MONOGRAPHER'S FOREWORD DEFENITIONS, SYMBOLS, ABBREVIATIONS, AND INDICES

Part I. LAWS AND RULES OF AEROSTATIC FLIGHT PRINCIPLE

Chapter 1. AIRCRAFT FLIGHT PRINCIPLE

- 1.1 Flight Principle Classification
- 1.2 Aerodynamic Flight
- 1.3 Aerostatic Flight
- 1.4 Rocket-Dynamic Flight
- 1.5 Ballistic Flight

Chapter 2. AEROSTATICS THEORETICAL FUNDAMENTALS

- 2.1 Laws Aerostatics is Based on
- 2.2 Excess Balloon Gas and Air Pressure Effect upon an Airship Hull
- 2.3 Air density to atmosphere parameter ratio
- 2.4 Atmosphere Parameter Effect on Aerostatic Airship Lift

Chapter 3. AEROSTATIC FLIGHT PRINCIPLE FEATURES

- 3.1 Kind of Medium Energetically Preferable for Flying
- 3.2 "Cube-Square: and "Cube-Cube" Laws for Heavier-than-Air and Lighter-than-Air A/C
- 3.3 Physical Fundamentals of Flying an Airship
 - 3.3.1. Unpowered Airship Flight
 - 3.3.2. Statically Balanced Airship Flight
 - 3.3.3. Statically Unbalanced Airship Flight

Part II. HISTORICAL AND ENGINEERING ANALYSIS OF AIRSHIP PLAN-AND-DESIGN AND SERVICE DECISIONS

Chapter 4. AEROSTATIC AIRCRAFT EVOLUTION

- 4.1 Aeronautics sources
- 4.2 Zeppelins
- 4.3 Umberto Nobile Semi-Rigid Airships
- 4.4 Airships-Giants
- 4.5 All-metal Airships
- 4.6 Airship Service in 40-70s of the XX-th Century
- 4.7 Present-Day Flying Airships
- 4.8 Transport Airship and Hybrid Aircraft Projects
 - 4.8.1. Vertostats and Planostats
 - 4.8.2. Vertical Take-Off and Landing Aircraft with Lifting Airframe (Airframe and Wing) and Tilting Lifting-Tractor Propellers
- 4.8.3. Heavy-Lift Ballasted Transport Airships
- 4.9 Stratospheric Unmanned Airship Projects
- 4.10. "Aerostatika" Company Developments

Chapter 5. GEOMETRICAL AIRSHIP APPEARANCE CHOICE

- 5.1. First Experimental Studies Based on Sea Fish Profile Analysis
- 5.2. Different Configuration Airship Model Feature Examination in Wind Tunnels
- 5.3 Empennage Arrangement Analysis and its Location Choice on the Airship Hull

Chapter 6. STRUCTURAL AIRSHIP ARRANGEMENT

- 6.1. Classification of Airship Types
- 6.2. Non-Rigid Airships
- 6.3. Semi-Non-Rigid Airships
- 6.4. Semi-Rigid Airships
- 6.5. Rigid Airships (Zeppelins)
- 6.6. All-Metal Airships

Chapter 7. LIFTING (BALLOON) GASES

- 7.1 General Characteristics of Lifting Gases
- 7.2. Warm Air
- 7.3. Hydrogen
- 7.4 Helium
- 7.5 Lighting Gas

Chapter 8. AIRSHIP POWER PLANTS

- 8.1. First Airship Structure Power Plants
- 8.2. Piston Engines
 - 8.2.1. Forced Ignition PE
 - 8.2.2. Diesel Engines
- 8.3 Turboprop and Turboshaft Engines
- 8.4. Electrical Converter Engines

Chapter 9. POWER PLANT ENERGY SOURCES

- 9.1. Conventional Fuels
- 9.2. Alternative Fuels
- 9.2.1. Natural Gas
- 9.2.2. Propane
- 9.3. Future Sources of Energy
 - 9.3.1. Hydrogen
 - 9.3.2. Solar energy

Chapter 10. STRUCTURAL MATERIALS

- 10.1 Conventional Aviation Material
- 10.2. Aeronautical Materials
 - 10.2.1. Aeronautical First-Generation Airship Materials
 - 10.2.2. Present-Day Aeronautical Materials
- 10.3 Balloon Fabric and Film Gas Permiability
- 10.4. Fabric and Fabric-Film Material requirements of New-Generation Rigid-Type Airships

Chapter 11. AIRSHIP SERVICE FEATURES

- 11. 1. Airship Mooring and Anchorage
 - 11.1.1. First-Generation Airship near-Earth and Ground Service features
 - 11.1.2. Present-Day Small and Average Volume Airship Mooring
 - 11.1.2.1. Manual Mooring Technique
 - 11.1.2.2. Mechanized Mooring
 - 11.1.3. Description of New Airship Mooring Technique to Moorage Mechanisms
 - 11.1.3.1. Ground and On-Board Pier-Mooring Mechanisms
 - 11.1.3.2. Mechanized Mooring to High (Low) Mooring Mast
 - 11.1.3.3. Mechanized Mooring to Anchor Device
 - 11.1.3.4.Spatial Airship Motion Simulation under Mooring and Ground Anchorage
 - 11.1.3.5. Airship Anchorage Feathering Dynamics

11.2. Airship Ballasting

- 11.2.1. Ballasted and Non-Ballasted Airships
- 11.2.2. Ballast Types Employed
- 11.2.3. Ways of Obtaining Water and Air Ballast on Board an Airship
- 11.3. Airship Anti-Icing Systems
 - 11.3.1. Wet Snow and Ice Effect upon Airship Service
 - 11.3.2. Hot-Air Airship Hull Anti-Icing System
 - 11.3.3. Tail Arrangement Anti-Icing System
 - 11.3.4. Anti-icing Systems of Power Plants, props, Gondola Glazing, Gas and Air Valves

Chapter 12. MAJOR TRANSPORT AIRSHIP DEVELOPMENT REQUIREMENTS

- 12.1. General requirements
- 12.2. Expected Service Conditions
 - 12.2.1. Flight Performance Conditions
 - 12.2.2. External Medium Parameters
 - 12.2.3. Service Factors
- 12.3. Airship Structure, Systems, and Equipment
 - 12.3.1. Airship Structure
 - 12.3.2. Major Systems
 - 12.3.3. Equipment and Mooring Devices
- 12.4. Airship Airworthiness Standards
 - 12.4.1. ICAO Requirements to Civil A/C Airworthiness Standards
 - 12.4.2. Airworthiness Criteria and Norms for Different-Dimension and Passenger Capacity Airships

Part III. STRUCTURAL-AND-PARAMETRIC ANALYSIS AND SYNTHESIS OF NEW GENERATION TRANSPORT AIRSHIPS

Chapter 13. DESIGN OBJECT RESEARCH TECHNIQUE

- 13.1. Airship as a Design Object is a Complex Engineering System
- 13.2. Structural Decomposition of a Research Object
- 13.3. Design Object Analysis and Synthesis Plan technique
- 13.4 Design decision optimization
- 13.5 Efficiency Estimation Criterion System
- 13.6. Airship Appearance Formation
 - 13.6.1. Structural-and-Functional Scheme of Airship Appearance Formation
 - 13.6.2. Project Model Nomenclature
 - 13.6.3. Restrictions Imposed on Airship Appearance Formation Model
 - 13.6.4. Airship Appearance Formation Project Procedure Structure

Chapter 14. GEOMETRICAL AND POWER-GENERATING AIRSHIP MODELS

- 14.1. Airship Drag
 - 14.1.1. Design Technique
 - 4.1.1.1 Airship Hull
 - 14.1.1.2. Empennage
 - 14.1.1.3 .Empennage and Hull Interference
 - 14.1.1.4. Gondola
 - 14.1.1.5 Supporting Struts
 - 14.1.1.6 Rigging
 - 14.1.1.7 Engine Nacelles
 - 14.1.2. Drag Design Estimation Technique

- 14.1.3 Drag Factor of Airship and its Main Parts Dependence on A/C Volume and Aspect Ratio
- 14.2. Airship Required Thrust and Thrust-to-Weight Ratio
- 14.3 Airship Required Power and Power-to-Weight Ratio
 - 14.3.1. Propelling Device Parameter Selection
 - 14.3.2. Required Power
 - 14.3.3. Power-to-Weight Ratio
- 14.4. Airship Power Plant Mass Models, Fuel and Mass Efficiency14.4.1. Major Engine Parameter Simulation
 - 14.4.1.1. Gas Turbine Engines
 - 14.4.1.2. Forced Ignition Piston Engines
 - 14.4.1.3. Diesel Engines
 - 14.4.2. Relative Power Plant and Required Fuel Mass Ratio

Chapter 15. AIRSHIP MASS EFFICIENCY OF DIFFERENT STRUCTURAL TYPE

- 15.1. Non-Rigid Airships
 - 15.1.1 Non-Rigid Airship Mass estimation Technique
 - 15.1.1.1. Non-Rigid Airship Hull design Load
 - 15.1.1.2. Hull Mass
 - 15.1.1.3. Empennage Mass
 - 15.1.1.4. Gondola Structure Mass
 - 15.1.1.5. Equipment and Control System mass
 - 15.1.1.6. Fuel and Ballast System Mass
 - 15.1.2. Non-Rigid Airship mass Efficiency
- 15.2. Semi-Rigid Airships
 - 15.2.1. Semi-Rigid Airship Envelope design Load
 - 15.2.2. Keel Beam Design load
 - 15.2.3. Keel Beam Design technique
 - 15.2.3.1. Keel Beam Design Model
 - 15.2.3.2. Three-Dimensional Truss Keel Beam Control Design
 - 15.2.3.3. Keel Beam project design
 - 15.2.4. Design Parameter Effect upon Keel Beam Mass
 - 15.2.5. Semi-Rigid Airship Mass efficiency
- 15.3 Rigid Airships
 - 15.3.1. Rigid Airship Hull Design Load
 - 15.3.2. Hull Load-Bearing Component Mass Estimation technique
 - 15.3.2.1. Stringer Estimation and Design
 - 15.3.2.2. Frame Estimation and Design
 - 15.3.2.3. Rigid Airship Mass Efficiency
 - 15.3.3. Rigid Airship Mass Efficiency

Chapter 16. AIRSHIP FLIGHT PERFORMANCE

- 16.1 Airship Existence and Function Equation
- 16.2. Airship Volume and payload Mass Ratio Estimation Technique
 - 16.2.1. Direct problem Minimum Required Payload Mass by Specified Airship Hull Volume
 - 16.2.2. Reverse Problem Volume Estimation by Specified Payload Mass
 - 16.2.3. Optimization problem Minimum Required Airship Hull Volume by Specified Payload Mass
- 16.3. Airship Weight Efficiency

- 16.4. Transport Airship Fuel efficiency
- 16.5. Flight Range and Time

Chapter 17. AIRSHIP COST-EFFECTIVE PERFORMANCE ESTIMATION

- 17.1 Economical and Mathematical Models of Airship Cost Estimation
 - 17.1.1. General Methodological Approach
 - 17.1.2. R&D Expenses
 - 17.1.3. Mass Production Expenses
 - 17.1.4. Operational Expenses
- 17.2. Airship Cost Factors
 - 17.2.1. Manufacturing Cost
 - 17.2.2. Flight-Hour and Ton-Kilometer Cost
- 17.3. Airship Military-Oriented Purpose Application Efficiency Estimation

Chapter 18. AIRSHIP ADVANTAGES.

POTENTIAL FIELDS OF THEIR APPLICATION

- 18.1. Comparative Commercial and Engineering Characteristics of Major Transport Types
- 18.2. Potential Capabilities of Transport Airships
- 18.3. Heavier-than-Air and Lighter-than-Air Aircraft Flight Performance Comparison
- 18.4. Factors Restraining Airship Construction
- 18.5. Potential Fields of Airship Application
 - 18.5.1. List of Engineering and Economical problems, in Solving of which an Airship Role May Be Pronounced or Decisive
 - 18.5.2. Comments on Some Potential Fields of Airship Application
 - 18.5.2.1. "Door to Door" Heavy and Bulk Freight Transportation
 - 18.5.2.2. Wood and Lumber Industry product Transportation
 - 18.5.2.3. Forest Fire Detection and Extinguishment
 - 18.5.2.4. Railroad Construction in Northern Regions
 - 18.5.2.5. Exploration of Mineral Resources
 - 18.5.2.6. Medical Aide Supply

APPENDICES

Appendix 1

Dimension Range, Type, and Realization Chronology of Most Valued Airship Projects

Appendix 2 First-Generation Airship Flight performance

Appendix 3 Gallery of Great Aeronautics Inventors

Appendix 4 Airship Construction in the USSR

Appendix 5 Airship classification by Federal Aeronautique Internationale (FAI) for Setting World records Appendix 6 International Standard Atmosphere Key parameter Values

REFERENCES

ALPHABET REFERENCE