CRANFIELD INSTITUTE OF TECHNOLOGY

3

RADIAL INFLOW TURBINE STUDY

SECOND INTERIM REPORT

by

Dr. C. Forster Prof. R.L. Elder

DECEMBER 1989

United States Army

EUROPEAN RESEARCH OFFICE OF THE U.S. ARMY

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Department of Turbomachinery & Engineering Mechanics School of Mechanical Engineering Cranfield Institute of Technology Cranfield, Bedford, MK43 OAL

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have now been overcome and the technology developed is both available and relevant to this programme. Good progress is predicted for the following year. No change in funding has been requested due to the delay but it is proposed that the completion date be delayed by six months.

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Period 1.3.89 - 31.12.89

Progress on the above project has been slower than anticipated partly due to establishing appropriate running conditions with Turbomach and, more significantly, the demands of a major programme at Cranfield, also concerned with Radial Inflow Turbines, which has taken much more of Dr. Forster's time than originally anticipated. This is not all bad news because this project is uncovering problems which are relevant to this programme and solutions being developed will help our joint objectives. I would stress that the objectives of the proposed project are both relevant and realisable and that Cranfield is very keen to complete its commitment.

Throughout the first year discussions have been held with Turbomach on running conditions, rig installation and the provision of optical access for laser measurements. One major area of difficulty has been the provision of optical access since at the time this project was proposed only a schematic drawing of the test rig was available and the actual rig differed somewhat in detail. Turbomach are unwilling to allow Cranfield to modify their rig components but have allowed considerable freedom to produce a new turbine volute and shroud design which will ease the access problems. This solution will involve extra work in the design and manufacture of new parts which are of course critical to the performance of the turbine. The installation and initial commissioning of the test rig can be carried out with the original components and this stage of the project is expected shortly.

During the first year of the programme it was proposed that Cranfield prepare the rig stand and test its operation over a range of conditions (Task 1.1) and to take the first set of laser measurements (Task 1.2). Due to the delays it is now proposed to operate the programe about six months late with completion of Task 1.1 in early 1990 and Task 1.2 in June 1990. Despite this lack of adherence to the proposed timescales steady progress has been achieved as described above.

As it is estimated that the project is running six months late, it is proposed that this note be accepted as the "normal six month" report and is provided as justification for the second (six month) payment. It is also proposed that the project operates six months late throughout its course and that the adjusted revised annual spend be as attached. It is emphasised that no change in overall costs are implied only a delay of six months. It is also emphasised that the cause of the delay was unforseen technical problems on an associated project, that these problems have now been overcome and the technology developed to overcome the problem is both relevant and available to this programme.

Amount of unused funds at the end of this period:

Property acquired during this period: None

APPENDIX C

BUDGET ESTIMATES

Yea	r 1 (1st January 1989 -	31st Decemb	er 1989) ERO	£1 = US \$ 1 COST SHARED	70 TOTAL(\$K)
Α.	<u>Salaries and Wages - Cr</u> <u>Staff</u>	anfield			
	Principal Investigator Prof. R.L. Elder (5% of	effort)	.66	.66	1.32
	Research Officer (Senio C.P. Forster (40% of ef	or) fort)	6.70		6.70
	Technician (30% of effo	ort)	2.76		2.76
	Secretary (10%)			.73	.73
в.	Overheads				
	100% of staff costs		10.13	1.40	11.53
A1.	Salaries and Wages - Tu (San Diego staff) super from C. Rodgers	rbomach vision		4.00	4.00
c.	Report Preparation		.09	.09	.18
D.	Expendable Supplies				
	i Instrumentation (us maintenance and of L.A. equipment)	e	3.00	7.00	10.00
	ii Preparation and mod to test rigs and fa	lification cilities	1.00	21.00	22.00
	iii Rig running costs (150 hours at \$168	p.h)			
	iv Computer (data redu	(ction)		.51	.51
E.	Non Expendable Items				
F.	Travel				
c	Taflation Datas t	Total	24.34	35.39	59.73
6.	(9 months at 4% p.a.)		.73	1.07	1.80
		Total	25.07	36.46	61.53

*Inflation from July 1988 to the mid-term of the first period.

Year 2 (1st January 1990 - 31st December 1990)

		ERO	COST SHARED	TOTAL(\$K)
Α.	Salaries and Wages - Cranfield Staff			
	Principal Investigator Prof. R.L. Elder (5% of effort)	1.33	1.33	2.66
	Research Officer (Senior) C.P. Forster (40% of effort)	13.40		13.40
	Technician (30% of effort)	5.53		5.53
	Secretary (10%)		1.47	1.47
в.	Overheads			
	100% of staff costs	20.26	2.80	23.06
Al.	Salaries and Wages - Turbomach (San Diego staff) supervision from C. Rodgers		8.00	8.00
c.	Report Preparation	.18	.18	.36
D.	Expendable Supplies			
	i Instrumentation (use and maintenance	5 10	11 20	16 30
		5.10	11.20	10.30
	to test rigs and facilities	3.20	5.60	8.80
	iii Rig running costs (150 hours at \$168 p.h)	17.33	20.47	37.80
	iv Computer (data reduction)		1.02	1.02
E.	Non Expendable Items			
F.	Travel	1.68		1.68
	Total	68.01	52.07	120.08
G.	Inflation Factor * (21 months at 4% p.a.)	4.83	3.57	8.40
	Total	72.84	55.64	128.48

*Inflation from July 1988 to the mid-term of the second period.

Year 3 (1st January 1991 - 30th December 1991)

			ERO	COST SHARED	TOTAL(\$K)
Α.	Salaries and Wages - Cra Staff	nfield			
	Principal Investigator Prof. R.L. Elder (10% of	effort)	1.33	1.33	2.66
	Research Officer (Senior C.P. Forster (55% of eff) fort)	13.40		13.40
	Technician (30% of effor	rt)	5.53		5.53
	Secretary (10%)			1.47	1.47
в.	Overheads				
	100% of staff costs		20.26	2.80	23.06
Al.	Salaries and Wages - Tur (San Diego staff) superv from C. Rodgers	bomach vision		8.00	8.00
с.	Report Preparation		.18	.18	.36
D.	Expendable Supplies				
	i Instrumentation (use maintenance of L.A. equipment)	e and	4.20	8.40	12.60
	ii Preparation and mod: to test rigs and fac	ification cilities	2.80	11.20	14.00
	iii Rig running costs (150 hours at \$168)	p.h)	11.55	13.65	25.20
	iv Computer (data redu	ction)		1.02	1.02
E.	Non Expendable Items				
F.	Travel		.84		.84
~	Toflation Dector t	Total	60.09	48.05	108.14
G.	(33 months at 4% p.a.)		6.60	5.29	11.87
		Total	66.69	53.34	119.81

*Inflation from July 1988 to the mid-term of the third period.

	· -	ERO	COST SHARED	total(\$K)
А.	Salaries and Wages - Cranfiel Staff	d		
	Principal Investigator Prof. R.L. Elder (10% of effo	rt) .67	.67	1.34
	Research Officer (Senior) C.P. Forster (55% of effort)	6.70		6.70
	Technician (30% of effort)	2.77		2.77
	Secretary (10%)		.74	.74
в.	Overheads			
	100% of staff costs	10.13	1.40	11.53
A1.	Salaries and Wages - Turbomac (San Diego staff) supervision from C. Rodgers	ch 1	4.00	4.00
c.	Report Preparation	.09	.09	.18
D.	Expendable Supplies			
	i Instrumentation (use and maintenance of L.A. equipment)	2.10	4.20	6.30
	ii Preparation and modificat to test rigs and faciliti	tion ies 1.40	5.60	7.00
	iii Rig running costs (150 hours at \$168 p.h)	5.78	6.82	12.60
	iv Computer (data reduction)	.51	.51
E.	Non Expendable Items			
F.	Travel	.42		.42
6	Tot	al <u>30.06</u>	24.03	54.09
G .	(39 months at 4% p.a.)	3.90	3.12	7.02
	Tot	al <u>33.96</u>	27.15	61.11

*Inflation from July 1988 to the mid-term of the third period.

Year 4 (1st January 1992 - 30th June 1992)

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Summary of Costs

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	ERO	COST SHARED	TOTAL(\$K)
Year 1 Year 2 Year 3 Year 4	25.07 72.84 66.69 33.96	36.46 55.64 53.34 27.15	61.53 128.48 119.81 61.11
Totals	198.56 (53.5%)	172.59 (46.5%)	371.15

R7-4.19/IH