Documenting Cold Fusion Research: Preserving a Vital Asset for Humankind

Thomas W. Grimshaw*

Abstract — Cold fusion (low energy nuclear reaction, LENR) was rejected by mainstream science within a year or so of its announcement in 1989. Despite the rejection, LENR continued to be investigated by many researchers worldwide. The LENR Research Documentation Initiative (LRDI) is underway to mitigate the loss of records of investigators who began their work shortly after the announcement and are now leaving the field. The LRDI began with a pilot project with Edmund Storms and now includes 15 participants. Projects typically include publications, unpublished reports, electronic and hardcopy files, lab descriptions and notebooks, publications by others (LENR library), and photos, recordings and other media. The records found in an LRDI project are supplemented with one or more rounds of recorded and transcribed interviews. Where possible, timelines of LENR research are prepared. Each project is documented with memos for each component followed by a report of the investigator's research contributions. Preservation of these records for additional review and analysis as progress is made in the field may contribute to the realization of LENR and its energy benefits. The long-term prospects of humankind will be improved greatly with new sources of abundant, inexpensive and clean energy like LENR.

1. Introduction

Humankind has an urgent requirement for abundant, inexpensive and clean energy. New sources are needed not only to secure energy supplies for the future, but also to reduce impacts of current sources, including global climate change and degradation of water supplies. Cold fusion (now widely referred to as low energy nuclear reaction, LENR) would, if its benefits could be realized, meet human needs for a secure and clean energy source for the foreseeable future.

LENR was announced in March 1989 by Dr. Martin Fleischmann and Dr. Stanley Pons. Although it was rejected by mainstream science within a year, it continued to be pursued by many researchers worldwide. But because it is a pariah science, few new scientists have been attracted to the field. Many of the researchers who began their work soon after the announcement are now leaving the field because of retirement or health issues. The large volume of research records developed over the past 30 years is at risk of being lost.

The LENR Research Documentation Initiative (LRDI) is underway to mitigate this potential loss. Its main objective is to help researchers make sure that their records are preserved and kept available for additional analysis and interpretation as the LENR field continues to progress. The LRDI began as a pilot project with Dr. Edmund Storms and now includes 15 participants. Because the records have promise of helping realize the benefits of LENR, they represent a vital asset for humankind.

2. Records Documentation Procedure

Projects are set up under the LRDI umbrella for participating investigators. A procedure has been developed to capture, document and preserve the records (Figure 1). An LRDI project is initiated by making contact with the researcher, reviewing the objectives and procedure, encouraging participation, establishing communications and arranging a site visit.

A professional resume (CV) is an important source of information and is requested during the initial contact. Research records are collected and interviews are conducted during the site visit. Photos are also taken of the participant and of the various records, which are also described individually with a cover memo. The interviews are recorded, transcribed and similarly documented with a cover memo.

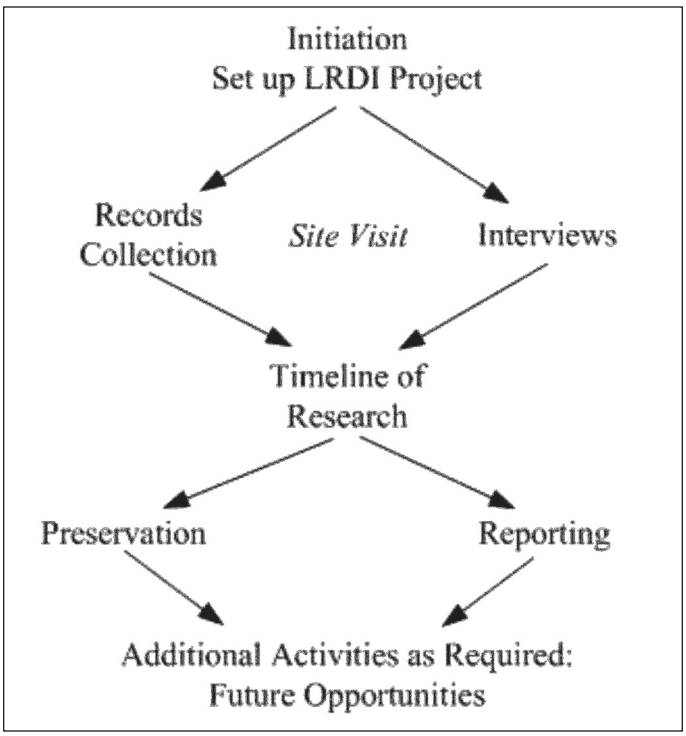

Figure 1. LRDI procedure.

Arrangements are also made during the visit for organizing and preserving the records. After the visit, the documented records and interview transcripts are reviewed, and a research timeline is usually developed. A draft report is prepared based on the memos and is submitted to the researcher for review. It includes additional work that may be performed after the report is submitted.

Projects are conducted on an informal basis. Confidentiality is assured, and any results of a project are reviewed with the researcher before being released in public venues. Information covered by any nondisclosure agreements is not included unless permission is obtained. Early documentation typically addresses the entire record in a general way. Subsequent efforts may include more in-depth characterization.

2.1. Components

For most long-term LENR researchers, a large record consisting of several components is available. The components are identified, described and collected during the site visit. They are different for each participant, depending on the type and amount of investigations, how the results were recorded and the methods of storage. Most researchers have six types of records.

Publications and Unpublished Reports

Investigators often include a comprehensive list of their LENR publications in their professional resumes. Publicly-available reports, papers and presentations in several venues, including journals (*e.g. Journal of Condensed Matter Nuclear Science*) and magazines (*e.g. Infinite Energy*) are obtained. Many of the publications for the LENR field have been assembled in the LENR-CANR.org website.[1] ResearchGate[2] is another source of participants' LENR publications. Items not found in public sources are usually available from the participant's files. Unpublished reports typically include analysis of lab results, progress summaries (*e.g.* to sponsors) and communications with other LENR researchers. A memo is prepared with a list of the publications found, and copies are collected and included in the project where possible.

Electronic Files

Nearly all researchers have a large assemblage of electronic files in different formats created by various kinds of software. The files are generally of two types—documents and data files from experiments. The initial emphasis in a project is collection and description of the documents followed by the data files. The electronic files are found on current computers and external storage, such as hard drives, flash memory, servers or the Cloud. Long-term researchers often have files on legacy media, such as CDs, ZIP discs, retired hard drives and floppy disks. The files are included or referenced in the project. Their location and the storage media on which they were found are recorded in a series of memos.

Hardcopy Files

LENR research began in the early years of the digital age, so paper files often comprise a major component, particularly for long-term investigators. These records are often found in file cabinets and in boxes or storage tubs. Memos are used to document the records, including an inventory, organization, type of storage and location. The storage containers are also photographed. The materials are prioritized for scanning, and PDF files are created as needed using an LRDI scanner. Scanning may be accomplished on site, or the materials may be borrowed, scanned at the LRDI location and returned to the participant.

Laboratory and Experiments

The participant's lab is characterized using any existing descriptions, including experimental methods, apparatus and equipment, materials, and data collection and analysis methods. Additional descriptions, including previous or legacy methods and equipment, are also prepared for the project as required. Photos of the lab and equipment are acquired—or new ones are taken—during the visit. Lab notebooks are described when they are available, and electronic lab files are identified for inclusion in the project. Memos are prepared for the descriptions and photos of the lab, equipment and notebooks.

Photos, Recordings and Other Media

Most participants have a collection of other types of media, such as photographs and images, audio and video recordings, and correspondence (*e.g.* emails, letters). The photos often include lab equipment and experiments as well as events like meetings and conferences. Many participants, for example, have pictures or video recordings of presentations and attendees taken at International Conferences on Cold Fusion (ICCF). Video recordings typically consist of purchased items (*e.g.* produced to describe or promote LENR), recorded television programs (*e.g.* news broadcasts covering the field) and self-made recordings of conferences and related events.

LENR Library

Nearly all participants have a collection not only of their own work, but also items prepared by other LENR researchers. These items include books, published papers, conference proceedings (*e.g.* ICCFs), magazines (*e.g. Infinite Energy*), reports (*e.g.* SRI International) and related materials. They are found in both hardcopy and electronic (*e.g.* PDF) form. Some participants have reference management software such as Endnote for their collection of references. Copies of the electronic versions are obtained for the project, and photos are taken of the books and other hardcopy items. Memos are prepared listing the materials found and including the photographs taken.

2.2. Interviews

Personal interviews with the participant are essential for LRDI projects. They provide the context for the research records and are principal sources for the timelines of investigation. The interviews are recorded using a hand-held device, such as a multi-function phone with a suitable app. The audio files are submitted to an online transcription service. When the transcripts are received, usually within 24 to 48 hours, a cover memo describing the date, participants and location is added. The interviews may be done in person or by phone using another app that records the call and produces the audio files.

Generally two or more rounds of interviews are accomplished covering the full range of LENR research as well as a summary of the investigator's pre-LENR background. They are conducted free-form to encourage the researcher to relate

what he or she feels is most memorable. Emphasis is placed on making the recollection an enjoyable experience. More than one round of interviews has the advantage that the descriptions of events may vary, resulting in a more complete yet consistent description of the research trajectory.

2.3. Timeline

Documentation of an investigator's research record is most complete when a timeline of experiments and results can be constructed. The timeline is determined by examining the records and, particularly, by reviewing the interview transcripts as well as conducting follow-up conversations. A researcher's timeline consists of phases and milestones that reflect his or her journey of LENR investigations. The basis of the milestones or turning points varies for different investigators and typically consists of his or her own experimental findings and progress, new ideas or insights, changes in sponsors and events in the LENR field. A major goal of the research timeline is to integrate the interview transcripts with the research record.

2.4. Preservation

A researcher's records are secured after they have been obtained and documented. Keeping the records available for more analysis and interpretation based on progress by the researcher or by new developments in the LENR field (and with concurrence of the researcher) is a principal objective of the LRDI. Both the participant's records and the project documents (memos and reports) are shared between the LRDI and the participant. This sharing is accomplished by high-capacity flash memory (thumb drive) or in the Cloud using commercially available storage such as Google Drive or Dropbox. In both cases the files are backed up on a high-capacity external hard drive for the LRDI.

2.5. Reporting

As noted, memos are used to document each component of the research record as well as with the interviews of the investigator. Attachments, such as photos or long tables, are included in the memos as required to document the materials found. Project reports are prepared based on the memos, and are typically organized as follows: 1) introduction; 2) research record components; 3) interviews; 4) timeline; 5) future opportunities; and 6) project methods. Future opportunities typically set forth actions to obtain additional information and conduct more in-depth analysis, such as more extensive descriptions of the records or additional detail in the timeline. The methods section describes the LRDI procedure and a list of the memos prepared during the project.

The project report is submitted to the participant for review and approval. The report and memos are added to the other project files in the selected storage medium. Where needed, the report is prepared in stages, such as information collection, organization (timeline) and documentation. Appendices are used in the reports for interview transcripts and voluminous descriptions of records, such as long lists of publications.

2.6. Future Opportunities

Nearly all LRDI projects are documented with suggestions of more that can be accomplished. As noted, the initial focus of a project is on a general description of the entire research record. The information can then be characterized more completely and in more detail in subsequent work. More interviews may also be conducted, such as for particularly significant events or findings. Additional visits to the participant may be necessary for the added records and interviews. The reports and other accomplishments of the projects may be presented or published, with concurrence by the participants, under LRDI sponsorship at conferences.

3. Pilot Project: Edmund Storms' LENR Career

The LRDI began with a pilot project for Edmund Storms, who was one of the earliest researchers to follow up on the 1989 announcement. He began his LENR investigations while at Los Alamos National Laboratory (LANL), where he already had a 35-year research career (since the mid-1950s) at the time of the LENR announcement. He had worked on high-temperature materials primarily for the nuclear rocket[3] (Rover) and space reactor[4] (SP-100) programs. This work led to his report on the refractory nitrides and carbides[5] as well as his book on refractory carbides.[6]

Dr. Storms has conducted investigations and developed explanations for the phenomenon in the 30 years since the announcement. His most prominent publications are his two books, published in 2007[7] and 2014.[8] He was honored (along with Michael McKubre) by *Wired* Magazine[9] in 1998 as one of the 25 people in the U.S. making a significant contribution to new ideas. He was awarded the Preparata Medal, the most prestigious award in the LENR field, in 2005. He has also co-authored a report demonstrating that LENR is science and not pseudoscience.[10]

Dr. Storms has developed a novel explanation for LENR, referred to as the "nanocrack and hydroton" hypothesis, which is explained at length in his 2014 book. He proposes that numerous narrow—approximately one nanometer—cracks are formed by stress in the host material, such as palladium. The cracks become occupied by deuterium or protium nuclei (hydrogen nuclei with or without a neutron) that are held in the crack by negative charges on the walls of the crack. The hydrogen nuclei become arranged in linear structures termed hydrotons and vibrate at high frequency. During the cycles of the vibration, the nuclei approach each other closely—so closely that fusion occurs and some of their mass is converted to energy in each cycle. The energy is conveyed from the hydroton to the host material as photons and causes the lattice to increase in temperature. The fusion energy, detected by the temperature increase, is referred to as "excess heat"—energy above (sometimes far above) what can reasonably be attributed to chemical reactions.

This hypothesis, like others in the LENR field, has not yet been verified by reproducible experiments.

Dr. Storms' LENR research record is extensive and goes back to his earliest work at LANL. He has produced about 125 publications and over 110 unpublished reports. He has thousands of electronic files on his current computer, CDs and DVDs, ZIP discs, VHS tapes, a retired external hard drive and 3.5-inch floppy disks. His hardcopy records are in 14 hanging-file storage tubs.

Dr. Storms' lab was set up to perform LENR experiments using the electrolytic cell, gas loading and gas discharge methods. Most of the experiments are described in ten lab notebooks. He reviewed the notebooks and prepared a

"Work History" summary in a spreadsheet that has 2,750 entries. His LENR library has 150 books on the subject and over 6,000 electronic and hardcopy papers authored by himself and nearly all of the other researchers in the LENR field. He has a website, LENR Explained,[11] to present his books and other works, and he helped Jed Rothwell establish the LENR-CANR.org website[12] based initially on his private collection of publications.

Three rounds of interviews totaling more than 22 hours were conducted and transcribed covering Dr. Storms' entire range of LENR investigations. He attended nearly all of the ICCF conferences from ICCF1 to ICCF18, and he has a nearly complete collection of their proceedings as well as a large number of photos of the conference attendees and events.

A timeline has been prepared for Dr. Storms' LENR research career based on the records and interviews. It has eight phases consisting of periods of support from sponsors interspersed with self-supported investigations:

1. LENR Work at Los Alamos National Laboratory (3/1989-8/1991)
2. Independent Investigation 1 (9/1991-12/1993)
3. ENECO Support (1/1994-2/1998)
4. Independent Investigation 2 (3/1998-6/2000)
5. Lattice Energy Support (7/2000-2/2006)
6. Independent Investigation 3 (3/2006-2/3007)
7. Kiva Labs (3/2007-3/2012)
8. Independent Investigation 4 (4/2012-12/2015)

Four reports have been prepared for the Storms pilot project: 1) information collection;[13] 2) organization (timeline);[14] 3) documentation;[15] and 4) summary report.[16] The project was reported at ICCF21 in 2018 as a poster.[17] The Storms LENR Research Documentation Project has also been described on his LENR Explained website. The project reported Dr. Storms' work through 2015, so a supplemental project is underway to extend the coverage for 2016 to 2018.

4. Participants and Projects

Participants in the LRDI vary greatly in their LENR research experience and types and quantity of records. Other variables are the methods of recording experiments, kinds of storage media and accessibility of the records. The LRDI procedure is flexible and is readily adapted to the various researcher situations. As noted, a project is set up under the LRDI umbrella for each participant or organization.

Candidates for participation are identified based on contributions to the LENR research, level of interest in the LRDI, proximity to leaving the field and potential risks of loss of the records. The 11 projects with 15 participants to date, in addition to the Storms pilot project, are shown below.

- Tom Claytor and Malcolm Fowler (Los Alamos National Laboratory, retired)
- Sidney Kimmel Institute for Nuclear Renaissance (SKINR): Dennis Pease, Arik El-Boher, Graham Hubler
- David Nagel (The George Washington University; Naval Research Lab, retired)
- Mahadeva Srinivasan (Bhabha Atomic Research Center, retired)
- Dennis Letts (LettsLab)
- Melvin Miles (Naval Air Warfare Center, China Lake, retired)
- Naval Research Lab: David Nagel, Graham Hubler, Ashraf Imam (all retired)
- George Miley (University of Illinois, professor emeritus)
- Fran Tanzella (SRI International, retired)
- EarthTech International: Scott Little, Marissa Little (former staff)
- Lawrence Forsley (Global Energy Corporation, U.S. NASA, The University of Texas at Austin)

As noted, a supplemental project to extend the coverage of the Storms Pilot Project for 2016 to 2018 is also being performed. The other 11 projects are in various stages of the LRDI procedure, from initial site visit to draft versions of the report. Records have been collected, and interviews have been accomplished with each of the participants. Nearly all of the investigators have published reports, electronic and hardcopy files, and a LENR library, and most of them have labs and associated experimental records.

5. Summary and Future Directions

Realization of LENR and its benefits may be critical for the future of humankind. Now 30 years after the LENR announcement, prominent researchers are leaving the field. Given the importance of LENR, loss of their research would be a tragedy both to the field and to humanity. The LRDI is underway to mitigate this loss. A sound procedure has been developed and has been proven many times. The records of 15 researchers are being documented. An LRDI status report was presented at ICCF22.[18] A number of candidates have been identified for future LRDI participation.

Future possibilities for the LRDI include presentations, reports, website preparation and other outreach initiatives to help make the case for LENR. More in-depth analysis of the records of current investigators, such as more detailed timelines, may also be accomplished. A central repository could be developed for improved protection of the LENR research records. It would need to be secured from outside penetration (hacking), protect researcher interests with confidentiality and be readily accessible by the researcher and others whom he or she designates.

Most importantly, the records of the investigators need to be systematically reviewed and analyzed to help understand LENR, achieve consistent reproducibility and realize its energy and other benefits.

6. Acknowledgments

Thanks go to the LRDI participants for their willingness to be a part of the effort and for their full support in making their projects a success. Gratitude is expressed to the Anthropocene Institute[19] for support for LRDI expenses. The Energy Institute[20] at The University of Texas at Austin has provided facilities and administrative support.

Ed Storms not only provided information, advice and resources for the pilot project, but also has been a supporter and collaborator for several years before and after the pilot. David Nagel has given generously in both moral and material support. Thanks also go to Chip Groat, formerly of the Energy Institute, for being a mentor and helping advance the cause of LENR research. Jed Rothwell's LENR-CANR.org website of references for the field has been invaluable for the LRDI projects.

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About the Author

Dr. Thomas Grimshaw became interested in the cold fusion field after a long career in environmental protection and cleanup. He has graduate degrees in geology and public policy. His interests are primarily in cold fusion public policy, supporting investigators and documenting research records. He pursued these interests for more than 14 years at The University of Texas Austin. Most recently he is continuing his work in the field as President of LENRGY LLC, a cold fusion consulting firm.

*Email: thomaswgrimshaw@gmail.com