Solar Powered Hydrogen Generating Facility and Hydrogen Powered Vehicle Fleet

Technical Progress Report for the period

October 1, 1994--December 31, 1994

James J. Provenzano

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Clean Air Now

1222 Lincoln Boulevard

Santa Monica, CA 90401

February, 1995

PREPARED FOR THE UNITED STATES DEPARTMENT OF ENERGY

Under Contract No. DE-FC36-94GO10039

Technical Progress Report #2

1. **INSTRUMENT NO.:** DE-FC36-94GO10039

2. **PROJECT TITLE:** Solar Powered Hydrogen Generating Facility And Hydrogen Powered Vehicle Fleet

3. **REPORTING PERIOD:** October 1, 1994 through December 31, 1994

4. **NAME AND ADDRESS:** (Project Office)

   Clean Air Now

   1222 Lincoln Boulevard

   Santa Monica, CA 90401

5. **PROJECT START DATE:** August 11, 1994

6. **COMPLETION DATE:** September 10, 1995

7. APPROACH CHANGES:

1. During the month of October efforts were placed on procuring a new electrolysis supplier to replace United Technologies Corporation/Hamilton Standard (UTC). Technical discussions were initiated with both Teledyne-Brown Engineering and **The Electrolyser Corporation (TEC)**. Each firm was invited to submit proposals to supply the electrolysis system and related components. Meetings were held with each proposer and a technical review committee was created to evaluate proposals, as discussed in Technical Progress Report #1. While both proposals were of high quality and indicated that either of the offers could satisfactorily complete the requirement, TEC was selected on the basis of the established criteria; importantly, their they offered system stand-alone capability which is extremely attractive in a demonstration project such as this. Verbal approval was given by the DOE Golden Field Office to commence contract negotiations. Contract negotiations were initiated with **TEC** and a **contract was executed on January 16,1995**.

2. **It was decided to isolate the entire hydrogen generation system from the electrical grid**, save the data acquisition equipment. This eliminated the capability to produce hydrogen at night using off peak power but, allowed us to be able state the project as 100% stand-alone and renewable. We finalized the aspects of the high pressure receiver, mentioned below in **8-5**. The Fill Cycle Dynamics of the high pressure system will allow us to fill the 11 cubic feet onboard storage to 3600 psi in a little over 3 minutes. This capability will add significantly to our vehicles' range.

8. PERFORMANCE VARIANCES, ACCOMPLISHMENTS, OR PROBLEMS:

1. On December 8, 1994, **Praxair, Inc. completed the Hydrogen Fueling Station and Storage Facility** four days ahead of schedule (see supporting attachments). As planned, this allowed us to support and service the **Ballard/South Coast Air Quality Management District fuel cell powered bus** during its public demonstration visit to Los Angeles International Airport. With this addition to the developing hydrogen infrastructure in southern California, a new capability was created for the makers of hydrogen vehicles to demonstrate their use in a high visibility area.

2. The original **delivery date for the first vehicle was adjusted** from December 13, 1994, to March 1, 1995. This allowed more time to resolve the issues of safety and storage tanks. The Constant Volume Induction (CVI) system provided by HCI, Inc., Littleton, Colorado, was also delayed.

3. Extensive discussions were held concerning the **vehicle design**. Of particular interest was the use of composite tanks (Please see **Attachments 11-4**). While there was a general agreement that these tanks were superior to the aluminum tanks used by the University of California, Riverside project, the lack of any certification or exemption for hydrogen was of concern to several members of the team. After consideration, it was agreed that this project would not use graphite composite tanks in the first vehicle, but that the certification of this material for hydrogen service would be a valuable benefit, hence, we decided to approach the U.S. DOE about the possibility of obtaining additional funding for this purpose (Please see related item **10-2** in Technical Status Report #1).

3a. Dr. Paul Scott, Project Engineer, began discussions with the **University of California Riverside's College of Engineering - Center for Environmental Research and Technologies** regarding the engine

performance and emissions testing to be run in conjunction with the truck deliveries. The subcontractor **Energy Technology Engineering Center** is also instrumental to this aspect of the project as they will be performing the bulk of the work regarding systems testing and analysis and safety review.

4. As discussed in Technical Progress Report #1, progress was made with the ongoing **safety reviews** of the overall system and vehicles to determine the adequacy of the safety precautions being implemented. The first formal meeting for the vehicle (**Vehicle Safety Review Meeting**) was held on October 26 at University California Riverside. There was general agreement that the vehicle design was satisfactory, but additional interlocks and check valves were contemplated for added safety. This included an interlock to ensure that the vehicle was properly grounded before the fuel-port door could be opened.

4a. The **failure mode analysis** will be addressed by Clean Air Now (Scott), ETEC, and Xerox. Xerox' Environmental, Health, and Safety Department will provide protocol and report review.

5. An overall **systems design and integration review** was held in El Segundo on December 15, 1994. The purpose of this meeting was to review the current design with The Electrolyser Corporation (TEC), the new subcontractor to furnish the electrolysis system, the compression system and the high pressure (5,000 psi) storage system. As a result of discussions held between the project manager, the project engineer, Praxair, Inc., and TEC, it was decided to isolate both the intermediate pressure system installed by Praxair, Inc., and the high pressure receiver to be installed by TEC. Praxair indicated that they had concerns about allowing the hydrogen produced by the photovoltaic-electrolysis system to be stored in their 80,000 standard cubic foot tube rack system. Their concern was due to their increased liability exposure should there be a mishap, and their lack of control over the gas being introduce into their equipment. They indicated that the concern was more an insurance issue rather than a technical concern over whether this would create a risk. A probable result of this change is that hydrogen produced on site would

have to be vented if the high pressure receiver was full. An advantage, however, was that the Praxair system would be a dedicated backup, with full service, to ensure that there would always be sufficient hydrogen if the demand increased due to higher usage of the project vehicles, or service to additional demonstration fleets was needed. Praxair will keep their tanks full with delivered hydrogen derived from steam reformation of natural gas.

6. Work was performed to develop the final information for a **process flow sheet** to contain overall material and energy flows for the project-(continues) (Please see Attachments 11-3).

7. James Provenzano and Paul Staples visited **Humboldt State University's** solar hydrogen installation. This lead to discussions between Paul Scott, Project Engineer, and Humboldt regarding the **data acquisition system**, with which they have substantial experience. Datalog design and execution is also being discussed with UCR. Of note is the use of LabView and QuickBasic for datalog programming/presentation with ThinkC for the control programming. Signal conditioning is done using boards from Analog Devices.

8. Work began on the **public awareness campaign**. The development of an information packet and appropriate project graphics are underway with Xerox' Document Production Center. DOE Golden was contacted to begin PR issues discussions. Policy makers' educational packet was distributed in Sacramento.

9. The next Technical Status Report will include a thorough discussion of the PV-electrolysis interface, and PV efficiencies and design.

9. OPEN ITEMS:

1. All **contracts** with subcontractors and participants have been signed.

2. **Cofunding documentation** reflecting contractual figures from the new contractor, The Electrolyser Corporation, City of West Hollywood, and Paul Staples (CAN's Executive Director) will be sent to Ruth Adams, Contract Administrator, DOE Golden Field Office by the end of the 1st quarter 1995.

3. Since we went under contract with a new electrolyzer supplier (TEC) for the project, Clean Air Now anticipates a (potential) formal submission for a **revision to the project's Statement of Work and Schedule**. (This is further discussed in Attachments 11-1 below.)

10. STATUS ASSESSMENT AND FORECAST:

1. After an initial review of the schedule, in light of the change in the electrolysis subcontractor (see Attachments' item #1), it appears that the **commissioning date for the plant, August 31, 1995**, will satisfy most requirements of the original project timeline. A project meeting will be held in the first quarter 1995 to develop the final schedule.

2. The **high pressure storage receiver** to be provided by TEC will contain sufficient hydrogen at 5,000 psi (13,000 SCF) to refuel one vehicle completely each day. Operationally, it may be more convenient to "top off" each vehicle every day. Xerox indicated that similar maintenance vehicles are driven about 5,000-6,000 miles per year. Considering this demand, it is expected that **there will be surplus hydrogen produced** by the system. Other uses for this hydrogen are being considered.

11. DESCRIPTION OF ATTACHMENTS:

1. Updated **"working" schedule** for the project, including the newly determined The Electrolyser Corporation's Statement of Work timeline parameters. Subsequent changes will include Energy Technology Engineering Center's (ETEC) timeline for systems' analysis, when that is finalized. DOE's approval for schedule and scope of work changes will be sought at that time..
2. The **Electrolyser Corporation's Statement of Work** as per our contract 1/16/95.
3. Project Manager William Hoagland's paper presented at the National Hydrogen Association's "**Codes & Standards for Safe Use of Hydrogen Energy" workshop** 1/25-/1/26/95 (Includes overview process flow diagram.).
4. Letter from Praxair, Inc. to William Hoagland RE: **Vehicle storage tanks**.
5. **Final Building Inspection and Fire permits** for the completed Clean Air Now/Xerox Hydrogen refueling station, El Segundo, CA.
6. Fueling station startup **Field Pneumatic Test Record**.
7. Communiqués between Xerox Corporation and Ballard Power Systems Inc. RE: **Ballard's Fuel Cell Bus visit** to, and use of, the hydrogen recharging facility, and Xerox' support during the bus' LA stay.
8. **Photos of fueling station** and the Ballard Fuel Cell Bus being recharged during its visit to Los Angeles International Airport, 12/8/94-12/19/94.
9. **4th Quarter Project Financial Report.**
10. Project **Contact List** as of 2/15/95. (This list excludes the US DOE & South Coast Air Quality Management District contacts.)

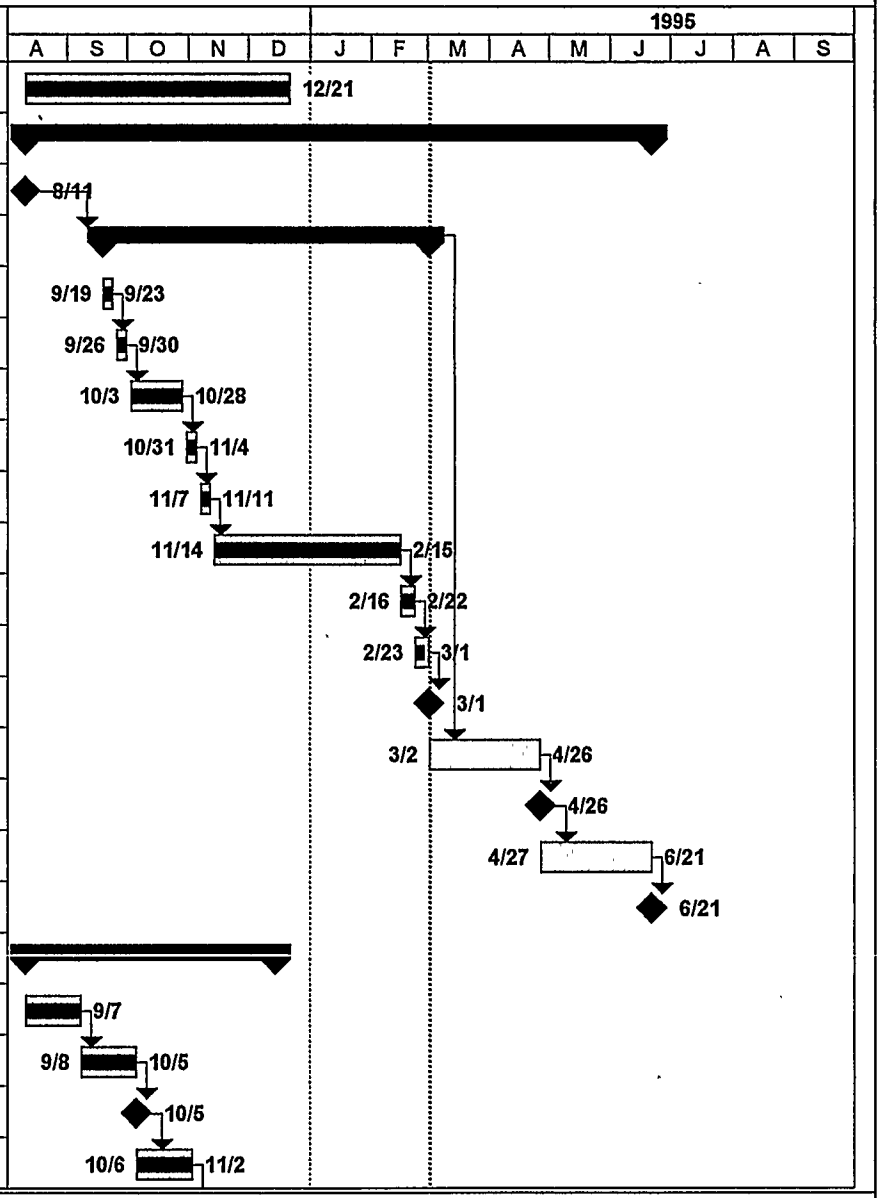
12. SIGNATURE OF RECIPIENT AND DATE:

/James J. Thompson 3/5/95

13. SIGNATURE OF DOE REVIEWING REPRESENTATIVE AND DATE:

Clean Air Now/Xerox Solar Hydrogen Vehicle Project

ID	Task Name	Duration	Start	Finish
1	**CAN negotiates contracts with all subs**	19w	8/11/94	12/21/94
2	**Vehicle Retrofit**	**225d**	**8/11/94**	**6/21/95**
3	**Xerox to procure vehicles**	**0d**	**8/11/94**	**8/11/94**
4	**AMD completes 1st vehicle**	**118d**	**9/19/94**	**3/1/95**
5	AMD prepares facility/safety	1w	9/19/94	9/23/94
6	AMD removes 1st engine	1w	9/26/94	9/30/94
7	AMD works cyl. hd. & cmshft.	4w	10/3/94	10/28/94
8	AMD procures supercharger & intclr.	1w	10/31/94	11/4/94
9	AMD procures fuel tanks	1w	11/7/94	11/11/94
10	AMD procures fuel inj. system	13.6w	11/14/94	2/15/95
11	AMD integrates systems	1w	2/16/95	2/22/95
12	AMD road tests truck	1w	2/23/95	3/1/95
13	**AMD returns truck w/ documentation**	**0d**	**3/1/95**	**3/1/95**
14	AMD completes 2nd vehicle	8w	3/2/95	4/26/95
15	**AMD delivers 2nd vehicle**	**0d**	**4/26/95**	**4/26/95**
16	AMD completes 3rd vehicle	8w	4/27/95	6/21/95
17	**AMD delivers 3rd vehicle**	**0d**	**6/21/95**	**6/21/95**
18	**Storage & Fueling Facility**	**90d**	**8/11/94**	**12/14/94**
19	Praxair & Xerox engineer station	4w	8/11/94	9/7/94
20	Xerox obtains all permits	4w	9/8/94	10/5/94
21	**Xerox receives approval from El Segundo**	**0d**	**10/5/94**	**10/5/94**
22	Praxair procures equipment	4w	10/6/94	11/2/94



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Clean Air Now/Xerox
Solar Hydrogen Project

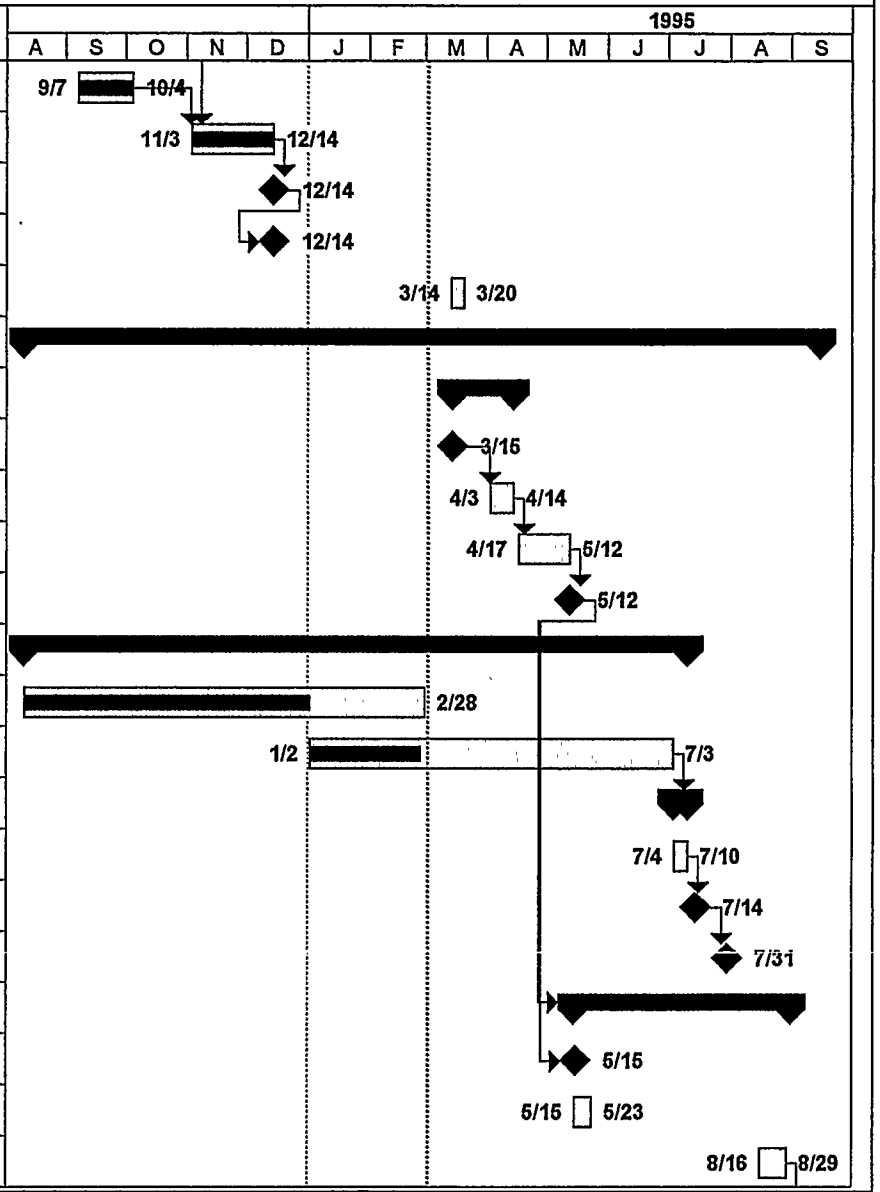
Task | Summary | Rolled Up Progress

Progress | Rolled Up Task

Milestone | Rolled Up Milestone

Clean Air Now/Xerox Solar Hydrogen Vehicle Project

ID	Task Name	Duration	Start	Finish
23	Praxair negotiates install contracts	4w	9/7/94	10/4/94
24	Praxair installs equipment for fueling st.	6w	11/3/94	12/14/94
25	**Xerox procures intm. H2 from Praxair**	**0d**	**12/14/94**	**12/14/94**
26	**Storage & Fueling Facility operational**	**0d**	**12/14/94**	**12/14/94**
27	CAN, Praxair, Mut. Pr. pers. training.	1w	3/14/95	3/20/95
28	**Photovoltaic Hydrogen Generation**	**287d**	**8/11/94**	**9/15/95**
29	**Engineering calcs., design & drawings of integr. sys.**	**23d**	**3/15/95**	**4/14/95**
30	**TEC, SEA & submit Engineering Design**	**0d**	**3/15/95**	**3/15/95**
31	CAN & Xerox approves "integration" design	2w	4/3/95	4/14/95
32	Install Contractor obtains all permits	4w	4/17/95	5/12/95
33	**Xerox receives approval from El Segundo**	**0d**	**5/12/95**	**5/12/95**
34	**TEC & SEA procures/fabricates equipment**	**238d**	**8/11/94**	**7/10/95**
35	Array Manufacturing	28.8w	8/11/94	2/28/95
36	Electrolyzer and Compressor System skid assembly	26.2w	1/2/95	7/3/95
37	**Systems Pre-Test & Demonstration**	**5d**	**7/4/95**	**7/10/95**
38	**CAN participation and sign-off before shipping**	**1w**	**7/4/95**	**7/10/95**
39	TEC Shipping Date Ex-Factories	0d	7/14/95	7/14/95
40	Electrolyzer & Compressor System on site	0d	7/31/95	7/31/95
41	**SEA, Xerox & TEC install Array & H2 Gen. Sys.**	**79d**	**5/15/95**	**8/31/95**
42	Start of Site Construction	0d	5/15/95	5/15/95
43	SEA Begins Delivery of PowerGrids	7d	5/15/95	5/23/95
44	PV Hydrogen Storage Integration and Test (initial phase)	2w	8/16/95	8/29/95



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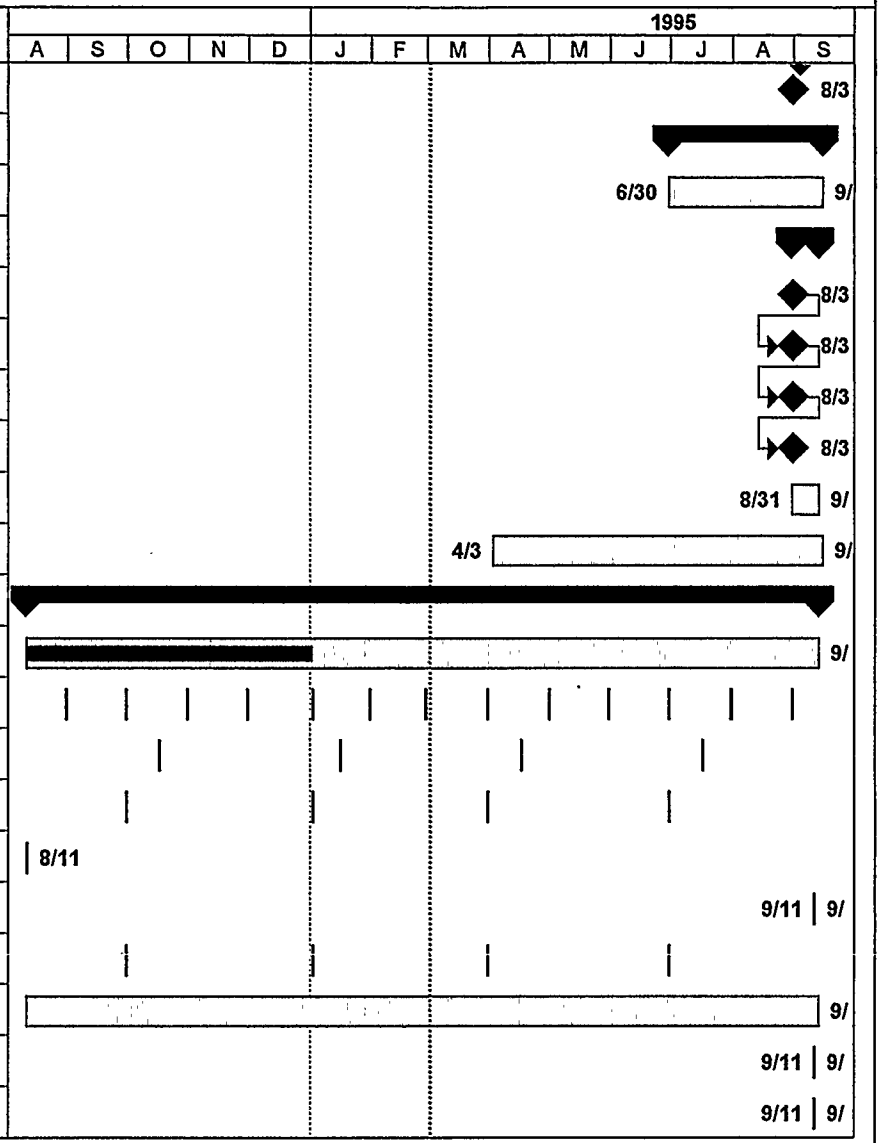
Clean Air Now/Xerox
Solar Hydrogen Project

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

Clean Air Now/Xerox Solar Hydrogen Vehicle Project

ID	Task Name	Duration	Start	Finish
45	**Commissioning of PV H2 Generation Plant**	0d	8/31/95	8/31/95
46	**CAN, Xerox, SEA & TEC perform eval. w/ETEC**	56d	6/30/95	9/15/95
47	**Site Test & Demonstration period**	11.2w	6/30/95	9/15/95
48	**Documentation Submitted by Subs**	10d	8/31/95	9/13/95
49	**Instr. & Control Doc., Ops. Manual, Sys. Doc.**	0d	8/31/95	8/31/95
50	**Sfty. Ops. Manual, placards**	0d	8/31/95	8/31/95
51	**Detailed schematics & flow diagrams**	0d	8/31/95	8/31/95
52	**Itemized list of all parts, ser.#'s, suppliers, war.**	0d	8/31/95	8/31/95
53	**CAN et al. train personnel**	2w	8/31/95	9/13/95
54	**CAN, Xerox Collects Data/ETEC Conducts T & A on Systs.**	24w	4/3/95	9/15/95
55	**Education and Promotion**	285d	8/11/94	9/13/95
71	Monitoring, Evaluation, and Reporting	57w	8/11/94	9/13/95
72	Contractors invoice CAN for costs incurred	262d	8/31/94	8/31/95
86	Contractors provide status report to CAN	261d	10/17/94	10/16/95
92	Financial Status Report (SF-269)	247d	9/30/94	9/11/95
98	Notice of Energy RD&D Project (DOE F 1430.22)	1d	8/11/94	8/11/94
99	Notice of Energy RD&D Project (DOE F 1430.22)	1d	9/11/95	9/11/95
100	Technical Progress Report	196d	9/30/94	6/30/95
105	Topical Report	57w	8/11/94	9/13/95
106	Final Technical Report	1d	9/11/95	9/11/95
107	Government Property Inventory Report	1d	9/11/95	9/11/95



3/2/95 Clean Air Now/Xerox Solar Hydrogen Project

Task | Summary | Rolled Up Progress
Progress | Rolled Up Task
Milestone | Rolled Up Milestone

Agreement

This Agreement dated this 16th day of January, 1995, by and between Clean Air Now, a California non-profit corporation ("CAN"), whose principal mailing address is 660 Venice Blvd. #112, Venice, Ca. 90291, and The Electrolyser Corporation (T.E.C.) a New York State corporation whose principal address is 1800 One M & T Plaza, Buffalo N. Y. 14208

WHEREAS, CAN has been awarded a Financial Assistance Award by the Department of Energy ("DOE") under the White House Technology Reinvestment Project (TRP) and the South Coast Air Quality Management District (SCAQMD) to construct a solar powered hydrogen generating facility and hydrogen powered vehicle fleet ("Project");

WHEREAS, CAN has entered into Cooperative Agreement No. DE-FC36-94GO10039 ("Cooperative Agreement") with the DOE which governs the terms and conditions of the Project;

WHEREAS, T.E.C. is a manufacturer of a hydrogen generator system and interface equipment for the production of hydrogen and desires to participate in the Project;

NOW, THEREFORE, the parties hereto mutually agree as follows:

ARTICLE I Scope of Work

1.1 The Scope of Work for T.E.C.'s portion of the Project, hereinafter referred to as the "Work," is set forth in Exhibit A attached hereto. T.E.C. agrees to perform such work under the general direction of CAN and subject to the final approval of CAN and DOE. T.E.C. agrees to, as detailed in Exhibit A attached hereto, install all equipment provided by T.E.C. and connect such equipment to the photovoltaics, utilities, and the hydrogen storage receiver. The Scope of Work will include the installation of fencing around the parameter of the photovoltaic array and the electrolyser equipment according to the local codes and permits.

1.2 Defective Goods-T.E.C. warrants to CAN that, at the time of delivery, the goods will be free from defects in material and manufacture and will conform substantially to the specifications as stipulated in the scope of work. T.E.C.'s liability and CAN's remedy under this warranty are limited to the repair or replacement, at T.E.C.'s election, of goods or parts thereof returned to T.E.C., which are shown to T.E.C.'s reasonable satisfaction to have been defective, provided that written notice of the defect shall have been given by CAN to T.E.C. within 1 year from the date of installation for the cell stack and 1 year from the date of installation for all other equipment supplied to T.E.C by a subcontractor, unless a longer warrantee period is provided by the subcontractor of said equipment to T.E.C., that T.E.C. incorporates into the Project. In addition, T.E.C., under the terms and conditions of T.E.C.'s price proposal in Exhibit B, will provide technical support including repair and/or replacement of defective equipment for an additional year after the warrantee period or until June 30, 1997, whichever comes first. Transportation charges for the return of defective goods to T.E.C. and their reshipment to CAN and the risk of loss thereof will be borne by T.E.C. only if returned in accordance with written shipping instructions from T.E.C.. If services or data are to be furnished hereunder, T.E.C. warrants to CAN that such services will be performed or such data prepared in a good workmanlike manner. T.E.C.'s liability and CAN's remedy under this warranty are limited to the correction of such services or data as are shown to T.E.C.'s reasonable satisfaction to have been defective; provided that written notice of such defective services or data shall have been given by CAN to T.E.C. within ninety (90) days after the performance of such services or delivery of such data by T.E.C.

1.3 The Work hereunder shall comply with all laws, ordinances, rules, regulations, or orders of any public authority having jurisdiction hereof. If the laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any portion of the Work to be inspected, tested or approved, T.E.C. shall give CAN timely notice of its readiness so CAN may observe such inspection, testing, or approval as requested by such regulatory authority. CAN shall attempt to have scheduled all said tests, inspections, and/or approvals during the period T.E.C. is scheduled to test and start-up the systems. If any delays in the project schedule occur and are caused by T.E.C., T.E.C. shall bear the cost of said inspection, test or approval if said inspection, test, and approval cannot be scheduled at the same time as the start-up of the system. If such an occasion occurs, CAN will make every effort to schedule said inspections, tests, and approvals at a time convenient to T.E.C..

1.4 T.E.C. shall allow CAN or its agents the opportunity to inspect all goods to be shipped to CAN before shipping takes place and shall cooperate with CAN, or its agents, in providing any information that they may so reasonably request.

ARTICLE II

Project Schedule

2.1 CAN acknowledges that the goods called for hereunder are to be manufactured by or for T.E.C. to fulfill this order and that the delivery dates are based on the assumption that there will be no delay due to causes beyond the reasonable control of T.E.C. If it is determined that a delay is caused by T.E.C., T.E.C. shall take whatever measures as may be necessary to remedy the situation at no additional cost to CAN. T.E.C. shall not be charged with any liability for delay or non-delivery when due to acts of God or the public enemy, compliance in good faith with any applicable foreign or domestic governmental regulation or order whether or not it proves to be invalid, fires, riots, labor disputes, unusually severe weather, or any other cause beyond the reasonable control of T.E.C. To the extent that such causes actually retard deliveries on the part of T.E.C., the time for the performance shall be extended for as many days beyond the date hereof as is required to obtain removal of such causes. This provision shall not, however, relieve T.E.C. from using its best efforts *(commercially acceptable)* to avoid or remove such causes and continue performance with reasonable dispatch whenever such causes are removed.

ARTICLE III

Changes in the Work

3.1 T.E.C. or CAN may make changes in the work; provided, however, that CAN and DOE have approved of such changes in accordance with the Cooperative Agreement.

3.2 No claims for extra work or charges above that specified in Exhibit B will be recognized or paid unless DOE has approved of such claim in accordance with the Cooperative Agreement.

ARTICLE IV General Provisions

4.1 The terms and conditions of the Cooperative Agreement No. DE-FC36-94GO10039 are hereby incorporated by reference herein and, in the event of any conflict between the terms hereof and the Cooperative Agreement, the Cooperative Agreement shall control, other than the foregoing, if there is any conflict between this Agreement and the Exhibits attached hereto, this Agreement shall control.

4.2 This Agreement shall be governed by the laws of the State of California.

4.3 All claims, disputes and other matters in question arising out of, or related to, this Agreement or the breach thereof shall be the subject of arbitration and decided in accordance with the rules of the American Arbitration Association. The award rendered by the arbitrators shall be final and judgment may be entered upon it in any court having jurisdiction thereof.

4.4 CAN agrees to the general conditions of purchase as stated in T.E.C.'s price proposal included in Exhibit B.

ARTICLE V **Taxes**

5.1 T.E.C. shall pay all taxes for the Work or portions thereof provided by T.E.C. which are legally enacted or required at the time the Agreement was executed.

ARTICLE VI **Intellectual Property Rights**

6.1 The rights to any intellectual property incorporated into the project or generated by the project are governed by the provisions of the Cooperative Agreement #DE-FC36-94GO10039 between Clean Air Now and the D.O.E., and any confidentiality agreement between CAN and T.E.C. regarding the *UNICELL-CLUSTER*™ technology. T.E.C. acknowledges that it has received a copy of the aforementioned Cooperative Agreement and reviewed the same. Whenever a conflict arises between the Cooperative Agreement and any other agreement between CAN and T.E.C., the Cooperative Agreement controls.

6.2 The parties do not expect to generate any invention or discovery as a result of the Project. However, in the event that an invention or discovery is generated as a result of the Project by CAN or its other participants (excluding T.E.C.), T.E.C. shall not obstruct CAN's right to file for a patent, to use, market or share said invention or discovery, including any art, method, process, machine, manufacture, design, or composition of matter, or any new and useful improvement thereof. If an invention or discovery is generated through a cooperative effort between CAN and T.E.C., T.E.C. will retain exclusive and perpetual ownership of the invention or discovery and a reasonable royalty (after patent costs are paid) will be paid to CAN based on the incremental enhancement to T.E.C.'s intellectual property to be determined by an independent technical assessment that will not unreasonably inhibit the commercial success of said invention or discovery. In addition, if T.E.C. generates an invention or discovery inside or outside the scope of work or the funding of the Project, and for the improvement of the Project, brings said invention or discovery into use in the Project, CAN waives any rights to any license in each patent application filed by T.E.C., including any art, method, process, machine, manufacture, design, or composition of matter, or any new and useful improvement thereof. However, nothing herein shall be interpreted as affecting the DOE's rights in and to said intellectual property as set forth in the aforementioned DOE Cooperative Agreement.

6.3 T.E.C. shall pay all license fees for materials, methods and systems incorporated in the work. T.E.C. shall defend all suites or claims for infringement of any patent rights and shall save CAN harmless from any liability that may arise out of such actions.

ARTICLE VII **Indemnification/Insurance**

7.1 To the fullest extent permitted by the law, the parties herein shall indemnify and hold harmless each other and their agents (including the other companies participating in the Project) and employees from and against all claims damages, losses and expenses including but not limited to attorney's fees, arising out of or resulting from their performance of the Work.

7.2 T.E.C. shall maintain general liability coverage protecting it from claims arising out of its activities hereunder. Upon request, T.E.C. shall provide CAN with evidence of such insurance coverage.

ARTICLE VIII

Payment

8.1 The Total payments due hereunder are stated in Exhibit B, including adjustments thereto, which is the total amount payable to T.E.C. for the performance of the Work under the Agreement.

8.2 Upon the first of each month, without delay, T.E.C. shall submit to CAN an itemized invoice as CAN or the DOE may require as well as a progress report for the work submitted for payment. Within ten (10) days after the first of the month, CAN shall submit such documentation to DOE for payment and, upon receipt from DOE, CAN shall immediately remit such payment to T.E.C.

8.3 T.E.C. warrants that title to all Work, materials and equipment covered by this agreement shall pass to CAN upon the receipt of payment by T.E.C. in accordance with this agreement, free and clear of all liens, claims, security interests or encumbrances.

8.4 All payments made by CAN to T.E.C. shall be for work performed in the thirty days prior to invoicing.

ARTICLE IX

SUSPENSIONS AND TERMINATION'S

9.1 Under the provisions of 10 CFR 600.29 and 600.121, the parties recognize that DOE may suspend or terminate the award, in whole or in part; (1) when DOE believes that CAN has materially failed to comply with the terms and conditions of the award; (2) for any reason by mutual agreement between DOE and CAN upon the request of either party; or (3) when the parties cannot mutually agree to the extent of a termination.

9.2 Normally, DOE's action to suspend or terminate an award for cause will be taken only after DOE has informed CAN of any deficiency on its part and given an opportunity to correct it. However, DOE may immediately suspend or terminate the award without prior notice when it believes such action is necessary to protect the interests of the Government.

9.3 No costs incurred during a suspension period or after the effective date of a termination will be allowable, except those costs which, in the opinion of DOE, CAN could not reasonably avoid or eliminate or which were otherwise authorized by the suspension or termination notice, provided such costs would otherwise be allowable under the terms of the award and the applicable Federal cost principles.

9.4 Final allowable costs under a termination settlement shall be in accordance with the terms of the award, including this term, and the appropriate Federal cost principles. In no event will the total of payments under a terminated award exceed the amount obligated by DOE or the DOE pro rata share when cost-sharing was required, whichever is less.

9.5 Within 90 days after the termination of the award, the recipient shall submit any final financial, performance, and other reports required by the terms and conditions of the award. (See 10 CFR 600.115 and 600.116).

9.6 A notice of termination other than by mutual agreement may be subject to review according to the provisions of 10 CFR 600.26, Disputes and Appeals.

9.7 Other than the provisions contained herein, no other right of termination exists hereunder.

ARTICLE X

Other Agreements

10.1 This Agreement is the full and final agreement of the parties, and no written or oral communication between the parties before the execution of this Agreement will modify or amend the Agreement except that CAN will execute a Purchase Order currently herewith for the purchase of equipment for the Project.

ARTICLE XI

Confidentiality and Ownership of Information.

11.1 The parties herein agree not to disclose or to communicate during the term of this agreement, or at any time subsequent thereto, any information, data, writings, calculation, agreements, or knowledge concerning the business, operating records, or operating secrets of the generating party and its affiliates, which either party herein obtains and is marked "confidential" or "proprietary information" and is not a public document and might from time to time acquire, to any person not an employee of the receiving party or an affiliate, except as expressly authorized by the generating party in writing.

11.2 The parties herein acknowledge that all records, writings, calculations, files, maps, drawings and similar data generated during the performance of the contract are the property of the generating party, and shall upon the termination of the agreement for whatever reason, remain the property of the generating party, and the receiving party covenants that the same shall not be removed or copies in whole or in part by the said party at any time, prior to or after such termination, and shall not be used in any way for benefit of any person or business entity save and except the generating party and its affiliates. All of such materials shall, upon termination of the contract, be returned immediately to the possession of the generating party.

IN WITNESS WHEREOF, the parties have executed this Agreement on the date first written above.

CLEAN AIR NOW	**THE ELECTROLYSER CORP.**
By: _____	By: _____
Its: EXECUTIVE DIRECTOR	Its: _____

EXHIBIT A:

CAN'S TECHNICAL STATEMENT OF WORK

ATTACHMENT 1: T.E.C'S TECHNICAL PROPOSAL # 1001:133-203

TECHNICAL STATEMENT OF WORK

for a subcontract to provide an

Electrolysis System and Related Equipment

with: The Electrolyser Corporation
1800 One M & T Plaza
Buffalo, N.Y. 14203

INTRODUCTION

Clean Air Now! (CAN), a non-profit corporation, acting under a U.S. Department of Energy Cooperative Agreement No. DE-FC36-94G010039 will build a Solar Hydrogen Generating Facility at the Xerox Corp. Facility in El Segundo, CA. An integral component of this system is an electrolyzer and related equipment for compression and storage of the produced hydrogen gas. CAN has selected The Electrolyser Corporation (T.E.C.) to fulfill this requirement.

THE WORK TO BE PERFORMED

The Electrolyser Corporation shall, in accordance with its Revised Proposal No. 1001:133-203 dated December 21, 1994, engineer, fabricate, deliver, install, test, commission, service and warrant the following:

1. Gas Generating System

   A complete gas generating system with a steady state operating capacity of 10.56 cubic meters (400 SCFH) hydrogen per hour and 5.28 cubic meters oxygen per hour based on 48 kWh DC input to the cells. The produced hydrogen shall have a purity of greater than 99.5%. (Excluding rectifier)

   T.E.C. shall connect the electrolysis system to the Photovoltaic Arrays using a copper bus bar through the center of the arrays. Electrical connection of the PV arrays to the bus bar will be completed by SEA Corp.

   The compete gas generating system shall be completely assembled including:

   - all DC bus bars to connect between cells
   - gas and water piping along cell banks
   - an automatic cell feedwater supply system
   - one (1) dual water seal to prevent reverse flow of gas from gasholder
   - an initial charge of electrolyte
   - analyzers, tools and test equipment as proposed

- one (1) reverse osmosis system, or equivalent, to supply high purity cell feedwater, complete with meter for measuring water purity and automatic diverter valve for low purity water with 100 liter demineralized water storage to hold 10 hours consumption of feedwater.

The unit shall be shipped fully assembled, fully wired and ready for connection to customer's utilities. The unit shall also be shipped with all installation materials required.

2. Hydrogen Compression System

One hydrogen compression system capable of compressing 12 cubic meter per hour of hydrogen to a pressure of 352 kg/cm2 compete with gasholder, mist eliminator, filters, a dryer, back pressure valve and electrical controls. The unit shall be shipped, with all installation materials required, pre-assembled fully assembled, wired and ready for connection to the rest of the system.

3. High Pressure Gas Storage System

One (1) high pressure gas storage system consisting of two ASME certified pressure vessels to store 13,756 SCF at 352 kg/cm2 (5,000 psig) or equivalent. The system shall include manual valving to switch between the medium and high pressure storage during refueling.

4. Drawings and Instructions

The contractor shall provide three (3) sets of outline drawings for all equipment supplied, as well as complete engineering designs for layout, foundations, wiring and piping, and instructions for commissioning, operation and maintenance.

SCHEDULE AND MILESTONES

All equipment shall be shipped within six months after receipt of a fully executed contract or written acceptance by The Electrolyzer Corp. of any changes to this statement of work, and receipt of necessary engineering information.

The following schedule is predicated upon a start date of January 16, 1995. All dates may be adjusted by an equal amount if the start date is delayed

Receipt of Order	January 16, 1995
Complete Design Review	February 15. 1995
Start Site Preparation	May 15, 1995
Ship Equipment	July 15, 1995
Deliver Equipment to Site	July 31, 1995
Complete Installation	August 15, 1995
Complete Commissioning	August 31, 1995
Plant Start-up	August 31, 1995

EQUIPMENT WARRANTY

All equipment will be warranted against defects in material and workmanship for a period of one year. The Electrolyzer Corporation will, at its option, replace or repair the defective equipment in accordance with the attached pages from its proposal dated December 21, 1994 (Exhibit B: Cost Proposal and Warrantee).

ANY CONFLICT BETWEEN THIS STATEMENT OF WORK AND THE SUBSEQUENT ATTACHMENTS, THIS STATEMENT OF WORK CONTROLS.

ATTACHMENT 1:

T.E.C.'S STATEMENT OF WORK
FROM PROPOSAL # 1001:133-203

Electrolyser

The Electrolyser Corporation
1800, One M & T Plaza
Buffalo, N.Y., 14203

Toronto Office:
122 The West Mall, Etobicoke
Toronto, Canada, M9C 1B9
Tel: (416) 621-9410
Fax: (416) 621-9461/9830

STUART PACKAGED *UNICELL CLUSTER* ™ PV HYDROGEN GENERATOR AND VEHICLE FILLING SYSTEM

for Clean Air Now
Proposal No. 1001: 133-203
Xerox El Segundo Project

December 21, 1994

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

DESIGN PARAMETERS

In preparing the data in this proposal, the following parameters have been taken from available specifications or assumed; if there are any discrepancies between these and the actual parameters, The Electrolyser Corporation (TEC) must be advised immediately in order that correct proposal data can be prepared.

1. Utilities

   Power Supply: Direct coupled connection to 48 kW(e) photovoltaic array

2. Site Ambient Conditions

   Temperature: 0°C minimum
   40°C maximum

   Altitude: Less than 600 m above sea level.

3. Operating Conditions:

   Plant control will be fully automated for "stand alone" operation.

DESIGN PARAMETERS (Continued)

4. Plant Effluent

The following effluent will occur from the equipment, as detailed in this proposal, during normal operation.

4.1 All water from traps in compression system will be collected at a common container with level indicator where it is then passed to an evaporation pan.

4.2 Oxygen gas with associated water vapour if not collected will be vented.

4.3 Water return flow from the RO feedwater preparation system will be passed to storm sewer, if RO feedwater system acceptable.

5. Location

5.1 The site for the plant will be as shown in the CAN-XEROX site plan issued 10/5/94 and referred to in the RFP.

5.2 Others will provide AC power lines to the control room. Xerox will make connection to a suitable electrical junction box at this locations. Xerox will provide water to the electrolyser feed water purification system and sewers for clean effluent.

5.3 Civil and installation work covered by TEC's proposal will include: installation of electrolyzer and control room and high pressure gas storage facility (all hardware to be provided by TEC or by its subcontractors), integration with existing hydrogen filling station, construction of control house and erection of perimeter fence around electrolysis equipment.

5.4 The electrolyser will be installed in the centre of the photovoltaic array as shown in the CAN-XEROX site plan. The high pressure storage facility will be installed beside the existing medium pressure gas storage facility inside the existing fenced enclosure.

DESIGN PARAMETERS (Continued)

5.5 Others will provide construction permits as required.

5.6 Xerox/CAN! will secure zoning authority necessary to operate facility.

Note: The price(s) quoted in this proposal are based on the above data. If any of the above are incorrect, TEC reserves the right to revise these prices(s) as necessary to take account of any changed datums.

THE *UNICELL-CLUSTER* ™ TECHNOLOGY

The Stuart Packaged Hydrogen Generator for Clean Air Now will be powered by an array of photovoltaic panels, and will be based on the ***UNICELL-CLUSTER*** ™ technology. The ***UNICELL-CLUSTER*** ™ uses TEC's proprietary process for directly coupling the PV array to a unipolar electrolysis cell.

Safety is a key design parameter in ***UNICELL-CLUSTER*** ™ systems. The unipolar cell, used by Stuart hydrogen generators, offers a higher level of safety over non-unipolar designs, as gas purity is not affected by bypass currents which occur in bipolar cells and which can create explosive mixtures when operating at low currents or under intermittent conditions. This has proven to be a significant safety concern for alkaline bipolar electrolyzers. Furthermore the ***UNICELL-CLUSTER*** ™ for Xerox/CAN! is designed to have a maximum DC voltage between cell components of 19 V, well below the 50 V limit which can cause shock. In terms of performance, the electrode stability inherent to unipolar designs assures cell efficiency is maintained during intermittent operation.

The Electrolyser Corporation developed the ***UNICELL-CLUSTER*** ™ technology for the production of hydrogen from renewable sources of energy such as wind or solar energy as a method of converting renewable electricity to a clean storable fuel. The basic technology is the culmination of a five year development program which started in 1989. The technology has been implemented at three sites:

1) at the world's first PV hydrogen vehicle filling station located at the University of California Riverside in Riverside California where TEC provided an integrated system consisting of a 4 kW PV array, a hydrogen generator with a 7 kW rectifier for night time "off-peak" hydrogen production and a high pressure gas compression system (5000 psi). Principal Contact : Jim Heffel, Tel: 909-781-5791
2) at the Florida Solar Centre in Cocoa Beach Florida where Electrolyser provided a gas generating system which is coupled to an experimental solar collector. Principal Contact: Kirk Collier , Tel: 407-783-0300
3) at a TEC test site in Toronto Canada. Principal Contact: Andrew Leslie, Tel: 416-621-9410

THE *UNICELL-CLUSTER* ™ TECHNOLOGY

Combined these three systems have logged 10 years of reliable operation without safety incident.

Letters from users endorsing the technology along with a technical brochure describing Photovoltaic-Hydrogen Packaged Energy Storage Systems appear in the appendices to this proposal.

The total budget for the development of the ***UNICELL-CLUSTER*** ™ technology to date has been over $1,000,000.00. The technical results from this development include:

- stable electrode catalytic activation without use of any protective equipment (diodes, battery polarisation etc.) after more than 1300 daily complete cycles
- average gas purities of hydrogen of 99.9% or higher
- average array utilization exceeding 90%, typically 94%
- successful operation with ambient temperature below -25 C to over 35 C
- average monthly electrolysis efficiencies ranging from 77% to 85% depending on ambient temperature, insolation levels and electrolysis peak loading factor
- during a 12 month period, the system efficiency (i.e. "Sunlight Striking the Array to Lower Heating Value of Hydrogen Produced") ranged up to 8.12% under a variety of direct coupling configurations Again the result depended on the ambient temperature, insolation levels and electrolysis peak loading factor. A typical value of 7% should be obtainable in the Toronto area and higher than 6.5% in the Los Angeles area.
- PV-driven compression systems are practical and effective for storing hydrogen gas where no electrical grid power is available.

After five years of development and operating experience the ***UNICELL-CLUSTER*** ™ technology is ready for larger scale deployment in the PV-hydrogen system proposed by Clean Air Now.

THE *UNICELL-CLUSTER* ™ TECHNOLOGY

Electrolyser is continuing to refine the ***UNICELL-CLUSTER*** ™ technology through the development of stand alone hydrogen energy systems, which could be used in remote power applications. This has lead to the development of new system controllers and to process modifications to optimize downstream energy conversion technologies. System integration has also led to the development of new ways of monitoring the process and new sensors for controlling the process. Electrolyser is also engaged in a technology program to develop the components needed to build packaged vehicle refilling appliances or hydrogen VRA's and has worked with Mazda in the technical marketing of hydrogen vehicles and hydrogen fuel systems.

Corporate Profile:

The Electrolyser Corporation, Buffalo N.Y. is a wholly owned subsidiary of The Electrolyser Corporation Limited of Toronto Canada. Established in 1952 to serve US customers, TEC has the capability to manufacture and deliver the full range of Electrolyser products. TEC has delivered industrial gas plants to General Electric and Union Carbide as well as developmental PV-hydrogen systems to South Coast Air Quality Management District and the Florida Solar Centre. TEC is supplying a 14000 SCFH plant to MG Industries in Pennsylvania and a 50 SCFH industrial hydrogen generator to Bechtel in California for an electrical power station. Attached for additional reference is a copy of our Corporate Profile.

GENERAL SYSTEM DESCRIPTION AND TECHNICAL APPROACH

The Stuart Packaged ***UNICELL-CLUSTER*** ™ PV Hydrogen Generator and Vehicle Filling System for Clean Air Now is designed to produce hydrogen for a small fleet of hydrogen vehicles. The vehicles will be fast filled through a hydrogen dispenser to be supplied by others. The capabilities of the filling station will be enhanced by the addition of a cascade gas storage system to be supplied by TEC. The hydrogen generator will use the safe and proven ***UNICELL-CLUSTER*** ™ technology.

The plant will be delivered to Xerox/CAN! for "turn key" operation. The equipment will be packaged in three modules. TEC will provide all connections between TEC supplied modules, and connections between TEC supplied modules and other facility modules, in particular the bus bar connection to PV array and gas connection to vehicle filling station, which are supplied by others.

All site work required to install the equipment and integrate the gas generator will be done by TEC's subcontractor Matrix Engineering of Oceanside, CA. Matrix Engineering has been awarded a sub-contract by Xerox/Praxair to install the medium pressure gas storage facility and hydrogen gas dispenser at the CAN! facility. Modifications to the site include installation of plant equipment subject to design parameters mentioned in the previous sections, installation of a perimeter fence and a control house. The control house will measure 12'x10' and will include door, lighting, 2 windows facing south and four electrical outlets.

With the equipment TEC will offer through its subcontractor, the University of California Riverside, the following technical support:

1) Participate in the system safety analysis and prepare safety plan for the gas generator and gas storage facility to level acceptable for PV hydrogen vehicle stations.

2) Supervise installation and plant commissioning

3) Training of operator personnel as required for simple process checks.

GENERAL SYSTEM DESCRIPTION AND TECHNICAL APPROACH (Continued)

4) Assist in 3 month start up evaluation of the facility, including preliminary analysis to determine optimal vehicle refuelling schedule.

5) Two year limited maintenance contract (ending June 30, 1997) which will provide three layers of operating support:

   i) Routine Process Checks: At least once per week the condition of the process will be checked electronically through the process computer, and, when justified, verbally with operators.

   ii) Monthly Site Visits: Once per month the visit will be visited and the operation of the facility will be checked.

   iii) Emergency Response: Within 48 normal business hours of equipment failure TEC personnel or its representatives will be on-site.

PROJECT TEAM:

TEC Project Manager for Xerox/CAN! Project:	Matthew Fairlie, Director of Technology, The Electrolyser Corporation
Leader of On-site Implementation Team:	Jim Heffel, Assistant Professor, University of California Riverside (UCR)
Civil Engineering and Construction:	Richard Capua, Matrix Engineering, Oceanside California

See Appendices (Part C), for biographies of key members of project team.

DESCRIPTION AND OPERATION OF UNICELL CLUSTER™ HYDROGEN GAS GENERATOR

The Gas Generating System is designed to meet the following requirements:

1. To deliver continuously the stated flow of electrolytic hydrogen at a purity of 99.9%, and of electrolytic oxygen at a purity of 99.7% when operated at full rated current. The principal impurity in the hydrogen is oxygen. Since purified water only is used for electrolysis, carbon monoxide, sulphur compounds or other deleterious impurities are not present.

2. To operate automatically, requiring only periodic inspection.

3. To operate intermittently and over a wide range of cell currents typical of photovoltaic applications both efficiently and safely.

The process is described by the standard flow diagram attached to the proposal. Direct coupling to the photovoltaic array provides the DC power to operate a battery of Stuart cells, producing hydrogen and oxygen by electrolysis of water. The oxygen is available at the water seal as a free by-product at a purity of 99.7% for such uses as cutting and welding, combustion air enrichment, etc. Fittings will be supplied at the water seal to allow addition of an oxygen gas recovery system.

The system is designed to be integrated with an 18.9 VDC photovoltaic system and will be supplied complete with the copper bus bar needed to connect the electrolyzer to the Photovoltaic array to be supplied by Sea Corp. The exact connection and integration of PV and electrolyser will be decided after a design/site review with Sea Corp. Bus bar connections will be sealed to air to prevent corrosion.

Stuart Cells operate without regular attendance and the cells are supplied automatically with feedwater through float valves. The feedwater system is closed to prevent the entry of atmospheric contaminants. Purified water is produced by a reverse osmosis unit with storage tanks sufficient in size to contain approximately ten hours consumption. Feedwater purity is monitored continuously by an automatic control device which diverts impure effluent to an evaporation pan.

DESCRIPTION AND OPERATION OF UNICELL CLUSTER™ HYDROGEN GAS GENERATOR (Continued)

On start-up, hydrogen is vented to atmosphere until reasonable gas purity is achieved and then is directed into the gasholder main. The oxygen passes through the water seal and is vented to atmosphere unless it is to be used.

The duties of the operator consist of visually inspecting the cell banks, the compressor system, the feedwater quality and analyzing gas purity at regular intervals.

In the case of the Clean Air Now Project a computer data logging system will be supplied to monitor system performance, and operator inspection will be limited to visual inspection of the process on a daily basis. Under the proposed maintenance contract, TEC through its subcontractor, the University of California Riverside will perform weekly process checks as well as monthly visits to the site.

DESCRIPTION AND OPERATION OF STUART ELECTROLYTIC PLANT HYDROGEN COMPRESSION AND HIGH PRESSURE GAS STORAGE SYSTEM

Hydrogen from the gas generating system passes to a wet-seal gasholder (pressure 125 mm water column maximum). The compressor, which withdraws hydrogen from the gasholder, is stopped and started automatically by limit switches actuated by the gasholder bell. The discharge pressure of the compressor will be 352 kg/cm^2 (5000 psig) The compressed gas is cooled in an aftercooler and condensed moisture is removed. For the Xerox/CAN! project the compressor discharge will pass through a dryer to reduce the water level to 10 ppm or less. A coalescing filter will remove compressor oil in the stream.

A mist eliminator at the compressor inlet removes electrolyte droplets carried over by the gas, thereby reducing maintenance on the compressor.

To obtain the drying effect of compression, pressure is maintained at a pre-set level by means of a back pressure valve.

The hydrogen is then dried to an expanded dew-point of -65°C (better than 10 ppm) in a regenerative-type dryer.

Both gas generating and hydrogen compression systems are shipped as a packaged plant mounted in one module with complete wiring and piping ready for connection to customer's power and water service line.

At full load generation the purity of the hydrogen at the discharge of the compression system will be 99.9%.

The compressor will be run from the PV energy source. The compressor will draw power from a DC to AC inverter which will be connected to a battery bank. The battery bank will be continuously charged by the PV array supplied by others.

PLANT CONTROLS

Plant controls will be located on a single control panel to be located in the electrical room of the electrolysis plant. Cell currents, voltages, temperatures and gas purity will be measured by a computer acquisition system. Gas purity of the hydrogen analyzed using a oxygen analyzer and dewpoint meter will be used to assure safe operation of the plant. In the event gas purity deviates significantly outside the specified range the controller will shut down the compressor and the cell battery will be vented.

In addition to a computer aided process monitoring system an Emergency stop button in the control room can be activated by the operator. The E-stop button will send a signal to the controller to shut down the plant and cut the cells.

SPECIFICATIONS

A. OPERATING DATA AND UTILITY SERVICES

1 GAS GENERATING SYSTEM

Output

Rate - Under steady state operating conditions the unit will produce

Purity - Hydrogen - 99.5-99.9%%
Oxygen - 99% to 99.7%
lower purities will be produced during periods of low solar insolation.

Service Requirements

Consumption per cubic metre of hydrogen and 0.5 cubic metres of oxygen:

Cells only	DC Power	- 4.5 kW-h
	Purified Feedwater	- 1 Litre

Note: All stated gas volumes refer to dry gas at O°C. and 760 mm of mercury.

2. HYDROGEN COMPRESSION SYSTEM

Compressor Capacity	- 12 m^3/hr. at 352 kg/cm^2 (5000 psig)
Electric Power	- Compressor at full capacity 10 kW intermittent

B. EQUIPMENT DETAILS

1. GAS GENERATING SYSTEM

Reference: Flow Diagram S/GGS/1001:133-203 and Layout Plan S/L/1001:133-203.

Connection to the PV Array: The electrolysis plant will be connected via copper bus bar to the PV arrays through the centre of the array. Connections to the bus bar will be provided by Sea Corp.

The control panel will be installed in a closed room at one end of the Electrolysis plant module.

Cell Battery and Auxiliaries

Cells - Eight (8) Stuart Cells rated for up to 400 SCFH, completely assembled; including all DC bus bars to connect between cells, gas and water piping along cell banks, automatic cell feedwater supply system, based insulators and gas scrubbers and coolers.

- Initial charge of caustic potash electrolyte.
- One dual water seal for hydrogen oxygen, to prevent reverse flow of gas from gasholder, equipment with triple manometers to measure inlet, outlet and differential pressures of hydrogen
- Special cell tools and electrolyte specific gravity tester.
- Gas analyzer for hydrogen and oxygen, unheated catalyst type.
- Automatic hydrogen analyzer, fuel cell type, with recorder and alarm contact.

B. **EQUIPMENT DETAILS**

1. GAS GENERATING SYSTEM (Continued)

- One (1) reverse osmosis system, to supply high purity cell feedwater, complete with meter for measuring water purity and automatic diverter valve for low purity water; and 100 litre demineralized water storage to hold 10 hours consumption of feedwater.

Assembly - Package Unit
The equipment will be shipped pre-assembled inside a portable building, fully wired and with all interconnecting piping, ready for connection to customer's utilities, and with flange connections for hydrogen delivery main. Please refer to attached Electrolyser outline drawing.

Installation Materials

DC Bus Bars - PV array-to-cell battery DC bus bars, including bus bar supports.

Wiring and Piping Materials - AC wiring materials, gas and water (pipe, valves and fittings for interconnection of equipment supplied and connection to the other parts of the facility. Piping between the electrolysis house and the gas storage facility and the manifold of the gas dispenser will be 1/2" stainless steel pipe (schedule 80 or higher) with all connections welded.

SPECIFICATIONS

B. EQUIPMENT DETAILS

2. HYDROGEN COMPRESSION SYSTEM

Reference: Flow Diagram S/HCS/1001:1334-203 and Layout Plan S/L/1001:133-203.

Gasholder - One wet seal gasholder, capacity 3 m^3 of hydrogen shipped fully fabricated with complete drawings and instructions for erection.

Mist Eliminator - One (1) high efficiency element type mist eliminator, to remove traces of entrained caustic mist.

Reciprocating Compressor and Auxiliaries - One (1) lubricated 4 stage hydrogen compressor, capacity 12 m^3 per hour at 352 kg/cm^2 with starter and explosion proof pushbutton. The following auxiliaries are included with the compressor.

Enclosed relief valves
Pressure gauge
Mechanical starting unloader
Complete V-belt drive
Air-cooled intercoolers and aftercooler with separator, for compressor discharge gas.

Filters - One (1) dual element filter for compressor discharge line to remove traces of entrained oil or oil vapour.

Desiccant Dryer - One (1) hydrogen dryer, explosion proof construction, closed cycle reactivation, 11 m^3 per hour hydrogen to an expected dew-point of -65°C complete with afterfilter to remove any desiccant fines.

Back Pressure Valve - To maintain 200 kg/Cm^2 pressure on the compressor discharge to obtain drying effect of compression.

SPECIFICATIONS

B. EQUIPMENT DETAILS

2. HYDROGEN COMPRESSION SYSTEM (Continued)

Assembly - Packaged Unit - The equipment would be shipped pre-assembled on one or more steel bases, fully wired and interconnected, ready for connection to customer's electric power and water services and to gas generating system, and including flange connections for hydrogen delivery and gas venting lines.

Installation Materials - All interconnecting wiring materials, pipe, valves and fittings for equipment supplied, and for connections to the gas generating system.

Motor Control Centre - Included in the control panel are continuous hydrogen gas analyzers, compressor motor starter and an audio/visual annunciator.

SPECIFICATIONS

B. EQUIPMENT DETAILS

3. HIGH PRESSURE GAS STORAGE SYSTEM

Hydrogen Pressure Storage - To consist of two forged steel pressure vessels connected to a cascade manifold certified to ASME code for storing hydrogen, with a capacity of 13,756 SCF at 352 kg/cm^2 or storage system based on smaller volume high pressure cylinders with an equivalent vehicle refueling capability (5000 psig).

Sequence Manifold Valve - A manual valve, set by the operator, will switch between the low and high pressure levels of storage in the cascade storage system when the vehicle is being refuelled. Dial type pressure gauges will indicate the pressure in each level. A differential pressure switch or equivalent system will be supplied to stop filling at vehicle delivery pressure.

SPECIFICATIONS

C. INSTRUMENTATION AND PROTECTION

Protection as required by the National Electrical Code (NEC) is supplied on all plants. Overcurrent protection is provided by fuses, circuit breakers and overload relays on motor starters etc. Also included are intrinsically safe relays (control circuits) and/or explosion proof housings and the use of rigid conduit with sealing fittings (control and power circuits) where required by the NEC.

1. Gas Generating System

D.C. Voltmeter
D.C. Ammeter, With Overcurrent Relay Single Phase Protection
Heat Sink Overtemperature Thermostat
Feedwater Conductivity Meter
- With Alarm Contact

Thermometers, Electrolytic Cells
Feedwater Level Switch
- Level Control
- With Alarm

Electrolyte Specific Gravity Tester (portable)
Manual Gas Analyzer
- Catalyst Type (H2 and 02)

Continuous Gas Analyzer, 02 in H2
- With Alarm Contact

Manometer, H2 Pressure at Water Seal
- Inlet
- Outlet
- Differential

Manometer, 02 Pressure at Water Seal
- Inlet

SPECIFICATIONS

C. INSTRUMENTATION AND PROTECTION

2. Hydrogen Compression System

Manometer, Mist Eliminator Differential Pressure
Gasholder Limit Switches
Compressor Inlet
- Pressure Switch

Inlet Valve Limit Switch
Compressor
- Temperature Gauge, Hydrogen Inlet
- Temperature Gauge, Hydrogen Outlet
- Pressure Gauge (1 per stage)
- Safety Relief Valve (1 per stage)
- Switch, High Outlet Temperature

Desiccant Dryer
- Pressure Gauge, Column Pressure
- Pressure Gauge, Bleed System
- Flow Rate Indicator, Bleed System

Dewpoint Meter
- With Alarm Contact

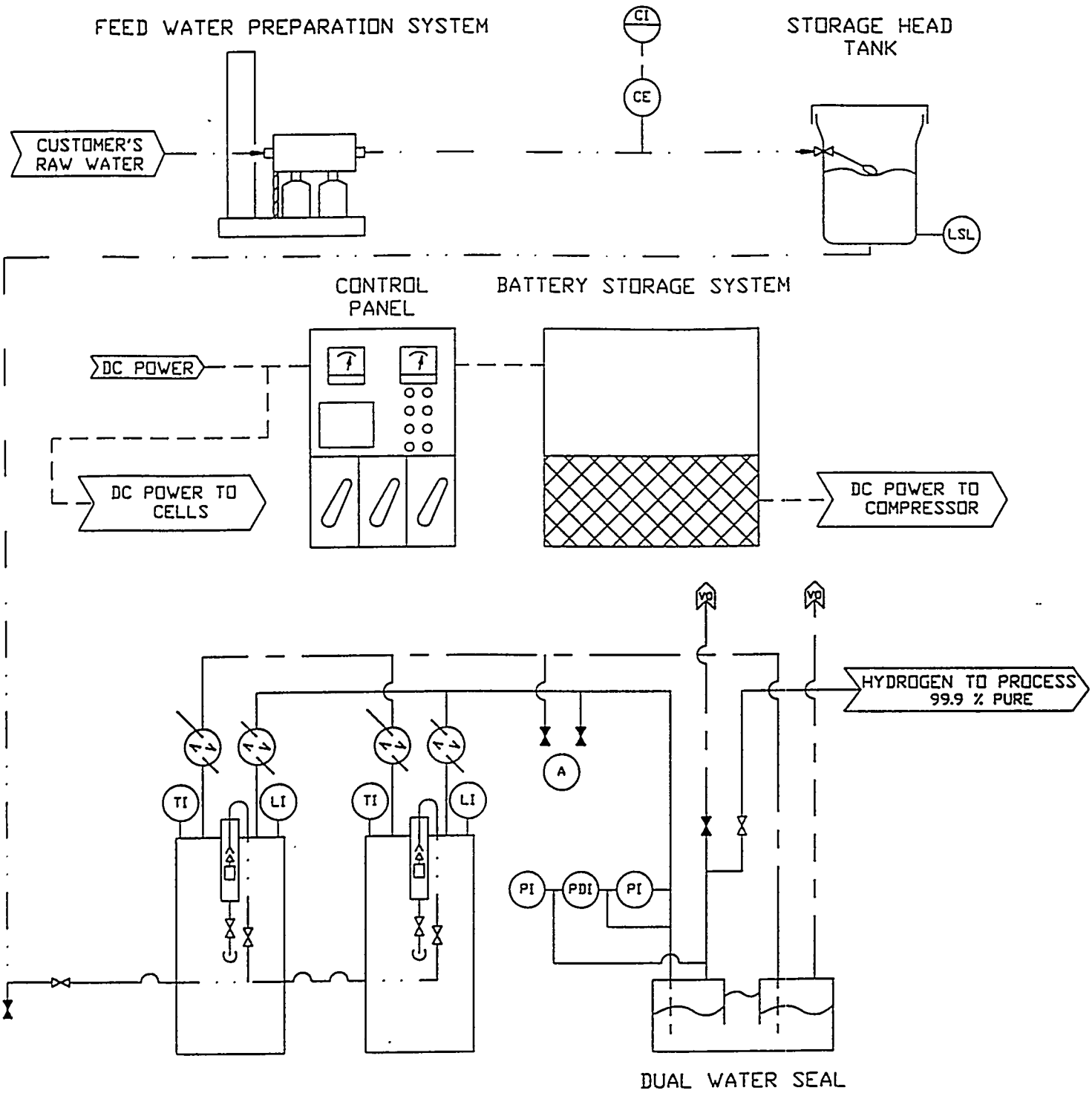
High Pressure Switch
Safety Relief Valve
Power Meter (VCR)

SPECIFICATIONS

C. INSTRUMENTATION AND PROTECTION

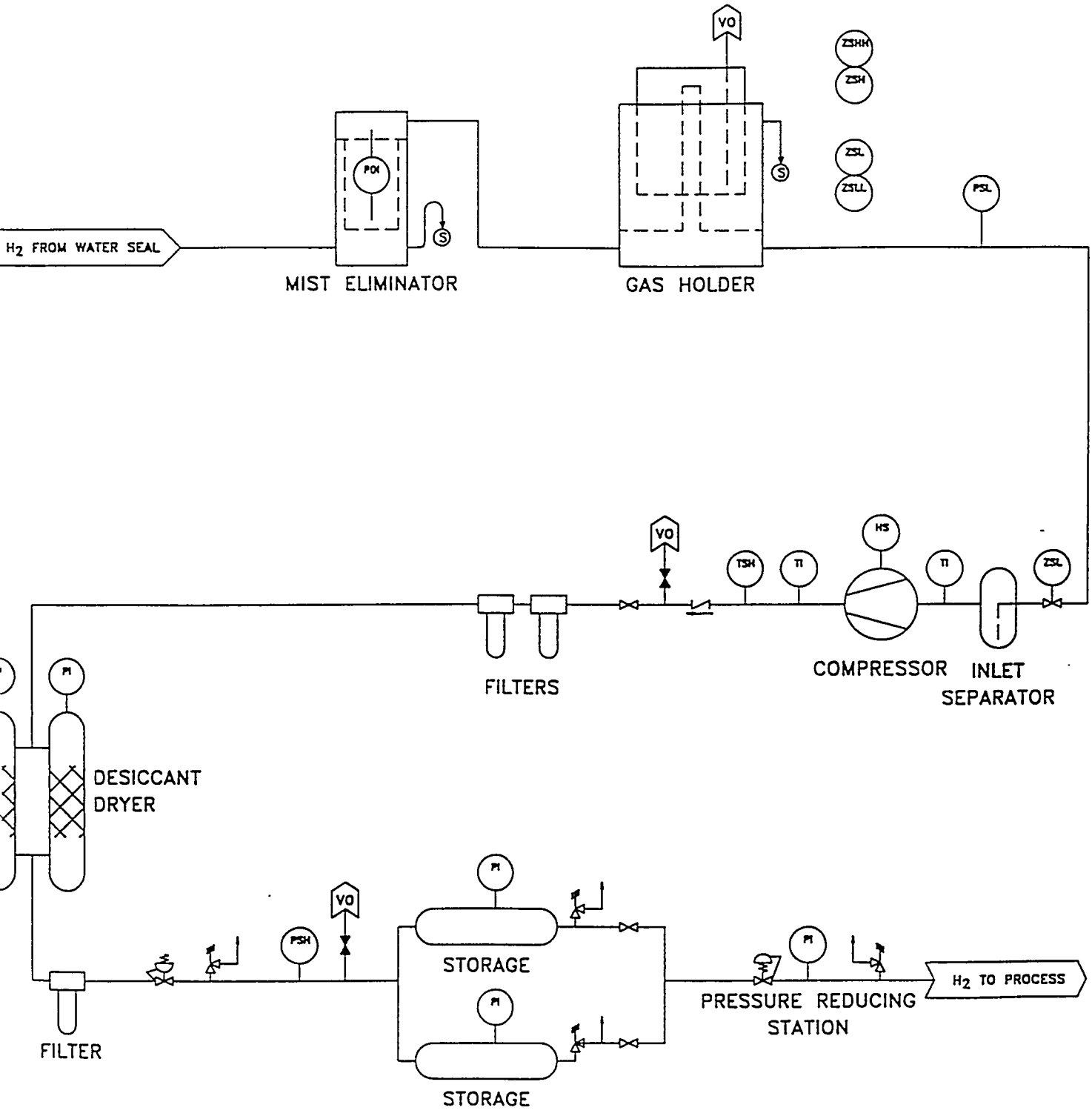
3. Gas Storage System

Pressure Gauge (1 per level of cascade)
Safety Relief Valve (1 per level of cascade)

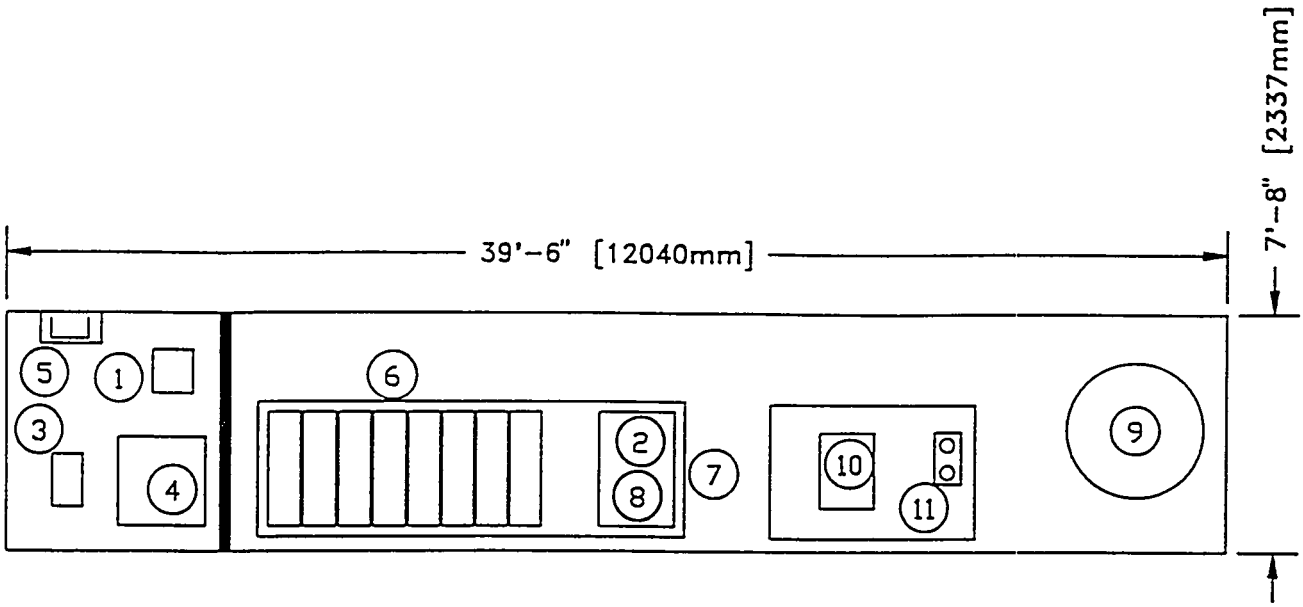


STUART CELLS
(TWO SHOWN)

HE ELECTROLYSER CORPORATION	APPR.	CHKD.	REV. No.
FLOW DIAGRAM GAS GENERATING SYSTEM	DATE 20/12/94	DRAWN GGP	SHEET 133-2G
	SCALE	DWG. No. S/GGS/1001:133-203	



THE ELECTROLYSER CORPORATION	APPR.	CHKD.	REV. No.
FLOW DIAGRAM HYDROGEN COMPRESSION SYSTEM	DATE 20/12/94	DRAWN G.G.P.	CAD #
	SCALE	DWG. No. S/HCS/1001:133-203	



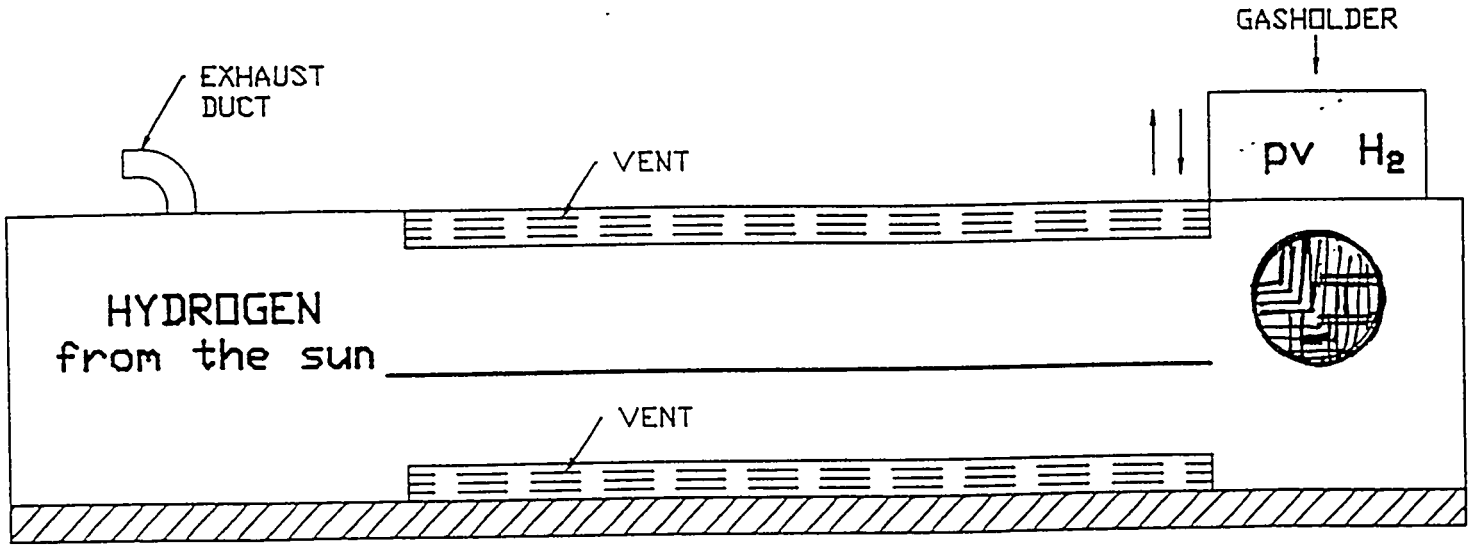
EQUIPMENT LIST

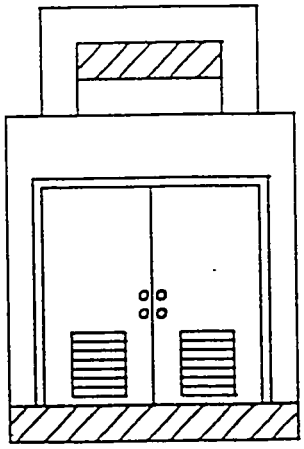
1. FEED WATER PREPARATION SYSTEM
2. FEED WATER STORAGE TANK
3. CONTROL PANEL
4. BATTERY SYSTEM
5. MANUAL GAS ANALYSER
6. ELECTROLYTIC CELLS
7. WATER SEAL
8. H_2 MIST ELIMINATOR
9. H_2 GAS HOLDER
10. H_2 COMPRESSOR
11. H_2 DESICCANT DRYER

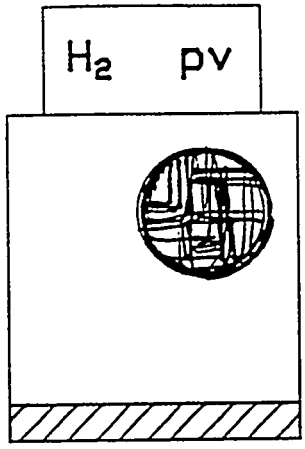
NOTES:

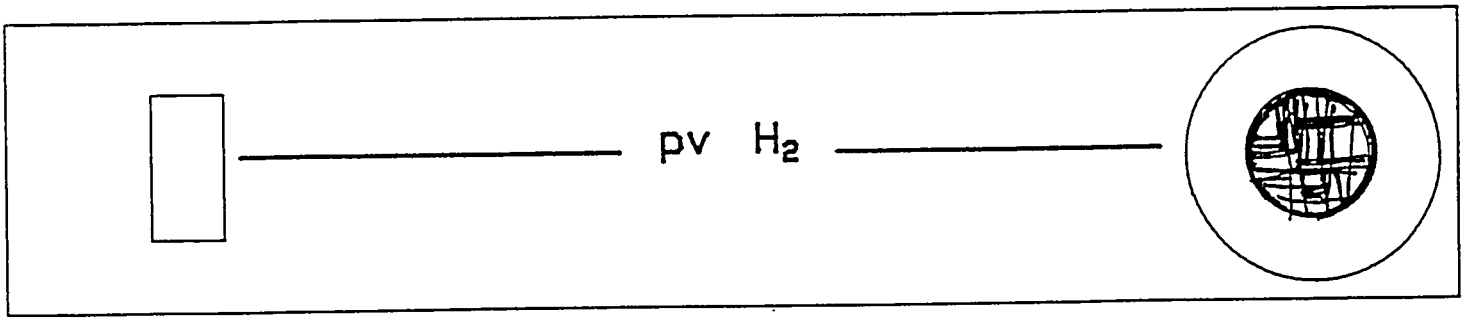
1. THIS DRAWING IS AN ESTIMATE ONLY OF THE EXPECTED SPACE REQUIREMENT.
2. NOT CERTIFIED FOR CONSTRUCTION.

THE ELECTROLYSER CORPORATION	APPR.	CHKD.	REV. No.
	DATE 20/12/94	DRAWN G.G.P.	CAD # 133-2
PLANT LAYOUT	SCALE 1=75	DWG. No. S/L/1001:133-203	


GASHOLDER
EXHAUST DUCT
VENT
pv H2
HYDROGEN from the sun
VENT




H2 pv


pv H2

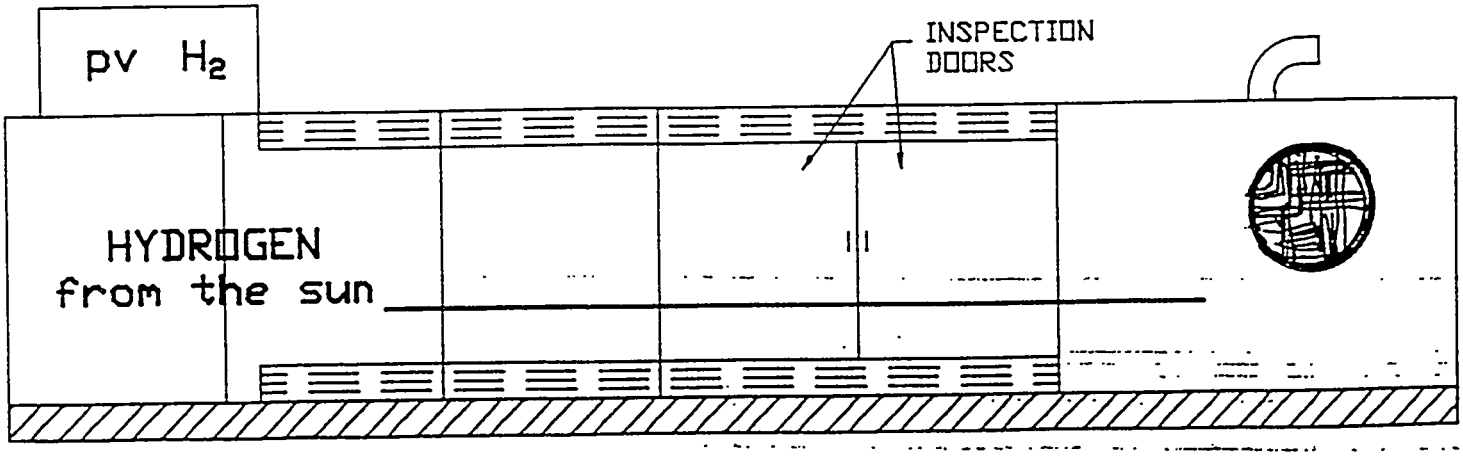

pv H2
INSPECTION DOORS
HYDROGEN from the sun

EXHIBIT B:

COST PROPOSAL AND WARRANTEE
FROM T.E.C.'S PROPOSAL # 1001:133-203

B Cost Proposal

AUTHORIZED NEGOTIATORS

The Electrolyser Corporation represents that the following persons are authorized to negotiate on its behalf with CAN! in connection with this RFP:

Alexander K. Stuart, Chairman, The Electrolyser Corporation
Andrew T.B. Stuart, Vice President of Technology, The Electrolyser Corporation
Gordon G. Potts, Marketing Engineer, The Electrolyser Corporation

PRICE, TERMS AND DELIVERY

Subject to the price and terms below and the attached "General Conditions" and "Equipment Warranty", TEC hereby agrees to sell and the Purchaser hereby agrees to buy the equipment described herein (the "equipment").
The Purchaser acknowledges and agrees that this document shall be considered a "Proposal" until executed by the Purchaser (as provided in clause 13. "Acceptance" in the General Conditions) at which time it will become a binding agreement (the "Contract").

Price - The equipment shall be delivered on a "Turn-Key" basis. Prices are stated in United States funds and shall remain firm for an order placed by January 16, 1995.

Total Cost (without options)	**925,000**
Less Cost share	**363,000**
Net	**562,000**

Terms of Payment

Date of Invoice	Details	Total	Cost SHARE	Net Share
1 month after order	Preliminary engineering including: - P & ID - Layout - Placement of major PO's	200,000	80,000	120,000
2 months after order	Receipt of cell components	165,000	65,000	100,000
4 months after order	Engineering including: - piping details - bus bar details - wiring details - skid outline	157,000	62,000	95,000
5 months after order	Receipt of components including: - compressor - dryer - rectifier - demineralizer - hydrogen storage tank	157,000		95,000
6 months after order	Final assembly and inspection	83,000		50,000
7 months after order	Start-up	163,000	61,000	102,000
Total		**925,000**	**363,000**	**562,000**

Delivery - The FOB, delivery date shall be six (6) months from the date of receipt of all of the following:

1. executed Contract, or written acceptance by TEC of any counter proposal or purchase order,
2. necessary final specifications or complete information required for engineering of the equipment

THE "GENERAL CONDITIONS" AND "EQUIPMENT WARRANTY" ATTACHED TO THIS CONTRACT ARE HEREBY MADE A PART HEREOF WITH THE SAME FORCE AND EFFECT AS THOUGH RECITED OVER THE SIGNATURE OF THE PURCHASER.

The Electrolyser Corporation

Date: Dec 21, 1994

Gordon G. Potts
Marketing Engineer

accepted on behalf of:

company name

Date:_____

Signature

print name and title

INFORMATION AND SERVICES

Drawings and Instructions - Price includes three (3) sets of outline drawings for all equipment supplied, together with complete engineering designs for layout. foundations, wiring and piping, and instructions for commissioning, operation and maintenance.

Estimated Shipping Data

2 x 40' containers

Proposed Schedule

CAN! order date, January 16, 1995
Complete Design Review, February 15, 1995
Start of Site Prep, May 15 1995
Shipping date ex-Factories, July 15, 1995
Plant at California site, July 31, 1995
Erection, August 15, 1995
Commissioning August 31, 1995.
Begin 3 mo. evaluation period August 31, 1995
Plant Startup August 1995

Commissioning - The plant will be supplied as a turn-key operation. All required installation /commissioning work will be performed by The Electrolyser Corporation or it representatives. The cost of the work is included in the price proposal.

GENERAL CONDITIONS

1. FORCE MAJEURE

Subject to paragraph 8. The Electrolyser Corporation ("TEC") shall not be liable to the purchaser for any loss or damage of any kind resulting from delay or non-delivery due to the acts of either civil or military authorities, acts or omissions of the Purchaser or by reason of force majeure, which shall be deemed to mean all other causes whatsoever not reasonably within the control of TEC, including but not limited to acts of God, war, riot or insurrection, blockades, embargoes, sabotage, epidemics, fires, strikes, lockouts or other industrial disturbances, delays of carriers, and inability to secure materials, labour or manufacturing facilities. Any delay or non-delivery resulting from any such act or event shall extend the delivery date correspondingly. In no event shall TEC be liable for any special, indirect or consequential damages arising from delay or non-delivery irrespective of the reason therefore, and receipt by the Purchaser shall constitute acceptance of delivery and waiver of any claims due to delay.

Notification of any such delay or non-delivery shall be given by TEC within thirty (30) working days of such act or event becoming known to TEC. When possible, such notification will include an estimate of the length of any delay resulting from such act or event; alternately, within ten (10) working days of the termination of such act or event, TEC will notify the Purchaser of such termination and the new delivery date established as a result of the delay. Notification will be deemed to have been given on the day such notice is placed in registered mail.

In addition, TEC shall have the right, upon occurrence of any of the acts or events set forth above, at it's option, to cancel this contract for the delayed equipment or any part thereof without any resulting obligations or liabilities to TEC.

2. SALES FOR EXPORT

The Purchaser or TEC, whichever is the proper party under the applicable statute or regulation, shall be responsible for procuring export, import or other licenses or authorizations that may be required and any extension(s) thereof. If the Purchaser is the proper party and the Purchaser fails to arrange for such licenses or authorizations prior to or by the date of delivery, TEC may, at its option, treat any such failure as a cancellation of the order placed hereunder and the Purchaser shall forthwith pay to TEC reasonable and proper cancellation charges as provided herein.

3. INSURANCE

The Purchaser shall bear all responsibility for loss or damage to the equipment after the risk of loss has passed to the Purchaser as provided herein and the Purchaser shall provide and maintain in good standing adequate insurance for the equipment to fully protect the interests of TEC between the time risk passes and final payment, and loss or damage by fire or other causes during such period shall not relieve the Purchaser from his obligation under this contract.

4. TAXES

TEC's prices do not include sales, use, excise or other taxes. Consequently, in addition to the price specified herein, the amount of any present or future sales, use, excise or other tax applicable to the sale of the equipment hereunder shall be paid by the Purchaser, or in lieu thereof the Purchaser shall provide TEC with a tax-exemption certificate acceptable to the appropriate taxing authorities.

5. INSTALLATION AND START-UP

TEC accepts no responsibility for material and equipment or for the acts of persons furnished by the Purchaser, nor will it be responsible for the performance of equipment not set up or started under the supervision of its service engineer or technician unless deficient performance is caused by defects independent of the installation.

6. CHANGES

TEC reserves the right to make at any time such changes in detail of design, construction, arrangements, or equipment as shall, in its judgement constitute an improvement over former practice. Any drawings furnished with this Proposal are submitted only to show general arrangement and approximate dimensions, and no work is to be based on them. TEC will furnish certified foundation or assembly drawings, when required, after the acceptance of this Contract.

Such changes shall not result in a delay in delivery except as such changes are the result of acts or events as provided in paragraph 1 herein.

7. CANCELLATION

Except as otherwise provided herein, it is agreed that this contract is not subject to cancellation except by mutual consent and payment to TEC of reasonable and proper cancellation charges as determined by TEC.

8. FREIGHT

If delivery is specified as C.I.F.. or C. & F. point of designation or F.O.B. TEC's plant with freight allowed, the Purchaser shall pay TEC, in addition to the purchase price any amount by which transportation charges may be increased by reason of increased transportation rates, between the date of this contract and the date of delivery.

Any delivered prices quoted herein are special and shall not be guaranteed unless shipment is routed by TEC. If Purchaser specifies a routing or any other shipping requirement which increases the cost of the freight, the difference shall be paid by the Purchaser.

Whenever TEC shall deliver or cause to be delivered to a common carrier any equipment covered by this contract, whether the particular common carrier shall have been designated by Purchaser or not, TEC shall be relieved of all responsibility for any delays or damages in shipment, and the common carrier to which TEC shall deliver such equipment is hereby declared to be agent of the Purchaser.

Upon delivery of any equipment to a common carrier, a clean bill of lading (except where maritime or other regulations require special arrangements which are reflected in such bill of lading) or express receipt shall serve as conclusive evidence of the good condition of such equipment. Purchaser shall make no claim against TEC for any loss or damage to the equipment unless such loss or damage was the direct (not consequential) result of TEC's negligence.

9. PATENT
TEC shall hold the Purchaser harmless against liability for direct (not consequential) costs resulting from infringement of any U.S. patent by TEC designed equipment. Otherwise, Purchaser shall hold TEC harmless. The party claiming indemnity hereunder must minimize damages and give prompt notice and full cooperation to the indemnitor who shall have sole right to defend or compromise.

10. WARRANTY
To the extent permitted by law, TEC makes no warranty or representation of any kind to the Purchaser or any other person other than as expressly set forth in this Contract or as TEC may, from time to time, set forth in writing addressed to the Purchaser. Nor shall TEC have incurred any other obligations or liabilities in connection with the purchase or servicing of the equipment unless expressly provided for herein.

11. PAYMENTS
Prices and any adjustments thereto are set out in the Proposal. The prices specified are payable in New York free of all expenses to TEC for collection charges. Delivery of equipment may be delayed at Purchaser's request provided that payment shall become due and payable upon notification by TEC that the equipment provided for by this Contract is ready for delivery, and it is agreed that storage will be at Purchaser's risk and expense with reasonable compensation to be paid to TEC for such storage and rehandling.

All delinquent accounts will be subject to a late charge at the rate of 1.5% per month on the unpaid balance or such other rates as may be set by TEC from time to time. TEC may, in its sole discretion, at any time, change or withdraw any credit terms previously extended to the Purchaser. In the event that any indebtedness owed by Purchaser to TEC shall be past due, TEC may, at its option and in addition to any other rights or remedies it may have, suspend further delivery until all such indebtedness shall have been fully paid. All equipment, after risk of loss has passed to the Purchaser as provided herein, shall be at the risk and expense of the Purchaser as to lose, destruction, damages, taxes and charges of every kind.

12. ASSIGNMENT

The Purchaser may not assign this contract or any rights, liabilities or obligations hereunder without TEC's written approval which TEC may withhold in its absolute discretion.

13. ACCEPTANCE
The Proposal is subject to acceptance by the Purchaser within the specified validity period of the Proposal and, in the meantime, may be changed or withdrawn by TEC upon written notice. Upon acceptance by the Purchaser, the Proposal shall become a Contract, as referred to herein, binding upon the parties hereto.

No counter proposal by the Purchaser and no purchase order by the Purchaser for any of the equipment offered in this Proposal shall create any contract between TEC and the Purchaser or be binding in any way upon TEC until such acceptance or purchase order is approved in writing by an TEC executive at its Headquarters in Toronto, Ontario, Canada.

14. INTERPRETATION
This contract shall be governed by and construed in accordance with the laws of the State of New York.

15. ENTIRE AGREEMENT
This contract and the general project cooperation agreement comprises the entire agreement between the parties hereto with respect to the subject matter and there are no representation, warranties or terms and conditions, express or implied, statutory or otherwise, with respect thereto other than those contained in this contract, the TEC warranty and the proposal. This contract supersedes all prior agreements and understandings relating to the subject matter.

16. AMENDMENTS
Except as otherwise expressly provided herein, any amendments or revisions to this contract by the Purchaser are not binding unless confirmed in writing by TEC.

17. SEVERABILITY
The validity of this contract as a whole shall not be affected by any of its provisions being or becoming invalid or unenforceable for any reason whatsoever or to violate any law or regulation. Such provision or provisions shall be considered divisible and shall be deleted from this contract and the remainder of this contract shall be valid and binding upon the parties.

18. NOTICE
Any notice which is required or permitted to be made under the terms of this Contract shall be given in writing by the party or to an officer of the other party at the address set forth hereunder or at such other address as the party may indicate in writing from time to time. The date of the personal delivery or the date of the registered mailing, as the case may be, shall be deemed to be the date of receipt of such notice

19. *UNICELL-CLUSTER* ™ OPERATING LICENSE
TEC grants CAN! a paid up operating license for the *UNICELL-CLUSTER* ™ technology for a period of five years, for the demonstration site in Xerox El Segundo. After this period a separate agreement will be worked out based on .01 $ per NCM. paid on a quarterly basis binding on CAN! or its successors

20. CONFIDENTIALITY AGREEMENT

The purchaser will hold confidential any written documents marked as confidential by TEC.

EQUIPMENT WARRANTY

Service Contract

To cover scheduled maintenance over the demonstration period, until June 30, 1997, TEC will provide up to 100 days (7 hours per day) of technical support at the El Segundo site, man-power to be provided by the project support team at UCR. This contract will include all scheduled maintenance i.e visits for regeneration of feedwater system etc as well as 48 hour response to process breakdowns. In addition, TEC will supply parts worth up to $30,000 in total value as needed to replace and repair defective or worn componets over the demonstration period ending June 30, 1997.

General Equipment Warranty

This warranty shall cover the following specifications and performances:

1. The equipment shall be of good material and workmanship.
2. TEC hereby extends the same warranty as is extended to it by the manufacturers of the sub-components of the system.

TEC warrants that the apparatus to be delivered hereunder, when operated in accordance with the suppliers reasonable instructions, will be of the kind designated or specified above, and no other warranty, statutory or otherwise, shall be implied. The conditions of any test shall be mutually agreed upon, and TEC shall be notified, and may be represented at all tests that may be made.

If it appears within one year from date of shipment that the apparatus delivered hereunder is not of a kind designated or specified under the above, and if the Purchaser notifies TEC immediately, in writing, TEC shall correct the defect or defects by repairing the defective part or parts, or by supplying a replacement thereof, f.o.b. its factory.

The liability of TEC shall not in any case exceed the cost of correcting defects in the apparatus as above provided, and upon the expiration of said one year, all liability of TEC shall terminate. The foregoing shall constitute the sole liability of TEC.

EQUIPMENT WARRANTY (Continued)

All disputes arising in connection with this warranty, or in connection with any other matters arising from the sales contract, shall be finally settled under the Rules of Conciliation and Arbitration of the International Chamber of Commerce by one or more arbitrators in accordance with the Rules.

Performance Warranty

For a period of 1 year after plant commissioning:

Cell Efficiency:
Under standard cell conditions of: electrolyte concentration 25 % KOH, cell temperature greater than 70 C, cell power consumption, measured at the cell bank, will be better than 4.5 ± .1 kW-h/NCM.

Gas Purity:
Under the conditions of the PV array operating at peak power conditions (48 kW DC) gas purities will be better than 99.7 % hydrogen in the hydrogen stream and better than 99.5 % oxygen in the oxygen stream.

The Electrolyser Corporation (TEC)

DOE
Scott

CLEAN AIR NOW! SOLAR POWERED HYDROGEN GENERATING FACILITY & UTILITY VEHICLE FLEET

William Hoagland
W. Hoagland & Associates, Inc.
Boulder, Colorado 80301
(303) 530-1140 Fax: (303) 530-1385

Introduction

In February 1994, Clean Air Now! (CAN), a non-profit California corporation was selected by the White House Technology Reinvestment Program to demonstrate a practical application of solar generated hydrogen as a fuel for utility vehicles. The project was transferred to the U.S. Department of Energy and the contract was awarded in August 1994. Construction of the facility is underway at the Xerox facility in El Segundo, CA, only a few miles south of the Los Angeles airport. As a deployment project, the project will utilize state-of the-art technology including photovoltaics, water electrolysis, high pressure storage and compression equipment and conversion of three internal combustion engines in Ford Ranger pick-up trucks to operate on pure hydrogen. In December 1994, the dispensing station was completed by Praxair, Inc. and a Hydrogen Fuel Cell powered bus built by Ballard Power Systems was refueled. This brings a new capability for makers of hydrogen vehicles to demonstrate new vehicle technology in the Los Angeles area.

Program Scope

The project consists of a 48 kW solar photovoltaic-electrolysis system to produce a minimum of 400 standard cubic feet per hour (SCFH) hydrogen to be compressed and stored at 5,000 pounds per square inch (psi). The high pressure storage system will contain sufficient hydrogen to refuel three Xerox maintenance vehicles modified to operate on hydrogen. In addition, Praxair, Inc. has provided approximately 80,000 SCF hydrogen storage to be replenished by tube trailer to supplement the PV-Electrolysis system, if required. In the interim this supplemental supply will provide hydrogen for the vehicles until the photovoltaic-electrolysis system is completed in the fall of 1995. The demonstration is a cooperative effort of several companies. A complete list of program participants is contained in Appendix 1.

Program Objectives

The objective of the project is to demonstrate the technical viability and safe operation of a solar hydrogen generating facility and use as a vehicular fuel. A primary benefit of the project is that several issues of infrastructure and safety are being addressed.

System Description

The Xerox project consists of four major components:

- PV-Electrolysis,
- hydrogen compression and storage,
- hydrogen dispensing, and
- the vehicle fleet.

The Solar photovoltaic array, produced by SEA Corp will provide approximately 48 kW direct current electricity to produce a minimum of 400 SCFH hydrogen. The produced hydrogen is compressed and stored at 5,000 psi for dispensing to hydrogen vehicles. A tube rack conventional hydrogen storage system, provided by Praxair, Inc., is used to provide hydrogen in the interim while the PV-electrolysis system is under construction. Later, this storage capability will provide supplementary hydrogen in the event that the demand exceeds the capability of the solar hydrogen system. The system will be located in the parking lot of the Xerox El Segundo facility. It will encompass an area of about one-half acre. In addition to the four components listed above, the facility will have a small control room to house electronics and to provide for future data acquisition equipment. The entire facility will also be enclosed by a protective fence. A schematic for the system is contained in Figure 1.

Codes and Standard Issues

An overriding criteria for the project was that safety would be of paramount importance. The project is intended to demonstrate the safe production, handling and use of hydrogen. The testing of unproven technology or the economics of hydrogen was not an issue. The project team was fortunate to have the support of Xerox Corporation in the review and implementation of safety procedures throughout the design and construction phases. Because of the lack of directly applicable codes and standards, all design decisions are being reviewed within the context of safety.

The first issue to be discussed was the applicability of existing codes and standard to this particular project. In referring to the National Fire Protection Association standard for gaseous hydrogen, NFPA 50A, "Standard for Gaseous Hydrogen at Consumer Sites", we see that it does not apply to manufacturing plants

During the project planning phase, the lack of readily usable standards was obvious. References to the existing codes resulted in many questions and issues that needed resolution. One approach we are using is to consider the precedents set by the natural gas filling stations and evaluate the risks involved in similar hydrogen vehicle facilities rather than blindly applying existing codes imposed by hazardous location classification. If hazardous classification restrictions were applied to existing natural gas or hydrogen buses, they could not be permitted. Only the dispensing area and the areas near the gas compressor enclosure are classified. As stated the NFPA 50A standard doesn't apply to hydrogen production plants and neither does the standard apply to storage systems of less than 11 m^3. The electrolysis and gas compression plant in El Segundo, excluding the fixed storage, will have a gas volume

Figure 1 - Schematic of the Clean Air Now! Solar Hydrogen Generating Facility

of less than 4 m^3. The fixed storage, approximately 13,000 SCF at 5,000 psi will have to comply to existing codes and is considered the primary hazard to be considered. For this fixed storage, we will follow Praxair, Inc. design and installation practices. Other safety issues that are under consideration are:

- Electrolyzer cell separator failure resulting in the mixing of gases,
- Failure in the feedwater system resulting in the dropping of the electrolyte level and drying of the separator
- hydrogen release through leakage or rupture of equipment and piping.

These hazards will be handled by isolating the power supply and controls in a separate enclosure. The electrical systems in the electrolysis cell area, with the exception of the bus bar, will be of explosion proof design. Additionally, sensors controlling a vent valve at the water seal will vent the cell stack to eliminate a pressure differential across the separator and also activate an emergency disconnect to the electrical supply. Sensors under consideration are:

- a continuous gas analyzer to detect impurities,
- level sensors to detect feedwater problems, and
- hydrogen sensors to detect leaks.

In considering the hazard from hydrogen, it is important to realize that the flammability limit (4%) is the same as for natural gas, but on an energy basis, the energy density is reduced significantly by one-third. Given the higher diffusivity of hydrogen, the probability of an equally hazardous volume of flammable mixture forming is much less. The NFPA standard removes some restrictions for small residential filling stations which are classified to less than 6 standard cubic feet per minute (SCFM). On an energy basis, 6 SCFM natural gas corresponds to a production rate of 18 SCFM hydrogen or about 1,000 SCFH. This is more than twice the rate of the Xerox El Segundo facility. In the longer term, similar exemptions for hydrogen systems are needed.

The primary safety issue for the refueling of the hydrogen vehicles is ensuring that the dispensing equipment and the vehicle is properly grounded to avoid a static discharge during filling. Several methods were considered, and one was selected. no details are included here, due to a possible patent application to be filed.

Conclusion

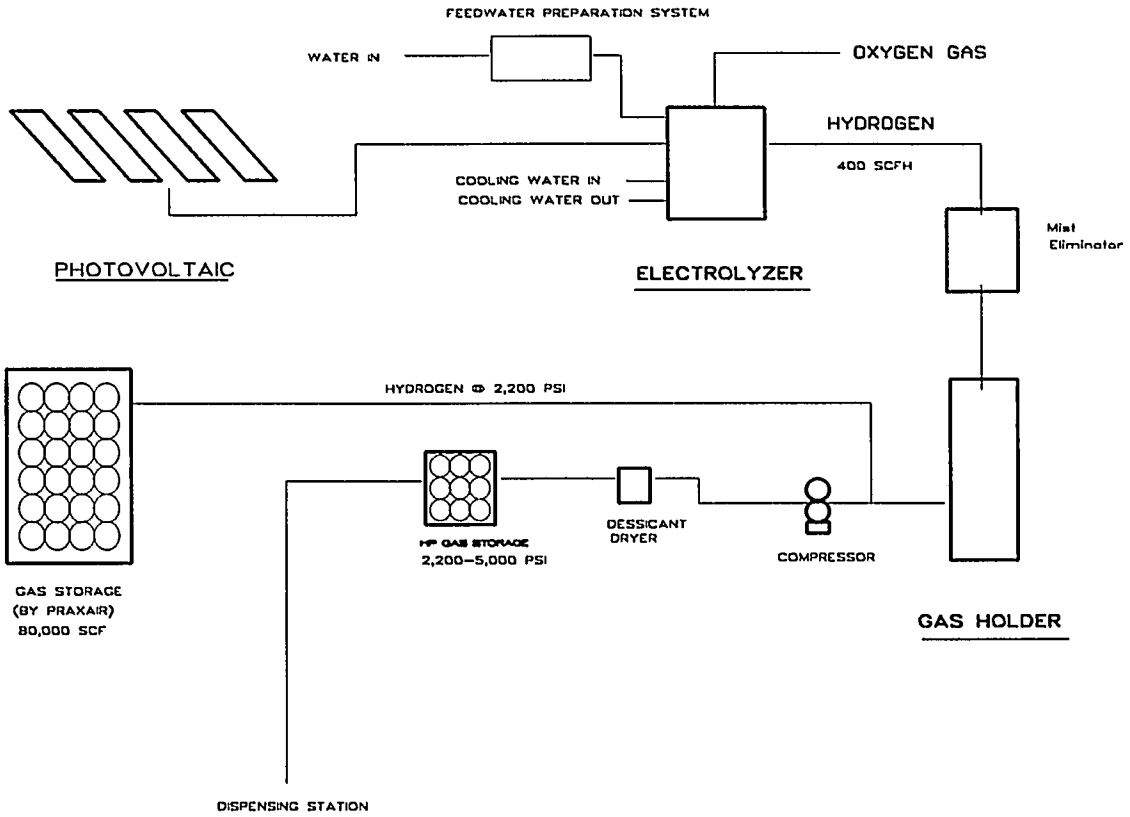
Although the Clean Air Now! project is not intended to advance the technical state-of-the-art, it directly addresses issues of infrastructure. Such issues as the ability to adequately reassure the permitting authorities to allow the construction of such a project, the ability to obtain liability insurance in the absence of operating loss experience or the standardization of connectors or safety devices so that the facility can be replicated with less difficulty, are all barriers to the practical application of hydrogen energy. In addition, operating experience will go a long way to increasing public acceptance of such systems. This is the real value of the project.

Acknowledgements

The author would like to acknowledge the assistance of Mr. Matthew Fairlie of the Electrolyser Corporation and Mr. Tom Halvorsen of Praxair, Inc. for their valuable input to this paper.

Clean Air Now!/Xerox Project Team

Clean Air Now!, Santa Monica, CA
Xerox Corporation, El Segundo, CA
Praxair, Inc., Tarrytown, NY
SEA Corporation, Santa Clara, CA
The Electrolyser Corporation, Buffalo, NY
The University of California, Riverside, CA
AMD, Inc., Highland, CA
Energy Technology Engineering Center, Canoga Park, CA
W. Hoagland & Assoc., Inc., Boulder, CO
Touchstone Technologies, Northridge, CA


FEEDWATER PREPARATION SYSTEM
WATER IN
OXYGEN GAS
HYDROGEN
400 SCFH
COOLING WATER IN
COOLING WATER OUT
Mist Eliminator
PHOTOVOLTAIC
ELECTROLYZER
HYDROGEN @ 2,200 PSI
HP GAS STORAGE
2,200–5,000 PSI
DESSICANT DRYER
COMPRESSOR
GAS STORAGE
(BY PRAXAIR)
80,000 SCF
GAS HOLDER
DISPENSING STATION

PRAXAIR

Praxair, Inc.
Applications Technology Planning
777 Old Saw Mill River Road
Tarrytown, NY 10591-6714
Tel (914) 789-3000
Fax (914) 789-2026

November 4, 1994

Mr. William Hoagland
Project Manager
Xerox/CAN Hydrogen Project
c/o W. Hoagland & Associates, Inc.
7467 Spy Glass Court
Boulder, CO 80301

Dear Bill:

We would like to take this opportunity to clarify Praxair's position regarding selection of vehicle fuel tanks for the Xerox/CAN demonstration project.

As you know, significant interest has been shown in a light weight composite container utilizing a plastic liner with carbon fiber overwrap. Frank Lynch has conducted some initial permeability tests on a Brunswick tank of this type with encouraging results. The carbon composite tank offers the promise of significant weight reduction over the current fiberglass wrapped aluminum tank (used on the UC Riverside vehicle) which would help future vehicle range and performance.

Unfortunately, despite these potential advantages, Praxair cannot endorse the use of carbon composite tanks for on board hydrogen storage at this time. These tanks need approval or an exemption for hydrogen from the US Department of Transportation (DOT). DOT approval/exemption calls for extensive safety testing and justification for on the road use. It is not unusual for the DOT approval/exemption process to take a year or more.

We strongly recommend that Xerox/CAN proceed with the fiberglass wrapped aluminum design for the initial vehicle conversions, until DOT approval is obtained for the carbon composite tanks. Fiberglass wrapped aluminum tanks already have DOT exemptions for hydrogen shipment and there is industry experience with these containers in hydrogen service.

Bill, we would appreciate your assistance in conveying our concerns to the Xerox/CAN project team. We have also copied Christian Lenci, Praxair's account manager for Xerox, on this letter. We have asked Christian to pass this letter on to Greg Forte, Stu Lough and other interested Xerox site personnel.

Sincerely,

Mike Hainsselin

M.H. Hainsselin
Applications Manager

Tom Halvorson

T.G. Halvorson
Senior Development Associate

MHH/dn

cc: C. Lenci

INSPECTION RECORD
DEPT. OF BUILDING SAFETY
CITY OF EL SEGUNDO

350 Main Street
7:30am-5:30pm, M-F 322-4670

Bldg Inspector:________________ Telephone Extension:________

24-Hour Inspection Request Telephone 310-322-7069

POST THIS CARD IN A SAFE & CONSPICUOUS PLACE

Job Address 857 S. Aviation
Permit No. 523-94 Date Issued
Owner Xerox Corp.
Contractor Matrix Eng. & Constr.
Description of Work Conc. Fdn.

Inspector Must Sign All Spaces Pertaining To This Job
REQUEST ALL INSPECTIONS 24 HOURS IN ADVANCE

INSPECTIONS	DATE	APPROVED BY
Temporary Power Pole		
Building Location		
Foundation		
Reinforcing Steel	[illegible]	[illegible]
UFER Ground		
OK to Pour Footings*		
*Do Not Pour Concrete Until the Above is Signed.		
Electrical Underground/Floor		
Plumbing Underground/Floor		
Floor Joists & Sills		
OK to Sheath Floor/Pour Slab*		
*Do Not Sheath Floor/Pour Slab Until the Above is Signed.		
Floor Nailing		
Roof Tear Off		
Roof Sheathing/Nailing*		
*Do Not Apply Roof Covering Until the Above is Signed.		
Roof FINAL		
Do Not Call for Framing** Inspection Until Electrical, Plumbing, & Heating Have Been Installed.		
Rough Electrical		
Rough Plumbing		
Rough Heating & Cooling		
Framing**		
OK to Cover Exterior*		
*Do Not Cover Exterior Until the Above is Signed.		
Sound Insulation		
Energy Insulation		
OK to Cover Interior*		
*Do Not Cover Interior Until the Above is Signed.		
Lathing Exterior		
Lathing Interior		
Dry Wall		
OK to Stucco/Plaster*		
*Do Not Stucco/Plaster Until the Above is Signed.		
Scratch Inspection (48 hours)		
Brown Inspection (72 hours)		
Sewer Cap ☐ Hookup ☐		
Gas Test		
NOTICE A list of subcontractors must be furnished prior to FINAL inspection.		
Final Electrical		
Final Plumbing		
Final Heating & Cooling		
Do Not Call for Final Building Inspection Until All of the Above Have Been Signed Off.		
FINAL BUILDING:	[illegible]	[illegible]

[illegible]

Pat [illegible] [illegible]

[illegible]

FPF-59
REV 7/92

EL UNDO FIRE DEPARTMENT INSPECTION RE D
FIRE PREVENTION BUREAU
314 MAIN STREET
EL SEGUNDO, CA 90245

PHONE# (310) 322-4311
FAX# (310) 414-0929

PC# 5?? ??

JOB ADDRESS: 351 S ?? PHONE#
OWNER: XEROX
JOB DESCRIPTION: STORAGE RACK
NEW HYDROGEN ... (SLIND)

INSPECTION TYPE	DATE	INSPECTED BY
SPRINKLER SYSTEM (NFPA 13/UFC 10)		
___Underground Hydro		
___Underground Flush		
___Overhead Hydro		
___Final		
STANDPIPE SYSTEM (NFPA 14/UFC 10)		
___Wet___Dry___Comb. (FPBR S-4a-b-d)		
___Hydro___Flow		
___Final		
FIRE HYDRANTS (NFPA 24/UFC 10)		
___Underground Hydro.		
___Underground Flush		
___Flow		
FIRE ALARM SYSTEM (NFPA 72/UFC 10)		
___Detectors		
___Manual Pull Stations		
___Audibles		
___Supervision		
___Annunciation/Control Panel		
___Final		
TENANT IMPROVEMENTS		
___Corridor		
___Exit Signs		
✓ Fire Estinguishers 2		
___Other		
___Final		
FIRE PROTECTION SYSTEMS		
___CO2 System (NFPA 12/FPBR E-2c)		
___Wet Dry Chemical System (NFPA 17/FPBR E-2-a)		
___Halon 1301 System (NFPA 12A)		
___Functional Test (FPBR E-2c)		
___Final		
U/G TANK (NFPA 30/FPBR F-1b)		
___Removal___Install		
___Hydro___Final		
CRYOGENIC TANK (NFPA 30/FPBR f-1b)		
___Hydro		
___Final FILE PERMIT		
LPG TANK (FPBR C-a)		
✓ Tank Installation		
✓ Dispensing Installing		
✓ Final		
OTHER ...		
... SENSOR ...		
...	1-20-95	
FINAL		

NOTICE: This card must be posted in conspicuous place on the job.
NOTIFY FIRE DEPARTMENT when job is ready for inspection.
48 HOUR inspection notice is required.
APPROVED PLANS SHALL BE ON JOB SITE

Figure 2

FIELD PNUEMATIC TEST RECORD

CUSTOMER Xerox Elsagowdo
LOCATION Elsagowdo CA
SERVICE CENTER 786
LINE No * 8507575

1) Region Authorization to pneumatic test

a) Region Safety Director [signature]

b) Date 12/7/94

	PSIG	COMPLETE
2) Preliminary Test (Section III A)		
a) Preliminary Test Pressure	100psi	RJC=
b) Hold for 10 minutes		
c) Blow down 25% for inspection	75psi	
d) No leaks Detected		RJC=
3) Pressure Test (Section III B)		
a) Step 1	484	
b) Hold for 10 minutes with no loss		RJC=
c) Step 2	968	
d) Hold for 10 minutes with no loss		RJC=
e) Step 3	1'452	
f) Hold for 10 minutes with no loss		RJC=
g) Step 4 (Test Pressure)	1'936	
h) Hold for 10 minutes with no loss		RJC=
4) Final leak test (Section III C)		
a) Design Pressure	2,420	
b) No leaks detected		RJC=

5) Test Completion

a) Test Manager [signature]

b) Date 12-6-94

* Line number as given on the site test plan

November 16, 1994

L. Stuart Lough
Manager Site Engineering, Construction & Maintenance
ESM5-021
Xerox Corporation
701 S. Aviation Blvd.
El Segundo, CA 90245

Dear Mr. Lough:

Re: Zero Emission Bus ("Bus")

This letter is to request the usage of your facility at El Segundo site, ("Facility") from December 8, 1994 to December 16, 1994, for overnight storage and refueling while the Bus is being demonstrated in Los Angeles.

In consideration of permitting us to use your Facility without charge, we agree that Xerox, its officers, directors, employees and other representatives shall not be liable for any loss, theft, damage or destruction (through negligence or otherwise) of the Bus while the Bus is in the Facility, provided, however, that this release from liability shall not limit the liability of any individual who may be personally guilty of theft, wrongful damage or destruction of the Bus.

We also agree to indemnify and hold Xerox, its officers, directors, employees and other representatives harmless from and against any suits, actions, claims, losses, demands and expenses directly occasioned by you as a result of storage of the Bus at the Facility.

Sincerely,
Ballard Power Systems Inc.

Paul Howard, P.Eng.
Vice President

Construction/Engineering

NOV 22 1994

STU LOUGH

107-980 West 1st Street
North Vancouver, B.C.
Canada V7P 3N4
Phone 604/986-9367
Fax 604/986-3262

Xerox Corporation
Construction Department
XSERV Western Operations
701 South Aviation Boulevard
Mail Stop ESM5-022
El Segundo, California 90245
FAX (310) 333-8366
(213) 333-5226

XEROX November 22, 1994

Paul Howard, P. Eng.
Vice President
Ballard Power Systems
107-980 West 1st Street
North Vancouver, B. C.

Dear Mr. Howard:

Re: Zero Emission Bus ("Bus")

Xerox hereby consents to your request for overnight storage of the Zero Emission Bus at our facility in El Segundo, California for the period from December 6, 1994 through December 16, 1994.

Please notify Mr. Jens Hansen of the approximate arrival time and he will assure proper access and security clearance with our Security office.

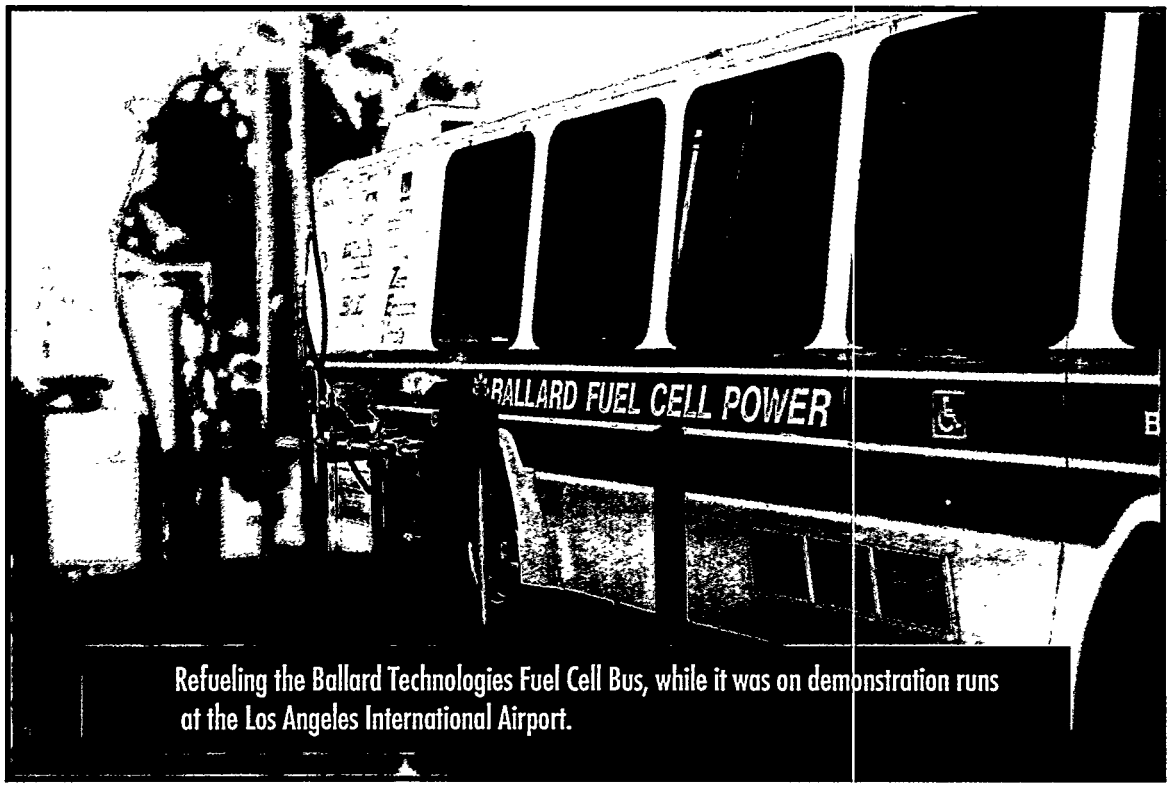
Jens may be reached at: (310) 333-9431 after November 28.

L. Stuart Lough, Manager
Site Construction, Engineering
and Maintenance

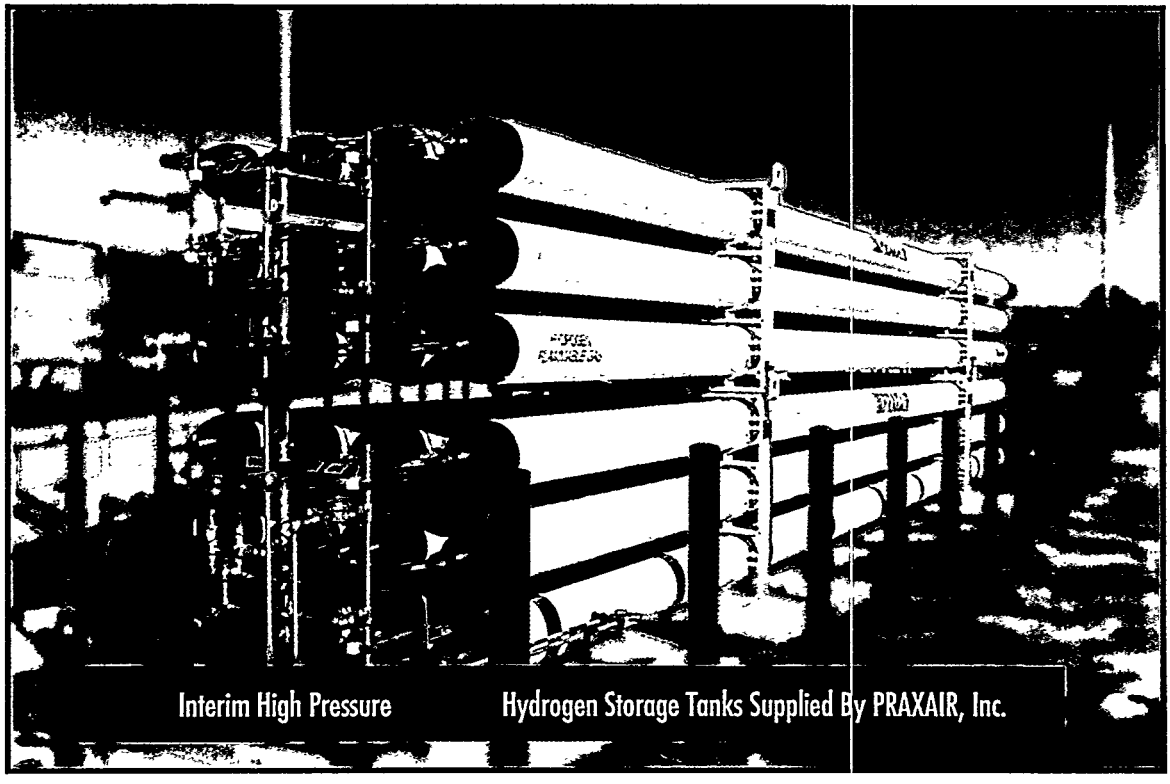
LSL:pm

c:
J. Hansen
P. Watson

Clean Air Now Solar Hydrogen Refueling Station
Xerox Facility - El Segundo, CA (December 1994)



Refueling the Ballard Technologies Fuel Cell Bus, while it was on demonstration runs at the Los Angeles International Airport.



Interim High Pressure Hydrogen Storage Tanks Supplied By PRAXAIR, Inc.

FINANCIAL STATUS REPORT

(Follow instructions on the back)

1. FEDERAL AGENCY AND ORGANIZATIONAL ELEMENT TO WHICH REPORT I

DEPARTMENT OF ENERGY

3. RECIPIENT ORGANIZATION *(Name and complete address, including ZIP code)*

Clean Air Now
1222 Lincoln Blvd.
Santa Monica, CA 90401

4. EMPLOYER IDENTIFICATION NUMBER: 33-0087555

5. RECIPIENT

8. PROJECT/GRANT PERIOD *(See instructions)*

FROM *(Month, day, year)*: OCTOBER 1, 1994

TO *(Month, day, year)*: DECEMBER 31, 1

10. STATUS OF FUNDS

PROGRAMS/FUNCTIONS/ACTIVITIES ►	(a)	(b)	(c)	(d)
a. Net outlays previously reported	$ 172,283.14	$	$	$
b. Total outlays this report period	421,871.24			
c. *Less:* Program income credits	0			
d. Net outlays this report period *(Line b minus line c)*	421,871.24			
e. Net outlays to date *(Line a plus line d)*	594,154.38			
f. *Less:* Non-Federal share of outlays	297,077.19			
g. Total Federal share of outlays *(Line e minus line f)*	297,077.19			
h. Total unliquidated obligations	0			
i. *Less:* Non-Federal share of unliquidated obligations shown on line h	0			
j. Federal share of unliquidated obligations	0			
k. Total Federal share of outlays and unliquidated obligations	297,077.19			
l. Total cumulative amount of Federal funds authorized	297,077.19			
m. Unobligated balance of Federal funds	0			

11. INDIRECT EXPENSE

a. TYPE OF RATE *(Place "X" in appropriate box)* ☐ PROVISIONAL ☐ PREDETERMINED ☐ FINAL ☐ FIXED

b. RATE	c. BASE	d. TOTAL AMOUNT	e. FEDERAL SHARE

12. REMARKS: *Attach any explanations deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation.*

13. CERTIFICATION

I certify to the best of my kn
lief that this report is correct
that all outlays and unliqui
are for the purposes set fo
documents.

269-102

* U.S. GOVERNMENT PRINTING OFFICE : 1982 O - 361-526 (7588)

STANDARD FORM 269 (BACK) (7-76)

INSTRUCTIONS

Please type or print legibly. Items 1, 2; 3, 6, 7, 9, 10d, 10e, 10g, 10i, 10l, 11a, and 12 are self-explanatory, specific instructions for other items are as follows:

Item	*Entry*
4	Enter the employer identification number assigned by the U.S. Internal Revenue Service or FICE (institution) code, if required by the Federal sponsoring agency.
5	This space is reserved for an account number or other identifying numbers that may be assigned by the recipient.
8	Enter the month, day, and year of the beginning and ending of this project period. For formula grants that are not awarded on a project basis, show the grant period.
10	The purpose of vertical columns (a) through (f) is to provide financial data for each program, function, and activity in the budget as approved by the Federal sponsoring agency. If additional columns are needed, use as many additional forms as needed and indicate page number in space provided in upper right; however, the totals of all programs, functions or activities should be shown in column (g) of the first page. For agreements pertaining to several Catalog of Federal Domestic Assistance programs that do not require a further functional or activity classification breakdown, enter under columns (a) through (f) the title of the program. For grants or other assistance agreements containing multiple programs where one or more programs require a further breakdown by function or activity, use a separate form for each program showing the applicable functions or activities in the separate columns. For grants or other assistance agreements containing several functions or activities which are funded from several programs, prepare a separate form for each activity or function when requested by the Federal sponsoring agency.
10a	Enter the net outlay. This amount should be the same as the amount reported in line 10s of the last report. If there has been an adjustment to the amount shown previously, please attach explanation. Show zero if this is the initial report.
10b	Enter the total gross program outlays (less rebates, refunds, and other discounts) for this report period, including disbursements of cash realized as program income. For reports that are prepared on a cash basis, outlays are the sum of actual cash disbursements for goods and services, the amount of indirect expense charged, the value of in-kind contributions applied, and the amount of cash advances and payments made to contractors and subgrantees. For reports prepared on an accrued expenditure basis, outlays are the sum of actual cash disbursements, the amount of indirect expense incurred, the value of in-kind contributions applied, and the net increase (or decrease) in the amounts owed by the recipient for goods and other property received and for services performed by employees, contractors, subgrantees, and other payees.
10c	Enter the amount of all program income realized in this period that is required by the terms and conditions of the Federal award to be deducted from total project costs. For reports prepared on a cash basis, enter the amount of cash income received during the reporting period. For reports prepared on an accrual basis, enter the amount of income earned since the beginning of the reporting period. When the terms or conditions allow program income to be added to the total award, explain in remarks, the source, amount and disposition of the income.
10f	Enter amount pertaining to the non-Federal share of program outlays included in the amount on line e.
10h	Enter total amount of unliquidated obligations for this project or program, including unliquidated obligations to subgrantees and contractors. Unliquidated obligations are: Cash basis—obligations incurred but not paid; Accrued expenditure basis—obligations incurred but for which an outlay has not been recorded. Do not include any amounts that have been included on lines a through g. On the final report, line h should have a zero balance.
10j	Enter the Federal share of unliquidated obligations shown on line h. The amount shown on this line should be the difference between the amounts on lines h and i.
10k	Enter the sum of the amounts shown on lines g and j. If the report is final the report should not contain any unliquidated obligations.
10m	Enter the unliquidated balance of Federal funds. This amount should be the difference between lines k and l.
11b	Enter rate in effect during the reporting period.
11c	Enter amount of the base to which the rate was applied.
11d	Enter total amount of indirect cost charged during the report period.
11e	Enter amount of the Federal share charged during the report period. If more than one rate was applied during the project period, attach a schedule showing the base against which the indirect cost rates were applied, the respective indirect rates the month, day, and year the indirect rates were in effect, amounts of indirect expense charged to the project, and the Federal share of indirect expense charged to the project to date.

CLEAN AIR NOW/XEROX SOLAR HYDROGEN PROJECT
CONTACT LIST 2/15/95

NAME	COMPANY	TITLE	ADDRESS	CITY, STATE	ZIP	PHONE & FAX
ROBERT ZWEIG, MD.	CLEAN AIR NOW	CHAIRMAN & PROGRAM DIR.	2936 MCALLISTER ST.	RIVERSIDE, CA	92503	909-688-5474 909-687-9001 FAX
PAUL STAPLES	CLEAN AIR NOW	EXECUTIVE DIRECTOR.	1222 LINCOLN BLVD.	SANTA MONICA, CA	90401	310-394-1214 310-917-4426 FAX
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BOB WITTKOWER	XEROX CORP.	MANAGER ENVIRONMENTAL, HEALTH, AND SAFETY	ESM1-003, 701 S. AVIATION BLVD.	EL SEGUNDO, CA	90245	310 333-5617 310-333-6996 FAX
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CHRISTIAN LENCI	PRAXAIR INC.	PROJECT. COORD./SALES	2300 E. P.C.H.	WILMINGTON, CA	90744	310-983-2145 310-983-2102 FAX
MICHAEL HAINSSELIN, CFA	PRAXAIR INC.	APPLICATIONS. MANAGER/PROJ. DIRECTOR	777 OLD SAWMILL RIVER RD.	TARRY-TOWN, NY	10591 -6714	914-789-2748 914-789-2026 FAX
TOM HALVORSON	PRAXAIR INC.	PROJECT MAN./TECHNICAL	175 E. PARK DR.	TONAWANDA, NY	14151 -0044	716-879-2334 716-879-7030 FAX
NEIL KAMINAR	SOLAR ENGINEERING APPLICATIONS CORP.	VP. ENGINEERING	3500 THOMAS RD. SUITE #E	SANTA CLARA, CA	95054	408-986-9231 408-986-9233 FAX
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RICHARD D. ROVANG	ENERGY TECHNOLOGY ENGINEERING CENTER (ETEC)	TECHNICAL STAFF/ROCKWELL PROGRAM MANAGER	ROCKETDYNE DIVISION, 6633 CANOGA AVE., P.O. BOX 7922, MAIL CODE: T038	CANOGA PARK, CA	91309 -7922	818-586-5163 818-586-5118 FAX
STEVEN MOORE	MUTUAL PROPANE	PRESIDENT	17117 BROADWAY	GARDENA, CA	90248 -3191	310-515-0553 310-515-2633 FAX
RICHARD CAPUA	MATRIX CONSTRUCTION & ENGINEERING	PRINCIPAL/INSTALL ENGINEER	475 PRODUCTION STREET	SAN MARCOS, CA	92069	619-744-4600 619-744-4607 FAX
JAMES HEFFEL & KENT JOHNSON	UC RIVERSIDE	DEVELOPMENT ENGINEERS	1200 COLUMBIA AVE.	RIVERSIDE, CA	92507	909-781-5783/6 909-781-5790 FAX