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U.S. Industry Opportunities for Advanced Nuclear Technology Development

James P. Burelbach

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FAUSKE & ASSOCIATES, LLC

WORLD LEADER IN NUCLEAR AND CHEMICAL PROCESS SAFETY

Report No.: FAI/19-0715

Final Report
U.S. Industry Opportunities for Advanced Nuclear Technology Development

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1.0 BACKGROUND

The Statement of Work (SOW) for this activity involved three main tasks.

(1) Carry out an international survey to construct a comprehensive list of safety related experimental programs that have been and are important contributors to the safety assessments for nuclear installations. Furthermore, this survey also served to collect the views of many scientists and engineers, who have been in nuclear safety for many decades, regarding the experimental programs for which there is the most immediate need to archive the experimental data.

(2) Perform a search for possible sources (libraries, experimental data bases, etc.) that may contain relevant information for one, or more of the three important, and expensive experiments initially identified as key experimental information to be preserved (LOFT, Marviken, HDR). The information gathered includes experimental test reports, peer reviewed technical papers, articles prepared for technical meetings that were not peer reviewed and papers that were written for specialist meetings but which did not have a peer review, all of which help to provide insights on the experiments of interest.

(3) Provide a demonstration of how the archival status of three of the most important experimental programs can be characterized and archived for the different levels of experimental documentation that might be found for each of the three experimental programs selected for the demonstration.

2.0 INTERNATIONAL SURVEY ACTIVITY

An international survey regarding the key reactor safety experiments that should be considered as candidates for archival was sent to 61 knowledgeable engineers, scientists and technical managers in the US, Canada, Europe and Asia on April 2, 2019. Appendix A shows the electronic file that was sent to the international community for their comments and additions. Related to this distribution, Prof. Mike Corradini brought to our attention a committee of university leaders, the Nuclear Engineering Department Heads Organization (NEDHO) in the United States. Mike contacted the current Chairperson of NEDHO (Prof. Arthur Motta of Penn State) and explained our objective for this information-gathering activity. Prof. Motta asked that we send him a copy of our survey and he would forward it to the committee members with his endorsement. This provided an additional, important expansion of the survey distribution.

Comments that we received identified several additional experiments that should be added to the archive list. In addition, one comment suggested that available plant information from industry accidents, such as Three Mile Island Unit 2 (TMI-2) and the Fukushima accidents, should be part of the archived data. We also received input from some members of the NEDOH Committee (the University of Michigan, MIT and Texas A&M University). These comments were addressed in the draft list of experiments that was distributed with the survey, and a copy of the updated list of experiments and accident-related data is included in Appendix B of the present report. With the incorporation of these comments, the updated list of experiments currently guides our archival activities.

3.0 LOCATIONS OF ARCHIVAL RECORDS OF INTEREST

Related to both Tasks 1 and 2, the GAIN Light Water Reactor Data Preservation Activity Team (Bob Budnitz, Mike Corradini, Bob Henry, Frank Rahn and Neil Todreas) has been in touch with several organizations that have the interest and the capabilities to archive experimental data.

3.1 OECD-NEA Paris France (Marviken Large Scale Experiments)

One of these is the OECD – NEA in Paris. OECD was the coordinating organization for all five of the Marviken large scale experimental programs. Each experimental program was sponsored by a group of OECD member countries, but each test program had a different list of sponsors. Since OECD is the over-arching organization sponsoring these experimental programs, they have also maintained and archived the test results in their computer system. In our discussions with Dr. Tatiana Ivanova of the NEA, we have learned that they have archived experimental files for the major test results obtained from each of the five test programs. These are shown in red in Appendix B,

Full Scale Containment Blowdown Experiments, Series I

Full Scale Containment Blowdown Experiments, Series II

Full Scale Critical Flow Tests

Full Scale Jet Impingement Tests

Aerosol Transport Tests

In reviewing the experimental results that are archived in the OECD-NEA files, we noticed that also included in those files are many of the testing programs given in the list of experiments distributed with the survey. For the readers' convenience these are also shown in red in Appendix B. As discussed further below, many of these records are associated with the LOFT in-reactor test program. With this information already archived in the OECD-NEA computers all that is needed for documenting these programs is to provide the appropriate contact information should some individuals or organizations wish to examine or use the experimental data. The list of experiments that are archived by the OECD-NEA can be found at the following electronic address: https://www.oecd-nea.org/tools/ie/ .

In comparing our personal files to those archived in the OECD-NEA files for the Marviken Large Scale Critical Flow Tests, it was noticed that some of the comparison tests are not included in the list of test that have been archived. (One of the objectives of the Critical Flow Tests was to demonstrate that the experimental results were reproducible; hence comparison tests were performed to address this concern.) Our personal files included many of these test results in the form of "Interim Test Reports". As a result we offered to provide searchable electronic documents of these additional available reports.

Dr. Kenya Suyama's (OECD-NEA) kind response to our offer is included as Appendix C. We understand that OECD-NEA-CNSI staff wishes to maintain the focus on the final reports for each test data. Furthermore, we are pleased to see they are considering adding the experimental results for the comparison tests that document the repeatability of the results. A demonstration of this was is an important objective of the large scale test program. The FAI staff and the GAIN Light Water Reactor Data Preservation Activity Team (Bob Budnitz, Mike Corradini, Bob Henry, Frank Rahn and Neil Todreas) unanimously support this addition to the OECD-NEA Archival records.

3.2 GRS (Heiss Dampf Reaktor [HDR])

In April, 2019, there was an ANS PSA Meeting in Charleston S.C. and Drs. Budnitz and Henry had discussions with a staff member from the German GRS regarding their role in the HDR large scale containment experiments. In these discussions we learned that German Federal Ministry for Economy and Energy (BWMi) has retained essentially all of the experimental information from these important experiments. It appears that to have access to this information, certain agreements would need to be constructed between BWMi and DOE or the NRC. The formation of such an agreement is defined below. For this investigation it will be assumed that an agreement is, or can be, put into place for access to the HDR experimental data. (In support of this, it is noted that an exchange agreement for safety related data was signed between the German Federal Ministry for Research and Technology (BMFT), a predecessor to BWMi, and the NRC and EPRI. Perhaps this agreement is still applicable, but if not it could serve as a framework for a new one.)

- Previous experimental data sharing agreements have always been reciprocal. So, the institution (or individuals) asking for reports/data from BMWi via the GRS project management office would be expected to offer other information/data to the German side (either BMWi or the GRS) in which German partners are interested.

- There must be an official request to BMWi via the GRS project management office specifying in detail which data/information/reports are requested to be shared. This likely would need to be a request from a research institute or the NRC.

- Moreover, information/data this organization might share as an equal exchange should be identified. (Also, if there have already been requests from Germany to share such information, this should also be mentioned.)

- With this background, the BMWi will decide how the information can be exchanged from both sides and will inform the requesting party regarding the information/data that is of interest to the German organizations.

- With a formal structure like this established, the exchange can then take place.

This structure shows that the information exists and that it could be made available through agency-to-agency agreements. Perhaps the first follow-up action should be to determine if there is already an agreement between DOE and BMWi for sharing technical information. Whether there is an agreement already in-place or if one needs to be developed, a path has been defined for access to this information and the technical insights it provides.

In our discussions that led to the above definition of how an agency-to-agency agreement could be structured, we also asked for a list of the experiments that are in the GRS records. To date, this has not been supplied. Therefore, to address the activities associated with Task 2, FAI accumulated papers and reports that are available in the FAI Library and personal files of the staff that discuss or use the containment experiments performed in the Heiss Dampf Reaktor (HDR). This is the first step in finding various publications that have used the experimental information from the spectrum of HDR experiments performed. To date, 21 papers and reports have been accumulated and electronic copies have been made of each publication. These provide the major experimental results for a number of the HDR tests, including E11.2 (also called International Standard Problem ISP-29), T31.5 (ISP-23) and V44 (ISP-16). More importantly, this helps to expand the knowledge related to the large scale tests and to identify how information from the open literature could be used productively by scientists and engineers that may not have the necessary agency-to-agency connections to access the final test reports.

3.3 Data Sources for the LOFT Experiments

As mentioned above, the list of experiments that are archived by the OECD-NEA on the OECD-NEA electronic address https://www.oecd-nea.org/tools/ie/ also include LOFT experimental data. This reflects the involvement of the OECD when some of the member countries sponsored several of the LOFT experiments.

During a recent visit to Idaho National Laboratory (INL), Professor Mike Corradini had an opportunity to meet with Dr. John Bess to discuss the INL storage of the LOFT data since the project was completed. We were particularly interested in using information from some of the LOFT Tests to develop the concepts in Task 3 in terms of generating an archival record of sample test results. Dr. Bess suggested that we contact the INL Library regarding a computerized source for the LOFT test information. The INL Library staff informed us that the LOFT data can also be found at the Office of Science and Technical Information web address https://www.osti.gov/[osti.gov].

4.0 A STRUCTURED FRAMEWORK TO ARCHIVING KEY EXPERIMENTAL DATA WITH VARYING LEVELS OF AUTHENTICITY

In the open literature there can be a broad range of documents that provide or use experimental data without reference to a qualified source for the specific information. The third task of this activity is to provide a draft archival structure that could enable the effective use of data that has been taken from a spectrum of publications including test reports, reviewed technical journal articles, meeting presentations and trade press articles. These various levels of open literature references for the three major experimental programs are used to show how information can be characterized and archived using different levels of documentation that may be useful for current and future researchers.

Multiple levels of documentation for individual experiments is a good way to capture the experimental data along with some of the ways that the information could be used. Additionally, it facilitates access to other forms of the information that might be found in the literature for investigators that may not have the contacts or the capability to acquire the original data files. The types of available files found in the literature for at least one of the three experimental programs selected for the demonstration (LOFT, Marviken and HDR) are the basis for the various documentation categories.

This task lists the spectrum of ways that the experimental data have been used to discuss and address safety questions. Such analyses help document the various archival levels that may be found for the experimental information. These various manners of presenting information may help to develop a template that characterizes the archival status, with the highest level of technical review being "A" and the lowest level having an “H” designation (see Appendices D, E and F). Descending levels from "A" to "H" represent a spectrum, from data taken with Quality Assurance calibrations of the individual measurements combined with technical reviews of the experimental reports at the highest level (A) of the archival structure, down to those documents that have received essentially no critical review to provide confidence in the data as represented or discussed (level H). Hence, if an author chooses to use such a lower level document, they do this at their own risk. Examples of each category can be organized and documented (derived from the three selected major experimental programs). An important part of the template is to capture the various levels of how the information has been taken and reported. Some of these entries may be proprietary and others may be in the open literature, but both are to be acknowledged.

To demonstrate how the available information can be collected, compiled and documented for the various levels of archiving experimental information, the following categories are considered. These are structured with respect to descending depth of archival comprehensiveness and review, again with A being the most comprehensive.

A) The original experimental data records or test reports that include tables or graphs (unprocessed or processed) of all of the measured information for a given experiment.

B) The experimental test report(s) that includes the processed data for those measurements judged to be the most important but does not satisfy the criterion in "A"

C) A program summary report that provides an overview of the test results

D) Peer reviewed papers for technical journals that have been published in the open literature by personnel directly associated with the experimental program

E) Peer reviewed papers for technical journals that have been published in the open literature by analysts that are using the experimental data

F) Industry reports that have been reviewed by a government agency as part of a licensing application.

G) Technical papers that have not received peer reviews but were presented at group or specialist meetings

H) Slides used for a presentation of experimental results at a group or specialist meeting

Documents that are either listed in archival records, or those found in the open literature concerning the Marviken Critical Flow, HDR and LOFT experiments are listed in terms of their archival categories in Appendices D, E and F. Appendix D presents the information for the Large Scale Marviken Critical Flow Tests, Appendix E lists a variety sources for the HDR experiments, and Appendix F provides the categorization for the in-reactor LOFT Program. While meeting presentations or open literature papers were not found for all of the categories in each of the major programs, articles for each of the categories were found for the HDR experiments. Providing these characterizations regarding the depth of review and checking of the experimental data helps the author(s) of future technical analyses and documents to select references for the experimental data that are either the original source documentation or a technical publication that has undergone the processes of a technical review and comment period.

5.0 OTHER SITES WITH ARCHIVED INFORMATION

During our investigations, it became apparent that there are other sites, in addition to Idaho National Laboratory (INL), OSTI, OECD and GRS, where information has been archived for specific experimental programs. Some of these are identified below. It is important to note that these are just those that were part of our literature search or from the recollections of the GAIN Light Water Reactor Data Preservation Activity Team (Bob Budnitz, Mike Corradini, Bob Henry, Frank Rahn and Neil Todreas).

- Argonne National Laboratory
- Battelle Columbus Laboratory
- Battelle Pacific Northwest Laboratory
- Brookhaven National Laboratory
- Electric Power Research Institute
- Los Alamos National Laboratory
- Lawrence Berkeley National Laboratory
- Lawrence Livermore National Laboratory
- Nuclear Regulatory Commission
- Oak Ridge National Laboratory
- Sandia National Laboratory

We have also found the website www.worldcat.org particularly useful in finding where university and public libraries have obtained copies of test reports on experiments of interest that are not easily obtained. This could be quite helpful for researchers in the future to locate desired references.

6.0 A POSSIBLE NEXT STEP

The present limited scope study has focused on preserving the results of important experimental programs for light water reactor safety by locating and documenting where the test information for three key programs has been archived. From these activities, there are two insights that stand out:

(i) Internationally, there are several locations where key experimental information has been archived. Furthermore, through our experience we have identified sites where other experimental information is likely archived. Given the limited scope of this study of three major experimental programs, it is likely that there are other archival sites for other significant experimental programs that were not identified by this activity.

(ii) Each of these identified organizations that has developed an archival program will continue to support that activity for their individual experimental interests in the future.

Nonetheless, the international survey results suggest that additional experiments be added to the list of key nuclear reactor safety experiments. Moreover, another survey comment suggested that the information related to plant events and accidents should also be archived. It is agreed that the data/information documented for the plant events/accidents, which occurred over the seven decades of commercial nuclear power, contain important insights that should not be lost. At the same time, it would require a substantial effort to locate and preserve the foundational experiments and plant transients/accidents identified in Appendix B.

Combining this with the observations and the discussion of other locations where archiving is currently being performed (and there are certainly others in addition to these), it seems that the most productive and cost effective approach to assure that the available information is accessible to the technical community would be to develop a roadmap to these current sites along with the information located at each site. There is some appeal to organizing a dynamic electronic directory listing where the experimental information can be found categorized both by the archival site and by the various phenomenological areas or reactor event/accident. In many cases these are journal articles, many are national laboratory reports, university theses and papers presented at specialist meetings. Any such directory needs to be dynamic so it can be updated in terms of archival sites and subject areas to ensure it remains current.

Such a directory would naturally include all the experimental programs and the spectrum of reactor events/accidents that were identified through the international survey. Furthermore, it would list the relevant publications for each item identified in Appendix B and perhaps organize the material using the structure provided in Appendices D, E and F. Also, as mentioned above, this could be a dynamic electronic directory to be periodically updated to include new experimental programs and additional references as they become available. A compendium of this information

would be very helpful in locating the various places that experimental information for a given experimental program could be found.

7.0 SUMMARY

The three tasks stated in the SOW were addressed by:

(i) Conducting an international survey to identify those experimental programs that are essential to the design, licensing and operation of nuclear reactors designed for generating commercial electrical power.
(ii) Performing a search for sources of the experimental data (where available) including the test reports, papers on the experiments in the open literature, national laboratory reports, publicly available papers that used the experimental results and presentations at expert meetings.
(iii) Developing a structured approach to the characterization of the various references specific to a given experiment where the experimental information is given, used and/or discussed.

The international survey collected the views of scientists and engineers, who have been actively involved with nuclear safety for many decades, regarding the experimental programs that are essential to safety assessments. In addition to the list of important experiments, one survey comment suggested that the data associated with various plant events and accidents should also be added to the archived information. A list of these events has been added to the list of experiments.

There appears to be only limited publicly available sources discussing or showing the use of data outside of the OECD and OSTI archival records for the Marviken and LOFT experiments (see Appendices D and F). However, there are a number of articles available regarding the use of the data taken in the HDR facility in Germany (Appendix E). This appendix is a good example of how the breadth of the literature can provide most, if not all, of the information that would be required to understand the meaning of an individual experiment.

The third task requires a structured list of publications that have entered the literature through various pathways. Of course the experimental information itself or even a test report that displays the information are the preferred references to quote in technical arguments., However, sometimes these are part of an archive that requires membership to access the data. For some purposes, only limited data are of interest and that is where the papers and reports in the open literature can be of help. Having the structure highlights the depth of review, which is helpful to future authors.

With the experiences provided by this effort, the great value of having experimental data archived is clear, especially for the three major experimental programs examined herein. Specifically, the data can be resurrected and reanalyzed should the need arise. Also clear is the need to have other experiments archived, and to a large extent this relates to DOE, NRC, national laboratory and EPRI programs that have preserved the results of sizable programs. However, the list of experiments and reactor transients/accidents which provide the foundation for the designs,

licensing and operation of current commercial nuclear power plants demonstrates that there are other programs that should be archived in some way so the information is not lost. To this end, we have recommended an "archive directory" as the next step for the preservation of key experimental data activity so that this preservation activity can move forward in a focused and cost-effective manner.

APPENDIX A: Letter and International Survey That was Distributed

Dear Colleague:

At the 2018 ANS Annual Meeting in Philadelphia, the NISD & TH Divisions jointly sponsored a special session on the need for Preservation of Key Nuclear Safety Data. The Organizing Committee for this special session comprised five individuals: Bob Budnitz, Mike Corradini, Frank Rahn, Neil Todreas and Bob Henry. This well-attended open session had lively discussions in the following areas:

- How do we ensure a commitment to archiving information in the context of rapid advances in computerized storage technology?
- How can we obtain funding to cover the vast amount of data to be preserved?
- How can a list of experiments be developed that encompasses all the various commercial power reactor designs?
- How can the overall effort be structured to encourage engineering students to participate in archiving one or more experimental programs as a learning process?
- Where are the best places to archive this key information to ensure the long-term preservation of the experimental information?

These critical topics must be addressed for such an ambitious program to succeed. To initiate the process, the US Department of Energy (DOE) GAIN Initiative is funding an international survey to develop a list of experiments that are candidates for preservation. We encourage and welcome your participation in this simple survey. There are only two main questions:

- *Is your organization already committed to archiving key information for one or more nuclear reactor safety experiments?* If so, please identify the archived experimental program(s) and the contact person(s) for the archiving effort(s). The archive location and contact details will be recorded for future use by interested parties, and are essential to ensure that valuable resources are not wasted on something that has already been done.
- Attached is a preliminary list of key experimental activities that need to be archived. This initial list includes many experiments related to thermal-hydraulics, reflecting the general background of the Activity Team. However, our goal is to develop a list of ALL experiments that are important to reactor design and operation. *Are there programs that you believe should be added?* If so, please mark-up the attached list and return it to us. Moreover, if you know of someone whose input should be included, please feel free to invite them to participate.

It is critical that we receive input from our colleagues with experience and interest in reactor safety assessments and experiments. Please use the attached form or email responses to craines@fauske.com, Survey Administrator. Your timely support (by May 15, 2019) will be a great help to us in building the foundation for this essential effort. Thank you in advance for contributing to this survey.

Sincerely,

The GAIN Light Water Reactor Data Preservation Activity Team:
Bob Budnitz, Mike Corradini, Bob Henry, Frank Rahn and Neil Todreas

International Survey for Candidate Information to be Considered for the GAIN LWR Data Preservation Activity

FAUSKE & ASSOCIATES, LLC

Is your organization already committed to archiving key information for one or more nuclear reactor safety experiments? If so, please identify the archived experimental program(s) and the contact person(s) for the archiving effort(s). The archive location and contact details will be recorded for future use by interested parties, and are essential to ensure that valuable resources are not wasted on something that has already been done.

Key nuclear reactor safety experiment(s) already archived:

Experiment: _____ Contact email: _____
Experiment: _____ Contact email: _____
Experiment: _____ Contact email: _____
Experiment: _____ Contact email: _____

Attached is a preliminary list of key experimental activities that need to be archived. This initial list includes many experiments related to thermal-hydraulics, reflecting the general background of the Activity Team. However, our goal is to develop a list of ALL experiments that are important to reactor design and operation. Are there programs that you believe should be added? If so, please mark-up the attached list and return it to us.. Moreover, if you know of someone whose input should be included, please feel free to invite them to participate.

I have reviewed the attached list and it is sufficiently comprehensive. ☐ *check box*

Additional experimental activities to be added that are not on attached list:

Experiment: _____ Contact email: _____
Experiment: _____ Contact email: _____
Experiment: _____ Contact email: _____
Experiment: _____ Contact email: _____

Comments:

Please email information to:
craines@fauske.com

Submit Form

List of Key Reactor Safety Experiments to be Archived
I. Integral Experiments
1) Fully Integral Experiments (Core, RCS, Containment, Fission Products)
a) LOFT – Loss of Fluid Tests
b) Peach Bottom Turbine Trip, Delayed Scram Transient Tests
c) Phebus Experiments
d) ANL - EBR-II Loss of Flow at Power Experiments
2) Partially Integrated Experiments (Core, RCS, Fission Products)
a) SFD Severe Fuel Damage Experiments in the PBF – Power Burst Facility
b) FLHT – Full Length Heat Transfer Experiments
3) Partially Integrated Experiments (Core, RCS, Containment)
a) OSU AP600 Experiments
4) Partially Integrated Experiments (Core, RCS)
a) LOFT Semiscale Tests
b) BWR Full Integral Simulation Tests (FIST)
c) ROSA-LSTF Experiments
d) ISPRA LOBI Experiments
e) RDM-14 Experiments at Whiteshell
f) Seimans 4 Loop PWR PKL Test Facility
g) Hitachi BWR Two-Bundle Loop Experiments
h) CEA 3 Loop PWR BETHSY Test Facility
i) FLECHT/SEASET Experiments
j) ANL – TREAT 'R' Series 7 Pin Sodium Voiding Data
k) ANL – Out-of-Reactor OPERA 7 Pin Sodium Voiding Data
5) Partially Integrated Experiments (RCS, Containment)
a) Marviken Suppression Pool Experiments
b) HDR RCS Blowdown Experiments
c) SNL IET Direct Containment Heating Experiments
d) ANL IET Direct Containment Heating Experiments
II. Separate Effects Core Experiments
1) Godiva Experiment
2) SNL ACPR Prompt Burst Excursion Experiments
3) SEFOR Experiments
4) CORA Core Damage Experiments
a) BWR
b) PWR

5) FZK QUENCH Experiments
6) SNL XR2-1 BWR Metallic Melt Relocation Experiments
III. Separate Effects RCS Experiments
1) EPRI – Westinghouse SF_6 Experiments on PWR Natural Circulation
2) IIST PWR Natural Circulation Experiments
3) UPTF 2D-3D Experiments for a PWR Upper Plenum
IV. Separate Effects Containment Experiments
1) S&L Containment Experiments
2) CVTR - Carolina-Virginia Tubular Reactor
3) BMC – Battelle Memorial Containment Experiments
4) CSTF – Containment System Test Facility Experiments
5) PS & ETH – PANDA Experiments on BWR Passive Heat Removal
6) ANL MACE (MCCI) Experiments
7) KfK BETA (MCCI) Experiments
8) CEA VULCANO (MCCI) Experiments
9) SNL 1/6 Scale Containment Ultimate Pressure Experiment
10) Westinghouse Ice Condenser Experiments
11) Westinghouse AP600 PCCS Experiments
12) NUPEC ¼ Scale of a 4 Loop PWR Containment
13) University of Wisconsin AP600 Experiments
14) JAERI Containment Spray Tests
15) Whiteshell Large Scale Gas Mixing Tests
V. Separate Effects Fission Product Experiments
1) ORNL Fission Product Release Experiments
2) CSE Fission Product Deposition by Sedimentation and Spray Experiments
3) ABCOVE Aerosol Deposition Experiments
4) ACE & LACE Experiments
5) Marviken Fission Product Release and Deposition Experiments
6) ANL Experiments on Fission Product Revaporization
7) JAERI WIND Experiments on Fission Product Deposition, Revaporization and F
VI. Separate Effects Phenomenological Experiments
1) Two-Phase Critical Flow
a) Marviken Critical Flow Tests
b) GE Blowdown Tests
2) Two-Phase Jet Impingement
a) Marviken Large Scale Impingement Tests

3)	**Metallic Oxidation Kinetics**
a)	Baker-Just Zirconium Oxidation in Steam
b)	Urbanik-Heidrick Zircaloy-2 and Zircaloy-4 Oxidation in Steam
c)	Baker-Liimatainen Aluminum Oxidation in Steam
4)	**Hydrogen Deflagration Experiments**
a)	EPRI NTS Experiments with a 70 m^3 Large Vessel
b)	SNL Experiments
c)	SNL Inerting Experiments
d)	VGES Experiments
e)	AECL Whiteshell Experiments on Non-Uniform Mixtures
f)	Whiteshell LSVCTF Experiments
5)	**Hydrogen Detonation Experiments**
a)	BNL Small Scale High Temperature Hydrogen-Air-Steam Experiments
b)	SNL FLAME Facility Experiments
6)	**FARO Large Scale Molten Core Water Quenching Experiments**
7)	**Steam Explosion Experiments**
a)	The BORAX-1 Test
b)	The SPERT-1 Test
c)	SNL FITS A and FITS B Experiments
d)	ISPRA Molten Salt-Water Explosion Experiments
e)	KROTOS Experiments
f)	JAERI ALPHA Experiments
g)	JAERI COTELS Tests
h)	KAERI TROI Tests
i)	ANL ZREX Experiments
j)	Molten Fuel Moderator Interaction (MFMI) Experiments - Chalk River Laborat
k)	KTH – PULiMS Experiments
l)	SNL Large Scale Molten Aluminum-Water Experiments
m)	University of Wisconsin Aluminum-Water Shock Tube Experiments
8)	**Vapor Explosion Experiments**
a)	ANL Out-of-Reactor Na Injected into Molten UO2
b)	ANL CAMEL Loop Tests
c)	CORECT-II Sodium – UO2 Experiments
9)	**Molten Pool Experiments**
a)	CEA - BALI Experiment of Molten Fuel Circulating in the Lower Head
b)	RASPLAV Experiments
c)	IVO - COPO Experiments
d)	PSI CORVIS Experiments

10) In-Vessel Retention
a) UCSB ULPU and ULPU-2000 Experiments
b) ACOPO and Mini-ACOPO Experiments
c) Penn State Experiments
d) SULTAN Experiments
e) SNL CYBL Facility Experiment
11) Possible RCS and RPV Failure Mechanisms
a) Stuttgart PWR Hot Leg Creep Rupture Failure Experiments
b) SNL Lower Head Creep Failure Tests
c) KTH EC-FOEREVER Experiments
d) EPRI Lower Head Penetration Experiments
e) PSI CORVIS Experiments

APPENDIX B: Updated List of Key Reactor Safety Experiments to be Archived

Black: Items included in the original draft list

Red: Items from the original draft list that are included in the OECD list of archived information

Green: Items suggested in responses from the survey

I. NUCLEAR REACTOR EVENTS & ACCIDENTS

a) Three Mile Island Unit 2
b) Chernobyl Unit 4
c) Fukushima Units 1, 2 and 3
d) SL-1
e) Fermi Unit 1
f) Lucens
g) Windscale
h) Santa Susana Sodium Reactor
i) NRX
j) LaSalle Unit 2 Dual Recirculation Pump Trip 3/9/88
k) Diablo Canyon Unit 2 Mid-Loop Event 4/10/87
l) Laguna Verde Power Oscillation Trip 1/24/95
m) Ringhals 1 Core Stability Benchmarks

II. INTEGRAL EXPERIMENTS

1) Fully Integral Experiments (Core, RCS, Containment, Fission Products)

a) LOFT – Loss of Fluid Tests

b) Peach Bottom Turbine Trip, Delayed Scram Transient Tests

c) Phebus Experiments

d) ANL - EBR-II Loss of Flow at Power Experiments (Shutdown Heat Removal Tests, Balance of Plant & Peak Inner Clad Temperature)

2) Partially Integrated Experiments (Core, RCS, Fission Products)
   a) SFD Severe Fuel Damage Experiments in the PBF – Power Burst Facility
   b) FLHT – Full Length Heat Transfer experiments
3) Partially Integrated Experiments (Core, RCS, Containment)
   a) OSU AP600 Experiments
4) Partially Integrated Experiments (Core, RCS)
   a) LOFT Semiscale Tests
   b) BWR Full Integral Simulation Tests (FIST)
   c) ROSA-LSTF Experiments
   d) Siemens 4 Loop PWR PKL Test Facility
   e) Hitachi BWR Two-Bundle Loop Experiments
   f) CEA 3 Loop PWR BETHSY Test Facility
   g) FLECHT/SEASET Experiments
   h) ISPRA LOBI Experiments
   i) ANL – TREAT 'R' Series 7 Pin Sodium Voiding Data
   j) ANL – TREAT fuel behavior experiments
   k) ANL – Out-of-Reactor OPERA 7 Pin Sodium Voiding Data
5) Partially Integrated Experiments (RCS, Containment
   a) Marviken Suppression Pool Experiments
   b) HDR RCS Blowdown Experiments
   c) SNL IET Direct Containment Heating Experiments in the Surtsey Facility
   d) ANL IET Direct Containment Heating Experiments

III. SEPARATE EFFECTS CORE EXPERIMENTS

1) Godiva Experiment
2) SNL ACPR Prompt Burst Excursion Experiments
3) SEFOR Experiments
4) CORA Core Damage Experiments
   a) BWR
   b) PWR
5) FZK QUENCH Experiments
6) SNL XR2-1 BWR Metallic Melt Relocation Experiments

7) Columbia University Downflow Experiments
8) Axial Xenon Transient Tests in Ginna
9) Measured Characteristics of Xenon-Induced Spatial Oscillations in H.B. Robinson Unit 2
10) Active Direct Measurement of Residual Fissile Content in Spent Fuel Assemblies (EPRI)
11) Nuclear Fuel Behavior during Reactivity Initiated Accidents (NEA/CSNI)
12) International Handbook of Evaluated Criticality Safety Benchmark Experiments (NEA/CSNI)
13) Evaluation of Mass Spectrometric and Radiochemical Analyses of Yankee Core I Spent Fuel, Including Isotopes of Elements Thorium through Curium (Westinghouse)
14) ANL Whole Pin Furnace (WPF) Tests
15) ANL Fuel Behavior Test Apparatus (FBTA) Experiments

IV. SEPARATE EFFECTS RCS EXPERIMENTS

1) EPRI – Westinghouse SF_6 Experiments on PWR Natural Circulation
2) IIST PWR Natural Circulation Experiments
3) UPTF 2D-3D Experiments for a PWR Upper Plenum

V. SEPARATE EFFECTS CONTAINMENT EXPERIMENTS

1) S&L Containment Experiments
2) CVTR – Carolina-Virginia Tubular Reactor
3) BMC – Battelle Model Containment Experiments
4) CSTF – Containment System Test Facility Experiments
5) PS & ETH – PANDA Experiments on BWR Passive Heat Removal
6) ANL MACE (MCCI) Experiments
7) KfK BETA (MCCI) Experiments
8) CEA VULCANO (MCCI) Experiments
9) SNL 1/6 Scale Containment Ultimate Pressure Experiment
10) Westinghouse Ice Condenser Experiments
11) Westinghouse AP600 PCCS Experiments
12) NUPEC 1/4 Scale of a 4 Loop PWR Containment
13) University of Wisconsin AP600 Experiments

14) JAERI Containment Spray Tests
15) NUPEC Large Scale Tests

V) SEPARATE EFFECTS FISSION PRODUCT EXPERIMENTS

1) ORNL Fission Product Release Experiments
2) CSE Fission Product Deposition by Sedimentation and Spray Experiments
3) ABCOVE Aerosol Deposition Experiments
4) ACE & LACE Experiments
5) Marviken Fission Product Release and Deposition Experiments
6) ANL Experiments on Fission Product Revaporization
7) JAERI WIND Experiments on Fission Product Deposition, Revaporization and Resuspension
8) ORNL Experiments on the Transport of Fission Products in Pressure Suppression Pools

VI) SEPARATE EFFECTS PHENOMENOLOGICAL EXPERIMENTS

1) Two-Phase Critical Flow

a) Marviken Critical Flow Tests
b) GE Blowdown Tests

2) Two-Phase Jet Impingement

a) Marviken Large Scale Impingement Tests

3) Metallic Oxidation Kinetics

a) Baker-Just Zirconium Oxidation in steam
b) Urbanik-Heidrick Zircaloy-2 and Zircaloy-4 Oxidation in steam
c) Baker-Liimatainen Aluminum Oxidation in steam

4) Hydrogen Deflagration Experiments

a) EPRI NTS Experiments with a 70 m^3 large vessel
b) SNL Experiments
c) SNL Inerting Experiments
d) VGES Experiments
e) AECL Whiteshell Experiments on Non-Uniform Mixtures
f) AECL Interconnected Vessel Tests

5) Hydrogen Detonation Experiments

a) BNL High Temperature Combustion - Hydrogen-Air-Steam Experiments

b) SNL FLAME Facility Experiments

c) HUCTA - Hydrogen Unconfined Combustion Tests

6) FARO Large Scale Molten Core-Water Quenching Experiments

7) Steam Explosion Experiments

a) The BORAX-1 Test

b) The SPERT-1 Test

c) SNL FITS A and FITS B Experiments

d) ISPRA Molten Salt- Water Explosion Experiments

e) KROTOS Experiments

f) JAERI ALPHA Experiments

g) JAERI COTELS Tests

h) KAERI TROI Tests

i) ANL ZREX Experiments

j) KTH – PULiMS Experiments

k) SNL Large Scale Molten Aluminum-Water Experiments

l) University of Wisconsin Aluminum – Water Shock Tube Experiments

8) Vapor Explosion Experiments

a) ANL Out-of-Reactor Na Injected into Molten UO_2

b) ANL CAMEL Loop Tests

c) CORECT-II Sodium – UO_2 Experiments

9) Molten Pool Experiments

a) CEA - BALI Experiment of molten fuel circulating in the lower head

b) MCCI Project (OECD – ANL)

c) RASPLAV Experiments

d) MASCA Experiments

e) IVO - COPO Experiments

f) PSI CORVIS Experiments

g) ECOKATS Tests

h) SNL Swiss Tests

i) COMET Experiments

j) DISCO Tests

10) In-Vessel Retention

a) UCSB ULPU and ULPU-2000 Experiments
b) ACOPO and Mini-ACOPO Experiments
c) Penn State Experiments
d) SULTAN Experiments
e) SNL CYBL Facility Experiment

11) Possible RCS and RPV Failure Mechanisms

a) Stuttgart PWR Hot Leg Creep Rupture Failure Experiments
b) SNL Lower Head Creep Failure Tests
c) KTH EC-FOREVER Experiments
d) EPRI Lower Head Penetration Experiments
e) PSI CORVIS Experiments

APPENDIX C: Dr. Kenya Suyama E-mail Response

Dear Prof. Henry,

Thank you for your information. And I am sorry for my late reply. After receiving your message, we discussed concerning the Marviken Full Scale Critical Flow Tests and CSNI package at https://www.oecd-nea.org/tools/abstract/detail/csni1001 in the NEA.

Because the CSNI safety experimental data package is designed to contain only the report of the specific (objective) experimental data, we don't think we should include additional report in the package CSNI1001. However, based on your information, now we are considering the possibility to add information on the comparison tests you mentioned in the web page of CSNI1001. I think it is the best solution for us not to lose important information for potential users of the package.

I you are fine for this idea, I am pleased to make necessary coordination in the NEA.

If you have any comments and questions, please do not hesitate to contact me.

I look forward to hearing from you.

Have a nice summer season.

Best regards,

Kenya

APPENDIX D: Example of Archival Records Depth for the Marviken Experiments

A. The original experimental data records or test reports that include tables or graphs (unprocessed or processed) of the measured information for a given experiment along with the documentation of Quality Assured calibrations for the measurements...

• Interim Report Test #1
• Interim Report Test #2
• Interim Report Test #4
• Interim Report Test #5
• Interim Report Test #6
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• Interim Report Test #7
• Interim Report Test #9
• Interim Report Test #10
• Interim Report Test #11
• Interim Report Test #12
• Interim Report Test #13
• Interim Report Test #14
• Interim Report Test #15
• Interim Report Test #16
• Final Report Test #17– Archived by OECD-NEA • http://www/oecd-nea.org/tools/abatract/detail/csni1001/
• Final Report Test #18– Archived by OECD-NEA • http://www/oecd-nea.org/tools/abatract/detail/csni1001/
• Final Report Test #19– Archived by OECD-NEA • http://www/oecd-nea.org/tools/abatract/detail/csni1001/
• Final Report Test #20– Archived by OECD-NEA • http://www/oecd-nea.org/tools/abatract/detail/csni1001/
• Final Report Test #21– Archived by OECD-NEA • http://www/oecd-nea.org/tools/abatract/detail/csni1001/
• Final Report Test #22– Archived by OECD-NEA • http://www/oecd-nea.org/tools/abatract/detail/csni1001/
• Final Report Test #23– Archived by OECD-NEA • http://www/oecd-nea.org/tools/abatract/detail/csni1001/
• Final Report Test #24– Archived by OECD-NEA • http://www/oecd-nea.org/tools/abatract/detail/csni1001/
• Final Report Test #25– Archived by OECD-NEA • http://www/oecd-nea.org/tools/abatract/detail/csni1001/
• Interim Report Test #26
• Interim Report Test #27

B. The experimental test report(s) that includes the processed data for those measurements judged to be the most important and a knowledge that QA procedures were followed but does not satisfy the criterion in "A".

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C. A program summary report that provides an overview of the test results.

• Summary Report – Archived by OECD-NEA • http://www/oecd-nea.org/tools/abatract/detail/csni1001/
• Conclusions Report – Archived by OECD-NEA • http://www/oecd-nea.org/tools/abatract/detail/csni1001/
• Sokolowski, L. and Kozlowski, 2012, "Assessment of Two-Phase Critical Flow Models Performance in RELAP5 and TRACE against Marviken Critical Flow Tests," NUREG/IA-0401.
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D. Peer reviewed papers for technical journals or national laboratory reports that have been published in the open literature by personnel associated directly with the experimental program.

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E. Peer reviewed papers for technical journals or national laboratory reports that have been published in the open literature by analysts that are using the experimental data.

• "A Comparison of the Marviken Critical Flow Tests With the Henry-Fauske Model", Martinec, E.J., Jr., 1979, ANL/RAS/LWR 79-8
• "Critical Flow Modelling in Nuclear Safety, A State-of-the-Art Report by a Group of Experts of the NEA Committee on the Safety of Nuclear Installations" OECK-NEA, 1982
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F. Industry reports that have been reviewed by a government agency as part of a licensing application.

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G. Technical papers that have not received peer reviews but were presented at group or specialist meetings.

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H. Slides used for a presentation of experimental results at a group or specialist meeting.

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APPENDIX E: Example of Archival Records Depth for the HDR Experiments

A. The original experimental data records or test reports that include tables or graphs (unprocessed or processed) of the measured information for a given experiment along with the documentation of Quality Assured calibrations for the measurements.

• "HDR Sicherheitsprogramm (HDR Safety Program)", Presented By: H. Wenzel, R. Grimm, L. Lohr, Presented For: Kernforschungszentrum Karlsruhe GmbH
• "Investigation of Reactor Containment Behavior During and After a Blowdown (Water and Steam Line Break)", Presented By: T. Kanzleiter and L. Valencia, Presented To: Kernforschungszentrum Karlsruhe GmbH
• "Investigations on Long-Term Behavior of the Atmosphere and on Hydrogen Distribution in a Reactor Containment after a Large LOCA (Technical Report 95-91)", Presented By: H. Holzbauer, L. Wolf, T. Cron, Presented To: Kernforschungszentrum Karlsruhe GmbH
• "**International Standard Problem ISP 16** – Rupture of a Steam Line Within the HDR-Containment Leading to an Early Two-Phase-Flow: Results of Post-Test Analyses", CSNI Report No. 112, M. Firnhaber, June 1985
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B. The experimental test report(s) that includes the processed data for those measurements judged to be the most important and a knowledge that QA procedures were followed but does not satisfy the criterion in "A".

• Hydrogen Mixing Experiments in the HDR-Facility, Presented by: L. Wolf and L. Valencia, Presented at: 17th Water Reactor Safety Meeting, Rockwell MD, USA October 1989
• Large – Scale HDR – Hydrogen Mixing Experiments Test Group E11, Presented by: L. Valencia and L. Wolf, Presented at: 18th Water Reactor Safety Information Meeting, Rockville MD, USA, October 22-24 1990
• "Overview of First Results on H2-Distribution Tests at the Large Scale HDR-Facility", Presented By: L. Valencia and L. Wolf, Presented At: International Conference on Containment Design and Operation, Toronto Canada October 14-17th 1990
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C. A program summary report that provides an overview of the test results.

• "Steam Blowdown in the HDR-Containment Results and Final Evaluation of the Open and Blind Containment Standard Problem", Presented By: M.

Firnhaber and W. Erdmann, Presented At: International Meeting on Reactor Thermal Hydraulics (ANS Sponsored), Newport Rhode Island, October 15-18th, (Paper 14.E)
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D. Peer reviewed papers for technical journals or national laboratory reports that have been published in the open literature by personnel associated directly with the experimental program.

• "Comparisons Between Multidimensional and Lumped-Parameter GOTHIC Containment Analyses with Data", **Presented By:** Lothar Wolf, Helmut Holzbauer, Manfred Schall, **Published In**: Nuclear Technology Vol. 125 Number 2 February 1999
• "Detailed Assessment of the Heiss Dampf Reaktor Hydrogen Deflagration Experiments E12", **Presented By:** Lothar Wolf, Ashok Rastogi, Dag Wennerberg, Thomas Cron, and Edgar Hansjosten, **Published in:** Nuclear Technology Vol. 125 Number 2 February 1999
• "Detailed Assessment of the Heiss Dampf Reaktor Hydrogen-Mixing Experiments E11", **Presented by:** Lothar Wolf, Helmut Holzbauer, and Thomas Cron, **Published in:** Nuclear Technology Vol. 125 Number 2 February 1999
• "GOTHIC Verification on Behalf of the Heiss Dampf Reaktor Hydrogen-Mixing Experiments", Presented By: Helmut Holzbauer and Lothar Wolf, Published in: Nuclear Technology Vol. 125 Number 2 February 1999
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E. Peer reviewed papers for technical journals or national laboratory reports that have been published in the open literature by analysts that are using the experimental data.

• "Benchmark of the Heiss Dampf Reaktor E11.2 Containment Hydrogen-Mixing Experiment Using the MAAP4 Code", **Presented by:** Sung Jin Lee, Chan Y. Paik, Robert E. Henry, Michael Epstein, and Martin G. Plys, **Published in:** Nuclear Technology Vol. 125 Number 2 February 1999
• "Hydrogen Distribution Tests Under Severe Accident Conditions at the Large-Scale HDR-Facility", Prepared By: Luis A. Valencia, Published in: Nuclear Engineering and Design (140) pages 51-60, 1993
• "Containment Thermal-Hydraulic Tests in the Heissdampfreaktor (HDR) Facility", **Authored by:** Tills, J., Phillips, J. and Notafrancesco, A., SNL Report SAND2018-9884. https://www.osti.gov/[osti.gov]
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F. Industry reports that have been reviewed by a government agency as part of a licensing application.

• Heat Transfer Coefficients in Containment During and After Blowdown, Prepared by: GRS – D.A. Schauer (Contract GRS-A-638), Prepared For: Federal Ministry for Research and Technology, September 1981
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G. Technical papers that have not received peer reviews but were presented at group or specialist meetings.

• "Experimental Results for Long-Term Large-Scale Natural Circulation in LWR Containments After Large and Small LOCAS", **Presented By:** Lothar T. Wolf and Kyongtaek K. Mun, **Presented at:** International Conference on Nuclear Engineering Volume 1 Part B ASME 1996
• "Modelling of the HDR-T51 Gas Fire Tests Using CFAST V3", Presented By: Jason E. Floyd and Lothar T. Wolf, Presented At: 5th International Conference on Nuclear Engineering, May 26-30, 1997, Nice France (Proceedings of ICONE-5)
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H. Slides used for a presentation of experimental results at a group or specialist meeting.

• ExpTests of Safety Systems and Components HDR – Safety Prog Lecture 1 – Wolf.pdf, Presented by: Lothar Wolf, Presented at: MIT Nuclear Power Reactor Safety Course, Cambridge MA, July 17, 1992
• HDR – Plots – Partial.pdf – *Assortment of FAI generated plots comparing to HDR data*
• HDR – E11 006 Partial.pdf – *Assortment of FAI generated plots and material supporting MAAP benchmarking*
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APPENDIX F: Example of Archival Records Depth for the LOFT Experiments

A. The original experimental data records or test reports that include tables or graphs (unprocessed or processed) of the measured information for a given experiment along with the documentation of Quality Assured calibrations for the measurements.

- LOFT System and Test Description (5.5 ft Nuclear Core 1 (LOCES)
- LOFT/L2-3, Loss of Fluid Test, 2nd NRC L2 Large Break LOCA Experiment
  - http://www.oecd-nea.org/tools/abstract/detail/csni0017
- LOFT/L2-5, Loss of Fluid Test, 3rd NRC L2 Large Break LOCA Experiment
  - http://www.oecd-nea.org/tools/abstract/detail/csni0016
- LOFT/L3-5, Loss of Fluid Test, 5th NRC L3 Small Break LOCA Experiment
  - http://www.oecd-nea.org/tools/abstract/detail/csni0022
- LOFT/L3-6, Loss of Fluid Test, 6th NRC L3 Small Break LOCA Experiment
  - http://www.oecd-nea.org/tools/abstract/detail/csni0018
- LOFT/L3-7, Loss of Fluid Test, 7th NRC L3 Small Break LOCA Experiment
  - http://www.oecd-nea.org/tools/abstract/detail/csni0021
- LOFT/L6-7, Loss of Fluid Test, Anticipated Transients with Multiple Failures
  - http://www.oecd-nea.org/tools/abstract/detail/csni0020
- LOFT/L8-2, Severe Core Transient Experiment
  - http://www.oecd-nea.org/tools/abstract/detail/csni0070
- LOFT/L9-3, Loss of Fluid Test, Anticipated Transients with Multiple Failures
  - http://www.oecd-nea.org/tools/abstract/detail/csni0019
- LOFT/LP-02-6, Loss of Fluid Test, 1st OECD Large Break Experiment
  - http://www.oecd-nea.org/tools/abstract/detail/csni0010
- LOFT/LP-FP-1B, Loss of Fluid Test, Fission Product Release Experiment
  - http://www.oecd-nea.org/tools/abstract/detail/csni0012
- LOFT/LP-FP-2, Loss of Fluid Test, Fission Product Release from Fuel
  - http://www.oecd-nea.org/tools/abstract/detail/csni0013
- LOFT/LP-FW-1, Loss of Fluid Test, PWR Response to Loss-of-Feedwater Transient
  - http://www.oecd-nea.org/tools/abstract/detail/csni0007
- LOFT/LP-LB-1, Loss of Fluid Test, Large-Break LOCA Experiment
  - http://www.oecd-nea.org/tools/abstract/detail/csni0002
- LOFT/LP-SB-1, Loss of Fluid Test, Small Hot Leg Break LOCA, Early Pump
  - http://www.oecd-nea.org/tools/abstract/detail/csni0008
- LOFT/LP-SB-2, Loss of Fluid Test, Small Hot Leg Break LOCA, Delayed Pump
  - http://www.oecd-nea.org/tools/abstract/detail/csni0009
- LOFT/LP-SB-3, Loss of Fluid Test, Cold Leg Break LOCA, No High Pressure Injection System (HPIS)
  - http://www.oecd-nea.org/tools/abstract/detail/csni0011

• "Experiment Data Report for LOFT Power Ascension Experiment L2-3"
• NUREG/2826"Experiment Data Report for LOFT Large Break Loss of Coolant Experiment L2-5, Bayless, P.D. and Devine, J.M., 1982
• "Experiment Data Report for LOFT Nonnuclear Small Break Experiment L3-0"
• "Experiment Data Report for LOFT Intermediate Break Experiment L5-1 and Severe Core Transient Experiment L8-2"

B. The experimental test report(s) that includes the processed data for those measurements judged to be the most important and a knowledge that QA procedures were followed but does not satisfy the criterion in "A".

• NUREG-CR-0230 / TREE-1240, LOFT Transient (Blowdown) Critical Heat Flux Test, Richard C. Gottula, April 1978
• NUREG-CR-0247, LOFT System and Test Description (5.5-FT Nuclear Core 1 LOCES), July 1978
• NUREG-CR-0606 / TREE-1244, An Investigation of Two-Phase Flow Regimes in LOFT Piping During Loss-Of-Coolant Experiments, Peter G. Prassinos, Chong-Kwang Liao, June 1979
• NUREG-CR-1145 Experiment Data Report for LOFT Nuclear Small Break Experiment L3-1, March 1980
• NUREG-CR-1695 Experiment Data Report for LOFT (Loss-of-Fluid-Test) Nuclear Small Break Experiment L3-5/L3-5A, November 1980
• NUREG-CR-1868, Experiment Data Report for LOFT Nuclear Small Break Experiment L3-6 and Severe Core Transient Experiment L8-1, February 1981
• NUREG-TR-0040, Advance Calculations for the Non-Nuclear LOFT Experiment L 1-4 (U.S. Standard Problem No. 7)
• OECD-LOFT-T-3708, Revision 1, OECD LOFT Project, OECD LOFT Fission Product Experiment LP-FP-1, Fission Product Data Report, Vol. 1 of 2, November 1986
• OECD-LOFT-T-3708, Revision 1, OECD LOFT Project, OECD LOFT Fission Product Experiment LP-FP-1, Fission Product Data Report Appendices, Vol. 2 of 2, November 1986
• OECD-LOFT-T-3802, Revision 1, OECD LOFT Project, OECD LOFT Project Experiment Specification Document, Fission Product Experiment LP-FP-2, May 1985
• OECD-LOFT-T-3804, OECD LOFT Project, Quick-Look Report on OECD LOFT, Experiment LP-FP-2, September 1985

C. A program summary report that provides an overview of the test results.

• Review of LOFT Large Break Experiments, OECD LOFT Project, NUREG/IA-0028
• OECD, 1990, "The OECD/LOFT Project, Achievements and Significant Results", Proceedings of an Open Forum, Madrid, Spain, May, 9-11

• OECD-LOFT-T-3907, OECD LOFT Project, An Account of the OECD LOFT Project, J. Fell, United Kingdom Atomic Energy Authority, S. M. Modro, EG&G Idaho, Inc. May 1990 http://www.oecd-nea.org/nsd/reports/OECD_LOFT_final_report_T3907_May1990.pdf

D. Peer reviewed papers for technical journals or national laboratory reports that have been published in the open literature by personnel associated directly with the experimental program.

• The LOFT Facility and Test Program, Presented By: Dr. G. D. McPherson, Unite States Nuclear Regulatory Commission, Washington, D>C. Presented at: GRS-Fachgesprach, Munich German, November 1979, CONF-791124--1
• LOFT Summary of ATWS Transients – Fuel Behavior During A LOCA – LOFT Experiments, M. L. Russell, et al., November 1980 – CSNI
• Significant Large Scale Phenomena Identified in LOFT Experiments, S. N. Aksan and S. M. Modro, (EG&G Idaho, Inc.) Paul Scherrer Institute (PSI) - Proceeding Proceedings of the CSNI Specialist Meeting on Transient Two-Phase Flow - 1992
• "Report of the LOFT Special Review Group", 1981, NUREG-0758

E. Peer reviewed papers for technical journals or national laboratory reports that have been published in the open literature by analysts that are using the experimental data.

• Crecy, Agnes de, et al, 2006, "The BEMUSE Programme: Results of the First Part Concerning the LOFT L2-5 Test", ASME ICONE-14, (Conference 20997072) Miami Florida
• "Problems of Scaling and Extrapolation Results in the Area of Fluiddynamics and Heat Transfer Related to Reactor Safety (A State of the Art Report)", edited by H. Karwat, European Applied Research Report – Nuclear Science and Technology, 1986. Vol. 7, pp 229-353.
• Koizumi, Y. et al., 1988, "LOFT Experiment LP-02-6 Analysis by RELAP5/MOD2 Code With Improved Minimum Film Boiling Temperature", Journal of Nuclear Science and Technology, 25, pp 395-403.
• Batt, D.L. and Berta, V.T., 1978, "ECC Delivery and Distribution in Scaled PWR Experiments", Proceedings of the ANS Winter Meeting, Washington, D.C.
• Gunta, S., 1990, "RELAP5/MOD2 Assessment of OECD-LOFT Small Break Experiment LP-SB-03" NUREG/IA-0018

F. Industry reports that have been reviewed by a government agency as part of a licensing application.

• Burtt, J.D., 1979, "Overview of the LOFT Experimental Program", paper presented at the International Colloquium on Irradiation Tests for Reactor Safety Programmes, Petten, the Netherlands
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G. Technical papers that have not received peer reviews but were presented at group or specialist meetings.

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H. Slides used for a presentation of experimental results at a group or specialist meeting.

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