Action Sheet 3

between

The Euratom Safeguards Directorate of the Commission of European Communities
and
The Department of Energy (DOE) of USA

for

Electromechanically-Cooled Germanium Detectors for Safeguards

1. Introduction

Under Article 3.1 of the Agreement between Euratom and DOE for Cooperation in Nuclear Material Safeguards Research and Development (hereafter called the "Agreement") signed on January 6, 1995, DOE and Euratom undertake to carry out a cooperative effort in the development of electromechanically-cooled germanium (EMC-HPGe) detectors for safeguards measurements.

2. Scope of Work

This Action Sheet provides for the assembly, test and delivery of a EMC-HPGe detector to Euratom for safeguards measurements. The work under this Action Sheet shall be performed at Lawrence Livermore National Laboratory (LLNL) in accordance with the terms and conditions of the Agreement.

3. Program Management

LLNL is responsible for the development and delivery of the detector system. Work to be done by LLNL is identified in Appendix I and is limited to that statement of work for the time being. Appendix II identifies coordinator and key personnel working on this project.

DOE and Euratom carry out this work interactively, exchanging information on the performance and applications of the detector system after delivery. At the conclusion of this work, Euratom will be requested to provide any recommendations for improvements and comments related to applications of this detector system in safeguards measurements.

4. Fiscal Management

Euratom shall provide DOE with the funds necessary to complete the proposed work.

5. Duration and Termination

This Action Sheet shall enter into force upon the later date of signature, and shall continue in force for a two year period, or until mutually agreed by the parties that all activities under this Action Sheet are judged to be completed by DOE and Euratom.

For the Euratom Safeguards Directorate

Signature

Wilhelm GMELIN
Type or Print Name

Director
Title

Date

21. 5. 96

For the United States Department of Energy

Signature

Kenneth E. Sanders
Type or Print Name

Director, International Safeguards Division
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12 June 1996
Date

Appendix I

Statement of Work for

The Assembly, Test And Delivery Of An Electromechanically-Cooled Germanium Detector System

Background

High-resolution, gamma- and X-ray spectrometry are used routinely in nuclear safeguards verification measurements of uranium and plutonium. These measurements are mostly performed with high-purity germanium (HPGe) detectors, that require cooling to liquid-nitrogen temperatures, thus limiting their utility in field and unattended safeguards measurements applications. Sodium-iodide scintillation detectors do not require cooling, but their low energy resolution (10% at 122 keV) is insufficient in most cases for reliable verification measurements. Semiconductor detectors that operate at room temperature, such as cadmium-zinc-telluride (CdZnTe) detectors, with energy resolution performance reaching 2% at 122 keV may complement HPGe detectors, though have insufficient detection efficiency for many safeguards applications. The Lawrence Liver-more National Laboratory (LLNL) has developed an electromechanically-cooled germanium (EMC-HPGe) detector system capable of satisfying these requirements under support from DOE's International Safeguards Division.

Description of Work

1.0 Objective

The Isotope Sciences Division at LLNL has developed an electromechanidally-cooled high purity germanium (EMC HPGe) detector system. This system requires no liquid nitrogen and, due to the cooler's gas bearing technology, has a predicted mean time to failure of 50, 000 hours (6 years). The mechanical cooler's vibration is attenuated by an active vibration control system so that the energy resolution of the detector is degraded by 10% or less. LLNL is currently optimizing the system to reduce the size and power while increasing the reliability and detector resolution. The results of these efforts will be incorporated into the EMC HPGe detector system for EURATOM.

2.0 Introduction

2.1 Scope

LLNL will build an EMC HPGe detector system for EURATOM. Fabrication of the system will begin once LLNL and EURATOM have determined the system requirements and specifications. When this has concluded, the fabrication will begin. LLNL will keep EURATOM appraised of the progress at regular intervals, and deliverables will be reports on the detector system at various stages of completion. Upon completion, the EMC HPGe will be delivered to EURATOM for evaluation and testing.

2.2 Description of EMC HPGe system to be built for EURATOM

LLNL will build single unit system with integral digital signal processor (DSP) vibration control and driver electronics. The Portable Option that includes the MCA, high voltage power for the detector and batteries can be incorporated at the request of EURATOM.

3.0 Tasks

3.1 Develop a detailed work plan and order the cryocooler.

- LLNL and EURATOM develop a detailed work plan that includes specifications, schedule, and deliverables. Provide EURATOM with the final plan, schedule and specifications.

- The cryocooler is a very long lead time item and needs to be ordered as soon as possible. Provide EURATOM with the invoice for the cryocooler.

3.2 Order and fabricate subsystems

- Specify and order detector, preamplifier, and mounting based on the specifications developed in Task 3.1.

-Specify and order the new smaller vibration control DSP system and driver electronics.

*Provide EURATOM with the final electrical and mechanical drawings for review prior to system assembly.

3.3 System assembly and characterization

*Fabricate the detector and cryocooler enclosure.

*Assemble the detector system with a surrogate Ge crystal mass

-Test the vibration and thermal performance of the system under various ambient and operational conditions.

*Report on the performance of the system

3.4 Detector integration and test.

*Install the Ge detector.

*Evaluate the system performance under lab conditions and in simulated field conditions as directed by EURATOM.

*Report on the detector system performance.

3.5 System delivery

*Deliver the system to EURATOM. Setup and demonstrate the system operation.

•Train EURATOM personnel in the system operation and maintenance.

3.6 Portable operation accessory suitcase integration.

•Purchase multi-channel analyzer (MCA), data acquisition software, batteries, power management unit, and enclosure.

*Assemble and test with the detector system.

4.0 Costs

Task	Task Description (mm = man-month)		cost (US$)
3.1	Develop a detailed work plan and order the cryocooler.		28,000
	0.5 mm engineer	10,000	
	0.1 mm technician	2,000	
	Sunpower cryocooler	16,000	
3.2	Order components and fabricate subsystems.		30,000
	0.1 mm engineer/technician	2,000	
	20% Ge detector, preamp, mounting	14,000	
	0.1 mm engineer	2,000	
	DSP and A/D board	3,000	
	Driver electronics board	1,000	
	0.4 mm engineer/technician	8,000	
3.3	System assembly and characterization.		25,000
	0.25 mm technician	5,000	
	0.25 mm engineer/technician	5,000	
	0.6 mm engineer	12,000	
	0.15 mm engineer	3,000	
3.4	Detector integration and test.		7,000
	0.1 mm engineer ($2,000)	2,000	
	0.2 mm engineer/technician ($4,000)	4,000	
	0.05 mm engineer ($1,000)	1,000	
3.5	System delivery.		15000
	0.5mm engineer	10,000	
	Travel expenses for 2 for 1 week	5,000	
Total	**Non-Portable EMC HPGe System**		**105,000**
3.6	Portable operation accessory suitcase integration		25,000
	0.25 mm technician	5,000	
	MCA, data acquisition software	10,000	

Batteries, power management unit, and enclosure	5,000
0.25 mm engineer /technician	5,000
Total Portable EMC HPGe System	**130,000**

5 .O Schedule

The following is an estimated schedule indicating the relative completion intervals for each task. All intervals are relative to execution date of the contract.

	CY 1996							
	Ml	M2	M3	M4	M5	M6	M7	MS
Develop a detailed work plan	X							
Order components and fabricate subsystems		X						
System assembly and characterization			X					
Detector integration and test						X		
Portable operation accessory suitcase integration							X	
System delivery								X

6.0 Financial Management

EURATOM shall make a cash contribution in a sum not to exceed $130,000 in US dollars to conduct the activities related to the development of an electromechanically-cooled germanium gamma-ray detection system as defined in Appendix I of this document.

All contributions by EURATOM shall be due and payable within sixty day of receipt by EURATOM of an invoice from DOE.

DOE shall be responsible for the budget planning and financial management and shall make best efforts to complete the EURATOM funded activities described in Appendix I satisfactorily and within the cash contribution by EURATOM. DOE costs are determined in accordance with DOE's policy for costing work it performs for others as set forth in 10 CFR Part 1009. The total cost to EURATOM for DOE's performance of work under this action sheet shall not, without EURATOM's prior consent, exceed the contributions set forth above.

The following payment schedule for system development that includes the Portable Option (Task 3.6) has been agreed. If the Portable Option is not included, the fourth payment will be eliminated.

i) First payment 28,000 USD upon signature
ii) Second payment 30,000 USD upon completion of Task 3.1
iii) Third payment 25,000 USD upon completion of Task 3.2
iv) Fourth payment 25,000 USD upon completion of Task 3.6
v) Final Payment 22,000 USD upon completion of all tasks.

Appendix II

Key Personnel

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