Final Report

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APPLICATION OF RUSSIAN THERMO-ELECTIRC DEVICES (TEDS)
FOR THE U.S. MICROGRAVITY PROGRAM
PROTEIM CRYSTAL GROWTH (PCG) PROJECT

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1. Introduction

Changes in the former Soviet Union have opened the gate for the exchange of new technology. Interest in this work has been particularly related to Thermal Electric Cooling Devices (TEDs) which have an application for the Thermal Enclosure System (TES) developed by NASA. Preliminary information received by NASA/MSFC indicates that Russian TEDs have higher efficiency. Based on that assumption NASA/MSFC awarded a contract to the University of Alabama in Huntsville (UAH) in order to study the Russian TEDs technology.

In order to fulfill this a few steps should be made:

- potential specifications and configurations should be defined for use of TEDs in Protein Crystal Growing (PCG) thermal control hardware
- work closely with the identified Russian source to define and identify potential Russian TEDs to exceed the performance of available domestic TEDs

Based on the data from Russia, it is possible to make plans for further steps such as buying and testing high performance TEDs. To accomplish this goal two subcontracts have been released. One subcontract to Automated Sciences Group (ASG) located in Huntsville, AL and one to the International Center for Advanced Studies "Cosmos" located in Moscow, Russia.

2. Specifications and Configurations Required for TEDs

In order to form the requirements for selection of Russian TEDs, the preparation of specifications and configuration for TEDs was required. Two meetings were held at NASA/MSFC to discuss these issues. Participants of the meetings were Blair Herren and Bob Bird of NASA/MSFC; Bill Epps and Bill Horn of Teledyne Brown Engineering; Gary Arnett of ASG; and Valery Aksamentov of UAH. The purpose of the meetings was to discuss required specifications and configuration of TEDs and to develop a statement of work for Russian colleagues. The proposed specifications are presented in Table I (Reference 1).

Specification for two-stage Thermo-Electric Module	
Dimension (inches)	1.18 c 1.18 x 0.36
Voltage	4.610 Volts
Current	2.062 Amps
Heat Load	3.125 Watts
Heat Rejected	13.039 Watts
Hot Side	42.36 °C
Cold Side	- 3.00 °C

At this time it is used eight of these devices with maximum electric power 128 Watts at 28VDC

Table I

Based on the proposed specifications, the Russian team has been asked to analyze and define Russian TEDs to exceed the presented specifications.

3. Results of Analysis

Analyzing presented specifications, the Russians proposed the use of one stage TEDs, which can provide the required parameters. For the anlaysis they have been using TEDs manufactured in two Russian companies: NORD in Moscow and OSTERM in St. Petersburg. Both of these organizations use technology developed by NPO "KVANT" in Moscow.

TEDs selected from both companies have been compared with the latest TEDs of similar performances from MELCOR. The main parameters for comparison have been:

- maximum current (corresponds to maximum cold capacity), Imax
- maximum cold capacity, Qmax
- maximum temperature difference between cold and hot side, Δ Tmax
- operating temperature range, °C
- type of ceramics
- dimensions
- service life in thousands of hours
- cost in U.S. dollars

A number of selected TEDs which can be used are presented in Table II (TEDs from NORD), Table III (TEDs from OSTERT), and Table IV (TEDs from MELCOR) (References 2 and 3)

A direct comparison of parameters for TEDs presented for NORD and MELCOR (see Table IV) shows that maximum cold capacity of the NORD TED is 19.2% higher, maximum temperature difference is 8.9% bigger, and dimensions are smaller (with all other parameters equal).

Characteristics of Russian Thermoelectric Devices produced at NORD

Characteristics of Thermomodules	Name of Thermocouples			
	TM-127-1,4-6,0	TM-127-1,0-3,9	TM-31-1,0-3.9	MTM-18-0,6-1-1,2
Maximum current Imax A	6,0	3,9	3,9	1,2
Maximum cold capacity Qmax W	62,5	39,8	9,7	1,5
Maximum voltage Vmax V	15,5	15,5	3,8	2,2
Maximum temperature difference Tmax °C	73,0	73,0	73,0	67,0
Operating temperature range °C	-150 ... +80	-150 ... +80	-150 ... +80	-150 ... +80
Ceramic type	AL_2O_3	AL_2O_3	AL_2O_3	AL_2O_3
Dimensions, in.	1.57 x 1.57 x 0.15	1.18 x 1.18 x 0.13	0.59 x 0.59 x 0.13	0.20 x 0.24 x 0.11
Service life, thousands of hrs	20	20	50	20
Cost, $	10*	8*	-	-

* Given thermodmodules are in series production and of great demand at Russian and international market.

Table II

Characteristics of Russian Thermoelectric Devices produced at OSTERM

Characteristics of Thermomodules	Name of Thermocouples			
	K1-127-1,0/0,6	K1-127-1/1,3	K1-31-1/1,3	K1-17-0.5/1,5
Maximum current Imax A	6,0	3,9	3,9	0,8
Maximum cold capacity Qmax W	53,0	33,4	8,15	0,9
Maximum voltage Vmax V	15,4	15,4	3,8	2,06
Maximum temperature difference Tmax °C	70 - 73	70 - 73	70 - 73	70 - 73
Operating temperature range °C	-150 ... +80	-150 ... +80	-150 ... +80	-150 ... +80
Ceramic type	AL_2O_3	AL_2O_3	AL_2O_3	AL_2O_3
Dimensions, in.	1.57 x 1.57 x 0.15	1.18 x 1.18 x 0.14	0.59 x 0.59 x 0.14	0.24 x 0.24 x 0.12
Service life, thousands of hrs	-	-	-	-
Cost, $	-	-	-	-

Table III

Characteristics of Thermoelectric Devices produced at MELCOR

Characteristics of Thermomodules	Name of Thermocouples			
	CPI.4-127-0,6L	CPI.0-127-0,5L	CPI.0-31-0,6L	FCO.6-18-0,6L
Maximum current Imax A	6,0	3,9	3,9	1,2
Maximum cold capacity Qmax W	51,4	33,4	8,2	1,46
Maximum voltage Vmax V	15,5	15,5	3,75	2,18
Maximum temperature difference Tmax °C	67,0	67,0	67,0	67,0
Operating temperature range °C	-150 ... +80	-150 ... +80	-150 ... +80	-150 ... +80
Ceramic type	AL_2O_3	AL_2O_3	AL_2O_3	AL_2O_3
Dimensions, in.	1.57 x 1.57 x 0.15	1.18 x 1.18 x 0.13	0.59 x 0.59 x 0.13	0.24 x 0.24 x 0.11
Service life, thousands of hrs	-	-	-	-
Cost, $	10 ... 15	10 ... 15	-	-

Table IV

4. Conclusion

Based on the presented materials using the Russian TED (TM-127-1,0-3,9) for the NASA/MSFC microgravity program, may result in benefits through increased efficiency of the PCG thermal control hardware and reduced power consumption. To be more definite it is necessary to do analysis based on test data from Russian TED.

The cost of Russian TEDs presented in Table II was confirmed by telephone conversation with Professor Oleg M. Alifanov, Director General of ICAS Cosmos. However, the cost of TM-31-1,0-3,9 and MTM-18-0,6-1,2 is not definite and will be based on many factors (availability, quantity, and time required for delivery), because it is not in series production.

In order to purchase the required TEDs it is necessary that the recommendation of NASA/MSFC for the desired type and quantity (not to exceed established budget limit) be received.