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MODEL AERODYNAMIC TEST RESULTS
FOR TWO VARIABLE CYCLE ENGINE
COANNULAR EXHAUST SYSTEMS
AT SIMULATED TAKEOFF
AND CRUISE CONDITIONS

COMPREHENSIVE DATA REPORT
VOLUME I
DESIGN LAYOUTS

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Commercial Products Division
Pratt & Whitney Aircraft Group
United Technologies Corporation

Prepared for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Lewis Research Center
Under
Contract NAS3-20061
1. Report No. CR-159819
2. Government Accession No.
3. Recipient's Catalog No.
4. Title and Subtitle Model Aerodynamic Test Results for Two Variable Cycle Engine Coannular Exhaust Systems at Takeoff and Cruise Conditions - Comprehensive Data Report
5. Report Date January 1981
6. Performing Organization Code
7. Author(s) D.P. Nelson
9. Performing Organization Name and Address Pratt & Whitney Aircraft Group Commercial Products Division United Technologies Corporation East Hartford, Connecticut 06108
10. Work Unit No.
11. Contract or Grant No. NAS3-20061
12. Sponsoring Agency Name and Address NASA Lewis Research Center Cleveland, Ohio 44135
13. Type of Report and Period Covered Contractor Report
15. Supplementary Notes
Project Manager: A. G. Powers, NASA Lewis Research Center

16. Abstract

Wind tunnel tests were conducted to evaluate the aerodynamic performance of an advanced coannular exhaust nozzle for a future supersonic propulsion system. Tests were conducted with two test configurations: 1) a short flap mechanism for fan stream control with an isentropic contoured flow splitter, and 2) an iris fan nozzle with a conical flow splitter. Both designs feature a translating primary plug and an auxiliary inlet ejector.

Tests were conducted at takeoff and simulated cruise conditions. Data were acquired at Mach numbers of 0, 0.36, 0.9, and 2.0 for a wide range of nozzle operating conditions. At simulated supersonic cruise, both configurations demonstrated good performance, comparable to levels assumed in earlier advanced supersonic propulsion studies. However, at subsonic cruise, both configurations exhibited performance that was 6 to 7.5 percent less than the study assumptions. At take-off conditions, the iris configuration performance approached the assumed levels, while the short flap design was 4 to 6 percent less.

17. Key Words (Suggested by Author(s)) Short Flap Ejector Iris Flap Ejector Coannular Exhaust Nozzle Inverted Velocity Profile
18. Distribution Statement

19. Security Classif. (of this report) Unclassified
20. Security Classif. (of this page) Unclassified
21. No. of Pages 2226
22. Price* For sale by the National Technical Information Service, Springfield, Virginia 22161

* For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-C-168 (Rev. 10-75)
FOREWORD

This report documents the work performed during the Nozzle Performance Tests (Task III) of Contract NAS3-20061. Because of the large amount of information, this report is presented in three Volumes to facilitate its use.

Volume I contains the design layouts and detailed design drawings of the nozzle models.

Volume II contains the tabular aerodynamic data generated in this program.

Volume III contains a graphical presentation of the data.

A complete description of the test hardware and test facilities is contained in the companion Task III Final Report, CR-159818. Significant test results and conclusions are also included in the Final Report.
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1. Introduction

Design drawings of the Task III nozzle performance test models are presented in this Volume of the report.

Section 2 provides a tabulated list of the model component drawings for each test configuration.

Section 3 contains the layout and detail design drawings.
2. Tabulated Component Drawing Index

The model drawings are arranged in an order that presents the layout assembly drawings first, followed by the component detail design drawings. The detail drawings are organized in ascending drawing number sequence. The layout drawings show the assembly of the component parts for each test configuration. A listing of the components parts required for each model configuration assembly is provided in Table 2-I.
### TABLE 2-I

**CONFIGURATION ASSEMBLY COMPONENT DRAWINGS**

<table>
<thead>
<tr>
<th>Short Flap Nozzle Models</th>
<th>Iris Flap Nozzle Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layout Assembly Dwg. 1741-1</td>
<td>Layout Assembly Dwg. 1741-2</td>
</tr>
<tr>
<td><strong>Component Drawing Number</strong></td>
<td><strong>Component Drawing Number</strong></td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td><strong>o Supersonic Cruise</strong></td>
<td><strong>o Supersonic Cruise</strong></td>
</tr>
<tr>
<td><strong>Configuration Components</strong></td>
<td><strong>Configuration Components</strong></td>
</tr>
<tr>
<td>Primary centerbody plug assembly</td>
<td>1-94161</td>
</tr>
<tr>
<td>plug forward end</td>
<td>1-94158</td>
</tr>
<tr>
<td>plug tapered end</td>
<td>1-94159</td>
</tr>
<tr>
<td>plug screw</td>
<td>1-94160</td>
</tr>
<tr>
<td>Flow splitter</td>
<td>1-94153</td>
</tr>
<tr>
<td>Fan nozzle</td>
<td>1-94162</td>
</tr>
<tr>
<td>Zero bleed fan nozzle spacer</td>
<td>1-95317</td>
</tr>
<tr>
<td>Bleed Flow Fan nozzle spacer</td>
<td>1-95312</td>
</tr>
<tr>
<td>Ejector shroud</td>
<td>1-93197</td>
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<tr>
<td>Shroud bleed screw</td>
<td>1-94166</td>
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<tr>
<td>Lead-in ring</td>
<td>1-95313</td>
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<tr>
<td><strong>o Subsonic Cruise</strong></td>
<td><strong>o Subsonic Cruise</strong></td>
</tr>
<tr>
<td><strong>Configuration Components</strong></td>
<td><strong>Configuration Components</strong></td>
</tr>
<tr>
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<td>1-94161</td>
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<td>plug forward end</td>
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<tr>
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<td>plug screw</td>
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<td>1-94153</td>
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<tr>
<td>Fan nozzle</td>
<td>1-94163</td>
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<tr>
<td>Ejector shroud assembly</td>
<td>1741-3</td>
</tr>
<tr>
<td>Clam shell</td>
<td>1-94157</td>
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<tr>
<td>Lead-in ring</td>
<td>1-95313</td>
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<tr>
<td><strong>o Takeoff Configuration Components</strong></td>
<td><strong>o Takeoff Configuration Components</strong></td>
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<td>2-95521</td>
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<tr>
<td>plug screw</td>
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<td>Fan nozzle</td>
<td>1-95316</td>
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<td>1-94157</td>
</tr>
<tr>
<td>Lead-in ring</td>
<td>1-95313</td>
</tr>
</tbody>
</table>
3. DESIGN DRAWINGS
NOTES:
1) INCLUDES ALLOWANCE FOR FINISHING AT ASS'Y.
2) DIA'S ALL DIA'S CONC WITHIN .010 TIR.
NOTES:
1) INCLUDES ALLOWANCE FOR FINISHING AT ASS'T
2) SHANK MUST BE STRAIGHT WITHIN .015
NOTES:
1) DO NOT MARK PART II OF ASS'Y.
2) PRESS TAP TUBING TO BE INSTALLED
   BY UTRC
STK LNGTH 'A' REF

BUTTON HEAD CAP SCREW
(SEE CHART FOR SIZES)

ITEM NO. | DASH NO. | N° REQ'd | 'A' REF | DIA 'B' | DIM 'C' | MAKE FROM
---------|----------|---------|--------|---------|---------|------------
48       | -1       | 2       | 1/2    | 0.150   | 0.250   | 1/4 x 28 x 1/2 |
49       | -2       | 24      | 3/8    | 0.145   | 0.160   | 10-32 x 3/4 |

NOTES:
1) BAG & TAG PART NO'S
View A

SCALE: 4/1

1) ALL DIAM CONE WITHIN .005 TIR.

~ NOTES ~
### Notes

<table>
<thead>
<tr>
<th>Inspection Req'd</th>
<th>Engineer</th>
<th>Case</th>
<th>Rev.</th>
<th>Date</th>
<th>App.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure ... Total</td>
<td>COWL</td>
<td>NASA PERF NUTS</td>
<td>A</td>
<td>2/21</td>
<td>4-15</td>
</tr>
</tbody>
</table>

### Dimensions

- 7.652 ± 0.005 DIA
- 7.476 ± 0.005 DIA
- 2.693 ± 0.001
- 3.120 ± 0.005
- 300
- 1.410
- 7.678 ± 0.001
- 2.363
- 0.022 (REF)
- 30°
- 0.025 ± 0.005 R
- 0.020 R MAX
- 3.098
- 15°
- 38°
- 1/44'36" REF

### Additional Information

- View A
- Scale: 4/1
- Part No.
- 232669
- Material: 6" G.D. 4.258 WALL T8-42511 (Lot #78720)

**NOTE:** All dimensions are within 0.005 TIP.

1. TAG PT NO.
NASA PERF. NOZZLE

CASE

PARTS LIST

PRINTED ON 12-18-83

UNITED TECHNOLOGIES
RESEARCH CENTER
East Hartford, Connecticut 06118
NOTES:
1) FINISH MACHINE WITH PART 1741-1-94159
2) SHANK MUST BE STRAIGHT WITHIN .015