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AIR-BREATHING ENGINE TEST FACILITIES REGISTER, (U)

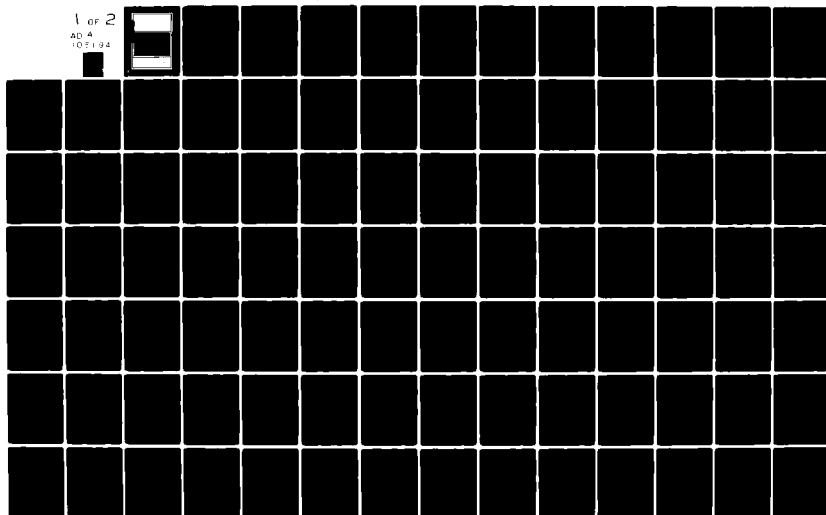
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AIR-BREATHING ENGINE TEST FACILITIES REGISTER



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ADVISORY GROUP FOR AEROSPACE RESEARCH & DEVELOPMENT

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AGARDograph No. 269

Air-Breathing Engine Test Facilities Register

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NORTH ATLANTIC TREATY ORGANIZATION
ADVISORY GROUP FOR AEROSPACE RESEARCH AND DEVELOPMENT
(ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD)

12/12

AGARDograph No. 269

AIR-BREATHING ENGINE TEST FACILITIES REGISTER

Compiled by

11 Joachim H. Krengel

11

This AGARDograph was prepared at the request of the Propulsion
and Energetics Panel of AGARD.

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THE MISSION OF AGARD

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- Exchanging of scientific and technical information;
- Continuously stimulating advances in the aerospace sciences relevant to strengthening the common defence posture;
- Improving the co-operation among member nations in aerospace research and development;
- Providing scientific and technical advice and assistance to the North Atlantic Military Committee in the field of aerospace research and development;
- Rendering scientific and technical assistance, as requested, to other NATO bodies and to member nations in connection with research and development problems in the aerospace field;
- Providing assistance to member nations for the purpose of increasing their scientific and technical potential;
- Recommending effective ways for the member nations to use their research and development capabilities for the common benefit of the NATO community.

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PREFACE

This Air-Breathing Engine Test Facilities Register was initiated by and prepared under the auspices of the AGARD Propulsion and Energetics Panel Subcommittee 01. The Subcommittee acknowledges the cooperation of the participating agencies in making this information available for publication. The Subcommittee is indebted to the author, Mr. Krengel, the DFVLR and the German Federal Ministry of Defence for donating the support which made this report possible.

It is observed that test facilities can be a large expense in the accomplishment of many research projects and development activities. Sometimes these facilities are only required on an occasional basis and construction of the test facilities by those who may wish to use them is not justified. The Propulsion and Energetics Panel intends for this compilation of the facility information to serve all scientists and engineers within the NATO Countries as a ready index of those test facilities which are available to them.

Only summary information is provided but contacts at each installation are given who can provide the desired detail.

James G. Mitchell
Chairman, Subcommittee 01

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Justification	

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CONTENTS

	Page
PREFACE by J.G.Mitchell	iii
INTRODUCTION	v
1. LIST OF ORGANISATIONS	1-1 - 1-3
2. TEST CAPACITY OF ORGANISATIONS	2-1 - 2-30
3. LIST OF ALTITUDE TEST CELLS	3-1 - 3-2
4. LIST OF SEA LEVEL TEST FACILITIES	4-1 - 4-3
5. LIST OF TEST CELLS WITH SPECIAL CAPABILITIES	5-1 - 5-3
6. ALTITUDE TEST CELLS	6-1 - 6-38
7. SEA LEVEL TEST CELLS WITH SPECIAL CAPABILITIES	7-1 - 7-27
8. APPENDICES	
I Supporting Panel Members	8-1
II Altitude Test Cell Information (continued)	8-2
III Abbreviations	8-3 - 8-4
IV Quick User's Flow Chart	8-5

INTRODUCTION

In context with its Symposium on "Turbine Engine Testing" it has been the aim of the Propulsion and Energetics Panel of AGARD to offer to the NATO community a survey on air-breathing engine test facilities which are presently available in NATO countries. It was concluded that the main interest is focussed on test facilities for research and development of aero-engines to be used as prime thrusters. Consequently production and post-overhaul acceptance test facilities are not to be found in this register, even though in some cases they have been used for special investigations.

In this book the reader will find a fairly complete survey of organisations which operate altitude and sea level test facilities for turbo-jet (including turbo-fan), ram-jet, and turbo-shaft engines. Though the book cannot claim comprehensiveness its initial working title was kept but the word register should not be understood in its prime sense and official meaning. Summary information about the test capacity of organisations and more detailed data for a number of individual test cells are offered and may be used for quick comparison and survey or for a preliminary selection of test facilities which the reader may wish to use in his research and development programmes.

There are two items to be observed when using the register :
The first one though randomly distributed is imminent to the applied system of raising and soliciting data. The user of this compilation will realise soon that depth and detail of information and data vary considerably between different organisations and for different test cells. This certainly is a deficiency of the register but one should bear in mind that participating in AGARD activities is voluntary and response to the inquiry made by a detailed question format was possible only to the extent of national or organisational desire and judgement. Most of the major testing centers have listed only their primary test cells which are used for development purposes.

The second item preferably applies to the facilities with altitude capability and may also be worth mentioning here. There usually are three factors which limit the operational range of a test cell : the electrical power available at the site, the compressor machinery for ram and exhaust purposes, and the piping system to and from the test cell. In many cases only the individual maximum values are quoted which in their direct combination would lead to unrealistic test cell capabilities. It was by no means possible to obtain and include triple sets of these data in order to characterize the capability of the individual test cell exactly. Since the actual range of operation does often also depend on the engine installed in the test cell an inquiry for a specific case will be the most effective approach. Very often a small alteration or adjustment leads to a satisfactory solution.

The compilation was effected upon request of the AGARD Propulsion and Energetics Panel, and Panel Members of almost all nations solicited data and helped in many ways. To them and to the engineers who submitted the data of the various organisations the author is very much indebted and wishes to express his thanks. He also acknowledges the permission of DFVLR and the German Federal Ministry of Defence to work on this AGARD activity.

Any major omissions or errors should be reported to the Propulsion and Energetics Panel Executive at AGARD Headquarters and corrections will be issued, if necessary, in due course.

1 LIST OF ORGANISATIONS

COUNTRY	ORGANISATION LOCATION	TEST FACILITIES INCLUDED IN THIS REGISTER						PAGE
		ALTITUDE			SEA LEVEL			
		TJ	RJ	TS	TJ	RJ	TS	
CANADA		1		(1) ¹⁾	10		14 + (1)	
	Carleton University Gas Turbine Laboratory Ottawa, Ontario						1	2-1
	Confederation College of Applied Arts & Technology, Aviation & Motive Power Dep. Thunder Bay, Ontario						1	2-2
	National Research Council Canada Ottawa, Ontario	1		(1)	4		1	2-3
	Pratt & Whitney Aircraft of Canada Ltd. St. Hubert and Longueuil, Quebec				4		8 + (1)	2-4
							(1)	
	Rolls Royce (Canada) Ltd. Lachine and Montreal, Quebec				2		2	2-5
	Westinghouse Canada Ltd. Hamilton, Ontario						1	2-6
FRANCE		7	(1)	(4)	14		(2)	
	Centre d'Essais des Propulseurs Saclay	7	(1)	(4)	3		(2)	2-7
	SNECMA Société Nationale d'Etude et de Construction de Moteurs d'Aviation Moissy Cramayel				11			2-8
GERMANY (FEDERAL REPUBLIC)		1	(1)	(1)	4	1	4	
	DFVLR Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt e.V. Köln-Porz					1		2-9
	MTU Motoren- und Turbinen- Union München GmbH München und Manching				4		4	2-10
	Universität Stuttgart Institut für Luftfahrt- Antriebe Stuttgart	1	(1)	(1)				2-11

1) Number in brackets refers to test cells already included in preceding column.

1 LIST OF ORGANISATIONS

COUNTRY ORGANISATION LOCATION	TEST FACILITIES INCLUDED IN THIS REGISTER						PAGE
	ALTITUDE TJ RJ TS			SEA LEVEL TJ RJ TS			
ITALY					1	4	
Alfa Romeo Aviazione Napoli						2	2-12
Costruzioni Aeronautiche G. Agusta Elicotteri Meridionali Frosinone						1	2-13
Fiat Aviazione S.p.A. Torino					1	1	2-14
UNITED KINGDOM	8	(3)	(1)		25	18 (4)	
Lucas Aerospace Ltd. Kenilwerth, Warwickshire					1		2-15
National Gas Turbine Establ. Pyestock, Farnborough	5	(2)			1	(1)	2-16
Noel Penny Turbines Ltd. Coventry						5	2-17
Plessey Co. Ltd. Ilford, Essex						1	2-18
Rolls Royce Ltd. Bristol	1	(1)			11		2-19
Derby	2		(1)		6	3	
Hatfield						9	
Hucknall					6	(3)	
UNITED STATES	37	7	6		11	(4)	
Air Force Aeropropulsion Lab.,Wright-Patterson Air Force Base Ohio	3	(1)					2-20
AIRResearch Manufacturing Co. Propulsion Engines Laboratory Torrance, California					2		2-21
Arnold Engineering De- velopment Center Arnold Air Force Station, Tennessee	11	1 (10)	(1)				2-22
General Electric Co. Cincinnati, Ohio	2						2-23
General Motors Corp. Detroit Diesel Allison Div. Indianapolis, Ind.	2		2 (1)				2-24
The Johns Hopkins Univer- sity Applied Physics La- boratory Laurel, MD.	4						2-25

1 LIST OF ORGANISATIONS

COUNTRY ORGANISATION LOCATION	TEST FACILITIES INCLUDED IN THIS REGISTER							PAGE
	ALTITUDE TJ RJ TS			SEA LEVEL TJ RJ TS				
The Marquardt Co. Van Nuys, California	2	1	(2)					2-26
NASA, National Aero- nautics and Space Administration Lewis Research Center Cleveland, Ohio	4	(2)						2-27
Naval Air Propulsion Center Trenton, New Jersey	3	(1)	4	4		(4)		2-28
Teledyne CAE Toledo, Ohio	2			2				2-29
United Technologies Corp. Pratt and Whitney Aircraft Div.								2-30
Florida Research & Development Center West Palm Beach, Fl.	3			3				
Andrew Willgoos Turbine Labora- tory East Hartford, Connecticut	5							
Chemical Systems Divis. Sunnyvale, California			1					

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Carleton University
Department of Mechanical and Aeronautical Engineering
Gas Turbine Laboratory

ADDRESS : Ottawa K1S 5B6, Canada

CONTACT : Chairman, Department of Mechanical and Aeronautical
Engineering
Phone 613-231-2639

2 TEST CELLS

One test cell for turbo-shaft engines like Pratt and Whitney ST-6. Kahn water brake and fairly comprehensive instrumentation including air flow measurement available.

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Confederation College of Applied Arts & Technology
Aviation & Motive Power Department

ADDRESS : P.O. Box 398
Thunder Bay, Ontario
Canada

CONTACT : W.B. Troniak - for contractual purposes
N. Denetto - for technical information

Phone 807-577-5751 (both gentlemen)

2 TEST CELLS

One test cell for turbo-shaft engines like Pratt & Whitney PT6A - 20.
Instrumentation similar to Twin Otter.

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : National Research Council of Canada
Division of Mechanical Engineering

ADDRESS : Ottawa, Ontario K1A 0R6, Canada

CONTACT : Various, see test cell data section 6 + 7

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow kg/s	Size			Page
				W	H	L	
Altitude Test Chamber	TJ/TS	13.7 km	5.4	Diam	2.13 m	3.66 m	6-33
No 5 TC	TJ	Sea Level	136	4.6mx	4.6 m x	18.3 m	
No 1 TC	TJ	Sea Level	15.2	6 m x	5 m x	12 m	
No 4 TC	TJ	Sea Level	15.0	7.5mx	7.5 m x	18 m	7-16
No 2 TC	TS	Sea Level	5.0	6 m x	5 m x	17.4 m	
Propulsion Tunnel	TJ	Sea Level	1324	3 m x	6 m x	12 m	

3 AIR SUPPLY AND EXHAUST FACILITIES

3.1 SUPPLY 5000 kW compressor set (Propulsion Tunnel)
 15 kg/s at 700 kPa¹⁾
 5 kg/s at 1000 kPa

COOLING 335 kw air refrigeration system

HEATING 5 kg/s at 1000 kPa up to 373 K

3.2 EXHAUST

2000 kW exhauster set (Propulsion Tunnel)

22.3 m³/s suction capacity¹⁾: 1.8 ÷ 5.4 kg/s
 7 ÷ 21 kPa

1) same compressor

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Pratt & Whitney Aircraft of Canada Ltd.

ADDRESS : Longueuil, Quebec, Canada

CONTACT : Manager, Test Support Engineering

Phone 677-9411 Ext. 619

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow kg/s	Size	Page
5 - 11	TJ	Sea Level			7-11
1 - 16	TJ	Sea Level	227		
1 - 17	TJ	Sea Level	227		
1 - 11A	TJ/TS	Sea Level			7-17
2 - 3	TS	Sea Level			
2 - 1	TS	Sea Level	11.4		
1 - 5	TS	Sea Level	11.4		
1 - 2	TS	Sea Level	8.2		
1 - 1	TS	Sea Level	385+		7-24
1 - 6	TS	Sea Level	385+		7-24
1 - 18	TS	Sea Level	385+		7-24
2 - 4	TS	Sea Level	385+		7-24

+ includes propeller mass flow

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Rolls Royce (Canada) Limited

ADDRESS : 9500 Cote de Liesse Road
Lachine, Quebec, H4Y 1B7

CONTACT : Director of Quality

Phone 514-631-3541

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow kg/s	Size	Page
No 3 TB	TJ	Sea Level	150		
No 2 TB	TJ	Sea Level	100		
No 1 TB	TS	Sea Level	20		
T 64 ⁺	TS	Sea Level			7-20

⁺Prop Test Cell

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Westinghouse Canada Ltd.

ADDRESS : P.O. Box 510
Hamilton, Ontario
Canada

CONTACT : Manager of Product Reliability
Phone 416-528-8811 Ext. 2294

2 TEST CELLS One building with two water dynamometers

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Centre d'Essais des Propulseurs

ADDRESS : Saclay
91 406 Orsay
France

CONTACT : Monsieur le Directeur
(or as mentioned in sections 6 and 7)

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow kg/s	Size Diam	Length	Page
R 5	TJ	20 km	375	5.5 m	30.0 m	6-21
R 3	TJ	20 km	200	3.5 m	18.0 m	6-22
R 4	TJ	20 km	200	3.5 m	18.0 m	6-22
S 1	TJ RJ TS	15 km	100	3.5 m	15.0 m	6-31
C 1	TJ TS	11 km	55	3.2 m	8.0 m	6-34
R 2	TJ TS	10 km		3.5 m		6-35
R 6	TJ TS	10 km		5.5 m		6-36
T x	TJ TS	Sea L.	Unlimited	55 m x 25 m	concrete area	7- 5
T 1	TJ	Sea L.	1200	10 m x 10 m x 26 m		
H 9	TJ TS	Sea L.				7-18

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : SNECMA
Société Nationale d'Etude et de Construction
de Moteurs d'Aviation

ADDRESS : 77 550 Moissy Cramayel
France

CONTACT : M. le Chef du Département Essais aux Bancs
Direction Technique

Phone: 6.437.91.23 Ext. 3118

2 TEST CELLS

Designation	Engine	Altitude km	Mass Flow kg/s	Size H x W x L
W 1 C 7	TJ	Sea L.	500	8 m x 7 m x 22.4 m
W 2 C 7 ¹⁾	TJ	Sea L.	400	8 m x 7 m x 22.4 m
W 9 H 7	TJ	Sea L.	100	7.2 m x 7 m x 19 m
W 10 H 7	TJ	Sea L.	100	7.2 m x 7 m x 19 m
W 11 H 7	TJ	Sea L.	200	7.8 m x 7 m x 23.2 m
W 12 H 7	TJ	Sea L.	100	7.8 m x 7 m x 22 m
W 7 H 5	TJ	Sea L.	100	6.2 m x 5 m x 16.2 m
W 8 H 5	TJ	Sea L.	100	6.2 m x 5 m x 16.2 m
W 1 H 8	TJ	Sea L.	500	7.2 m x 7.5 m x 27 m
I Site No 3	TJ	Sea L.	Unlimited	Concrete surface area of 10.000 m ²
I Site No 5	TJ	Sea L.	Unlimited	Open air test bed

¹⁾ Reverse thrust capability

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Deutsche Forschungs- und Versuchsanstalt
für Luft- und Raumfahrt e.V. (DFVLR)

ADDRESS : Postfach 90 60 58
5000 Köln 90
Federal Republic of Germany

CONTACT : Institut für Experimentelle Strömungsmechanik
Phone: 2203-601-2278

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow	Size			Page
				H	W	L	
VMK	RJ	Sea Level up to 7.5 km ⁺	90 kg/s	4 m	x 4 m	x 6 m	7-15

⁺depending on Mach-Number

3 AIR SUPPLY FACILITIES

SUPPLY 1000 m³ compressed dry air storage at 6000 kPa (about 70 Mg)
for blow-down mode

10 kg/s at 6000 kPa continuous

HEATING Regenerative heater: max. temperature 800 K
max. pressure 3500 kPa
capacity 60 kg/s for 1 min up to
800 K

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Motoren- und Turbinen-Union München GmbH

ADDRESS : Postfach 50 06 40
8000 München 50
Fed. Rep. of Germany

CONTACT : Dep. EVP
Development Test Facilities

Phone 89-1489-708

2 TEST CELLS

Designation	Engine	Altitude of Test St.	Mass Flow kg/s	Size H W L	Page
ETB 1	TJ	0.5 km	250/700 ⁺	6 m x 6 m x 20 m	
ETB 2	TJ	0.5 km	250/700 ⁺	6 m x 6 m x 20 m	
Open Air Test Bed	TJ	0.5 km	100	6 m x 6 m x 12 m (mobile hangar)	7-14
ETB 3	TS	0.5 km	2.5/5 ⁺	4 m x 4 m x 7 m	
ETB 4	TS	0.5 km	2.5/6 ⁺	4 m x 4 m x 7 m	
ETB 6	TS	0.5 km	3	4 m x 4 m x 7 m	
ETB 7	TS	0.5 km	2	4 m x 4 m x 7 m	
ETB 9	TJ	0.5 km	5		

⁺ Supply/Exhaust Capacity

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Universität Stuttgart

ADDRESS : Pfaffenwaldring 6
7000 Stuttgart 80 (Vaihingen)
Fed. Rep. of Germany

CONTACT : Direktor, Institut für Luftfahrt-Antriebe
Phone 711-7841 Telex 07 255 727

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow kg/s	Size	Page
HPT	TJ RJ	20 km	70	Diam 3 m, Length 10 m	6-23
HPT ¹⁾	TS	16 km	70	3 m	10 m 6-23

1) alternative use

3 AIR SUPPLY AND EXHAUST FACILITIES

Compressor	volumetric flow	pressure ratio	entry temp.	application
AV 1	60 m ³ /s	2.2 (max. 2.5)	303 K	exhaust only
AV 2	31 m ³ /x	2.2 (max. 2.5)	303 K	ram + exhaust
AV 3	16 m ³ /s	2.0 (max. 2.5)	303 K	ram + exhaust

Cooling turbine

	mass flow	pressure ratio	entry/exit temp.	application
LT 1	13 kg/s	up to 9	263 K/208-263 K	ram air cooling
LT 2	13 kg/s	up to 9	263 K/208-263 K	ram air cooling

Refrigeration system:

Two stage system capable of pre-cooling (before entering the cooling turbines) maximum mass flow 52 kg/s to 263 K during 4 hours.

Dryer

Absorption dryer may be used before passing the air flow into the second cooling stage of the refrigeration system.

Heater

Inlet air flows of 40 kg/s may be heated up to 423/450 K by a hot water heater which receives the heat either from a steamplant or from the exhaust gas cooler.

4 SUPPLEMENTARY INFORMATION

Höhenprüfstand für Turboflugtriebwerke,
Beschreibung der Anlage
ILA 80 A - 04

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Alfa Romeo Aviazione
Azienda di Pomigliano d'Arco

ADDRESS : 80 038 Pomigliano d'Arco
Napoli
Italy

CONTACT : Technical Director

Phone 8841344 Telex 710083 ALFAPO

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow	Size H x W x L	Page
Hangar TB	TS	Sea L.		6 m x 5 m x 14 m	7-27
Dynamom. Test Bed	TS	Sea L.		4 m x 5 m x 7 m	

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Elicotteri Meridionali

ADDRESS : Via G. Agusta 1
03100 Frosinone
Italy

CONTACT : Allison 250 Technical and Service Manager

Phone 0775-82801 Telex 611377

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow	Size H	W	L
	TS	Sea Level	3 kg/s	8 m	x 7 m	x 9 m

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Fiat Aviazione S.p.A.

ADDRESS : Corso Ferrucci 122
10100 Torino
Italy

CONTACT : Direzione Progettazione

Phone 11 - 332133
Telex FIATAP 221 564

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow	Size		
				H	W	L
Fiat Sangone Cell No 6	TJ	Sea Level	400 kg/s	10 m	9 m	27 m
Fiat Sangone Cell No 9	TS	Sea Level		4 m	4.4 m	10 m

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Lucas Aerospace Ltd.

ADDRESS : Oldwich Lane, Fen End
Kenilwerth, Warwickshire
England

CONTACT : Engineer in Charge, Engine Management Division

Phone Berkswell 32761 Telex 338781

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow	Size
Honiley	TJ	Sea Level		5.5 m x 7.4 m x 21 m

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : National Gas Turbine Establishment
 ADDRESS : Pyestock, Farnborough, Hants GU 14 OLS
 England
 CONTACT : Director, NGTE
 Phone 0252-44411 Telex 858 231

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow kg/s	Size Diam	Length	Page
Cell 4	TJ/RJ	0 ÷ 30 km ⁺	270	9 m	21 m	6- 4
Cell 1	TJ/RJ	0 ÷ 30 km ⁺	180	3.7 m	37 m	6- 5
Cell 3	TJ/RJ	0 ÷ 19 km	270	6 m	24 m	6-28
Cell 3 W	TJ	0 ÷ 18 km	630	7.5 m	17 m	6-29
Cell 2	TJ/RJ	0 ÷ 17 km	180	3.7 m	37 m	6-30
Glen Test House	TJ/TS	Sea Level	200			

⁺Supersonic free jet with spill diffusion

3 AIR SUPPLY AND EXHAUST FACILITIES

NGTE has a central air supply/exhaust system serving all the test cells with local additional heating/cooling of the inlet air at the cells.

3.1 SUPPLY

Compressors: 8 GEC centrifugal sets which can be used either as compressors or exhausters at 9/1 or 3/1 pressure ratio.
 As compressors: 90 kg/s at 910 kPa abs per set
 or 122 kg/s at 304 kPa abs per set
 Maximum power supply to site allows five sets to be run as compressors (135 MW)
 Two axial compressors each giving 27 kg/s at 600 kPa abs.

Cooling: Minimum inlet temperature at cell:
 Cell 1 - ambient
 Cell 2 - ambient
 Cell 3 - 41 kg/s at 200K from expansion turbine
 Cell 3W-363 kg/s at 236K from cold store system
 Cell 4 - ambient

Heating: Maximum inlet temperature at cell:
 Cell 1 - 483K + 3 MW trimming heater
 Cell 2 - 483K + 3 MW trimming heater
 Cell 3 - 255 kg/s at 480 K plus 45 kg/s at 870K from oil fired heater
 Cell 3W- ambient
 Cell 4 - 255 kg/s at 480 K plus 45 kg/s at 870 K from oil fired heater

3.2 EXHAUST

8 GEC centrifugal sets which can be used as exhausters:
 9.4 kg/s at 11.3 kPa abs per set in 9/1 pressure ratio arrangement, or:
 37 kg/s at 33.8 kPa abs per set in 3/1 pressure ratio arrangement
 One axial exhaustor: 25 kg/s at 11.3 kPa abs with maximum driving power of 25 MW
 One axial exhaustor: 11.3 kg/s at 7.8 kPa abs with maximum driving power limit of 27 MW
 (No 9 m/c)

4. SUPPLEMENTARY INFORMATION

General description and background: Engineering, June 14,21,28 1957

Cell 3W: An altitude test facility for large turbofan engines
 P F Ashwood, Journal of Aircraft, Vol. 10, No 8, August 1973

Cell 4: Free jet testing of supersonic intake/engine combination
 P F Ashwood, Journal Royal Aeronautical Society, Vol. 74, pp 205-212, 1970

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Noel Penny Turbines Ltd

ADDRESS : Siskin Drive, Toll Bar End
Coventry CV 3 4 FE
England

CONTACT : A. F. Varney

Phone 0203-301528
Telex Penny 311 065

2 TEST CELLS

Five test cells suitable for sea-level testing of turbo-shaft engines (maximum power 2575 kW).
The number of test cells may rise to eight within the near future.

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Plessey Co. Ltd.

ADDRESS : Vicarage Lane
Ilford, Essex
England

CONTACT : Test Facility Manager
Deputy Engineering Executive

Phone Titchfield 43031 Ext. 2428/2401

2 TEST CELLS

Designation	Engine	Altitude	Mass Flow	Size H	W	L	Page
Plessey Aerospace Test Fac. (6 cells)	TS	Sea Level	4.5 kg/s	2.7 m	x 4.6 m	x 9.1 m	7-26

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Rolls Royce Ltd

1. Aero Division Bristol (RR - BR)

ADDRESS : P.O. Box 3
Filton, Bristol
EnglandCONTACT : Assistant Chief Engineer
Test Engineers Department
Phone Bristol 693872 Ext. 384

2. Aero Division Derby (RR - DE)

ADDRESS : P.O. Box 31
Derby DE 2 8BJ
England

CONTACT : Phone 0332-42424 Telex 37645

3. Hatfield (RR - HA)

ADDRESS : Manor Road
Hatfield
EnglandCONTACT : RR Site Manager
Phone Hatfield 63830

4. Hucknall (RR - HU)

ADDRESS :

CONTACT :

2 TEST CAPACITY OF ORGANISATIONS

2 TEST CELLS

Designation	Engine	Altitude km	Mass Flow kg/s	Size H W L	Page
BR TP 131 A	TJ/RJ	27.4	182	Diam 3.05m x 24.4 m	6 - 7
DE ATF Cell 1	TJ/TS	21.3	272	Diam 3.81m x 11.5 m	6 - 19
DE ATF Cell 2	TJ	21.3	272	2.75m x 3.81m x 11.5 m	6 - 19
HU TB No 9	TJ	Sea Level	unlimited	open air test bed (accept large fan engines)	7 - 1
BR METS A+B	TJ	Sea Level	unlimited	6300m ² concrete area	7 - 2
HU TB No 5	TJ/TS	Sea Level	unlimited	open air test bed (no large fan engines)	7 - 6
HU TB No 7	TJ/TS	Sea Level	unlimited	open air test bed	7 - 7
DE TB No 48	TJ	Sea Level	1000	12 m x 10 m x 64 m	
DE TB No 49	TJ	Sea Level	1000	12 m x 10 m x 64 m	
HU TB No 10	TJ	Sea Level	907		
BR TP 105	TJ	Sea Level	536	13.4mx 11.9m x 21.0m	7 - 10
BR TP 137	TJ	Sea Level	536	13.4mx 11.9m x 24.0m	7 - 10
BR TP 107	TJ	Sea Level	454	7.3mx 7.0m x 11.6m	
BR TP 103	TJ	Sea Level	304	7.8mx 10.5m x 21.9m	
BR TP 104	TJ	Sea Level	304	7.8mx 10.5m x 21.9m	
BR TP 140	TJ	Sea Level	272	9.8mx 9.4m x 44.2m	
BR TP 141	TJ	Sea Level	272	9.8mx 9.4m x 45.4m	
HU TB No 8	TJ/TS	Sea Level	204	6.1mx 6.1m x 6.1m	7 - 12
DE TB No 41	TJ	Sea Level	180	7.6mx 7.3m x 17.4m	
DE TB No 42	TJ	Sea Level	180	7.6mx 7.3m x 17.4m	
DE TB No 43	TJ	Sea Level	180	7.6mx 7.3m x 17.4m	
DE TB No 44	TJ	Sea Level	180	7.6mx 7.3m x 17.4m	
HU TB No 2	TJ	Sea Level	180	7.6mx 7.3m x 15.2m	
BR TP 108	TJ	Sea Level	170	7.0mx 7.0m x 21.0m	
BR TP 131 E	TJ	Sea Level	77	6.4mx 8.5m x 20.7m	
BR TP 125	TJ	Sea Level	77	2.7mx 5.5m x 13.1m	
DE Hangar H	TS	Sea Level	1800	7.9mx 7.9m x 44 m	7 - 19
DE TB No 16	TS	Sea Level	26	5.2mx 5.2m x 22 m	
DE TB No 18	TS	Sea Level	26	5.2mx 5.2m x 22 m	
HA TB No 16	TS	Sea Level		7.6mx 4.9m x 11.6m	7 - 21
HA TB No 15	TS	Sea Level		2.0mx 4.9m x 8.2m	7 - 22
HA TB No 19	TS	Sea Level		2.0mx 4.9m x 8.2m	
HA TB No 12	TS	Sea Level		2.7mx 4.9m x 6.0m	7 - 23
HA TB No 13	TS	Sea Level		2.7mx 4.9m x 6.0m	7 - 23
HA TB No 13 A	TS	Sea Level		2.7mx 4.9m x 6.0m	7 - 23
HA TB No 20	TS	Sea Level		2.7mx 4.9m x 6.0m	
HA TB No 11	TS	Sea Level		5.1mx 4.9m	
HA TB No 21	TS	Sea Level		4.9mx 4.8m x 42.7m	7 - 25

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Air Force Aero Propulsion Laboratory

ADDRESS : Wright-Patterson Air Force Base
Ohio 45433
USA

CONTACT : Technical Area Manager
AFWAL / POTC

Phone 513 - 255 - 2121

2 TEST CELLS

Designation	Engine	Altitude km	Mass Flow kg/s	Size
Ramjet	TJ/RJ	16.8	109	
TC 21	TJ	15.2	109	Diam 3.0 m x 5.2 m
TC 24	TJ	15.2	109	Diam 3.7 m x 6.1 m
Sea Level Eng.Test Fac.	TJ	Sea L.	1045	13 m x 10 m x 27 m

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : AIR esearch Manufacturing Co.
Propulsion Engines Laboratory

ADDRESS : 20 000 Van Ness Avenue
Torrance, California, USA

CONTACT :

2 TEST CELLS

Two sea level development test cells both accepting turbojet engines producing up to 111 kN thrust.

Test cell inner dimensions are 6.7 m x 7 m x 25.9 m

The test cells are equipped with the real time engine guard system (50 channels: 20 temperatures, 20 pressures, 6 frequencies, 4 misc.). and a data logging system (300 temperatures, 552 pressures, 36 differential pressures, 10 frequencies, and 60 miscellaneous). Also fully automatic control of engine testing is possible by T-PEC (taped program engine controller).

3 -

4 SUPPLEMENTARY INFORMATION

R. S. OLIVE Modern Jet Engine Development Facility
ASME Paper 71-WA/GT-6

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Arnold Engineering Development Center
 ADDRESS : Arnold Air Force Station
 Tennessee 37389
 USA
 CONTACT : AEDC/DOX

2 TEST CELLS

Designation	Engine	Altitude km	Mass Flow kg/s	Size H W L	Page
PWT 16 S	TJ/RJ	47.2		4.9 m x 4.9 m x 12.2 m	6 - 1
ASTF C ₂ ¹⁾	TJ/RJ	30.5	1250	Diam 8.5 m x 25.9 m	6 - 2
APTU	RJ	30.5	863	Diam 1.2 m x 12.8 m	6 - 3
ASTF C ₁ ¹⁾	TJ/RJ	30.5	660	Diam 8.5 m x 25.9 m	6 - 2
PWT 16 T	TJ/RJ	27.5		4.9 m x 4.9 m x 12.2 m	6 - 6
J-1	TJ/RJ	24.4	636	Diam 4.9 m x 21.9 m	6 - 8
J-2	TJ/RJ	24.4	636	Diam 6.1 m x 21.0 m	6 - 9
T-1	TJ/RJ	24.4	363	Diam 3.7 m x 22.9 m	6 - 10
T-2	TJ/RJ/TS	24.4	363	Diam 3.7 m x 20.7 m	6 - 11
T-4	TJ/RJ	24.4	363	Diam 3.7 m x 16.8 m	6 - 12
T-6	TJ	24.4	170	Diam 0.9 m x 5.5 m	6 - 15
T-5	TJ/RJ	24.4	41	Diam 2.1 m x 5.2 m	6 - 17

3 AIR SUPPLY AND EXHAUST FACILITIES

The AEDC is comprised of various highly versatile facilities of which the following are relevant for this register:

- | | | |
|--|---------------|----------|
| 1. Propulsion Wind Tunnel | 16 Supersonic | PWT 16 S |
| 2. Propulsion Wind Tunnel | 16 Transonic | PWT 16 T |
| 3. Aerodynamic and Propulsion Test Unit | | APTU |
| 4. Engine Test Facility - Basic (T-Cells) | | ETF - B |
| 5. Engine Test Facility - Addition (J-Cells) | | ETF - A |
| 6. Aeropropulsion Systems Test Facility | | ASTF |

Each facility is equipped with its individual supply and exhaust system which may be linked to a certain extent in support of the test cells listed above.

3.1 SUPPLY

		air mass flow kg/s	pressure kPa
Compressors	ETF-B 4 centrifugal (one stage)	82	275
	ETF-A 3 axial flow (one stage)	200	275
	ETF-A+B (two stage)	215	930
	ASTF 6 axial flow (two stage) (4 x 20.1 MW 2 x 39.1 MW)	500	1034
	(one stage)	660	275
Storage	APTU 630 m ³ high pressure air storage reservoir containing about 204.000 kg at 27.6 MPa		
Heating	ETF-A indirect fired heater maximum temperature air mass flow		672 K 227 kg/s
	ASTF heat input to process air		287.5 MW
	APTU regenerative storage heater maximum matrix temperature max. air mass flow vessel design pressure plus vitiated air heater		1366 K 116 kg/s 34.5 MPa

2 TEST CAPACITY OF ORGANISATIONS

Cooling	ETF-B	continuous mech. refrigeration	3.33 MW
	ETF-A	continuous mech. refrigeration	8.54 MW
	ASTF	electromechanical refrigeration	28.7 MW
		plus	
		five refrigeration turbines	
		each 136 kg/s from 250 K to 195 K	

3.2 EXHAUST

		mass flow kg/s	pressure kPa
ETF-B	6 centrifugal compressors	204	from 30.3
ETF-A	2 axial flow compressors		
ASTF	8 axial flow compressors	136	from 4.1
	(each 20.5 MW)	272	from 12.4
	4 axial flow compressors	1133	from 31.0
	(each 32.8 MW)		

(Suction capacity of PWT plenum evacuation compressors may be used for exhaust augmentation of ETF-B and ETF-A)

4. SUPPLEMENTARY INFORMATION

AEDC Test Facilities Handbook, June 1979

J.G. Mitchell The Airo-Propulsion Systems Test Facility
AIAA-Paper No. 72-1034

J.R. Rickard Instrumentation and Control for a Large Engine Test
M.W. Lawley Facility
to be found in
Imaginative Engineering through Education and Experience.
Proc. of the Southeast Region 3. Conference
Williamsburg, Va. April 4-6, 1977,
New York, Institute of Electrical and Electronics
Engineers Inc.
1977, p 511-514

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : General Electric Co.
ADDRESS : Cincinnati, Ohio 45215
USA
CONTACT :

2 TEST CELLS

Designation	Engine	Altitude km	Mass Flow kg/s	Size
TC-43	TJ	24.4	454	Diam 5.2 m x 17.1 m
TC-44	TJ	24.4	182	Diam 5.2 m x 17.1 m

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : General Motors Corporation
Detroit Diesel Allison Division

ADDRESS : 2355 S. Tibbs Avenue
Indianapolis, Indiana 46241
USA

CONTACT :

2 TEST CELLS

Designation	Engine	Altitude km	Mass Flow kg/s	Size
871-2	TS	20	54.5	Diam 6.1 m x 12.2 m
881	TJ	15.2	190	Diam 5.5 m x 20.7 m
873	TJ/TS	13.7	45.4	Diam 4.3 m x 12.2 m
885	TS	7.6	2.5	Diam 5.5 m x 14.6 m

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : The Johns Hopkins University
Applied Physics Laboratory

ADDRESS : Laurel, Maryland 20810
USA

CONTACT :

2 TEST CELLS

Designation	Engine	Altitude km	Mass Flow kg/s	Size H W L
TC-1	RJ	45.7	68	3.7 m x 3 m x 12.2 m
TC-2	RJ	45.7	68	3.7 m x 3 m x 12.2 m
TC-3	RJ	45.7	68	3.7 m x 3 m x 12.2 m
TC-4	RJ	45.7	68	3.7 m x 3 m x 12.2 m

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : The Marquardt Co.
ADDRESS : 16 555 Saticoy Street
Van Nuys, California 91409
CONTACT :

2 TEST CELLS

Designation	Engine	Altitude km	Mass Flow kg/s	Size
TC-8	TJ/RJ	52	363	Diam 4.3 m x 24.4 m
TC-2	TJ/RJ	24.4	182	Diam 3.0 m x 18.3 m
TC-7	RJ			Diam 1.8 m x 9.1 m

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : National Aeronautics and Space Administration
Lewis Research Center

ADDRESS : 21 000 Brookpark Road
Cleveland, Ohio 44 135
USA

CONTACT :

2 TEST CELLS

Designation	Engine	Altitude km	Mass Flow kg/s	Size	Page
PSL-4	TJ	21.3	340	Diam 7.3 m x 11.6 m	6-18
PSL-3	TJ	21.3	340	Diam 7.3 m x 11.6 m	6-18
PSL-1	TJ/RJ	21.3	204	Diam 4.3 m x 7.3 m	6-20
PSL-2	TJ/RJ	21.3	204	Diam 4.3 m x 7.3 m	6-20

3 AIR SUPPLY AND EXHAUST FACILITIES

SUPPLY		air mass flow kg/s	pressure kPa
	Central Supply System	217	414
		174	1138
		17.2	3206
Heating	2 J57 heat exchangers		
	127 kg/s to 922 K (max. pressure 1138 kPa)		
Cooling	3 turboexpanders		
	181 kg/s to 205 K		

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Naval Air Propulsion Center

ADDRESS : P.O. Box 7176
Trenton, New Jersey 08628
USA

CONTACT : Resource Management Officer
Code RM

Phone 609-882-1414 Ext. 298 or 373

2 TEST CELLS

Designation	Engine	Altitude km	Mass Flow kg/s	Size H W L	Page
3 E	TJ/RJ	24.4	318	Diam 5.2 m x 9.1 m	6-13
2 E	TJ	24.4	195	Diam 4.4 m x 5.5 m	6-14
1 E	TJ	24.4	195	Diam 4.4 m x 5.5 m	6-14
3 W	TS	20.0	54.5	2.4 m x 2.4 m x 4.6 m	6-24
4 W	TS	20.0	54.5	Diam 3.0 m x 6.1 m	6-25
5 W	TS	20.0	54.5	2.9 m x 2.9 m x 5.2 m	6-26
6 W	TS	20.0	54.5	3.0 m x 3.0 m x 5.2 m	6-27
SLC 1 W	TJ/TS	Sea Level	159	4.3 m x 7.0 m x 17.1 m	7-13
SLC 2 W	TJ/TS	Sea Level	159	4.3 m x 7.0 m x 17.1 m	7-13
Var. Atti- tude Test Stand	TJ/TS	Sea Level	unlimited	Wing and Engine Center Line 1.5 ÷ 7.6 m above ground	7-3
Turntable Engine Stand	TJ/TS	Sea Level	unlimited		7-4

3 AIR SUPPLY AND EXHAUST FACILITIES

Ram air facility	Fixed exhaust diffuser (1 E/2 E)
Air heater	
Air cooler	Test cell refrigeration
Exhaust gas cooler	Liquid air cooling system
Vacuum exhauster	

(1 W/2 W)

2 TEST CAPACITY OF ORGANISATIONS

1 ORGANISATION

NAME : Teledyne CAE/USAF Plant 27

ADDRESS : 1330 Laskey Road
Toledo, Ohio 43613
USA

CONTACT :

2 TEST CELLS

Designation	Engine	Altitude km	Mass Flow kg/s	Size H W L
TC-1	TJ	27.4	10(25) ¹⁾	0.8 m x 1.2 m x 2.1 m
TC-2	TJ	27.4	10(25) ¹⁾	0.8 m x 1.2 m x 2.1 m
Environmental Chamber	TJ	Sea Level		
Cell 41	TJ	Sea Level	27	

plus 8 additional sea level test cells not primarily used for research and development work.

¹⁾ mass flow if altitude does not exceed 4.6 km

3 AIR SUPPLY AND EXHAUST FACILITIES

SUPPLY

Four compressors each delivering 5 kg/s, pressure ratio 1.33.
Compressors can be valved in series and parallel.

Two steam heaters each heating 5 kg/s up to 355/375 K
(Electrical heater (TC-1 and TC-2) 540 KW max.
discharge temperature 411 K)

One water cooler 5 kg/s to 267 K

Refrigeration system: total cooling capacity 530 kW
(stage discharge temperature are 277/310 K, 275 K, 241 K, and 219 K)

EXHAUST

Exhaust gas water cooler (TC-1 and TC-2) 11.7 MW

Fourteen vane type positive displacement vacuum pumps.

4 SUPPLEMENTARY INFORMATION

D.J. Fressie Teledyne CAE Small Gas Turbine Test Complex
ASME Paper 71-WA/GT-7

2 TEST CAPACITIES OF ORGANISATIONS

1 ORGANISATION

NAME : United Technologies Corporation
 and
 ADDRESS 1 Pratt & Whitney Aircraft Division
 Government Products Division
 Florida Research and Development Center
 P.O. Box 2691
 West Palm Beach, Florida 33402, USA

2 Pratt & Whitney Aircraft Division
 Commercial Products Division
 Andrew Willgoos Turbine Laboratory
 East Hartford, Connecticut 06 108, USA

3 Chemical Systems Division
 P.O. Box 458
 Sunny vale, California, USA

2 TEST CELLS

Place	Designation	Engine	Altitude km	Mass Flow kg/s	Size	Page
FL	A - 1	TJ	simulated	114		6-37
FL	C - 4	TJ	simulated	55		6-38
FL	C - 5	TJ	simulated	55		6-38
FL	A - 2	TJ	Sea L.			
FL	A - 8	TJ	Sea L.			
FL	C -10	TJ	Sea L.			
CT	X -207	TJ	27.4	263	7 m	
CT	X -208	TJ	27.4	263	Diam 3.7 m x 10.4 m	
CT	X -210	TJ	27.4	227	7.8 m	
CT	X -209	TJ	27.4	147.6	Diam 3.7 m x 10.4 m	
CT	X -217	TJ	13.7	545	Diam 5.5 m x 10.7 m	6-32
CA	IRR-GTF	RJ	24.4	81.6		6-16

3. AIR SUPPLY AND EXHAUST FACILITIES

1. Florida Research and Development Center
no information available
2. Andrew Willgoos Turbine Laboratory
- Power Supply:
- o Six naval cruiser-type boilers producing 503 t/h steam at 3 MPa and 666 K i.e. about 102 MW.
 - Twenty-one steam turbines in the range of 4.4 ÷ 29.4 MW
 - o Three P & W industrial gas turbines (type FT4A-8LF) each rated at 21 MW (3600 rpm) for 26.7°C - day, particularly used for driving six exhausters.
- Ram Air Facility:
- o Thirteen air compressors (five different types of machines) to be operated in various combinations and delivering e. g. 265 kg/s at 304 kPa
60 kg/s at 847 kPa
 - o Air refrigeration system T ≥ 216 K
 - o Air heating system e.g. 265 kg/s up to 630 K
- Exhaust:
- Twelve centrifugal exhausters (32.3 m³/s each)
- eight exhausters may be used as compressors also.
- Six axial exhausters (133.6 m³/s each).
3. Chemical System Division
- Ram Air Supply:
- o Compressed air storage 13.600 kg air at 16.9 MPa
 - o Vitiated air heater
 - o Oxygen addition and control
- Exhaust System
- o Steam accumulator (34.000 kg of steam at a rate of 34 kg/s)
 - o Steam driven ejector

4. SUPPLEMENTARY INFORMATION

- G. P. Adamson: Jet Engine Test Facilities: Laboratories for
Tomorrow's Engines
ASME Paper 71-WA/GT-12
- T. D. Myers Ground Test Facility for Integral Rocket Ramjet Engines
G. Stromberg
AIAA/SAE 14th Joint Propulsion Conference, Paper No. 78-934
Las Vegas, Nev., July 25 - 27, 1978

3 LIST OF ALTITUDE TEST CELLS

ENGINE TJ RJ TS	ALTITUDE KM	MACH RANGE	MAX.MASS FLOW RATE KG/S	TEST FACILITY DESIGNATION	PAGE	ORGANISATION NAME	PAGE
x x	52	0.8-8.2	363	TC-8		MAR	2-26
x x	13.7-47.2	1.5-4.75		PWT 16 S	6-1	AEDC	2-22
x	45.7	1 -10	68	TC-1		JHU-APL	2-25
x	45.7	1 -10	68	TC-2		JHU-APL	2-25
x	45.7	1 -10	68	TC-3		JHU-APL	2-25
x	45.7	1 -10	68	TC-4		JHU-APL	2-25
x x	30.5	0 - 3.8	1,250	ASTF C 2	6-2	AEDC	2-22
x	30.5	0 - 5.6	863	APTU	6-3	AEDC	2-22
x x	30.5	0 - 3.8	660	ASTF C 1	6-2	AEDC	2-22
x x	30.0	0 - 3.5	270	ATF Cell 4	6-4	NGTE	2-16
x x	30.0	0 - 3.5	180	ATF Cell 1	6-5	NGTE	2-16
x x	27.5	0.2-1.5		PWT 16 T	6-6	AEDC	2-22
x	27.4	0 - 3.0	263	X-207		P & W - AW	2-30
x	27.4	0 - 3.0	263	X-208		P & W - AW	2-30
x	27.4	0 - 3.0	227	X-210		P & W - AW	2-30
x x	27.4	0 - 4.2	182	TP 131 A	6-7	RR-BR	2-19
x	27.4	0 - 3.0	147.6	X-209		P & W - AW	2-30
x	27.4	0 - 2.0	10	TC-1		TE-CAE	2-29
x	27.4	0 - 2.0	10	TC-2		TE-CAE	2-29
x x	24.4	0 - 3.3	636	J-1	6-8	AEDC	2-22
x x	24.4	0 - 3.3	636	J-2	6-9	AEDC	2-22
x	24.4	0 - 3.0	454	TC-43		GE	2-23
x x	24.4	0 - 3.0	363	T-1	6-10	AEDC	2-22
x x x	24.4	0 - 3.0	363	T-2	6-11	AEDC	2-22
x x	24.4	0 - 3.0	363	T-4	6-12	AEDC	2-22
x x	24.4	0 - 3.0	318	3 E	6-13	NAPC	2-28
x	24.4	0 - 2.4	195	2 E	6-14	NAPC	2-28
x	24.4	0 - 2.4	195	1 E	6-14	NAPC	2-28
x x	24.4	0.8-5.0	182	TC-2		MAR	2-26
x	24.4	0 - 3.0	182	TC-44		GE	2-23
x	24.4	0 - 3.0	170	T-6	6-15	AEDC	2-22
x	24.4		81.6	IRR-GTF	6-16	UT-CSD	2-30
x x	24.4	0 - 1.5	41	T-5	6-17	AEDC	2-22
x	21.3	0 - 4.0	340	PSL-4	6-18	NASA-LE	2-27
x	21.3	0 - 3.0	340	PSL-3	6-18	NASA-LE	2-27
x x	21.3	0 - 2.5	272	ATF Cell 1	6-19	RR-DE	2-19
x	21.3	0 - 2.5	272	ATF Cell 2	6-19	RR-DE	2-19
x x	21.3	0 - 3.0	204	PSL-1	6-20	NASA-LE	2-27
x x	21.3	0 - 3.0	204	PSL-2	6-20	NASA-LE	2-27
x	20.0	0 - 4.0	375	R 5	6-21	CEPr	2-7
x	20.0	0 - 2.4	200	R 3	6-22	CEPr	2-7
x	20.0	0 - 2.4	200	R 4	6-22	CEPr	2-7
x x x	20.0	0 - 2.2	70	HPT	6-23	US-ILA	2-11
x	20.0	0 - 1.0	54.5	871-2		DDAD	2-24
x	20.0		54.5	3 W	6-24	NAPC	2-28
x	20.0		54.5	4 W	6-25	NAPC	2-28
x	20.0		54.5	5 W	6-26	NAPC	2-28
x	20.0		54.5	6 W	6-27	NAPC	2-28

3 LIST OF ALTITUDE TEST CELLS

ENGINE TJ RJ TS			ALTITUDE KM	MACH RANGE	MAX.MASS FLOW RATE KG/S	TEST FACILITY DESIGNATION	PAGE	ORGANISATION NAME	PAGE
x	x		19.0	0 - 3.5	270	ATF Cell 3	6-28	NGTE	2-16
x			18.0	subsonic	630	ATF Cell 3 W	6-29	NGTE	2-16
x	x		17.0	0 - 2.5	180	ATF Cell 2	6-30	NGTE	2-16
x	x		16.8		109	Ramjet		AFAPL	2-20
x			15.2	0 - 1.0	190	881		DDAD	2-24
x			15.2	0 - 1.5	109	TC 21		AFAPL	2-20
x			15.2	0 - 1.5	109	TC 24		AFAPL	2-20
x	x	x	15.0	0 - 2.0	100	S 1	6-31	CEPr	2- 7
x			13.7	0 - 1.0	545	X-217	6-32	P & W - AW	2-30
x	x		13.7	0 - 1.0	45.4	873		DDAD	2-24
x	x		13.7		5.4	ALT.FAC.	6-33	NRC	2- 3
x	(x)		11.0 (5.6)	0 - 1.0	55	C 1	6-34	CEPr	2- 7
x	x		10.0	0.1-1.0		R 2	6-35	CEPr	2- 7
x	x		10.0	0.1-1.0		R 6	6-36	CEPr	2- 7
	x		7.6	<1.0	2.5	885		DDAD	2-24
	x					TC-7		MAR	2-26
x						A-1	6-37	P & W - FL	2-30
x						C-4	6-36	P & W - FL	2-30
x						C-5	6-38	P & W - FL	2-30

4 LIST OF SEA LEVEL TEST FACILITIES

ENGINE			MASS FLOW KG/S	THRUST/ SHAFT P. KN/KW	SPECIAL CAPABILITY SECTION	TEST FACILITY		ORGANISATION	
TJ	RJ	TS				DESIGNATION	PAGE	NAME	PAGE
x			Unlimited	310 kN	5.3/5.5/5.12	TB No 9	7-1	RR-HU	2-19
x			Unlimited	222 kN	5.1/5.3/5.8	METS A+B	7-2	RR-BR	2-19
x	x		Unlimited	222 kN	5.4/5.8/5.10	Var.Attitude Stand	7-3	NAPC	2-28
x	x		Unlimited	222 kN	5.3/5.12	Turntable Engine Stand	7-4	NAPC	2-28
x	x		Unlimited	180 kN	5.2	TX	7-5	CEPr	2-7
x	x		Unlimited	2x90kN	5.2/5.5/5.10	TB No 5	7-6	RR-HU	2-19
x	x		Unlimited	90(45) ¹⁾ kN	5.3/5.5	TB No 7	7-7	RR-HU	2-19
x			Unlimited			ISite No 3		SNECMA	2-8
x			Unlimited			I " No 5		SNECMA	2-8
x				445 kN	5.7	A-8	7-8	P&W-FL	2-30
x				334 kN	5.8	C-10		P&W-FL	2-30
x	x		1300	20 kN Lift 10 kN Drag		Propulsion Tunnel		NRC	2-3
x			1200	250 kN		T 1		CEPr	2-7
x			1045	267 kN		SLETF		AFAPL	2-20
x			1000	310 kN	5.8	TB No 48		RR-DE	2-19
x			1000	310 kN	5.8	TB No 49		RR-DE	2-19
x			907	310 kN	5.2/5.5	TB No 10		RR-HU	2-19
x				267 kN		A-2		P&W-FL	2-30
x				180 kN		No 3 TB		RR-CA	2-5
x			536	178 kN	5.8	TP 105	7-10	RR-BR	2-19
x			536	178 kN	5.8	TP 137	7-10	RR-BR	2-19
x			500			W 1 C 7		SNECMA	2-8
x			500			W 1 H 8		SNECMA	2-8
x			454	98 kN	5.11	TP 107		RR-BR	2-19
x			400			W 2 C 7		SNECMA	2-8
x			400	100 kN		Cell No 6		FIAT	2-14
x			304	98 kN	5.11	TP 103		RR-BR	2-19
x			304	98 kN	5.11	TP 104		RR-BR	2-19
x			272	222 kN	5.7	TP 140		RR-BR	2-19
x			272	222 kN	5.7	TP 141		RR-BR	2-19
x				222 kN		5-11	7-11	P&W-AC	2-4
x			250 ²⁾	80 kN		ETB No 1		MTU	2-10
x			250 ²⁾	80 kN		ETB No 2		MTU	2-10
x			227	22 kN		1-16 / 1-17		P&W-AC	2-4
x	x		204	133 kN		TB No 8	7-12	RR-HU	2-19
x	x		200	190 kN		Glen Test House		NGTE	2-16
x			200			W 11 H 7		SNECMA	2-8
x			180	130 kN	5.11	TB No 41		RR-DE	2-19
x			180	130 kN	5.11	TB No 42		RR-DE	2-19
x			180	130 kN	5.11	TB No 43		RR-DE	2-19
x			180	130 kN	5.11	TB No 44		RR-DE	2-19
x			180	90 kN	5.8	TB No 2		RR-HU	2-19
x			170	222 kN	5.11	TP 108		RR-BR	2-19
x	x		159	133 kN	5.1/5.9	SLC 1 W	7-13	NAPC	2-28
x	x		159	133 kN	5.1/5.9	SLC 2 W	7-13	NAPC	2-28
x			136	135 kN		No 5 TC		NRC	2-3

1) Reverse thrust 2) Exhaust 700

4 LIST OF SEA LEVEL TEST FACILITIES

ENGINE			MASS FLOW KG/S	THRUST/ SHAFT-P. KN/KW	SPECIAL CAPABILITY SECTION	TEST FACILITY		ORGANISATION	
TJ	RJ	TS				DESIGNATION	PAGE	NAME	PAGE
x				111 kN				AIRes.	2-21
x				111 kN				AIRes.	2-21
x			100	80 kN	5.2/5.4	Field	7-14	MTU	2-10
x			100			W 9 H 7		SNECMA	2-8
x			100			W 10 H 7		SNECMA	2-8
x			100			W 12 H 7		SNECMA	2-8
x			100			W 7 H 5		SNECMA	2-8
x			100			W 8 H 5		SNECMA	2-8
	x		90	10 kN	5.4	VMK	7-15	DFVLR	2-9
x				67 kN		No 2 TB		RR-CA	2-5
x				67 kN		Honiley		LUCAS	2-15
x			77	36 kN	5.12	TP 131 E		RR-BR	2-19
x			77		5.12	TP 125		RR-BR	2-19
x			27			Cell 41		TE-CAE	2-29
x					5.9	Env. Chamber		TE-CAE	2-29
x			15.2			No 1 TC		NRC	2-3
x			15.0		5.1	No 4 TC	7-16	NRC	2-3
x			5.0			ETB No 9		MTU	2-10
x	x				5.9	1-11 A	7-17	P&W-AC	2-4
x	x			2 kN 2000 kW	5.4	H 9	7-18	CEPr	2-7
		x		29 MW		Gas Turbine Test Fac.		WE-CA	2-6
		x		8950 kW		2-3		P&W-AC	2-4
		x	1800	6600 kW	5.6	Hangar H	7-19	RR-DE	2-19
		x	26	6600 kW	5.12	TB No 16		RR-DE	2-19
		x	26	6600 kW	5.12	TB No 18		RR-DE	2-19
		x		3900 kW		No 1 TB		RR-CA	2-5
5	x			60-2575 kW				NPT	2-17
	x			2200 kW	5.6	T 64	7-20	RR-CA	2-5
	x			1840 kW		2-1		P&W-AC	2-4
	x			1840 kW		1-5		P&W-AC	2-4
	x			1840 kW		TB No 16	7-21	RR-HA	2-19
	x		8.2	1765 kW		1-2		P&W-AC	2-4
	x		5.0	1470 kW		No 2 TC		NRC	2-3
	x			1470 kW	5.7	TB No 15	7-22	RR-HA	2-19
	x			1470	5.12	TB No 19		RR-HA	2-19
	x			1100 kW	5.7	TB No 12	7-23	RR-HA	2-19
	x			1100 kW	5.7	TB No 13/13A	7-23	RR-HA	2-19
	x			1100 kW		TB No 20		RR-HA	2-19
	x		385	956 kW	5.6	1-1	7-24	P&W-AC	2-4
	x		385	956 kW	5.6	1-6	7-24	P&W-AC	2-4
	x		385	956 kW	5.6	1-18	7-24	P&W-AC	2-4
	x		385	956 kW	5.6	2-4	7-24	P&W-AC	2-4
	x			956 kW		Dynamometer T.B.		AR	2-12
	x			735 kW	5.12	TB No 11		RR-HA	2-19
	x			662 kW	5.6	TB No 21	7-25	RR-HA	2-19
	x		2.5 ³⁾	660 kW		ETB No 3		MTU	2-10

3) Exhaust 5.0

4 LIST OF SEA LEVEL TEST FACILITIES

ENGINE			MASS FLOW KG/S	THRUST/ SHAFT-P. KN/KW	SPECIAL CAPABILITY SECTION	TEST FACILITY		ORGANISATION	
TJ	RJ	TS				DESIGNATION	PAGE	NAME	PAGE
x			3	660 kW		ETB No 6		MTU	2-10
x			2.5 ⁴⁾	500 kW				CC-AMPD	2-2
x				400 kW		ETB No 4		MTU	2-10
x				309 kW				EM	2-13
x			4.5	220 kW	5.1/5.2/5.3 5.8/5.12	PASTF	7-26	PL	2-18
x			2	180 kW		ETB No 7		MTU	2-10
x								CU-GTL	2-1
x					5.6	Hangar TB	7-27	AR	2-12
x						Cell No 9		FIAT	2-14

4) Exhaust 6.0

5 LIST OF TEST FACILITIES WITH SPECIAL CAPABILITIES

TYPE OF ENGINE	ALTITUDE	MASS FLOW	THRUST/ SHAFT-P.	TEST FACILITY		ORGANISATION	
	KM	KG/S	kN/kW	DESIGNATION	PAGE	NAME	PAGE
<u>5.1 I C I N G</u>							
TJ/RJ	24.4	636		J-1	6-8	AEDC	2-22
TJ/RJ	24.4	318	222 kN	3-E	6-13	NAPC	2-28
TJ	24.4	195	133 kN	2-E	6-14	NAPC	2-28
TJ	24.4	195	133 kN	1-E	6-14	NAPC	2-28
TJ	19.0	270	220 kN	ATF Cell 3	6-28	NGTE	2-16
TJ	18.0	630	220 kN	ATF Cell 3W	6-29	NGTE	2-16
TJ/TS	10.0			R 2	6-35	CEPr	2-7
TJ	Sea L.	Unlimited	222 kN	METS A+B	7-2	RR-BR	2-19
TJ/TS	Sea L.	159	133 kN	SLC 1 W	7-13	NAPC	2-28
TJ/TS	Sea L.	159	133 kN	SLC 2 W	7-13	NAPC	2-28
TJ	Sea L.	15		No 4 TC	7-16	NRC	2-3
TS	Sea L.	4.5	220 kW	PASTF	7-26	PL	2-18
<u>5.2 F O R E I G N O B J E C T D A M A G E</u>							
TJ	Sea L.	Unlimited	310 kN	TB No 9	7-1	RR-HU	2-19
TJ	Sea L.	Unlimited	222 kN	METS A+B	7-2	RR-BR	2-19
TJ/TS	Sea L.	Unlimited	180 kN	Tx	7-5	CEPr	2-7
TJ/TS	Sea L.	Unlimited	2x90 kN	TB No 5	7-6	RR-HU	2-19
TJ	Sea L.	907	310 kN	TB No 10	7-9	RR-HU	2-19
TJ	Sea L.		222 kN	5-11	7-11	P & W-AC	2-4
TJ	Sea L.	100	80 kN	Field	7-14	MTU	2-10
TS	Sea L.	4.5	220 kW	PASTF	7-26	PL	2-18
<u>5.3 N O I S E</u>							
TJ	Sea L.	Unlimited	310 kN	TB No 9	7-1	RR-HU	2-19
TJ	Sea L.	Unlimited	222 kN	METS A+B	7-2	RR-BR	2-19
TJ/TS	Sea L.	Unlimited	222 kN	Turntable Eng. Stand	7-4	NAPC	2-28
TJ/TS	Sea L.	Unlimited	90 kN	TB No 7	7-7	RR-HU	2-19
TS	Sea L.	4.5	220 kW	PASTF	7-26	PL	2-18
<u>5.4 A T T I T U D E (ENGINE INCIDENCE AND YAW VARIATION)</u>							
TJ	30.0	720	220 kN	ATF Cell 4	6-4	NGTE	2-16
TJ/TS	Sea L.	Unlimited	222 kN	Var. Attitu- de Stand	7-3	NAPC	2-28
TJ	Sea L.	100	80 kN	Field	7-14	MTU	2-10
RJ	Sea L.	90	10 kN	VMK	7-15	DFVLR	2-9
TJ/TS	Sea L.		2/2000	H 9	7-18	CEPr	2-7

5 LIST OF TEST FACILITIES WITH SPECIAL CAPABILITIES

TYPE OF ENGINE	ALTITUDE KM	MASS FLOW KG/S	THRUST/ SHAFT-P. KN/KW	TEST FACILITY DESIGNATION	PAGE	ORGANISATION NAME	PAGE
<u>5.5 INTAKE COMPATIBILITY / CROSS WIND</u>							
TJ	Sea L.	Unlimited	310 kN	TB No 9	7-1	RR-HU	2-19
TJ/TS	Sea L.	Unlimited	2 x 90 kN	TB No 5	7-6	RR-HU	2-19
TJ/TS	Sea L.	Unlimited	90 kN	TB No 7	7-7	RR-HU	2-19
TJ	Sea L.	907	310 kN	TB No 10	7-9	RR-HU	2-19
<u>5.6 TS - ENGINE WITH PROPELLER</u>							
TS	Sea L.	1800	6600 kW	Hangar H	7-19	RR-DE	2-19
TS	Sea L.		2200 kW	T 64	7-20	RR-CA	2-5
TS	Sea L.	385	956 kW	1-1	7-24	P&W-AC	2-4
TS	Sea L.	385	956 kW	1-6	7-24	P&W-AC	2-4
TS	Sea L.	385	956 kW	1-18	7-24	P&W-AC	2-4
TS	Sea L.	385	956 kW	2-4	7-24	P&W-AC	2-4
TS	Sea L.		662 kW	TB No 21	7-25	RR-HA	2-19
TS	Sea L.			Hangar TB	7-27	AR	2-12
<u>5.7 PREHEATED AIR / HEATED INLET</u>							
TJ	Sea L.		445 kN	A-8	7-8	P&W-FL	2-30
TJ	Sea L.	272	222 kN	TP 140		RR-BR	2-19
TJ	Sea L.	272	222 kN	TP 141		RR-BB	2-19
TS	Sea L.		1470 kW	TB No 15	7-22	RR-HA	2-19
TS	Sea L.		1100 kW	TB No 12	7-23	RR-HA	2-19
TS	Sea L.		1100 kW	TB No 13	7-23	RR-HA	2-19
TS	Sea L.		1100 kW	TB No 13 A	7-23	RR-HA	2-19
<u>5.8 VECTORED AND REVERSE THRUST / JET DEFLECTION</u>							
TJ/TS	Sea L.	Unlimited	222 kN	Var.Atti- tude Stand	7-3	NAPC	2-28
TJ	Sea L.	1000	310 kN	TB No 48		RR-DE	2-19
TJ	Sea L.	1000	310 kN	TB No 49		RR-DE	2-19
TJ	Sea L.		334 kN	C-10		P&W-FL	2-30
TJ	Sea L.	536	178 kN	TP 105	7-10	RR-BR	2-19
TJ	Sea L.	536	178 kN	TP 137	7-10	RR-BR	2-19
TJ	Sea L.	180	90 kN	TB No 2		RR-HU	2-19
TS	Sea L.	4.5	220 kW	PASTF	7-26	PL	2-18
<u>5.9 COLD START</u>							
TJ/TS	Sea L.	204	133 kN	TB No 8	7-12	RR-HU	2-19
TJ/TS	Sea L.	159	133 kN	SLC 1 W ¹⁾	7-13	NAPC	2-28
TJ/TS	Sea L.	159	133 kN	SLC 2 W ¹⁾	7-13	NAPC	2-28
TJ/TS	Sea L.			1-11 A	7-17	P&W-AC	2-4
TJ	Sea L.			Env.Chamber		TE-CAE	2-29

5 LIST OF TEST FACILITIES WITH SPECIAL CAPABILITIES

TYPE OF ENGINE	ALTITUDE KM	MASS FLOW KG/S	THRUST/ SHAFT-P. KN/KW	TEST FACILITY DESIGNATION	PAGE	ORGANISATION NAME	PAGE
<u>5.10 TWIN - ENGINE</u>							
TJ/TS	Sea L.	Unlimited	222 kN	Var.Attitu- de Stand	7-3	NAPC	2-28
TJ/TS	Sea L.	Unlimited	2x90 kN	TB No 5	7-6	RR-HU	2-19
TS	Sea L.		1840 kW	TB No 16	7-21	RR-HA	2-19
<u>5.11 REHEAT</u>							
TJ	Sea L.	454	98 kN	TP 107		RR-BR	2-19
TJ	Sea L.	304	98 kN	TP 103		RR-BR	2-19
TJ	Sea L.	304	98 kN	TP 104		RR-BR	2-19
TJ	Sea L.	180	130 kN	TB No 41		RR-DE	2-19
TJ	Sea L.	180	130 kN	TB No 42		RR-DE	2-19
TJ	Sea L.	180	130 kN	TB No 43		RR-DE	2-19
TJ	Sea L.	180	130 kN	TB No 44		RR-DE	2-19
TJ	Sea L.	170	222 kN	TP 108		RR-BR	2-19
<u>5.12 OTHER SPEC. CAP.</u>							
X - RAY							
TJ	Sea L.	Unlimited	310 kN	TB No 9	7-1	RR-HU	2-19
INFRA-RED SIGNATURE							
TJ/TS	Sea L.	Unlimited	222 kN	Turntable Eng.Stand	7-4	NAPC	2-28
VIBRATION							
TS	Sea L.	4.5	220 kW	PASTF	7-26	PL	2-18
SPOOL TESTING							
TJ	Sea L.	77	36 kN	TP 131 E		RR-BR	2-19
TJ	Sea L.	77		TP 125		RR-BB	2-19
DYNAMOMETER							
TS	Sea L.	26	6600 kW	TB No 16		RR-DE	2-19
TS	Sea L.	26	6600 kW	TB No 18		RR-DE	2-19
TS	Sea L.		1470 kW	TB No 19		RR-HA	2-19
TS	Sea L.		735 kW	TB No 11		RR-HA	2-19

6 ALTITUDE TEST CELLS	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">ALTITUDE (MAX. NOMINAL)</td> <td style="width: 40%;">13.7 - 47.2 km</td> </tr> <tr> <td>FLIGHT MACH N^o</td> <td>1.5 - 4.75</td> </tr> </table>	ALTITUDE (MAX. NOMINAL)	13.7 - 47.2 km	FLIGHT MACH N ^o	1.5 - 4.75
ALTITUDE (MAX. NOMINAL)	13.7 - 47.2 km				
FLIGHT MACH N ^o	1.5 - 4.75				

1 IDENTIFICATION

ORGANISATION AEDC Arnold Engineering Development Center	LOCATION Arnold Air Force Station Tennessee USA	TEST CELL DESIGNATION PWT 16 S
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2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE Turbo-Jet	TEST SECTION CONFIGURATION Free Jet (closed loop wind tunnel)	SPECIAL CAPABILITY Accepts engines with cowling full scale and in missiles
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SIZE : WIDTH 4.88 m HEIGHT 4.88 m DIAM LENGTH 12.20 m

AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY

SUPPLY

MASS FLOW	kg/s	
PRESSURE	kPa	2.9 - 23.4 (operating range of stagnation press.)
TEMPERATURE	K	322 - 600 (operating range of stagnation temp.)

	Mach-No	- Flight Height Range
	1.5	13.7 - 22 km
	2.4	20.7 - 33.5 km
	3.4	30.5 - 45.7 km
	4.75	41.1 - 47.2 km

TRANSIENTS

Mach No	1.5 - 2.4	0.05 Mach/minute
Mach No	2.4 - 4.75*	0.14 Mach/minute

*changes beyond 4.5 require three five minutes tape changes at M = 3.7

The PWT comprises two separate Windtunnels 16 T (transonic) and 16 S (supersonic). Both tunnels employ the same set of two induction (25 and 18 MW) and two synchronous motors (each 61 MW) for driving their separate compressor sets. They are primarily designed for various aerodynamic tests but both have systems to remove engine exhaust gases from the tunnel and replace with clean air. Typical testing of air-breathing engines includes the following:

- 1) engine-inlet matching involving changes in pressure recovery and distribution with model altitude and engine power
- 2) propulsion nozzle and afterbody characteristics
- 3) variable geometry performance in inlet and nozzles
- 4) control systems interactions and response characteristics for complete propulsion systems
- 5) heat-transfer studies of cooling systems including auxiliary inlets and of internal cooling effectiveness

The aim is usually a combined systems test i.e. propulsion and aerodynamics, and not engine performance. Therefore correct simulation of flight conditions is dispensable and some mismatch of stagnation temperature is tolerated.

Both tunnels are equipped with flexible wall Laval-type nozzles leading into 4.88 m x 4.88 m quadratic test sections of up to 12 m length. Test section and +)

PUBLICATION ETC	AEDC Test Facilities Handbook, June 1979	+) Continued on Page 8-2, Appendix II
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3 CONTACT :

Arnold Engineering Development Center AEDC/DOX Arnold Air Force Station Tennessee 37389 USA	
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6 ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) 30.5 km. FLIGHT MACH NO - 3.8																									
1 IDENTIFICATION <table border="0"> <tr> <td data-bbox="396 336 536 357">ORGANISATION</td> <td data-bbox="792 336 892 357">LOCATION</td> <td data-bbox="1073 336 1321 357">TEST CELL DESIGNATION</td> </tr> <tr> <td data-bbox="396 367 644 430">AEDC Arnold Engineering Development Center</td> <td data-bbox="792 367 1032 451">Arnold Air Force Station Tennessee USA</td> <td data-bbox="1073 367 1205 430">ASTF C 1 and ASTF C 2</td> </tr> </table>			ORGANISATION	LOCATION	TEST CELL DESIGNATION	AEDC Arnold Engineering Development Center	Arnold Air Force Station Tennessee USA	ASTF C 1 and ASTF C 2																		
ORGANISATION	LOCATION	TEST CELL DESIGNATION																								
AEDC Arnold Engineering Development Center	Arnold Air Force Station Tennessee USA	ASTF C 1 and ASTF C 2																								
2 TECHNICAL DATA/CAPACITIES <table border="0"> <tr> <td data-bbox="297 567 462 588">TYPE OF ENGINE</td> <td data-bbox="669 567 966 588">TEST SECTION CONFIGURATION</td> <td data-bbox="1082 567 1288 588">SPECIAL CAPABILITY</td> </tr> <tr> <td data-bbox="297 598 421 619">Turbo-Jet</td> <td data-bbox="677 598 792 619">Free Jet</td> <td></td> </tr> <tr> <td data-bbox="297 630 396 651">Ram-Jet</td> <td data-bbox="677 630 867 651">Direct Connect</td> <td></td> </tr> </table>			TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY	Turbo-Jet	Free Jet		Ram-Jet	Direct Connect																
TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY																								
Turbo-Jet	Free Jet																									
Ram-Jet	Direct Connect																									
SIZE : WIDTH HEIGHT DIAM 8.53 m LENGTH 25.9 m																										
AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY <table border="0"> <tr> <td data-bbox="297 808 371 829"><u>SUPPLY</u></td> <td data-bbox="611 808 660 829">C 2</td> <td data-bbox="875 808 1032 829">C 1 and C 2</td> </tr> <tr> <td data-bbox="297 840 404 861">MASS FLOW</td> <td data-bbox="512 840 834 903">kg/s 1250 (with atmospheric inbleed)</td> <td data-bbox="875 840 1123 861">660 500</td> </tr> <tr> <td data-bbox="297 882 396 903">PRESSURE</td> <td data-bbox="512 882 561 903">kPa</td> <td data-bbox="875 882 1123 903">276 896</td> </tr> <tr> <td data-bbox="297 924 421 945">TEMPERATURE</td> <td data-bbox="512 924 751 945">K 200 - 822</td> <td></td> </tr> <tr> <td data-bbox="297 966 379 987"><u>EXHAUST</u></td> <td data-bbox="611 966 768 987">C 1 C 2</td> <td></td> </tr> <tr> <td data-bbox="297 997 404 1018">MASS FLOW</td> <td data-bbox="512 997 834 1018">kg/s 1250 660</td> <td data-bbox="867 997 1214 1018">1135 almost linearly 136</td> </tr> <tr> <td data-bbox="297 1029 396 1050">PRESSURE</td> <td data-bbox="512 1029 561 1050">kPa 70</td> <td data-bbox="875 1029 1239 1050">31 decreasing to 4.1</td> </tr> <tr> <td data-bbox="297 1071 421 1092">TEMPERATURE</td> <td data-bbox="512 1071 933 1092">K as from engine delivered</td> <td></td> </tr> </table>			<u>SUPPLY</u>	C 2	C 1 and C 2	MASS FLOW	kg/s 1250 (with atmospheric inbleed)	660 500	PRESSURE	kPa	276 896	TEMPERATURE	K 200 - 822		<u>EXHAUST</u>	C 1 C 2		MASS FLOW	kg/s 1250 660	1135 almost linearly 136	PRESSURE	kPa 70	31 decreasing to 4.1	TEMPERATURE	K as from engine delivered	
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<u>TRANSIENTS</u> Full flight environment and engine power transients Mass Flow Rate 227 kg/s ² Inlet Pressure 2.76 kPa/s Inlet Temperature 2.2 K/s Both cells are part of an open-circuit facility designed primarily for testing air-breathing engine propulsion systems in an optimised free-jet test mode. It is possible to produce transient rate-of-change necessary to follow both flight environment and engine power transients. Three nozzles are available permitting test up to Mach.7 with jet cross section of 9.3 m², up to 1.0 with 5.6 m² and up to 3.8 with 4.2 m²																										
<u>MEASURING EQUIPMENT</u> - o 1700 "static" measurements (typically < 1 kHz) including 600 pneumatic multiplex 1020 electrical multiplex - o 226 "dynamic" measurements up to 20 kHz - including 24 channels up to 50 kHz 12 channels up to 100 kHz																										
<u>DATA ACQUISITION AND PROCESSING</u> Mass Data Storage Facility (MDSF) and Executive Data Processing System (EDPS). EDPS accomplishes major performance calculations in real time with testing activities. An extensive interactive display system, both alpha-numeric and graphic terminals, is provided.																										
PUBLICATION ETC J.G. MITCHELL The Aero-Propulsion Systems Test Facility AIAA Paper No 72-1034, 1972																										
3 CONTACT : Arnold Engineering Development Center AEDC/DOX Arnold Air Force Station Tennessee 37389, USA																										

6 ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) 30,0 km FLIGHT MACH NO - 3.5										
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TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY									
Turbo-Jet	Free Jet	Attitude (Variation of intake incidence and yaw)									
Ram-Jet											
SIZE : WIDTH HEIGHT DIAM 9 m LENGTH 21 m											
AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY <u>SUPPLY</u>											
MASS FLOW kg/s 270 max.											
PRESSURE kPa abs 300 max.											
TEMPERATURE K ambient to 740											
<u>EXHAUST</u>											
MASS FLOW kg/s 270											
PRESSURE kPa abs 35 (Min pres 11.3)											
TEMPERATURE K 2000											
<u>TRANSIENTS</u> Full engine transients plus flight transients Mach No 0.02/s; pitch 10 °/s; yaw 5 °/s											
<u>REMARKS:</u> Cell 4 is a large free-jet supersonic test cell with a variable Mach number blowing nozzle and variation of incidence and/or yaw while running. It was designed to test engines of about 70 kg/s (150 lb/s) sea-level static flow over a range of Mach number from 1.5 to 3.5. The size of the blowing nozzle has since been doubled to 2.3 m ² (25 sq ft) to enable tests of a Concorde intake and Olympus 593 engine to be carried out over a Mach number range from about 1.7 to 2.3. It has recently been used for free-jet testing at subsonic speeds. Operating such large plant is costly and a meticulous approach is essential to ensure that the maximum amount of information is obtained in the shortest possible time. For this reason the test instrumentation is directly connected to a computer and the data processed on-line, giving the test controller immediate information on all the essential parameters, both measured and computed, whilst the test is in progress. Cell is not at present in use but is being held on a care & maintenance basis.											
<u>MEASURING EQUIPMENT:</u> No thrust measurement capability Standard facility for 200 individual temperatures and 300 individual pressures plus shaft speed and fuel flow. 40 transient pressures can be continuously recorded on magnetic tape.											
<u>DATA ACQUISITION AND PROCESSING:</u> On-line processing (at data processing center) and display.											
<u>PUBLICATION ETC</u> Journal RAeS, Vol 74, pp 205-212 (1970)											
3 <u>CONTACT :</u>	Director NGTE Pyestock Farnborough GU14 OLS Hants UK										
	Phone Farnborough 44411 Telex 858231										

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The PWT comprises two separate Windtunnels 16 T (transonic) and 16 S (supersonic). Both tunnels employ the same set of two induction (25 and 18 MW) and two synchronous motors (61 MW each) for driving their separate compressor sets. They are primarily designed for various aerodynamic tests but both have systems to remove engine exhaust gases from the tunnel and replace with clean air. Typical testing of air-breathing engines includes the following: 1) engine-inlet matching involving changes in pressure recovery and distribution with model altitude and engine power 2) propulsion nozzle and afterbody characteristics 3) variable geometry performance in inlet and nozzles 4) control systems interactions and response characteristics for complete propulsion systems 5) heat-transfer studies of cooling systems including auxiliary inlets and of internal cooling effectiveness The aim is usually a combined systems test i.e. propulsion and aerodynamics, and not engine performance. Therefore correct simulation of flight conditions is dispensable and some mismatch of stagnation temperature is tolerated. Both tunnels are equipped with flexible wall Laval-type nozzles leading into 4.88 m x 4.88 m quadrate test sections of up to 12 m length. Test section and supporting structure is an entire unit (test section cart) and removable from tunnel. Five carts are available (two 12m, three 6 m long) with different support systems (vertical strut pitching system; vertical pitch table; sting; special).+)																																									
PUBLICATION ETC AEDC Test Facilities Handbook +) Continued on page 8 - 2, Appendix II																																									
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TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY									
Turbo-Jet	Free Jet										
Ram-Jet	Direct Connect										
SIZE : WIDTH HEIGHT DIAM 3.75 m LENGTH up to 22.9m											
<u>AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY</u>											
<u>SUPPLY</u>											
MASS FLOW	kg/s	363 227									
PRESSURE	kPa	241 483									
TEMPERATURE	K	189 $\pm$ 652									
<u>EXHAUST</u>											
MASS FLOW	kg/s	363									
PRESSURE	kPa	2.7									
TEMPERATURE	K										
<u>TRANSIENTS</u>											
<u>REMARKS</u> Free jet and wind tunnel aerodynamic testing can be performed using available nozzles at subsonic Mach numbers and at Mach numbers 1.2; 1.6; 2.0 and 3.0. Test article installation is accomplished through the aft end of the test cell by removal of the exhaust ducting and aft portion of the cell.											
<u>MEASURING EQUIPMENT</u> Thrust 134 kN Large quantity equipment of transducers, signal conditioners, recorders and indicators was carefully selected to provide optimum performance and reliability for a wide variety of testing requirements. 300 aerodynamic pressure channels 288 temperature channels 192 high speed general purpose channels (20,000 samples/s max) Other types of instrumentation systems supplied with the test article can be accommodated.											
<u>DATA ACQUISITION AND PROCESSING</u> Computer controlled data acquisition system (SEL 700) includes limited on-line and quick-look capability.											
<u>PUBLICATION ETC</u> AEDC Test Facilities Handbook, June 1979											
3 <u>CONTACT :</u> Arnold Engineering Development Center AEDC/DOX Arnold Air Force Station Tennessee 37389 USA											

6	ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) 24.4 km FLIGHT MACH N° - 3.0
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1

IDENTIFICATION

ORGANISATION AEDC Arnold Engineering Development Center	LOCATION Arnold Air Force Station Tennessee USA	TEST CELL DESIGNATION Propulsion Development Test Cell T-2
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2

TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY
Turbo-Jet	Free Jet	
Ram-Jet	Direct Connect	
Turbo-Prop		

SIZE :	WIDTH	HEIGHT	DIAM	3.75 m	LENGTH up to 20.7 m
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AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY

SUPPLY

MASS FLOW	kg/s	363	227
PRESSURE	kPa	241	483
TEMPERATURE	K	189 ÷ 652	

EXHAUST

MASS FLOW	kg/s	363
PRESSURE	kPa	2.7
TEMPERATURE	K	

TRANSIENTS

REMARK

Test article installation is accomplished through the aft end of the test cell by removal of the exhaust ducting and aft portion of the cell.

MEASURING EQUIPMENT

Thrust 134 kN
 Large quantity equipment of transducers, signal conditioners, recorders and indicators was carefully selected to provide optimum performance and reliability for a wide variety of testing requirements.
 300 aerodynamic pressure channels
 288 temperature channels
 192 high-speed general purpose channels (20,000 samples/s max)
 Other types of instrumentation systems supplied with the test article can be accommodated.

DATA ACQUISITION AND PROCESSING

Computer controlled data acquisition system (SEL 700) includes limited on-line and quick-look capability.

3

CONTACT :

Arnold Engineering Development Center
 AEDC/DOX
 Arnold Air Force Station
 Tennessee 37389 USA

4

PUBLICATION ETC

AEDC Test Facilities Handbook, June 1979

6 ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) 24.4 km FLIGHT MACH N ^o ÷ 3.0	
1 IDENTIFICATION		
ORGANISATION AEDC Arnold Engineering Development Center	LOCATION Arnold Air Force Station Tennessee USA	TEST CELL DESIGNATION Propulsion Development Test Cell T-4
2 TECHNICAL DATA/CAPACITIES		
TYPE OF ENGINE Turbo-Jet Ram-Jet	TEST SECTION CONFIGURATION Free Jet Direct Connect	SPECIAL CAPABILITY
SIZE : WIDTH HEIGHT DIAM 3.75 m LENGTH 16.8 m		
AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY		
<u>SUPPLY</u>		
MASS FLOW	kg/s 363	227
PRESSURE	kPa 241	483
TEMPERATURE	K 189 ÷ 652	
<u>EXHAUST</u>		
MASS FLOW	kg/s 363	
PRESSURE	kPa 2.7	
TEMPERATURE	K	
<u>TRANSIENTS</u>		
<u>REMARK</u>	Test article installation is accomplished through the aft end of the test cell by removal of the exhaust ducting and aft portion of the cell, alternatively an overhead hatch is available.	
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6 ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) 24.4 km FLIGHT MACH N ^o ÷ 3.0	
1 <u>IDENTIFICATION</u>		
ORGANISATION AEDC Arnold Engineering Development Center	LOCATION Arnold Air Force Station Tennessee USA	TEST CELL DESIGNATION Propulsion Development Test Cell T-6
2 <u>TECHNICAL DATA/CAPACITIES</u>		
TYPE OF ENGINE Turbo-Jet	TEST SECTION CONFIGURATION Free Jet Direct Connect	SPECIAL CAPABILITY
SIZE : WIDTH	HEIGHT	DIAM 0.91 m LENGTH 5.50 m
<u>AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY</u>		
<u>SUPPLY</u>		
MASS FLOW	kg/s	170
PRESSURE	kPa	483
TEMPERATURE	K	219 ÷ 652
<u>EXHAUST</u>		
MASS FLOW	kg/s	170
PRESSURE	kPa	2.7
TEMPERATURE	K	
<u>TRANSIENTS</u>		
<u>REMARK</u> Test cell T-6 consists of a 2.14 m diameter inlet plenum chamber, the test section, and an exhaust diffuser. T-6 is preferably used for specific tests of rocket engines.		
<u>MEASURING EQUIPMENT</u>		
Large quantity equipment of transducers, signal conditioners, recorders and indicators was carefully selected to provide optimum performance and reliability for a wide variety of testing requirements.		
100 aerodynamic pressure channels		
36 temperature channels		
192 high-speed general purpose channels (20,000 samples/s max)		
Other types of instrumentation systems supplied with the test article can be accommodated.		
<u>DATA ACQUISITION AND PROCESSING</u>		
Computer controlled data acquisition system (SEL 700) includes limited on-line and quick look capability.		
PUBLICATION ETC AEDC Test Facilities Handbook, June 1979		
3 <u>CONTACT :</u>		
Arnold Engineering Development Center AEDC/DOX Arnold Air Force Station Tennessee 37389 USA		

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<u>TRANSIENTS</u> <u>REMARK</u> The test cell T-5 is designed for small aerodynamic tests and tests of small turbofan, turbojet and ram-jet engines (simulated air launched starts, inlet total pressure distortion).																																		
<u>MEASURING EQUIPMENT</u> Thrust 22 kN Large quantity equipment of transducers, signal conditioners, recorders and indicators was carefully selected to provide optimum performance and reliability for a wide variety of testing requirements. 240 aerodynamic pressure channels 192 temperature channels 200 high-speed general purpose channels (20,000 samples/s max) Other types of instrumentation systems supplied with the test article can be accommodated.																																		
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6 ALTITUDE TEST CELLS		ALTITUDE (MAX. NOMINAL) 21.3 km	
		FLIGHT MACH N° : 4.0 :	

:: for PSL - 3 only : 3.0

1 IDENTIFICATION

ORGANISATION	LOCATION	TEST CELL DESIGNATION
NASA	Lewis Research Center Cleveland, Ohio, USA	PSL - 4 (also TC - 4) PSL - 3 (also TC - 3)

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY
Turbo-Jet	Direct Connect	

SIZE :	WIDTH	HEIGHT	DIAM	7.3 m	LENGTH	11.9 m
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AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY

<u>SUPPLY</u>	Chamber Design Criteria	Central Supply System Capacity
MASS FLOW	kg/s 340	218 174 17
PRESSURE	kPa 1138	414 1138 3206
TEMPERATURE	K 227 - 624	Heating 127 kg/s at 1138 kPa up to 960 K
<u>EXHAUST</u>		Cooling 181 kg/s to 205 K
MASS FLOW	kg/s 340	
PRESSURE	kPa 4.4	
TEMPERATURE	K 2200	

TRANSIENTS

MEASURING EQUIPMENT

Thrust	178 kN (present engine mount structure limit) 445 kN (maximum bed limit)
600	pressures, utilizing 25 scanivalves
72	pressures, one strain gauge transducer/channel
384	temperatures
30	frequencies
24	accelerometers

DATA ACQUISITION AND PROCESSING

1 On-site	1.2 EAI 680 Analog Comp.
1.1 SEL 8600 Digital Comp	
- steady state data acquisition	- on-line computation of high response information
- on-line monitor and record	
- limits monitor	- control of dynamic inlet pressure distortion system
- equipments and systems control	

also various recorders (tape, oscillographs, plotter) 75 channels strain gauge monitor equipment

2 Remote central recording location	
2.1 Analog Record	2.2 Digital Record
Multi-level input (5 mV-2 V)	Up to 30,000 samples/s
195 channels FM multiplexed	from up to 200 input sig-
DC to 8 kHz response	nals. Quick look playback to test cell.

PUBLICATION ETC

3 CONTACT :

Director, Propulsion Systems Laboratory
NASA Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135
USA

6	ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) 21.3 km FLIGHT MACH N° ÷ 2.5
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1 IDENTIFICATION

ORGANISATION
Rolls Royce Ltd.
Aero Div. Derby

LOCATION
Sinfen A Site
Derby
U.K.

TEST CELL DESIGNATION
Altitude Test
Facility
Cell 1
Cell 2

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE
Turbo-Jet
Turbo-Shaft (one cell only)
Reheat-Systems

TEST SECTION CONFIGURATION
Free Jet
Direct Connect

SPECIAL CAPABILITY

SIZE :

WIDTH 3.81 m

HEIGHT 2.75 m

DIAM 3.81 m
(second cell)

LENGTH 11.5 m

AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY

SUPPLY

MASS FLOW	kg/s	180
PRESSURE	kPa	500
TEMPERATURE	K	193 ÷ 453

EXHAUST

MASS FLOW	kg/s	272
PRESSURE	kPa	2.75
TEMPERATURE	K	2100

TRANSIENTS Full transient capability for testing gas turbine engines from idling to max. mil. rating in 5 s (stability in 10 s)

REMARK Two test cells run alternately. Six 17.5 MW exhausters/compressors electrically driven.

MEASURING EQUIPMENT

Thrust	90 kN, shaft power	4500 kW
240 pressures	9 fuel flows	
178 temperatures	3 speeds	

DATA ACQUISITION AND PROCESSING Full automatic data recording by on-line computer.

PUBLICATION ETC

3 CONTACT :

Rolls Royce Ltd
Aero Division Derby
P.O. Box 31
Derby DE 2 8BJ
U.K.

Phone
0352 - 42424

6 ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) 20.0 km FLIGHT MACH N° ± 4.0	
1 <u>IDENTIFICATION</u>		
ORGANISATION CEPr Centre d'Essais des Propulseur	LOCATION Saclay Orsay France	TEST CELL DESIGNATION R 5
2 <u>TECHNICAL DATA/CAPACITIES</u>		
TYPE OF ENGINE Turbo-Jet	TEST SECTION CONFIGURATION Free Jet Direct Connect	SPECIAL CAPABILITY
SIZE : WIDTH HEIGHT DIAM 5.5 m LENGTH 30.0 m		
<u>AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY</u>		
<u>SUPPLY</u>		
MASS FLOW	kg/s	375
PRESSURE	kPa	700
TEMPERATURE	K	923
<u>EXHAUST</u>		
MASS FLOW	kg/s	375
PRESSURE	kPa	5.0
TEMPERATURE	K	2073
<u>TRANSIENTS</u>		
<u>MEASURING EQUIPMENT</u>		
	Thrust	300 kN
		1000 channels
PUBLICATION ETC		
3 <u>CONTACT :</u>		
	M. le Directeur Centre d'Essais des Propulseurs Saclay 91406 Orsay France	

6 ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) 20.0 km FLIGHT MACH N° ÷ 2.4													
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Turbo-Jet	Free Jet													
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SIZE : WIDTH HEIGHT DIAM 3.50 m LENGTH 18.00 m														
<u>AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY</u> <u>SUPPLY</u>														
MASS FLOW kg/s 200														
PRESSURE kPa 200														
TEMPERATURE K 208 ÷ 473														
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PRESSURE kPa 5.0														
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<u>TRANSIENTS</u>														
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<table border="0"> <tr> <td>MASS FLOW</td> <td>kg/s</td> <td>270 max</td> </tr> <tr> <td>PRESSURE</td> <td>kPa</td> <td>200 max</td> </tr> <tr> <td>TEMPERATURE</td> <td>K</td> <td>200 to 740 (870 for special installations)</td> </tr> </table>			MASS FLOW	kg/s	270 max	PRESSURE	kPa	200 max	TEMPERATURE	K	200 to 740 (870 for special installations)
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MASS FLOW	kg/s	270									
PRESSURE	kPa abs	38 (Min pres 11.3)									
TEMPERATURE	K	2000									
<u>TRANSIENTS</u> Full engine transients											
<u>REMARKS</u> Connected tests can be made on engines such als Olympus 593, Pegasus, or Spey. Performance evaluation, engine handling, altitude relight and icing trials are possible.											
<u>MEASURING</u> Thrust measuring capacity up to 220 kN											
<u>EQUIPMENT</u> Standard facilities for 200 individual temperatures and 300 individual pressures plus shaft speed and fuel flow											
<u>DATA ACQUISITION AND PROCESSING</u> On-line processing (at data processing center) and display											
<u>PUBLICATION</u> ETC											
3 <u>CONTACT</u> : Director NGTE Pyestock Farnborough GU14 OLS Hants UK Phone Farnborough 44411 Telex 858231											

6 ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) 18 km FLIGHT MACH N° Subsonic				
1 <u>IDENTIFICATION</u> <table border="0"> <tr> <td data-bbox="413 357 806 462"> ORGANISATION NGTE National Gas Turbine Establishment </td> <td data-bbox="806 357 1057 462"> LOCATION Pyestock Farnborough UK </td> <td data-bbox="1057 357 1395 462"> TEST CELL DESIGNATION Altitude Test Facility Cell 3W </td> </tr> </table>			ORGANISATION NGTE National Gas Turbine Establishment	LOCATION Pyestock Farnborough UK	TEST CELL DESIGNATION Altitude Test Facility Cell 3W
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TYPE OF ENGINE Turbojet	TEST SECTION CONFIGURATION Direct Connect/Free-jet	SPECIAL CAPABILITY Icing Test			
SIZE : WIDTH HEIGHT DIAM 7.5 m LENGTH 17 m					
<u>AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY</u> <u>SUPPLY</u>					
MASS FLOW	kg/s	630 max			
PRESSURE	kPa abs	ambient max			
TEMPERATURE	K	236 to ambient			
<u>EXHAUST</u>					
MASS FLOW	kg/s	630			
PRESSURE	kPa abs	48 (Min pres 11.3)			
TEMPERATURE	K	800			
<u>TRANSIENTS</u>	Full engine transients				
<u>REMARKS</u>	Connected tests of high by-pass ratio turbofans in the 180-220 kN thrust class, also icing trials on helicopters fuselage.				
<u>MEASURING EQUIPMENT</u>	Thrust measuring capacity up to 220 kN Standard facilities for 200 individual temperatures and 300 individual pressures plus shaft speed and fuel flow				
<u>DATA ACQUISITION AND PROCESSING</u>	On-line processing (at data processing center) and display				
PUBLICATION ETC					
P. F. ASHWOOD An Altitude Test Facility for Large Turbofan Engines Journ. Aircraft, Vol. 10, pp 468-474 (1973)					
3 <u>CONTACT :</u> Director NGTE Pyestock Farnborough GU14 0LS Hants UK	Phone Farnborough 44411 Telex 858231				

6 ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) - 17 km FLIGHT MACH N ^o - 2.5	
1 <u>IDENTIFICATION</u>		
ORGANISATION NGTE National Gas Turbine Establishment	LOCATION Pyestock Farnborough UK	TEST CELL DESIGNATION Altitude Test Facility Cell 2
2 <u>TECHNICAL DATA/CAPACITIES</u>		
TYPE OF ENGINE Ram-Jet Turbo-Jet	TEST SECTION CONFIGURATION Direct Connect	SPECIAL CAPABILITY
SIZE : WIDTH HEIGHT DIAM 3.7 m LENGTH 37 m		
<u>AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY</u>		
<u>SUPPLY</u>		
MASS FLOW	kg/s	180 max
PRESSURE	kPa abs	910 max
TEMPERATURE	K	ambient to 490 max
<u>EXHAUST</u>		
MASS FLOW	kg/s	77
PRESSURE	kPa abs	50 (min pressure 14)
TEMPERATURE	K	2000
<u>TRANSIENTS</u>	Full engine transients	
<u>REMARKS</u>	Cell 2 is used for connected testing of reheat systems without an engine and for a wide variety of tests on jet engines in- cluding tests at conditions representing low altitude and high subsonic speed. Cells exhausted by four air driven ejectors.	
<u>MEASURING</u>	Thrust measuring capacity up to 220 kN	
<u>EQUIPMENT</u>	Standard facilities for 200 individual temperatures and 300 individual pressures plus shaft speed and fuel flow	
<u>DATA ACQUISITION AND PROCESSING</u>	On-line processing (at data processing center) and display	
<u>PUBLICATION</u> ETC	General description and background Engineering June 14, 21, 28 (1957)	
3 <u>CONTACT</u> :	Director Phone Farnborough 44411 NGTE Telex 858231 Pyestock Farnborough GU14 OLS Hants UK	

6 ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) 15.0 km FLIGHT MACH N° > 2.0													
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<u>TRANSIENTS</u>														
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<u>DATA ACQUISITION AND PROCESSING</u> Central computer														
<u>PUBLICATION ETC</u>														
3 <u>CONTACT :</u> M. le Directeur Centre d'Essais des Propulseurs Saclay 91406 Orsay France														

6 ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) 13.7 km FLIGHT MACH N° 1																																
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<u>MEASURING EQUIPMENT AND DATA ACQUISITION AND PROCESSING</u> 1. Steady State Data Acquisition System 687 measurements including pressures, temperatures, speeds, flows, and thrust. All channels recorded within 90 sec. Processing for quick look purposes takes 3.5 - 5 minutes. Information in the form of final data and plots is available within 3 hours. 2. Transient Digital Data Systems Analogue data are digitized and recorded on magnetic tapes Three modes of operation - single record (steady state) - intervalometer (steady state and slow transient) - gapped continuous (fast transient recording) 20 000 data points/sec. 400 channels maximum Speed depends on number of channels recorded i.e. 50 data point per channel and second minimum. 3. MARS = Multiplexed Analogue Recording System providing a record of the various parameters immediately before and during a failure.																																	
PUBLICATION ETC G. D. Adamson Jet Engine Test Facilities: Laboratories for Tomorrow's Engines. ASME 71-WA/GT-12 3 <u>CONTACT :</u>																																	

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6	ALTITUDE TEST CELLS		ALTITUDE (MAX. NOMINAL)	10.0 km
			FLIGHT MACH N°	0.1 ÷ 1.0

1 IDENTIFICATION

ORGANISATION	LOCATION	TEST CELL DESIGNATION
CEPr	Saclay	R 6
Centre d'Essais des Propulseurs	Orsay	
	France	

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY
Turbo-Jet	Free Jet	Icing Test
Turbo-Shaft		

SIZE : WIDTH HEIGHT DIAM 5.5 m¹⁾ LENGTH

AIR CONDITIONING, SUPPLY, AND EXHAUST CAPACITY

SUPPLY

MASS FLOW	kg/s	water content	6 ÷ 10 g/m ³
PRESSURE	kPa	mean volumetric diam	
TEMPERATURE	K	of water droplets	15 ÷ 30 · 10 ⁻⁶ m
		(under certain conditions)	40 · 10 ⁻⁶ m

EXHAUST

MASS FLOW	kg/s
PRESSURE	kPa
TEMPERATURE	K

TRANSIENTS

REMARK

1) Maximum inlet diameter of vacuum test chamber for icing flow condition 1.7 m, below this diameter adaptable to test article.

MEASURING EQUIPMENT

Apparati used for measuring droplet diameter and water contact:

- PMS probe (Dr. Knollenberg)
- Fusil Napier
- Aquasonde of French National Meteorological Service
- turning cylinder
- Ruskin's apparatus

PUBLICATION ETC

3 CONTACT :

Mr. I.A. Fagegaltier	Phone
Centre d'Essais des Propulseurs	1-941.81.50
Saclay	Ext. 713
91406 Orsay	
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6 ALTITUDE TEST CELLS	ALTITUDE (MAX. NOMINAL) km FLIGHT MACH N°																														
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3 <u>CONTACT :</u> Pratt & Whitney Aircraft Division Florida Research and Development Center P.O. Box 2691 West Palm Beach, Florida 33402 USA																															

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<u>DATA ACQUISITION AND PROCESSING</u>	Automatic data recording																																									
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7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

<u>ORGANISATION</u>	<u>LOCATION</u>	<u>TEST CELL DESIGNATION</u>
Rolls Royce Ltd. Aero Division Derby	Hucknall England	TB No 9

2 TECHNICAL DATA/CAPACITIES

<u>TYPE OF ENGINE</u>	<u>TEST SECTION CONFIGURATION</u>	<u>SPECIAL CAPABILITY</u>
Turbojet	Free-jet	Noise Intake Compatibility Cross Wind X-Ray Foreign Object Damage

<u>SIZE:</u>	<u>WIDTH</u>	<u>HEIGHT</u>	<u>DIAMETER</u>	<u>LENGTH</u>
--------------	--------------	---------------	-----------------	---------------

DESCRIPTION/COMMENT The master open air performance test bed accepts large fan engines

SPECIAL EQUIPMENT Mobile measuring equipment for transients

AIR SUPPLY CAPACITY

MASS FLOW	kg/s	Unlimited
PRESSURE	kPa	Ambient
TEMPERATURE	K	Ambient

MEASURING EQUIPMENT Thrust 310 kN

DATA ACQUISITION AND PROCESSING Automatic data recording system

PUBLICATION

3 CONTACT:

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION

Rolls Royce Ltd
Aero Division Bristol
(Site rented by RR from Procurement Executive, Ministry of Defense)

LOCATION

Aston Down
Nr. Strond
Glos.
England

TEST CELL DESIGNATION

Main Engine Test
Site (A + B)

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE

Turbojet

TEST SECTION CONFIGURATION

Free jet

Field

SPECIAL CAPABILITY

Icing
Noise
Vectored Thrust
Foreign Object Damage

SIZE:

WIDTH

6320 m²

HEIGHT

concrete area

DIAMETER

LENGTH

DESCRIPTION/COMMENT

Depending on type, engines can be mounted on a choice of stands on either of two alternative adjacent sites. The starboard side allows hardstanding mounting. Fore and aft and lateral noise recording up to 46 m radius.

SPECIAL EQUIPMENT

Vans equipped with transient u/v, strain gauge and portable data logging.

AIR SUPPLY CAPACITY

MASS FLOW kg/s Unlimited

PRESSURE kPa Ambient

TEMPERATURE K Ambient

MEASURING EQUIPMENT

Thrust 222 kN forward, 67 kN reverse

In addition to all basic engine driving instrumentation:

100 pressures up to 2760 kPa (gas)
20 pressures up to 13790 kPa (liquid)
60 temperatures thermocouples (12 alarms)
12 temperatures resistance (6 alarms)

DATA ACQUISITION AND PROCESSING

Manual

PUBLICATION

3 CONTACT:

R. F. Jeffery
Assistant Chief Engineer, Test Operations
Rolls Royce Ltd, Aero Division Bristol
P.O. Box 3
Bristol, England

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION

NAPC
Naval Air Propulsion
Center

LOCATION

NAS, Lakehurst
New Jersey
USA

TEST CELL DESIGNATION

Variable Attitude
Stand

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE

Turbojet
Turboshaft

TEST SECTION CONFIGURATION

SPECIAL CAPABILITY

Attitude
Jet Deflection
Twin Engine Test

SIZE:

WIDTH

HEIGHT

DIAMETER

LENGTH

DESCRIPTION/COMMENT

The test facility consists a variable attitude wing section and supports on which the wing and engine height can be varied from 1.5 to 7.6 m above the ground, a thrust, torque and engine rotation system and a control station containing the control and recording equipment.

SPECIAL EQUIPMENT

Pitch attitude speed between 0 and 2 rpm. Automatic dead weight compensation at all attitudes, capability of testing either a single engine or two engines simultaneously in a 1.5 to 12.2 m wing span.

AIR SUPPLY CAPACITY

MASS FLOW	kg/s	Unlimited
PRESSURE	kPa	Ambient
TEMPERATURE	K	Ambient

MEASURING EQUIPMENT

thrust	0 - 222 kN	} over a range of
torque	0 - 67 kN	
shaft power	0 - 8.8 MW	
		pitch angles from - 45° to + 105°
		roll angles from - 30° to + 30°

DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

Resource Management Officer
Code RM
Naval Air Propulsion Center
P. O. Box 7176
Trenton, New Jersey 08628, USA

Phone:

609 - 882 - 1414
Ext. 298 or 373

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION	LOCATION	TEST CELL DESIGNATION
NAPC	NAS, Lakehurst	Turntable Test
Naval Air Propulsion Center	New Jersey	Facility
	USA	

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY
Turbojet		Noise
Turboshaft		IR-Signature

SIZE:	WIDTH	HEIGHT	DIAMETER	LENGTH
-------	-------	--------	----------	--------

DESCRIPTION/COMMENT

The facility consists of a thrust measurement table and engine stand mounted on a modified 127 mm/38 twin gun mount carriage. The carriage is used as the turning mechanism. The gun base rotates in a horizontal plane over a range of - 100° to + 100°. All types of engines can be installed on this stand.

SPECIAL EQUIPMENT

The engine can be locked at the various angles where thrust can be directly read out and continuously recorded during test operation. Characteristics of the stand are: thrust 0 to 222 kN, rotation direction - clockwise and counterclockwise, maximum rotations 200°, plane of rotation - horizontal, fixed speed of rotation - 0.23 rad/sec, turning table can be rotated and locked remotely at any angle with engine running, and maximum live load is 0 to 11340 kg.

AIR SUPPLY CAPACITY

MASS FLOW	kg/s	Unlimited
PRESSURE	kPa	Ambient
TEMPERATURE	K	Ambient

MEASURING EQUIPMENT

Thrust 222 kN

DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

Resource Management Officer
Code RM
Naval Air Propulsion Center
P. O. Box 7176
Trenton, New Jersey 08628, USA

Phone:
609 - 882 - 1414
Ext. 298 or 373

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION	LOCATION	TEST CELL DESIGNATION
CEPr	Saclay	Tx
Centre d'Essais des	Orsay	(Banc d'essais
Propulseurs	France	d'ingestion)

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY
Turbojet	Field	Foreign Object Damage
Turboshaft		

<u>SIZE:</u>	WIDTH	HEIGHT	DIAMETER	LENGTH
--------------	-------	--------	----------	--------

DESCRIPTION/COMMENT Concrete area (55 m x 25 m) consisting of three main parts

- one protected zone for shooting at fixed targets
- one open air zone
- a control cabin usable for either zone

SPECIAL EQUIPMENT

AIR SUPPLY CAPACITY

MASS FLOW	kg/s	Unlimited
PRESSURE	kPa	Ambient
TEMPERATURE	K	Ambient

MEASURING EQUIPMENT Thrust 180 kN
250 parameters

DATA ACQUISITION AND PROCESSING Automatic data logging and processing by computer

PUBLICATION

3 CONTACT: M'le Directeur
Centre d'Essais des Propulseurs
Saclay
91406 Orsay, France

7 SEA LEVEL TEST CELLS1 IDENTIFICATIONORGANISATION

Rolls Royce Ltd

LOCATIONHucknall
EnglandTEST CELL DESIGNATION

TB No 5

2 TECHNICAL DATA/CAPACITIESTYPE OF ENGINE

Turbojet

Turboshaft

TEST SECTION CONFIGURATION

Free jet

SPECIAL CAPABILITY

Foreign Object Damage

Intake Compatibility

Twin Engine

SIZE:WIDTHHEIGHTDIAMETERLENGTHDESCRIPTION/COMMENTGeneral purpose open air test bed capable of twin engine
installation.
Not suitable for large fan enginesSPECIAL EQUIPMENTAIR SUPPLY CAPACITY

MASS FLOW kg/s Unlimited

PRESSURE kPa Ambient

TEMPERATURE K Ambient

MEASURING EQUIPMENT

Thrust 2 x 90 kN

Pressures, temperatures, speeds, all manual

DATA ACQUISITION AND PROCESSINGPUBLICATION3 CONTACT:

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

<u>ORGANISATION</u>	<u>LOCATION</u>	<u>TEST CELL DESIGNATION</u>
Rolls Royce Ltd.	Hucknall	TB No 7
	England	

2 TECHNICAL DATA/CAPACITIES

<u>TYPE OF ENGINE</u>	<u>TEST SECTION CONFIGURATION</u>	<u>SPECIAL CAPABILITY</u>
Turbojet	Free jet	Noise
Turboshaft		Intake Compatibility
		Cross Wind

<u>SIZE:</u>	<u>WIDTH</u>	<u>HEIGHT</u>	<u>DIAMETER</u>	<u>LENGTH</u>
--------------	--------------	---------------	-----------------	---------------

<u>DESCRIPTION/COMMENT</u>	Open air performance test bed suitable for noise testing. Intake test with cross wind. Not suitable for large fan engines
----------------------------	---

SPECIAL EQUIPMENT

AIR SUPPLY CAPACITY

<u>MASS FLOW</u>	kg/s	Unlimited
<u>PRESSURE</u>	kPa	Ambient
<u>TEMPERATURE</u>	K	Ambient

<u>MEASURING EQUIPMENT</u>	Thrust 90 kN (Reverse 45 kN) Pressures, temperatures, speeds, thrust, all manual
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DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

<u>ORGANISATION</u>	<u>LOCATION</u>	<u>TEST CELL DESIGNATION</u>
United Technologies Corp. Pratt & Whitney Aircraft Florida Research and Development Center	West Palm Beach Florida USA	A - 8

2 TECHNICAL DATA/CAPACITIES

<u>TYPE OF ENGINE</u>	<u>TEST SECTION CONFIGURATION</u>	<u>SPECIAL CAPABILITY</u>
Turbojet		Heated Inlet

<u>SIZE:</u>	<u>WIDTH</u>	<u>HEIGHT</u>	<u>DIAMETER</u>	<u>LENGTH</u>
--------------	--------------	---------------	-----------------	---------------

DESCRIPTION/COMMENT Thrust: No thrust measurement is available on this stand. The thrust block is rated at 445 kN maximum force.

Fuel-System: Three independent fuel systems can supply jet fuels with flows up to 10 kg/s at 690 kPa (gauge) and ambient temperature.

SPECIAL EQUIPMENT Natural gas is available at flow rates up to 1.9 kg/s at 3.1 MPa (gauge)

Compressed Air System: 2.65kg/s of air at 690 kPa and ambient temperature is available for engine starting and motoring.

AIR SUPPLY CAPACITY

MASS FLOW	kg/s
PRESSURE	kPa
TEMPERATURE	K

A direct fired gas heater can heat 22.7 kg/s air to 422 K to simulate fan discharge temperature to a core engine. The heater is connected to automatic controls which provide timed engine acceleration and deceleration cycles to achieve endurance testing on engine parts.

MEASURING EQUIPMENT

Test stand A-8 is not tied into Automatic Data and Acquisition Systems. However, manually read instrumentation is available in the test stand and consists of manometers (36 each by 2 m), vibration meters (4). Thermocouple readouts (1 vertical Brown with 56 channels), gauges (30), speed and flow digital readouts, over-temperature module, PLA programmer, timing and abort modules, RCVV schedule, HIGV error detector and temperature module, and heater gas controls.

DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

AD-A105 194 ADVISORY GROUP FOR AEROSPACE RESEARCH AND DEVELOPMENT--ETC F/G 14/2
AIR-BREATHING ENGINE TEST FACILITIES REGISTER, (U)
JUL 81 J H KRENGEL

UNCLASSIFIED AGARD-A6-269

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7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION

Rolls Royce Ltd

LOCATION

Hucknall
England

TEST CELL DESIGNATION

TB No 10

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE

Turbojet

TEST SECTION CONFIGURATION

Free jet

SPECIAL CAPABILITY

Foreign Object Damage
Intake Compatibility
Cross Wind

SIZE:

WIDTH

HEIGHT

DIAMETER

LENGTH

DESCRIPTION/COMMENT

Closed test cell - non thrust measuring, accept large fan engine,
design capacity 310 kN

SPECIAL EQUIPMENT

Computer controlled automatic throttle

AIR SUPPLY CAPACITY

MASS FLOW kg/s

907

PRESSURE kPa

ambient

exhaust pressure 148 kPa (abs)

TEMPERATURE K

ambient

exhaust temperature 1100 K

MEASURING EQUIPMENT

DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION	LOCATION	TEST CELL DESIGNATION
Rolls Royce Ltd	Gipsy Patch South	TP 105 / 137
Aero Division Bristol	Bristol	
	England	

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY
Turbojet		TP 105 Foreign Object Damage
		TP 105 } Vectored Thrust
		TP 137 } Endurance

SIZE:	WIDTH	HEIGHT	DIAMETER	LENGTH
	11.9 m	13.4 m		21 m
				TP 137 24 m

DESCRIPTION/COMMENT This bed has been designed for use with the Pegasus range of engines. It has a cradle mounted engine which is suspended beneath the test stand the centre line of the engine being 4 m above ground level. The hot and cold jet flows are collected in four ducts and joined to issue into a common detuner. This procedure allows adequate detuner cooling without water injection in TP 105. In TP 137 provision for reheat work is made by providing reheat fuel flow and collector duct cooling capabilities.

SPECIAL EQUIPMENT

AIR SUPPLY CAPACITY

MASS FLOW	kg/s	536 through splitters
PRESSURE	kPa	atmospheric
TEMPERATURE	K	ambient exhaust temperature 773 K, dry

MEASURING EQUIPMENT Thrust 178 kN vertical
 178 kN horizontal
 44.5 kN reverse
 250/350 pressure lines } manual readings
 200/190 temperature lines }

DATA ACQUISITION AND PROCESSING

1. "On bed" RIKADENKI pen recorder with 6 channels to display any signal which can be converted to mV (i. e. speed, temperature, pressure, or flow)
2. "Plug in" caravan recording and monitoring of any parameters.
 Closed circuit TV for engine monitoring.

PUBLICATION

3 CONTACT:

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION	LOCATION	TEST CELL DESIGNATION
Pratt & Whitney	St. Hubert	5 - 11
Aircraft of Canada Ltd	Quebec	
	Canada	

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY
Turbojet		Foreign Object Damage

<u>SIZE:</u>	WIDTH	HEIGHT	DIAMETER	LENGTH
--------------	-------	--------	----------	--------

DESCRIPTION/COMMENT

The system is capable of testing engines up to 22.3 kN thrust capacity. The engine is operated in free air conditions, i. e. ambient conditions of temperature, pressure, and wind velocity. Effect of winds below 4.5 m/s are considered negligible. Operation in winds above 4.5 m/s is acceptable, providing the wind direction is within an arc of 180° in front of the engine.

SPECIAL EQUIPMENT

gun capable of shooting 1.8 kg birds at 224 m/s

AIR SUPPLY CAPACITY

MASS FLOW	kg/s
PRESSURE	kPa
TEMPERATURE	K

MEASURING EQUIPMENT

Thrust 222 kN

DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

K. H. Scholz
Manager, Test Support Engineering
Phone 677 - 9411 Ext. 619

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION

Rolls Royce Ltd
Aero Division Derby

LOCATION

Hucknall
England

TEST CELL DESIGNATION

TB No 8

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE

Turbojet
Turboshaft

TEST SECTION CONFIGURATION

Free jet

SPECIAL CAPABILITY

Cold Start

SIZE:

WIDTH 6.1 m

HEIGHT 6.1 m

DIAMETER

LENGTH 6.1 m

DESCRIPTION/COMMENT

Low temperature starting facility for all types of RR engines,
large fan engines with restricted massflow

SPECIAL EQUIPMENT

AIR SUPPLY CAPACITY

MASS FLOW kg/s 204

PRESSURE kPa ambient

TEMPERATURE K 219 K

exhaust pressure 138 kPa (gauge)

exhaust temperature 1100 K

MEASURING EQUIPMENT

Thrust 133 kN

DATA ACQUISITION AND PROCESSING

Measurement engineering mobile caravan with automatic data reduction link with Derby computer.

PUBLICATION

3 CONTACT:

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION	LOCATION	TEST CELL DESIGNATION
NAPC	Trenton	SLC 1 W
Naval Air Propulsion Center	New Jersey	SLC 2 W
	USA	

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY
Turbojet		Icing
Turboshaft		Water Ingestion
		Corrosion
		Hot + Cold Start

SIZE: WIDTH 7 m HEIGHT 4.3 m DIAMETER LENGTH 17.1 m

DESCRIPTION/COMMENT This facility consists of Sea Level Test Cells for testing air breathing engines at flight MACH-numbers up to 1.1. Liquid air from a 53 m³ storage tank is piped to the inlet of each cell. A spray bar with nozzles is used to distribute the liquid air in the air stream. This system supplements mechanical refrigeration.

SPECIAL EQUIPMENT The inlet section contains provision for water ingestion and icing tests of engines. Icing capability is 0.5 x 10⁻³ m³/s at 25 x 10⁻⁶ m droplet size through 100 spray nozzles and 0.22 x 10⁻³ m³/s at 15 x 10⁻⁶ m droplet size through 100 spray nozzles.

AIR SUPPLY CAPACITY

MASS FLOW	kg/s	159	
PRESSURE	kPa	5.75 ÷ 284	maximum continuous
TEMPERATURE	K	219 ÷ 377	exhaust temperature 2200 K

MEASURING EQUIPMENT Thrust 133 kN (flexure supported thrust stand)

DATA ACQUISITION AND PROCESSING

The facility is connected to a central on-line data acquisition and computation system with real time output of test data on a control room CRT. Full printer listings and tape data storage are also performed on-line.

PUBLICATION

3 CONTACT:

Resource Management Officer, Code RM	Phone 609 - 882 - 1414
Naval Air Propulsion Center	Ext. 298 or 373
P.O. Box 7176	
Trenton, New Jersey 08628, USA	

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION

MTU
Motoren- und Turbinen-
Union München GmbH

LOCATION

Manching
Ingolstadt
F. R. Germany

TEST CELL DESIGNATION

Open Air Test Bed

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE

Turbojet

TEST SECTION CONFIGURATION

Free jet
Field

SPECIAL CAPABILITY

Foreign Object Damage
Attitude

SIZE: WIDTH 6 m HEIGHT 6 m DIAMETER LENGTH 12 m

DESCRIPTION/COMMENT

Open air test bed which can be sheltered by mobile hangar
suitable for testing of
- thrust reversing systems
- turbo-jet-engines with and without after burner e.g. RB 199
Noise measurements restricted.

SPECIAL EQUIPMENT

Engine turning mechanism: pitch angle + 90°
Also possible is turning the engine around its centre line
+ 20° for testing the oil system and internal air system.
Equipment for bird ingestion tests (11 birds, Ma ~ 1)

AIR SUPPLY CAPACITY

MASS FLOW kg/s 100
PRESSURE kPa ambient (test site 500 m above sea level)
TEMPERATURE K ambient; exhaust temperature 2000 K

MEASURING EQUIPMENT

Thrust 80 kN (40 kN reverse)
Measuring equipment conventional
Special equipment for measuring horizontal, vertical, and
asymmetric reverse thrust.

DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

Mr. Kirschey, Code EVP
Development Test Facilities
MTU - München GmbH
Dachauer Straße 665
8000 München 50, Federal Republic of Germany

Phone 89 - 1489 - 708

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION
DFVLR

LOCATION
Köln-Porz

TEST CELL DESIGNATION
VMK

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE
Ramjet

TEST SECTION CONFIGURATION
Free jet

SPECIAL CAPABILITY
Attitude

SIZE: WIDTH 4 m HEIGHT 4 m DIAMETER LENGTH 6 m

DESCRIPTION/COMMENT

The facility is a blow down windtunnel with vertical flow direction. A variety of axially symmetric nozzles in 3 sizes of up to 312 mm diameter is available. The test cell is built in reinforced concrete withstanding explosion pressures up to 500 kPa.

SPECIAL EQUIPMENT

Flight Mach number range; subsonic - 3.2
quick change of pressure
change of angle of attack $2^\circ/\text{sec}$; range $\pm 15^\circ$.

AIR SUPPLY CAPACITY

MASS FLOW kg/s ≤ 90
PRESSURE kPa ≤ 3500 kPa (stagnation pressure)
TEMPERATURE K ≤ 770 K (stagnation temperature)

MEASURING EQUIPMENT

Thrust 10 kN
Forces: 3- and 6-component balances
Pressures: pressure transducers, scanivalves
Tempera-
tures: thermocouples, thermovision
Others: Schlierenoptics, high speed camera

DATA ACQUISITION AND PROCESSING

Hewlett-Packard HP 2116 B, on-line

PUBLICATION

DLR - FB 65 - 24

3 CONTACT:

E.-O. Krohn
Institut für Experimentelle Strömungsmechanik
DFVLR
Postfach 906058
5000 Köln 90, Federal Republic of Germany

Phone: 2203-601-2278

7 SEA LEVEL TEST CELLS1 IDENTIFICATIONORGANISATION

NRC

National Research Council

LOCATION

Ottawa

Ontario

Canada

TEST CELL DESIGNATION

No 4 TC

(Engine Laboratory)

2 TECHNICAL DATA/CAPACITIESTYPE OF ENGINE

Turbojet

TEST SECTION CONFIGURATION

Free jet

SPECIAL CAPABILITY

Icing

SIZE:

WIDTH 7.5 m

HEIGHT 7.5 m

DIAMETER

LENGTH 18 m

DESCRIPTION/COMMENT

The permanently installed icing test facilities permit the generation of supercooled water droplets and of ice particles, as well as the admission of natural snow into the icing duct. Tests are being carried out under ambient pressures, but two air ejectors enable the simulation of forward flight velocity for a limited bypass stream. A heat exchanger provides limited air cooling, but tests depend basically on ambient temperature conditions.

SPECIAL EQUIPMENT

Supercooled water droplets

15-40 μm , calibrated

Ice particles

10-500 μm , random

Snow

natural snow collected and injected into air duct

Simulated flight velocity

up to 190 m/s (430 mph) engine

and ejector combined, depending

on geometry of bypass duct

Air cooling

10°C at a mass flowrate of 27 kg/s

AIR SUPPLY CAPACITY

MASS FLOW kg/s 15 and 5 ; 180

PRESSURE kPa 600 1000 ambient

TEMPERATURE K

MEASURING EQUIPMENTDATA ACQUISITION AND PROCESSINGPUBLICATION3 CONTACT:

Mr. E.H. Dudgeon Tel. 613-993-2425
 Section Head
 Engine Laboratory
 Division of Mechanical Engineering
 National Research Council Canada
 Montreal Road
 OTTAWA, Ontario. K1A 0R6

Mr. W. Grabe
 Tel. 613-993-2214
 Engine Laboratory
 Division of Mechanical
 Engineering
 National Research Council
 Canada, Montreal Road
 OTTAWA, Ontario. K1A 0R6

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION	LOCATION	TEST CELL DESIGNATION
Pratt & Whitney	Longueuil	1 - 11 A
Aircraft of Canada Ltd.	Quebec	
Longueuil, Quebec	Canada	
Canada		

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY
Turbojet		Cold Start
Turboshaft		

SIZE:	WIDTH	HEIGHT	DIAMETER	LENGTH

DESCRIPTION/COMMENT This cell is used to evaluate and investigate cold starting characteristics of small turbine engines. Air/methanol heat exchangers are used to cool the air in the test chamber.

SPECIAL EQUIPMENT The air circulation fan provides approximately three air changes per minute. Two completely separate cooling systems, each with a centrifugal pump for methanol circulation are provided. These may be operated together or independently as required.

AIR SUPPLY CAPACITY

MASS FLOW	kg/s
PRESSURE	kPa
TEMPERATURE	K

MEASURING EQUIPMENT

DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

K. H. Scholz	Phone 677 - 9411
Manager, Test Support Engineering	Ext. 619
Pratt & Whitney Aircraft of Canada Ltd	
Longueuil, Quebec	
Canada	

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION

CEPr

Centre d'Essais

des Propulseur

LOCATION

Saclay

Orsay

France

TEST CELL DESIGNATION

H 9

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE

Turbojet

Turboshaft

TEST SECTION CONFIGURATION

Free jet

SPECIAL CAPABILITY

Attitude

SIZE:

WIDTH

HEIGHT

DIAMETER

LENGTH

DESCRIPTION/COMMENT

SPECIAL EQUIPMENT turntable, range - 30° to + 30°
angular speed range 1 to 60°/s

AIR SUPPLY CAPACITY

MASS FLOW kg/s

PRESSURE kPa ambient

TEMPERATURE K ambient

MEASURING EQUIPMENT Thrust 2 kN, Shaft Power 2000 kW
100 parameters

DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

M. le Directeur
Centre d'Essais des Propulseurs
Saclay
91406 Orsay, France

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION

Rolls-Royce Ltd
Aero Division

LOCATION

Victory Road
Derby
England

TEST CELL DESIGNATION

Hangar "H"

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE

Turboshaft

TEST SECTION CONFIGURATION

SPECIAL CAPABILITY

Engine with propeller

SIZE: WIDTH 7.9 m HEIGHT 7.9 m DIAMETER LENGTH 44 m

DESCRIPTION/COMMENT

This facility is a propeller hangar incorporating a wing section which is capable of running turbo-shaft engines up to 6700 kW.
Maximum diameter of propeller: 4.9 m

SPECIAL EQUIPMENT

AIR SUPPLY CAPACITY

MASS FLOW kg/s 1800
PRESSURE kPa atmospheric
TEMPERATURE K atmospheric

MEASURING EQUIPMENT

shaft power 6700 kW
manual

DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

Rolls Royce Ltd, Aero Division, Derby DE 2 8 BJ, U.K.

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION

Rolls-Royce
(Canada) Limited

LOCATION

Pie / X Bld.
Montreal
Quebec

TEST CELL DESIGNATION

T 64
(Prop test cell)

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE

Turboshaft

TEST SECTION CONFIGURATION

SPECIAL CAPABILITY

Engine with propeller

SIZE:

WIDTH

HEIGHT

DIAMETER

LENGTH

DESCRIPTION/COMMENT

The T 64 Turbo Prop is tested, using a RCAF slave propeller.
It is a torque reaction installation. (Fuel JP 4).

SPECIAL EQUIPMENT

AIR SUPPLY CAPACITY

MASS FLOW kg/s

PRESSURE kPa

TEMPERATURE K

MEASURING EQUIPMENT Shaft Power 2200 kW

DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

Director of Quality
Rolls Royce (Canada) Limited
9500 Cote de Liesse Road
Lachine, Quebec
Canada H4Y 1 B 7

Phone 514 - 631 - 3541

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION	LOCATION	TEST CELL DESIGNATION
Rolls-Royce Ltd	Hatfield	TB No 16

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY
Turboshaft		Twin Engine Test

SIZE: WIDTH 4.9 m HEIGHT 7.6 m DIAMETER LENGTH 11.6 m

DESCRIPTION/COMMENT Gnome twin wessex engines with coupling gear box

SPECIAL EQUIPMENT

AIR SUPPLY CAPACITY

MASS FLOW kg/s
PRESSURE kPa
TEMPERATURE K

MEASURING EQUIPMENT Shaft Power 1860 kW

DATA ACQUISITION AND PROCESSING

Mobile recording caravan

PUBLICATION

Aero- and Industrial Test Facilities Manual (Section 16)

3 CONTACT:

T. Goswell, RR Site Manager Phone Hatfield 63830
Manor Road
Hatfield
England

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION

Rolls Royce

LOCATION

Hatfield

TEST CELL DESIGNATION

TB No 15

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE

Turboshaft

TEST SECTION CONFIGURATION

SPECIAL CAPABILITY

Pre-heated air

SIZE:

WIDTH 4.9 m

HEIGHT 2 m

DIAMETER

LENGTH 8.2 m

DESCRIPTION/COMMENT

Helicopter turbo-shaft development test bed

SPECIAL EQUIPMENTAIR SUPPLY CAPACITY

MASS FLOW kg/s

PRESSURE kPa

TEMPERATURE K

MEASURING EQUIPMENT

Shaft Power 1470 kW

DATA ACQUISITION AND PROCESSING

Mobile recording caravan

PUBLICATION

Aero- and Industrial Test Facilities Manual (Section 16)

3 CONTACT:

T. Goswell, R.R Site Manager Phone Hatfield 63830
 Manor Road
 Hatfield
 England

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

<u>ORGANISATION</u>	<u>LOCATION</u>	<u>TEST CELL DESIGNATION</u>
Rolls Royce	Hatfield	TB No 12 13 13 A

2 TECHNICAL DATA/CAPACITIES

<u>TYPE OF ENGINE</u>	<u>TEST SECTION CONFIGURATION</u>	<u>SPECIAL CAPABILITY</u>
Turboshaft	Free jet	Pre-heated air

SIZE: WIDTH 4.9 m HEIGHT 2.7 m DIAMETER LENGTH 6 m

DESCRIPTION/COMMENT Helicopter turbo-shaft development test beds

SPECIAL EQUIPMENT

AIR SUPPLY CAPACITY

MASS FLOW kg/s
PRESSURE kPa
TEMPERATURE K

MEASURING EQUIPMENT Shaft Power 1100 kW
U.V. Trace Recorders

DATA ACQUISITION AND PROCESSING

Automatic Data Recording schemed for 1980

PUBLICATION

Aero- and Industrial Test Facilities Manual (Section 16)

3 CONTACT:

T. Goswell, RR Site Manager Phone Hatfield 63830
Manor Road
Hatfield
England

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION	LOCATION	TEST CELL DESIGNATION
Pratt & Whitney	Longueuil	1 - 1
Aircraft of Canada Ltd.	Canada	1 - 6
		1 - 18
		2 - 4

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE	TEST SECTION CONFIGURATION	SPECIAL CAPABILITY
Turboshaft		Engine with propeller

<u>SIZE:</u>	WIDTH	HEIGHT	DIAMETER	LENGTH
--------------	-------	--------	----------	--------

DESCRIPTION/COMMENT Propeller test cells used for testing the PT-6 turboprop engines. Cells are of the "L"-type configuration. Engine is mounted on an overhead stand accomodating propellers up to 3.35 m diameter.

SPECIAL EQUIPMENT

AIR SUPPLY CAPACITY

MASS FLOW	kg/s	385
PRESSURE	kPa	ambient
TEMPERATURE	K	ambient

MEASURING EQUIPMENT

Shaft Power 956 kW
Test cells are fully instrumented for endurance performance and other tests.

DATA ACQUISITION AND PROCESSING

PUBLICATION

3 CONTACT:

K. H. Scholz, Manager, Test Support Engineering
Pratt & Whitney Aircraft of Canada Ltd.
Longueuil, Quebec
Canada

Phone: 677-9411
Ext. 619

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION

Rolls-Royce Ltd.

LOCATION

Hatfield
England

TEST CELL DESIGNATION

TB No 21

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE

Turboshaft

TEST SECTION CONFIGURATION

SPECIAL CAPABILITY

Engine with propeller

SIZE: WIDTH 4.8 m HEIGHT 4.9 m DIAMETER LENGTH 42.7 m

DESCRIPTION/COMMENT

Prop-shaft engine ASTAZOU 16 D test bed Hangar test facility capable of full engine flight clearance test with propeller fitted, including reverse pitch operation. (propeller diam. 2.64 m).

SPECIAL EQUIPMENT

AIR SUPPLY CAPACITY

MASS FLOW kg/s

PRESSURE kPa

TEMPERATURE K

MEASURING EQUIPMENT

Shaft Power 662 kW
U. V. trace
Singer analyzer

DATA ACQUISITION AND PROCESSING

Recording caravan

PUBLICATION

Aero- and Industrial Test Facilities Manual (Section 16)

3 CONTACT:

T. Goswell, RR Site Manager Phone Hatfield 63830
Manor Road
Hatfield
England

7 SEA LEVEL TEST CELLS

1 IDENTIFICATION

ORGANISATION
Alfa Romeo

LOCATION
Napoli
Italy

TEST CELL DESIGNATION
Hangar Test Bed

2 TECHNICAL DATA/CAPACITIES

TYPE OF ENGINE
Turboshaft

TEST SECTION CONFIGURATION
Free jet

SPECIAL CAPABILITY
Engine with propeller

SIZE: WIDTH 5 m HEIGHT 6 m DIAMETER LENGTH 14 m

DESCRIPTION/COMMENT maximum diameter of propeller 2.3 m

SPECIAL EQUIPMENT

AIR SUPPLY CAPACITY

MASS FLOW kg/s

PRESSURE kPa

TEMPERATURE K

MEASURING EQUIPMENT

DATA ACQUISITION AND PROCESSING

Microcomputer for data acquisition
Minicomputer for real time data analysis
Main data storage on IBM 30/33

PUBLICATION

3 CONTACT:

Dott. Ing. G. Balassone - Technical Director
Alfa Romeo, Pomigliano d'Arco, Napoli, Italy
Tel. 8841 344
Telex 710 083 ALFAPO

APPENDIX I

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 P.O. Box 31
 Derby DE2 8BJ, England

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 Turbine Engine Division/ TB
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 Wright-Patterson AFB, Ohio 45433, U.S.A.

APPENDIX II

Altitude Test Cell Information continued

1. PWT 16 S continued from page 6 - 1

Test section and supporting structure is an entire unit (test section cart) and removable from the tunnel. Five carts are available (two 12 m, three 6 m long) with different support systems (vertical strut pitching system, vertical pitch table, sting, special) Two carts have perforated walls for unchoking the test section near sonic speeds and for alleviating wall interference effects.

The same compressor drive system, with a total capacity of 166 MW, is used for both tunnels PWT 16 S and PWT 16 T. The main compressor of PWT 16 S consists of four axial-flow compressors (barrels), which are orientated such that any number from one to four barrels may be operated in series. The compressor operates at a constant speed of 600 rpm with volume flow adjustment provided by remotely controlled inlet guide vanes and stator blades of the first, second, and third barrels.

Various auxiliary supply systems are installed: electrical power systems, fuel systems, liquid propellant supply system, explosion and fire prevention system, high pressure auxiliary air supply systems.

2. PWT 16 T continued from page 6 - 6

Two carts have perforated walls for unchoking the test section near sonic speeds and for alleviating wall interference effects.

The same compressor drive system, with a total capacity of 166 MW, is used for both tunnels PWT 16 T and PWT 16 S. The tunnel 16 T compressor, which normally operates at a constant speed of 600 rpm, is a three-stage, axial-flow machine having a 9.14 m tip diameter and a hub-to-tip ratio of 0.6. The inlet guide vanes and the three interstage stator rows of the compressor are remotely controllable through an angle range that satisfies the range of volume flow requirements. Subsynchronous, variable speed operation is also possible and this extends the tunnel operating range to low subsonic Mach numbers.

Various auxiliary supply systems are installed: electrical power systems, fuel systems, liquid propellant supply system, explosion and fire prevention system, high pressure auxiliary air supply system.

8.3 APPENDIX III : ABBREVIATIONS ¹⁾

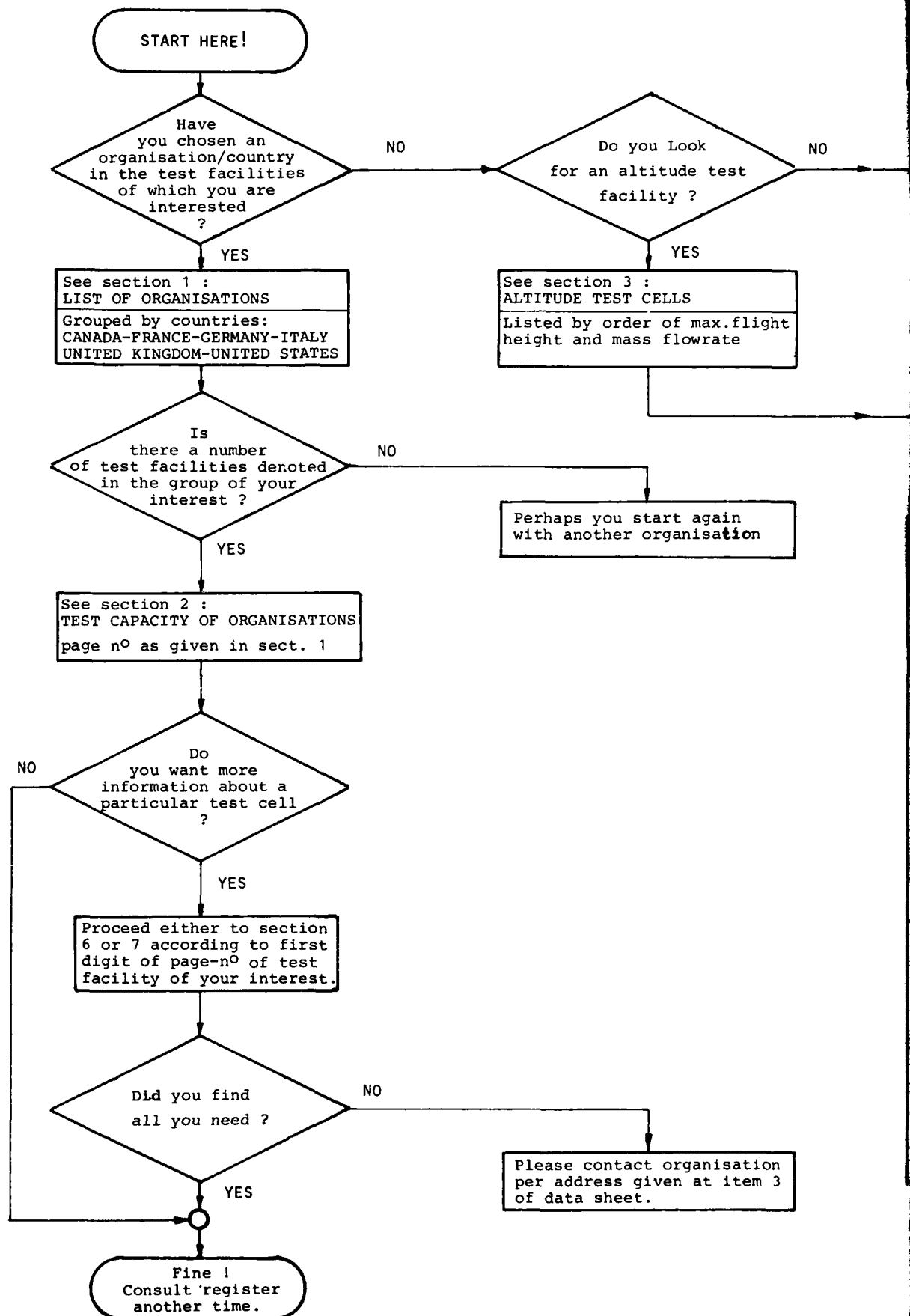
AIRes.	AIResearch Manufacturing Co.
AEDC	Arnold Engineering Development Center
AFAPL	Air Force Aero Propulsion Laboratory
AR	Alfa Romeo
BR	Bristol
CA	California
CC-AMPD	Confederation College of Applied Arts & Technology Aviation & Motive Power Department
CEPr	Centre d'Essais des Propulseurs
CRT	Cathode Ray Tube
CT	Connecticut
CU-GTL	Carleton University Gas Turbine Laboratory
DCU	Data Collection Unit
DDAD	General Motors Corporation Detroit Diesel Allison Division
DE	Derby
DFVLR	Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt e.V.
EM	Costruzioni Aeronautiche G. Agusta Elicotteri Meridionali
FIAT	Fiat Aviazione S.p.A.
FL	Florida
FOD	Foreign Object Damage
GE	General Electric Co.
H	Height
HA	Hatfield
HU	Hucknall
IRR	Integral Rocket Ramjet
JHU-APL	The Johns Hopkins University Applied Physics Laboratory
L	Length
LUCAS	Lucas Aerospace Limited
MAR	The Marquardt Co.
MTU	Motoren- und Turbinen-Union München GmbH
NAPC	Naval Air Propulsion Center
NASA-LE	National Aeronautics and Space Administration Lewis Research Center
NGTE	National Gas Turbine Establishment
NPT	Noel Penny Turbines Limited
NRC	National Research Council Canada

¹⁾ Test Cell Designations, Engine Designations, and SI-Units not included

8.3 APPENDIX III : ABBREVIATIONS ¹⁾

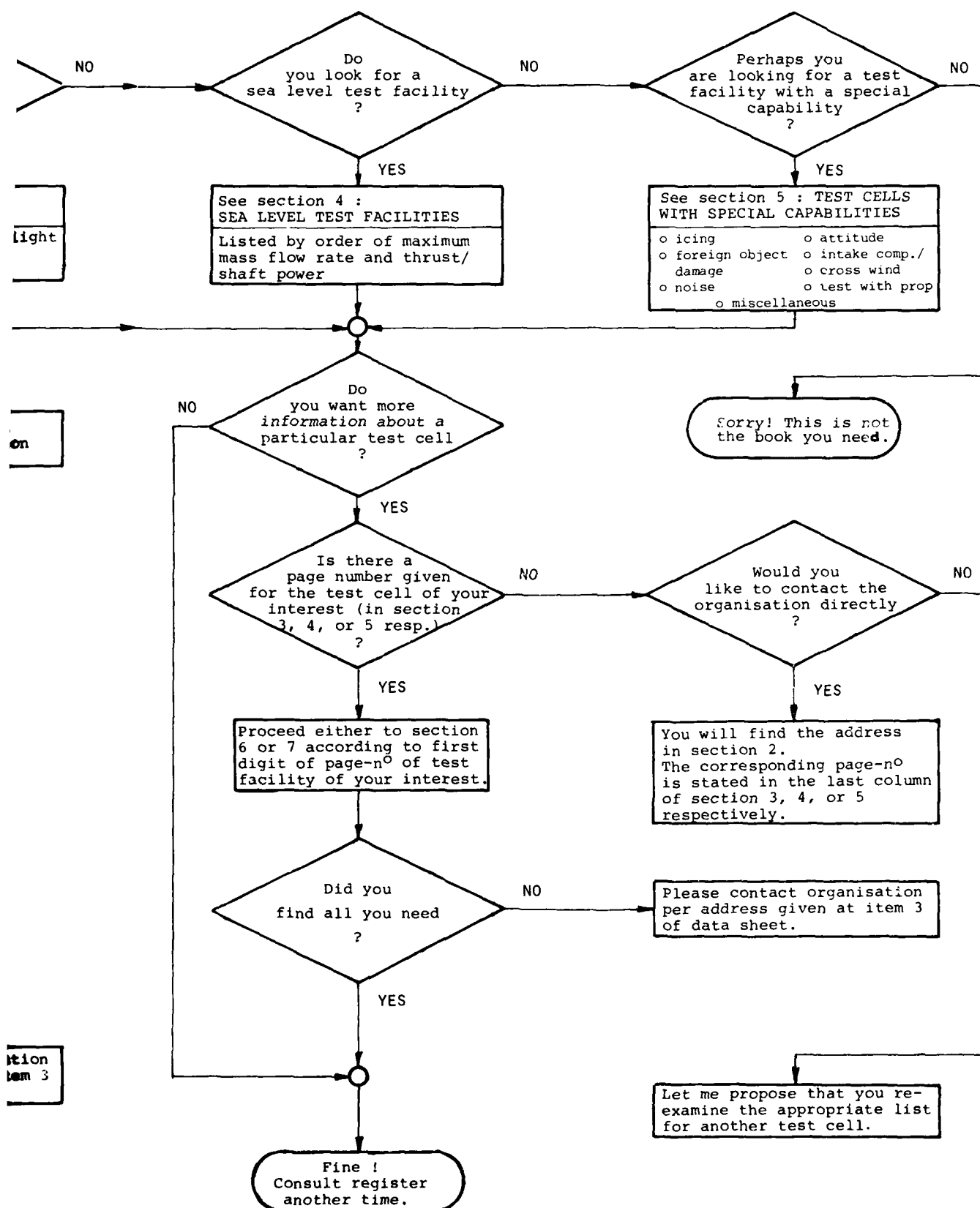
PL	Plessey Company Limited
P&W-AC	Pratt & Whitney Aircraft of Canada Ltd.
P&W-AW	United Technologies Corporation Pratt & Whitney Aircraft Division Commercial Products Division Andrew Willgoos Turbine Laboratory
P&W-FL	United Technologies Corporation Pratt & Whitney Aircraft Division Government Products Division Florida Research & Development Center
RJ	Ram-Jet
RR-BR	Rolls Royce Limited Aero Division, Bristol
RR-CA	Rolls Royce (Canada) Limited
RR-DE	Rolls Royce Limited Aero Division, Derby
RR-HA	Rolls Royce Limited, Hatfield
RR-HU	Rolls Royce Limited, Hucknall
SNECMA	Société Nationale d'Etude et de Construction de Moteurs d'Aviation
s/s	Samples/Second
TE-CAE	Teledyne CAE
TJ	Turbo-Jet (including Turbo-Fan)
TS	Turbo-Shaft
US-ILA	Universität Stuttgart Institut für Luftfahrt-Antriebe
UT-CSD	United Technologies Corporation Chemical Systems Division
W	Width
WE-CA	Westinghouse Canada Limited

¹⁾ Test Cell Designations, Engine Designations, and SI-Units not included



APPENDIX IV

QUICK USER'S FLOW CHART



REPORT DOCUMENTATION PAGE

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14. Abstract

Complementary to the Symposium on 'Turbine Engine Testing', sponsored by the Propulsion and Energetics Panel, and held in Turin, Italy on 29 September-3 October 1980, a register of airbreathing engine test facilities was compiled, aimed at comprising the test facilities relevant for research and development in NATO countries. Included are test facilities being in use or under construction at the various research organizations, industrial firms, and universities.

Test facilities and their technical data are given as far as the response to a questionnaire was received or open literature was available. Nevertheless interested test engineers will be able to find whether a test facility suiting their specific demands already exists or may be easily adapted to their purposes.

In order to ease contacts with organizations, complete addresses are given and cross-reference from the lists of test facilities and their data sheets to the list of organizations or vice versa is possible.

This AGARDograph was prepared at the request of the Propulsion and Energetics Panel of AGARD.

AGARDograph No. 269 Advisory Group for Aerospace Research and Development, NATO AIR-BREATHING ENGINE TEST FACILITIES REGISTER Compiled by Joachim H.Krengel Published July 1981 126 pages Complementary to the Symposium on 'Turbine Engine Testing', sponsored by the Propulsion and Energetics Panel, and held in Turin, Italy on 29 September -3 October 1980, a register of airbreathing engine test facilities was compiled, aimed at comprising the test facilities relevant for research and development in NATO countries. Included are test facilities being in P.T.O.	AGARD-AG-269 Test facilities, test cells Airbreathing engines Jet engines Turbofan engines Turbo-shaft engines Ramjet engines Sea level test facilities Altitude test facilities	AGARDograph No. 269 Advisory Group for Aerospace Research and Development, NATO AIR-BREATHING ENGINE TEST FACILITIES REGISTER Compiled by Joachim H.Krengel Published July 1981 126 pages Complementary to the Symposium on 'Turbine Engine Testing', sponsored by the Propulsion and Energetics Panel, and held in Turin, Italy on 29 September -3 October 1980, a register of airbreathing engine test facilities was compiled, aimed at comprising the test facilities relevant for research and development in NATO countries. Included are test facilities being in P.T.O.	AGARD-AG-269 Test facilities, test cells Airbreathing engines Jet engines Turbofan engines Turbo-shaft engines Ramjet engines Sea level test facilities Altitude test facilities
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