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## Environment-Induced Degradation and Crack-Growth Studies of Candidate Target Materials: AAA Task-4 Quarterly (June 1 – August 31, 2001) Report

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## **MEMORANDUM**

To: Drs. Anthony Hechanova and Gary Cerefice, HRC  
From: Drs. Ajit Roy and Brendan O'Toole, MEG  
Date: September 01, 2001

### **Subject: AAA Task-4 Quarterly (6/1 – 8/31, 2001) Report**

#### **Introduction**

The subject task entitled “Hydrogen-Induced Embrittlement of Candidate Target Materials for Applications in Spallation-Neutron-Target Systems” had commenced during the quarter ending on August 31, 2001. A research account has been established, contracts for both faculty and students have been prepared, and efforts are well underway to embark on the related research activities, as proposed.

As the title of this project implies, the primary objective of this task is to evaluate the effect of hydrogen on environment-assisted cracking of candidate materials for applications in spallation-neutron-target (SNT) systems such as accelerator production of tritium (APT) and accelerator transmutation of waste (ATW). The materials selected for evaluation and characterization are martensitic stainless steels including HT-9, EP 823 and 422. The susceptibility to stress corrosion cracking (SCC) and hydrogen embrittlement (HE) of these alloys will be evaluated in environments of interest using tensile specimens under constant load and slow-strain-rate (SSR) conditions. The extent and morphology of cracking of these alloys will further be evaluated by optical microscopy and scanning electron microscopy (SEM). The concentration of hydrogen resulting from cathodic charging will be analyzed by secondary ion mass spectrometry (SIMS).

#### **Highlights of Accomplishment**

- Dr. Ajit Roy has joined the Department of Mechanical Engineering (MEG) in July 2001 as an Associate Research Professor on a full-time basis, concentrating on both Yucca Mountain (YM)/AAA-funded research projects and teaching activity (MEG). Dr. Roy's salary is being paid 50:50 from AAA program and YM Cooperative project fund. The current project participants are listed below.

Principal Investigators: Dr. Ajit K. Roy  
Dr. Brendan J. O'Toole  
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Investigators (UNLV): Dr. Zhiyong (John) Wang, Department of Mechanical Engineering  
Dr. David Hatchet, Department of Chemistry  
Mr. Raymond Kozak, Department of Mechanical Engineering  
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Collaborator (DOE): Dr. Ning Li, Los Alamos National Laboratory, New Mexico  
Phone: (505) 665-6677 email: [ningli@lanl.gov](mailto:ningli@lanl.gov)

- The test specimen design has been completed.
- Three experimental heats of Alloys HT-9, EP 823 and 422 have been melted. These ingots are currently being processed by hot working to convert them into bars at the vendor's facility, and will subsequently be shipped to UNLV for thermal treatments and specimen machining.
- A plan to establish a materials performance user facility has been developed and presented to the appropriate authorities for approval. This facility will have capabilities to conduct thermal treatments, metallographic evaluation, sample preparation, mechanical testing, along with corrosion studies (SCC/HE/Electrochemical Polarization etc.) involving numerous aqueous environments of interest both at elevated and ambient temperatures. This facility will house some recently procured equipment using YM funding, some existing equipment, and future equipment to be purchased from AAA funding. A list of future AAA-funded equipment, their descriptions, and rationale have already been presented to Dr. Hechanova and Cerefice in August this year.
- Equipment procured using the YM funding are the following.
  - Constant-Extension-Rate-Test (CERT) systems (3) including high-temperature (up to 120<sup>0</sup>C) test vessels. Vendor: Cortest Inc. Purchase Price: \$77,435
  - Proof Ring test assemblies (4) including high-temperature test vessels. Vendor: Cortest Inc. Purchase Price: \$17,311
  - Potentiostat (2), Corrosion Cell (2), and other accessories. Vendor: PerkinElmer. Purchase Price: \$35,511
  - Computers (3) for data acquisition and monitoring. Vendor: Gateway. Purchase Price: \$6,000
- An undergraduate student is being selected to assist in experimental work commencing during the following quarter.
- The estimated first quarter expenditures are given in the following table.

**Problems**

No problems are anticipated. The final location of the AAA user facility within the College of Engineering is yet to be decided. In the interim, experimental program is being initiated in a laboratory located at the Harry Reid Center (HRC).

**Status of Funds**

Expenditures incurred during this first quarter are within the target amount allocated.

**Plans for Next Quarter**

- Prepare Implementing Procedures (IPs) on equipment and experimental techniques.
- Heat treat test materials, machine and prepare test specimens.
- Set up the interim laboratory at HRC using the YM-funded equipment.
- Process purchase requisitions for the remainder of equipment to be funded by both YM and AAA programs.

<b>Task 4 First Quarter Expenditures</b>	
<b>A. Senior Personnel</b>	
Brendan O'Toole - summer support	\$ 4,354
David Hatchet - summer support	\$ 3,500
John Wang - summer support	\$ 3,491
<b><i>TOTAL SENIOR PERSONNEL</i></b>	<b><i>\$ 11,345</i></b>
<b>B. Other Personnel</b>	
Raymond Kozak, 3 months	\$ 4,500
Mark Jones, 3 months	\$ 4,500
Undergraduate Assistant	\$ -
<b><i>TOTAL STUDENT SALARIES</i></b>	<b><i>\$ 9,000</i></b>
<b>C. Fringe Benefits</b>	
Faculty (3.31 %)	\$ 376
Graduate students (1.75%)	\$ 158
<b><i>TOTAL FRINGE BENEFITS</i></b>	<b><i>\$ 533</i></b>
<b>D. Operations</b>	
Purchase Test Materials	\$ 9,000
Machine Test Materials	\$ -
Lab Supplies	\$ -
Office Expenses	\$ -
<b><i>TOTAL OPERATIONS</i></b>	<b><i>\$ 9,000</i></b>
<b>E. Travel</b>	
Conference Travel	\$ -
Travel to Los Alamos	\$ -
<b><i>TOTAL TRAVEL</i></b>	<b><i>\$ -</i></b>
<b>F. Other</b>	
15 credits per graduate student per year	\$ 1,500
Equipment	
SEM fees at UNLV	\$ -
<b><i>TOTAL OTHER</i></b>	<b><i>\$ 1,500</i></b>
<b>G. Total Direct Costs</b>	<b><i>\$ 31,378</i></b>
<b>H. MTDC (G - Equipment &amp; Tuition)</b>	<b><i>\$ 29,878</i></b>
<b>I. F&amp;A 50% of MTDC</b>	<b><i>\$ 14,939</i></b>
<b>J. Total Project Cost</b>	<b><i>\$ 46,317</i></b>