# LENR Investigations by Scott Little and Marissa Little at EarthTech International
# Austin, TX

## *A Project of the LENR Research Documentation Initiative*

## Third Draft Report

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## Contents

## 1. Introduction

Cold fusion (CF) was announced on March 23, 1989, by Dr. Martin Fleischman and Dr. Stanley Pons. The immense potential energy benefits of CF (also referred to as Low Energy Nuclear Reactions, LENR) were immediately recognized. Humankind's need for a source of cheap, clean, inexhaustible, and safe energy seemed to be permanently satisfied. However, LENR was rejected by mainstream science within a year or so, and it remains highly marginalized to this day. On the other hand, the phenomenon has continued to be rigorously pursued by many investigators in several countries. The mounting evidence for the reality of LENR shows that its potential benefits may yet be realized.

Because it is a "pariah" science, LENR has attracted relatively few new investigators to the field. Many of the researchers became active in the early months and years after the 1989 announcement. Now 30 years later many of these investigators are leaving the field. The results of their many years of LENR investigation are at risk of being lost, which would be extremely unfortunate not only for the field, but also potentially for humanity.

An initiative is underway to mitigate the risk of loss of research records of LENR investigators. Its objectives are to collect, organize, document, and archive these records. It is being performed by LENRGY, LLC[1], whose President is Dr. Thomas Grimshaw. The LENR Research Documentation Initiative (LRDI) assists researchers in making sure that their efforts are preserved and kept available for additional analysis and interpretation. The LRDI is described in a recent article in Infinite Energy[2] as well as on a dedicated website[3].

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[1] LENRGY: LENR Energy – Pursuing the Benefits of Cold Fusion Realization. www.lenrgyllc.com.

[2] Grimshaw, T., 2020. Documenting Cold Fusion Research: Preserving a Vital Asset for Humankind. Infinite Energy, Issue 150, March/April 2020, p. 9-13.

[3] LENR Research Documentation Initiative: Collection, Organization, Description, Archiving of LENR Research Records. www.lenr-documentation.org.

A project has been initiated under the umbrella of the LRDI to document the LENR research of Scott Little, mostly while at EarthTech International (EarthTech)[4,5]. The objective of the Little LENR Research Documentation Project (LLRDP) is to collect and record as much of his research record as possible. Memos have been prepared as progress was made in collecting the records.

Mr. Little (Figure 1-1[6]) began his LENR experiments soon after the 1989 announcement using the electrolytic cell method of Fleischmann and Pons. These experiments were conducted during non-working hours in his home garage with the assistance of colleagues at Asoma, a firm in Austin where he was general manager.

*Figure 1-1.*
*Scott Little at His Home near Dale, Texas*
*Photo Taken January 2020*

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[4] Documentation of Cold Fusion Research at EarthTech. Email to Hal Puthoff and Scott Little from Tom Grimshaw November 11, 2019.

[5] Email Response from Scott Little to Tom Grimshaw, November 11, 2019.

[6] Proposed Photo for the EarthTech LENR Research Documentation Project, Memo to Scott Little from Tom Grimshaw, February 8, 2020.

He presented a poster at the DOE Santa Fe conference in May 1989[7], where he met Ed Storms and Bob Huggins. Based on discussions with Dr. Huggins, Mr. Little attempted to achieve LENR using Huggins' cell design. These early LENR experiments were not successful.

Mr. Little did not continue pursuit of LENR for several years until he joined EarthTech in 1993. His main emphasis there was initially on finding a way to develop a successful resource from zero point energy (ZPE). This ZPE research was in line with EarthTech's mission to develop useful energy from novel sources, which was also the basis for its LENR investigations.

Mr. Little received a degree in Engineer Physics at The University of Texas at Austin and has nearly 50 years of experience, with particular expertise in lab apparatus and experiment setup, precision calorimetry, and X-ray fluorescence. More information on Mr. Little is in Section 3.2.

One of the first EarthTech LENR verification attempts under Mr. Little's direction took place in 1997. It was for the Mills electrolysis method using nickel, potassium carbonate and water. The verification was not successful. He then gave a presentation and demonstration of water-flow calorimetry with Dr. Fran Tanzella at ICCF-7 in Vancouver in 1998. His participation in this conference was followed by experiments with some of the foremost LENR researchers at the time.

Scott's daughter, Marissa Little, joined EarthTech fulltime in 2005. Previously in about 1998 or 1999, she had worked parttime, primarily in fabricating parts for EarthTech's large calorimeter (called MOAC, described below). After receiving a BS degree in Mechanical Engineering, she returned to EarthTech in 2005, where she participated in many of the LENR experiments until she left the organization in 2018.

Although EarthTech did not verify experiments and claims of LENR researchers, the organization and Mr. Little made major contributions to the field by demonstrating how difficult the phenomenon is to achieve and how much care and precision is needed in the experiments to avoid false indications of the presence of LENR.

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[7] Reference

# 2. EarthTech Overview

EarthTech is well described on the organization's website[8]. The Institute for Advanced Studies, a research division of Earth Tech, was founded by Harold Puthoff, PhD, in 1985. In 1991 it was incorporated under EarthTech as an innovative research facility to explore the forefront reaches of science and engineering. EarthTech and it's Institute for Advanced Studies are characterized as a "privately-funded research organization exploring novel ideas in basic and applied flight physics and engineering". Dr. Puthoff's photo from the website appears in Figure 2-1. A brief biography is in Section 3.2. The current location of EarthTech in Austin, Texas is shown in Figure 2-2.

## 2.1. Research Focus

Earth Tech's mission is "shaping the future by innovating breakthroughs that inspire new modes of space transportation and new sources of the energy". Its vision is "striving to be an innovative leader in breakthrough energy and propulsion physics to advance the frontier of space exploration". The organization's research interests reflect its focus on developing innovative space propulsion and sources of energy:

- Theories of space-time, gravity and cosmology
- Studies of the quantum vacuum
- Modifications of standard theories of electrodynamics
- Interstellar flight science
- Search for extraterrestrial intelligence

Earth Tech's research is conducted in for topical areas:

- Fundamental Physics
- Interstellar Studies
- Experiments
- Life Sciences

[8] EarthTech Information and Cold Fusion Reports on EarthTech Website. Memo to Scott Little from Tom Grimshaw, November 15, 2019.

*Figure 2-1*
*Dr. Hal Puthoff*[9]

*Figure 2.2*
*EarthTech Building at 11,855 Research Blvd., Austin, Texas*[10]

[9] Source: EarthTech Website, https://earthtech.org/pubs/.
[10] Source: EarthTech Website, https://earthtech.org/contact/.

## 2.2. Services

EarthTech and its Institute of Advanced Studies provide services such as inhouse laboratory experimentation, consulting for public and private clients, and collaborating with other scientists and institutions. The services are described on its website in four areas as shown below.

Consulting

With several decades of high-level professional engagement and multi-faceted scientific expertise, the Institute for Advanced Studies at Austin is recognized as a premier organization at the leading edge of Physics Theory, Experimentation, and Emergent Life Sciences. Our team pushes the boundaries of science for our Institute, our clients, and among collaborating institutions or with independent colleagues.

Experimental

The Institute for Advanced Studies at Austin offers our clients the opportunity to collaborate with forefront experimentalists who implement state-of-the-art equipment and technique. From conception to completion, our team prides itself on precision in all applicable experimental disciplines. Services include but are not limited to:

1. Engineering and management of technical projects
2. Mechanical Design
3. Fabrication
4. Precision machining
5. Constructing laboratory apparatus
6. Precision calorimetry
7. X-ray Fluorescence Analysis
8. Computer drafting and controls
9. Custom simulation programs
10. Data Analysis

Please note, when a project requires faculties or exotic materials or measurements outside of our scope of expertise, we are able to tap our extensive network to address our client's needs. This is a priority at the beginning of any project. The only surprises we expect are breakthroughs.

Institutional Collaborations

Our Mission: Shaping the future by innovating breakthroughs that inspire new modes of space transportation and new sources of energy.

True to our mission, EarthTech International Inc. and the Institute for Advanced Studies at Austin actively engage in numerous collaborations with industry, the US government, scientific research foundations, and academia. We also collaborate with non-profit scientific research institutes such as the Tau Zero Foundation, the Fetzer Institute, and Icarus Interstellar, Inc.

Maverick Inventors Program

EarthTech International Inc. offers a unique opportunity tailored towards inventors and forward-thinkers alike: The Maverick Inventor Program. We invite inventors to contact us with new ideas that might be of interest to our institute. No idea is too small, no conceptual framework is too large. This program is based on the premise that a great breakthrough in the energy and propulsion field might not come from a well-funded Tier-1 organization, but rather, from a Maverick Inventor who stumbles on a heretofore, undiscovered novel approach.

- As a respected, established, and published research lab, EarthTech Int'l brings numerous and significant assets to the table. If a technology or idea looks promising and we are able –in our labs and under our strict laboratory conditions, to verify or validate its principles or use, EarthTech Int'l would consider assisting in the development under a mutually-beneficial prototype-to-market program.
- Device concepts examined to date in the Maverick Inventor Program range from new approaches to fuel cells, through novel approaches in the cold fusion arena, to claims for highly-efficient space drives.

For each of the service areas, directions are provided to interested parties, such as a statement of interest, desired deliverables and timeline and projected budget. The directions vary somewhat among the four areas.

## 3. LENR Research at EarthTech

Scott Little was the leading LENR researcher at EarthTech. He had responsibility for most of the conceptualization, design, conduct, and analysis of results of experiments. Although he is no longer affiliated with EarthTech, and little or no LENR research is known to be continuing at the organization, the research record of the previous work is extensive. As noted, on the website[11,12], the LENR endeavors were conducted within the third area of EarthTech services, "Experiments". They are described as follows:

> We have explored excess energy claims from various sources throughout our years of research. In our present age of science and technology almost everybody accepts the laws of thermodynamics. The majority of "excess energy" claims are therefore based upon the idea of tapping a new source of energy. It is these claims that deserve our attention and are the primary focus of our investigations.
>
> One particularly active branch of "excess energy" research is Cold Fusion. Cold fusion refers to a proposed nuclear fusion process of unknown mechanism offered to explain a group of disputed experimental results first reported by electrochemists Martin Fleischmann and Stanley Pons. It is sometimes termed "Low Energy Nuclear Reaction" (LENR) or Chemically Assisted Nuclear Reaction (CANR).
>
> In order to study these claims, we have spent considerable time and effort in the art and science of calorimetry – the measurement of the quantity of heat exchanged.

The EarthTech LENR research is described on its website starting with an overview, a calorimetry introduction, and researcher biographies. They are described below. Collaborations and verification attempts with other LENR researchers were central to the EarthTech program. The researchers and resulting reports are covered in Section 4.

### 3.1. Cold Fusion Overview

Background information and the overall LENR research approach at EarthTech is well described on its website [memo or website link] as shown below.

> In March of 1989 Martin Fleischmann and Stanley Pons of the University of Utah announced that they had succeeded in making D-D fusion occur in an electrochemical cell near room temperature. Compared to the ordinary conditions required for this reaction, this claim was aptly named "cold fusion". The announcement of

[11] EarthTech Information and Cold Fusion Reports on EarthTech Website. Memo to Scott Little from Tom Grimshaw, November 15, 2019.

[12] EarthTech Information and Cold Fusion Reports on EarthTech Website (Addendum). Memo to Scott Little from Tom Grimshaw, November 18, 2019.

cold fusion generated intense interest as it promised to solve most if not all of our energy problems here on Earth. The fuel is plentiful and the waste products are relatively benign. However, widespread failure to replicate the experiment soon resulted in rejection of cold fusion by the mainstream scientific community.

Despite this rejection a number of scientists continue to investigate cold fusion. Hundreds of papers reporting positive results have been published and international conferences are held every couple of years. However, to this day, there exists no cold fusion demonstration experiment. That is because cold fusion phenomena are extremely difficult to reproduce. This situation greatly hampers cold fusion research because it makes the usual empirical investigation almost impossible.

The primary signature of cold fusion is excess heat, which means that the electrochemical cell produces more heat power than the electrical power used to stimulate it. Thus calorimetry is often involved in testing cold fusion experiments. In our laboratory we have expended a great deal of effort on the development of calorimeters suitable for cold fusion experiments. Over the years we have had the opportunity to test a relatively small number of cold fusion cells, some that we constructed ourselves and some that were brought to our laboratory by other investigators who had seen positive signs of excess heat in their own labs. ***None of these cold fusion experiments have shown any convincing evidence of excess heat in our calorimeters.*** We cannot say that we have never seen any signs of excess heat in our laboratory because all calorimeters drift somewhat and, inevitably, that drift sometimes goes in a positive direction and looks just like a low level of genuine excess heat. When that occurs we strive to check the calorimeter's calibration as quickly and thoroughly as possible. Usually the drift in calibration is evident and its magnitude matches, and thus explains, the apparent excess heat signal. In a few cases the calibration check did not explain the apparent excess heat signal. But when we returned the cell to the calorimeter after the calibration check, the excess heat signal did not reappear. This tantalizing behavior either means that the cell did produce low levels of excess heat for a while or the calorimeter was simply drifting up and down in unfortunate synchrony with our observations.

In our laboratory, we are not novices at making measurements. We have about 70 years combined experience designing, building, and operating various measuring systems, gauges, and analytical instruments. In addition we have constructed at least a dozen calorimeter systems over the past 15 years in our quest to identify new energy sources. From this broad perspective it seems safe to say that calorimetry excels at providing a fertile medium for the spawning and nurturing of subtle systematic errors. Furthermore we have found it nearly impossible to anticipate the causes of these errors. Their elucidation usually occurs only after you have constructed the instrument, tested it extensively, and struggled for days to comprehend its misbehavior.

The culmination of our efforts to build an accurate and reliable calorimeter for cold fusion experimentation is an instrument we call MOAC (Mother of All Calorimeters). MOAC was designed to achieve +/- 0.1% relative accuracy. At the typical input power level of 10 watts, that is equivalent to +/- 0.01 watts. On a good day, when freshly calibrated, this accuracy is actually achieved. A month after calibration, the system typically drifts by up to 0.03 watts. Despite this small problem, we feel that MOAC is one of the best calorimeters now available for cold fusion research. We are committed to maintaining MOAC in top working condition on a continuous basis. In the interest of scientific progress, we have made a standing offer for free testing of promising cold fusion cells in MOAC.

The primary signature of LENR used By Earth Tech was "excess heat", the indicator that was used by Drs. Fleischmann and Pons. It is particularly noteworthy that "None of these cold fusion experiments have shown any convincing evidence of excess heat in our calorimeters".

### 3.2. LENR Researchers

Brief biographies of Mr. little and the other main LENR researchers at EarthTech – Marissa Little and Hal Puthoff – are found on the website and are shown below[13].

> Scott Little
>
> Mr. Little has over forty-five years of experience in experimental physics, engineering and management of technical projects. He has mastered a variety of fabrication techniques and has extensive experience constructing and using laboratory apparatus. He has particular expertise in power-balance measurements including precision calorimetry, and in x-ray fluorescence analysis. In the course of this work he has acquired proficiency in the use of computers to control and monitor laboratory experiments. He also has considerable skill with computer-aided design, including writing custom simulation programs.
>
> Mr. Little has a degree in Engineering-Physics from The University of Texas at Austin. Before joining Earthtech in 1993, he was General Manager of ASOMA Instruments, starting the company from scratch and developing a product line that includes portable XRF analyzers for product control and on-line XRF systems for process control, an endeavor that provided endless engineering challenges and an enduring understanding of systematic errors that has proven invaluable in his experimental physics. Following that he was Analytical Product Development Manager at TN Technologies working on a similar line of instrumentation. Following that he was one of the founding engineers at Active Power, designing a flywheel energy storage system.
>
> Marissa Little
>
> Ms. Little has over a decade of experience in experimental physics and various engineering disciplines. She has the ability to take an experimental project from concept to completion, performing every step along the way. This includes experimental design and construction, where she is skilled in mechanical design, computer drafting, and machining. Many of the experiments she has completed have included sophisticated computer controls and data analysis. Her reports of several experiments have been published in peer reviewed journals.
>
> Ms. Little earned a degree in Mechanical Engineering from The University of Texas at Austin. She worked as a Material Scientist for Lockheed Martin during the Return to Flight effort following the Columbia accident. She has also worked in the semiconductor industry reverse engineering replacement parts for ion implanters, in redesign efforts for various x-ray analyzer systems, and volunteers her time in the science lab of a local elementary school.
>
> Harold E. Puthoff, PhD
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> Harold (Hal) Puthoff, PhD, is President, CEO and Chairman of the Board of EarthTech International, Inc., and Director of the Institute for Advanced Studies at Austin. Earning his PhD from Stanford University in 1967 as a theoretical and experimental physicist specializing in lasers, his present research activities range from theoretical studies concerning fundamental electrodynamics, gravitation, and the quantum vacuum to laboratory studies of innovative approaches to energy generation and space propulsion.
>
> With a professional background spanning decades of research at General Electric, Sperry, the National Security Agency, Stanford University and SRI International, Dr. Puthoff has a publication stream in Tier-1 physics journals on electron-beam devices, lasers, quantum vacuum energy physics, general relativity models and space propulsion, is co-author of a graduate-level textbook Fundamentals of Quantum Electronics published in English, French, Russian and Chinese, and has patents issued in the laser, communications and energy fields. Dr. Puthoff regularly serves various foundations, corporations, NASA, and the DoD and intelligence communities as advisor on leading-edge technologies and future technology trends, and his awards and honors include a DoD Certificate of Commendation from NSA for his work on high-speed opto-electronic computers.

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[13] Biographies for the EarthTech LENR Research Documentation Project. Memo to Scott Little from Tom Grimshaw, February 10, 2020.

Dr. Puthoff is a member of several professional organizations, including AFIO (Assoc. of Former Intelligence Officers), is listed in such biographical reference works as Who's Who in the World, and has been designated a Fetzer Fellow (1991) and a Fellow of the British Interplanetary Society (2012).

### *3.3. Calorimetry*

As noted in the preceding section, EarthTech faced challenges in measuring excess heat as the main signature of LENR. To meet these challenges, and to make a major contribution to the LENR field, the organization designed and built a sophisticated calorimeter (Mother of All Calorimeters, MOAC) in its laboratory[14]. The overview shown below is from the website. A detailed description is also included and is provided in Appendix A. In addition, a paper about MOAC was published in the Proceedings of the 14th International Conference on Condensed Matter Nuclear Physics[15].

> Calorimetry is conceptually simple but considerable effort is required to reduce systematic errors to acceptable levels. Since 1989, we have designed and constructed a dozen calorimeter systems for cold fusion research. Each of these systems provided valuable experience in error detection and correction. The culmination of our efforts, an instrument with a design accuracy of 0.1% relative, is nicknamed MOAC (Mother Of All Calorimeters) (Figure 3-1).

*Figure 3-1*
*MOAC, "Mother of All Calorimeters"*

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[14] EarthTech Information on Calorimetry and "MOAC", Memo to Scott Little from Tom Grimshaw, November 19, 2019.

[15] Little, S., G. Luce, and M. Little, 2008. MOAC - A High Accuracy Calorimeter for Cold Fusion Studies. in ICCF-14 International Conference on Condensed Matter Nuclear Science. Washington, DC.

MOAC operates on a simple and fundamental principle. Flowing water is used to extract the heat from the cell. The flow rate is measured and the temperature rise of the water is measured. The product of the temperature rise, the flow rate, and the specific heat of water yields the heat power being extracted from the cell. Despite its simple concept, MOAC is not a simple instrument. Two independent computer-based data acquisition systems monitor a total of 45 parameters, including 22 temperatures. Fourteen analog outputs, driven by proportional-derivative feedback algorithms, control various critical parameters. The cell and heat exchanger are located in a chamber whose walls are made almost perfectly insulating by a system that heats the outer surface of each of the six wall panels so that its temperature matches that of the corresponding inner surface. This active insulation ensures that virtually all of the heat dissipated by the cell leaves the chamber via the flowing water. A cascade of three independent Peltier regulators controls the temperature of the water entering the heat exchanger to +/- 0.0003°C. A positive-displacement pump driven by a synchronous motor powered by a crystal-based oscillator produces an exceedingly stable flow of about 2.5 gm/s. A flowmeter consisting of an automated batch weighing system measures the flow rate periodically and typically reports a standard deviation of only +/-0.0002 gm/s (i.e. 0.01% relative). A large well-insulated enclosure houses the entire system. Air circulates over the calorimetry apparatus and then is ducted to a Peltier air-conditioner where its temperature is regulated to +/- 0.001°C before it re-enters the enclosure.

MOAC was designed to achieve +/- 0.1% relative accuracy. At the typical input power level of 10 watts, that is equivalent to +/- 0.01 watts. On a good day, when freshly calibrated, this accuracy is actually achieved. A month after calibration, the system typically drifts by up to 0.03 watts. We believe this drift originates primarily in the thermistors used to measure inlet and outlet water temperatures. Despite this small problem, we feel that MOAC is one of the best calorimeters now available for cold fusion research. The space available for the cell is relatively large (about 10 cm x 25 cm x 25 cm). The cell sits in a stirred air environment where it is not thermally clamped to a specific temperature. MOAC exhibits excellent specimen versatility by producing precisely the same reading regardless of the size, shape, or location of the heat source. We are committed to maintaining MOAC in top working condition on a continuous basis. In the interest of scientific progress, we have made a standing offer for free testing of promising cold fusion cells in MOAC.

The links on the left hand side contain all of the information published in a paper entitled “MOAC – A High Accuracy Calorimeter for Cold Fusion Studies,” an abridged version of which was published in the Proceedings of the 14th International Conference on Condensed Matter Nuclear Physics. To read the full version in PDF format, download it here.

## 4. Collaborations and Verifications

A primary way that Scott Little and EarthTech contributed to the LENR field was by working with other researchers, particularly in seeking to verify observations and claims[16,17]. Reports for eight of these collaborations and verifications have been obtained from the EarthTech website:

| | |
|---|---|
| SPAWAR | RIFEX |
| PACA | Hydrogen Purifier |
| Dash-Zhang | Mizuno |
| Case | Mills |

Table 4-1 summarizes basic information in these reports, including the approximate dates, investigators and affiliations, and LENR methods and signatures. Additional information on the eight reports is provided in the subsections below. EarthTech also worked with a number of other LENR researchers, the results of which are not included on the website. These individuals and organizations are also noted below.

### 4.1. SPAWAR

The US Navy's Space and Naval Warfare Systems Command (SPAWAR) has conducted LENR experiments going back to the early days of the field. Individuals identified with this work include Stan Szpak, Pam Mosier-Boss, Frank Gordon, and Larry Forsley. The SPAWAR group has published observations of nuclear radiation from LENR using CR-39 as the detector.

In November 2010 Stephen Krivit of the New Energy Times launched the Galileo Project to confirm the SPAWAR CR-39 findings[18]. EarthTech was one of a number of labs and organizations that participated in the Galileo Project. The report of their investigations contains several sections, which are listed below.

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[16] EarthTech Information and Cold Fusion Reports on EarthTech Website. Memo to Scott Little from Tom Grimshaw, November 15, 2019.

[17] EarthTech Information and Cold Fusion Reports on EarthTech Website (Addendum). Memo to Scott Little from Tom Grimshaw, November 18, 2019.

[18] The Galileo Project. http://newenergytimes.com/v2/news/2006/NET19.shtml#tgp.

*Table 4-1*
*Summary of LENR Collaboration Results*

| No | ET Reference | Approx. Date(s) | Investigator | Affiliation | LENR Method | Signature | Verified? | Notes |
|---|---|---|---|---|---|---|---|---|
| 1 | SPAWAR | Dec 2006 | Stan Szpak<br>Pam Boss | SPAWAR | Electrolytic cell | Nuclear radiation (CR-39) | No | Galileo Project |
| 2 | PACA | May 2007 | Richard Oriani | University of Minnesota | Electrolytic cell | Nuclear radiation (CR-39) | No | O-ring contamination |
| 3 | Dash-Zhang | Fall 2006 | John Dash<br>Wu Shon Zhang | Portland State University, OR | Electrolytic cell | Excess heat | No | MOAC used<br>Heat of wetting |
| 4 | Case | May 1998 | Les Case | Fusion Power, Inc. Newfields, NH | Catalytic fusion w/ treated charcoal & D2 gas | Excess heat | No | MOAC was used |
| 5 | RIFEX | Jun 1997 | James Patterson<br>George Miley<br>Dennis Cravens | Clean Energy Technologies, Inc. (CETI), Dallas, TX<br>University of Illinois | Electrolytic cell with coated beads | Transmutation<br>Excess heat | No | Neither signature was verified. |
| 6 | Hydrogen Purifier | Dec 1997 | N/A | N/A | Gas loading w/ protium | Excess heat | No | Future work w/ D2 gas |
| 7 | Mizuno | Sep 1998 | Tadahiko Mizuno | Hokkaido University, Sapporo, Japan | Electrolytic cell w/ incandescent tungsten cathode | Excess heat | No | Verifications by<br>J Naudin<br>J Fauvarque |
| 8 | Mills | Sep 1997 | Randell Mills | BlackLight (now Brilliant Light) Power<br>Cranbury, NJ | Electrolysis w/ Ni, K2CO3 & H20 | Excess heat | No | Hydrino concept; very controversial |

- “Extraordinary Evidence” Replication Effort
- TGP Protocol
- Initial Replication
- Magnetic Effect
- Accelerating the Protocol
- Varying the Chemistry
- Plating Metal Changes
- Isolating the CR-39 from the Electrolyte
- Other Observations
- Other Resources

Excerpts from the introduction and conclusions of the report are as follows:

> "Extraordinary Evidence” Replication Effort
>
> In an article entitled “Extraordinary Evidence (http://lenrcanr. org/acrobat/KrivitSextraordin.pdf)” published in Issue #19 of New Energy Times, Pam Boss and Stan Szpak of the US Navy’s SPAWAR lab in San Diego CA report the observation of copious pitting of CR-39 nuclear track detectors placed in close proximity to the cathode of their cold fusion cells. They claim that this pitting is evidence of nuclear activity in the cell. In December 2006, we joined The Galileo Project (TGP), a private collaboration among several labs organized by Steve Krivit, the editor of New Energy Times, to promote replication of the SPAWAR results. Our secret identity in this group was “Beta 2”.
>
> We began our experimentation without the benefit of the official TGP protocol, using instead a similar protocol published by Boss and Szpak in “The Effects of External Fields on Surface Morphology of Codeposited Pd/D Films (http://lenrcanr. org/acrobat/SzpakStheeffecto.pdf)”. Our first experiments were highly successful. Our CR-39 “chips” were heavily pitted in the immediate vicinity of the cathode. This report details our efforts to determine the origin of these “SPAWAR pits”.
>
> Conclusions
>
> Our results do not provide a positive identification of the origin of SPAWAR pits. However, they do show that chemical origin is a distinct possibility and therefore that nuclear origin is not a certainty. The accelerated etching rate observed for CR-39 that has soaked in TGP electrolyte for several weeks proves that there is a chemical interaction. “The observation that SPAWAR pits are visible before etching shows that they are unlike the tracks made by ionizing particles. The observation that SPAWAR pits are stopped by a 6 micron Mylar film is consistent with a chemical origin but only proves that they cannot be due to nuclear particles which would penetrate such a barrier (e.g. alpha particles of energy >1 MeV). The rest of our observations, such as the invariance of the result when the electrolyte is changed from heavy water to light water, are less conclusive but are still consistent with chemical origin of SPAWAR pits.
>
> It has been suggested that SPAWAR pits are a mixture of chemical and nuclear pits. This is a difficult hypothesis to evaluate. Frankly, the idea of trying to identify pits which “look nuclear” is not very appealing from an objectivity standpoint.

EarthTech did not verify the SPAWAR CR-39 observations. “Our results do not provide a positive identification of the origin of SPAWAR pits.” “However, they do show that chemical origin is a distinct possibility and therefore that nuclear origin is not a certainty..”

## 4.2. PACA

Dr. Richard Oriani was one of the first scientists who claimed to verify the Fleischmann and Pons findings[19]. He was a professor at the University of Minnesota, where he conducted his experiments. He utilized the electrolytic cell method and radiation, detected with CR-39, as the signature. He referred to his method as the PACA Protocol – Protection Against Chemical Attack ("PACA")[20].

EarthTech conducted experiments to replicate Oriani's findings in 2007. Two reports were prepared and are posted on the website. The contents of the reports, "PACA" and "PACA Followup", are as follows:

| PACA | PACA Followup |
|---|---|
| Introduction | Introduction |
| Initial Replication | Verifying the Activity of the O-ring |
| Further Investigation | Alpha Spectroscopy |
| Contamination Hypothesis | Tracks in the Middle of the CR-39 |
| Determining the Radioisotope | Summary |
| Clusters | |
| Summary | |

Relevant excerpts from the reports are shown below.

> Introduction
>
> In May of 2007, we began a replication attempt of a phenomenon reported by Richard Oriani – the creation of tracks in CR-39, a nuclear track detector, placed within an electrolysis experiment. Oriani further claims these tracks to be direct evidence of nuclear reactions occurring in the cell. Our goals were to replicate the creation of tracks and to determine their origin.
>
> Initial Replication
>
> We constructed a cell very similar to the one Oriani employs and purchased materials from the same manufacturer when possible. It was reported to us by Oriani that the best way to replicate his experiment would be to use a 'seed' from his own experiments. Therefore, he sent us a number of 'used' o-rings to employ in our work
>
> Summary
>
> While we do not yet have direct evidence that the tracks seen in these experiments are due to contamination, it is still a viable hypothesis. Mundane causes must be ruled out before declaring that the results are a departure from currently understood science. There is not enough evidence to suggest that there are nuclear reactions occurring in the cell at this time. However, we are continuing to investigate this phenomenon and hope to provide more convincing evidence for either hypothesis in the future.

[19] Frazier, C., 2015. Fusion Pioneer Richard Oriani, 1920-2015. Infinite Energy, Issue 123, September/October.
[20] Macy, M., 2015. Richard Oriani's PACA Protocol. Infinite Energy, Issue 123, September/October.

Introduction (PACA Followup)

In May of 2007, we began a replication attempt of a phenomenon reported by Richard Oriani – the creation of tracks in CR-39, a nuclear track detector, placed within an electrolysis experiment. Oriani further claims these tracks to be direct evidence of nuclear reactions occurring in the cell. Our goals were to replicate the creation of tracks and to determine their origin. We succeeded in replicating Oriani's observations only when using o-rings from his lab. The recognition of the vital importance of the o-rings and the fact that they remained active after electrolysis led us to consider the possibility that the o-rings were contaminated with radioactive material. In October of 2007, we received additional o-rings from Richard Oriani, one of which was an order of magnitude more active than previous o-rings. Oriani also sent us a piece of CR-39 that had been exposed to this o-ring and subsequently etched. The CR-39 contained numerous tracks in a pattern coincident with the o-ring.

Summary (PACA Followup)

The results of the testing conducted are consistent with the o-ring being contaminated with thorium and its progeny. The alpha spectrum identifies all alpha emitting decay products of Th-228. Contamination from this isotope and its progeny also explain a previously mysterious phenomenon – the appearance of tracks in the middle of the CR- 39. In view of this evidence, the contamination hypothesis seems more likely than the hypothesis that the tracks are a result of low-energy nuclear reactions occurring during electrolysis.

Verification of Dr. Oriani's LENR observations was not achieved by EarthTech. "There is not enough evidence to suggest that there are nuclear reactions occurring in the cell at this time." "In view of this evidence, the contamination hypothesis seems more likely than the hypothesis that the tracks are a result of low-energy nuclear reactions occurring during electrolysis."

### 4.3. Dash-Zhang

Dr. John Dash was one of the earliest LENR researchers, having started experiments in April 1989[21]. He did his research as professor (and professor emeritus) at Portland State University. Wu-Shon Zhang visited Dr. Dash at the university from China for a considerable period of time.

Dash and Zhang visited EarthTech in 2007 in hopes of confirming their observations of excess heat in an electrochemical cell. The replication attempts were made in EarthTech's MOAC setup. The "Dash-Zhang" report had the following sections.

Introduction
Experimental Efforts
- I – EarthTech Cell and Unsealed DZ Cell
- II – Modified EarthTech Cell
- III – Modified EarthTech Cell with Titanium Sulfate
- IV – Sealed DZ Cell

[21] Frazier, C., 2016. John Dash: 1933-2016. Infinite Energy, Vol. 22, Issue #22.

V – Computer Simulation
VI – Heat of Wetting
Conclusions
Follow Up
Final Results

Shown below are excerpts from EarthTech's website.

Introduction

In the Fall of 2006, Drs. John Dash and Wu-Shou Zhang came to our lab to assist in a replication effort of their CMNS experiment. During the previous year, they published a paper entitled Seebeck Envelope Calorimetry With A Pd/D2O+H2SO4 Electrolytic Cell in which they report excess power of nearly 10% in several experiments (see Table 1). This performance was reported to be reproducible as well.

Dash and Zhang brought their cell (the 'DZ cell') to EarthTech to be tested in our high-accuracy calorimeter (MOAC). We tested the DZ cell in the same configuration they use in their laboratory as well as in various modified configurations. We did observe some apparent excess heat in our testing but not as large as previously reported by Dash and Zhang. However, after much investigation, the evidence points only to mundane causes for the excess heat signals observed in our lab.

Conclusion

We did see an apparent excess heat signal from the Dash-Zhang cell when operated with their protocol. It took the form of a broad pulse that started just as the cell was reaching equilibrium temperature and always died away to nothing after about 8 hours of operation. The maximum apparent excess heat power for a closed cell (DZ8) reached 0.2 W while the total input power was about 15 W. We found two separate mundane causes for this heat pulse.

1. The release of heat energy stored in the cell during the high-power period at the beginning of the run. This effect is made larger by the use of insulation around the cell such as the cardboard box recommended by Dash and Zhang.

2. The heat of wetting released when ~100 g of recombiner pellets is wetted by water vapor rising from the nearly-boiling electrolyte.

We also conducted a number of experiments using electrodes supplied by Dash and Zhang mounted in standard ET cells. None of these runs showed any signs of excess heat above MOAC's detection limit, which is approximately 30 mW.

Follow up

After presenting our results to Dash, he pointed out that the mass lost by the cell during a run represented output energy that we were not including in our analysis. Dash thinks the lost mass is most likely to be D2 and O2 gas.

Final Results

...even the most optimistic result on DZ7 (+3457 joules) does not meet the usual qualification for a detected positive result because it is less than 3 times the uncertainty. Furthermore, it is only 0.28% of the total input energy.

The Dash-Zhang observations were not confirmed by EarthTech. "…after much investigation, the evidence points only to mundane causes for the excess heat signals observed in our lab." "None of these runs showed any signs of excess heat above MOAC's detection limit, which is approximately 30 mW."

### 4.4. Case

Dr. Les Case demonstrated an apparatus at ICCF-7 in 1998 that he referred to as a "Catalytic Fusion" setup[22]. He provided a brief paper in the conference proceedings describing his claimed reaction of deuterium into helium-4[23]. In April and May 1998, EarthTech undertook a series of investigations to replicate Dr. Case's experimental results. The reports for these investigations are on the EarthTech website in a series of 10 documents:

| | |
|---|---|
| Case | Case Run 5 |
| Case Run 1b | Case Run 6 |
| Case Run 2 | Case Run 7 |
| Case Run 3 | Case Run 8 |
| Case Run 4 | Case Zero Run |

Selected excerpts from these reports are shown below.

> Case
>
> At ICCF-7, Dr. Les Case presented tantalizing data from a simple experiment in which standard Pd hydrogenation catalyst is exposed to D2 gas at elevated temperatures. According to Dr. Case, the right catalyst at the right temperature and gas pressure will make significant excess heat for weeks on end.
>
> Fortunately Dr. Case is eager to have his experiment replicated by other labs and has been completely open about the necessary protocol.
>
> Also fortunately, we happen to have on hand nearly all the necessary equipment to perform this experiment.
>
> Case Run 3
>
> *** This test was conducted with the real catalyst! ***
>
> Run 3 employed the recommended G75-E catalyst from United Catalysts. Inc. Otherwise it was very similar to Run 2. In fact horribly similar!
>
> Despite having the recommended catalyst, there was no sign of the desired effect!!!
>
> Case Run 4
>
> ** This test was conducted with the real catalyst! ***
>
> After Run 3 ended, I left the chamber filled with D2 overnight. Run 4 was conducted without opening the chamber, mainly to see if some other catalyst temperature would stimulate the excess heat to occur in my apparatus.
>
> Finally I went to 30 watts and Tbtm reached about 230° C. As you can see from the Pin and Pout traces there is no sign of an excess heat phenomenon in this experiment.

---

[22] Mallove, E., 1998. Reproducible Catalytic Fusion Process Announced by Dr. Les Case. Infinite Energy, Vol. 4, #19.

[23] Case, L., 1998. Catalytic Fusion of Deuterium into Helium-4. in The Seventh International Conference on Cold Fusion. 1998. Vancouver, Canada: ENECO, Inc., Salt Lake City, UT.

Case Run 5

*** This test was conducted with a sample of the very same catalyst that Dr. Case has used successfully! ***

This run looks just like our previous runs. There is no significant difference between deuterium and hydrogen (protium). There is also no sign of excess heat from this experiment.

Case Run 8

Goal: Maximize the D/H ratio in the atoms adsorbed onto the catalyst surface.

In Run 8 we exposed the catalyst to multiple successive charges of pure D2 so the hydrogen attached to the catalyst surface would be more nearly completely replaced with deuterium than in our previous runs.

Through all of these charging cycles, the Pout trace stayed right on top of the Pin trace. There was never any indication that the experiment was making excess heat. Also the catalyst temperatures, Ttop and Tbtm (Tbtm), remained rather constant at about 178° C. There was no sign of the gradually increasing temperature that Dr. Case has observed.

Conclusion:

Despite the measures taken to enrich the deuterium content of the catalyst, and despite using tested catalyst supplied by Dr. Case himself, Run 8 exhibited no evidence of excess heat.

Run 8 and the other experiments we have performed conclusively demonstrate that it is not sufficient merely to heat the right catalyst to around 180°C…and expose it to D2 gas…to observe the Case phenomenon. A critical ingredient or attribute is apparently missing from our experiment.

Furthermore, our results raise an important question about the Case phenomenon:

Does his "excess temperature" represent "excess heat"?

At this point, we feel that the most prudent next step is to use our water-flow calorimetry to measure the heat evolved from Case's own apparatus

The observations and claims of Dr. Case were not verified. "…there is no sign of an excess heat phenomenon in this experiment." "There was no sign of the gradually increasing temperature that Dr. Case has observed." "Furthermore, our results raise an important question about the Case phenomenon: Does his "excess temperature" represent "excess heat"?

## 4.5. RIFEX

Dr. James Patterson developed a device that he claimed produced much more power output than the input power[24]. The device was also claimed to induce elemental transportations and shifts in relative abundance of element isotopes[25]. The Patterson Power Cell utilized small spherical plastic or glass beads that were coated with thin films of nickel and palladium in a packed-bed electrolytic

[24] Mallove, E., 1998. Reproducible Catalytic Fusion Process Announced by Dr. Les Case: Pending Full Validation, Commercial Applications Could Be Very Rapid. Infinite Energy, Vol 4, Issue 19.

[25] Miley, G. and J. Patterson, 1996. Nuclear Transmutations in Thin-Film Nickel Coatings Undergoing Electrolysis. J. New Energy. Vol. 1, No. 3.

cell. He and his grandson (by marriage), Jim Reding, formed Clean Energy Technologies (CETI) to develop and market the Power Cell.

Dr. Patterson worked with Dr. George Miley at the University of Illinois to research the thin-film bead LENR method. They postulated a reaction model term the "Reaction in a Film-Excited Complex" (RIFX)[26]. Assemblies, termed RIFX kits, were developed and distributed to other researchers for verification. EarthTech conducted several investigations with one of the kits. The procedure and results were reported on the website and in two papers, one on transmutation[27] and the other on calorimetry[28]. The contents of the reports are as follows.

Nuclear Transmutation Paper
- Abstract
- Introduction
- Initial Preparations and Description of Apparatus
- Run 1
- Run 2
- Run 3
- Quantification of XRF Results
- Tentative Conclusions
- Analysis of the Electrolyte
- Discussion
- Speculation
- Acknowledgments
- Epilogue: SIMS Analysis of the Run 3 Beads

Calorimetric Study Report
- Abstract
- Introduction
- Experimental Procedure
- Results
- Discussion
- Acknowledgments
- Appendix: Dual-Method Calorimeter

The notations on the website make reference to the two reports and include the following narrative.

> Transmutation RIFEX Report (PDF)
>
> A series of experiments has been performed with the CETI RIFEX kit. In each experiment an electrolytic cell with a cathode composed of metal-coated plastic beads was operated for two weeks. The cathode beads were then analyzed by x-ray fluorescence for evidence of nuclear transmutations. Several elements were observed to appear in the reacted beads. Analyses of the electrolyte and other components of the system in contact with the electrolyte are not conclusive but suggest to us that these elements were present in the system initially.
>
> Calorimetric RIFEX Report (PDF)
>
> A series of calorimetric experiments have been performed with the CETI RIFEX kit. In these experiments an electrolytic cell with a cathode composed of Pd/Ni-coated plastic beads was operated in a calorimeter that simultaneously measured the heat evolved from the cell by two independent methods. With a detection limit

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[26] Miley, G., and J. Patterson 1996. Nuclear Transmutations in Thin-Film Nckel Coatings Undergoing Electrolysis. Infinite Energy, Vol. 2, Issue 9.

[27] Little, S., and H. Puthoff, 1998. Search for Evidence of Nuclear Transmutations in the CETI RIFEX Kit. Unpublished Report, EarthTech International, Inc. 33 p.

[28] Little, S., and H. Puthoff, 1998. Calorimetric Study of Pd/Ni Beads From the CETI RIFEX Kit. Unpublished Report, EarthTech International, Inc. 15 p.

of approximately 0.1 watts we did not observe any excess heat from these beads. Included is a detailed description of the calorimeter, which was designed and constructed specifically for these experiments.

The abstracts from the nuclear transmutation report and calorimetric study report are essentially the same as the notations on the website.

The results of EarthTech's attempted verification of transmutation in the RIFEX kit were not successful: "Several elements were observed to appear in the reacted beads. Analyses of the electrolyte and other components of the system in contact with the electrolyte are not conclusive but suggest to us that these elements were present in the system initially." "Despite a large investment in time and money, this study is not exhaustive. We performed only three runs with our RIFEX kit. We followed the protocol provided by CETI to the best of our ability but difficulties with the apparatus forced us to make a few changes on each run. As a result each of the three runs behaved noticeably differently." "We did obtain results from our investigation. However, we can only speculate as to their significance."

The results of the calorimetric study did not verify excess heat production in the RIFEX kit: "Then for the next two days the system ran a near-perfect thermal equilibrium with no detectable signs of excess heat generation in the cell." "Although we did not observe any excess heat in this experiment it is possible that a different protocol would stimulate these beads to produce excess heat…"

### *4.6. Hydrogen Purifier*

A hydrogen purifier is a device to purify hydrogen if hydrogen production is done from hydrocarbon sources, the ultra-high purified hydrogen is needed[29]. In palladium membrane hydrogen purifiers, the membrane is typically a metallic tube of a palladium and silver alloy material. This material has the unique property of allowing only monatomic hydrogen to pass through its crystal lattice when it is heated above 300°C.

Some cold fusion researchers, for example at U.S. NASA[30], investigated the possibility that LENR and excess heat occur when hydrogen or deuterium gas passes through the palladium membrane of

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[29] Hydrogen Purifier. Wikipedia. https://en.wikipedia.org/wiki/Hydrogen_purifier.

[30] Fralick, G., A. Decker, and J. Blue, 1989. Results of an Attempt to Measure Increased Rates of the Reaction 2D +2D -> 3He + n in a Nonelectrochemica! Cold Fusion Experiment. NASA Technical Memorandum 102430. December.

a hydrogen purifier. EarthTech conducted experiments to investigate whether LENR occurs. No collaborators were identified for the experiments. The most relevant parts of the report are extracted below.

> **Calorimetric Measurement of Pd/Ag Alloy Permeated by a Steady Hydrogen Flux**
>
> The phenomena known collectively as "cold fusion" include (stet) numerous reports of caloric anomalies in metal-hydride systems. As part of an ongoing effort to observe these anomalies, we have recently performed a calorimetric measurement on a membrane of 75Pd/25Ag alloy with a steady flux of hydrogen passing through it. No excess heat was detected in this measurement.
>
> Thus we can conclude that, if there is any anomalous heat generation due to the passage of H atoms through a Pd/Ag alloy under these conditions, it is substantially less that 0.017 eV/atom of hydrogen.
>
> Future Directions
>
> The experiment should be repeated with deuterium instead of hydrogen (protium). It also seems prudent to try high pressures combined with lower temperatures in order to make the Pd/Ag alloy load significantly with hydrogen.

EarthTech did not conclude that excess heat is generated in the hydrogen purifier apparatus in their experiments.

### *4.7. Mizuno*

Dr. Tadahiko Mizuno received his undergraduate and graduate education at Hokkaido University, Sapporo, Japan[31] and subsequently continued his LENR research there. He has conducted his research since the beginning of the field, starting within days of the 1989 announcement[32]. His work has included both excess heat and elemental transmutation[33] for LENR signatures.

Mizuno and several other researchers from Japan presented results of their experiments in 1998 at ICCF-7[34,35,36]. EarthTech conducted a series of three sets of experiments to verify the excess heat observations reported in the Ohmori and Mizuno paper, "Detection of Radiation Emission, Heat

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[31] Taahiko Mizuno. Wikipedia. https://en.wikipedia.org/wiki/Tadahiko_Mizuno.

[32] Rothwell, J., 1997/98., Nuclear Transmutation: The Reality of Cold Fusion, 1997, by Dr. Tadahiko Mizuno, Book Review. Infinite Energy, Vol. 3, Issue 17, December/January.

[33] Mizuno, T., 1998. Nuclear Transmutation: The Reality of Cold Fusion. Concord, NH. Infinite Energy Press.

[34] Ohmori, T., and T. Mizuno, 1998. Strong Excess Energy Evolution, New Element Production, and Electromagnetic Wave and/or Neutron Emission in Light Water Electrolysis with a Tungsten Cathode. Proceedings of ICCF-7, Vancouver, B.C. April 19-24 1998.

[35] Mizuno, T., T. Ohmori, and T. Akimoto, 1998. Detection of Radiation Emission, Heat Generation and Elements from a Pt Electrode Induced by Electrolytic Discharge in Alkaline Solutions. Proceedings of ICCF-7, Vancouver, B.C. April 19-24 1998.

[36] Mizuno, T., T. Ohmori, and T. Akimoto, 1998. Probability of Neutron and Heat Emission from Pt Electrode Induced by Discharge in the Alkaline Solution. Proceedings of ICCF-7, Vancouver, B.C. April 19-24 1998.

Generation and Elements". The reports for these experiments are referred to as "Incandescent" and are included on the website as follows:

| First Incandescent W | Second Incandescent W | Third Incandescent W |
|---|---|---|
| Run 1 | Run 1, 2 | Run 1 |
| Run 2 | Run 3 | Run 2 |
| Run 3 | Run 4 | Run 3 |
| Run 4, 5, 6 | Run 5 | Run 4 |
| Run 7 | Run 6 | Run 6 |
| Run 8, 9, 10 | Run 7 | |
| | Run 8 | |
| | Run 9 | |

The most significant descriptions and findings are presented in the initial webpage for each of the three sets of experiments as well as a fourth "Incandescent Pt" investigation. Excerpts from the four experiments are shown below below.

**First Incandescent W**

Introduction

At the 7th International Cold Fusion conference in Vancouver earlier this year, Ohmori and Mizuno reported on a new electrolysis experiment in which a W cathode becomes incandescent under certain conditions. They made preliminary calorimetric measurements on cells operating in this mode and concluded that the phenomenon produced significantly more heat energy than the electrical energy required to stimulate it.

Then, in the latest issue of Infinite Energy magazine, it was reported that several other groups have succeeded in replicating the incandescent W experiment and that they, too, have observed evidence of excess heat production.

The experiment is relatively simple and the desired phenomenon can be produced on demand, in sharp contrast to traditional cold fusion experiments. We have successfully replicated the experiment and measured its heat output accurately with our versatile water-flow calorimeter. Unlike Ohmori and Mizuno, we did not perform any analytical studies on our experiment. We concentrated on the calorimetry.

As far as we could tell, our experiment functioned exactly like that of Ohmori and Mizuno. We repeatedly observed the incandescent cathode effect but we observed no sign of excess heat.

Conclusion

In 10 attempts, we have observed no sign of the large excess heat reported by Ohmori & Mizuno. This is particularly surprising in view of the fact that we have apparently succeeded in duplicating the fundamental phenomena that they were investigating: the incandescent W cathode.

We cannot explain the discrepancy between our results and those of Ohmori & Mizuno. We remain open to suggestions for improvement of our experiments.

**Second Incandescent W**

The discouragement that followed our first series of experiments with the incandescent W cell evaporated recently when Jed Rothwell reported that Mizuno et al had constructed a water-flow calorimeter and that it was confirming the large excess heat signals they reported at ICCF-7. After contacting Mizuno and learning the details of his new calorimeter, we were even more excited about the new results, typically 100 watts in and 250 watts out…according to Rothwell's report.

With Dr. Mizuno's full and generous cooperation, we have therefore launched a new effort to replicate his excess heat result here at EarthTech. We are making a new cell that is very close to Mizuno's cell. In this effort we are enjoying the benefits of rapid text and graphics communication provided by the Internet. We have exchanged pictures of our apparatus during the construction phase and Dr. Mizuno has made numerous constructive criticisms.

**Third Incandescent W**

After obtaining negative excess heat results in our first two series of these experiments, we sent some W cathodes of our own manufacture to Dr. Tadahiko Mizuno at Hokkaido University in Japan. Operated in his cell our cathodes DO appear to generate excess heat! This fact eliminates a number of questions about our cathode preparation methods, including the TIG welding procedure we developed to attach the W sheet to the W lead wire. In recent discussions with Dr. Mizuno, he indicated that results are significantly better if the cell voltage is around 200 volts or more. The DC power supply we used in our earlier experiments was only capable of 150 volts. In view of this and the fact that both Mizuno and Ohmori continue to observe apparent excess heat in their experiments we decided to purchase a new power supply and continue this experimentation. We are also in possession of a great deal of visual information (video and photos) obtained by Jed Rothwell during a recent visit to Mizuno's lab in Japan. This information documents essentially all the procedures that Mizuno employs in his experimentation. A review of this material has yielded a number of ideas for changes in our technique that will be employed in this next series of experiments.

Mizuno has recently sent us 5 more cathodes made with his fabrication techniques. They arrived in good condition and we are anxious to test them. However, for the first few runs we will use our own cathodes to get the new system running properly.

**Incandescent Pt**

Search for Excess Heat from a Pt Electrode Discharge in K2CO3-H2O and K2CO3-D2O Electrolytes

Introduction

At the 7th International Cold Fusion conference in Vancouver earlier this year, Mizuno, Ohmori, and Akimoto reported on an electrolysis experiment in which a Pt cathode becomes incandescent under certain electrolytic conditions. This experiment is similar to another experiment involving a W cathode, but they report observing substantially higher excess heat levels for the Pt experiment. Quoting from the abstract of reference 1, "High heat output of the order of several hundred watts was observed from input power of tens of watts." In other words they report a power gain of order 10 for the Pt experiment.

Unfortunately, there is no discussion of the excess heat measurements in the body of either report.

It was a simple process to modify the apparatus employed in our Incandescent W Experiments to perform this experiment. We have completed three runs including one run with a D2O solvent. With an excess heat detection limit of about 3% relative, we found no evidence of excess heat.

Conclusions

Mizuno claims in his report that "the reaction is 100% reproducible." A casual observer would certainly have to agree that we have replicated the basic phenomenon that Mizuno, et al were investigating. However, we see no sign of excess heat in our experiments. Our calorimetry has an overall accuracy of about 1% relative and this results in an excess heat detection limit of about 3% relative. Therefore we have not accidentally missed "high heat output of the order of several hundred watts…from input power of tens of watts".

EarthTech apparently did not observe excess heat in the First, Second or Third Incandescent W experiments or in the Incandescent Pt investigation:

First Incandescent W: "As far as we could tell, our experiment functioned exactly like that of Ohmori and Mizuno. We repeatedly observed the incandescent cathode effect but we observed no sign of excess heat."

Third Incandescent W: “After obtaining negative excess heat results in our first two series of these experiments, we sent some W cathodes of our own manufacture to Dr. Tadahiko Mizuno at Hokkaido University in Japan.”

Incandescent Pt: “With an excess heat detection limit of about 3% relative, we found no evidence of excess heat.”

In the Third Incandescent W series, experiments at EarthTech were conducted with cathodes supplied by Dr. Mizuno. Excess heat was apparently not observed. Shown below are excerpts from most of the six runs of this experimental series.

Run 1: We tentatively conclude that there was no excess heat generated in this run.

Run 3: Discussion. With this experiment we have apparently begun to establish that it is not just our style of calorimetry that explains the lack of excess heat in our version of the O&M experiments. In other words, when we do the calorimetry like they do, we still do not observe excess heat!

Run 4: The sum of these heat losses is 167,838 joules, which is essentially EQUAL to the measured electrical input energy! Clearly there is no sign of the massive excess heat observed by Mizuno and Ohmori.

Run 5: However, this run brings the differences between our efforts and those of Mizuno and Ohmori into sharp focus.

Run 6: We see no sign of excess heat in these data.

EarthTech also attempted to confirm two claimed replications of Mizuno’s findings. The outcome of the first verification, “Replication of Jean-Louis Naudin's Replication”[37] is excerpted below.

Introduction

At the 7th International Cold Fusion conference in Vancouver in 1998, Ohmori and Mizuno reported on a new electrolysis experiment in which a W cathode becomes incandescent under certain conditions. They made preliminary calorimetric measurements on cells operating in this mode and concluded that the phenomenon produced significantly more heat energy than the electrical energy required to stimulate it.

During 1998-2000 we made an extensive effort to replicate their experiment. Despite having the full cooperation of Dr. Mizuno, including his providing several W cathodes to us, all of our experiments failed to show excess power production.

Recently, Jean-Louis Naudin has revived this experiment and has published extensive and detailed reports of his work on his website. Naudin’s results indicate substantial excess power production with power output/input ratios typically around 1.6 but sometimes exceeding 2.5.

Stimulated by Naudin’s apparent success with the experiment we embarked upon a campaign to replicate his work.

[37] Naudin, J., 2003. The Cold Fusion Reactor. May. http://jlnlabs.online.fr/cfr/html/cfr10.htm.

Conclusion

Our experiments show no sign of the large excess power levels observed by Naudin. In fact, our final results (COP2) average very close to unity, which indicates that there are no anomalous energy-producing reactions in this experiment.

Excerpts from the second claimed replication, Fauvarque, Clauzon, and Lalleve's Replication[38], are shown below

Introduction

At the 7th International Cold Fusion conference in Vancouver in 1998, Ohmori and Mizuno reported on a new electrolysis experiment in which a W cathode becomes incandescent under certain conditions. They made preliminary calorimetric measurements on cells operating in this mode and concluded that the phenomenon produced significantly more heat energy than the electrical energy required to stimulate it.

During 1998-2000 an effort was made at Earthtech to replicate their experiment2. Despite having the full cooperation of Dr. Mizuno, including his providing several W cathodes to us, all of our experiments failed to show excess power production.

Jean-Louis Naudin has peformed his own version of this experiment and has published extensive and detailed reports of his work on his website. Naudin's results indicate substantial excess power production with power output/input ratios typically around 1.6 but sometimes exceeding 2.5. In July 2003 Earthtech mounted a campaign to replicate Naudin's results. Although we succeeded in reproducing some of his numerical values, we also demonstrated that they were a result of erroneous data manipulation. When correctly evaluated none of our experimental results showed excess power production.

Recently Fauvarque, J., P. Clauzon, and G. Lalleve reported positive excess power from their version of this experiment. Fauvarque et al employed a fundamental approach to the calorimetry in which the heat power produced by the cell is determined by measuring the rate at which water is evaporated from the cell during operation at the boiling point. With the cooperation of Ludwik Kowalski of Montclair State University, we now endeavor to replicate this work.

Discussion

Favarque et al report observing COP's up to 1.41 in their experiments. Clearly we have not replicated their results. Among the possibilities to explain the differences between our results are errors in input power measurement and errors in heat output power measurement.

There is always the possibility that our results do not show excess heat because we did not perform the experiment properly. If anyone reading this report has suggestions for making the cell perform like it did for Favarque et al, please don't hesitate to pass them on to us (little@earthtech.org).

EathTech was not able to verify either of the two claimed replications:

> Naudin: "Our experiments show no sign of the large excess power levels observed by Naudin. In fact, our final results (COP2) average very close to unity, which indicates that there are no anomalous energy-producing reactions in this experiment."

[38] Fauvarque, J., P. Clauzon, and G. Lalleve, 2005. Abnormal Excess Heat Observed during Mizuno-Eype experiments. Laboratoire d'Electrochimie Industrielle, Conservatoire National des Arts et Métiers: Paris. Available at http://www.lenr-canr.org/acrobat/FauvarqueJabnormalex.pd

Fauvarque: "Clearly we have not replicated their results. Among the possibilities to explain the differences between our results are errors in input power measurement and errors in heat output power measurement."

### *4.8. Mills*

Randell Mills has claimed that he has developed a new source of energy that is different from LENR. His concept is based on the "hydrino", in which the electron in a hydrogen atom falls below the ground state (closer to the nucleus than the s orbital). He has described his concept in his self-published book[39]. Brilliant Light Power, located in New Jersey, is his current company for pursuing the new source of energy. Previously it was BlackLight Power and HydroCatalysis before that. Mills' idea and writings have been the subject of intense controversy[40].

In 1997 EarthTech did experiments to verify Mills' claims using information on the (then) BlackLight Power website. Excerpts from the report on the EarhTech website are shown below.

Attempt to Observe Excess Heat in a Ni-H2O-K2CO3 Electrolysis System – 9OCT97

Introduction

Dr. Randall Mills reports multiple observations of excess heat in the Ni-H2O-K2CO3 system on the Blacklight Power web page at http://www.blacklightpower.com. In the section entitled Detail on Technology and Representative Technical Support several examples are mentioned:

- 24.6 watts out for 4.73 watts in during pulsed current electrolysis. Source unclear, perhaps Mills & Good
- pulsed and continuous current electrolysis with Pout/Pin > 37. Mills and Kneizys
- pulsed and continuous current electrolysis with 41 watts out and Pout/Pin > 8. Thermacore, Inc.
- pulsed and continuous current electrolysis with Pout/Pin > 16. HydroCatalysis Power Corporation.
- reproduction of Mills & Kneizys experiment with Pout/Pin ~ 1.67. Noninski
- continuous electrolysis with Pout/Pin ~ 2. Noninski w/ Weismann observing at Brookhaven.
- electrolysis with Pout/Pin ranging from 2.7 to 3.4. Notoya & Enyo of Catalysis Research Center, Hokkaido U
- electrolysis similar to Thermacore with Pout/Pin up to 1.68. NASA Lewis
- electrolysis with Pout/Pin ~ 10. MIT Lincoln Laboratories
- electrolysis with Pout/Pin ~ 2. Westinghouse Electric Corporation
- electrolysis with Pout/Pin 1.28-1.38. Atomic Energy Canada Limited, Chalk River Labs
- electrolysis with Pout = .75 watts and Pin = .3 watt (V*I). Moscow Power Engineering Institute
- pulsed electrolysis with Pout/Pin = 8.5. Idaho National Engineering Laboratory

After reading this list we decided to build a Ni-H2O-K2CO3 cell of our own design and run it in the water-flow calorimeter originally intended for the Ragland triode cell work.

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[39] Mills, R., Updated January 2020. The Grand Unified Theory of Classical Physics. Self Published. https://brilliantlightpower.com/book/.

[40] Brilliant Light Power on Wikipedia. https://en.wikipedia.org/wiki/Brilliant_Light_Power.

Conclusion

Our Mills experiment shows no detectable sign of excess heat. A 10% excess…less than any of the reported confirmations of Mills' experiment showed…would have produced a prominent positive signal in our experiment. water-flow calorimeter originally intended for the Ragland triode cell work.

EarthTech was not able to verify the excess heat claims of Randell Mills and his company, Brilliant Light Power: "Our Mills experiment showns no detectable sign of excess heat."

### 4.9. Other LENR Researchers

In addition to the eight verification attempts described above, Mr. Little and EarthTech worked with a number of other researchers and organizations that are not reported on the website. Many of them have been identified in transcriptions of Mr. Little's interview, electronic files, lab notebooks, and other sources. Candidates who ET may have worked with are listed below:

| | |
|---|---|
| Yan Kucherov (ENECO) | Coolescence? |
| Dennis Letts | Francesco Celani? |
| Melvin Miles | Yasuhiro Iwamura |
| Roger Stringham | Lockheed? |
| National Instruments? | Mitchell Swartz? |
| Ed Storms? | |

Additional information on these researchers may be available in the future.

# 5. Reports and Publications

Most of the documents related to Mr. Little's and EarthTech's LENR investigations are unpublished reports, most of which are posted on the website. As previously noted, the reports have been downloaded in PDF format and are the basis of the descriptions of the eight collaborations and verifications in Section 4. The downloaded reports have been included in the LLRDP Dropbox folder. Screenshots of the folder contents are shown in Figure 5-1.

Two documents in conventional report format (unlike the other website reports) were also found on the website and are also included in the Project Dropbox folder.

> Little, S., and H. Puthoff, 1998. Search for Evidence of Nuclear Transmutations in the CETI RIFEX Kit. Unpublished Report, EarthTech International, Inc. 33 p.
>
> Little, S., and H. Puthoff, 1998. Calorimetric Study of Pd/Ni Beads From the CETI RIFEX Kit. Unpublished Report, EarthTech International, Inc. 15 p.

In addition to the website reports, Mr. Little has authored or contributed to published papers. Table 5-1 shows four items found on the LENR-CANR.org website. Copies of the last three items in the table have been included in the Project Dropbox folder.

*Table 5-1*
*LENR-CANR.org Entries for Author Search for "Little"*

| | | |
|---|---|---|
| Kowalski, L. | 2005 | Kowalski, L., et al. New results and an ongoing excess heat controversy. in The 12th International Conference on Condensed Matter Nuclear Science. 2005. Yokohama, Japan. |
| Kowalski, L. | 2005 | Kowalski, L., et al. Searching for excess heat in a Mizuno-type Cell (PowerPoint slides). in The 12th International Conference on Condensed Matter Nuclear Science. 2005. Yokohama, Japan. |
| Kowalski, L. | 2005 | Kowalski, L., S. Little, and G. Luce. Searching for excess heat in Mizuno-type plasma electrolysis. in The 12th International Conference on Condensed Matter Nuclear Science. 2005. Yokohama, Japan. |
| Little, S. | 2008 | Little, S., G. Luce, and M. Little. MOAC - A High Accuracy Calorimeter for Cold Fusion Studies. in ICCF-14 International Conference on Condensed Matter Nuclear Science. 2008. Washington, DC. |

20 CF on ET Website 191109

100 Cold Fusion Overview - EarthTech.pdf
200 SPAWAR - EarthTech.pdf
300 PACA - EarthTech.pdf
350 PACA Followup - EarthTech.pdf
400 Dash-Zhang - EarthTech.pdf
500 Case - EarthTech.pdf
510 Case Run 1b - EarthTech.pdf
520 Case Run 2 - EarthTech.pdf
530 Case Run 3 - EarthTech.pdf
540 Case Run 4 - EarthTech.pdf
550 Case Run 5 - EarthTech.pdf
560 Case Run 6 - EarthTech.pdf
570 Case Run 7 - EarthTech.pdf
580 Case Run 8 - EarthTech.pdf
590 Case Zero Run - EarthTech.pdf
600 RIFEX - EarthTech.pdf
610 rifex.pdf
620 rifexcal.pdf
700 Hydrogen Purifier - EarthTech.pdf
800 Mizuno - EarthTech.pdf
810 Incandescent Pt - EarthTech.pdf
820 First Incandescent W - EarthTech.pdf
821 First W - Run 2 - EarthTech.pdf
822 First W - Run 3 - EarthTech.pdf
823 First W - Run 4, 5 and 6 - EarthTech.pdf
824 First W - Run 7 - EarthTech.pdf
825 First W - Run 8, 9 and 10 - EarthTech.pdf
830 Second Incandescent W - EarthTech.pdf
831 Second W - Run 1 and 2 - EarthTech.pdf
832 Second W - Run 3 - EarthTech.pdf
833 Second W - Run 4 - EarthTech.pdf
834 Second W - Run 5 - EarthTech.pdf
835 Second W - Run 6 - EarthTech.pdf
836 Second W - Run 7 - EarthTech.pdf
837 Second W - Run 8 - EarthTech.pdf
838 Second W - Run 9 - EarthTech.pdf
840 Third Incandescent W - EarthTech.pdf
841 Third W - Run 1 - EarthTech.pdf
842 Third W - Run 2 - EarthTech.pdf
843 Third W - Run 3 - EarthTech.pdf
844 Third W - Run 4 - EarthTech.pdf

838 Second W - Run 9 - EarthTech.pdf
840 Third Incandescent W - EarthTech.pdf
841 Third W - Run 1 - EarthTech.pdf
842 Third W - Run 2 - EarthTech.pdf
843 Third W - Run 3 - EarthTech.pdf
844 Third W - Run 4 - EarthTech.pdf
845 Third W - Run 5 - EarthTech.pdf
846 Third W - Run 6 - EarthTech.pdf
850 Replication of Jean-Louis Naudin's Replication - EarthTech.pdf
860 Replication of Fauvarque, Clauzon, and Lalleve's Replication - EarthTech.pdf
900 Mills - EarthTech.pdf

*Figure 5-1*
*Screenshots of Reports Downloaded from EarthTech Website*

## 6. Hardcopy Records: Lab Notebooks

Mr. Little has 34 hardcopy lab notebooks that he has included in the LLRDP[41] (Figure 6-1). They are dated from May 1989 to November 2005, which is about the time EarthTech gave up on actively pursuing LENR and started research on internal ideas, such as gravity experiments. In a January 2020 email, Mr. Little provided the following descriptions of the notebooks:

> I found 34 notebooks that have something to do with cold fusion, although 5 of these in the upper left corner, named "Zeus #n" are devoted to our EV work (Ken Shoulders). The first Zeus notebook starts in May 1989 and has the tail end of our initial P&F replication efforts. I have lost the first notebook for that effort.
>
> These notebooks span from May 1989 to Nov 2005, which is about the time we gave up on actively pursuing CF and started on research of our own ideas, e.g. the gravity experiments, etc.
>
> The top row has the roman numeral series from I to VII. The middle row is the Arabic numeral series 1 thru 7. The lower row is the letter series B thru G (I must have lost A).
>
> In the middle of the top row are two special notebooks. "Sonocaloric" is devoted to our efforts with Roger Stringham, and "Eneco" to the work we did with Yan Kucherov.
>
> In the lower left area of the table are several individual notebooks that contain some personal stuff as well as notes on CF experiments. The little one is a notebook that I took to ICCF7 in Vancouver where Fran Tanzella and I presented on calorimetry and I had a live, operating water-flow calorimeter on the stage.

More detail on the contents of each of the notebooks may become available to the Project in the future.

[41] Scott Little Lab Notebooks from EarthTech. Memo to Scott Little from Tom Grimshaw, January 23, 2020.


*Figure 6-1*
*Photo of Scott Little's EarthTech Lab Notebooks*

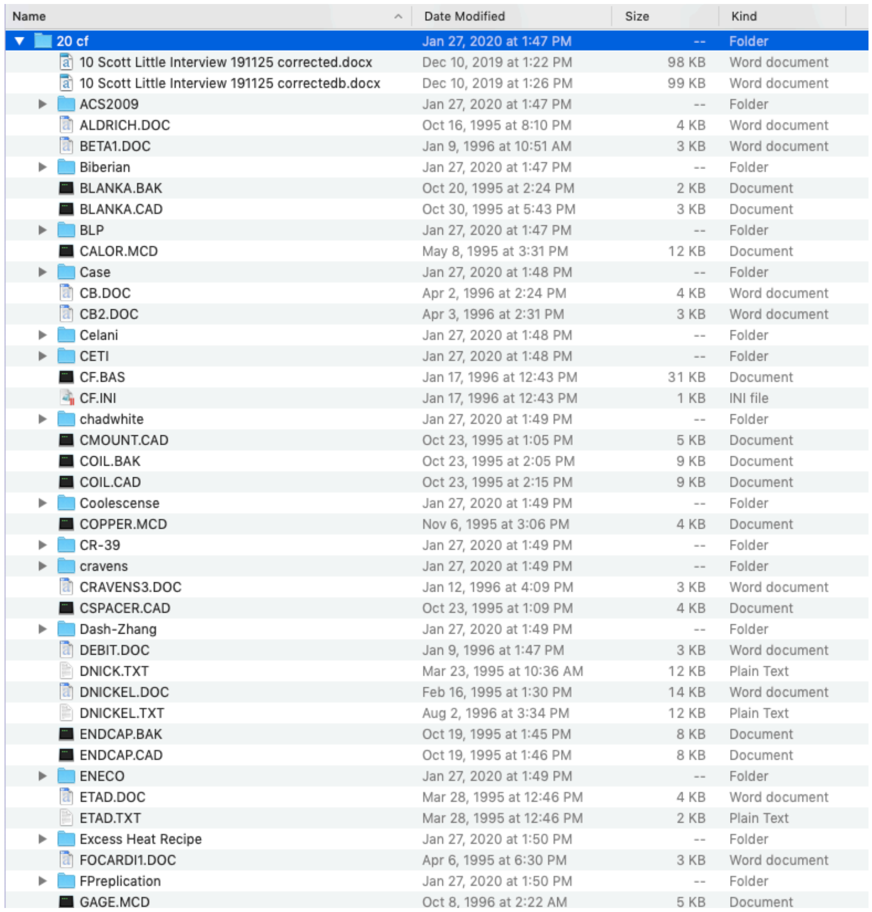
# 7. Electronic Files

Mr. Little has provided to the LLRDP many folders with files related to LENR research at EarthTech. The most significant files are in the "CF" folder, which contains over 7000 files. The contents of the "CF" folder are shown in Figure 7-1.

There are in addition about five folders in the electronic files that appear to be LENR-related and have been included in the project. They are shown below.

- Eneco
- ICCF-7
- JLN Mizuno
- Letts
- moac

Additional electronic files may be added to the project in the future.



| Name | Date Modified | Size | Kind |
|---|---|---|---|
| 20 cf | Jan 27, 2020 at 1:47 PM | -- | Folder |
| 10 Scott Little Interview 191125 corrected.docx | Dec 10, 2019 at 1:22 PM | 98 KB | Word document |
| 10 Scott Little Interview 191125 correctedb.docx | Dec 10, 2019 at 1:26 PM | 99 KB | Word document |
| ACS2009 | Jan 27, 2020 at 1:47 PM | -- | Folder |
| ALDRICH.DOC | Oct 16, 1995 at 8:10 PM | 4 KB | Word document |
| BETA1.DOC | Jan 9, 1996 at 10:51 AM | 3 KB | Word document |
| Biberian | Jan 27, 2020 at 1:47 PM | -- | Folder |
| BLANKA.BAK | Oct 20, 1995 at 2:24 PM | 2 KB | Document |
| BLANKA.CAD | Oct 30, 1995 at 5:43 PM | 3 KB | Document |
| BLP | Jan 27, 2020 at 1:47 PM | -- | Folder |
| CALOR.MCD | May 8, 1995 at 3:31 PM | 12 KB | Document |
| Case | Jan 27, 2020 at 1:48 PM | -- | Folder |
| CB.DOC | Apr 2, 1996 at 2:24 PM | 4 KB | Word document |
| CB2.DOC | Apr 3, 1996 at 2:31 PM | 3 KB | Word document |
| Celani | Jan 27, 2020 at 1:48 PM | -- | Folder |
| CETI | Jan 27, 2020 at 1:48 PM | -- | Folder |
| CF.BAS | Jan 17, 1996 at 12:43 PM | 31 KB | Document |
| CF.INI | Jan 17, 1996 at 12:43 PM | 1 KB | INI file |
| chadwhite | Jan 27, 2020 at 1:49 PM | -- | Folder |
| CMOUNT.CAD | Oct 23, 1995 at 1:05 PM | 5 KB | Document |
| COIL.BAK | Oct 23, 1995 at 2:05 PM | 9 KB | Document |
| COIL.CAD | Oct 23, 1995 at 2:15 PM | 9 KB | Document |
| Coolescense | Jan 27, 2020 at 1:49 PM | -- | Folder |
| COPPER.MCD | Nov 6, 1995 at 3:06 PM | 4 KB | Document |
| CR-39 | Jan 27, 2020 at 1:49 PM | -- | Folder |
| cravens | Jan 27, 2020 at 1:49 PM | -- | Folder |
| CRAVENS3.DOC | Jan 12, 1996 at 4:09 PM | 3 KB | Word document |
| CSPACER.CAD | Oct 23, 1995 at 1:09 PM | 4 KB | Document |
| Dash-Zhang | Jan 27, 2020 at 1:49 PM | -- | Folder |
| DEBIT.DOC | Jan 9, 1996 at 1:47 PM | 3 KB | Word document |
| DNICK.TXT | Mar 23, 1995 at 10:36 AM | 12 KB | Plain Text |
| DNICKEL.DOC | Feb 16, 1995 at 1:30 PM | 14 KB | Word document |
| DNICKEL.TXT | Aug 2, 1996 at 3:34 PM | 12 KB | Plain Text |
| ENDCAP.BAK | Oct 19, 1995 at 1:45 PM | 8 KB | Document |
| ENDCAP.CAD | Oct 19, 1995 at 1:46 PM | 8 KB | Document |
| ENECO | Jan 27, 2020 at 1:49 PM | -- | Folder |
| ETAD.DOC | Mar 28, 1995 at 12:46 PM | 4 KB | Word document |
| ETAD.TXT | Mar 28, 1995 at 12:46 PM | 2 KB | Plain Text |
| Excess Heat Recipe | Jan 27, 2020 at 1:50 PM | -- | Folder |
| FOCARDI1.DOC | Apr 6, 1995 at 6:30 PM | 3 KB | Word document |
| FPreplication | Jan 27, 2020 at 1:50 PM | -- | Folder |
| GAGE.MCD | Oct 8, 1996 at 2:22 AM | 5 KB | Document |

*Figure 7-1a*
*Screenshot of the "cf" Files (Upper Part)*

| Name | Date Modified | Size | Kind |
|---|---|---|---|
| FPreplication | Jan 27, 2020 at 1:50 PM | -- | Folder |
| GAGE.MCD | Oct 8, 1996 at 2:22 AM | 5 KB | Document |
| GENE1 | Mar 28, 1995 at 9:20 AM | 4 KB | Unix executable |
| George.doc | Oct 27, 1997 at 2:03 PM | 19 KB | Word document |
| gibbsfree.mcd | Nov 3, 2005 at 10:15 PM | 7 KB | Document |
| Gimpel | Jan 27, 2020 at 1:50 PM | -- | Folder |
| GRIGGS | Jan 27, 2020 at 1:50 PM | -- | Folder |
| H-NI | Jan 27, 2020 at 1:50 PM | -- | Folder |
| H-NI.DOC | Oct 10, 1995 at 6:46 PM | 8 KB | Word document |
| H2OCALOR | May 6, 1995 at 6:20 PM | 12 KB | Unix executable |
| Haeffner.mcd | Oct 28, 1997 at 9:33 AM | 8 KB | Document |
| HD-PLASM | Jan 27, 2020 at 1:50 PM | -- | Folder |
| HD-SMALL | Jan 27, 2020 at 1:50 PM | -- | Folder |
| HISTORY.DOC | Nov 7, 1996 at 11:36 PM | 8 KB | Word document |
| HMETAL1.DOC | Nov 7, 1996 at 11:33 PM | 10 KB | Word document |
| HMETAL1.TXT | Nov 21, 1995 at 3:45 PM | 8 KB | Plain Text |
| HMETAL2.DOC | Nov 22, 1995 at 2:23 PM | 18 KB | Word document |
| HMETAL2.TXT | Nov 22, 1995 at 2:23 PM | 4 KB | Plain Text |
| HY-DIFF.MCD | Apr 18, 1995 at 1:47 PM | 2 KB | Document |
| iasad.doc | Sep 23, 1997 at 2:11 PM | 23 KB | Word document |
| Inc-W | Jan 27, 2020 at 1:50 PM | -- | Folder |
| JBD | Jan 27, 2020 at 1:51 PM | -- | Folder |
| Jullian Dual Cell | Jan 27, 2020 at 1:51 PM | -- | Folder |
| Kitamura | Jan 27, 2020 at 1:51 PM | -- | Folder |
| Krivit.doc | Aug 7, 2006 at 7:17 PM | 28 KB | Word document |
| LATTVIB2.MCD | Feb 8, 1996 at 11:54 AM | 12 KB | Document |
| letts | Jan 27, 2020 at 1:51 PM | -- | Folder |
| Ludwik | Jan 27, 2020 at 1:51 PM | -- | Folder |
| MARTIN1.DOC | Jan 9, 1996 at 1:14 PM | 4 KB | Word document |
| miles | Jan 27, 2020 at 1:51 PM | -- | Folder |
| MIZUNO.DOC | Aug 12, 1996 at 3:46 PM | 3 KB | Word document |
| National Instruments | Jan 27, 2020 at 1:51 PM | -- | Folder |
| New folder | Jan 27, 2020 at 1:51 PM | -- | Folder |
| New folder (2) | Jan 27, 2020 at 1:51 PM | -- | Folder |
| OGLE.MCD | Oct 11, 1994 at 10:39 AM | 4 KB | Document |
| OTHEREND.CAD | Oct 20, 1995 at 2:11 PM | 8 KB | Document |
| PLA18987.pdf | Aug 10, 2009 at 10:56 PM | 999 KB | Adobe...cument |
| POST.TXT | Mar 5, 1995 at 10:55 AM | 1 KB | Plain Text |
| POTAPOV | Jan 27, 2020 at 1:51 PM | -- | Folder |
| Prize | Jan 27, 2020 at 1:52 PM | -- | Folder |
| Purify | Jan 27, 2020 at 1:52 PM | -- | Folder |
| Review.doc | Oct 27, 1997 at 11:45 AM | 24 KB | Word document |

| Name | Date Modified | Size | Kind |
|---|---|---|---|
| Purify | Jan 27, 2020 at 1:52 PM | -- | Folder |
| Review.doc | Oct 27, 1997 at 11:45 AM | 24 KB | Word document |
| Seebeck | Jan 27, 2020 at 1:52 PM | -- | Folder |
| SOLEN-P.MCD | Nov 21, 1995 at 11:28 AM | 11 KB | Document |
| SonoCalo | Jan 27, 2020 at 1:52 PM | -- | Folder |
| Storms | Jan 27, 2020 at 1:52 PM | -- | Folder |
| Swartz | Jan 27, 2020 at 1:52 PM | -- | Folder |
| tr1862-volume1.pdf | Apr 17, 2002 at 11:14 PM | 3.4 MB | Adobe...cument |
| tr1862-volume2.pdf | Apr 17, 2002 at 11:15 PM | 248 KB | Adobe...cument |
| TRIANGLE.MCD | Nov 2, 1995 at 4:57 PM | 5 KB | Document |
| Triodes | Jan 27, 2020 at 1:52 PM | -- | Folder |
| TUBE.CAD | Oct 20, 1995 at 2:24 PM | 5 KB | Document |
| Widom-Larsen | Jan 27, 2020 at 1:53 PM | -- | Folder |
| 30 Other CF 201027 | Jan 28, 2020 at 10:53 AM | -- | Folder |

*Figure 7-1b*
*Screenshot of the "cf" Files (Lower Part)*

## 8. LENR Library

A listing of Mr. Little's holdings of books, reports and other works by other LENR researchers has not yet been developed for the LLRDP.

## 9. Interviews

A two-part interview was accomplished on November 25, 2019 with Mr. Little regarding his LENR investigations at EarthTech as well as before he joined the organization[42]. He has reviewed the transcripts of the interviews and made corrections where required[43]. The corrected transcript is in Attachment B. Marissa Little, Scott's daughter, was also an employee at EarthTech and did extensive LENR work[44]. She was interviewed on December 13, 2019. The transcript of her interview is in Appendix C.

## 10. LENR Research Phases

A detailed timeline of Mr. Little's LENR research at EarthTech (and before) may be prepared in the future based on the interviews and the research records for the LLRDP in the future.

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[42] Transcripts of Interview for the EarthTech LENR Research Documentation Project. Memo to Scott Little from Tom Grimshaw, November 25, 2019.

[43] Scott Little Response to November 25 Memo from Tom Grimshaw (Transcripts of Interview for the EarthTech LENR Research Documentation Project), December 12, 2019.

[44] Transcripts of Interview for the EarthTech LENR Research Documentation Project. Memo to Marissa Little from Tom Grimshaw, December 19, 2019.

## 11. Future Opportunities

This draft report includes partial documentation of Mr. Little's LENR research at EarthTech. There are many opportunities for additions to the research records as well as for extending the scope to include other participants and collaborators. Shown below are possible ways to add to and extend the LLRDP.

- Obtain relevant reports not posted on the EarthTech website
- Document any additional hardcopy records, such as at Mr. Little's home in Austin
- Describe the lab notebooks individually to identify experiments and collaborators
- Secure any available electronic lab notebooks
- Obtain any existing descriptions and photos of the EarthTech lab when the LENR work was being done
- Review and annotate interviews conducted so far for Scott and Marissa Little
- Conduct a second round of interviews with Mr. Little
- Add a timeline of Mr. Little's LENR research based on the interviews and research records
- Supplement the timeline as appropriate for non-LENR research by Mr. Little
- Expand the scope of the LLRDP to include others at EarthTech, particularly Dr. Puthoff (if available)
- Extend the project to include previous collaborators (including interviews)
- Include "marginally related" EarthTech accomplishments such as Ken Shoulder's EV (EVO) research and non-LENR excess energy verification attempts

These opportunities for additions and scope expansion may be included in future drafts of this report

## 12. Project Methods

The methods used in the LLRDP are based on general LRDI procedures that are modified to meet the specific requirements of individual LENR investigators[45]. The project is being performed according to accepted project management practices[46]. As noted above, the overall LRDI procedure is set forth in a recent article in Infinite Energy[47].

The Project was initiated with an email to Scott Little and Hal Puthoff[48] on November 11, 2019. Mr. Little responded affirmatively[49] also on November 11, and the Project was initiated. He provided a description and photo of his lab notebooks from his LENR work at EarthTech. Dr. Grimshaw reviewed the EarthTech website and downloaded the most relevant webpages and reports in PDF format. Subsequently the entire website was downloaded for preservation in both the HTML[50] and PDF[51] formats.

Recorded telephone interviews were conducted with Mr. Little on November 25, 2019 and with Marissa Little on December 13, 2019. A visit was made to Mr. Little's home near Dale, Texas on January 27, 2020 during which several items were accomplished as listed in the followup memo[52].

- Photos of you in your back yard for possible inclusion in the Project report
- Review of your lab notebooks, which you described previously (and are documented in a memo dated January 23, 2020)
- Proposal to document the notebooks in more detail, including photos of the covers, topics included, and date range for each one

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[45] Grimshaw, T.W., 2019. Collection, Organization, and Documentation of LENR Research Results: Guideline. January.

[46] Project Management Institute, 2017. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) — Sixth Edition and Agile Practice Guide (ENGLISH). Project Management Institute. Newtown Square, PA.

[47] Grimshaw, T., 2020. Documenting Cold Fusion Research: Preserving a Vital Asset for Humankind. Infinite Energy, Issue 150, March/April, p. 9-13.

[48] Documentation of Cold Fusion Research at EarthTech. Email to Hal Puthoff and Scott Little from Tom Grimshaw November 11, 2019.

[49] Email Response from Scott Little to Tom Grimshaw, November 11, 2019.

[50] With WinHTTrack Website Copier. https://www.httrack.com/.

[51] With Adobe Acrobat "Create" → "PDF From Webpage".

[52] Summary of Visit for EarthTech LENR Research Documentation Project. Memo to Scott Little from Tom Grimshaw, January 29, 2020.

- Possible access to and documentation of electronic lab notebooks, which include the construction and operation of MOAC
- Receipt to the Project of numerous electronic files onto a thumb drive
- Addition of professional biographies of yourself and others from the EarthTech website
- Identification of possible hard-copy files at another location near your home and/or at your home in Austin

Strategies were also discussed for possibly including Hal Puthoff as a source of information for the Project. And we discussed the potential value of Mr. Little preparing a timeline of his work at EarthTech, not only in cold fusion, but also many other areas of endeavor.

A number of memos have been prepared as progress has been made (Table 12-1), and a Dropbox folder was established to store files for the Project. The organization of the folder (Figure 12-1) includes subfolders that are in general numbered sequentially as materials were located and progress was made. A high-capacity external hard drive is used for periodic backup of the LLRDP and other LRDI project files.

*Table 12-1.*
*List of Memos Prepared for the Little LENR Research Documentation Project*

| Date | Memo | DBF* |
|---|---|---|
| 11/15/2019 | EarthTech Information and Cold Fusion Reports on EarthTech Website. Memo to Scott Little from Tom Grimshaw, | 17 |
| 11/18/2019 | EarthTech Information and Cold Fusion Reports on EarthTech Website (Addendum) | 17 |
| 11/19/2019 | EarthTech Information on Calorimetry and "MOAC" | 40 |
| 11/25/2019 | Transcripts of Interview for the EarthTech LENR Research Documentation Project (Scott Little) | 50 |
| 12/19/2019 | Transcripts of Interview for the EarthTech LENR Research Documentation Project (Marissa Little) | 60 |
| 1/23/2020 | Scott Little Lab Notebooks from EarthTech | 70 |
| 1/29/2020 | Summary of Visit for EarthTech LENR Research Documentation Project. Memo to scott Little from Tom Grimshaw, January 29, 2020 | 90 |
| 2/6/2020 | Electronic Files for the EarthTech LENR Research Documentation Project | 80 |
| 2/8/2020 | Proposed Photo for the EarthTech LENR Research Documentation Project | 100 |
| 2/10/2020 | Biographies for the EarthTech LENR Research Documentation Project | 110 |

*DBF = Dropbox Folder Designation


*Figure 12-1*
*Screenshot of "Little EarthTech Austin" Folder on Dropbox*

# *Appendix A. MOAC Description from EarthTech Website*

## Introduction

One of the most important effects associated with cold fusion is excess heat. In order to measure excess heat a special calorimeter is required; one that simultaneously measures both the electrical power into the cell and the heat power out of the cell. Most of the calorimeters routinely used in chemical studies are unsuitable for this purpose because they only measure the heat power or energy released by the specimen.

For cold fusion research it is desirable to have a calorimeter with high accuracy so that small effects can be studied. Unfortunately, high-accuracy calorimetry is not easily achieved. It is especially difficult to realize accuracy better than 1% relative. Compared to a calorimeter with 1% accuracy, at least an order of magnitude more effort is required to achieve 0.1% accuracy .

MOAC was designed and constructed over an 8-month period from November 2003 to June 2004. Having constructed and tested a number of other calorimeters in the preceding 15 years, we were able to draw from a wide and varied experience in the design of MOAC. This experience was surely beneficial but, as you will see below, MOAC presented its own unique set of challenging systematic errors that had to be identified and eliminated before its performance would begin to approach the design accuracy goal of +/- 0.1% relative.

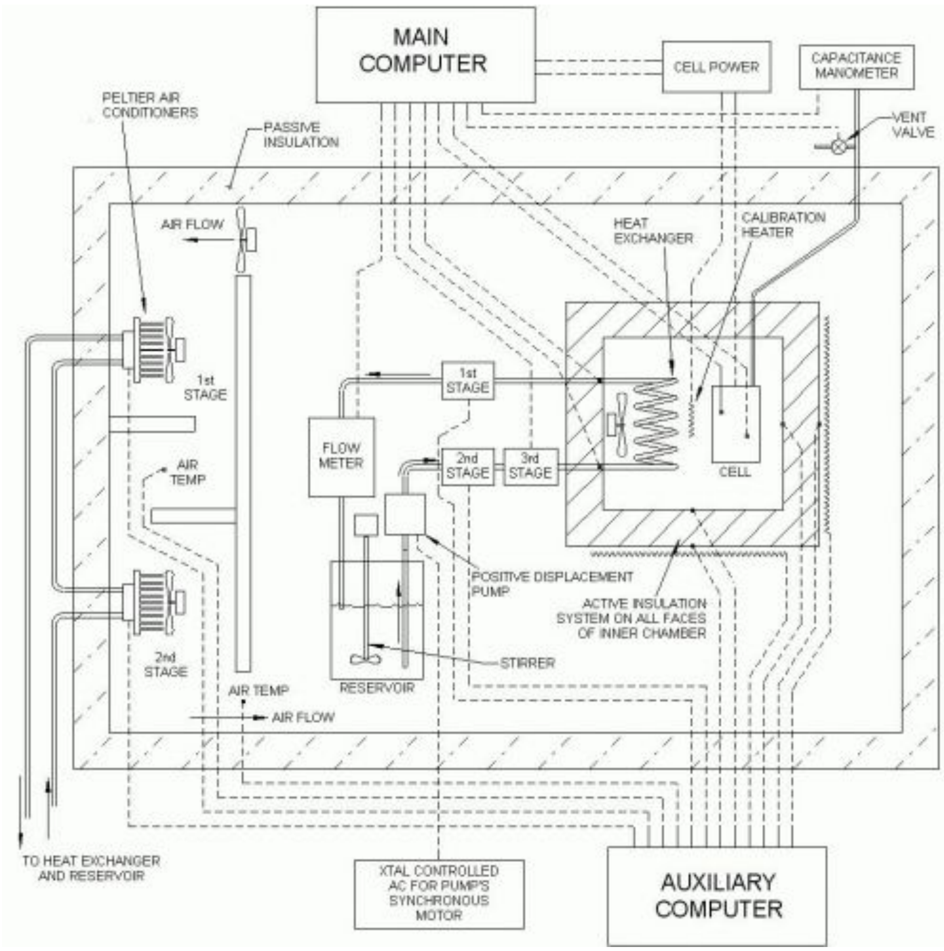
Measurement Strategy

MOAC operates on a simple principle. Flowing water is used to extract the heat from the cell. The flow rate and the temperature rise of the water are measured. The product of the temperature rise, the flow rate, and the specific heat of water yields the heat power being extracted from the cell. This approach is commonly referred to as flow calorimetry. In addition, MOAC simultaneously measures the heat output of the cell by isoperibolic calorimetry. In this technique, which is based upon Newton's Law of Cooling, the heat output power is assumed to be proportional to the temperature difference between the electrolyte and the gently stirred air that surrounds the cell. These two independent methods of heat power measurement provide important insights into the thermal behavior of cold fusion cells.

The cell is placed in an insulated chamber with a liquid-air heat exchanger and a small fan. This stirred-air environment provides relatively weak thermal coupling to the calorimetry water, which allows the cell to operate at elevated temperatures if desired.

Construction

Despite its simple concept, MOAC is not a simple instrument. Two independent computer-based data acquisition systems monitor a total of forty-five parameters, including twenty-two separate temperatures. Fourteen analog outputs, driven by proportional-derivative feedback algorithms, control various critical parameters. Below is a simplified block diagram of the system (click for a larger image).




The cold fusion cell, heat exchanger, fan, and permanent calibration heater are located in the calorimetry chamber (CC) whose walls are made almost perfectly insulating by a system that heats the outer surface of each of the six wall panels so that its temperature matches that of the corresponding inner surface. This active insulation (AI) ensures that virtually all of the heat dissipated by the cell leaves the chamber via the flowing water.

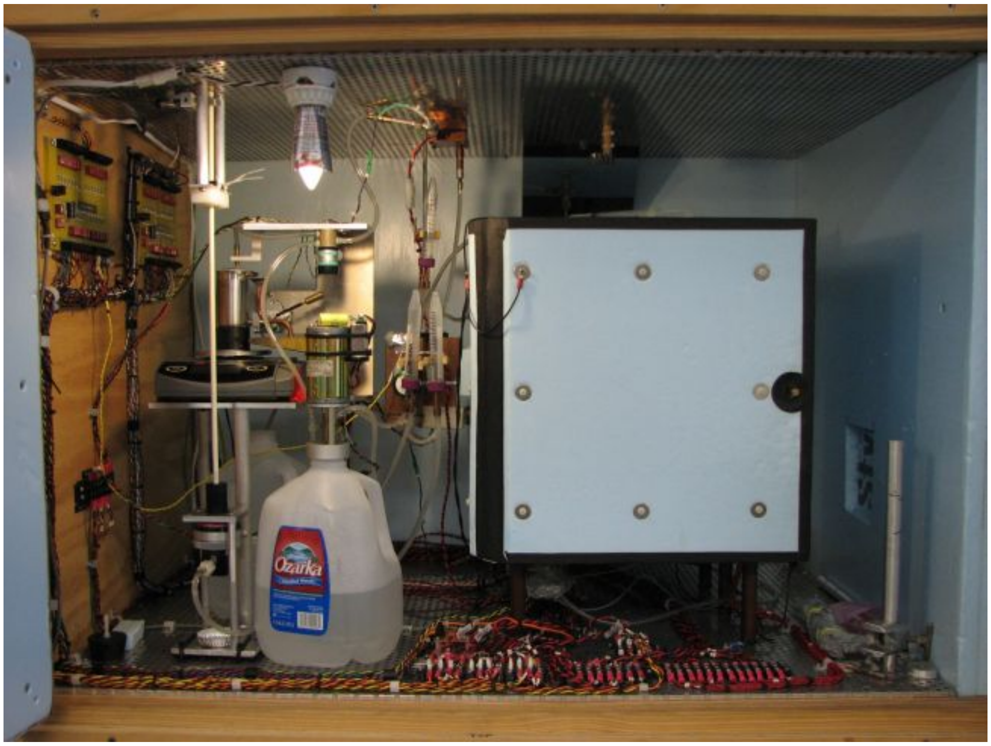
A three-stage Peltier temperature regulator (which can add or remove heat as needed) controls the temperature of the water entering the heat exchanger. A positive-displacement pump driven by a synchronous motor powered by a crystal-based oscillator produces a stable flow of about 2.5 gm/s. This flow rate gives MOAC a nominal sensitivity of about 10 W/°C. A flowmeter consisting of an automated batch weighing system measures the flow rate periodically. A large insulated environmental enclosure (EE) houses the entire system. Air circulates over the calorimetry apparatus and then is ducted to a two-stage Peltier air conditioner where its temperature is tightly regulated before it re-enters the enclosure.

Below is a photograph of the entire system. The CC is the light blue box visible inside the wooden environmental enclosure. Also visible through the door window is the water reservoir and the flowmeter. Under the computer bench is a bank of DC power supplies. Under the bench that supports the EE is the water reservoir and heat exchanger for the Peltier air conditioners.

A color video camera with zoom and pan-tilt functions is mounted in the laboratory to permit viewing of the calorimeter system, its computer screens, and its peripheral equipment. Audio monitoring is also available. The camera is publicly accessible and controllable via the Internet.

## Environmental Enclosure

The EE is the temperature-controlled housing for the water flow system and the CC. Below is a photograph of the workspace of the EE. On the left is the flowmeter and water reservoir (gallon jug). On the far left at the bottom is the positive-displacement pump. On the right is the CC. In the foreground at the bottom are the terminal strips that provide all electrical connections to the interior of the CC.




The EE is a 19 mm thick plywood shell lined with two layers of 19 mm thick rigid polystyrene foam insulation that has a thermal conductivity of 0.036 W/m/K. Estimated heat leakage from the laboratory room is 22 W for a 3 °C temperature difference between the room and the enclosure interior. Exterior dimensions of the enclosure are 1.5 m wide by 1.15 m high by 0.77 m deep.

The EE has two plenums, an air conditioner, and a main workspace. The workspace is 1 m wide by 0.66 m high by 0.66 m deep. Grilles form the ceiling and floor. The grilles are 6.35 mm aluminum plates perforated with 6.35 mm diameter holes on a staggered 12.7 mm pattern. The holes permit airflow through the workspace and provide a means of mounting equipment. Three of the walls of the workspace are solid and the fourth wall has a removable insulated door. A triple-glazed window in the door permits viewing the interior. The two plenums are located above and below the workspace. The air conditioner forms the left-hand portion of the EE. The plenum above the ceiling grille collects return air and is connected to the inlet of the air conditioner. The outlet of the air conditioner connects to the plenum below the floor grille. Four 2.94 m3/min fans move the air from the return air plenum into the air conditioner. The fans operate from regulated DC power to minimize speed variations. Each fan dissipates approximately 5 W. Removable insulated panels cover the air conditioner and plenums.

The temperature of the EE is controlled by a two stage Peltier air conditioner. The first stage contains two dual-element Peltier assemblies while the second stage has a single dual-element assembly. Each assembly consists of two commercial Peltier devices of nominal 50-watt capacity sandwiched between a substantial, finned aluminum heat sink and a water-cooled copper block. Each fan on the Peltier assemblies dissipates approximately 5 W. Baffles in the air conditioner improve the air mixing by adding turbulence. Temperature sensors between stages and at the outlet provide signals for regulation of the air temperature. Additional sensors monitor the temperature of the EE air at the ceiling and at the inlet to the air conditioner.

The water circuit for these Peltiers consists of a 114-liter vessel, a small circulating pump, and a fan and radiator assembly. The large external vessel serves as a thermal capacitor, reducing the effect of sudden changes in room temperature.

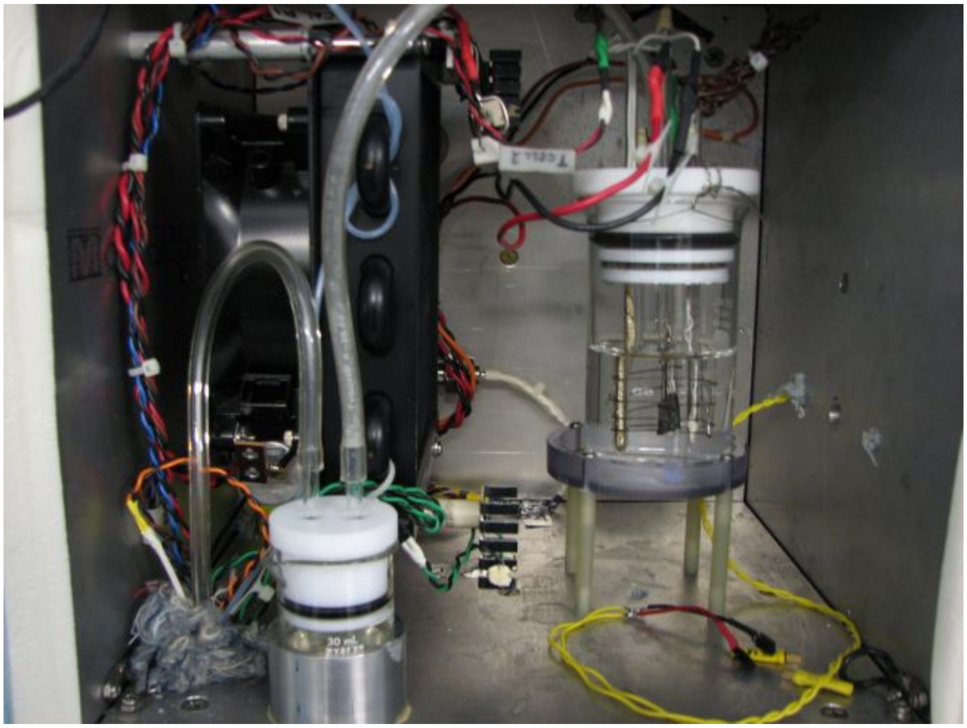
The capacity of the EE air conditioner is adequate for CC dissipation of about 20 W plus the other heat sources in the EE. The additional loading of the air conditioner comes from the flowmeter equipment, circulating fans, ohmic losses in the electrical circuits, Active Insulation (AI) heaters, EE light, and heat ingress from the laboratory room. The air conditioner maintains the EE at 24.5 °C for most experiments. The control system permits a smooth transition between cooling and heating, minimizing temperature lag and overshoot. The Peltier assemblies also provide enclosure heating when needed. The relative humidity in the EE is about 45% at 25 °C. Under these conditions, the dew point is approximately 15 °C. We have not observed condensation on the air conditioning cooling assemblies. Condensate drains are not used.

Dow Chemical Company Styrofoamâ; Extruded polystyrene foam insulation board; R = 3.75 ft2h°F/Btu; (www.dow.com/styrofoam)

Melcor Corporation; Type CP 1.4-127-06L; 6 Ampere, 51.4 watts at DT = 0; (www.melcor.com)

## Calorimetry Chamber

The CC is a cubical chamber located within the EE. Below is a photograph of the interior of the CC. On the right is the cell, in this case our standard calibration cell. On the left is the liquid-air heat exchanger and fan. Between the heat exchanger and the cell is the permanent calibration heater. In the foreground at the bottom is a liquid trap that collects any liquid ejected from the cell and protects the pressure measurement sensor located outside the enclosures.



Each wall has an interior 6.35 mm aluminum panel, covered by two layers of 19 mm rigid polystyrene foam insulation. An additional 6.35 mm aluminum panel is attached to the outer surface of this insulation and a final layer of 19 mm rigid polystyrene foam insulation covers the entire assembly. Rigid PVC angle material holds the panels at the edges and provides a slight separation. This arrangement makes the panels thermally independent. The inner dimensions of the chamber are 25 cm by 25 cm by 25 cm. The outer dimensions of the chamber assembly are approximately 35 cm by 35 cm by 35 cm. The front of the CC is a gasketed and insulated hinged door with mitered edges that fit snugly with the adjacent sides of the chamber. The CC is attached to the bottom grille of the EE by four 14 cm long by 19 mm diameter phenolic stand-offs.

The walls of the CC form the Active Insulation (AI). Each outer aluminum panel has 16 series-connected 1 Ω resistors attached to its surface that act as heaters. An imbedded temperature sensor is located at the center of each outer panel. A corresponding sensor is located at the center of the adjacent inner panel. The heating resistors connect to the outputs of six independent feedback-loop controllers. The set point for each feedback loop is the temperature of the inner aluminum panel. With this arrangement, the output of each controller forces the temperature of each outer panel to match that of the corresponding inner panel. The term "Active Insulation" (AI) refers to this temperature-tracking technique. The technique produces near-adiabatic conditions. In other words, no heat transfer to or from the CC interior takes place through the chamber walls.

There are several components inside the CC. A liquid-air heat exchanger and circulating fan occupy the left side of the chamber. A regulated DC voltage operates the heat exchanger fan. A tachometer sensor within the fan permits monitoring of the fan speed by the system software. The fan speed varies slightly with chamber temperature as the air viscosity changes. At constant temperature, the nominal fan speed is 1600 RPM, with a one-sigma standard deviation of about 0.2 RPM. We avoid a variable power contribution to the calorimetry measurements by deliberately leaving the fan speed unregulated. Fan power dissipation remains close to 0.86 watts during experimental runs. Between the heat exchanger and the open area where cells are located is the permanent calibration heater. Typically, a stand constructed of phenolic is attached to the bottom panel to hold the cell in the approximate center of the open space of the chamber and permit free circulation of air around it.

There are ports in the chamber walls for electrical connections, optical instruments and gas and liquid handling. Two ports are located on the bottom of the chamber to admit wiring for the heat exchanger fan, calibration resistors, cell power, AI panel heaters, and temperature sensors for the cell and AI panels.

Three small optical ports are located on the right side of the CC. One port is primarily used for a borescope to allow viewing of the cell. A matched port is located in the side of the EE allowing borescope access from the laboratory outside the enclosure. A small video camera optionally attaches to the borescope. The other two ports were designed for a laser or other device to illuminate a portion of the cell. A small phenolic tube in these ports, closed at the ends with microscope cover glasses, reduces heat transfer and provides a clear optical path.

In order to prevent dangerous pressures inside closed cells, MOAC has an automatic cell venting system. A 3 mm I.D. PVC tube connects the cell, through a liquid trap in the CC, to a capacitance manometer and solenoid relief valve outside of the EE. The manometer output is monitored and recorded by the main computer. Pressures outside of the range 700 Torr to 800 Torr trigger the opening of the solenoid valve. This valve is normally open which ensures that in the case of power failure, the valve stays open. A syringe or other volumetric device connected to the pressure line permits the determination of the total headspace volume as well as providing an indication that the cell is sealed.

Some experiments require periodic additions of fluid to the cell. A 1.6 mm I.D. TFE refill tube runs from the interior of the CC to the outside of the EE, where it can be connected to a syringe. The interior end of the refill tube connects to the cell when required, allowing it to be refilled during operation without opening the calorimeter. A retainer prevents displacement of the syringe plunger by the pressure in the cell.

Caddock Electronics, Inc.; Type MP915; 1 ohm, 1%, MF, 15W, TO-126 (www.caddock.com)

Lytron Corporation; Model 6105 G1SB Copper Tube Heat Exchanger; (www.lytron.com)

MKS Instruments Inc.; Baratronâ Capacitance Manometer; Model 222BHS-B-B-1000; (www.mksinst.com)

## Water Loop

Distilled water flows in a recirculating loop and serves as the medium for heat removal from the CC. Accurate power measurement depends upon a stable and accurately known flow rate. The use of a positive-displacement pump and a precision flowmeter produces excellent results. The entire calorimetry water loop is within the temperature-controlled environment of the EE.

The calorimetry water loop consists of a heat exchanger, three temperature regulators, a flowmeter, a circulating pump, a stirred reservoir, and three air traps. Water enters the CC and passes through the heat exchanger where it collects heat from the experiment. After leaving the CC, the water passes through an air trap and into the first-stage temperature regulator. The water then passes though the flowmeter and into a stirred reservoir. From there, the water is drawn through the second air trap into the pump and out into the third air trap. Finally, the water circulates into the second- and third- stage temperature regulators before entering the CC again.

Temperature sensors are located at the boundary of the CC in both the inlet and outlet lines. The temperature at each point is determined by averaging the readings of a pair of sensors. The inherent offset between the inlet and outlet sensor pairs was measured prior to their installation and is used in power calculations.

For regulation of the calorimetry water temperature, three single-element assemblies were constructed with a Peltier device sandwiched between two copper blocks. One copper block in each assembly is made with a labyrinthine water passage and fitted with copper inlet and outlet tubes for connection to the flow loop. The first-stage regulator is attached to the ceiling grille and thus delivers the bulk of the heat extracted from the CC directly to the EE air conditioner. The second-stage and third-stage regulators, which make only small changes in the water temperature have a larger copper block that serves as a heat sink and thermal capacitor to minimize sudden changes in the cooling or heating characteristics of the regulator. With the entire calorimetry water loop located within the controlled temperature of the EE, the water temperature is maintained close to the desired heat exchanger inlet temperature. This allows the second-stage and third-stage temperature regulators to run in a lightly loaded, near-idle state.

The water flow rate is measured by a mechanism consisting of a 100 ml cup secured to the platen of a digital balance. The cup fills with calorimetry water when a diverter valve is operated for a precisely timed period. The cup is weighed just before each filling to determine the tare. After filling and settling, the cup is again weighed to determine the gross weight accumulated during the timed fill period. When the weight has been measured, the cup is drained into a small dump pan from which the water returns to the reservoir. The calorimetry water stream is diverted to the cup only during a flow rate measurement. Otherwise, it bypasses the cup and flows directly to the reservoir. The cup dump valve is operated by a motor-and-lever mechanism that is arranged to remain clear of the cup during the taring and weighing portions of the flowmeter cycle. The digital balance is connected to the main computer through a serial communications port. The main computer software controls the flowmeter cycle by the use of a crystal-based counter-timer function, avoiding timing uncertainties associated with the computer operating system delays and the computer clock. Measurement time and related delays are set so that sufficient time is allowed for settling of disturbances caused by the filling and dumping of the flowmeter cup. A complete cycle of the flowmeter takes about 1.5 minutes. We typically observe one-sigma deviation in the measured flow rate of about 0.0005 gm/sec, which is 0.02% relative.

The positive-displacement pump is a modified commercial device. It has a ceramic piston that rotates and reciprocates in a ceramic cylinder. Displacement is adjusted by changing the angle between the pump head and its drive shaft. At 1800 RPM and the current angle setting, the mass flow rate is about 2.47 gm/s. The pump is located at the lowest point in the process loop. The manufacturer’s seals were removed to reduce friction, which was found to be variable and to produce as much as one watt of heating of the pumped water. Absence of the seals has not caused leakage or permitted air ingress. The pump is driven by an AC synchronous motor that is mounted outside the EE to remove its significant heat load from the Peltier air conditioners. An extended shaft connects the motor to the circulating pump on the bottom grille of the enclosure. The motor is powered by a precision-frequency supply based on a 6-Megahertz quartz crystal standard.

The reservoir is a 3.8-liter plastic container of commercial distilled water located in the EE. A motor driven stirrer and the reservoir inlet and outlet connections mount on an aluminum cap that fits snugly on the top of the jug in place of the usual plastic cap. This arrangement permits rapid change of the reservoir and its contents. The inlet connection deposits the returning calorimetry water near the top of the reservoir. The outgoing calorimetry water comes from the bottom of the reservoir. A regulated DC source provides the power for the stirrer motor. A spare container of distilled water is stored in the EE for quick reservoir change without creating a water temperature disturbance.

Each air trap consists of an inverted polypropylene centrifuge tube with a stopper that holds inlet and outlet tubes. Entrained and dissolved air in the water rises to the conical upper end of the tube. The markings on the transparent tubes provide a convenient means of estimating the amount of trapped air. Most of the air is trapped in the tube immediately following the reservoir. The air traps prevent air from accumulating in the heat exchanger. A valve mounted on a tee just prior to the second-stage temperature regulator is used with a water-filled syringe to purge air from the system after maintenance.

Ohaus Corporation; Model Scout II; Digital Scale; 200 gm capacity, 0.01 gm readability, 0.01 gm repeatability, +/-0.01 gm linearity; (www.ohaus.com)

Fluid Metering Incorporated; Model RVH1CKC; (www.fmipump.com)

Oriental Motor U.S.A. Corporation; Model 3SK10A-AULA; (www.orientalmotor.com)

## Computer System and Software

Two desktop computers handle MOAC operation using Windows 2000 Professional and Labview 7 Graphical Environment Program as the basis for the calorimeter control program. The computers are designated as the auxiliary computer and the main computer.

An analog input board and an analog output board reside in the auxiliary computer. The analog input card receives signals from twenty-two thermistor temperature sensors. The analog output board provides the drive signals for eleven power operational amplifier modules. This card also provides six channels of digital on-off control for calorimeter functions

The auxiliary computer is responsible for the control of the AI panels, the second-stage and first-stage calorimetry water temperature regulators, the EE air conditioning system, as well as the measurement, display, and recording of the temperatures of the calorimetry water, the cooling air temperatures and the AI panels as well as the voltages of the Peltier devices and AI panel heaters. This software also includes on-off control of the calorimeter power supplies, the circulating pump, and the EE light.

The main computer is fitted with an analog input board, an analog output board, and a counter-timer board. The analog input card receives signals from fourteen thermistor temperature sensors and from eight voltage and current sensing circuits related to input power measurements. The crystal-based counter-timer function of the analog input card controls the flowmeter fill valve. The analog output board in the main computer provides drive signals for five power operational amplifier modules. It also provides three channels of digital off-on control of calorimeter functions. The counter-timer board in the main computer controls the monitoring, calculation, and display of the speeds of the heat exchanger fan and circulating pump motor. The use of the crystal oscillator on the counter-timer board avoids uncertainties of the computer clock and operating system timing. The serial interface port on the main computer is used with the ASCII data output of the flowmeter balance.

The main computer is responsible for control of the flowmeter and regulation of the heat exchanger inlet water temperature. It is also responsible for input and output power measurements, related data analysis and statistical calculations, as well as the measurement, display, recording, and statistical analysis of other operating parameters.

The software in both computers records the experimental data to disk files. Subsequent playback of these files permits detailed examination of events that have occurred during an experimental run.

All operation of MOAC is by means of the graphical programming environment. This software provides excellent display capability and relative ease of developing complex programs using ready-made modules. Particular use was made of the PID controller functions, the statistical functions, and the data display capability. The library of standard functions was augmented with custom-made modules and formula blocks.

A feature in the graphical environment software permits publication of the current screen displays on the Internet. System operators and experimenters have a separate password-protected program for remote control, logbook entry, and emergency shutdown.

Two system computers are used. Each has an ABIT motherboard, Athlon XP2600+ CPU, 500 Megabyte RAM, 80 GB Hard Drive, and LAN Interface.

National Instruments Corporation; (www.ni.com)

Measurement Computing Corporation; Model CIO-CTR05 Counter-Timer Board; www.measurementcomputing.com

UltraVNC Ltd. UK; Virtual Network Computing Software; (www.uvnc.com)

## Temperature Measurement and Regulation

Measurement

Precise temperature measurement is essential to the operation of a calorimeter. We chose thermistor sensors because of their relatively high sensitivity, reproducibility, interchangeability, as well as small size and short time constant. The temperature sensors in MOAC are 10K Ω (at 25 °C) commercial thermistors. These are negative temperature coefficient devices with a guaranteed interchangeability of 0.1 °C, and a stability specification of 0.011°C aging per year at 75 °C. Observed stability in the calorimeter is considerably better, likely due to the low operating temperature, absence of physical stress, and avoidance of higher temperatures during handling and installation.

Nonlinearity of the thermistor temperature-resistance characteristic requires use of the Steinhart-Hart equation and its empirically derived coefficients to determine temperature. A voltage divider with the thermistor as the lower element and a ±50 ppm/°C precision 10K Ω fixed resistor as the upper element provides the means of resistance measurement. A highly regulated 2.5 V DC voltage supplies the divider. The thermistor signal is very close to 1.25 V at 25 °C. The signal from the voltage divider tap is fed into an analog input on the computer. Use of a relatively low voltage across the sensors reduces self-heating. Thermistor dissipation is less than 0.0002 W. The software converts the non-linear thermistor voltage signal to temperature. The conversion requires accurate values for the voltage applied to the voltage divider and for the fixed resistance in each channel. These values were determined during fabrication of the individual dividers and of each regulated voltage source. Each fixed resistor was measured at 27 °C with a reliable instrument and its value entered into the software. Each voltage regulator output was measured to obtain its actual output voltage and its temperature coefficient. For the two voltage regulators used in the MOAC system, one has a temperature coefficient of -0.0035%/°C and the other has a coefficient of +0.0056%/°C. Both values are consistent with the manufacturer's specifications.

Two precision voltage regulator circuit board assemblies are mounted in the temperature-controlled portion of the EE. Each assembly accommodates up to 24 sensors. Some of the unused channels are fitted with fixed resistors instead of thermistors, to permit monitoring of the condition of the voltage regulator and to provide an indication of the noise floor of the temperature measuring system. Care has been taken with the sensor wiring to avoid ground loops and noise pickup. The sensor signals are connected to differential inputs of the analog boards in the computers.

Regulation

Temperature regulation is of critical importance in the design of a precision calorimeter. Heating and cooling capability is necessary for the EE and for the regulation of the calorimetry water temperature. Proportional instead of "on-off" control is employed.

A bipolar drive signal is fed to each Peltier element to provide a smooth transition between cooling and heating. Each element is driven by its own power operational amplifier assembly. These modules have a voltage gain of 2.4, originally chosen so that an input signal of 0-5 V would produce an output signal of 0-12 V for the Peltier element. The input signal range was later changed to 0-6 V to permit the application of more than 12 volts to the Peltier, a change necessitated to overcome circuit losses caused by the resistance of the wiring. Each assembly uses Peltier elements of nominal 50-watt capacity.

The signals from the temperature control sensors are fed into the analog input boards in the system computers. The software uses each signal as the process variable input of a software proportional-integral-derivative (PID) controller with a programmable set point. The output of the PID controls the signal generated by the computer's analog output board. The analog output drives the input of the power operational amplifier module. A closed feedback loop is created by this arrangement. The thermal time constants of the various temperature regulators differ, making it necessary to tune the individual PID controller. Controller tuning was accomplished empirically by observing the response of each regulator to step changes in its set point or load.

The closed-loop regulation scheme achieves exceptionally close control of temperature. We typically observe one-sigma deviations of 0.001 °C for the temperature of the water leaving the second-stage regulator and 0.0007 °C for the temperature of the water leaving the third-stage temperature regulator. For the EE air conditioner, we typically observe one-sigma deviations of

0.0015 °C for the temperature at the outlet. For the active insulation, temperature differences between the inner and outer panels of the AI are about 0.0002 °C when equilibrated.

MOAC uses twelve power operational amplifier modules to control the six AI panels, the three EE air conditioner Peltier assemblies, and the three water temperature regulators. Power is obtained from linear power supplies to avoid noise problems that can arise from switching-type power supplies. Six linear supplies are used for the AI and Peltier assembly power sources. A seventh linear power supply is used with the operational amplifier modules that control the power to the calibration resistors and the cell.

- Betatherm Corporation; Type 10K3A1A Thermistor; (www.betatherm.com)
- I.S. Steinhart & S.R. Hart in "Deep Sea Research" Vol. 15, p. 497 (1968).
- See also: ww.http://www.betatherm.com/stein.htm) for further information specific to Betatherm thermistors.
- The general form of the equation is: 1/TK = A + B(ln(R)) + C(ln(R))3 .
- For the Betatherm 10K3 thermistor, A = 1.129241×10-3; B = 2.341077×10-4; and C = 8.775468×10-8, for calibration points at 0°C, 25°C and 70°C.
- Vishay; BC Components; Type BC207C-F; 1%, 0.4 W, Metal Film; (www.vishay.com/company/brands/bccomponents)
- Keithley Instruments Inc.; Model 2000 Digital Multimeter; 6.5 digits
- National Semiconductor Corporation; Type LM723 Voltage Regulator
- National Semiconductor Corporation; Type LM12CL 80 Watt Operational Amplifier
- Measurement Computing Corporation; Model PCI-DAS6033 16 Bit, 64 Channel Analog Input Board
- Measurement Computing Corporation; Model PCI-DAC6703 16 Bit, 16 Channel Analog Output Boar

## Power Measurement

CC Input Power

Operational amplifier modules are used for control of the cell and for control of two calibration resistors. These modules are in closed feedback loops similar to those used with the temperature regulation channels. Input power is determined by the input voltages and currents of the devices within the CC:

Pin = Vin × Iin  (1)

where Vin is the voltage at the boundary of the CC, and Iin is the current through the device. In the case of multiple devices, the total power is the sum of the individual device dissipations.

A four wire sensing configuration is used for voltage measurements. The sensing connection is made to the terminal block points to which the load device wires are connected. The measurement reflects only the voltage at that point and a correction must be applied to compensate for ohmic losses, even in the relatively short wires from the terminal block to the boundary of the CC. The voltage sensing wires are connected to 2:1 resistive dividers mounted on the terminal block and run to the differential inputs of analog input boards in the system computers.

The voltage divider arrangement is necessary because some experiments require application of voltages beyond the 10 V limit of the analog input channels. The voltage dividers are constructed with ±50 ppm/°C, 10K Ω precision metal film fixed resistors. The resistors used in each of the dividers were measured with a reliable instrument and paired. The divider ratio was calculated and entered into the voltage measurement portion of the software.

Current is measured as a voltage drop across a resistor in series with each device. For each current measurement, a ±50 ppm/°C precision fixed 1 Ω power resistor is used, except for the cell current where a 0.5-ohm resistor is used to accommodate higher device currents. Voltage sensing wires are connected to the terminals of each current sensing resistor and run to the differential inputs of analog input boards in the system computers. This is also a four-wire configuration. Insertion of the series current sensing resistor results in a voltage drop between the terminal block and the CC boundary, which is corrected for in the software. Measured values of the sensing resistors are used in the current measurement portion of the system software. The current sensing resistors are mounted to the floor grille of the EE for heat dissipation and temperature stability.

The resistances of the connecting wires between the measurement points and the load points were determined by measuring the length of the each pair of wires and calculating their resistance from the known 0.004016 Ω per foot resistance of the 16 gauge copper wire. The wire resistances are entered into the device power calculations in the software.

Wires that connect the load devices to the terminal blocks dissipate a small amount of power. Inside the CC, this power appears as heat to be absorbed in the heat exchanger, and is not distinguished from the dissipation of the load devices. Outside the CC, the heat is lost to the EE environment and does not enter into the power calculations.

In addition to the measurements of the actual resistance values used in the power measuring circuits, the voltages and currents were measured with independent instruments and found to agree well with the corresponding values measured by the analog input boards and associated software.

CC Output Power

The rise in water temperature across the heat exchanger and the mass flow of the water are used to determine the power dissipated in the CC:

$$P_{flow} = DT \cdot G \cdot c \quad (2)$$

where: DT = Tout – Tin + Sensor Offset; G = the mean flow rate in gm/s; and c = 4.1796 J/gm-°C at 25 °C. The values Tout and Tin are the averages of the temperatures indicated by the individual sensors in each dual-thermistor sensor assembly at the boundaries of the CC. With no heat source in the chamber, the difference between the outlet and inlet water temperatures should be zero. Small differences in the sensors create an offset between the inlet and outlet temperature indications at zero power that must be taken into account in the calculation of DT.

For calibration, accurately known electrical power levels are applied to any or all of several devices inside the CC. First, the permanent calibration heater, R1, is always employed so that the calibration may be checked at a later date no matter what changes have been made to the cell. Second, a standard electrolysis cell, made with Pt-Pt electrodes and $H_2O$-$H_2SO_4$ electrolyte with Pt catalyst recombiner in the headspace, is operated to provide a heat source that closely mimics a real cold fusion cell. Third, another calibration heater, R2, is immersed in the electrolyte of the cell to provide yet another heat distribution for calibration purposes. These three heat sources are operated singly and in combination at different power levels for extended periods to acquire the calibration data. The readings are used in a statistical regression analysis to obtain the slope, intercept, and quality of fit of the calibration curve. Coefficients a (intercept: watts) and b (slope: dimensionless) are obtained. The coefficients are then used in the calorimeter power equation:

Pflow(cal) = a + b·Pflow + wire loss (3 )

The term wire loss is the effect of the thermal conductivity of the copper wires entering the CC through the bottom ports. Each bundle of wires has temperature sensors imbedded where the wires pass through the inner and outer aluminum panels of the CC. The wire cross-sectional area, length, thermal conductivity, and temperature difference between the inner and outer surfaces are used to calculate the wire loss correction term. The thermal conductivity of the vinyl insulation on the wires was ignored because it is only about 10-4 of the conductivity of the copper conductors. When 10 W is dissipated in the chamber, the wire loss is typically about 60 mW.

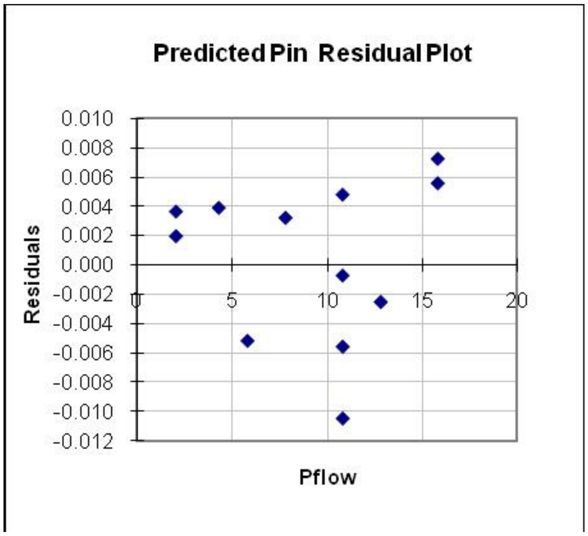
Panasonic Type ERO-S2PHF1002; 1%, 0.25 W, Metal Film; (www.panasonic.com/industrial/components)

Caddock Electronics, Inc.; Type MP930; 1%, MF, 30W. TO-220

## Performance

The primary measure of MOAC's performance is its overall measurement accuracy. When recently calibrated, MOAC can achieve the original design goal of +/- 0.1% relative accuracy. The table below shows a typical calibration regression result which provides the coefficients a and b for equation 3.

| | | |
|---|---|---|
| Regression Statistics | | |
| Multiple R | 0.999999281 | |
| R Square | 0.999998562 | |
| Adjusted R Square | 0.999998431 | |
| Standard Error | 0.005744603 | |
| Observations | 13 | |
| Coefficients | Standard Error | |
| a | 0.010942798 | 0.00372184 |
| b | 1.000451508 | 0.000361737 |
| RESIDUAL OUTPUT | | |
| Heat Source | Predicted Pin | Residuals |
| 10R1 | 10.8512 | -0.0007 |
| 10R2 | 10.8603 | -0.0105 |
| 10E | 10.8561 | -0.0056 |
| 5R1 | 5.8569 | -0.0052 |
| 1.25E | 2.1028 | 0.0020 |
| 1.25R1 | 2.1015 | 0.0037 |
| 3.5R1 | 4.3506 | 0.0039 |
| 7R1 | 7.8507 | 0.0032 |
| 10R1 | 10.8482 | 0.0048 |
| 10R1+5R2 | 15.8447 | 0.0073 |
| 5R1+5R2+5E | 15.8437 | 0.0056 |
| 12E | 12.8519 | -0.0025 |
| 10E | 10.8572 | -0.0062 |




Note how close the value of b is to unity. This demonstrates the fundamental nature of this approach to calorimetry and also shows that MOAC's thermal design is successful in removing heat from the chamber only via the flowing water.

Another important aspect of performance is specimen versatility. MOAC excels in this area by producing precisely the same reading on a wide variety of heat sources. The size, shape, temperature, and location within the chamber have very little effect on the measurement.

In the table above above, note how closely the various heat sources (R1, R2, and E – electrolysis power) fit the calibration line. This is a clear demonstration of MOAC's excellent specimen versatility. We also conducted a location study in which a calibration heater was operated at 15 watts at several different locations within the CC. For all the reasonable locations, the difference between electrical input power and heat output power was 12 mW or less (i.e. within 0.1% relative). When the calibration heater was placed in one of the extreme corners of the chamber, the heat output power read 25 mW lower than the electrical input power (i.e. a 0.2% error).

Errors

MOAC exhibits both random and systematic errors. The random errors appear to be a combination of electrical noise and digital granularity in the temperature measurements. This conclusion is supported by the fact that fixed precision resistors located within the environmental enclosure report about the same jitter as the thermistors. Even with 100-reading averages comprising each observation, these errors produce a jitter in the temperature signals of about +/- 0.0005 °C. Given MOAC's 10 W/°C sensitivity and the fact that inlet and outlet water temperatures are measured independently, this jitter corresponds to almost +/- 10 mW in the heat output power signal. Fortunately, MOAC's thermal time constant is about one hour so it is permissible to apply additional averaging to the signals to reduce this jitter to negligible levels.

The systematic errors are more complex. When MOAC was first commissioned in the summer of 2004, it readily achieved 1% relative accuracy. However, numerous systematic errors prevented it from approaching the design goal of 0.1% accuracy. It took nearly 2 years of intensive testing and evaluation to find and eliminate these errors.

For the first few months of operation we observed mysterious perturbations in the heat output power reading. Usually the reading would slowly recover to the value before the disturbance. We finally determined that these perturbations were due to the sudden expulsion of an air bubble in the liquid-air heat exchanger in the CC. When the bubble departed, the wetted area of the heat exchanger was suddenly increased, which increased its efficiency and thus cooled the contents of the chamber slightly. We solved this problem by installing three air traps at strategic locations in the calorimetry water loop. The trap located just after the water is drawn from the stirred reservoir collects the most air and must be emptied every two or three months.

Another problem that caused noticeable short-term drift was instability in the water flow rate. We initially constructed MOAC with a pump system from FMI that was advertised to provide a highly stable flow rate. Once we identified pump speed variations as the problem we abandoned the FMI controller and tried a custom closed-loop speed control that employed a digital tachometer. That worked better but the brushes in the DC pump motor caused undesirable speed perturbations. After trying another type of DC motor with similar results we abandoned DC motors altogether and installed a synchronous AC motor powered by the 120VAC 60Hz mains. Small line frequency variations were clearly visible in the measured flow rate. Finally we conquered the flow rate stability problem by constructing a crystal-based 60Hz power supply for the synchronous motor. The result is a flow rate whose stability is typically +/- 0.02% relative.

For the first 6 months of operation, MOAC required a b calibration coefficient of approximately 1.01. In other words, we were losing 1% of the heat from the chamber. We tracked this loss down to the power and signal wires passing through the walls of the chamber. We initially thought that the active insulation system would eliminate losses in these wires because the temperature difference across the walls is forced to be zero. However, our wire bundles were not adequately thermally clamped at each wall so ambient air temperatures were having an unexpected influence. We solved this problem by instrumenting the wire bundles with temperature probes located at each wall of the CC. The measured temperature difference from these probes is used to calculate the wire loss term used in equation 3. After this correction was implemented, the b coefficient typically comes out between 0.999 and 1.001; in other words, within 0.1% of unity.

A number of other issues have been identified and addressed over MOAC's four-year operating history. For example, we have struggled to find a suitable gasket for the calorimetry chamber door. Several designs were tried and some of them caused noticeable heat leaks. It must be remembered that a 0.5% loss is easily noticeable in a calorimeter that is expected to achieve 0.1% accuracy.

At the time of this writing, MOAC is quite reliable and readily achieves 0.1% accuracy when recently calibrated. The largest remaining source of error is the drift exhibited by the thermistors used for the critical inlet and outlet water temperature measurements. The observed drift is usually quite slow and is only a fraction of the manufacturer's specification. That is, the thermistors are performing significantly better than the manufacturer's guarantee but we can still see their drift. Because of this drift, MOAC typically requires recalibration, usually only a change in the a term, once every month or two.

## Interesting Results

One of the primary reasons we constructed MOAC was to verify the excess heat effect in the laser-stimulated cold fusion cells of Dennis Letts. In Letts' laboratory, his cells often exhibit the Letts Effect, a sudden rise in electrolyte temperature in response to illuminating the Pd cathode with only ~20 mW of red laser light. According to isoperibolic calorimetry, this electrolyte temperature rise corresponds to an increase in heat output of 250-500 mW. However, isoperibolic calorimetry is generally not as reliable as flow calorimetry. Isoperibolic calorimetry is critically dependent upon the thermal coupling between the electrolyte and the surround air. This coupling is affected by parameters that are not necessarily stable. Examples include the convection current patterns in the electrolyte, circulation patterns in the surrounding air, bubbles adhering to the cell walls, and deposits of other material on the cell walls.

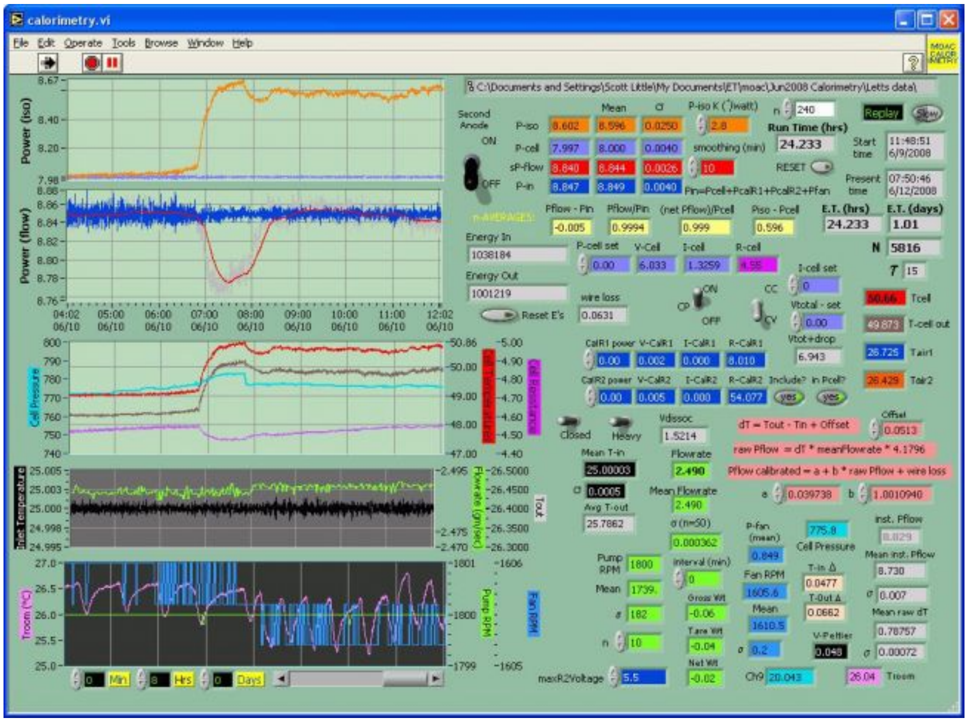
MOAC was specifically designed to permit operation of the Letts cell with both isoperibolic and flow calorimetry measurements occurring simultaneously. The observation of essentially the same excess heat signal in both measurements would verify that the Letts Effect was real excess heat.

Over the past four years Letts has run a number of cells in MOAC but none have produced a robust example of the Letts Effect. Because of this frustrating situation, we have not been able to use MOAC to determine whether the Letts Effect represents real excess heat or not.

However, we have observed some significant differences between isoperibolic and flow calorimetry results that deserve attention. Figure 5 shows MOAC's main computer screen during a run with a Letts cell. No lasers were used in this experiment. The plots depict an eight-hour period during which the electrical input power to the cell was constant at 8 W. The uppermost plot shows the isoperibolic calorimetry results. The vertical scale is 0.2 watts/div. The blue line is the electrical input power and the orange line is the heat output power as computed from the temperature difference between the electrolyte and the air around the cell inside the CC. Note the sharp increase that occurs around 0700. The heat output power, which was closely matched with the electrical input power, rises to a value about 600 mW greater. This is typical of the sudden rise that occurs in the Letts Effect but, in this case, there was no laser stimulation of the cathode. This event was spontaneous and, from the isoperibolic data alone, looked exactly like the sudden onset of 600 mW of excess heat.

The next plot down shows the flow calorimetry results. The vertical scale is 0.02 W/div. Again the blue line is the electrical input power but now it is about 0.85 W higher because it includes the power to the heat exchanger fan. The red line is the heat output power from the flow calorimetry. Instead of rising like the isoperibolic result, it dips and then returns to its original value. There is no sign of excess heat, especially not 600 mW, which would have driven the red line off the scale.

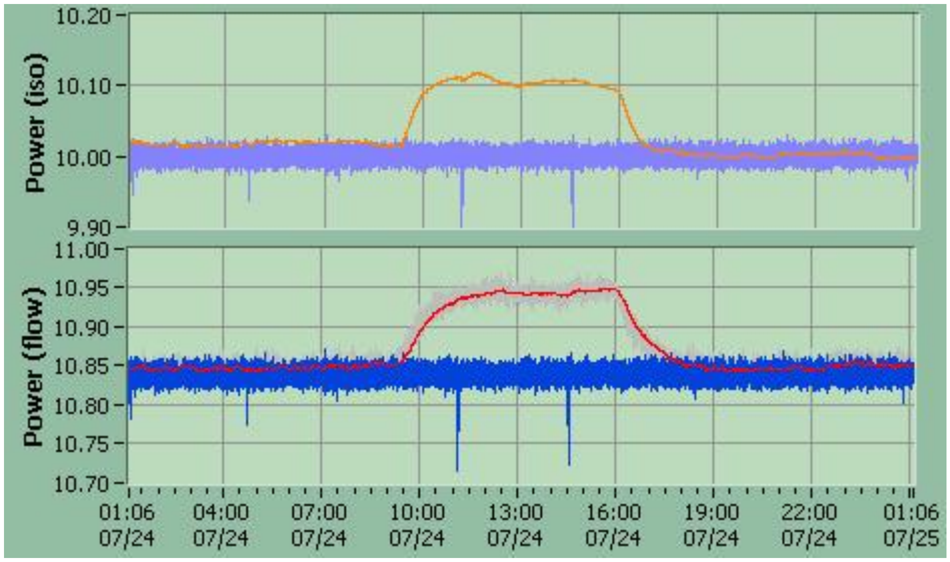
The middle plot shows the two electrolyte temperature probes (red and brown traces), which behaved similarly; cell pressure (cyan), which rose slightly during the event; and cell resistance, which dropped slightly. The next-to-bottom plot shows the flow rate (green) and inlet water temperature (black), both of which were very steady at all times. The bottom plot shows room temperature (pink) and the heat exchanger fan speed.




Unfortunately, none of these supporting data help us understand why the cell behaved as it did. But the top two plots are sufficient to understand what happened. This event was caused by a relatively sudden decrease in the thermal coupling coefficient between the electrolyte and the surrounding air. As the change occurred, electrolyte temperature necessarily rose to reestablish dynamic equilibrium. Because electrolyte temperature was rising, the internal energy of the electrolyte was increasing. Since the input power was constant at all times, Conservation of Energy required the heat output power to decrease accordingly, hence the behavior of the flow calorimetry data. This example clearly demonstrates the value of simultaneous calorimetric measurement by independent methods.

Simulated Excess Heat

To date, our operating experience with MOAC has been singularly devoid of opportunity to observe real excess heat signals. However, using R2, the calibration heater immersed in the electrolyte of our standard calibration cell, we can simulate an excess heat signal to see how MOAC responds. Figure 6 shows both the isoperibolic and flow calorimetry results for a 24-hour period during which our standard cell was operated at 10 W of electrolysis power.




At about 0900, a voltage was applied to R2 that caused the dissipation of an additional 100 mW in the electrolyte. To make this signal look like excess heat, the software was configured so that this power was not included in the plotted value of the electrical input power. As you can see, both the isoperibolic and flow traces rise up 100 mW above the electrical input power. At about 1600, the simulated excess heat signal was turned off. Clearly MOAC is capable of quantifying excess heat signals of this magnitude.

## Appendix B. Interview of Scott Little.

### Appendix B1. Scott Little Interview for LENR Research at EarthTech, Part 1

Tom Grimshaw: Scott, are you there?

Scott Little: Yes, I am, Tom.

Tom Grimshaw: Okay, good. I'll do the introduction here. This is Tom Grimshaw. I'm speaking with Scott Little, and it's in the nature of an interview. We're going to be talking about Scott's adventures with cold fusion and his research into that field from the time it was announced in March of 1989 up until the last involvement.

Scott, I would mention that today is November 22nd. We're starting at about 3:00 in the afternoon. The purpose of the interview is, we hope that it'll be part of a project to document Scott's research in what I call the LENR Research Documentation Initiative. This will be another project of that initiative, and it will join other projects that are being done with other cold fusion investigators in the years since the announcement.

Scott, without further ado, why don't you start by noting maybe a little bit about what you were doing at the time of the March 1989 announcement, how you heard about it, and then what you did after you heard about it.

Scott Little: All right. At that time I was general manager of Asoma Instruments, A-S-O-M-A, a small company devoted to the design and manufacture of X-ray fluorescence analyzers located in Austin, Texas. I had a number of colleagues who were on the technical side of that operation. I don't remember how we heard about it. Anyway, at some point that multiply-faxed copy of that initial paper by Pons and Fleischmann ... It was hard to read, I remember, but people were getting faxes of faxes. That was back in the days of faxes, of course.

We got a copy of it. The technical group: myself, Buddy Brinkley, Dave Clifton, I think John Harlan, at Asoma were of course just fascinated and enthralled with the possibility. As an X-ray analyzer company, we had lots of pure element samples on hand. We had hunks of palladium. We had almost everything we needed just sitting there.

So, as an after-hours project, we threw together a cell and built my first waterflow calorimeter and all set it up in my garage in northwest Austin, fairly close to where the company was located. We proceeded to start electrolyzing. We bought heavy water. We started electrolyzing palladium cathodes, following the basic outline of the experiment, which we all expected to work, because they had claimed it would.

Trying to make our calorimeter work properly, we encountered all kinds of problems. I remember one time when the weather turned cold, we started getting really positive results and finally realized that it was because the ambient temperature had declined markedly, and one thing after another. That early work kind of ended in a dead end. We never got any robust positive results.

But we did attend the first get-together in Santa Fe, which I think was in May. Was it not, Tom?

Tom Grimshaw: Yes, I believe that's correct. It was a DOE-sponsored conference with an invitation primarily to government laboratories, and it was sponsored by, actually, Los Alamos at the time. I'm glad you were able to attend.

Scott Little: Yes. We went out there. We presented our null results in a poster session, and I met Ed Storms and a fellow ... I believe his name was Bob Huggins from Stanford ... who was reporting positive results with a unique cathode preparation technique that captured our interest. He was vacuum-melting the palladium under argon, under argon melting the palladium and then melting it into a little coin shape. We talked to him at great length.

We also witnessed firsthand the beginning of the row that arose over cold fusion. I forget the names of the players, but in the big conference hall for the oral presentations in a question-and-answer session, we witnessed firsthand some rather vitriolic exchanges between people who just were adamantly opposed to the idea that such a phenomenon could happen. It violates all the high-energy physics claims we know about fusion. Then, the people who were much more open-minded or else had already seen positive results were trying to defend.

We came back from Santa Fe and tried to replicated Bob Huggins' cathode preparation scheme. It's that we built a little simple apparatus for arc melting under palladium using a TIG welder as the arc. It really worked real well. I still have that little box somewhere, glove box kind of. Then those experiments also for us proved some more results. Not sure what I meant to say here. Maybe “provided some more null results”,

So, pretty soon, within months, we gave up. I returned to my normal job as an X-ray analyzer person. Let's see. I can't remember exactly how it went. Years passed. I left Asoma and went to Texas Nuclear, or TN Technologies, as manager of their analytical instrument division and there developed some other X-ray analyzers. Somewhere along that line I met Hal Puthoff, and Hal intrigued me entirely. That was the beginning of EarthTech, although I didn't know it at the time.

Hal utterly captured my fancy with his proposal that possibly zero-point energy could be tapped in some way. So, from a very humble beginning of working after hours and then gradually working up to full-time employment at EarthTech, we set out initially to try to find out a way to extract energy from a zero-point field.

Tom Grimshaw: Okay. Do you recall about when you made that transition, started working at EarthTech?

Scott Little: I think it was 1993. Because I thought I knew something about calorimetry, we developed calorimetry methods. One of the hypotheses for extracting energy from the zero point involved something called EVs, which a guy named Ken Shoulders had pioneered the work on years ago. EV stands for Electrum Validum. That's for strong electron.

The hypothesis there was that, when you make a spark discharge, the first thing that goes across the gap is not a few single electrons, but rather a ball of condensed electrons, 10 to the 10th electrons, which isn't a lot as far as current goes, because it takes 10 to the 19th to make one coulomb. A little ball would go across, and Hal had developed some kind of theory that maybe the zero point field was responsible for squeezing these together due to something called a Casimir force.

To make a long story short, we built a spark apparatus which sparked repeatedly and put that inside of a calorimeter and tried to measure the power going in and the heat power going out. Boy, was that ever a challenge, because any time you have spark discharges going on, you have ridiculous RF noise…the basis of the spark gap transmitter. It was very difficult to make careful and accurate measurements while the sparking apparatus was going on. That went on for a number of years.

It looks like, looking back at our records, in the late 1990s ... That would've been maybe five years later or four years later ... we began to despair of extracting energy from a zero-point field and we started looking at the many exciting reports that were being published in the Infinite Energy Magazine about successful cold fusion experiments.

Tom Grimshaw: Maybe I jump in with a question?

Scott Little: Yes.

Tom Grimshaw: Some people see a connection between the work of Ken Shoulders and cold fusion. Would you care to comment about that?

Scott Little: Well, right off the bat, I don't see a relationship. But, perhaps, do you happen to know anything about the mechanism that they are suggesting?

Tom Grimshaw: I do not. It's just that ... Well, for example, Dave Nagle, now at the George Washington University, has the copy of that Shoulders' report that I'm sure you're aware of or have a copy of it.

Scott Little: Mm-hmm (affirmative).

Tom Grimshaw: He understands a little bit about a possible connection. Some of the people who used to be at SKINR, Sidney Kimmel Institute of Nuclear Renaissance, have also sought a connection. As I think about it, Ed Storms did some stuff, too, with Ken Shoulders, trying to make that connection. So, those would be the ones that come to my mind.

Scott Little: I remember Ed Storms talking about on the possibility of some kind of triboelectric phenomenon, where the loading of the palladium would cause the lattice to crack, and those cracks would generate great voltages across them, which would have electrons accelerate across the gap and possibly get up the energy sufficient to create ordinary D-D fusion.

But that's not quite Ken Shoulders. Ken Shoulders is this EV thing, which is, anytime you talk about sparks, Ken would say, "Ah, yes, you've got EVs."

Tom Grimshaw: Okay.

Scott Little: Just for the record, I'll have to say that, try as I might, I could never demonstrate conclusively that there was such a thing as an EV. Compare that to Shoulders, who generated this entire book, EV: A Tale of Discovery. It's a 100-page book with page after page of results that he claims demonstrate the existence, and reality, and the phenomemon of these things called EVs.

It's kind of the story of my experimental career, is trying to confirm observations reported by others and not being successful. People can criticize me and say, "Well, Little doesn't know how to do the experiment." But there are other interpretations. I hope at least every once in a while I might be on the right side of that.

Tom Grimshaw: Yeah. Well, I would hope so. Yeah. Okay. Go ahead.

Scott Little: After struggling away with the EVs for a while, we began to realize that we should start looking at ... Our mission at EarthTech was to look for novel energy sources, and so the zero-point field was just our starting point. It would've been wonderful if it worked. But when it become apparent that it wasn't going to, we started looking at cold fusion, because that also would be wonderful.

Tom Grimshaw: Of course. Right. Yeah.

Scott Little: So, we did a number of things in no particular order. You've heard, I'm sure, of Randell Mills.

Tom Grimshaw: Yes.

Scott Little: There was a description of an electrolysis experiment in the back of one edition of his book, which kept changing, his Unified Theory of Everything book, about a fairly low power, a very low power, electrolysis experiment, and that's on our website: Attempt to Observe Excess Fusion of Nickel, Water, Potassium Carbonate System.

That experiment was significant because it was the first real firsthand experience with the phenomenon of recombination. If you operate an electrolysis cell at a low enough current, so instead of making vigorous bubbling, you produce the hydrogen and oxygen at a rate that's sufficient for them to dissolve ... at least some of the evolved hydrogen and oxygen to dissolve in the electrolyte ... you can get recombination in the electrolyte, and the gases do not leave the cell, and their caloric value does not leave the cell.

So, Mills was doing his calorimetry with the assumption that all of the H2 and O2 produced was leaving the cell, when in fact it was mostly recombining in the cell, and that was the source of his apparent excess heat.

Tom Grimshaw: Okay. Yeah. I need to jump in at this point and note that I think at that time Randell Mills was calling his company BlackLight Power, and he's since changed it to Brilliant Light Power. He's still very much active, I think, although he sought to distance himself from the cold fusion field in order to avoid the tar, as I understand it. That's hearsay.

Scott Little: I think that's right, and I haven't followed much of his recent stuff.

That was one of our early experiments, and I can talk briefly about some of the others, if you'd like.

Tom Grimshaw: Well, that would be the objective here, to kind of step through them, timeline if you can, but not necessarily.

Scott Little: Yeah. I can go roughly in order. One that's not on the list that's important for sequencing is a little involvement we had with ENECO. I was surprised to see that Ed Storms was involved with them at the outset, because by the time I met them, there was no mention of Ed Storms, possibly after the falling out or something.

Tom Grimshaw: I think that's true. Ed, he actually started with them doing literature surveys, which he had started while he was still at Los Alamos National Lab. Then they invited him to come onto the board and then to do experiments. I think that there was something that caused a falling out between Ed and Yan Kucherov 00:17:19].

Scott Little: Well, that's not surprising. Jan was a brilliant, but strong-headed Russian.

Tom Grimshaw: Right. Yeah.

Scott Little: I think Fred somebody was the general manager. Do you know that name? I can't remember his last name.

Tom Grimshaw: Well, the guy who was funding it is still around. He's in San Antonio.

Scott Little: Charles Becker.

Tom Grimshaw: Charles Becker. Thank you.

Scott Little: I know him.

Tom Grimshaw: Yeah. In fact, I met him again just maybe a year or 18 months ago. He came up [inaudible 00:17:56] National Instruments. But I don't think I can remember Fred's name.

Scott Little: Anyway, there was this guy named Fred, who was kind of a businessman-type, found out about us. At the time, Jan had gotten some experiment with gas loading going that was a complicated thing with a vacuum system, and some palladium powder in a chamber, and a heater wound around it and stuff. He was claiming to get excess heat.

I invited Fred, contacted Hal ... Hal Puthoff is the president of EarthTech ... and asked if we could possibly come up and try to validate his result, and so I did. I discovered during my visit there that Jan had a wiring problem in his power measurement circuitry. He was getting AC current into this heater, and there were two ground legs, and he only was measuring the current in one of them. So, he was missing some of the current that was running his heater. That caused him to underestimate the input power, and that was the source of his apparent excess heat.

Tom Grimshaw: Okay. I had not heard about that. I knew about Thad Spike, who had Naval Research Lab. They were also onto this.

Scott Little: Well, this was just the way it was when I was there. Maybe they changed it and tried to make it work better or something. But when I was there, it wasn't making excess heat because of this issue. Apparently, that impressed Fred. Fred was involved in organizing ICCF-7 in Vancouver, and Fred invited me to give a talk on calorimetry. It turned out to be me and Fran Tanzella doing this talk together at ICCF-7.

I decided that I would build a portable waterflow calorimeter and make it part of the presentation.

Tom Grimshaw: Oh, man.

Scott Little: I was an ambitious and energetic fellow back then. I hooked up this crazy thing ... It worked pretty well ... and took it up there. It had a pump, and temperature sensors, and all that stuff. We set it up on the podium there in front of the lecture hall and had it running while we were giving the talk. I'll never forget that, when Mitchell Swartz found out that Fred had invited me to talk, he tried to get Fred to cancel my invitation, because I don't have a PhD.

Tom Grimshaw: Oh, no. You're kidding.

Scott Little: I'm not kidding.

Tom Grimshaw: Wow.

Scott Little: Needless to say, Mitchell Swartz and I have not been good friends.

Tom Grimshaw: That's so interesting. Yeah. Okay.

Scott Little: Okay. So, the ICCF-7 happened, and that was significant because I met Dr. Case there and listened to his interesting presentation about this simple gas phase experiment with this carbon-activated charcoal catalyst that had palladium deposited on it somehow. So, I came home all excited and made an effort to replicate the Case experiment, which is one of the things on the website. We never saw the big signals that he was seeing. We saw some interesting behavior, kind of odd oscillations in the temperature. That's detailed on the website, but it never looked like any kind of an excess heat signal.

Somewhere along in there I become interested in the Mizuno incandescent tungsten experiment. I like things that have lots of power, and light, and glow, and fury, and that's a real exciting experiment. I don't know if you've ever seen it run.

You put two or three hundred volts across the cell with a tungsten cathode, and the cathode gets white hot, and the electrolyte is boiling, it really represents a calorimetry challenge, because everything is so active, and you've got this steam coming off the cell. Anyway, again we managed to get an energy balance on our experiments, but we never saw the large excess heat signals that he saw. We even got him to send us some cathodes, and I believe we sent him some. Jed Rothwell, who's got good Japanese connections, was facilitating this communication. We also got no excess on Mizuno's cathodes.

Then, if you'll look at that report on the website, there's a couple of other people who tried to replicate. Jean-Louis Naudin did one and also these other guys whose names I have a hard time pronouncing, but one of them is Clauzon. They did a replication ... Faurarque, Clauzon, and Lavelle's Replication.

That last one was interesting because the calorimetry was particularly simple. It involved simply measuring the weight loss from the cell, assuming that 2200 joules of energy has been required to evaporate every gram of water that left the cell, the heat of vaporization for water, and then that's how you figure out how much heat energy you put into it. Well, we replicated that and also did not get excess heat, because we became aware that, in addition to evaporation from the cell, the violent behavior of the cell spits out liquid water as well.

Tom Grimshaw: Well, that's not good.

Scott Little: No. It's real cheap energy-wise to spit out liquid water, much cheaper than evaporating the water or vaporizing the water. So, once again, another little example of a subtle problem that caused an error in the measurement. Somewhere along here, James Patterson and the people at CETI were claiming fabulous results. Miley was involved. There was all this talk about transmutations and fabulous, unbelievable results when you used a cathode in the form of little beads, plastic beads, coated with layers of palladium and nickel.

They were so excited about it that, to their credit, they put together a kit, which they called the RIFEX kit, and they offered this kit for sale. We bought one, and they had an orientation meeting. I think it was in Urbana-Champaign at Miley's place, the University of Illinois. We went up there, and to my astonishment, we and ... What's his name, the French guy ... were the only two-

Tom Grimshaw: [crosstalk 00:26:10]

Scott Little: Huh?

Tom Grimshaw: No, go ahead.

Scott Little: Me and ... I can't remember his right name ... the short, jovial French fellow that's been here forever.

Tom Grimshaw: Oh, you may be thinking of Jean-Paul Biberian.

Scott Little: I am. I am.

Tom Grimshaw: When you described him, it formed an immediate [inaudible 00:26:31].

Scott Little: Jean-Paul Biberian.

Tom Grimshaw: Yeah.

| | |
|---|---|
| Scott Little: | Anyway, he and EarthTech were the only two people that purchased the RIFEX kit. So, of course, we came home with our RIFEX kit and we set up this kind of complicated experiment, with electrolyte pumping through the cell and all this other stuff. We got the beads out. And we have X-ray fluorescence. Because of my prior experience with X-ray fluorescence, I resort to that whenever possible. We had an X-ray analyzer at EarthTech, so we were able to do elemental analysis on the beads real easily.<br><br>Now, Miley did mass spectrometry too, but we didn't have that, but we could certainly do the elemental analysis with the things. Right away we started seeing a bunch of different things on these beads, and it's in our report. We tracked every singly one of the new elements that appeared on those beads down to various sources of that element somewhere in the apparatus, in the electrolyte loop.<br><br>It's not surprising that those elements would end up on the beads, because the beads are the cathode, and the operation of an electrolysis cell is to deposit all the cations in solution onto the cathode. So, if you have anything dissolved in that electrolyte, it's concentrated onto the cathode. We made a point of that in our report, that even as little as one part per million of the contaminant in the original electrolyte would make a detectable amount of stuff on the cathode if you electrolyzed it for a long time to deposit every bit of it onto the cathode. |
| Tom Grimshaw: | Right. |
| Scott Little: | So, another one chalked up to the null report list. |
| Tom Grimshaw: | Right, right. |
| Scott Little: | Dash-Zhang: John Dash ... I think it was somewhere in Oregon ... and his Chinese graduate student, Zhang, visited the lab. They had this experiment. It was, as I recall, pretty much an ordinary Pons and Fleischmann-type cell with recombiner pellets. Those pellets were pretty ubiquitous in the field, little alumina pellets, cylindrical pellets, coated with platinum in some kind of high-surface-area manner. You arranged them in the headspace of the cell.<br><br>As the electrolysis proceeds, the hydrogen and oxygen gases hit those pellets and recombine into water vapor, releasing heat, of course, and then that water vapor condenses and falls back into the cell. So, you can make a closed cell that way. That's how most researchers do things, Dennis Letts, for example. We ran all of our cells in MOAC as closed cells<br><br>Well, it takes about 10 of these little pellets to recombine all of the gases from an ordinary cold fusion cell operating at one amp or so. Well, John Dash had at least a thousand pellets. I mean, he had a half pint of pellets in the headspace of his cell. |
| Tom Grimshaw: | Wow. |
| Scott Little: | We were just stunned at that, but we thought, "Well, okay." Well, then we noticed that after each run those pellets, which start off dry, would be soaking wet. That's not good news, because when they're doing their job, they're hot. |

They're recombining their hydrogen and oxygen, and that heat of that combustion, if you will, that energy's liberated there at the surface of the pellets, so the pellets run hot, and they should not ever get wet.

So, that led down this path to discover a phenomenon called the heat of wetting. We even did a simple experiment inside of MOAC, where we put a jar of those dry pellets and a little container of water in there in that MOAC kind of equilibrium and then dumped the water into the pellets with a little remote actuator from outside and observed this big pulse of heat coming off of those pellets.

Tom Grimshaw: Wow.

Scott Little: The water wetted them.

Tom Grimshaw: I see your point. Yes. You might confuse that with excess heat.

Scott Little: His results always were a large signal, which would last for a few hours and then go away. So, it perfectly explained his results.

Tom Grimshaw: Yeah. Okay, yeah.

Scott Little: He was real dismissive of our orally presented conclusion when he was there. But a few weeks later, when we presented him with a written report of this, he wrote back or called back and said, "Yeah, you guys are good," as soon as he got it. I understand he's passed away.

Tom Grimshaw: He has passed away. I used to see him at all the ICCF conferences, but his wife passed, and then he kind of went downhill very quickly after that.

Scott Little: That's a shame.

Tom Grimshaw: Yeah.

Scott Little: Next one I see on the list here is the PACA, and for the life of me I can't remember what that stands for. It was an acronym that Richard Oriani coined to describe this experiment he did. Anyway, you can see the report there. It involved an electrolysis cell made out of a tube closed at the bottom with a sheet of CR-39, the special plastic that is used as an alpha detector. The alphas make tracks in the plastic. Then, after you've exposed the plastic to these alpha particles, you can develop the plastic by etching it with sodium hydroxide, and the tracks become visible. It eats away the ion-damaged areas.

He was getting these nice, strong signals, and of course, we didn't get anything. I shouldn't say, "Of course," but true to form, we didn't get anything. Then he sent us some of his special O-rings, and lo and behold, we got positive results with his O-rings. That was suspicious.

Tom Grimshaw: [crosstalk 00:33:45]

Scott Little: Yeah. As you can see in the report, the track density was highest right where the O-rings were, as if the O-rings were the source of the alpha particle, not the electrolysis experiment at all.

We finally got Richard to admit that he had handled thorium solutions on the bench at his lab in years past, and we confirmed that the alpha energies ... We bought an alpha detector, a solid state alpha detector, and confirmed that the spectrum of alpha energies was consistent with that of this thorium and its daughters-

Tom Grimshaw: Alpha set.

Scott Little: ... and another one went down in flames. Another one bites the dust, I guess.

Tom Grimshaw: Yeah. Yeah.

Scott Little: That brings us to the SPAWAR, or Space Warfare Navy group, Pamela Boss and Steve Krivit's Galileo Project, in which he got a bunch of labs to try to replicate a certain protocol that would produce ... So, we joined in that effort. I'll never forget. We were the first to report any kind of results at all. It didn't take us very long at all to figure out that something fishy was going on, because we had alpha sources.

We were able to expose some pieces of CR-39 to, say, the alphas from the smoke detector. I mean, everybody can get one of those at Home Depot. Americium 241 inside of a smoke detector is an alpha source. You can make tracks in the CR-39 and then compare that to what the tracks in this experiment looked like, and they weren't very similar. That was immediately an alert to us.

I'll never forget. When we started looking for why they were different in the experiment, Steve Krivit got mad at us for deviating from the Galileo protocol. This proved in an instant that Steve Krivit is not a scientist. Like any good scientist, we wanted to understand what was happening in this experiment, and he just didn't want us to deviate from the protocol.

Tom Grimshaw: Right. Right.

Scott Little: We demonstrated that you can make things that look kind of like alpha tracks on CR-39 by a variety of other treatments, a chemical attack and/or mechanical abuse of the surface. If you scratch the surface or abrade it with a rough substance, it makes things that look quite a bit like these alpha tracks. That was the end of that for us, anyway, and we weren't very popular for pointing that out.

It's kind of funny the way this goes. You point that out, and the original researcher maybe times doesn't want to talk to you anymore. You've thrown cold water on their claim to fame. They think that their experiment's different. We're not working closely with the original investigator. We're a couple of steps away from them.

So, we didn't have any direct contact with Pam Boss, and that frequently went that way. In all of these we frequently did not have direct contact with the investigator, which is bad. I mean, you'd rather be right in there like we were with Yan Kucherov, for example, and the ENECO thing. We were face-to-face. He saw it when I saw it and he accepted it.

Tom Grimshaw: Yeah. Yeah.

Scott Little: I can think of another one that was early on that never got written up for some reason and that was: we went out and visited Roger Stringham in his lab. This was when he was in California.

Tom Grimshaw: I believe he was with SRI International.

Scott Little: Well, yeah, he might have ... This was after that. He had left them, and him and Russ George had some connection. When they heard about cold fusion, they tried palladium as a target in an ultrasound experiment, a so-called sonofusion.

We visited Roger at a facility they must have rented or something. He was there, and who was that other guy? Tom somebody?

Tom Grimshaw: Was it Tom Dolan?

Scott Little: That doesn't sound familiar.

Tom Grimshaw: No, Tom Passell.

Scott Little: Tom Passell was there. I took this portable calorimeter that I made, a different one from the one I took to ICCF-7. I made another one called a versatile waterflow calorimeter, which didn't have a sample chamber. It was everything except a sample chamber. It was the pumps, and the electronics, and the temperature sensors, and everything.

What you do is you go to the experiment and wrap a coil of copper tubing around the device you wanted to test and connect it up to the inlet and outlet temperature sensors on the pump and everything, and then you would wrap all that assembly in this big ball of insulation so that more or less the only path for heat to escape from the device was through the flowing water. It was primitive, but you could get 95, 97, 98% heat recovery out of it. I did that to Roger's apparatus out there, and started it up, and measure the heat coming out, and confirmed that he was having trouble measuring the input power to this thing, which is not surprising, because it's an ultrasonic transducer with the high end running at 20 kilohertz. It's not an easy thing to measure.

But we had a Clarke-Hess power analyzer, which turns out to be the industry standard in the ultrasonic transducer industry for measuring the power that goes to ultrasonic transducers. It works great at 20 kilohertz. Clarke-Hess advertises it as a wide-band power analyzer. You just let it look at the voltage across the device and feed the current through the thing, and it gives you an accurate reading of the power being delivered, even if the voltage and current are way out of phase with each other, which they typically are on something that's got a piezoelectric transducer. It looks like a capacitor to a driving system, so it has big phase shift. But that doesn't bother the Clarke-Hess. There's a lot of instruments called power analyzers, and the Clarke-Hess is, or was, one of the better ones at the time.

Tom Grimshaw: Okay.

Scott Little: That also was a null result, and it showed that Roger was making mistakes in the input power measurement. I didn't ever write a report on that. Nobody that was there was happy to see me produce this result. They all wanted us to confirm their excess heat results, but we didn't.

Tom Grimshaw: Not the first time you had encountered that situation, I suppose.

Scott Little: No, it wasn't. I hate to be too critical of all this. I'm the first to say that on the day I was there this was happening. That doesn't mean that the next day they didn't solve the problem and make genuine excess heat, but the chances of that are kind of small. I think everybody will agree it's more likely that they were making this measurement error.

One of the things I say when people question me on the whole business of cold fusion is, "Well, we don't have any cold fusion-powered cars, or radios, or light bulbs, so something's wrong." Obviously, it's not a robust phenomenon that can be repeated at will.

Tom Grimshaw: Yeah. That's for sure.

Scott Little: I frequently compare it to the development of the transistor. Yes, in the early days of the transistor there were horrible problems with reproducibility, because they didn't really understand exactly what was going on. But they figured that out in a matter of years, and look where we are now.

Tom Grimshaw: Yeah.

Scott Little: If cold fusion had followed anything remotely parallel to that path, we'd all be driving around in cars powered by it now.

Tom Grimshaw: That's absolutely true. Well, let me jump in, because we're kind of up against our time. I'd like to ask if we could do a second session as we conclude this one. Are you available this afternoon?

Scott Little: Yeah, I can. I don't know what else we have, really, to-

Tom Grimshaw: Well, I was-

Scott Little: I haven't talked about MOAC, which would be something to talk about.

Tom Grimshaw: Yeah. Well, let's do that. Let's go ahead and finish this one up. You're pretty well done with your work that you did with Roger Stringham and Russ George, I take it.

Scott Little: Yes, although none of this is ongoing, I have to admit. MOAC still exists and could be recommissioned, but it just sits there. We used it for the Dash-Zhang thing and some of these others. We wrote a paper on it. I mean, that might be worth talking about a little bit, because calorimetry is tough, and that's where I think a lot of the so-called positive results have come from. So, we can talk about that.

Tom Grimshaw: Okay. Well, let's finish this one up, and I'll call you right back.

Scott Little: Okay.

Tom Grimshaw: As I customarily do, I'll make some concluding remarks. This is Tom Grimshaw interviewing Scott Little about his cold fusion work while at EarthTech and even before that. I should also mention that this is November 22nd. Scott, we'll continue with our second session here, and I'll call you right back.

Scott Little: Okay. Okay, Tom.

Tom Grimshaw: [inaudible 00:45:40]

## *Appendix B2. Scott Little Interview for LENR Research at EarthTech, Part 2*

Tom Grimshaw: Okay, Scott, we're back on the air again, so to speak, with this little recording app. I'll start by saying, this is Tom Grimshaw interviewing Scott Little about his work in cold fusion, going back to his days at Earth Tech and some experiments even before that. Today is the 22nd of November. And Scott, I think in our, and this is the second session. And in session number one, I think you kind of concluded with your description of the work you had done with Roger Stringham and Russ George, and then you started to talk about calorimetry and MOAC. And that might be a good place for us to pick up with this second session. Tell us about MOAC, why you decided to build it, and how did you use it?

Scott Little: Okay, one little lead into that. We, as you can tell from the litany of replication efforts, we didn't do much original cold fusion research. It never appealed to us. We wanted to try to replicate other people's experiments. And so as a result of that general philosophy, we focused almost entirely on the measurement problems, trying to figure out what kind of errors people were making and how to avoid them. And by the time we got around to thinking that we might need a really fancy calorimeter, I had already played with the ones with the sparking machines for the EV experiment. That was a big challenge for electrical power. I built two sort of portable waterflow calorimeters, and each of which had certain limitations and you could make them give the wrong answer a lot of times.

Anyway, so there was a lot, there was a fair amount of experience under our belts. And so we realized that it could be useful to have a really high quality calorimeter. And so we set out to make something that would be really, really reliable and really trustworthy and [inaudible 00:03:13] the waterflow. So that was where MOAC got started, the Mother Of All Calorimeters, kind of a silly name for it, but that's what we called it. And we wanted it to work on all sorts of Pons and Fleischman cell, electrolysis cells of moderate size. We ended up making it a chamber that could contain a variety of experiments, but we had in mind a 200 milliliter beaker. We set out to make an instrument that would try to solve all of the problems.

So just in quick summary, the device under test, the cell, is contained in a chamber that's about a 10 inch cube, the walls of which are actively insulated. This was a big step forward from just passive insulation. Active installation, each of the six faces of thiscubical chamber has a thick aluminum inner plate, some insulation, and a thick aluminum outer plate, a temperature sensor on the inner plate since it's the temperature that the experiment wants that inner plate to be, and then a servo circuit drives heaters attached to that the outer face until the temperature of the outer plate matches the temperature of the inner plate. These were six independent systems keeping the Delta T across the walls of this chamber, effectively zero. So there's no path for heat to escape the chamber through the walls.

Inside the chamber along with cell is a little heat exchanger or a water air heat exchanger like an ordinary radiator, a small automobile radiator, but real small and a little fan. And so the fan circulates the air around the chamber, past the experiment back through the heat exchanger and so water is flowing through this heat exchanger.

So the only path out of the chamber for heat is via warming up this water that's flowing through the heat exchanger. And we had a careful temperature measurement of the water going in and water coming out, and that's where we got the Delta T. We designed, my daughter contributed to the design of a rather Rube Goldberg apparatus for measuring the flow rate of the water, which is measured all the time. It wasn't the same because we did use a constant displacement pump, but we had a regular Ohaus] balance and a valving system that would divert the flow into a cup on top of the balance for a precisely timed period. And the computer would read the balance before the water went in and after the water went in, and then a clever little mechanism would dump the water out of the cup without actually touching during the measurement, nothing touched the cup obviously. But during the dump, a lever would reach over and open this valve that would dump the water out.

You can see it sometime or you've probably seen it. It's Rube Goldberg-y, but the performance of this flow meter was not shabby at all. We, we would take the standard deviation of subsequent readings on this flow meter, and it was surprisingly good. We could get plus or minus 0.01% relative stability in the flow. This system a hundredth of a percent relative, way better than we need it. Our design goal for MOAC was 1/10th percent relative, and so designing everything from the outside to be 10th percent relative accurate meant that by the time we got everything working, we were pretty happy if it got, you know, within 1% or half a percent was relative accuracy of heat input compared to the heat output.

And in the paper, we wrote about it. It talks about how complicated the instrument ended up. We had all of that that I just described is enclosed in an environment box, which is temperature-regulated and that's important. You can't have varying external temperatures and that [inaudible 00:08:08] also room for stability. It was very important to have the water flowing into this chamber be extremely constant temperature. So I had a three stage temperature regulation going in, and we typically would run the water in at 25 degrees centigrade. And that was monitored very carefully, and it would be 25 plus or minus 0.001 degrees centigrade. So there's a lot of really nice accurate things about MOAC, and yeah, the end result was a pretty good calorimeter and some of the things that were good about it that are bad about other calorimeters was it had really good location sensitivity.

One of the things you worry about in a calorimeter which has a chamber where you can put the experiment is does it matter where the experiment is located inside the chamber? If you put the heat source at the top of the chamber, do you get the same answer as if you put the heat source at the bottom? So we conducted location studies in which we used a ceramic power resister as the heat source, and we'd just prop it up on blocks of wood over in one corner of the chamber and run for a while and move it down to another corner of the chamber. And MOAC was really good at that. It didn't vary more than about 1% when you moved it around in the chamber.

And I contrast that with, at one point in our Earth Tech career, we rented a Seebeck Envelope, which is a commercially made gadget from, I can't remember the guy's name. Heinz Poppendieck was the fellow's name out in California somewhere. He built these Seebeck Envelopes for various commercial applications, and we thought, "Oh, this would be wonderful."

In theory, they should also have no location sensitivity because if you put the heat source over in one corner, that just makes those thermocouples produce a bigger output than the rest of them. But since they're all wired in series, you ought to get the same answer. But if the Seebeck Envelope is poorly constructed and doesn't have the same thermal resistance across every portion of the walls all around that, you won't get the same answer. And lo and behold, this thing we rented from Heinz Poppendieck was poor. It had a pronounced location sensitivity.

The other thing that we tested was, let's see, we were able to run... Like 10 watts, for example, can be, you know, a one pint jar that's just warm to the touch or it can be a taillight lamp from an automobile that's white hot. And so you can have a rather different distribution of the heat, a large sort of warm thing or a small ultra hot thing. And those should of course read the same if they're both 10 watts. And MOAC was real good at that as well. It seemed to, we tried a variety of heat sources and got real nice comparison, again, something that other types of calorimetry don't do very well at.

And this is important because, especially in a cold fusion cell, you can have people worry about the circulation patterns in the electrolyte, and if you have just one or two temperature sensors will the circulation, convection circulation in the electrolyte might change significantly due to some reason and cause your temperature sensors to change their reading when in fact that total power being dissipated in the cell hasn't changed at all. But it looks like something's hotter. These sorts of problems of lead people astray in the past.

Tom Grimshaw: Right, right.

Scott Little: Yeah.

Tom Grimshaw: So that's a lot of additional information from what's [inaudible 00:12:29] . You have a good description up on the Earth Tech website, but this is a lot of the additional information and insight. So thank you.

Scott Little: You're welcome. And there were some other systems involved too. We had to, let's see, we were running closed cells, but only a fool would actually seal up a cold fusion cell with absolutely no escape because it's likely to explode if the recombiners quit working. We had our cell, the gas connection to our cell went outside of MOAC to a capacitance manometer to measure the pressure in the cell and then to a relief valve, which the system could open if the pressure went above. We set limits on what we thought was an acceptable pressure, and if it went above our limit, which I think was 800 millimeters, which isn't very high pressure, just a little bit above atmospheric, we would open the valve and let the cell burp.

And if it went too low, like below 700, atmospheric being 760, we would open the valve also and let the cell breathe in. And you could watch a brand new cell. When you fired it up, the pressure would rise, and it would burp, and it would rise, and it would burp. And on about the second, after the second burp, it would rise and then level off and just stay there or even go down as the recombiners kicked in and started handling everything. And it just didn't, you know, it would work as a perfectly closed cell then, but it had that safety system built in so it wouldn't explode.

Tom Grimshaw: Yeah, that's a good idea. I've talked to Ed Storms, and the way he'd handle it, he would design the top to his cell so that it would pop off.

Scott Little: Yeah.

Tom Grimshaw: Exploding.

Scott Little: Yeah. We thought it was important. I mean it was informative and know the pressure in the cell and just to see what was going on. And I don't know, you know. I tried, another thing I just mentioned here, I tried running open cells and measuring the flow rate of gas coming out of the cell and comparing it with the current, because there's a stoichiometry there for every two electrons that passes through the cell, you should liberate two hydrogen atoms and one oxygen atom. So you ought to be able to relate the volume of gas that's leaving the cell to the current that's going through the cell. And I had relatively primitive gas flow measurement apparatus, the inverted graduated cylinder full of water and let the gas bubble up inside the cylinder and displace the water downward until you, and then you use the stopwatch and wait for a while and then click the watch and measure the volume. Look at the graduated cylinder to see how much gas had come out in that period of time.

And we always got about 4%, 4% or 5% more gas than the current would predict. And I attributed that to water vapor. And that was just a hypothesis that was never proven. But just thought I'd mention that because we were looking at, you know, when you want to see a little excess heat signal, you wonder if well, are we getting all the gas we're supposed to or some recombining in the cell and thus producing heat that we weren't expecting. And that's only for running open cells that you have to worry about that.

Tom Grimshaw: Okay. Well let me jump in and ask a couple of questions. You completed the work with Stringham and George. Was it in that timeframe that you built MOAC? Or do you recall what the sequence was?

Scott Little: I think that Roger Stringham stuff was before MOAC. It was probably in the late 90's. MOAC came along. We definitely did the Dash Zhang experiment in MOAC, but that was... One of the things we built MOAC for was for Dennis Letts' experiments.

Tom Grimshaw: Go ahead and describe those experiments please.

Scott Little: Dennis, you know, at that time he was experimenting with laser-stimulated effects, and so MOAC features three insulated optically transparent ports that lead into a chamber so that you could send the laser beam through all the walls of MOAC into the chamber there and illuminate the cathode. And we use a bore scope, a cool gadget that's used for inspecting rifle bores and stuff. It's an optical instrument that you can look down, and we used a bore scope to look at the experiment. And I'll have to admit that Dennis and we all became frustrated trying to line up the lasers to illuminate the cathode properly.

At one time he wanted to have two different wavelengths illuminating the same spot, and that just became virtually impossible. But we had trouble. And you look at the cathode through one of the three ports and shine lasers in the other two ports and didn't have a real wonderful way to aim them properly. But Dennis' experiments never showed robust excess heat in MOAC, and he became discouraged and understandably so because it was difficult to conduct them in MOAC. MOAC, despite our efforts to make it accommodate all of his requirements, it still was much more restrictive than his usual setup, which was in that wine cooler deal that he uses with a great big glass front where you can see the whole experiment real easily.

Tom Grimshaw: And I do remember that. Yes.

Scott Little: Yes.

Tom Grimshaw: Okay. What came next? Did you use MOAC with other experimenters or other cells?

Scott Little: Yeah, and I'm just trying to remember. As I mentioned, we used the for the Dash Zhang thing. We put some other things in there, and frankly right now I can't remember what else went in there.

Tom Grimshaw: I'm doing a project with Mel Miles, and I think you had done some work with him that he told me about [crosstalk 00:00:20:05].

Scott Little: Mel Miles visited us once, and we did some stuff with him. And I'll never forget being so impressed with his brain. He is a smart man.

Tom Grimshaw: Yeah.

Scott Little: He whipped out some calculation that I was able to follow, and I just... I can't remember what the details were, but I was real impressed that he could whip something out just on basically the back of an envelope and figure out how much stuff was supposed to be coming out of his cell. He really understands the stuff.

Tom Grimshaw: Right? Yeah.

Scott Little: But what was? That never made it into our reports, whatever it was. MOAC was, yeah, MOAC was constructed. Earth Tech moved in the middle of all of this from its original location on Braker Lane to its present location on Research Boulevard. And MOAC was constructed at the Braker Lane location. And all of it was moved and set up again on Research Boulevard. I'm pretty sure. Golly, I can't remember. Yeah. Yes, of course. Yeah.

Tom Grimshaw: I think I remember visiting your Braker Lane when I first started in this field. It was with the help of Dennis Letts.

Scott Little: Yeah.

Tom Grimshaw: I do remember taking a photograph of him in front of MOAC there when it was still on Braker Lane.

Scott Little: Yeah, okay, good. All this, all that. Your memory's better than mine then. Tom, I can't remember what else we put into MOAC.

Tom Grimshaw: Okay. That's all right.

Scott Little: I do have somewhere all of my lab notebooks. Not somewhere. I have them over at my other house, and it might be interesting to peruse through those in this era because I'm sure we'd see things. We could flip through them pretty fast, pretty rapidly. We'd see some things of interest there.

Tom Grimshaw: That would be great. Yeah.

Scott Little: I'd like to give credit to George Luce for assistance and great contribution to MOAC. George Luce was my boss many years ago at Texas Nuclear when I was first there as a peon right out of college. And then I went off and started ASOMA Instruments and built that up into something good and then had a falling out with the owner of ASOMA and went back to Texas Nuclear and George was still there. And then we both retired, and when I got interested in building MOAC, I thought, "Who's the best electronics guy I can think of?" And it was George. And I called him and asked him if he wanted to do some moonlighting and he said yes. And he designed all of the servo amp circuitry that adjusts these heaters for this active insulation and bunch of other stuff that was critical to the electronic side of MOAC. And together we built that thing and got it working. So he was a big part of that. It's just as a part-time guy.

Tom Grimshaw: Good. [inaudible 00:23:25]

Scott Little: George L-U-C-E. Luce. Yeah.

Tom Grimshaw: Yeah, he's still up on the website.

Scott Little: Okay, good.

Tom Grimshaw: As are you and [inaudible 00:23:35] and your daughter Marissa.

Scott Little: Yeah, Marissa was there. She helped design the flow meter, and then she did a lot of the work on the CR-39, the Richard Oriani PACA and the SPAWAR stuff. She was the primary investigator on that, and she deserves a lot of credit for that.

Tom Grimshaw: Good. Well let's just kind of pan back. Well, let's do this. About when, do you recall, did you complete your work with MOAC and with cold fusion? About what timeframe did that come to an end?

Scott Little: You know, we almost... At one time there was, if you can find something about the, is there anything on the website about the Earth Tech prize? We were about to give up when we published the Earth Tech prize, which was, we were going to read, or maybe we never made it official, but we wanted to offer. We wanted to, we had MOAC sitting there waiting to run. Nobody was bringing any experiments to us. Dash and Zhang had come and gone, and we said, "Gosh, what we need is somebody to bring us an experiment so we can run it in the MOAC." And here it is. In the fall of 2006 that's dash and Zhang. So that's probably, yeah, that sounds about right Oh in May of 2007. No, PACA was may of 2007. Oh, and then SPAWAR was after that. But no, SPAWAR might have been before that.

Yeah, it was. Okay. 2006 was, so I think around 2007, we gave up on actively pursuing cold fusion because we had a batting record of zero on successful, on positive results. I think our experiments were successful, but they didn't ever produce, you know, from an experimental standpoint, but they never produced positive results. So at that time, we turned to other things. When did we go to, we went to, we met at a big campaign at the synchrotron in Madison, Wisconsin, to see if we could demonstrate that the ground state of the hydrogen molecule was dependent on the zero point field. And that was a big campaign. Ground states in the zero point field. Does it say?

Tom Grimshaw: I don't have the website open.

Scott Little: Yeah. Anyway, we built an apparatus and took it up to... Anyway, we began to turn back to research that came from our own theoretical ideas. And so one was this experiment we did on the synchrotron, which also turned out to be null. And then another, which was a major effort from Marissa and I, was this gravity experiment in which we were looking for signs of the MOND effect here in the laboratory. The MOND (Modified Newtonian dynamics). Are you familiar with it?

Tom Grimshaw: I'm not familiar with MOND per se, but I do recall the experiment because we had to park the car away from the building.

Scott Little: That's right. Yeah. And that also showed that Newton was right down to, almost down to 10 to the minus 12 meters per second square. And our apparatus was quite sensitive. We'd been once estimated that it was, it's the same concept that Henry Cavendish built in 1798, but ours was 500,000 times more sensitive than his.

Tom Grimshaw: Yeah. Wow.

Scott Little: And so anyway, but there's a lot of extenuating circumstances. And so we did manage to get that published. It's tests of Newton's second law, Newton's law of gravity. Anyway, it was published in Quantum and Classical Gravity, kind of somewhat obscure second tier physics journal. Not Phys. Rev. or any of those, but we did find a journal that published it.

Tom Grimshaw: Very good.

Scott Little: And that took a long time. That was the most challenging experiment I've ever done with all that cars away from the parking lot and all these artifacts and problems. And that took a long time. And then it kind of, we never have gotten anybody to come back with a cold fusion experiment. Over the years, we had a number of free energy experiments, and those are those ones that you had listed on your memo at first, like the glow discharge panel and the MRA, the magnetic resonance amplifier. And we had several people claim that they could electrolyze water and for less than the theoretical amount of energy it takes.

Tom Grimshaw: Uh-huh (affirmative) Okay. So just to kind of summarize then, I think we pretty well exhausted the journey. I do have some more questions I want to ask you. But I want to just kind of check in and see thinking any other people that you worked with, or experiments that you ran, or tests or attempts at verification that come to mind. Sounds like you pretty well covered the landscape.

Scott Little: As far as I can remember. And now that doesn't mean there's not some gaping omission that when I get reminded of it, I'll go, "How could I forget that?" you know?

Tom Grimshaw: Right.

Scott Little: But I'll do some soul searching and also ask Marissa if she can think of any. Her memory is much better than mine is.

Tom Grimshaw: Yeah. Yeah. She's a little bit younger.

Scott Little: Yes, she is.

Tom Grimshaw: So, okay, well let me ask you a few other questions if I may.

Scott Little: Yeah.

Tom Grimshaw: Let's get to the bottom line. What do you think is cold fusion a real phenomenon or not?

Scott Little: You know, Tom, I guess my inclination is that it's not, that we have here that well perhaps the biggest example of pseudoscience that's ever happened before. And this largely colored by my own experience at finding subtle mistakes in other researchers' measurements.

But it could be. I won't say, you know, I'm not close-minded, "Hell no," but that's my opinion. I think it might be all gone, all nothing. I say that, every time I say that, I catch myself, "What am I saying?" I've got guys like Ed Storms, you know, he's not dumb.

Tom Grimshaw: Right.

Scott Little: I tell you though, to be sure there are some personalities that have not helped the thing, and there's a wonderful quote that was, I don't know if you've ever heard of Henry Dircks. Henry Dircks lived in the late 1800's and wrote a book about perpetual motion machines and Perpetuum Mobile, I think was the name of his book. And he wasn't a perpetual motion enthusiast. He was a regular scientist.

And he had a quote at the back of his book that was so fabulous. It's goes as follows, "A more self-willed, self-satisfied, or self-deluded class of the community, making at the same time pretension to superior knowledge. It would be impossible to imagine. They hope against hope, scorning all opposition with ridiculous vehemence, although centuries not advanced them one step in the way of progress."

Well, in the late 90's when I was was, it was before the LENR mailing group list was available. Everything was going on on one of those old psy.fusion.org, those old, whatever they were, listservs or news groups, and there was vitriol spewing. We had Jeff Rothwell, who got nicknamed Frothwell, and you know, there was just the true believers and the skeptics were just at each other's throat. And I have to admit, I participated in that somewhat. And I started signing my posts with that quote modified slightly. This was in around 1999, 89. Yeah. Anyway, maybe it was in 2009. It was 20 years after the [inaudible 00:33:41].

So instead of all those centuries have not advanced him one step in the way of progress, I've put all the 20 years of not advancing one step in the way of progress and that caused some more flames to be thrown. It was me criticizing these people as being self-willed, self satisfied, or self-deluded.

Tom Grimshaw: Right.

Scott Little: You know? But there was ridiculous and uncalled-for vehemence and vitriol, and you know, science is supposed to be objective, but as we, as you and I both know, it can be a highly emotionally-charged endeavor.

Tom Grimshaw: Well, fortunately there is a field which deals just with this very thing. It's called the sociology of science, which is about not scientific. It's about how science is done.

Scott Little: Yeah.

Tom Grimshaw: It's not very scientific at all.

Scott Little: Science is not very scientific. No. Everyone gets their champion idea and defends it irrationally, and...

Tom Grimshaw: Yeah. The human condition then you know, the idea of free exchange and so forth is supposed to correct for that. But needless to say, that's imperfect in the extreme.

Scott Little: Yes. Yeah. So there's, the bottom line is I am, I think there's a strong possibility that there's nothing to it, that it's just a giant pseudoscience circus. And I know that there are people who would just yell, jump down my throat for saying that because they've got this giant trove of papers and evidence and so forth. But the few little tidbits of that evidence that they refer to that I have had a personal ability to dig into, and it takes a month to dig into one of these.

Tom Grimshaw: Right.

Scott Little: I have found them to be false. So...

Tom Grimshaw: Yep.

Scott Little: And that, you can see why I feel the way I do.

Tom Grimshaw: Yeah. Well it's a probably a legitimate sample.

Scott Little: Mm-hmm (affirmative).

Tom Grimshaw: So to speak. So, well, so it's kind of hard for me to ask this next question, but I will. What do you think ought to be done next to approve, disprove, or in this even smallest probability that it's real given the benefits, what should we do?

Scott Little: Well, the same thing we needed to do all along. Come up with a cold fusion demonstration experiment. And that reminds me, I was in the audience when Martin Fleischmann gave the opening remarks that ICCF-7. And one of the things he said that just drove home into my brain like a nail was he said, "To this day, there exists no cold fusion demonstration experiment."

And I wrote that down, and I started telling people that. And to my astonishment, the true believers like Rothwell didn't or couldn't hear him say that. They said, "No, he didn't say that."

Tom Grimshaw: Yeah.

Scott Little: But it's true to this day. There's no recipe that you can go follow that produces the effect. Right this minute I'm still, I'm in contact with Dennis Letts trying to. He sends me his latest positive results and says, "What do you think of this?" And I tell him to check this and check that. And, you know, he's got a pretty complicated experiment. So it's not easy. Once again, it's not easy to debug, but I'm still in there kicking, trying to find something that is real.

Tom Grimshaw: Yeah. Well, I like to say that the cold fusion is in, lacks only two things. Adequate reproduceability and an adequate explanation. Otherwise [crosstalk 00:37:58]

Scott Little: Yeah.

Tom Grimshaw: Good shape.

Scott Little: Yeah, yeah. Yeah. So what should be done next I guess is, it's never going to get any big funding. I don't know though. We've got this, I'm not in real close touch with it, but there was this effort funded by Google to try to reproduce it. And I hear rumors of these things, and I don't know anything about them. But apparently there's been some efforts recently ongoing, including, you know, not just Dennis Letts.

Tom Grimshaw: Oh, absolutely. Google has a fairly active program. You may know about industrial heat. They have a very active program, so supporting many researchers. And I think it's kind of confidential. I don't guess it's confidential on who it is.

Scott Little: No. That's who, I'm essentially working with them. So they've engaged me to see if I think Dennis Letts' results are real or not.

Tom Grimshaw: Oh, okay. I did not know that. Well, congratulations. And then of course there's the effort at Texas Tech being funded by Bill Gates.

Scott Little: Oh yeah. I heard about Bill. I didn't know where it was, but Bill Gates. Good. He's got enough money.

Tom Grimshaw: Yep. Well, I mean, I think the argument, you know, somewhat in response to your assessment of the status of this is, you know, if there's the slightest possibility that it could ever become a real effect, you know, when they look at the immense benefits, and I think that's what. I don't get the sense that if there's been dishonesty pervasive in the field.

Scott Little: I agree.

Tom Grimshaw: It's not intentional dishonesty, but it's the prospect, whether for money or for legacy of having made some elements of contribution to the success of this thing because of its immense benefit.

And in some people's minds, you know, the salvation of humankind.

Scott Little: Yes. And I agree with you. Earthtech's whole existence was, as Hal characterized it, colossal risk, colossal reward. So a tiny chance, but if it does work, even then everything's wonderful. So yeah, I'm glad that there are some efforts ongoing.

Tom Grimshaw: Yeah. I mean, a pseudoscience or difficult, that's where the Occam's Razor is, I think on this.

Scott Little: Yeah. Yeah. That's one of the two.

Tom Grimshaw: Yeah. All right. Well let's talk about a couple of other things. As far as this project is concerned, you know, the interview that we're doing now is a big part of it. What we've already gotten, what you all had diligently posted on the Earthtech website is also a major part. Other things that we might consider as they're shown in that Storms report are you mentioned the lab notebooks. You know, we can incorporate, at least reference to them ,and maybe have some pictures like I did with Ed Storms.

Scott Little: Mm-hmm (affirmative).

Tom Grimshaw: Other, maybe if you have ever assembled a collection of all the reports in addition to what's posted up, that would be another really worthwhile thing. Oftentimes they go to Jed Rothwell's LENR-CANR website, although he may have taken the search function away from me. I don't know. But you know, if there's anything up there under Little, or [inaudible 00:42:08] and Little, or you and the other people that would, you know, find whatever's in the public record, but [crosstalk 00:42:15].

Scott Little: There isn't. There isn't. We never published like a lot of the other guys did. However, the MOAC, our MOAC paper did get published as part of a conference proceedings. I think it was one of the ICCF conference proceedings. That's the extent of our publishing on cold fusion. We just did the web reports. Hal does have a compendium of those monthly progress reports that we made to our sponsors.

Tom Grimshaw: Ah.

Scott Little: And that includes all this stuff. But I mean that's in some notebooks in his office. I don't know how you would, I mean you can you just say they exist and that's it or do you have to make them available to the public?

Tom Grimshaw: Well, I mean any of the above. I mean whatever's, you know, it is what it is, and we accommodate whatever it is, and we document as much as we can. You know, another area of concern is that we run into is nondisclosure agreements. I don't want to touch anything that is covered by NDA of course.

Scott Little: Right. There is one that comes to mind that, there were several that were covered under NDAs, and I was just thinking about one of them probably ought not even mention it on the recorded interview, but there have been a few [inaudible 00:43:44] the NDAs, covered by NDAs.

Tom Grimshaw: Yeah.

Scott Little: I don't know if they're still in effect.

Tom Grimshaw: Well, I mean in the case of NDAs, usually they don't provide, have provisions that you can't even mention it. So I mean, whatever we say in this interview won't go past the two of us except as you approve, as I'd already mentioned.

Scott Little: Yeah.

Tom Grimshaw: But you know, just reference to something having been done is usually not subject to NDA in my experience.

Scott Little: Yeah, and I think that's right. Well, this particular one that sticks in my mind is, I don't know if you've ever heard of it, but along the lines of sonofusion, there was back around the day when that was coming out, there was a guy named Jim Griggs in Georgia developed something called the Hydrosonic Pump.

Did you ever hear about that? It was a cavitation device?

Tom Grimshaw: No, I'm not familiar with that.

Scott Little: Well that appealed to us because the phenomenon of cavitation is this astoundingly abrupt collapse of tiny bubbles. And actually you can get sonoluminescence. You can get bursts of light coming out of these tiny bubbles of water. And people were just fascinated with this phenomenon because how can you get a burst of light out of water, room temperature water, you know?

Tom Grimshaw: Yeah.

Scott Little: And Hal immediately theorized it might have something to do with the Casimir force squeezing the bubbles down super fast, which then turns out to be related to the zero point field. And so there we were off and running zero point energy again. And so this thing that was supposed to use cavitation to generate excess heat was evaluated. And the Hydrosonic Pump, it was big.

It was a elaborate device. It was a 50 horsepower electric motor that ran this pump out. Hal and I built a cradle dynamometer to measure the power being delivered by this 50-horsepower motor to this pump. It was a exciting experiment.

Tom Grimshaw: Yeah. Yeah. Let's go back again just for a moment. I guess I can just ask Hal if those progress reports could be made available, if not for scanning then at least for references of what was done.

Scott Little: Yeah, I think you should do that.

Tom Grimshaw: Okay. I'll do that. Any other records that you can think of that might help document all that work that you guys did?

Scott Little: Those in our lab notebooks is it.

Tom Grimshaw: Okay.

Scott Little: [crosstalk 00:46:46] on the website, so, yeah.

Tom Grimshaw: Okay, good. All right. I can't think of other topics. You know, usually I just want to capture what's your recollection is and what your impressions were, which is, in my view, way more important, well, at least equal in importance to the physical record, whatever might exist.

Scott Little: Yeah. Well, I'm happy to help, and I'm glad that you're doing it. So I'll continue to cooperate.

Tom Grimshaw: Okay. If we, you know, I think the next steps would be to talk about your lab notebooks, and I'll make contact with Hal and maybe even try to get an interview with him as well. What about your daughter, Marissa? Do you think she might be interested in giving her recollections of this?

Scott Little: Yeah, she probably would. I'll talk to her about it.

Tom Grimshaw: Okay. That would be great. And of course you have my phone number.

Scott Little: Yes.

Tom Grimshaw: Or I can give her a call and so I'll try for any interview with Hal. I'll try for the progress reports and we'll see where we go from there.

Scott Little: Okay, Tom, real good.

Tom Grimshaw: Thanks for hanging in there and for doing such a nice job. I think you've given a very thorough recollection of what all took place. And so whatever happens, we'll write this up in the report that has kind of a similar look and feel to the one that I did for Storms that you have.

Scott Little: Cool. All right. Thank you. I enjoyed it.

Tom Grimshaw: All right. Thank you. And I'll, again, wrap up by saying that this is Tom Grimshaw interviewing Scott Little about his cold fusion work. This is the second session, and it's November 22nd, 2019 and thank you again.

Scott Little: You're welcome, Tom.

Tom Grimshaw: Bye.

Scott Little: Bye-bye.

## *Appendix C. Interview of Marissa Little.*

Tom Grimshaw: Okay.

Marissa Little: Okay.

Tom Grimshaw: So I have to push a button that it didn't want to push in order to get the thing to work.

Marissa Little: Of course.

Tom Grimshaw: I'll start with an introduction. We're being recorded now. This is Tom Grimshaw. I'm talking with Marissa Little, and what we're doing is we're talking about Marissa's work in the cold fusion area going back to when it was first announced in March of 1989. This interview, I should note the date is December 13 and the interview is a part of these, what I call, the LENR, the cold fusion, the low energy nuclear reactions documentation initiative. It's called the LRDI. And under the umbrella of the initiative, we have various projects with different people who were involved in the field. And Marissa, I know that most of your work, if not all of it, took place here in Austin when you were still at EarthTech. So why don't we begin with just kind of a review if you would of what you were doing at the time that the announcement hit, and what was your early work or what were the first things that you did in the cold fusion field?

Marissa Little: Well, in 1989 I was nine years old, but I actually was involved in some minor way from the very beginning. My father Scott Little immediately began trying to replicate the experiment in our home garage, and I do recall him and [Dave Puften 00:02:10] working in the garage for hours and hours on end for weeks building an apparatus and testing it. And of course I didn't understand what it was that they were really doing, but it has kind of just been part of the lore of my family since it was announced. I didn't really get involved until, I guess, it would have been '98 or '99. After I had graduated high school, I worked in the machine shop at EarthTech, just as a contract, and helped build and design pieces to what later became MOACs, the mother of all calorimeters. Which is one of the main testing devices that EarthTech had, a water flow calorimeter, for testing not only cold fusion devices but any kind of electrical input, heat output claimed over-unity devices.

I then went to college for mechanical engineering and it wasn't until 2005 that I returned to EarthTech as an actual full-time employee and began working on the experiments. Throughout the years, I mean we... In the beginning... Excuse me. In the early days, we would read papers or try and come up with our own ideas based on what other people were saying and designed our own cells. Eventually though, after failure, after failure of those sorts of experiments, we mainly began working on testing other people's working cells. So we would invite researchers to the laboratory in order to test something they actually brought with them.

Sometimes we would get just their equipment. Sometimes they would actually come with it in order for us to work together for a number of days or even a week or two to try and verify the results that they were seeing in their own laboratory.

Tom Grimshaw: So let me ask. If I may, I'll jump in just for a moment, just kind of review. So you knew about the field from the very beginning, but you were nine years old and so it was after you graduated from high school and you began working in the EarthTech machine shop in about 2005. And about the time you started working there is when you got involved with the cold fusion field then, I guess?

Marissa Little: Right, in '98 or '99 is when I helped build MOAC, the apparatus. But I wasn't actually involved in any of the testing until I was hired full-time in 2005. But 2005 was when I actually got involved with the experimental side of things, yes.

Tom Grimshaw: Okay, good. Why don't you tell us a little bit first about the work that you were involved with where you were building your own cells and then the launch into the phase when you started working to test other people's cells and experiments.

Marissa Little: So in 2005, we were towards the end of running our own cells at the point where I became a full-time employee. But there was sort of a very typical recipe that kept getting repeated in reports of positive results using deuterium with lithium electrolyte. So we would simply kind of copy a little bit what was being done by other researchers, of course, but then nothing specific. No, this is exactly the geometry of the cell, or this is the exact power pulses or anything like that. We would just run cells with a palladium electrode, heavy water electrolyte and hope for results. And we ran plenty of those cells and never could find anything. But it is actually how we refined our calorimetry techniques because we also would build control cells made out of light water and with say nickel electrodes.

So during that whole period, I would say that we became very versed in all of the problems with calorimetry and that was how MOAC was developed over the years was turning that into a precision instrument, because with the control cell, we would know if we put in 10 watts of electrical power, we'd better see 10 watts of heat coming out. And so we were able to refine that and really nail that down to, I believe it was, either 0.1 to 0.01% error. Scott knows far more of the little details like that right off the top of his head. I usually have to look those up.

Tom Grimshaw: Okay. I'll jump in-

Marissa Little: So that was mainly our-

Tom Grimshaw: Let me jump in and ask you a couple of questions. During that time when you were using your own cells, did you attempt to replicate as close as possible or as close as you could the actual procedure used by Martin Fleischmann and Stanley Pons? I know you were using the general procedure. Did you try to replicate their experiment?

Marissa Little: There was a time before I became a full-time employee that the exact experiment was attempted. Replication was attempted. I was vaguely involved on my summer vacations, just going and seeing my dad at work, and I can describe what the apparatus looks like to you and a few things along those lines, but I honestly was not involved in that part of the experiment in that version of experimentation. But I do know EarthTech did test it following up on the-

Tom Grimshaw: Okay, so that was just before your time then in a way?

Marissa Little: Yes.

Tom Grimshaw: Yes. Okay, got it.

Marissa Little: Yes, that was all pre-2005. It was in the early 2000s I would say was when most of that was going on, like 2002 or 2003. And concurrently with that was also testing of just sort of, I don't know how to call it, generic cold fusion cells because that had been going on, of course, since 1989 was just the testing of similar cells.

Tom Grimshaw: Okay. Good. Okay, we'll pick it up then if you would. What was the first thing you did after you, in other words, working with others as opposed to having your own cells? Well, let me first ask, did you continue to operate your cells as you started working with others or did that work come to an end?

Marissa Little: No. Pretty much by 2005 that had just almost dwindled down completely, and we decided to focus entirely on replicating someone else's cell that actually worked, because we were never seeing positive results in a lab with our own formulas or our own procedures. So it almost was shooting in the dark. So why not go with somebody who is saying, "Hey, I actually got it. I found the recipe. I found the procedure. I found whatever it was that was special about their particular experiment that actually had a positive result." Let's replicate that. So rather than starting from scratch and exploring parameters say, let's just replicate. So at that point is when we really started focusing on that. And at first, we didn't have a lot of contacts necessarily in the field, so we would read a published report and try and copy exactly what was said in the report, but reports don't have all of the details in them. So we would attempt to contact the researcher and then we would start a, hopefully, relationship with them and work through it. Sometimes we would receive materials from them. For instance, the Mizuno experiment, the incandescent tungsten. That was probably one of the first experiments that I was involved in that we actually had cooperation from the researcher and we even received some tungsten electrodes, I believe, from Mizuno. And so we tested that repeatedly in the laboratory.

Unfortunately, that test ended slightly inconclusively simply because of how disruptive the actual experiment was to measurements. There was a lot of electrical noise. It ruined hundreds of dollars worth of sensitive scales. So it was an unfortunate experiment that we can never actually nail down a measurements on, but we never had got a definitive positive result on it either. We never really got a positive result that we felt was worth investing tens of thousands of dollars into more measurement equipment for it.

Tom Grimshaw: Okay, good. Was that the first one that you recall being involved with?

Marissa Little: Yes, that was definitely the first one that I think was along this line of sort of the researcher-led replication, the Ohmori-Mizuno one. I'm really terrible with timelines and dates, so this is sort of difficult me to know all of the various little steps.

Tom Grimshaw: Yeah, that's not expected here by the way, so you're doing great.

Marissa Little: Another one that sticks out starkly in my mind is we had John Dash and Wu-Shou Zhang actually came to EarthTech for well over a week, and we're in the lab every day running their exact cell. They brought all of their parts with them, and so we ran that in MOAC and all observed and all watched. So that was a really great experience just because... I felt like it was a good experience because we weren't stuck in that terrible position of, well, we got a negative result because we did the experiment wrong. When you're trying to prove these sorts of cold fusion experiments, it's really difficult because if you get a negative result, it's so easy to just shrug your shoulders and say, "Well, we did something wrong." Whereas the skeptic, of course, would say, "Cold fusion isn't real," but we really were out to show that it was really happening.

So we didn't want to just say, "Okay, we got one negative result. Let's move on and never tested again." We kept saying, "Okay, we're doing the experiment wrong, so how do we fix this?" So actually having Dr. Dash and Wu-Shou at the lab was great because they could say, "Yes, this is exactly how we do things." On the other hand, they would disagree. We sadly parted ways with Scott and I believing that we had found a measurement... Not a measurement error, but a mundane explanation for their result where they left the lab thinking that we still just had never done the experiment correctly.

Tom Grimshaw: You know, it's pretty hard to prove a negative.

Marissa Little: Exactly.

Tom Grimshaw: I understand that you give it your best shot and if you don't see it, you don't see it. But that doesn't mean it doesn't exist, it just means you didn't see it.

Marissa Little: Right. Exactly.

Tom Grimshaw: So, okay-

Marissa Little: But for that particular experiment, for instance, they had a rather large quantity of recombiner pellets, a hundred grams of them, in fact. And typically, most cold fusion cells that we have other experience with would have maybe 10 or 20 of these little tiny alumina pellets coated with platinum or palladium. And they had just an entire jar full of them at the top. And then the whole thing was also in this cardboard box. So we wondered if it was just sort of a heat capacity issue. We had a real hard time, but we investigated just every little detail of that. And we actually were able to show in MOAC... After they would run the experiment, they also ran it near boiling. So the recombiner pellets were actually wet because of water vapor, not hydrogen and oxygen separately, but actual water vapor condensing on the recombiner pellets. So most of the pellets were wet and there would only be one spot of dry pellets that were actually active. Once the pellets get wet, they're no longer actually recombining.

So there is a phenomenon called the heat of adsorption. When water adsorbs onto a surface, it releases a small amount of heat from Gibbs free energy. The surface of a recombiner pellet is extremely porous, so it has a lot of surface area so it actually releases enough heat that you can see it through how they were measuring the experiment and also how we were measuring it with MOAC. So with just a bottle of water with recombiner pellets suspended above it, and we had a long arm sticking out from MOAC and we were able to... So we had everything calibrated and it was all running. It was showing zero power in, of course, zero power out. And then we turned that over with an arm sticking out of the calorimeter, and we could actually see the heat of adsorption. We saw the heat output from the recombiner pellets getting wet. And the quantity of heat matched fairly similarly to the quantity of heat that was measured from their actual cold fusion cells.

The cold fusion cell would only produce excess heat for a certain number of hours and then it would drop back down to power in equals heat out. So in our minds, that was a pretty significant result. We showed that over time it reaches an equilibrium, it's not producing excess heat anymore. We found a reasonable explanation for how it was producing excess heat, it was simply a heat of adsorption, but of course, John Dash and Wu-Shou Zhang did not. They didn't think that that was significant, unfortunately.

Tom Grimshaw: Okay, well, that's very interesting. So what's the next one that you remember? Or, well, let me cut you off on that one. But what do you recall was the next one?

Marissa Little: So another significant one was Steve Krivit organized the replication of the SPAWAR experiment, which I thought was an incredible effort. I mean, somebody organized a bunch of independent labs to replicate and repeat this experiment following a procedure that had been nailed down by the original laboratory to say, "We get results every time using this." I mean, it was one of those projects where it's like, "Oh, finally this is going to nail it. We're going to do this." So we were extremely excited to be part of that project because it felt like somebody was finally taking this multi-headed beast and going to get it figured out by bringing researchers together and focusing on one version of the experiment rather than everyone having their own different recipe.

Tom Grimshaw: Okay. Let me jump in if I may. Tell us a little bit about the procedure and the signature. I guess it was codeposition and was it a CR-39 or was it-

Marissa Little: Yes. This was the codeposition CR-39 experiment. So it was the CR-39 which is a alpha particle detector essentially with the cathode wrapped around it, and it was supposed to be the deuterium and the palladium getting codeposited on to that at the same time in order to facilitate nuclear reaction. So that experiment, we got it set up, we followed it to the T, we went down the procedure list. I mean, we followed it to a T to the point from, you know, there were certain times like six hours later do this, 72 hours later do that. So we were right on the dot. And actually, Christmas morning, I was up in the lab because that was the day that the experiment turned off and we needed to look at the results. So this was Christmas Day, I'm at the lab, lo and behold, we have what looks like positive results. I'm on the phone, and my dad comes up there. My mom's irate because Christmas dinner is off. We can't leave the lab.

We immediately then said, "Wow, what's happening? Let's figure this out." And this was a point of contention because we then went off and started performing additional experiments. We had followed the procedure exactly. We'd come up with the expected result. We were so excited. So we began exploring what was going on, and Steve Krivit did not believe that that was the proper way to go about this. He wanted a much more controlled, okay, now let's all try this now let's all try that, which is understandable. One thing that we did was cover the CR-39 in a very thin film of Mylar. Now an alpha particle... So the positive result that we were seeing was that there were pits where the cathode was in contact with the CR-39 after you etched it. An alpha particle hitting the CR-39 leaves a damage trail through the polymerized chains in there. And then when you etch it, it opens up into a tunnel, a pit that you can see under a microscope. So we were seeing something similar, but they didn't look quite the same. So we started experimenting with CR-39. We found that physical damage to it, like if you... I walked around one day with one in my pocket, so it just got kind of scratched. That produced similar odd-looking pits to the same ones that were produced in the cold fusion experiment.

We just tried all sorts of different things and we were finding that CR-39 was not just as perfect if there's a dark mark on it, it's an alpha particle. It could be other things. So we covered the CR-39 with Mylar inside the electrolytes. So now there's just an extremely thin piece of Mylar and then the CR-39. We proved that alpha particles from an americium source would travel through the Mylar and still produce pits in the CR-39, but the SPAWAR experiment no longer produced pits on CR- 39 with the Mylar barrier. So in our opinion, that looked like, okay, we've now isolated it from this harsh chemical environment of the electrolyte where there's ions all over the place, which can obviously cause damage to molecular bonds.

And so we started down the path of thinking that was chemical damage. Now we could never 100% prove it was chemical damage, but again, this was one of these cases where we came up with a reasonable alternative explanation and couldn't prove one over the other. But when you have chemical damage versus room temperature nuclear reactions, we unfortunately lean towards the chemical damage side.

Tom Grimshaw: Yep. Yeah. Well it's called off Occam's razor. You take the simplest explanation, right?

Marissa Little: Right, exactly.

Tom Grimshaw: Yep. Okay. What was-

Marissa Little: Let's see. Richard Oriani. That was another really great experiment where again, we had the actual researcher involved. He also used the CR-39 in his experiment. We used glass. I think they're called glass O-ring joints was actually what his cell was made out of. And so in between these two glass joints was a piece of CR-39. It was basically the barrier. And so it was kind of the bottom of the cell. And sure enough, after a while of running a cold fusion cell in the electrolyte, in the joint, with the CR-39 being the bottom, there would be pits on it.

Now these did look exactly like alpha particle pits. Just 100% they looked so similar to them, but the cell only ever worked if we used O-rings, which sealed the glass tube to the CR-39, from Richard Oriani's lab. We purchased the exact same ones that he had purchased in the past from the same company, they didn't show anything. It was only him mailing them to us that we could actually see that. I then discovered by a extremely tedious mapping of the pits on the piece of CR-39 that they were densest in an area directly underneath the O-ring. We then measured the O-ring, and the O-ring itself was radioactive. So Richard Oriani believed that the experiment was working properly in his lab and that the O-ring had become radioactive because of the cold fusion process that was happening in the cell and that we still just weren't doing the experiment right. And so we were only seeing it because we were using the radioactive... And he felt like, yes, we were only seeing radiation from the O-ring that he sent because they were sort of pre-primed and that we weren't doing the experiment correctly.

Tom Grimshaw: Okay.

Marissa Little: So that was an unfortunate one. I mean, and again, we could only come up with did he spill something radioactive on the O-rings? We actually tested. We let the O-ring sit in a high percentage radon gas environment for a long time thinking that maybe his lab is in a basement and there's a lot of radon and for whatever reason these were absorbing something that were making them radioactive. We, again, could never come up with a really conclusive thing, but we never saw the positive results using materials that we completely purchased. It always had to be something furnished from him and that material came to us already radioactive.

Tom Grimshaw: Okay. All right. Got it.

Marissa Little: Let's see. I feel like those are kind of the main ones that just stuck out to me as... I mean Dennis Letts. We worked with Dennis Letts so much, but we never had a result where it was just this resounding, wow, we're seeing what we're supposed to be seeing and then we would research further and find a reason for it. The ones that I've mentioned were ones that... Oh, except for the Mizuno one. But when we actually could really repeat the exact results in our lab, saying, "Man, we've got it!" But then upon further investigation, either discover some measurement error or it's due to some mundane or just something that there's another explanation, like you said, Occam's razor.

So Dennis Letts. There was one experiment where there was an anomalous heat bump that... There were various arguments back and forth. Again, this was kind of... I wasn't actually actively involved with this particular experiment so I don't remember the details. Scott does, because he and Dennis went back and forth on this a whole lot. But there was one that had an anomalous heat bump. And frequently in Dennis's cells there would be a sort of a thermal rearrangement of everything. And so we could produce transient effects, the bubbling would change or something. So you would have thermometers down inside the electrolyte would suddenly start reading higher and that would cause the readings on the calorimeter to change. But there was never any prolonged long-term effects. So his experiments in some ways were kind of frustrating because we couldn't get them to show an effect in the lab that could then say we can then investigate and work on further.

Tom Grimshaw: Okay. And when you were working with Dennis, it was electrolytic cells obviously, that's what he worked with.

Marissa Little: Yes.

Tom Grimshaw: He was using laser stimulation as I recall at that point.

Marissa Little: Yes. We actually modified MOAC very specifically to allow lasers to hit the cathode in his cells. That tube, the passageway to allow the laser to come in... Because we didn't want the laser inside of there with extra heat and everything. So the beam was beamed in from outside. And that passage tube was actually where I put the dowel in order to turn over John Dash's cell to wet the recombiner pellets. But, yeah, so we were able to do the laser stimulation in the lab. We worked with Dennis a lot, and we still have a good relationship with him. He was probably one of the few people that really believed that we truly were wanting to see a positive result. So he kept coming back and testing things out in MOAC, and we let them test anything he wanted and just, unfortunately, never could see a positive result there.

Tom Grimshaw: Okay. Okay. Anyone else that you recall? I do remember that you gave a presentation one time that I was able to attend to James Truchard over at National Instruments.

Marissa Little: Oh, yes.

Tom Grimshaw: Do you still have that?

Marissa Little: I forgot all about that.

Tom Grimshaw: Do you think you could lay your hands on that possibly?

Marissa Little: I know Scott mentioned that we had somewhat of a falling out with how... All of my backup computer files are on the server at EarthTech. I did not bring anything. I didn't know that I wouldn't have access to any of that stuff sadly.

Tom Grimshaw: Yeah, okay.

Marissa Little: I only have access to things that happened in the last two or three years because they were still on the computer that I have. But as I would switch computers, I would back everything up on the physical server there, so it's sad that I don't.

Tom Grimshaw: It would be interesting to see how Hal responds. I did actually talk to him very briefly when I was starting this. I just stopped by, since I live on Jollyville Road now. I just stopped by and rang that doorbell and we had a nice conversation. He didn't bring up anything at that point, but he did give me Scott's contact information so that's kind of how I got started in. It was interesting that Hal mentioned that he thought that there was something to it. Well, maybe I ought to not bring that up because [crosstalk 00:30:59] unadulterated opinion.

Marissa Little: No he- That's okay. I can disagree with Hal. It's happened plenty of times.

Tom Grimshaw: Okay. So what do you think? Maybe we move to that phase at this point. Do you think there's something to this phenomenon?

Marissa Little: So my opinion has changed greatly over the last... 13 years was really how long I was actively involved in this. We were running cold fusion experiments on and off, you know, not every single day but for the 13 years that I was really active at EarthTech. And at the beginning, oh man, I was ready to win a Nobel prize. Our lab was going to be the one to prove this. Our lab was going to be able to be the one that actually made a replicable experiment and turned it into an actual power producing device because I have an engineering background and I was going to be able to take this physics demonstration experiment and actually build an engine out of it. I mean, I was just ridiculously gung ho back then. It wasn't necessarily the repeated failures to see this phenomenon, it was... I mean, of course that played into it.

But it was just diving more into this entire field and researching more and looking at every one of these experiments that I could get my hands on. I mean, I would read the ICCF proceedings and pay attention to the CMNS newsgroup. I mean, I was active in all these locations and it never seemed like the way other discoveries have gone. There have been other earth-shattering discoveries that just proceeded in such a different way. There's a bizarre phenomenon that somebody discovers, but it's hard to replicate. I'm thinking of like the invention of the transistor. It was so difficult for them to actually figure out what was going on and make something that worked, but they could always go back into the lab and go back to their original experiments and go, okay, this is how it works, now let's proceed forward and refine it.

And they would go down some avenue and it wouldn't work. Okay. Go back to the original experiment. Okay, it works here. That's just never been the case with cold fusion. It has branched out into... I mean, it started out as an electrolytic cell. There's now gas cavitation, the incandescent tungsten, the exploding wires. It seems like there is an infinite number of ways to produce room temperature nuclear reactions, yet none of them are repeatable. And I just kept... It nagged at me that instead of narrowing down parameter space and everyone concluding or coming to a consensus on how to make this phenomena actually appear, it's just shattered into a million pieces, and everybody's following a different line, and they all seem to have positive results. It's just incredible to me that there's so many different ways to make it happen, yet it's not repeatable. And that frustrates me. It doesn't seem like good science.

So, sadly, my conclusion currently really is that it is one of these things that it's measurement error in most of the cases. I will never say that there's nothing there, that there's absolutely, it can't be possible. The effect has also gotten smaller and smaller over the years as people have spent more and more time focused on this and really trying to figure out what's going on, the effect gets smaller. And yeah, I'm terribly skeptical at the moment, so. I don't like saying that. I'm reluctant to really admit how skeptical I am of it. But it's the truth. I mean, I spent so long knowing that it was real and we were going to figure it out. And now to come to this point, yeah.

Tom Grimshaw: Tough. Well, I mean, nothing wrong with that conclusion obviously. I've been working in the field probably a little less than you have. I think about... The first thing I did was in 2006, so I started about the same time, a little bit after you.

Marissa Little: Mm-hmm (affirmative).

Tom Grimshaw: When I went back after a long environmental career, went back and got a master's degree in public policy and wrote my thesis, what they call a professional paper, on this very subject. And so what I like to say when people ask, "Well, is this a real phenomenon?" I say, "Well, there's a lot of experimental indicators that there are, but we're only missing two things and that is sufficient reproducibility and an adequate explanation. Otherwise, we're in good shape."

Marissa Little: Yep. Yes. I like that. I mean, that is exactly what it is. And me being more of an experimentalist, I was okay with the not knowing the adequate explanation. I was okay with it being an entirely empirical thing and then we'll figure out what's going on because those things have happened too. I mean, yes, it would've been great if somebody said, "Hey, Einstein's theory of whatever, I can interpret it to show that room temperature nuclear reactions happen." And then, great. But let those guys figure that part out and we can figure out the experiment. So the lack of adequate explanation did bother me, but being more of a nuts and bolts engineer physicist, I was okay with it not being there.

Tom Grimshaw: Yeah. Well, I mean, both compliment each other, the empirical approach and the theory development.

Marissa Little: Right.

Tom Grimshaw: There's a real interplay. I mean, it's almost-

Marissa Little: Oh, if we had a theory that could predict the circumstances that would cause this. I mean, by all means that would have been incredible.

Tom Grimshaw: Yeah.

Marissa Little: Which I know what Widom and Larsen would... I've spent plenty of time on the phone with Larsen, so I was following up on all of those leads too.

Tom Grimshaw: Yeah? Yeah. Of course, Steve Krivit is an adherent to the Widom-Larsen theory. What are your thoughts?

Marissa Little: I don't have a strong enough opinion on it really to have a lot of thoughts. I mean, I can read almost any physics paper and decide that it's true because it's written in enough fancy language that it sounds right.

Tom Grimshaw: Yeah.

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| Marissa Little: | I can really dig down and nitpick at things and try and figure it out. But, I just... I can't. I never spent that much time on that theory to really nail down whether I thought it was true. |
| Tom Grimshaw: | Well, you can't ask Larsen anymore, he passed recently. |
| Marissa Little: | Oh, I didn't know that. I'm sorry to hear that. |
| Tom Grimshaw: | Yeah, it was, I think, late summer, early fall, somewhere in there. |
| Marissa Little: | Oh. |
| Tom Grimshaw: | Yeah. So, if you had time, you had a good sponsor, potential sponsor, would you be interested in being back involved in this field or have you moved on? And if you are interested, what would you do? |
| Marissa Little: | That's a tough question. I still really believe that there is a lot of physics out there that's not being adequately looked at because it doesn't meet in with this sort of rigorous academic paradigm where you have to get a national science grant and do exactly this and just chip away at the known world, and just make tiny little advancements. So I would love to be involved in cutting-edge research again. Would it necessarily be room temperature nuclear reactions? I don't know. If I had all the options open to me in the world, that's kind of where I'm going. If it was that or have a cubicle engineering job, by all means, I'll do cold fusion experiments all day long. But if I had the options of a grant to research whatever in physics I wanted to, cutting-edge physics, breakthrough physics, I'm not sure that I would lean toward cold fusion anymore. I would definitely look at other things though that the majority of the scientific community either turns their nose up at or just can't research because of the restrictions of their funding. So I would still be interested in looking at out-there physics theories, but cold fusion might be not quite on the top of the list. |
| Tom Grimshaw: | Okay. That's fair. So, you're familiar with Thomas Kuhn's book, The Structure of Scientific Revolutions? |
| Marissa Little: | I don't think so. |
| Tom Grimshaw: | That might be one along these lines. I mean, you have other endeavors now, but it's not a new book. It goes back probably 20 or 30 years. But his point is that all radical new scientific discoveries are rejected. |
| Marissa Little: | Right. Oh, I am familiar with this kind of that phenomenon, for sure. |
| Tom Grimshaw: | Okay. |
| Marissa Little: | What is it called? Structural revolutions? |
| Tom Grimshaw: | Structure of Scientific Revolutions. I can send you or I can text you the reference. |
| Marissa Little: | That'd be great. I liked reading stuff like that. |
| Tom Grimshaw: | Okay. It's a small book and it's pretty controversial. But people didn't want to hear that because incremental science is easy, revolutionary science is damn near impossible. |

Marissa Little: Yes. What's the saying? Science moves forward with every funeral.

Tom Grimshaw: Yep.

Marissa Little: Yeah. Well, I mean, anytime somebody would kind of laugh at me for having spent so much of my life involved in cold fusion, I'll ask them if they know anything about plate tectonics. Oh, well, yeah, of course. And you can clearly see that South America was connected to Africa at some point. Well, in 1940 nobody thought that and the guy who came up with that, they all thought he was absolutely insane. It wasn't even a hundred years ago that we thought plate tectonics was total hogwash. So something that the everyday person now... My kids take it for granted. So those are the sorts of things that just happen on a regular basis. It's not unusual for somebody to have an idea, for everyone to tell them they're crazy. Unfortunately that person usually dies before, like Mendel. Mendel died before everyone was like, "Oh Mendelian genetics. That's actually how it works."

Tom Grimshaw: I'm very closely allied with your analysis or comparison with plate tectonics as a geologist. I got my PhD in 1976.

Marissa Little: Okay. There you go.

Tom Grimshaw: So it's one I point to quite frequently in this. And my interest in it is, if I had to make a living at it, I wouldn't do it. But in retirement it's been fantastic, so.

Marissa Little: Yeah, I mean, to get back into the experimental field, like I said, if I had to research cold fusion for the rest of my life or work as a cubicle engineer, I mean, there's not even a moment's hesitation what I would do. Yeah. I mean, it's interesting. It's fascinating. I would love to wake up one morning to a news breaking story that somebody's driving around in their homemade cold fusion-run car because they've finally figured it out and actually produced an engine off of it. I mean, I'll be the first to say that I was wrong, and I was too skeptical, and I should've kept at it.

Tom Grimshaw: Yeah. Well, I hope you have the opportunity to say that.

Marissa Little: Yeah. I mean, I'd love it. I'd love it.

Tom Grimshaw: Yeah. Okay. Well, any final thoughts? We've gone a little bit long here, but I figured as long as we're on a roll [crosstalk 00:44:09]. Final thoughts?

Marissa Little: Yeah. The one final thing I'd just like to say is that I really do think this is an admirable project. I'm sure you're familiar with the file drawer effect. This is something that a lot of people within the cold fusion community will say, "Well there's 200 scientists that have positive results all around the world. Surely that means something." But there have been thousands and thousands of attempts that have not shown positive results, but nobody publishes those. Nobody talks about those because it's like, "Oh, I proved that accepted physics is actually happening." You can't get negative cold fusion results published anywhere. So I think anything that anyone can do, like what you're doing, talking about the failures. I feel like it paints a better picture because they're having a lot of books with talking about the successes that have gone on.

Tom Grimshaw: Mm-hmm (affirmative).

Marissa Little: So I think it's good to have both sides of it, just so everybody can be familiar with what's going on and also so that the general scientific community, it's more palatable. Because if you just talk about how awesome it is and how much it works, the general scientific community is just going to say, "Okay, show me." If you can at least say, "They're having a lot of people that have worked on it and haven't been able to get positive results." And say that we need to fix that part of it. Admit that that's part of the problem and fix it! Hopefully somebody will fix that part. Yeah. That's it. Yeah.

Tom Grimshaw: Yeah. Okay. Good. Well, I'm trying to think if there's anything else. Oh, is there any records that you have? You mentioned that a lot of what you have been engaged with is possibly no longer available.

Marissa Little: Right.

Tom Grimshaw: Is there anything you can point to that you do have? For example, Scott indicated that he has lab notebooks and we're going to add those to this project when the time comes. He also said he lives 40 miles away now, so.

Marissa Little: Yes. I do have. I have still not gone through everything that I pulled out of my office at EarthTech, but I do, I have lab notebooks. I'm a pretty terrible lab notebook taker. Most of my stuff was electronic. We have the website that had a bunch listed on it and that's still, I believe, that's still all completely publicly available.

Tom Grimshaw: Yes. One of the first steps, I went in and downloaded and have added all that material into this project.

Marissa Little: And I can look on my current, the last backup that I actually have with me, but it's only a couple of years old and there just weren't any major projects during the last couple of years, I don't think. I could be missing something, but I'm happy to look though.

Tom Grimshaw: Yeah, that would be fine then. I don't know exactly the whole story with Hal, but I'm going to approach him at an appropriate time again and see if he can become interested in this effort and maybe some of that information could become available again.

Marissa Little: I think he would be. He's always wanted this to... He has remained more optimistic about it, but he wants cold fusion to be successful so I don't see why he wouldn't be interested in helping out.

Tom Grimshaw: Yeah. Well, he's been in on the initial efforts when... Of course not the interviews because those are just clean us. But when I did the downloads of everything, I included him on the distribution of everything.

Marissa Little: Okay.

Tom Grimshaw: So we'll see how that plays out well. Well, think about it and if you have anything that you think might be helpful, and if I am successful with Hal, we might circle back around and engage you again in the project if I find some of the stuff that you have developed.

Marissa Little: Sure, of course.

Tom Grimshaw: Oh, okay. Well, thank you. I'll go ahead and do a little wrap up here. Ask one more time. Any last thoughts or...?

Marissa Little: No, I think we covered a lot of it.

Tom Grimshaw: Good deal. Well, we'll wrap up. I'll say again, this is Tom Grimshaw. I'm talking to Marissa Little. She's actually the daughter of Scott Little, and she worked with Scott and others at EarthTech. As you said, Marissa, from 2005 until... Well, I forgot to ask. When does your work end at EarthTech?

Marissa Little: 2018 was when I left EarthTech. I feel like the last two years, maybe even three, we didn't do any cold fusion experiments, but yeah.

Tom Grimshaw: Okay. All right. So, again, Tom Grimshaw with Marissa Little and today is December 13th, 2019, and I'll say thank you again, Marissa, for participating in this, and we'll see where it goes in the spring. Take care.

Marissa Little: All right. Thank you for including me.

Tom Grimshaw: Okay. Bye bye.

Marissa Little: Bye bye.