report describes work conducted by TRW Systems under Contract AF04 (611)-11316 during the period April 1966 to March 1967. The purpose of this effort was to compile data, update text, and publish revisions to a design handbook on aerospace fluid component technology entitled "Aerospace Fluid Component Designers' Handbook". The initial preparation of this handbook under Contract AF04(611)-8385 is described in Technical Report AFRPL-TR-65-238. The Air Force Rocket Propulsion Laboratory was the sponsor for this program. The Air Force Project Manager was James L. Lawrence, and the TRW Systems Project Manager was Terry M. Weathers.

James R. Lawrence
Project Engineer

ABSTRACT

The report describes the program of literature and industry surveys, data compilation, writing, editing, etc., which led to the publication of Revision B to the Aerospace Fluid Component Designers' Handbook. The purpose of the program, approach to updating of the handbook, results of surveys, problems encountered during the handbook preparation, and recommendations for future efforts are discussed.

CONTENTS

I. INTRODUCTION

The Aerospace Fluid Component Designers' Handbook was conceived as a means for avoiding some of the waste in time, money, and technology resulting from the fact that a valve designer faced with a new problem previously had no ready access to the experience of designers before him who were faced with a similar problem. The handbook has been prepared to provide a readily available single source of basic data on fluid component technology organized for ease of use by design and application engineers and readily adaptable for ease of expansion and revision to accommodate new information.

The data compilation, organizing, writing, editing, and revision of the handbook has been performed by TRW Systems under contract to the Air Force Rocket Propulsion Laboratory. A description of the original program from inception through publication of the initial document and the first revision is contained in "Preparation of the Aerospace Fluid Component Designers' Handbook", Technical Report AFRPL-TR-65-238, December 1965.

This final report has been prepared both to document the progress of the Aerospace Fluid Component Designers' Handbook Program from 1 April 1966 to 31 March 1967, and to set forth the experiences associated with preparation of the second revision. Future reflection upon these experiences, combined with evaluation of the success of various techniques employed in the program, are expected to be of significant value towards the preparation of similar handbooks covering other subjects, as well as towards making further revisions to improve the quality of this handbook. Therefore, this final report presents a discussion of the approach taken towards performing the various program functions, pertinent comments and statistics associated with the surveys conducted, a summary of the problems encountered during the program and how they were solved or circumvented, and a list of conclusions and recommendations based upon these experiences.

II. HANDBOOK DESCRIPTION

A. HANDBOOK PURPOSE

The Aerospace Fluid Component Designers' Handbook provides a comprehensive up-to-date engineering manual intended for use by the designers and users of aerospace valves and related fluid components. Provision for periodic revisions to maintain currency is a fundamental aspect of the handbook program.

B. HANDBOOK CONTENTS

The handbook (illustrated in Figure 1) is addressed primarily to the subject of fluid flow control components, although other related fluid components such as connectors, filters, and flowmeters, as well as pressure, temperature, and fluid-level transducers are included. Non-valve fluid components are treated in the handbook primarily from the standpoint of their selection rather than their design. The handbook includes basic theory of heat transfer and fluid flow contained respectively in Sections 2.0 and 3.0. A brief discussion of how valves are used in typical aerospace fluid systems is included in Section 4.0. Section 5.0 of the handbook describes fluid components by general classification and design types. Components are discussed with respect to performance characteristics and applications and limitations for various aerospace services. The Fluid Components Section also includes a glossary of fluid component terminology. Section 6.0 of the handbook covers the design and selection of the various modules which must be integrated into a valve design. These modules include basic valving units, seals, springs, bearings, bellows, diaphragms, and actuators. Section 7.0 of the handbook presents dynamic analysis techniques including servo theory, vibration and shock analysis, and component dynamic performance analysis. The use of computers, both analog and digital, as design tools are discussed in Section 8.0. Section 9.0 discusses the subject of fluid component specifications, including a description of specification types and presentation of guidance for the preparation of adequate specifications. Included in this section are tables listing specifications and standards commonly referred to in component design specifications. The subject of contamination and cleaning as related specifically to fluid components is discussed in Section 10.0. Included in this section are techniques for controlling contamination as well as design considerations for minimizing contamination sensitivity of fluid components. Section 11.0 presents the subject of reliability, briefly summarizing reliability definitions and mathematics and discussing component design factors to be considered in maximizing fluid component reliability. Section 12.0

(A) Four-color, 11-1/2 by 11-1/2" binder

(B) Sheet lifter and tab dividers

(C) Reference fold-out for Units and Dimensions

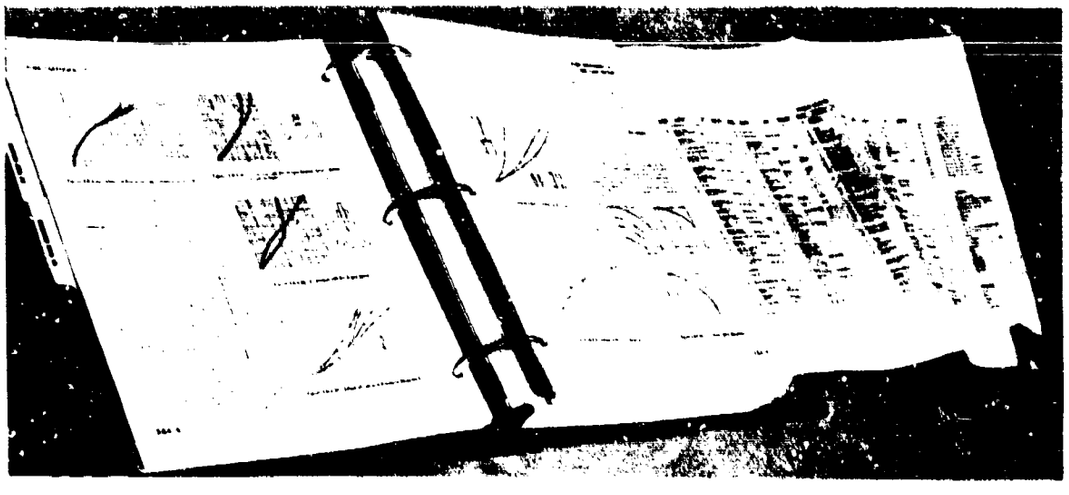


Figure 1. Aerospace Fluid Component Designers' Handbook

presents data on materials used in aerospace valve design. In addition to considering physical properties of commonly-used fluids and structural materials, this section presents guidelines for selecting materials based on propellant compatibility. Data on permeability and friction coefficients are also presented. Section 13.0 presents the environmental considerations important to the aerospace fluid component designer. Environments included in this section are pressure, acceleration, shock and vibration, the atmosphere, temperature, space environment and corrosion. Useful general engineering data and conversion factors are presented in Appendix A of the handbook. A Revision Record Section (Appendix B), a bibliography and an index complete the handbook.

C. PUBLICATION DATES

Due to funding and schedule considerations, the initial handbook publication was divided into two basic phases, each phase involving publication of certain sections to the handbook. The following material was included in the first phase of the program:

Section 1.0	Introduction
Section 2.0	Heat Transfer
Section 3.0	Fluid Mechanics
Section 4.0	Fluid Systems
Section 5.0	Fluid Components (except Connectors)
Section 6.0	Modules (except Valving Units, Static Seals and Dynamic Seals)
Section 7.0	Dynamic Analysis
Section 8.0	Computers
Section 10.0	Contamination and Cleaning
Section 11.0	Reliability
Section 13.0	Environments
Appendix A	Engineering Data and Conversion Factors
Bibliography	
Index	

Publication of the material included in the first phase of the handbook effort was completed in May 1964. As soon as the first phase publication effort was completed, the program continued toward the preparation of the remaining sections; namely, Connectors, Static Seals, Dynamic Seals, Valving Units, Section 9.0 Specifications, and Section 12.0 Materials. Publication of this material was completed in December 1965. These newly added sections were distributed to all holders of the handbook in March 1966. In addition to the new materials, changes to already published material were distributed in the form of some 30 revision sheets correcting and/or updating published material.

This combination of additions and revisions was designated Revision A and increased the size of the handbook to slightly over 1000 pages. Also with the Revision A package, a second loose leaf binder (Volume 2) was provided to accommodate additional pages. All handbooks distributed after March 1966 were updated through Revision A by TRW Systems and shipped as completed two-volume documents.

The effort described in this report resulted in the revising of over 200 pages and the addition of 16 new pages, constituting Revision B. As a result of the necessary reprinting of unrevised backing pages, the total page count for the Revision B packages ran well over 300 pages. These Revision B packages were distributed to all holders of the handbook in March 1967.

III. PROGRAM APPROACH AND RESULTS

A. DATA ACQUISITION

1. Literature Survey

As was the case in the initial program, a major portion of the handbook updating program consisted of an extensive search of the technical literature. The facilities of the TRW Systems Technical Library were primarily utilized in conducting the search. The location, screening and acquisition of references was performed primarily by the TRW Systems Project Manager and support personnel. The literature survey during this period was concentrated upon material relating to the following sections of the handbook:

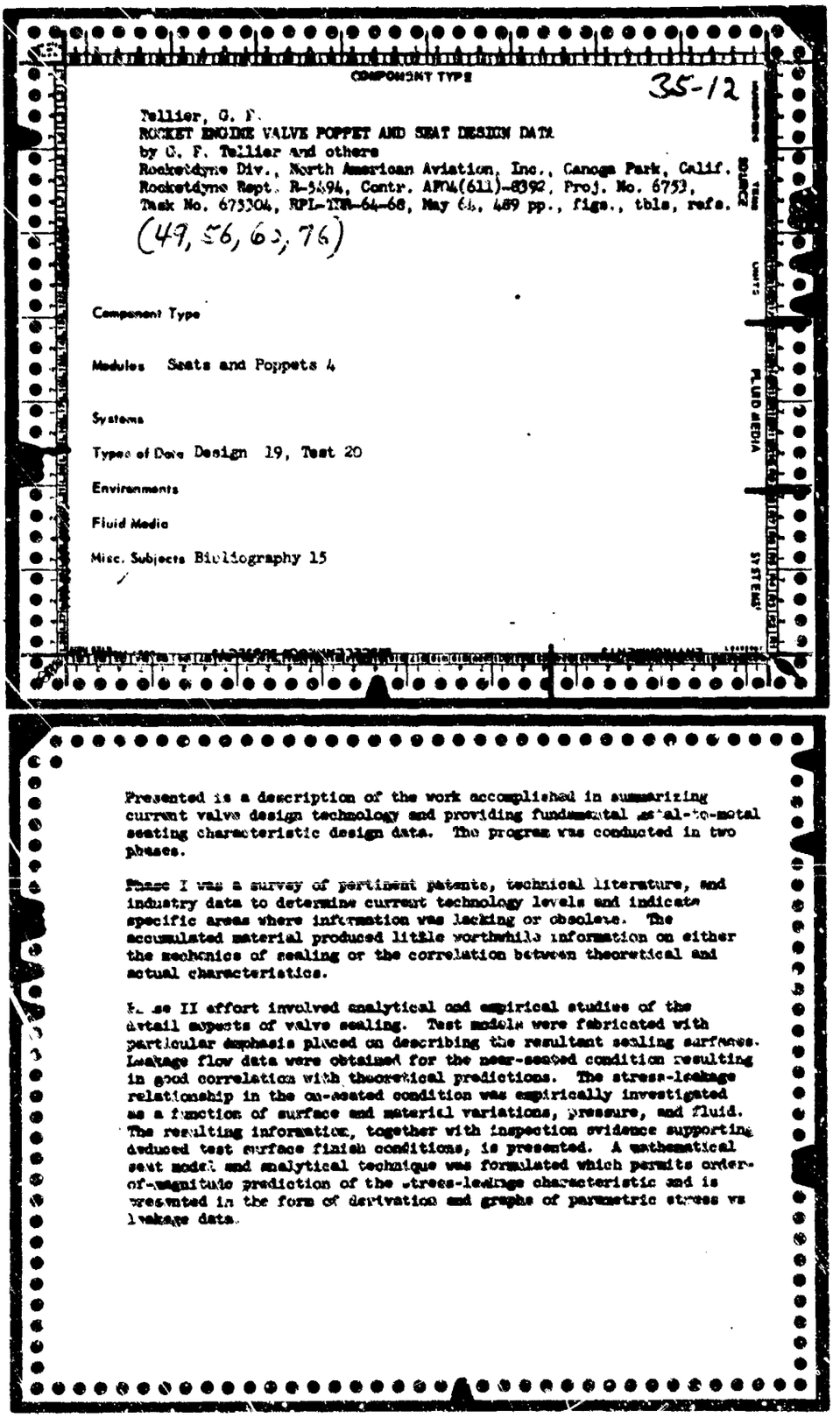
2.0 Heat Transfer
3.0 Fluid Mechanics
5.0 Components
6.0 Modules
7.0 Dynamic Analysis

Whenever a document containing applicable subject matter was located, a bibliabstract card was prepared citing the reference by title, author, etc., in addition to giving appropriate descriptors. An abstract was typed on the back of each card. A sample reference card is shown in Figure 2. Cards on pertinent references were then keypunched thereby coding the source and descriptors (in accordance with those shown in Table 1) on the periphery of the card, making the card readily retrievable at a later date by sorting the deck with a sorting needle. The referenced cards proved to be a convenient means for making the results of the literature survey readily available. By sorting the deck of bibliabstract cards using the desired descriptors, one may quickly review all of the references dealing with the given subject.

Approximately 300 pertinent new references were located during the course of this extension of the literature search. Of this total number of pertinent references, 69 were actually used in the completion of Revision B of the handbook.

2. Industry Survey

The purpose of the industry survey was to gather component design data, as well as to gain the support of industry in augmenting the literature search effort and evaluating the functional quality of the handbook. The industry survey was initiated by distribution of a questionnaire to the 548 holders of record in May 1966. The questionnaire



COMPONENT TYPE

35-12

Tellier, C. F.
ROCKET ENGINE VALVE POPPET AND SEAT DESIGN DATA
by C. F. Tellier and others
Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif.
Rocketdyne Rept. R-5494, Contr. AF04(611)-8392, Proj. No. 6753,
Task No. 675304, RPL-TDR-64-68, May 64, 489 pp., figs., tbls, refs.
(49, 56, 63, 76)

Component Type

Modules Seats and Poppets 4

Systems

Types of Data Design 19, Test 20

Environments

Fluid Media

Misc. Subjects Bibliography 15

SOURCE

UNITS

FLUID MEDIA

SYSTEMS

Presented is a description of the work accomplished in summarizing current valve design technology and providing fundamental metal-to-metal seating characteristic design data. The program was conducted in two phases.

Phase I was a survey of pertinent patents, technical literature, and industry data to determine current technology levels and indicate specific areas where information was lacking or obsolete. The accumulated material produced little worthwhile information on either the mechanics of sealing or the correlation between theoretical and actual characteristics.

Phase II effort involved analytical and empirical studies of the detail aspects of valve sealing. Test models were fabricated with particular emphasis placed on describing the resultant sealing surfaces. Leakage flow data were obtained for the near-seated condition resulting in good correlation with theoretical predictions. The stress-leakage relationship in the on-seated condition was empirically investigated as a function of surface and material variations, pressure, and fluid. The resulting information, together with inspection evidence supporting deduced test surface finish conditions, is presented. A mathematical seat model and analytical technique was formulated which permits order-of-magnitude prediction of the stress-leakage characteristic and is presented in the form of derivation and graphs of parametric stress vs leakage data.

Figure 2. Sample Reference Card

Table I. Categorized List of Descriptors

(Numbers in parenthesis correspond with descriptor numbers following references)

A. COMPONENT TYPE

Accumulators (96)
Ball Valves (8)
Butterfly Valves (9)
Check Valves (10)
Connectors (Fittings) (20)
Control Valves (11)
Diaphragm Valves (12)
Explosive Valves (Squib) (13)
Filters (14)
Flow Meters (16)
Flexible Fluid Couplings (Hoses, Joints, Bellows) (15)
Gate Valves (17)
Globe Valves (18)
Level Sensors (19)
Multiple Passage Valves (21)
Needle Valves (22)
Pinch Valves (23)
Poppet Valves (25)
Plug Valves (24)
Pressure Switches (28)
Pressure Sensors (27)
Pumps (29)
Quick Disconnects (30)
Regulators (31)
Servo Valves (32)
Solenoid Valves (33)
Spool Valves (34)
Temperature Sensor (35)
Transducers, General (36)
Vacuum Instruments (37)
Valves, General (38)
Venturi Valves (40)
Vent and Relief Valves (39)

B. MODULES

Bearings and Pivots (41)
Bellows (10)
Diaphragms (43)
Mechanical Couplings (44)
Orifices and Nozzles (45)
Packings (46)
Seals, Static (48)
Seals, Dynamic (47)
Seats and Poppets (49)
Solenoids (50)
Springs (51)
Temperature Compensators (52)

C. SYSTEMS

Attitude Control (1)
Hot Gas (2)
Hydraulic (3)
Pneumatic (4)
Propellant Feed (5)
Servo (6)
Thrust Vector Control (7)

D. TYPES OF DATA

Comparison (55)
Design (56)
Dynamic Analysis (34 and 57)
Functional Performance (58)
Reliability (59)
Static Analysis (54)
Test (60)
Weight and Cost (99)

E. ENVIRONMENTS

Acceleration (61)
Atmosphere (97)
High Pressure (62)
High Temperature (63)
Low Temperature (64)
Radiation (65)
Space (66)
Vacuum (67)
Vibration (68)
Zero Gravity (69)

F. FLUID MEDIA

Cryogenics (70)
Hot Gas (71)
Hydraulic Fluid (72)
Pneumatic Fluid (73)
Storables (74)

G. MISCELLANEOUS SUBJECTS

Analog Computers (75)
Bibliography (76)
Contamination and Cleaning (77)
Corrosion (78)
Digital Computers (79)
Fluid Flow (80)
Fluid Power Control (81)
Heat Transfer (83)
Leakage (84)
Lubrication (85)
Manufacturing (86)
Materials (87)
Materials Compatibility (95)
Propellant Properties (82)
Reliability (88)
Sealants (93)
Specifications (89)
Storage (90)
Testing (92)
Tubing and Piping (94)
Wear (91)
Welding and Brazing (98)

AEROSPACE FLUID COMPONENT DESIGNERS' HANDBOOK
STATUS QUESTIONNAIRE

1. **ADDRESSEE.** Our records indicate that copy No. 094 is held by:

TRW SYSTEMS
ONE SPACE PARK
REDONDO BEACH, CALIFORNIA
ATTN G. W. HOWELL

X16 43

(Computer Printout Address Label)

If this is not now accurate, please correct above or insert the correct address below.

124 Address Changes

2. **HANDBOOK STATUS.** Please check or fill in as applicable.

____ Volumes I and II are intact and complete through Revision A.

The following material is apparently missing. _____

3. **HANDBOOK USE.** How is this copy of the handbook used? Please check the most applicable or explain below:

88 Used regularly
130 Used occasionally
12 Used very little
3 Not used; file copy only

Copy No. 094

AEROSPACE FLUID COMPONENT DESIGNERS' HANDBOOK QUESTIONAIRE

1. IN WHAT CAPACITY ARE YOU USING THE HANDBOOK?

Please check or write in what best describes your present job responsibilities

45	Management	55	Research
68	Project Eng.	76	Development
88	Design	27	Test
3	Manufacturing		

30 Other _____

_____

2. WHAT NEW SECTIONS WOULD YOU LIKE TO SEE ADDED?

Please check or write in your choices

61	Component Testing
20	Component Weight Analysis
71	Stress Anal, is
24	Fasteners (under Modules, Section 6.0)
32	Fabrication Techniques
31	Valve Graphic Symbols (Appendix)
107	Fluidic Control

75 Other _____

_____

3. WOULD YOU LIKE TO DISCUSS THE HANDBOOK PERSONALLY?

if so, please note your business telephone number _____
or, if you prefer, call the TRW project manager, Terry Weathers at area code 213, 679-8711 Ext. 23323 or 22669.

NOTE: If we do not already have your name on file (because the Handbook copy you have been using belongs to your library or to another individual), please list your name and business address below.

_____

_____

_____

_____

4. CAN YOU HELP IMPROVE THE HANDBOOK?

Please check any of these contributions which you can make to each of the sections below.

If possible, please describe the contribution to the right or on the reverse. If this is not convenient, we will be glad to phone or visit you.

Section	Can you ... indicate technical or editorial errors which you have noted?	suggest revisions of format or content for clarification?	suggest expansion of specific topics or complete subject areas?	suggest new topics for addition within the scope of these sections?	provide data which you have found would like to see added?	recommend new references or other sources of information?
2.0 Heat Transfer						
3.0 Fluid Mechanics						
4.0 Fluid Systems						
5.0 Fluid Components						
6.0 Modules						
7.0 Dynamic Analysis of Fluid Components						
8.0 Computers						
9.0 Specifications						
10.0 Contamination and Cleaning						
11.0 Reliability						
12.0 Materials						
13.0 Environments						
Appendix A - Engineering Data and Conversion Factors						

Please use this space and or the reverse to describe errors, suggestions, new references, etc., or for any comments.

85 replies included comments in this space.

was designed to encourage response by minimizing writing effort and by including a pre-addressed return envelope. Some 243 questionnaires (44.3%) were returned and the statistical results are summarized on the sample questionnaire shown on the following pages. The replies to question No. 2 on the second page of the questionnaire were used as the basis for considering future additions of material on stress analysis and component testing to the handbook.

The questionnaire replies also formed the basis for numerous telephone and letter contacts with interested handbook users as well as visits to 20 companies where the handbook is in use. These contacts and visits have proven to be most useful in acquiring unpublished design data for updating the handbook and in gaining a more thorough understanding of how the handbook is actually being used in industry.

B. COMPILATION OF REVISION RECOMMENDATIONS

As a result of the surveys and other experience with the handbook program, two sets of recommended revisions and additions were prepared in August 1966. The first of these consisted of the revisions to be made to the handbook under this program. This list was expanded appreciably by the time Revision B actually went to press, both as a result of additional new data received and as a result of various opportunities for upgrading of the original text which were noted in the process of actually incorporating other revision material. The second list consisted of recommendations for future program efforts and comprised several major revisions and additions of new sections on the basis of the industry survey. These recommendations may be found in the Conclusions and Recommendations section of this report.

C. WRITING AND EDITING

The approach to the writing and editing task for Revision B was essentially identical to that described in "Preparation of the Aerospace Fluid Component Designers' Handbook", AFRPL-TR-65-238, December 1965. The only major distinction between the two efforts is that the limited scope of Revision B permitted the Project Manager to personnally accomplish virtually all of the writing.

D. REVIEW

In addition to the writing and editing task associated with Revision B to the handbook, an extensive review procedure was utilized. Technically qualified personnel not directly associated with the handbook program were selected to do a critical review of each major revision (wherein an entire sub-section was rewritten). In some cases more than one

individual reviewed a given revision. In addition to review by TRW engineers, some revisions were reviewed by recognized experts in industry who offered their services in reviewing handbook material. After completion of TRW review, all revision material was submitted in draft form to the Air Force for final review and approval which was effected by the Air Force Project Engineer.

E. BIBLIOGRAPHY

In addition to the Bibliography Section of the handbook which lists all of the references actually utilized in the course of preparing the handbook, it was desired to publish the complete results of the very comprehensive literature search in a separate volume. This bibliography was published in December 1965 as Report No. AFRPL-TR-65-239 and includes cross-referencing of each document by its assigned number, by source, and by topic.

F. PRINTING

Printing of Revision B was performed in a manner identical to that of the Revision A with unstripped negatives provided by TRW Systems to the Air Force Space Systems Division Print Shop. One thousand copies of the revision were printed by that organization with highly satisfactory results.

G. DISTRIBUTION

A key element of the handbook program has been the strict control of distribution of original copies of the handbook. Of even greater significance than the costs associated with publishing and distributing such a document, was the desire to get the maximum number of copies into the hands of the designers and users of aerospace fluid components. It is, of course, such individuals for whom the handbook was intended and it is therefore these same engineers who may be expected to provide the most useful feedback for further improving and updating the handbook.

Distribution control has been effected by requiring approval of all requestors by AFRPL and by maintaining both alphabetical and numerical lists. These lists are maintained on keypunch cards and printed with conventional computer printout equipment. This automated technique greatly facilitates orderly additions and changes to the list of names and addresses of holders of the handbook. This is essential if those copies of the handbook in use are to be periodically updated and if contact with users is to be maintained for the purpose of obtaining feedback.

Even with the automated techniques employed, maintainence of an up to date distribution list has proven to be a significant task. During the year covered by this report,

handbook distribution increased from about 500 copies to over 700 copies. In addition, the questionnaire returns indicated the need for some revision in address for over 50% of the addresses.

IV. PROBLEM AREAS

(Note: "Preparation of the Aerospace Fluid Component Designers' Handbook", AFRPL-TR-65-238, December 1965, set forth a number of problem areas encountered in the initial preparation of the handbook. Except insofar as they may be modified by the comments below, those problem areas may be considered still applicable to this and any other similar effort.)

A. EFFECTIVE HANDBOOK DISTRIBUTION

A problem since the selection of the initial distribution list has been that of getting copies of the handbook into the hands of those design engineers for whom the document was intended. While the majority of copies are apparently in effective use, a small minority tend to gather dust upon shelves of supervisory & marketing personnel. Conversely in some areas where the handbook sees constant use, the lack of sufficient copies reportedly drives the frustrated design engineer to seek other sources of information. Wherever either situation has been encountered, steps have been taken to get idle handbooks into the proper location or to recommend additions to the distribution list. It had been hoped that the ready availability of copies of the handbook from the Defense Documentation Center, Alexandria, Virginia would alleviate the latter situation, but to date the quality control problems associated with microfilm reproduction of the handbook's fine print have rendered this source relatively ineffective. As of 20 March 1967, DDC has reportedly received 527 requests for copies of the handbook and in view of this high demand efforts were being initiated to improve the quality of reproduction.

B. PRINTING

Exceptional attention to detail in all steps of the printing procedure is necessary for a handbook of this nature. The necessity for such care was again emphasized in the course of preparing Revision B, wherein many problems of previous printings were completely eliminated but others recurred in small quantities to mar an otherwise near-perfect printing job.

C. PROPRIETARY DESIGN LIMITATIONS

Although the great majority of requests to industry for design information were readily answered, several manufacturers declined to release very desirable data for proprietary reasons.

D. REVISION INSERTION

The effort required to update a Revision A copy of the handbook to Revision B is excessive (in the order of one-half man hour). This stems from the fact that most of the over 300 pages of the Revision B package are individual pages rather than a few large blocks of many pages. Reprinting of complete sections or even the entire document, rather than only discrete pages, would alleviate this problem.

VII. CONCLUSIONS AND RECOMMENDATIONS

A. HANDBOOK ACCEPTANCE

Based on extensive feedback from component manufacturers, aerospace prime contractors, and government agencies, the handbook is definitely fulfilling its intended purpose and has gained wide acceptance and extensive usage by both designers and users of aerospace fluid components.

B. SUBSTANTIATION OF PREVIOUS RECOMMENDATIONS

Experience during the course of the past year's effort has further substantiated the need for better materials compatibility data and flow characteristization techniques, so these recommendations are reiterated below.

1. Materials Compatibility

Based on the experience of compiling the materials compatibility data for the handbook it can be concluded that a concerted effort directed towards compiling use type of materials compatibility data would be a most beneficial endeavor. A canvassing of user experience in valves operated with various corrosive propellants might prove to be far more beneficial than an extensive laboratory test program utilizing the usual static analysis technique for determining compatibility.

2. Flow Characterization

A program addressed to the confusing problem associated with accurately identifying valve flow capacity could potentially result in a significant advancement of valve technology.

C. FLUIDICS

The questionnaire returns revealed an extraordinary interest in the addition of fluidic design data to the handbook (nearly twice the interest shown for any other subject). The constant flow of new literature on the subject clearly illustrates that this relatively new technology is definitely within the state of the art in some industries (i.e., machine tools), although effective aerospace applications have been very limited to date. It is incumbent upon a document as highly regarded throughout the industry as the handbook to treat such a popular related subject. Ideally such treatment should comprise a comprehensive section on the design of fluid components utilizing fluidic

principles (such as a fluidic valve for secondary injection thrust vector control). As a minimum the handbook should describe basic fluidic principles and clearly define the numerous problem areas (such as the influence of variations in temperature and density) which have limited the number of aerospace applications of fluidics to date.

D. COMPONENT TESTING AND STRESS ANALYSIS

The questionnaire returns also showed a high level of interest in the areas of component testing and stress analysis, and plans are presently underway for the addition of these subjects to the handbook.

E. BIPROPELLANT VALVES

The unique nature of bipropellant valves and the interesting design concepts now in use warrant inclusion of this subject under Sub-Section 5.2, Shutoff Valves.

[redacted]
Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

ORIGINATING ACTIVITY (Corporate author) [redacted]	2a. REPORT SECURITY CLASSIFICATION [redacted]
	2b. GROUP

3. REPORT TITLE

Update, of the Aerospace Fluid Component Designers' Handbook

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

N/A

5. AUTHOR(S) (Last name, first name, initial)

[redacted], T. F.

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c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) AFRPL-TR-67-126	
d.		

10. AVAILABILITY/LIMITATION NOTICES

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of [redacted], Edwards, California 93523

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Air Force Rocket Propulsion Laboratory

13. ABSTRACT

The report describes the program of literature and industry surveys, data compilation, writing, editing, etc., which led to the publication of Revision B to the Aerospace Fluid Component Designers' Handbook. The purpose of the program, research in updating of the handbook, results of surveys, problems encountered during the handbook preparation, and recommendations for future efforts are discussed.

DD FORM 1 JAN 64 1473

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Security Classification

[redacted]

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
[redacted]						

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2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

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