

Evaluation of Hydrogen Fuel Cell Power Source for Cathodic Bridge Protection System

FINAL REPORT
March 2001

Submitted by

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Mr. Henry Schweber

In cooperation with

New Jersey
Department of Transportation
Division of Research and Technology
and
U.S. Department of Transportation
Federal Highway Administration

Disclaimer Statement

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16. Abstract <p>This report pertains to a preliminary study to test the feasibility of retrofitting an existing bridge cathodic protection system with an ammonia/hydrogen fuel cell power supply. The feasibility study includes the selection of an appropriate hydrogen fuel cell, the design and installation of a data logger and remote collection unit, and long term monitoring of fuel cell performance. A detailed specification for each unit was developed and described in a Request For Proposals (RFP) sent by the Center for Advanced Infrastructure and Transportation (CAIT) to perspective fuel cell manufacturers. Also, a bridge site was selected for the installation of and applying the most reliable fuel cell under closely controlled conditions. The data logger was designed to allow for remote monitoring and data collection of fuel cell performance data under field conditions.</p> <p>Based on the initial phase of the study, it is recommended that the hydrogen fuel cell system might not be the best alternative to supply power for the cathodic protection system, especially if electric power is available. Although, the project did not conclude by installing the fuel system and testing it under field conditions, it might be shown that technically it is feasible to use such technology, however, it is expected to be costly prohibitive in comparison with electric power and/or solar energy.</p>			
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TABLE OF CONTENTS

ABSTRACT	1
OBJECTIVE	1
BACKGROUND	1
ACCOMPLISHED TASKS	2
REFERENCES	4
APPENDIX A.....	5
APPENDIX B.....	6
APPENDIX C.....	46

ABSTRACT

This report pertains to a preliminary study to test the feasibility of retrofitting an existing bridge cathodic protection system with an ammonia/hydrogen fuel cell power supply. The feasibility study includes the selection of an appropriate hydrogen fuel cell, the design and installation of a data logger and remote collection unit, and long term monitoring of fuel cell performance. A detailed specification for each unit was developed and described in a Request For Proposals (RFP) sent by the Center for Advanced Infrastructure and Transportation (CAIT) to perspective fuel cell manufacturers. Also, a bridge site was selected for the installation of and applying the most reliable fuel cell under closely controlled conditions. The data logger was designed to allow for remote monitoring and data collection of fuel cell performance data under field conditions.

Based on the initial phase of the study, it is recommended that the hydrogen fuel cell system might not be the best alternative to supply power for the cathodic protection system, especially if electric power is available. Although, the project did not conclude by installing the fuel system and testing it under field conditions, it might be shown that technically it is feasible to use such technology, however, it is expected to be costly prohibitive in comparison with electric power or solar energy.

OBJECTIVE

The main objective of this study was to test the feasibility and develop a specification for retrofitting an existing bridge cathodic protection system with an ammonia/hydrogen fuel cell power supply. The project includes selecting a specific bridge site and applying the most reliable fuel cell under closely controlled conditions.

BACKGROUND

Cathodic protection (CP) is a very effective system for keeping the electric potentials of a structure at such levels to prevent development of corrosion. In New Jersey, 18 bridges on I-80 and one deck on Rt. 17 near Saddle Brook have cathodic protection systems. The CP systems installed on the bridges operate on the principle of balancing the flow of electrons across the bridge deck and supporting reinforcing steel. By inducing a small electrical DC current into the deck and controlling the electron flow within the bridge deck, the system can greatly slow down the corrosion rate by keeping steel from rusting, greatly extending the useable life of the bridge. The systems on I-80 were installed in 1988, and consist of Raychem Ferex 100 anode, Harco conductive polymer mound anode, and ELGARD 210 anode mesh. The anodes are covered with a 1.25 to 1.50 inch latex modified concrete (LMC) overlay. Some of the anode systems have performed better than others, and several of the Raychem systems are scheduled to be abandoned this year.

However, five systems which were installed using ELGARD titanium anode mesh on the I-80 Bridge continue to work well. According to a NJDOT research report [1], the ELGARD titanium mesh anode systems had the highest level of corrosion protection, the best overall performance, and the longest projected anode life (estimated 35 to 40 years). However, the rectifiers that control the operation of these systems have not proven to be very reliable and require routine monitoring and specialized skills to keep them operating properly. Some of the rectifier systems have already ceased to be used.

Therefore, it is suggested by NJDOT to retrofit one corrosion protection system on a bridge on I-80 with fuel cell system and hydrogen fuel supply capacity. The Rutgers Team was asked to evaluate the process and study the feasibility of such fuel system for future implementation on sites with similar defects. The section below describes the work accomplished in the project as of to date.

ACCOMPLISHED TASKS

The Rutgers research team conducted a comprehensive search of companies and manufacturers using various database search resources. **Appendix A** lists all the companies that were selected based on experience with Hydrogen fuel cells. The Rutgers team consulted with the NJDOT project contact about the technical specifications of the fuel cell system and its general requirements. The general requirements and technical specifications were to be included in a Request For Proposal (RFP), which in turn was mailed later to the companies listed in Appendix A. The Rutgers team did not have enough information about the requirements of the existing cathodic protection system already in place at the bridge site. The information was not provided by the NJDOT project contact. The Rutgers Team proceeded according to the University rules and regulations for awarding a subcontract and prepared a detailed RFP with the help of the University Procurement and Contracting. **Appendix B** lists a copy of the RFP with the cover letter that was mailed to all companies listed in **Appendix A**. Also, listed in **Appendix B** is a copy of the H-Power proposal in response to the RFP. The response to the RFP was limited to only one company (H-Power) responding with a proposal to install one fuel cell system with a power capacity of only 19 Watt on four zones/circuits on I-80-WB Bridge over Horseneck Road (Structure # 0726-151). The Rutgers Team discussed the H-Power proposal with the NJDOT project contact on many occasions. The concern was that the power supply of only 19 watts might not be sufficient enough to power the system as well as to generate extra power for the data collection unit, heating and cooling units, etc. Moreover, other bridges of similar configuration (e.g., I-80 EB bridge over Horseneck Road- twin span of same bridge under consideration) had more circuits and required more power (40.92 watt) as shown in a previous NJDOT report [1]. The NJDOT report was acquired by Rutgers directly from the NJDOT Librarian. **Appendix C** shows a copy of correspondence between Rutgers and the NJDOT Quality Management office for a typical bridge installation for the cathodic protection where the total power needed is 40.92 Watt. Therefore, the Rutgers Team made the point that

the contract cannot be awarded unless a more comprehensive and detailed study of using a battery with higher power output. It is the research team position that it might not be feasible to install such a fuel system due to lack of the minimum power range needed. The NJDOT project contact asked Rutgers to go ahead and award the contract to H-Power without further analysis of the technical data. The Rutgers Team requested that the NJDOT project contact re-issue a written task order for a change of the project scope to allow for the use of a 19-watt battery system. The project was on hold since no such written statement was provided by NJDOT to that effect and subsequently the subcontract was not issued. The Rutgers team made the same point during two of the quarterly meeting after which it was decided by NJDOT research office to close the project. Therefore, tasks 4 through 6 were not accomplished and it was decided by NJDOT office to close out the project.

REFERENCES

1. Younger, C.L., (1994) "Evaluation of Bridge Deck Cathodic Protection," New Jersey Department of Transportation, Quality Assurance, Improvement, research, FHWA/NJ-93-006-7520, March, pp. 45.

APPENDIX A

CAIT

Center for Advanced Infrastructure & Transportation
Rutgers University

Department of Civil and Environmental Engineering
623 Bowser Rd. Piscataway, NJ 08854-8014
Tel: 732-445-0579 Fax: 732-445-0577

H. Power Corp.
60 Montgomery Street
Belleville, NJ 07109

Ballard Power Systems Inc.
9000 Glenlyon Parkway
Burnaby BC
Canada V5J5J9

International Fuel Cells
195 Governors Highway
South Windsor, CT 06074

Aspen Systems, Inc.
184 Cedar Hill Street
Marlborough, MA 01752

Arthur D. Little, Inc.
Acorn Park
Cambridge, MA 02140-2390

Energy Research Corporation-Fuel Cell
Manufacturing
P.O. Box 538
Torrington, CT 06790-0538

Avista Corp.
Corporate Communications Department
1411 E. Mission St.
P.O. Box 3727
Spokane, WA 99220-3727

Energy Partners, L.C.
1501 Northpoint Parkway, Suite 102
West Palm Beach, FL 33407

Hydrogenics Corporation
Woodbridge, ON
CANADA L4L 5Y9

REQUEST FOR PROPOSAL
THIS IS NOT AN ORDER

UNIVERSITY PROCUREMENT & CONTRACTING
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
56 BEVIER ROAD
PISCATAWAY, NEW JERSEY 08854-8010

THE R.F.P. NUMBER MUST APPEAR ON ALL
CORRESPONDENCE REGARDING THIS
PROPOSAL.
R.F.P. 9-11-03-1

APPENDIX B

RETURN SIGNED PROPOSAL IN A SEALED ENVELOPE. SHOW
R.F.P. # ON OUTSIDE OF ENVELOPE.

IN EVENT OF THIS PROPOSAL BEING ACCEPTED, A PURCHASE
ORDER WILL BE SENT.

SEE REVERSE SIDE FOR TERMS & CONDITIONS.

4. ANY EXPENSE INCURRED BY THE BIDDER IN CONNECTION
WITH THIS PROPOSAL IS THE SOLE RESPONSIBILITY OF THE
BIDDER.

5. IF PROPOSAL IS NOT F.O.B. DESTINATION, YOU MUST SHOW
COST OF FREIGHT AS A SEPARATE ITEM.

FILE COPY

DATE 2/6/99	THIS R.F.P. WILL BE OPENED: January 12, 2000	1:30 PM	BY <i>M. Deane</i> DIRECTOR OF PURCHASES 12/14/99
PLEASE QUOTE THE FOLLOWING F.O.B. DESTINATION			

RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY, requests formal written proposals for a Fuel Cell Cathodic Bridge Protection project for the Center for the Advanced Infrastructure & Transportation, Department of Civil and Environmental Engineering as outline the enclosed General Requirements Document, Primary Terms & Conditions.

PLEASE NOTE ADDITIONAL TERMS & CONDITIONS ON REVERSE SIDE OF THIS SHEET.

ALL RUTGERS UNIVERSITY TERMS AND CONDITIONS WILL BECOME PART OF ANY CONTRACT(S) AWARDED AS A RESULT OF THE REQUEST FOR BID OR PROPOSAL, WHETHER STATED IN PART, IN SUMMARY OR BY REFERENCE. IN THE EVENT THE BIDDER'S TERMS AND CONDITIONS CONFLICT WITH RUTGERS THE RUTGERS TERMS AND CONDITIONS WILL PREVAIL, UNLESS THE BIDDER IS NOTIFIED IN WRITING OF RUTGERS ACCEPTANCE OF THE BIDDER'S TERMS AND CONDITIONS.

ANY EXPENSE INCURRED BY THE VENDOR IN CONNECTION WITH THIS PROPOSAL IS THE SOLE RESPONSIBILITY OF THE VENDOR.

READ THE ENTIRE PROPOSAL INCLUDING ALL TERMS, CONDITIONS AND SPECIFICATIONS.

PROPOSAL DOCUMENTS ARE TO BE SUBMITTED IN INK, ANY PRICE ALTERATIONS I.E. WHITEOUTS, CROSSOUTS AND ERASURES MUST BE INITIALED OTHERWISE THE PROPOSAL WILL BE REJECTED. (SEE NUMBER 17, TERMS & CONDITIONS)

THIS (ORIGINAL LEGAL SIZE SHEET) REQUEST FOR QUOTATION FORM "MUST" BE SIGNED AT THE BOTTOM AND RETURNED WITH THE PROPOSAL SHEET(S) YOUR ENTIRE PROPOSAL WILL BE REJECTED AND DISQUALIFIED IF THIS FORM IS "NOT" SIGNED AND RETURNED ON OR BEFORE THE PROPOSAL DUE DATE AND TIME. FURTHERMORE PROPOSERS WHO WISH TO REMAIN ON OUR "QUALIFIED" BIDDERS LIST SHOULD ALSO SIGN AND RETURN THIS PROPOSAL FORM INDICATING REASON(S) FOR NOT SUBMITTING PROPOSALS OR PROPOSALS.

PROPOSALS SHOULD BE RETURNED IN THE ENCLOSED YELLOW ENVELOPE OR ATTACH THE YELLOW ENVELOPE TO THE OUTSIDE OF A LARGE ENVELOPE, IF NECESSARY. TELEGRAPHIC AND FACSIMILE PROPOSALS ARE NOT ACCEPTABLE. BIDDER MUST SUBMIT SEALED PROPOSALS ONLY. ANY COMMUNICATION (SUCH AS FACSIMILE TRANSMITTAL), WHICH REVEALS THE CONTENTS OF A SEALED PROPOSAL WILL RESULT IN DISQUALIFICATION OF THE ENTIRE PROPOSAL.

IT IS THE BIDDERS RESPONSIBILITY TO SEE THAT THEIR PROPOSAL ARRIVES AT THE UNIVERSITY PROCUREMENT & CONTRACTING OFFICE BEFORE THE PROPOSAL OPENING DATE AND TIME.

PROPOSALS DELIVERED IN PERSON OR BY EXPRESS SERVICE SHOULD BE TO OUR ACTUAL LOCATION.

THIS LOCATION IS: RUTGERS-THE STATE UNIVERSITY OF NEW JERSEY
UNIVERSITY PROCUREMENT AND CONTRACTING
56 BEVIER ROAD
PISCATAWAY, NEW JERSEY 08854-8010

SIGNATURE OF THE BIDDER ATTESTS THAT THE BIDDER HAS READ, UNDERSTANDS, AND AGREES TO ALL TERMS, CONDITIONS, AND SPECIFICATIONS SET FORTH IN THE REQUEST FOR PROPOSAL UNLESS OTHERWISE STATED IN WRITING AND SUBMITTED WITH THE PROPOSAL. FURTHERMORE, SIGNATURE BY THE BIDDER SIGNIFIES THAT THIS IS A CONTRACT IMMEDIATELY UPON RECEIPT OF THE PURCHASE ORDER FROM RUTGERS UNIVERSITY FOR ANY OR ALL OF THE ITEMS ORDERED FOR THE LENGTH OF TIME INDICATED IN THE PROPOSAL. FAILURE TO ACCEPT A CONTRACT WITHIN THE TIME PERIOD INDICATED IN THE PROPOSAL TO HOLD PRICES OR MEET ANY OTHER TERMS AND CONDITIONS AS DEFINED IN THE PROPOSAL DURING THE TERM OF THE CONTRACT, SHALL CONSTITUTE BREACH AND WILL RESULT IN SUSPENSION OR DISBARMENT FROM FURTHER BIDDING TO RUTGERS UNIVERSITY.

IF ALL QUESTIONS REGARDING THIS REQUEST TO: CONTACT: PFEIFER/732-443-3002	NOTE: SHOW ALL TAXES AS SEPARATE ITEM	GRAND TOTAL ➡
--	---------------------------------------	---------------

THIS SPACE TO BE FILLED IN BY BIDDER

PAIDMENT CAN BE MADE IN _____ DAYS FROM RECEIPT OF ORDER	*We quote you as above subject to the Terms and Conditions on the reverse.	
	SIGNATURE:	PHONE NUMBER
	PRINT NAME AND TITLE	

REQUEST FOR PROPOSAL
THIS IS NOT AN ORDER

UNIVERSITY PROCUREMENT & CONTRACTING
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
56 BEVIER ROAD
PISCATAWAY, NEW JERSEY 08854-8010

THE R.F.P. NUMBER MUST APPEAR ON ALL
CORRESPONDENCE REGARDING THIS
PROPOSAL.
R.F.P. 9-11-03-1

RETURN SIGNED PROPOSAL IN A SEALED ENVELOPE. SHOW
R.F.P. # ON OUTSIDE OF ENVELOPE.

IN EVENT OF THIS PROPOSAL BEING ACCEPTED, A PURCHASE
ORDER WILL BE SENT.

SEE REVERSE SIDE FOR TERMS & CONDITIONS.

4. ANY EXPENSE INCURRED BY THE BIDDER IN CONNECTION
WITH THIS PROPOSAL IS THE SOLE RESPONSIBILITY OF THE
BIDDER.

5. IF PROPOSAL IS NOT F.O.B. DESTINATION, YOU MUST SHOW
COST OF FREIGHT AS A SEPARATE ITEM.

DATE 2/6/99	THIS R.F.P. WILL BE OPENED: January 12, 2000	1:30 PM	BY
PLEASE QUOTE THE FOLLOWING F.O.B. DESTINATION			DIRECTOR OF PURCHASES

1. ALL CASH TERMS WILL BE ACCEPTABLE, HOWEVER, TERMS LESS THAN 3X-30 DAYS WILL NOT BE CONSIDERED IN THE PROPOSAL AWARD.
2. ANY ADDENDUMS TO THIS REQUEST FOR PROPOSAL MUST BE ACKNOWLEDGED BY SIGNATURE BELOW. FAILURE TO COMPLY WILL RESULT IN REJECTION OF PROPOSAL.

YOU MUST SIGN BELOW FOR EACH ADDENDUM RECEIVED.

ADDENDUM: #1 _____ (Signature)

#2 _____ (Signature)

#3 _____ (Signature)

3. BIDDERS MUST COMPLY WITH ALL PROPOSAL ENCLOSURES AND MUST RETURN CERTAIN ENCLOSURES WITH PROPOSAL FORM. PHOTOCOPIES OF ANY REQUIRED ENCLOSURES ARE NOT VALID. THOSE INDICATED MUST HAVE ORIGINAL SIGNATURES AND NOTARY SEAL. FAILURE TO COMPLY WILL RESULT IN REJECTION OF PROPOSAL.

- THEY ARE: (1) N.J. PL 1977 C.33 (MUST BE SIGNED AND RETURNED)
(2) NON-COLLUSION STATEMENT NCS-1 (MUST BE NOTARIZED)
(3) AFFIDAVIT (MUST BE NOTARIZED)

4. A. REQUIREMENT TO BE PROVIDED BY SUCCESSFUL BIDDER AFTER PROPOSAL AWARD IS MADE.

(1) PL 1975 C.127 WITHIN SEVEN (7) DAYS AFTER RECEIPT OF PURCHASE ORDER.

NOTE: "IF AWARDED CONTRACT YOUR COMPANY/FIRM WILL BE REQUIRED TO COMPLY WITH THE REQUIREMENTS OF PL 1975 C.127. (NJAC17:27)"

(2) INSURANCE, AFTER AWARD AND PRIOR TO START OF WORK.

- B. SUPPLEMENTAL TERMS & CONDITIONS, FORM STC-1 IS A NOTICE OF REQUIREMENT FOR COMPLIANCE BY BIDDER TO WHOM AN AWARD IS MADE AND IS TO BE RETAINED BY BIDDER.

ADDITIONAL ENCLOSURES ARE: DID YOU SHEET/GENERAL REQUIREMENTS/PRIMARY TERMS & CONDITIONS/SAMPLE SUB-CONTRACT AGREEMENT

5. ALL PROPOSALS SUBMITTED TO RUTGERS UNIVERSITY, PROCUREMENT & CONTRACTING WILL BECOME PUBLIC INFORMATION AS OF THE PROPOSAL OPENING DATE AND TIME.

6. NOTE PERMITS - SEE ATTACHED NOT APPLICABLE _____

FOR ALL QUESTIONS REGARDING THIS REQUEST TO: REIGHTON PFEIFER/H/732-445-3002	NOTE: SHOW ALL TAXES AS SEPARATE ITEM	GRAND TOTAL →
---	---------------------------------------	---------------

THIS SPACE TO BE FILLED IN BY BIDDER

PAYMENT CAN BE MADE IN _____ DAYS FROM RECEIPT OF ORDER	*We quote you as above subject to the Terms and Conditions on the reverse.	
SIGNATURE:	PRINT NAME AND TITLE	PHONE NUMBER
MS:		

H. Power Corp.
50 Montgomery Street
Belleville, NJ 07109

Ballard Power Systems Inc.
9000 Glenlyon Parkway
Burnaby BC
CANADA V5J 5J9

International Fuel Cells
195 Governors Highway
South Windsor, CT 06074

Aspen Systems, Inc.
184 Cedar Hill Street
Marlborough, MA 01752

Arthur D. Little, Inc.
Acorn Park
Cambridge, MA 02140-2390

Energy Research Corporation
Fuel Cell Manufacturing
P. O. Box 538
Torrington, CT 06790-0538

Avista Corp.
Corporate Communications Dept.
1411 E. Mission St.
P. O. Box 3727
Spokane, WA 99220-3727

Energy Partners, L. C.
1501 Northpoint Parkway, Suite 102
West Palm Beach, FL 33407

Hydrogenics Corporation
Woodbridge, ON
CANADA L4L 5Y9

RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
UNIVERSITY PROCUREMENT AND CONTRACTING

GENERAL REQUIREMENTS

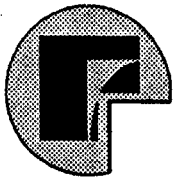
REQUESTS FOR PROPOSAL (RFP)

RFP# 9-11-03-1

For

**FUEL CELL POWERED CATHODIC BRIDGE PROTECTION
PROJECT**

For



CAIT

**Center for Advanced Infrastructure & Transportation
Rutgers, The State University of New Jersey**

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Rutgers, The State University of New Jersey
University Procurement and Contracting
RFP #9-11-03-1**

SCOPE OF WORK

Fuel Cell Powered Cathodic Bridge Protection

I. OBJECTIVES

The main objectives of this study are to test the feasibility and develop a specification for retrofitting a corrosion protection system on the I-80 bridge over Horseneck Road (Structure # 0726-151) with a fuel cell system and hydrogen fuel supply capacity. The proposed project identifies fuel cell systems that are environmentally safe and will provide uninterrupted power under all operating conditions.

II. RESPONSIBILITIES OF CONTRACTOR

- a) Meet with project schedule and deadlines.
- b) Exercise common care with all project equipment.
- c) Share knowledge and experience with project partners.
- d) Work along side Rutgers personal in set-up stages.
- e) Work with CAIT and Rutgers personnel to ensure completion.
- f) Notify and seek approval from the Project Manager for any changes.
- g) Install fuel cell and its accessories at bridge site.
- h) All equipment installed for the project becomes the property of the State of New Jersey.
- i) Maintain fuel cell power supply, including refueling and periodical maintenance.
- j) Monitor the operation of the fuel cell, report on overall efficiency, cost of operation, and system reliability.
- k) Assist Rutgers with quarterly progress reports.
- l) Assist in final evaluation of fuel cell performance.
- m) Participate in preparing a final report to the State of New Jersey upon completion of the project.

III. FUEL CELL REQUIREMENTS

- a) Design, construct, and enclose a 40 Volt, 5 amp fuel cell power supply.
- b) Obtain or supply all needed accessories, subsystems, regulators and components of fuel cell system.
- c) Able to withstand year-round weather conditions in an outdoor setting.
- d) Must be easily refueled and serviceable.
- e) Must be adjustable in-order to fine-tune for application.
- f) Be in good operating condition for the duration of the year-long project.
- g) The installed system is expected to function 24 hrs/day, 7 days/week, regardless of weather conditions.

The fuel cell and its subsystems will be bench tested prior to installation on the bridge. NJDOT's Project Manager will approve the testing protocol and witness specification testing. In order to meet project deadlines, delivery must occur no later than March 15th, 2000. Any special innovative concepts or benefits

that can be brought to the project, in addition to the initial project, should be submitted on a separate sheet.

IV. TESTING

- a) CAIT will act as the contract administrator for the project.
- b) Contractor will design and construct a fuel cell system to meet the application requirements.
- c) Contractor would conduct a depolarization test on the subject deck to determine the optimum levels of current necessary to control the corrosion of the reinforcing steel prior to the retrofit work.
- d) Contractor will routinely monitor the operation of the fuel cell system and document the performance of the system for power delivery, reliability, maintenance requirement, and operation cost.
- e) Contractor will provide a method for automatic data monitoring, collection and processing to assess the performance and reliability of the fuel cell system. Data collection should be made remotely and using regular or cellular phone lines connected to office computers at Rutgers and NJDOT.
- f) Contractor will coordinate refueling activities to ensure continued operation of the fuel cell system.
- g) Contractor would provide testing and adjustment of the cathodic protection systems parameters.
- h) Contractor will perform the installation of the new wiring for the retrofit, and the energizing and adjustment of the fuel cell system.
- i) Contractor shall design and install a data logging system allowing for remote data collection on Fuel Cell performance.
- j) Contractor shall provide all steel enclosure required for housing equipment.

V. YEAR 2000 WARRANTY

Certification that each hardware, software and firmware product delivered under this proposal must be century performance compliant and will meet year 2000 functionality requirements including but not limited to, date recognition, calculations and manipulations which accommodate same and multi-century formulas including leap year calculations must be submitted with the proposal.

VI. GUIDELINES FOR PROPOSAL PREPARATION

1. Five sets of the entire proposal are to be submitted. It is the responsibility of the proposer to ensure that each submission is complete and include:
 - a) All tasks your company will provide
 - b) Work Schedule
 - c) Potential designs
 - d) Total Costs and breakdown
 - e) List of all major components, suppliers and sub-contractors
2. Each proposal must contain a technical section that addresses items listed in Section III, items a-g on page 2 and a section that describes team qualifications along with cost proposal. There is a 20-page limit for the technical section of the proposal.
3. The technical section of the proposal must include the description of the hardware and software proposed.

4. The qualification's section of the proposal must include a brief description of your company's qualifications and resumes of Project Manager and Key Staff.
5. The staff you propose (Project Manager and Key Staff) MUST be used in the performance of the project.
6. If you list a key person(s) that is (are) not currently employed by your firm, you need to enclose with the proposal a letter of commitment from the individual indicating that the individual or individuals will be available at the start of the project and throughout the duration of the project.
7. The enclosed bid sheet must be submitted as the cost proposal and must include:
 - a) The cost of hardware and software component.
 - b) Installation
 - c) Maintenance costs
 - d) An itemized list of components offered manufacturer and related product literature.
8. Formal Proposal Document (2 gray colored pages - must be signed and dated on the bottom right) Photocopies of required documents are not acceptable.
9. PL 1977 C.33 (must be completed and signed) Photocopies of required documents are not acceptable
10. Non-collusion Statement NCS-1 (must be signed and notarized) Photocopies of required documents are not acceptable.
11. Questions regarding bidding procedures should be directed to Creighton Pfeifer at (732) 445-3002.
12. Questions regarding the technical requirements on this RFP, should be directed to Dr. Hani H. Nassif at (732) 445-4414.
13. Questions should be submitted in writing to Procurement & Contracting to the address listed below, verbal answers will not be binding.

Creighton Pfeifer, Senior Buyer
University Procurement & Contracting
Rutgers, The State University of New Jersey
56 Bevier Road
Piscataway, NJ 08854
E-Mail: ipfeifer@rci.rutgers.edu

VII. EVALUATION AND PROJECT AWARD

1. **Evaluation Criteria**: The following criteria will be used to evaluate all proposals received. The order in which the criteria are listed in no way indicates the importance in the evaluation process.
 - a) Technical content of proposal.
 - b) Comprehension of the Project by the Project Manager and Key Staff.
 - c) Particular ability to perform work. (Including prior experience, appropriateness, ability and references.)
 - d) Cost of the proposed work.
 - e) Special innovative concepts or benefits to bring to the project.

2. **Contract Award**: Upon the review of proposals, the best proposal teams will be invited to NJDOT in Trenton to give a proposal presentation. Rutgers, The State University of New Jersey, reserves the right to reject any or all proposals and further reserves the right of judgement of which proposal(s) is in the best interest of the university. Final contract awards will be the sole responsibility of University Procurement and Contracting.

RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
UNIVERSITY PROCUREMENT AND CONTRACTING
FUEL CELL POWERED CATHODIC BRIDGE PROTECTION PROJECT
PRIMARY TERMS AND CONDITIONS
RFP# 9-11-03-1

1. PERMITS AND LICENSES:

Permits and licenses, including filing and fees, required by public authorities having jurisdiction, shall be the responsibility of the contractor(s) on the work. Each contractor shall obtain and pay for such permits, licenses, and fees necessary for the completion of the work pertaining to this contract and making arrangements with NJDOT for the proper installation of the traffic/weather monitoring / warning system. The contractor will be responsible for providing evidence to the University of this Compliance prior to or at the time work is started.

The bidders attention is directed to the fact that all applicable state laws, municipal ordinances, and rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the contract throughout, and they will be deemed to be included in the contract the same time as though herein written out in full.

2. INDEMNIFICATION:

The Sub-Contractor agrees to indemnify, defend and hold harmless the Rutgers University, NJDOT and the employees of the Rutgers University the NJDOT from and against all claims, suits, losses, judgements, costs, and expenses for loss of life, property damage, or bodily injury of any persons whatsoever, which claims shall arise out of, or result from, the work performed by the Sub-Contractor and from negligent acts, errors, or omissions of either the Sub-Contractor, or the agents, servants, and employees of the Sub-Contractor in the performance of the service under the Agreement.

3. INSURANCE:

- A. The Sub-Contractor shall secure and maintain in force during and at least one (1) year after completion of the services performed, liability insurance as provided herein as follows:
- 1) Comprehensive General Liability policy shall be maintained as broad as the standard form currently in use in the State of New Jersey which shall not be circumscribed by any endorsements limiting breadth of coverage. The policy shall include endorsements of contractual liability and professional liability. Limits of liability shall not be less than \$1,000,000 combined single limit per occurrence for bodily injury liability and property damage liability. **Rutgers University and the NJDOT must be named as an additional insured in this policy** such insurance shall be deemed primary.
 - 2) Comprehensive Automobile Liability policy shall be maintained covering owned, non-owned, and hired vehicles with limits of liability of at least \$1,000,000 combined single limit per occurrence for bodily injury liability and property damage liability.

3) Workers' Compensation Insurance or a program of self insurance shall be maintained applicable to the laws of the State of New Jersey and Employees' Liability Insurance with a limit not less than \$5,000,000.

4) The Sub-Contractor shall carry Errors and Omissions, Professional Liability Insurance and/or Professional Malpractice Insurance sufficient to protect the Sub-Contractor from any liability arising out of professional obligations performed pursuant to the requirements of this Agreement. This insurance shall be in the amount of \$1,000,000.

B. The Sub-Contractor shall provide to the Rutgers University and the NJDOT current certificates of insurance for all coverage's and renewals thereof, which renewed certificates must contain a provision that the insurance renewal shall not be canceled except after thirty (30) day written notice to Rutgers University and the NJDOT.

4. GENERAL INFORMATION:

1) The successful supplier will be required to sign a formal Subcontract Agreement with Rutgers University. A sample copy of this subcontract agreement is enclosed.

2) The installed system is expected to function 24 hrs/day 7 days/week regardless of weather conditions.

3) Rutgers, The State University of New Jersey is tax exempt.

**RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
UNIVERSITY PROCUREMENT AND CONTRACTING
FUEL CELL POWERED CATHODIC BRIDGE PROTECTION PROJECT
BID SHEET
RFP #9-11-03-1**

SUPPLIER NAME _____

Cost of hardware and software components: _____

(Attach an itemized list of components offered, manufacturers and related product literature.)

Maintenance costs: _____

Installation costs: _____

Total: _____

Warranty Period:

Hardware and software components: _____

Workmanship: _____

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

**Interdepartmental Communications
University Procurement Services**

February 2, 2000

BID NOTIFICATION

TO: Pat Zary, Associate Director - CAIT
Civil and Environmental Engineering

FROM: Creighton Pfeifer, Senior Buyer *(Signature)*
University Procurement & Contracting

RE: Request For Proposal #9-11-03-1

Job Description: FUEL CELL POWERED CATHODIC BRIDGE PROTECTION PROJECT

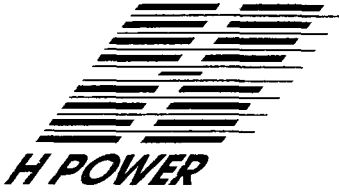
9 quotations were requested on the above. 1 bid were submitted.
Results are as follows:

	<u>VENDOR</u>	<u>AMOUNT BID</u>
1.	<u>H-POWER</u>	<u>\$39,900</u>
2.	<u>_____</u>	<u>_____</u>
3.	<u>_____</u>	<u>_____</u>
4.	<u>_____</u>	<u>_____</u>
5.	<u>_____</u>	<u>_____</u>
6.	<u>_____</u>	<u>_____</u>
7.	<u>_____</u>	<u>_____</u>
8.	<u>_____</u>	<u>_____</u>
9.	<u>_____</u>	<u>_____</u>
10.	<u>_____</u>	<u>_____</u>

NOTE: USING DEPARTMENTS ARE NOT PERMITTED TO AWARD THIS BID TO A SUPPLIER VERBALLY OR OTHERWISE UNLESS APPROVAL HAS BEEN OBTAINED FROM THE BUYER IN UNIVERSITY PROCUREMENT & CONTRACTING.

A copy of the bid is enclosed for your review and files. We will await your comments and/or a requisition to cover this work. A letter of justification will be required if you decide not to select the lowest qualified bidder. If you have any questions, please do not hesitate to call.

c: Michael Dunn



February 1, 2000

Mr. Creighton Pfeifer
University Procurement and Contracting
Rutgers, The State University of New Jersey
56 Bevier Road
Piscataway, New Jersey 08854-8010

Mr. Pfeifer:

H Power is please to submit this proposal (Ref # 020100-01) in response to RFP#9-11-03-1 for "Fuel Cell Powered Cathodic Bridge Protection Project." In 1998, H Power was awarded a contract by the New Jersey Department of Transportation to retrofit sixty-five (65) variable message signs (VMS) with fuel cell systems. To date, thirty-nine (39) systems have been installed and are operational on highways throughout the State of New Jersey. Consequently, we are familiar with the environmental and roadside conditions of New Jersey, and our fuel cell system will meet all CAIT / NJDOT specifications. In addition, our location in New Jersey will allow frequent monitoring and quick service of the unit. H Power has enlisted the expertise of Corpro Companies, Inc. to aid in the integration of the fuel cell system with the existing cathodic protection system.

The system will deliver the required power continually for a period of at least one year. Design of the proposed system will be based upon the VMS units and field experience gained from the VMS contract. Delivery of this system will be four months after the contract is awarded.

We will be happy to meet with CAIT or NJDOT to resolve any questions in our proposal, and we look forward to starting the work upon award of the contract.

Very truly yours,

A handwritten signature in black ink, appearing to read "R. DuBois", written in a cursive style.

Rene DuBois
Director of Sales and Marketing



REQUEST FOR PROPOSAL
THIS IS NOT AN ORDER

UNIVERSITY PROCUREMENT & CONTRACTING
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
56 BEVIER ROAD
PISCATAWAY, NEW JERSEY 08854-8010

CORRESPONDENCE REGARDING THIS PROPOSAL
R.F.P. 9-11-03-1

- RETURN SIGNED PROPOSAL IN A SEALED ENVELOPE. SHOW R.F.P. # ON OUTSIDE OF ENVELOPE.
- IN EVENT OF THIS PROPOSAL BEING ACCEPTED, A PURCHASE ORDER WILL BE SENT.
- SEE REVERSE SIDE FOR TERMS & CONDITIONS.

- 4. ANY EXPENSE INCURRED BY THE BIDDER IN CONNECTION WITH THIS PROPOSAL IS THE SOLE RESPONSIBILITY OF THE BIDDER.
- 5. IF PROPOSAL IS NOT F.O.B. DESTINATION, YOU MUST SHOW COST OF FREIGHT AS A SEPARATE ITEM.

1. Power Corp.
50 Montgomery Street
Belleville, NJ 07109

DATE 2/6/99	THIS R.F.P. WILL BE OPENED: January 12, 2000	1:30 PM	BY
PLEASE QUOTE THE FOLLOWING F.O.B. DESTINATION			DIRECTOR OF PURCHASES

- 2. ALL CASH TERMS WILL BE ACCEPTABLE, HOWEVER, TERMS LESS THAN 3X-30 DAYS WILL NOT BE CONSIDERED IN THE PROPOSAL AWARD.
- 3. ANY ADDENDUMS TO THIS REQUEST FOR PROPOSAL MUST BE ACKNOWLEDGED BY SIGNATURE BELOW. FAILURE TO COMPLY WILL RESULT IN REJECTION OF PROPOSAL.

YOU MUST SIGN BELOW FOR EACH ADDENDUM RECEIVED.

ADDENDUM: #1 Rene DuBois (Signature)
#2 _____ (Signature)
#3 _____ (Signature)

- 4. BIDDERS MUST COMPLY WITH ALL PROPOSAL ENCLOSURES AND MUST RETURN CERTAIN ENCLOSURES WITH PROPOSAL FORM. PHOTOCOPIES OF ANY REQUIRED ENCLOSURES ARE NOT VALID. THOSE INDICATED MUST HAVE ORIGINAL SIGNATURES AND NOTARY SEAL. FAILURE TO COMPLY WILL RESULT IN REJECTION OF PROPOSAL.

- THEY ARE: (1) N.J. PL 1977 C.33 (MUST BE SIGNED AND RETURNED)
(2) NON-COLLUSION STATEMENT NCS-1 (MUST BE NOTARIZED)
(3) AFFIDAVIT (MUST BE NOTARIZED)

- 5. A. REQUIREMENT TO BE PROVIDED BY SUCCESSFUL BIDDER AFTER PROPOSAL AWARD IS MADE.

- (1) PL 1975 C.127 WITHIN SEVEN (7) DAYS AFTER RECEIPT OF PURCHASE ORDER.
NOTE: "IF AWARDED CONTRACT YOUR COMPANY/FIRM WILL BE REQUIRED TO COMPLY WITH THE REQUIREMENTS OF PL 1975 C.127. (NJAC17:27)"
- (2) INSURANCE, AFTER AWARD AND PRIOR TO START OF WORK.

- B. SUPPLEMENTAL TERMS & CONDITIONS, FORM STC-1 IS A NOTICE OF REQUIREMENT FOR COMPLIANCE BY BIDDER TO WHOM AN AWARD IS MADE AND IS TO BE RETAINED BY BIDDER.

ADDITIONAL ENCLOSURES ARE: DID YOU SHEET/GENERAL REQUIREMENTS/PRIMARY TERMS & CONDITIONS/SAMPLE SUB-CONTRACT AGREEMENT

- ALL PROPOSALS SUBMITTED TO RUTGERS UNIVERSITY, PROCUREMENT & CONTRACTING WILL BECOME PUBLIC INFORMATION AS OF THE PROPOSAL OPENING DATE AND TIME.

• NOTE PERMITS - SEE ATTACHED X NOT APPLICABLE _____

ALL QUESTIONS REGARDING THIS REQUEST TO: LIGHTON PFEIFER/H/732-445-3002	NOTE: SHOW ALL TAXES AS SEPARATE ITEM	GRAND TOTAL → \$39,900
--	---------------------------------------	------------------------

THIS SPACE TO BE FILLED IN BY BIDDER

PAYMENT CAN BE MADE IN <u>120</u> DAYS FROM RECEIPT OF ORDER <u>H POWER PLANT</u>	*We quote you as above subject to the Terms and Conditions on the reverse.	
TERMS: <u>NET 30</u>	SIGNATURE: <u>Rene DuBois</u> PRINT NAME AND TITLE: <u>RENE DuBois</u>	PHONE NUMBER: <u>973-4806</u>

REQUEST FOR PROPOSAL
THIS IS NOT AN ORDER

UNIVERSITY PROCUREMENT & CONTRACTING
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
56 BEVIER ROAD
PISCATAWAY, NEW JERSEY 08854-8010

THE R.F.P. NUMBER MUST APPEAR ON ALL
CORRESPONDENCE REGARDING THIS
PROPOSAL.

R.F.P. 9-11-03-1

- RETURN SIGNED PROPOSAL IN A SEALED ENVELOPE. SHOW R.F.P. # ON OUTSIDE OF ENVELOPE.
- IN EVENT OF THIS PROPOSAL BEING ACCEPTED, A PURCHASE ORDER WILL BE SENT.
- SEE REVERSE SIDE FOR TERMS & CONDITIONS.

- 4. ANY EXPENSE INCURRED BY THE BIDDER IN CONNECTION WITH THIS PROPOSAL IS THE SOLE RESPONSIBILITY OF THE BIDDER.
- 5. IF PROPOSAL IS NOT F.O.B. DESTINATION, YOU MUST SHOW COST OF FREIGHT AS A SEPARATE ITEM.

Power Corp.
10 Montgomery Street
Belleville, NJ 07109

DATE 2/6/99	THIS R.F.P. WILL BE OPENED: January 12, 2000	1:30 PM	BY <i>Michael J. Kellum</i> DIRECTOR OF PURCHASES 12/14/99
PLEASE QUOTE THE FOLLOWING F.O.B. DESTINATION			

RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY, requests formal written proposals for a Fuel Cell Cathodic Bridge Protection project for the Center for the Advanced Infrastructure & Transportation, Department of Civil and Environmental Engineering as outlined in the enclosed General Requirements Document, Primary Terms & Conditions.

- PLEASE NOTE ADDITIONAL TERMS & CONDITIONS ON REVERSE SIDE OF THIS SHEET.
- ALL RUTGERS UNIVERSITY TERMS AND CONDITIONS WILL BECOME PART OF ANY CONTRACT(S) AWARDED AS A RESULT OF THE REQUEST FOR BID OR PROPOSAL, WHETHER STATED IN PART, IN SUMMARY OR BY REFERENCE. IN THE EVENT THE BIDDER'S TERMS AND CONDITIONS CONFLICT WITH RUTGERS, THE RUTGERS TERMS AND CONDITIONS WILL PREVAIL, UNLESS THE BIDDER IS NOTIFIED IN WRITING OF RUTGERS ACCEPTANCE OF THE BIDDER'S TERMS AND CONDITIONS.
- ANY EXPENSE INCURRED BY THE VENDOR IN CONNECTION WITH THIS PROPOSAL IS THE SOLE RESPONSIBILITY OF THE VENDOR.
- READ THE ENTIRE PROPOSAL INCLUDING ALL TERMS, CONDITIONS AND SPECIFICATIONS.
- PROPOSAL DOCUMENTS ARE TO BE SUBMITTED IN INK, ANY PRICE ALTERATIONS I.E. WHITEOUTS, CROSSOUTS AND ERASURES MUST BE INITIALED OTHERWISE THE PROPOSAL WILL BE REJECTED. (SEE NUMBER 17, TERMS & CONDITIONS)
- THIS (ORIGINAL LEGAL SIZE SHEET) REQUEST FOR QUOTATION FORM "MUST" BE SIGNED AT THE BOTTOM AND RETURNED WITH THE PROPOSAL SHEET(S). YOUR ENTIRE PROPOSAL WILL BE REJECTED AND DISQUALIFIED IF THIS FORM IS "NOT" SIGNED AND RETURNED ON OR BEFORE THE PROPOSAL DUE DATE AND TIME. FURTHERMORE PROPOSERS WHO WISH TO REMAIN ON OUR "QUALIFIED" BIDDERS LIST SHOULD ALSO SIGN AND RETURN THIS PROPOSAL FORM INDICATING REASON(S) FOR NOT SUBMITTING PROPOSALS OR PROPOSALS.
- PROPOSALS SHOULD BE RETURNED IN THE ENCLOSED YELLOW ENVELOPE OR ATTACH THE YELLOW ENVELOPE TO THE OUTSIDE OF A LARGE ENVELOPE, IF NECESSARY. TELEGRAPHIC AND FACSIMILE PROPOSALS ARE NOT ACCEPTABLE. BIDDERS MUST SUBMIT SEALED PROPOSALS ONLY. ANY COMMUNICATION (SUCH AS FACSIMILE TRANSMITTAL), WHICH REVEALS THE CONTENTS OF A SEALED PROPOSAL WILL RESULT IN DISQUALIFICATION OF THE ENTIRE PROPOSAL.
- IT IS THE BIDDERS RESPONSIBILITY TO SEE THAT THEIR PROPOSAL ARRIVES AT THE UNIVERSITY PROCUREMENT & CONTRACTING OFFICE BEFORE THE PROPOSAL OPENING DATE AND TIME.
- PROPOSALS DELIVERED IN PERSON OR BY EXPRESS SERVICE SHOULD BE TO OUR ACTUAL LOCATION.
- THIS LOCATION IS: RUTGERS-THE STATE UNIVERSITY OF NEW JERSEY
UNIVERSITY PROCUREMENT AND CONTRACTING
56 BEVIER ROAD
PISCATAWAY, NEW JERSEY 08854-8010

SIGNATURE OF THE BIDDER ATTESTS THAT THE BIDDER HAS READ, UNDERSTANDS, AND AGREES TO ALL TERMS, CONDITIONS, AND SPECIFICATIONS SET FORTH IN THE REQUEST FOR PROPOSAL UNLESS OTHERWISE STATED IN WRITING AND SUBMITTED WITH THE PROPOSAL. FURTHERMORE, SIGNATURE BY THE BIDDER SIGNIFIES THAT THIS IS A CONTRACT IMMEDIATELY UPON RECEIPT OF THE PURCHASE ORDER FROM RUTGERS UNIVERSITY FOR ANY OR ALL OF THE ITEMS, AND FOR THE LENGTH OF TIME INDICATED IN THE PROPOSAL. FAILURE TO ACCEPT A CONTRACT WITHIN THE TIME PERIOD INDICATED IN THE PROPOSAL TO HOLD PRICES OR MEET ANY OTHER TERMS AND CONDITIONS AS DEFINED IN THE PROPOSAL DURING THE TERM OF THE CONTRACT, SHALL CONSTITUTE A BREACH AND WILL RESULT IN SUSPENSION OR DISBARMENT FROM FURTHER BIDDING TO RUTGERS UNIVERSITY.

ALL QUESTIONS REGARDING THIS REQUEST TO: RICHARD PFEIFER/H/732-445-3002	NOTE: SHOW ALL TAXES AS SEPARATE ITEM	GRAND TOTAL → \$39,900
--	---------------------------------------	------------------------

THIS SPACE TO BE FILLED IN BY BIDDER	
DELIVERY CAN BE MADE IN <u>120</u> DAYS FROM RECEIPT OF ORDER	*We quote you as above subject to the Terms and Conditions on the reverse.
<u>H POWER PLANT</u>	SIGNATURE: <i>RENE DuBois</i>
TERMS: <u>NET 30</u>	PRINT NAME AND TITLE: <u>RENE DuBois</u>
	PHONE NUMBER: <u>973-450-4400</u>

**RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
UNIVERSITY PROCUREMENT AND CONTRACTING
FUEL CELL POWERED CATHODIC BRIDGE PROTECTION PROJECT
PRIMARY TERMS AND CONDITIONS
RFP# 9-11-03-1**

1. PERMITS AND LICENSES:

Permits and licenses, including filing and fees, required by public authorities having jurisdiction, shall be the responsibility of the contractor(s) on the work. Each contractor shall obtain and pay for such permits, licenses, and fees necessary for the completion of the work pertaining to this contract and making arrangements with NJDOT for the proper installation of the traffic/weather monitoring / warning system. The contractor will be responsible for providing evidence to the University of this Compliance prior to or at the time work is started.

The bidders attention is directed to the fact that all applicable state laws, municipal ordinances, and rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the contract throughout, and they will be deemed to be included in the contract the same time as though herein written out in full.

2. INDEMNIFICATION:

The Sub-Contractor agrees to indemnify, defend and hold harmless the Rutgers University, NJDOT and the employees of the Rutgers University the NJDOT from and against all claims, suits, losses, judgements, costs, and expenses for loss of life, property damage, or bodily injury of any persons whatsoever, which claims shall arise out of, or result from, the work performed by the Sub-Contractor and from negligent acts, errors, or omissions of either the Sub-Contractor, or the agents, servants, and employees of the Sub-Contractor in the performance of the service under the Agreement. } NJ

3. INSURANCE:

A. The Sub-Contractor shall secure and maintain in force during and at least one (1) year after completion of the services performed, liability insurance as provided herein as follows:

- 1) Comprehensive General Liability policy shall be maintained as broad as the standard form currently in use in the State of New Jersey which shall not be circumscribed by any endorsements limiting breadth of coverage. The policy shall include endorsements of contractual liability, and ~~professional liability~~. Limits of liability shall not be less than \$1,000,000 combined single limit per occurrence for bodily injury liability and property damage liability. **Rutgers University and the NJDOT must be named as an additional insured in this policy** such insurance shall be deemed primary.
- 2) Comprehensive Automobile Liability policy shall be maintained covering owned, non-owned, and hired vehicles with limits of liability of at least \$1,000,000 combined single limit per occurrence for bodily injury liability and property damage liability.

3) Workers' Compensation Insurance or a program of self insurance shall be maintained applicable to the laws of the State of New Jersey and Employees' Liability Insurance with a limit not less than \$5,000,000.

N/A RP
4) ~~The Sub-Contractor shall carry Errors and Omissions, Professional Liability Insurance and/or Professional Malpractice Insurance sufficient to protect the Sub-Contractor from any liability arising out of professional obligations performed pursuant to the requirements of this Agreement. This insurance shall be in the amount of \$1,000,000.~~

B. The Sub-Contractor shall provide to the Rutgers University and the NJDOT current certificates of insurance for all coverage's and renewals thereof, which renewed certificates must contain a provision that the insurance renewal shall not be canceled except after thirty (30) day written notice to Rutgers University and the NJDOT.

4. GENERAL INFORMATION:

- 1) The successful supplier will be required to sign a formal Subcontract Agreement with Rutgers University. A sample copy of this subcontract agreement is enclosed.
- 2) The installed system is expected to function 24 hrs/day 7 days/week regardless of weather conditions.
- 3) Rutgers, The State University of New Jersey is tax exempt.

RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY
UNIVERSITY PROCUREMENT AND CONTRACTING
FUEL CELL POWERED CATHODIC BRIDGE PROTECTION PROJECT
BID SHEET
RFP #9-11-03-1

SUPPLIER NAME H POWER CORP

Cost of hardware and software components: _____
(Attach an itemized list of components offered, manufacturers
and related product literature.)

Maintenance costs: _____

Installation costs: _____

NON RECURRING ENGINEERING & HARDWARE Total: \$ 39,900
(REFER TO ATTACHED COST BREAKDOWN)
Warranty Period: *N/A FIRST GENERATION PROTOTYPE*

Hardware and software components: _____

Workmanship: _____

1/31/00

Cost breakdown for Cathodic Protection Proposal
RFP # 9 -11-03-1

H Power Corp	U/P	Qty	Total
Material			
Fuel Cell System	\$4,050		\$4,050
Hydrogen Fuel Supply	\$1,000		\$1,000
Cellular Phone connection	Responsibility of Rutgers/NJDOT		
		Subtotal A	<u>\$5,050</u>
Labor			
	<u>Hrs</u>	<u>\$/HR</u>	
Engineering	240	30	\$7,200
Documentation	80	28	\$2,240
Engrg Support & Follow Up160	540	30	\$16,200
Maintenance	96	25	<u>\$2,400</u>
			\$28,040
Engrg O/H		100%	<u>\$28,040</u>
		Subtotal B	\$56,080
 <u>Corrpro Corp.</u>			
Material			
Cord2-12 channel DAQ			\$3,990
Variable Resistor Pack			<u>\$1,000</u>
		Subtotal C	\$4,990
Labor			
System Testing			\$250
System Engrg and Documentation			\$500
Commissioning & Training			<u>\$1,545</u>
		Subtotal D	\$2,295
		 Grand Total	 \$68,415
H Power cost share portion			\$28,515
Rutgers Request for funding			\$39,900

Office of Research and Sponsored Programs
Administrative Services Building • Annex II • Busch Campus
Rutgers, The State University of New Jersey
58 Bevier Road • Piscataway • New Jersey 08854-8010
732/445-2880 • FAX: 732/445-3257 • Email: U025001@rutadmin.rutgers.edu

**SUBCONTRACT AGREEMENT NO.
IN AGREEMENT WITH
RUTGERS, THE STATE UNIVERSITY
and**

Subcontractor: *H POWER CORPORATION*

Address: *60 MONTGOMERY ST
BELLEVILLE NJ 07809*

For: Performance of certain work and services in connection with Rutgers
account number: 4-2
award number:

Project Sponsor: *NJDOT*

Project Title:

Rutgers Project Director/
Principal Investigator:

Department:

Type of Contract: Cost Reimbursement

Period of Performance: to

Maximum Allowable Price: \$

Issued by: Rutgers, The State University
Office of Research and Sponsored Programs
58 Bevier Road
Piscataway, NJ 08854-8010

Invoice to: Rutgers, The State University

TABLE OF CONTENTS

<u>ITEM</u>	<u>PAGE</u>
PREAMBLE	3
TERMS AND CONDITIONS	
ARTICLE 1 SCOPE OF WORK	3
ARTICLE 2 KEY PERSONNEL	3
ARTICLE 3 PERIOD OF PERFORMANCE	3
ARTICLE 4 COMPENSATION AND METHOD OF PAYMENT	3
ARTICLE 5 MATCHING AND COST SHARING REQUIREMENTS	
ARTICLE 6 REPORTING REQUIREMENTS	4
ARTICLE 7 AUDIT	4
ARTICLE 8 EQUIPMENT	4
ARTICLE 9 RIGHTS IN DATA AND COPYRIGHTS	4
ARTICLE 10 INTELLECTUAL PROPERTY	5
ARTICLE 11 TERMINATION	5
ARTICLE 12 PROVISIONS OF PRIME AGREEMENT	5
ARTICLE 13 PUBLICITY	5
ARTICLE 14 DISPUTES	5
ARTICLE 15 PHS ATTESTATION	6
ARTICLE 16 DEBARMENT AND SUSPENSION	6
ARTICLE 17 EQUAL OPPORTUNITY/AFFIRMATIVE ACTION	6
ARTICLE 18 INDEMNIFICATION	6
ARTICLE 19 ASSIGNMENT	7
ARTICLE 20 ENTIRE AGREEMENT	7
ARTICLE 21 SITUS	-7
EXHIBIT A STATEMENT OF WORK	
EXHIBIT B BUDGET	
EXHIBIT C PROVISIONS OF PRIME AGREEMENT	
EXHIBIT D BILLING FORM	

This Agreement is entered into by and between Rutgers, the State University of New Jersey, with principal offices in New Brunswick, New Jersey (hereinafter called "RUTGERS"), and *H POWER* (hereinafter called "SUBCONTRACTOR"), and constituting a subcontract under Grant/Contract No. from the issued to Rutgers, the State University.

WITNESSETH THAT:

SUBCONTRACTOR agrees to perform the work and services in accordance with the terms and conditions set forth in this Agreement for the consideration stated herein. Therefore, it is agreed as follows:

ARTICLE 1. SCOPE OF WORK

- a) SUBCONTRACTOR shall provide the necessary personnel, equipment, facilities, and supplies to perform the work described in the Statement of Work, which is attached hereto as Exhibit A.
- b) Unless specifically stated elsewhere in this Agreement, the quality of all services rendered hereunder shall conform to the highest standards in the relevant profession, trade, or field of endeavor. All services shall be rendered by or supervised directly by individuals fully qualified in the relevant professions, trade, or field, and holding any licenses required by law.

ARTICLE 2. KEY PERSONNEL

- a) SUBCONTRACTOR shall designate _____ as its Project Director/Principal Investigator. ~~shall not be removed or replaced without the prior written approval of RUTGERS.~~ *RUTGERS WILL BE INFORMED IF PROJECT DIRECTOR IS REPLACED*
- b) RUTGERS hereby designates _____ as its Project Director/Principal Investigator for this work.

ARTICLE 3. PERIOD OF PERFORMANCE

- a) The period of performance under this Agreement shall begin on _____ and shall end on _____, unless extended by mutual written agreement, or terminated in accordance with the terms of this Agreement.

ARTICLE 4. COMPENSATION AND METHOD OF PAYMENT

- a) The total amount available to SUBCONTRACTOR for performance hereunder is \$ _____ as specified in the budget, Exhibit B hereunto, which shall not be exceeded unless changed by written amendment to this Agreement.
- b) SUBCONTRACTOR shall, at approximately ninety (90) day intervals following commencement of work, submit invoices to RUTGERS for payment of costs incurred during the preceding quarter. Each original invoice will present, by approved budget line item, costs for the current period being billed along with cumulative amounts billed to date according to Exhibit D. These invoices shall contain all costs incurred during the billing

period and shall be sufficiently detailed to allow RUTGERS personnel to make the required fiscal reports to the sponsor. Invoices shall be submitted to the referencing account No. 4-2 . Payment of final invoice shall be withheld pending receipt and acceptance of all closeout documents, including final cost-sharing certification.

ARTICLE 5. MATCHING AND COST SHARING REQUIREMENTS

- a) The subgrantee shall be required to account to the satisfaction of RUTGERS and the sponsor for matching and cost-sharing requirements of this subgrant as specified in the Request for Proposal.

ARTICLE 6. REPORTING REQUIREMENTS

- a) SUBCONTRACTOR shall submit such technical reports to the RUTGERS Project Director/Principal Investigator as required by RUTGERS to meet the technical report requirements of the prime agreement. Each report shall be submitted sufficiently in advance of the report deadline to allow review and comment by the RUTGERS Project Director/Principal Investigator prior to transmittal to the funding agency.
- b) All required technical/financial reports and project-related records will be maintained and made available by SUBCONTRACTOR in accordance with FAR 32.215.1, "Examination of Records by Controller General," for a period of not less than three (3) years following the submission and acceptance of the final reports. N

ARTICLE 7. AUDIT

- a) SUBCONTRACTOR shall maintain appropriate accounting records sufficient to properly document costs claimed as incurred in the performance of this Agreement, and shall make such records available, upon request, to authorized RUTGERS or sponsor personnel for audit purposes pursuant to FAR 52.215.2, "Audit Negotiation." Said records shall be retained and kept available by SUBCONTRACTOR for a period of not less than four (4) years after final payment by the University, or if notified of an audit and notification by RUTGERS of resolution of any exceptions resulting therefrom, whichever occurs first.
- b) If any amount paid hereunder by RUTGERS is subsequently disapproved or disallowed by the sponsor or another agency, SUBCONTRACTOR shall upon demand and without litigation, promptly repay RUTGERS said disapproved or disallowed amount.

ARTICLE 8. EQUIPMENT

- a) Title to equipment acquired with subcontract funds shall be vested in SUBCONTRACTOR, unless otherwise stated in Article 10, and subject to the rights of the Government, if applicable. However, unless so provided in SUBCONTRACTOR's budget, SUBCONTRACTOR shall not acquire any items of equipment with subcontract funds unless prior written approval has been obtained from RUTGERS.
- b) SUBCONTRACTOR shall be responsible for maintaining equipment and associated materials, including inventory, accountability, and disposition of equipment, ~~in accordance with RUTGERS policy.~~ WHILE EQUIPMENT & MATERIALS IS IN SUBCONTRACTOR POSSESSION. R1

ARTICLE 9. RIGHTS IN DATA AND COPYRIGHTS

- a) Unless otherwise specified herein, any data developed by SUBCONTRACTOR in the performance of this Agreement shall be and remain the sole property of SUBCONTRACTOR.
- b) SUBCONTRACTOR is free to copyright material developed under or in connection with this Agreement, and shall give notice to RUTGERS of any material so copyrighted.
- c) RUTGERS and sponsor shall have a royalty-free, nonexclusive, world-wide and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use, such data and material.

ARTICLE 10. INTELLECTUAL PROPERTY

- a) "Intellectual Property" shall mean patents, patent applications, and know-how.
- b) Unless otherwise provided herein, all Intellectual Property relating to inventions conceived and reduced to practice solely by SUBCONTRACTOR in the performance of this Agreement shall be and remain the sole property of SUBCONTRACTOR. Intellectual Property relating to inventions conceived and reduced to practice solely by RUTGERS in the performance of this Agreement shall be and remain the sole property of RUTGERS. Intellectual Property relating to inventions conceived and reduced to practice jointly by RUTGERS and SUBCONTRACTOR in the performance of this Agreement shall be ~~jointly owned~~ *owned by SUBCONTRACTOR UNLESS AGREED TO IN WRITING BY BOTH PARTIES.*
- c) *N* *N/A* ~~Unless otherwise provided herein, RUTGERS shall have a royalty-free, nonexclusive, worldwide, and irrevocable right to use SUBCONTRACTOR'S Intellectual Property both for research and educational purposes, and to satisfy the requirements of the Sponsor.~~
- d) *RL* *N/A* ~~In the event that commercially useful developments are made from SUBCONTRACTOR'S rights to Intellectual Property originating under or derived from this Agreement, SUBCONTRACTOR, in consideration for RUTGERS funding hereunder, shall provide RUTGERS reasonable compensation which shall be mutually determined by the parties at the time these developments are reasonably identified.~~
- e) Certain patent and invention rights and other rights of RUTGERS, SUBCONTRACTOR, and the U.S. Government relating to inventions hereunder are specified in and governed by 48CFR227 and 252, as amended, and 37CFR401.14 of July 1, 1987, which provisions are incorporated herein by reference.

ARTICLE 11. TERMINATION

- a) RUTGERS may terminate this Agreement with or without cause at any time by giving thirty (30) days written notice when it is determined that termination is in RUTGERS' best interest. SUBCONTRACTOR shall, upon receipt of notice of termination from RUTGERS, refrain from incurring any further costs under this Agreement and shall use

its best efforts to cancel any commitments made by it prior to receipt of such notice. Such termination shall, however, not affect any commitments which, ~~in the judgement of RUTGERS,~~ have properly become legally binding prior to the effective date of termination and which could not reasonably have been rescinded by SUBCONTRACTOR. Any prepaid but unearned funds shall be returned to RUTGERS. rd

- rd N/A
- b) ~~It is understood and agreed, however, that in the event that SUBCONTRACTOR is in default upon any of its obligations hereunder at the time of termination, RUTGERS reserves the right to pursue, in addition to termination, any other rights or remedies which RUTGERS may have against SUBCONTRACTOR, and RUTGERS may withhold any payments to SUBCONTRACTOR for the purpose of set-off until such time as the exact amount of damages may be determined.~~

ARTICLE 12. PROVISIONS OF PRIME AGREEMENT

~~All provisions contained in Exhibit C shall be binding upon the SUBCONTRACTOR and SUBCONTRACTOR hereby agrees with same.~~ N/A. rd

ARTICLE 13. PUBLICITY

No publicity matter having or containing any reference to RUTGERS or in which the name of RUTGERS is mentioned shall be made use of by SUBCONTRACTOR until written approval has been obtained from RUTGERS.

ARTICLE 14. DISPUTES

Any disagreements arising out of this Agreement, or from a breach thereof, shall be submitted to arbitration, and the judgement upon the award rendered by the arbitrators may be entered in any court having jurisdiction thereof. The arbitration shall be held under the procedures and rules of the American Arbitration Association. Any arbitration shall be held in Newark, New Jersey, unless mutually agreed otherwise.

ARTICLE 15. PHS ATTESTATION

If this Agreement is funded as a result of an award to RUTGERS from US Public Health Service, SUBCONTRACTOR attests that it has filed all the proper assurances/certifications in compliance with PHS Form 398. In the event that SUBCONTRACTOR cannot make such an attestation, then it agrees to be subject to the policies of RUTGERS with respect to the research being supported, and RUTGERS will send a copy of its policies to SUBCONTRACTOR upon request.

ARTICLE 16. DEBARMENT AND SUSPENSION

- a) In accepting this Agreement, SUBCONTRACTOR certifies that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in the transaction by any Federal department or agency. Any change in the debarred or suspended status of SUBCONTRACTOR during the life of this Agreement must be reported immediately to RUTGERS.

SUBCONTRACTOR agrees to incorporate the Debarment and Suspension Certification into any subcontract that they may enter into as a part of this Agreement.

- b) If SUBCONTRACTOR is unable to certify to any of the statements in this certification, SUBCONTRACTOR shall attach an explanation to this Agreement.
- c) This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participant's responsibilities. The regulations were published as Part VII of the May 26, 1988 Federal Register, pages 19160-19211. Copies of the regulations may be obtained by contacting the authorizing official of RUTGERS.

ARTICLE 17. EQUAL OPPORTUNITY/AFFIRMATIVE ACTION

- a) This Agreement is subject to the requirements of Executive Order 11246 and 11375 and the rules and regulations of the Secretary of Labor (41 CFR Chapter 60) in promoting Equal Employment Opportunities.
- b) SUBCONTRACTOR hereby certifies that it does not and will not maintain any facilities it provides for its employees in a segregated manner, or permit its employees to perform their services at any location under its control, where segregated facilities are maintained; and it will obtain a similar certification prior to award of any non-exempt subcontract approved hereunder.

ARTICLE 18. INDEMNIFICATION

All persons ^{EMPLOYED OR CONTRACTED BY SUBCONTRACTOR,} rendering services covered by this Agreement, ~~on behalf of SUBCONTRACTOR, including faculty, staff, students, or other agents,~~ shall be considered to be employees of SUBCONTRACTOR for the purpose of any state workers' compensation laws or federal workers' compensation statutes. ~~SUBCONTRACTOR hereby agrees to indemnify RUTGERS against all claims or awards under such workers' compensation laws arising out of this Agreement.~~ nl
EOP

ARTICLE 19. ASSIGNMENT

This Agreement shall not be assigned in whole or in part without the prior written consent of RUTGERS.

ARTICLE 20. ENTIRE AGREEMENT

This Agreement constitutes the entire agreement between RUTGERS and SUBCONTRACTOR with respect to the subject matter hereof, and supersedes and replaces any other arrangements, oral or written, between the parties hereto pertaining to this subcontract. No waiver, modification, or amendment of any of the terms and conditions hereof shall be effective unless set forth in writing duly signed by RUTGERS and SUBCONTRACTOR.

ARTICLE 21. SITUS

Regardless of place of physical execution or performance, this Agreement shall be construed according to the laws of, and deemed to have been executed in, the state of New Jersey.

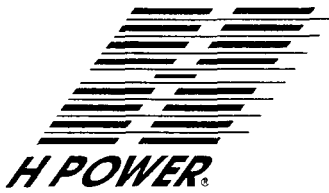
IN WITNESS WHEREOF, the respective parties have executed this Agreement on the dates indicated below.

RUTGERS, THE STATE UNIVERSITY

Andrew B. Rudczynski, Ph.D.
Associate Vice President for Research
Policy and Administration

Date

Date



H Power Corp.

A Company Overview

H Power Corp., founded in 1989, employs approximately 65 people at its Belleville, NJ headquarters facilities and 20 more at its Canadian affiliate, H Power Enterprises of Canada, in Ville St. Laurent, Quebec. The Company is among the leaders in the development of proton-exchange membrane (PEM) fuel cells and has taken the initiative in commercializing this technology. Our headquarters are located at:

H Power Corp.

60 Montgomery Street, Belleville, New Jersey 01109 <http://www.hpower.com>

Our Canadian affiliate is located at:

H Power Enterprises of Canada, Inc.

1069 Begin Street, St. Laurent, Quebec, Canada H4R 1V8 <http://www.hpowercanada.com>

H Power received the world's first commercial order for a sizable number of competitively-bid, non-subsidized, for-profit, field deployable PEM fuel cell systems offered with a warranty. The order was issued by the New Jersey Department of Transportation in March 1998 for back-up power in the State's entire fleet of variable-message signs. Many of these systems have been deployed, and all units under this order are delivered many months ahead of schedule.

H Power offers sub-kilowatt fuel cell systems for a variety of telecommunications and back-up power applications. These sub-kilowatt systems are suitable for many mobile applications involving light utility vehicles. They can also be used as auxiliary power units in conjunction with conventional power generating systems, e.g. onboard battery chargers in electric vehicles or motor cars.

H Power is currently building and testing stack modules in the 1-6 kW range and developing on-site cogeneration systems in the 2-3 kW range for remote and grid-connected residential applications with propane and natural gas.

H Power is, in summary:

- *A leader in PEM commercialization*
- *Experienced in hybrid-vehicle systems, both on-road and off-road*
- *Highly concerned with reliable, cost-effective manufacture*
- *One of the world's first large-scale manufacturer of PEM fuel cell products*
- *A pioneer in low power (<1 kW) fuel cell*

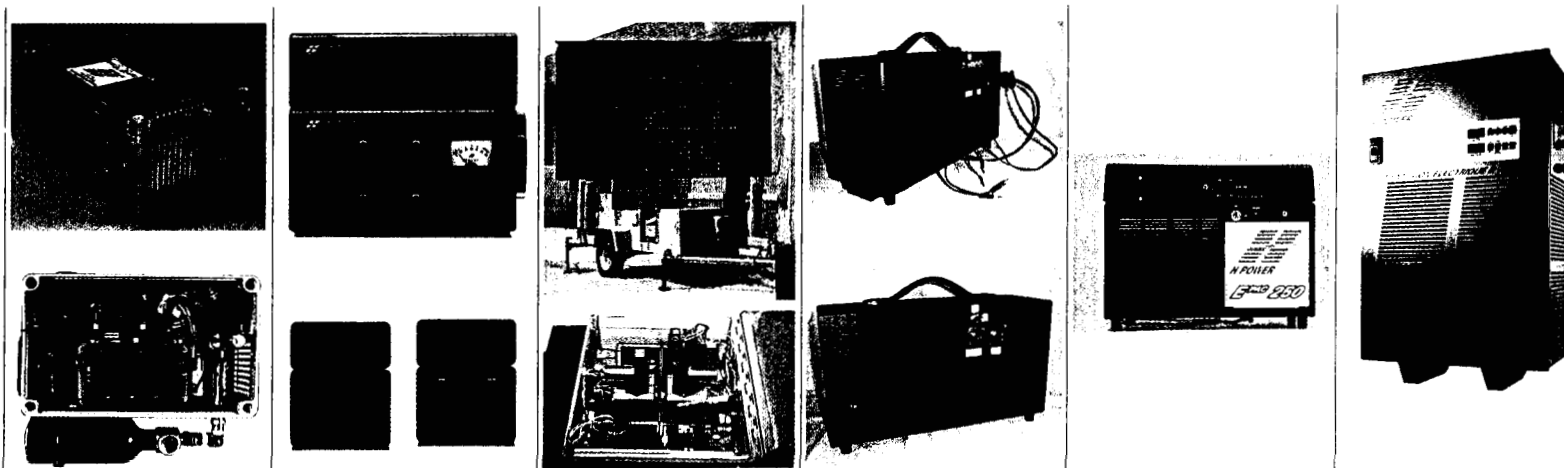
H Power is a privately held company. Among our shareholders are four major strategic investors that have provided us with additional capital infusions, as well as assistance in areas relating to their own particular expertise.

- **Sofinov Société Financière D'Innovation**, the technology branch of the largest Canadian pension fund, Caisse de Dépôt et Placement du Québec.
- **Singapore Technologies Automotive, Ltd.**, part of a multi-billion dollar conglomerate, engaged in an ordinance and commercial business in Asia, with strong interests in heavy vehicles such as trucks and buses.
- **Duquesne Enterprises Inc.**, the wholly owned investment arm of DQE, a public utility and energy services company based in Pittsburgh, Pennsylvania.
- **Energy Co-opportunity of Herndon, VA. (ECO)**, a strategic investment partner and national energy cooperative with the role of exclusive representation of H Power's multi-kilowatt products to rural utility co-op members.





H Power Fuel Cell Systems Product Overview



Model	PowerPEM [®] -D35	PowerPEM [®] -SSG50	PowerPEM [®] -VMS50	PowerPEM [®] -PS250	EPAC [™] -250	EPAC [™] -500
Power (W Nom.)	35	50	50	250	250	500
		12 Reg.	12	28 Unreg.	120 Vac	120 Vac
		13.5 6.1	29.8 13.5	22.5 10.2	30 13.6	Approx. 90 45.3
System Dim.						
H x W x L (in)	4.2 x 7.9 x 9.4	9.2 x 7.2 x 11.5	10.9 x 14.6 x 18.8	9.7 x 6.2 x 16.0	12 x 6.2 x 16	35.4 x 23.6 x 7.9
H x W x L (mm)	107 x 202 x 239	234 x 183 x 191	276 x 370 x 478	247 x 158 x 407	305 x 158 x 406	900 x 600 x 200
Provided with H2 Fuel Sys.	Yes (MH)* 70 L H ₂	Yes (MH)* 140 L H ₂	No	No	No	No

* Metal Hydride Alloy

H Power Corp.

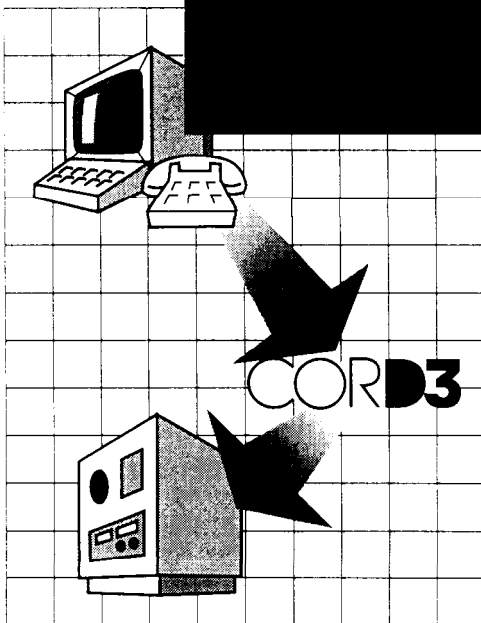
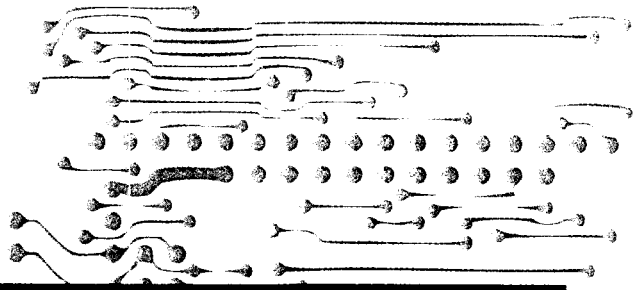
60 Montgomery Street • Belleville, NJ 07109 • Phone: 973-450-4400 • Fax: 973-450-9850

H Power Enterprises of Canada, Inc.

1069 Begin Street • St. Laurent, Quebec H4R 1V8 • Phone: 514-956-8932 • Fax: 514-956-5426

For additional information, contact your local customer service representative or visit our web site at www.hpower.com

CORD3



Features:

- 8 input channels
- 1 rectifier interruption
- 8 K Data storage with battery back-up.
- Uses conventional telephone line
No dedicated line required.
- Laptop computer connection for on site testing.
- Optional remote rectifier adjustment.

COREXCO

New Jersey Department of Transportation H Power Corporation with Corrpro Companies Inc.

Cathodic Protection Fuel Cell Retrofit Program RFP #9-11-03-1 I-80 Bridge Deck over Horseneck Road (Structure #0726-151)

Introduction (Summary of Offering)

New Jersey DOT, Rutgers University, H Power Corp. and Corrpro Companies, Inc. propose a cooperative program to evaluate the viability of using fuel cells to power cathodic protection installations on New Jersey bridges and other similar installations. **It is proposed that fuel cells will provide an improvement in reliability for these installations and offers the additional benefit of applying corrosion protection to structures located at remote sites where power is not readily available from electric distribution networks.**

Scope of Work

Background

In New Jersey 18 bridges on I-80 and one deck on Rt. 17 near Saddle Brook have cathodic protection (CP) systems. The systems on I-80 were installed in 1988, and consist of Raychem Ferex 100 anode, Harco conductive polymer mound anode, and ELGARD 210 anode mesh. The anodes are covered with a 1.25 to 1.50 inch latex modified concrete (LMC) overlay. Some of the anode systems have performed better than others, and several of the Raychem systems have already been abandoned.

However five systems which were installed using ELGARD titanium anode mesh on the I-80 bridges continue to work well. According to a NJDOT research report dated March 1994, the ELGARD titanium mesh anode systems had the highest level of corrosion protection, the best overall performance, and the longest projected anode life (estimated at 35 to 40 years).

Unfortunately the rectifiers that control the operation of these systems have not proven to be very reliable and require routine monitoring and specialized skills to keep them operating properly. Some of the rectifier systems have already ceased to be used.

Proposed activity

H Power and Corrpro propose to retrofit one of the ELGARD systems on a bridge on I-80 with a PEM fuel cell system and hydrogen fuel supply. A local gas supplier will be contracted to provide refueling service to power the corrosion protection system for a period of one year. During this time the reliability and performance of the fuel cell system will be established and evaluated. H Power will monitor the operation of the fuel cell system and will report overall efficiency, cost of operation, and system reliability. Corrpro will evaluate the performance of the corrosion protection system while powered by the fuel cell system and report the level of performance and degree of protection applied to the bridge as compared to a standard rectifier powered system.

Site Selection

The site selected for the fuel cell retrofit is the I-80 bridge over Horseneck Road (structure no. 0726-151). An existing eight circuit rectifier provides CP current to both the eastbound (Harco mound) and westbound (ELGARD anode mesh) bridge decks. The rectifier at I-80 over Horseneck Road is located beneath the westbound structure.

This site is an excellent choice for the proposed fuel cell retrofit since it is out of the way from large volume public traffic, easily accessible for retrofit and refueling of the fuel cell system, and is located very close to H Power's offices to enhance the ease and frequency of monitoring.

Benefits

Fuel cells have been incorporated by NJDOT into Variable Message Signs (VMS). To date there have been thirty nine (39) VMS trailers that have been retrofitted with an H Power VMS50 PEM fuel cell system and are working well in the field. The technology has been identified as a key technology for future Intelligent Transportation System (ITS) applications. The H Power fuel cell systems are considered to be the state-of-the-art power supplies for remote and portable applications.

Fuel cells will not require the in-depth training of service personnel necessary to safely work on the rectifier systems. Fuel cell systems will be able to operate independently of whether the electric power distribution systems are operable or not. Power outages, which frequently occur due to adverse weather conditions, will not have an impact on the continuity of CP power delivery to the bridge.

The State of New Jersey is not presently monitoring the CP systems on a routine basis. Regular inspection and maintenance by specially trained personnel are key to the long term successful operation of these devices. Fuel cells systems do not require specially skilled personnel and because of their modular construction can easily be maintained by regular service providers.

A trial installation as described would allow the State of New Jersey to determine the performance and benefits of fuel cell power. In addition this will provide data which can be used in defining the benefits of using fuel cells in other applications.

Technical Aspects

CP System Design

A grid-powered cathodic protection system for both eastbound and westbound I-80 bridge decks over Horseneck Road is currently operational. An inspection conducted on January 29, 1998 indicated that all eight circuits were operating and providing adequate CP current to the bridge decks. The westbound CP system (using ELGARD anode mesh) will be taken off-line and retrofitted with a fuel cell system for evaluation.

The operating parameters for the ELGARD system at the time of the inspection were as follows:

<u>Circuit No.</u>	<u>Volts</u>	<u>Amps</u>	<u>Resistance (Ohms)</u>	<u>Ag:AgCl Ref. Cell</u>
5	2.4	0.8	3.00	-424 mV
6	3.1	2.7	1.15	-883 mV
7	2.8	2.8	1.00	-455 mV
8	2.3	0.7	3.28	-339 mV
Total Current:		7.0 Amps		
Total Resistance:		0.37 Ohms		
Total Watts:		19.74 Watts		

As each circuit has unique current-voltage characteristics, a set of parallel rheostats will be used to control the current from the fuel cell system to each anode zone. A NEMA 4 junction box will be used to house the rheostats, and will be mounted in the same cabinet as the fuel cell system.

Fuel Cell System Design

The Variable Message Signal, VMS-50, Fuel Cell Power System was designed for long term usage in a roadside environment during winter months. Component environmental testing along with initial System temperature testing and actual VMS deployment show favorable results during operation at low temperature and transportation shock and vibration levels. As such, an inexpensive 50W demonstration unit can be prototyped using the VMS design and component parts. This has already been done once for a prototype fuel cell power source for a Trafcon arrow board sign. While mass and volume efficiency will not be optimized, a prototype demonstration unit can be fabricated with minimal design and other non-recurring efforts. Typically high prototype costs will also be minimized by using components already available from the VMS design.

The VMS Fuel Cell Power System is shown in Figure 1. The VMS FCPS was designed as a redundant system. This system is comprised of two fuel cell stacks including all the required auxiliary hardware for independent and failsafe operation. Incoming air baffles, fans and insulation were incorporated to assist in the thermal management of the fuel cell stacks. The system contains two controllers and other electronics required for the VMS operational scenario.

The proposed demonstration unit will utilize the VMS Box enclosure and will contain only one fuel cell stack and its required auxiliary hardware. The unit will have a controller and a DC-DC converter to regulate the output voltage. Minor design modifications will be made to centrally locate the stack and auxiliary hardware within the enclosure. A Series E Sensidyne pump will be used to provide quiet operation. Additionally, a commercially available 9V long life primary battery will be designed into the system. This battery is needed to deliver initial power to the controller, pump and solenoids. Changes in the controller algorithm and DC to DC converter scheme will be made to meet the TBD control and output requirements for the Cathodic Bridge Protection project.

Hydrogen Subsystem Design

The fuel cell system will operate on extra-dry grade hydrogen contained in 12 "T" sized cylinders (12-pack). Each T cylinder is 10" in diameter, 56" tall and is compressed to approximately 2400 psig. It is estimated that each 12 pack will

fuel the system for at least 4 months. A local gas supplier will be contracted to provide refueling during the 1 year period. Three refuelings are projected during the test period. A pressure transducer will be used to remotely monitor the remaining amount of fuel. H Power will coordinate refueling activities as necessary. The 12 pack must be enclosed for safety and vandalism reasons. A cement pad will be poured to support the cylinders and enclosure. This enclosure will be separated from the remaining system components.

Data Collection and Communications Design

Data collection and communications will be via a commercially available system from Corexco, Incorporated, supplied by Corrpro. A dual CORD3 system is capable of monitoring up to 12 channels and storing 2000 readings per channel. The system will monitor anode zone parameters and certain fuel cell system parameters. This system operates on 110 VAC power and will be connected to the existing AC power line. Future systems may warrant a DC powered Remote Monitoring Unit (RMU) or the incorporation of a small DC/AC inverter. It is possible that the remote monitoring system can use the existing telephone line in the rectifier for operation of the RMU modem. However, if this is not the case, a cellular telephone will be used for communication.

Tasks

1. H Power will act as Prime Contractor for the project, coordinating activities with Corrpro, a subcontracted gas supplier, NJDOT and Rutgers.
2. H Power will design and construct a fuel cell system to meet the requirements of the application including designing and constructing an enclosure for the fuel cell system and the hydrogen supply that will accommodate the year round environmental requirements of the application. Variable resistors (rheostats) will be used to control the current to each anode zone. The current will be measured using shunts installed in each anode leg.
3. H Power and Corrpro will routinely monitor the operation of the fuel cell system using a Corexco remote monitoring unit (RMU) (see attached data sheet). The Corexco system is certified to be Y2K compliant. The Corexco RMU (CORD3) will monitor the voltage and current for each anode zone, as well as hydrogen cylinder pressure, ambient temperature, stack current and voltage. It is hopeful that the remote monitoring system can use the existing telephone line in the rectifier for operation of the RMU modem. However, if this is not possible, a cellular telephone will be used for communication.
4. H Power will coordinate the refueling activities to ensure continued operation of the fuel cell system.
5. Corrpro Companies, Inc., a corrosion engineering and cathodic protection firm, would provide testing and adjustment of the cathodic protection system

parameters. Corrpro is familiar with the cathodic protection systems in use on I-80 and was initially involved in the installation and testing of these systems.

6. Prior to the retrofit work Corrpro will conduct a depolarization test on the subject deck to determine the optimum levels of current necessary to control the corrosion of the reinforcing steel. The most commonly used criterion for cathodic protection of reinforcing steel in concrete is a polarization decay of at least 100 mV over a minimum 4-hour period. For this test Corrpro will use the existing silver-silver chloride (Ag:AgCl) reference electrodes that are embedded in the concrete deck. Since the CP system has been in operation for some period of time, it is envisioned that the current requirements to maintain cathodic protection will be somewhat lower than what the rectifier system is presently supplying.
7. Corrpro will supervise the installation of the new wiring for the retrofit and assist H Power in the energizing and adjustment of the fuel cell system to match the CP requirements.
8. H Power and Corrpro will submit written reports to Rutgers on a quarterly basis and provide a final report at the end of the one year monitoring period. These reports will document the performance of the system, power delivery, efficiency, reliability, maintenance requirements, and operating costs.
9. All components of the system (software and hardware) will be certified as Y2K compliant.

Key Personnel

Keith Miller

Product Development Supervisor

As the Product Development Supervisor at H Power, Mr Miller is responsible for the mechanical design of Fuel Cell Systems. His duties include managing the drafting department (which provides drafting support to all H Power organizations) in addition to providing documentation and configuration management control of drawings and procedures. He also is a project engineer who designs and develops new Fuel Cell Systems. Before joining H Power, Mr. Miller worked for a major defense company for 13 years designing test equipment and packaging electronics. In this capacity, he conducted thermal, dimensional, and shock testing and analysis and vendor auditing.

Education

B.S. in Mechanical Engineering, Pennsylvania State University, 1983

M.S. in Manufacturing Engineering, University of Massachusetts, 1988

George Richardson

Electronics Engineering Supervisor

George Richardson is an electronics engineer with over 20 years experience in the design and troubleshooting of industrial control systems. Before joining H Power as full time Electronics Engineering Supervisor, George ran his own consulting business for 10 years, frequently doing work for H Power in the design of fuel cell controllers and hybrid electric vehicle control. George's past design work has included automated pharmaceutical plants, electronic blood analyzers, high speed networking and imaging systems, and even microprocessor-controlled cookie makers and jelly donut fillers.

George currently manages a staff of two technicians and handles all software and hardware development for H Power fuel cell products.

List of major components, suppliers, and sub-contractors

Fuel Cell System

H Power Corporation

Data Logging / Remote Monitoring System

Corrpro

Hydrogen Storage System

H Power Corporation

1/31/00

Cost breakdown for Cathodic Protection Proposal

RFP # 9 -11-03-1

H Power Corp	U/P	Qty	Total
Material			
Fuel Cell System	\$4,050		\$4,050
Hydrogen Fuel Supply	\$1,000		\$1,000
Cellular Phone connection	Responsibility of Rutgers/NJDOT		
		Subtotal A	<u>\$5,050</u>
Labor			
	<u>Hrs</u>	<u>\$/HR</u>	
Engineering	240	30	\$7,200
Documentation	80	28	\$2,240
Engrg Support & Follow Up160	540	30	\$16,200
Maintenance	96	25	<u>\$2,400</u>
			\$28,040
Engrg O/H		100%	<u>\$28,040</u>
		Subtotal B	\$56,080
 <u>Corrpro Corp.</u>			
Material			
Cord2-12 channel DAQ			\$3,990
Variable Resistor Pack			<u>\$1,000</u>
		Subtotal C	\$4,990
Labor			
System Testing			\$250
System Engrg and Documentation			\$500
Commissioning & Training			<u>\$1,545</u>
		Subtotal D	\$2,295
		Grand Total	\$68,415
H Power cost share portion			\$28,515
Rutgers Request for funding			\$39,900

Months ARO

Task name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Design Fuel Cell System	### ###	##																
Build Fuel Cell System		## ##																
Installation and Start up			## #															
Test Period				###	###	###	###	###	###	###	###	###	###	###	###			
Evaluation Period																	## ###	
Write Final Report																		###

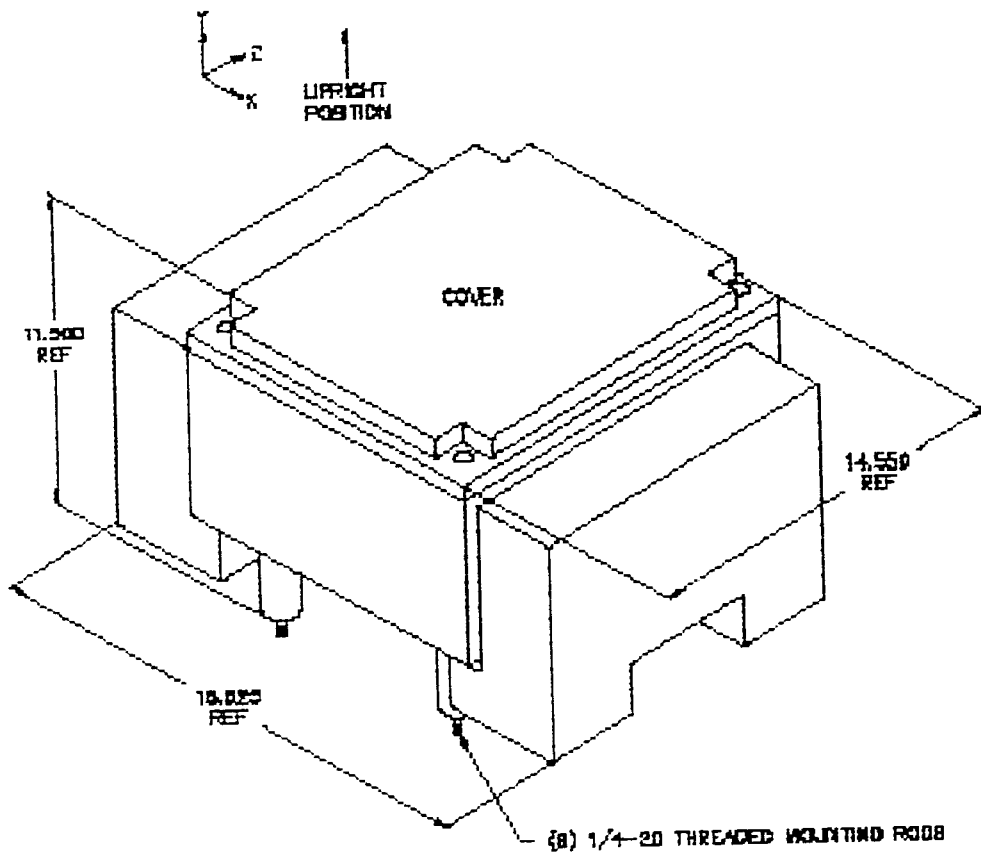


Figure 1
VMS FCPS

RECTIFIER MAINTENANCE SHEET

Project I-80, Section JAD & 4AY Bridge Identification 0726-150 & 151 Construction #13 & #14
 Rectifier Model No. VADCA 20-80-C2 Rectifier Serial No. MP-88005
 Rectifier Output: 20 Volts DC 80 Amps DC 8 Circuits
 Anode System 0726-150 (Harco-"A"), 0726-151 (Elgard-"C")
 Tester WJS (Carrpro) Deck Conditions Dry
 Date 11-11-88 Time 1:00 pm Ambient Temperature 60°F

Remarks _____
Final Adjustment for Continuous Operation
CKTS #1-4 for Bridge 0726-150 (#13)
CKTS #5-8 for Bridge 0726-151 (#14)

ZONE	Voltage (V)	Current (A)	Mode of Operation Voltage/ Current/ Potential	Ref. Cell #1 (mv)		Ref. Cell #2 (mv)		Potential Set (mv)	Potential Control Switch On / Off	Reference Cell Switch Position 1 / 2	Reference Cell "ON" Monitor Position 1 / 2
				IR Drop Free	ON	IR Drop Free	ON				
1	2.4	0.7	Current	-436	-486	-420	-476	-1495	ON	1	2
2	3.8	4.4	Current	-448	-498	-500	-587	-1500	ON	1	2
3	4.2	4.5	Current	-520	-563	-493	-553	-1498	ON	1	2
4	2.8	1.3	Current	-373	-396	-446	-500	-1498	ON	1	2
5	1.4	0.7	Current	-428	-458	-503	-528	-1500	ON	1	2
6	1.9	2.7	Current	-451	-497	-528	-552	-1499	ON	1	2
7	1.8	3.0	Current	-434	-482	-475	-517	-1501	ON	1	2
8	1.5	0.7	Current	-392	-423	-428	-467	-1499	ON	1	2
9											
10											

DEPOLARIZATION TEST DATA SUMMARY
 PROJECT I - 80, SECTION 3AD & 4AY
 NOVEMBER 10, 1988 - AMBIENT TEMPERATURE: 50 F

Bridge No. 1415-155/156 (#9 & #10)

ZONE	1	2	3	4	5	6	7	8	9	10								

BEFORE DECAY TEST																		
Voltage (V)	3.5	1.9																
Current (A)	3.8	3.3																
	Potential (-mvs)																	
REF. CELL NO.	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1-off	489	476	433	451														
240 min off	244	223	219	152														
4 hr Decay (mvs)	245	253	214	299														

AFTER DECAY TEST																		
Voltage (V)	3.1	1.6																
Current (A)	3.9	3.3																

Bridge No. 1415-157/158 (#11 & #12)

ZONE	1	2	3	4	5	6	7	8	9	10										

BEFORE DECAY TEST																				
Voltage (V)	2.4	2.4	3.3	3.8	3.9	3.6	4.1	4.2	4.1	4.1										
Current (A)	4.0	4.5	4.1	4.7	3.4	2.7	3.1	3.3	2.7	2.8										
	Potential (-mvs)																			
REF. CELL NO.	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2		
1-off	573	468	469	481	352	398	519	617	458	696	483	640	492	480	555	506	547	481	539	464
240 min off	219	366	288	282	151	162	354	491	313	621	300	466	279	231	270	346	326	286	265	307
4 hr Decay (mvs)	354	102	181	199	201	236	165	126	145	75	183	174	213	249	285	160	221	195	274	157

AFTER DECAY TEST																				
Voltage (V)	2.3	2.3	3.2	4.0	3.7	3.6	4.0	4.2	4.0	4.1										
Current (A)	4.2	4.5	4.1	5.6	3.4	2.9	3.0	3.3	2.6	2.6										

Bridge No. 0726-150/151 (#13 & #14)

ZONE	1	2	3	4	5	6	7	8	9	10								

BEFORE DECAY TEST																		
Voltage (V)	2.9	4.3	4.7	3.2	1.7	2.1	2.1	1.5										
Current (A)	1.0	4.4	4.5	1.5	0.9	3.0	3.5	1.0										
	Potential (-mvs)																	
REF. CELL NO.	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1-off	499	450	419	473	555	536	370	426	411	554	467	583	425	515	409	472		
240 min off	193	234	305	255	389	365	178	183	214	205	222	366	191	261	202	248		
4 hr Decay (mvs)	306	216	114	218	166	171	192	243	197	349	245	217	234	274	207	224		

AFTER DECAY TEST																		
Voltage (V)	2.6	3.9	4.3	2.9	1.4	1.7	1.8	1.6										
Current (A)	1.1	4.4	4.5	1.6	1.0	3.0	3.6	1.0										

POST INSTALLATION TESTING AND ADJUSTING

Project I-80, Section 3AD & 4AY
 Bridge Identification 0726-150 & 151 Construction #13 & #14
 Anode System 0726-150 (Harco-"A"), 0726-151 (Elgard-"C")
 Date 9-12-88 Time 4:30 pm Ambient Temperature 78°F
 Tester(s) WJS (Corpro) Deck Condition Dry
 Remarks Ckts #1-#4 for bridge 0726-150 (#13)
Ckts #5-#8 for bridge 0726-151 (#14)
Re-test 9-16-88, 9-21-88 Zone 2, Reference Cell #1, bad

10-5-87
New Cell
Zn 2, RC1

NO POWER-STATIC CONDITION DATA

ZONE	1	2	3	4	5	6	7	8	9	10
Zone Size (ft ²)	1430	4350	4450	1480	1370	3500	4100	1350		
SN to Anode Res. (Ω)	0.74	0.50	0.58	0.77	0.16	0.12	0.14	0.24		
RC1 to Gnd Res. (Ω)	1500		910	1600	570	540	570	725		540
RC2 to Gnd Res. (Ω)	1300	840	990	1100	1900	620	870	1300		
SN to Both RC Gnd Res (Ω)	1.9	2.0	3.3	4.0	1.6	1.5	2.4	3.3		
SN to RC1 Res. Gnd. (Ω)	3.0	3.5	5.8	2.0	3.3	3.9	4.9	6.4		
SN to RC2 Res. Gnd. (Ω)	4.2	4.5	7.0	8.5	2.9	2.3	4.5	6.3		
SN to Anode Pot (mv) *	210	212	196	122	246	217	221	196		
RC1 to Both RC Gnd Pot (mv) *	435		363	249	247	211	171	200		330
RC2 to Both RC Gnd Pot (mv) *	245	203	320	270	276	278	311	294		
SN to RC1 Gnd Pot (mv) *	0.2	0.5	0.0	0.0	0.0	0.0	0.4	0.5		
SN to RC2 Gnd Pot (mv) *	0.4	0.2	0.4	0.0	0.0	0.0	0.4	0.5		

POWER - INITIAL START UP DATA - SET IN CURRENT CONTROL

ZONE	1	2	3	4	5	6	7	8	9	10
ma/ft ² Concrete Surface	1	1	1	1	1	1	1	1		
Volts (v)	3.8	5.1	5.3	3.6	1.7	1.9	1.9	1.9		
Current (A)	1.4	4.4	4.5	1.5	1.4	3.5	3.5	1.4		
RC-1 "ON" *	625		548	361	515	532	532	512		
RC-1 "IO"	504		486	344	460	464	464	440		
RC-2 "ON" *	524	786	564	451	586	546	546	560		
RC-2 "IO"	446	528	457	404	546	513	513	478		
Meter Calibrated										
V Rect/Port	ok	ok	ok	ok	ok	ok	ok	ok		
I Rect/Port	ok	ok	ok	ok	ok	ok	ok	ok		
Pot Rect/Port	ok	ok	ok	ok	ok	ok	ok	ok		

* Potential Measurements with portable meter negative terminal to structure (negative or ground)

Table 6. Final Adjustment for Constant Current Control (continued)

Bridge No.	Anode System	Zone No.	Current (A)	Current Density (ma/ft ²)
1415-152/153(7&8)	B	4	6.6	1.1
1415-155/156(9&10)	A	1	3.3	0.8
1415-155/156(9&10)	C	2	2.8	0.7
1415-157/158(11&12)	C	1	4.1	1.0
1415-157/158(11&12)	C	2	4.3	1.1
1415-157/158(11&12)	C	3	3.9	1.0
1415-157/158(11&12)	C	4	4.7	1.2
1415-157/158(11&12)	A	5	4.0	1.5
1415-157/158(11&12)	A	6	2.7	1.0
1415-157/158(11&12)	A	7	3.0	1.0
1415-157/158(11&12)	A	8	3.2	1.0
1415-157/158(11&12)	A	9	2.7	1.0
1415-157/158(11&12)	A	10	2.7	1.0
0726-150/151(13&14)	A	1	0.7	0.5
0726-150/151(13&14)	A	2	4.4	1.0
0726-150/151(13&14)	A	3	4.5	1.0
0726-150/151(13&14)	A	4	1.3	0.9
0726-150/151(13&14)	C	5	0.7	0.5
0726-150/151(13&14)	C	6	2.7	0.8
0726-150/151(13&14)	C	7	3.0	0.7
0726-150/151(13&14)	C	8	0.7	0.5
0726-153/154(15&16)	B	1	4.8	1.1
0726-153/154(15&16)	B	2	3.7	0.9
0726-155/156(17&18)	B	1	7.2	1.5
0726-155/156(17&18)	B	2	4.9	1.0
0726-155/156(17&18)	B	3	8.0	1.6
0726-155/156(17&18)	B	4	4.9	1.0
0726-155/156(17&18)	C	5	4.9	1.0
0726-155/156(17&18)	C	6	7.4	1.5