

**UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION**

**Atomic Safety and Licensing Board**

**Before Administrative Judges:**

ASLBP BOARD 09-892-HLW-CAB04 Thomas S. Moore, Chairman Paul S. Ryerson Richard E. Wardwell
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<b>In the Matter of</b>	)	
	)	
<b>U.S. DEPARTMENT OF ENERGY</b>	)	<b>Docket No. 63-001-HLW</b>
	)	
<b>(High Level Waste Repository)</b>	)	<b>August 24, 2009</b>

**STATE OF NEVADA'S MOTION FOR LEAVE TO FILE  
NEW CONTENTION BASED ON NEWLY AVAILABLE INFORMATION**

The State of Nevada ("Nevada") moves for leave to file a new contention (NEV-SAFETY-206) in accordance with 10 C.F.R. §§ 2.309(f)(2) and 2.323(a) and (b) and the CAB's January 29, 2009 Case Management Order No. 1, paragraphs B.1. and B.2. Nevada states the following:

1. The information upon which Nevada's new contention is based was not previously available. Nevada's contention is based two DOE documents (LSN# DEN001614752 and DEN001614731), both of which were first made publicly available on the Licensing Support Network ("LSN") on July 31, 2009. This has been confirmed by the LSN Administrator.
2. The new information upon which Nevada's new contention is based is materially different from information previously available. The document with accession number DEN001614731 discloses that DOE conducted Secondary Ion Mass Spectrometry (SIMS) analysis of five-year Alloy-22 corrosion coupons and that it received "an unexpected test result,"

relating to varying oxide thicknesses on parts of the sample coupons, a result that will "require additional investigation." The document with accession number DEN001614752 discloses that the inspection of Alloy-22 components exposed for 9.5 years in the Long-Term Corrosion Testing Facility (LTCTF) revealed that a subset of the coupons have a visually observable residue on the sample surfaces which "may be an unexpected organic compound." It was determined by DOE or its contractor that the substance was not representative of salt deposits that are typically found on coupons removed from the LTCTF. Forty out of 132 coupons were found to have such residue, whose composition has not yet been determined, and according to DOE, "therefore, it is not known if the residue is . . . a contaminant." The time and extent of aqueous contamination of Alloy-22 are undefined as a consequence of the information revealed by DOE in these two new documents. The actual causes of contamination are uncertain. The source documents are new. Their findings are new. And the deficiencies in DOE's Alloy-22 corrosion testing suggested by these documents are new and materially different from that which was previously available.

3. The new contention has been submitted in a timely fashion based on the availability of the new information. Specifically, CAB issued its First Case Management Order on January 29, 2009, and provided in paragraph B.2., that "Notwithstanding the time period specified in 10 C.F.R. § 2.323(a), such motion and proposed contention [i.e., motion for leave to file new or amended contention] shall be deemed timely under 10 C.F.R. § 2.309(f)(2) if filed within 30 days of the date when the new and material information on which it is based first became available." This Motion for leave to file Nevada's proposed new contention (NEV-SAFETY-206), a copy of which is attached to this Motion as Exhibit A, is being filed well

within 30 days of the date the new and material information first became available (i.e., the two documents which first became available on the LSN on July 31, 2009).

4. Nevada has made a sincere effort to contact the other parties in this proceeding regarding their objection or non-objection to the Motion, in an effort to resolve any differences in that regard in accordance with 10 C.F.R. § 2.323(b). Counsel for Inyo County, the State of California, NCAC, Nye County, Clark County, the Timbisha (JTS), the Four Counties, NEI, and White Pine County do not object to the Motion. DOE "does not object to the filing of the motion, reserving all rights to challenge the admission of the contention on all appropriate grounds." NRC Staff "takes no position on the motion, and will file a response once it is filed." Without respect to the objection or non-objection of the parties, Nevada is nevertheless required by Case Management Order No. 1 to file this Motion to seek leave of CAB to file the new contention. Nevada's filing of this Motion and the CAB's grant of leave to file it in no way constitute a ruling on the admissibility of the contention. Rather, in accordance with 10 C.F.R. § 2.309(h) and paragraph B.1. of CAB's Case Management Order No. 1, "Within twenty-five (25) days after service of the motion and proposed contention, the answer shall be filed, responding to both the motion and the contention. Within seven (7) days after service of the answer, the movant may file a reply."

WHEREFORE, PREMISES CONSIDERED, Nevada states that it is submitting this Motion for Leave to File New Contention in full compliance with the provisions of 10 C.F.R. §§ 2.309(f)(2) and 2.323(a) and (b) and the CAB's January 29, 2009 Case Management Order No. 1, paragraphs B.1. and B.2., and respectfully requests that its Motion for Leave to File a New Contention attached to this Motion as Exhibit A be granted.

Respectfully submitted,

*(signed electronically)*

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Dated: August 24, 2009

# Exhibit A

**NEV-SAFETY-206 - INADEQUATE DOE WEIGHT-LOSS MEASUREMENTS FOR  
GENERAL CORROSION TESTING OF ALLOY-22**

1. A one-sentence statement of the contention itself

SAR Subsections 2.3.6.2.2, 2.3.6.3 and similar subsections, which deal with waste package degradation and general corrosion testing of Alloy-22, inadequately address generalized corrosion because they rely on flawed experimental data.

2. A brief one-sentence summary of the basis for the contention

To derive estimates for general corrosion of Alloy-22, the DOE utilizes Alloy-22 coupon bath tests employing SDW, SCW, and SAW test solutions for which there is now strong evidence of contamination in relation to the 5-year and 9.5-year tests (LSN# DEN001614752 and DEN001614731). This contamination was evident in inorganic and organic coatings on the Alloy-22. As a consequence of this contamination that has recently been documented by DOE, the general corrosion rates reported in SAR Subsection 2.3.6.2.2 and similar subsections are not supported by any data collected under adequately specified conditions, setting aside the additional consideration of whether the conditions that DOE intended to study are relevant to the service environment at Yucca Mountain. The reacting fluids (SDW, SCW and SAW) have been modified at unknown times and degrees with contaminants; consequently, and independent of the determined rates, DOE has lost control of these experiments. Indeed, it is possible that some of the contamination arose from the initial conditions of the specimens themselves, so that they were never exposed to the intended corrosion environment.

3. A demonstration that the contention is within the scope of the hearing

This contention raises an issue whether DOE has complied with the NRC requirements applicable to Yucca Mountain, and falls within the scope of the hearing as specified in section II, paragraph 1 of the Notice of Hearing.

4. A demonstration that the contention is material to the findings NRC must make to license Yucca Mountain

10 C.F.R. § 63.31(a)(2) states that the NRC may authorize construction of the GROA at the Yucca Mountain site if it determines that there is reasonable expectation the materials described in the application can be disposed of without unreasonable risk to the health and safety of the public. In reaching this determination, 10 C.F.R. § 63.31(a)(3) requires the LA to satisfy the requirements contained in 10 C.F.R. § 63.21, and the site and design comply with Subpart E of 10 C.F.R. Part 63. 10 C.F.R. § 63.21(c)(3)(ii) requires the SAR to discuss the design of the engineered barrier system and its relationship to the post-closure performance objectives, and Section 63.21(c)(14) requires the SAR to evaluate the natural features of the geologic setting and the design features of the engineered barrier systems important to waste isolation. 10 C.F.R. § 63.102(h) (part of Subpart E) requires the performance assessment to address how the natural barriers and the engineered barrier system work in combination to enhance the resiliency of the geologic repository. 10 C.F.R. § 63.113 (also part of Subpart E) requires the geologic repository to be designed with proper consideration to the engineered barrier system working in combination with the natural barrier to limit radiological exposures. 10 C.F.R. § 63.115 (also part of Subpart E) addresses barriers important to waste isolation recognizing both the engineered barrier system and the natural features of the geologic setting. 10 C.F.R. § 63.114(f) requires that any performance assessment used to demonstrate compliance with Section 63.113 must provide the technical basis for either inclusion or exclusion of degradation, deterioration, or alteration processes of engineered barriers in the performance assessment, including those processes that would adversely affect the performance of natural barriers. Degradation, deterioration, or alteration processes of engineered barriers must be evaluated in detail if the magnitude and time of the resulting radiological exposures to the reasonably maximally exposed individual, or radionuclide releases to the accessible environment, would be significantly changed by their omission. This contention alleges noncompliance with these regulatory provisions and therefore raises a material issue within the scope of the licensing proceeding.

5. A concise statement of the facts or expert opinions supporting the contention, along with appropriate citations to supporting scientific or factual materials

DOE defines *general corrosion* and *general aqueous corrosion* as a uniform metal thinning that is treated as being temperature (constant for a given temperature) and aqueous composition dependent (SAR 2.3.6.2.2, page 2.3.6-10). DOE has determined the general corrosion rates by experimental weight-loss measurements after a five-year exposure to test environments.

SAR Subsection 2.3.6.3.2.1 (at 2.3.6-19) reports that long-term weight-loss measurements are used to determine the general corrosion rates of Alloy-22 in three Long-Term Corrosion Test Facility test solutions (SDW, SCW, and SAW) at 60°C and 90°C. The test solutions were covered with a blanket of flowing air, and three types of Alloy-22 samples were tested (U-bends, crevice samples, and weight-loss samples). These Alloy-22 samples were mounted on insulating racks and placed in the sample test solution tanks. About one-half of the samples were located above the waterline and half were submersed in the aqueous phase. DOE reports that condensed water was present on samples located above the aqueous phase. On page 2.3.6-20 of this same SAR section, DOE reports that most of the uncertainties in the general corrosion rate of Alloy-22 have resulted from the resolution of the sample weight-loss measurements. As would be expected however, their reported degree of uncertainty does not account for contamination of either the test solutions or the surface of the Alloy-22 test samples.

Very recently, two DOE documents have become available (LSN# DEN001614752 and DEN001614731) demonstrating that the long-term tests have been contaminated, likely from their initiation.

DEN001614752 is a Condition Report that indicates on page 1 that a waxy organic residue on 40 out of 132 (9.5-year tested) Alloy-22 coupons was observed. On page 7 of this

report, it is stated that the residue is confirmed to be a long-chain molecule consistent with a lubricant, and on page 1 of the Apparent Cause Analysis for CR 12868, it is reported that the contaminated vessels were from SAW 60°C and 90°C, and from SDW 90°C testing solutions (vessels 25, 26 and 30). Further, on page 2, the document states that the impact beyond potentially adding uncertainty to the corrosion rates for the 9.5-year Alloy-22 coupons has not been determined. On page 3 of this document it is suggested that at least part of the contaminant is similar to calcium stearate (as determined by infrared spectrometry).

On pages 3-4 of this document, it states that:

Additional LTCTF samples were evaluated to identify any noticeable trends in the quantity of the residue, as to position of sample in the vessel, location on the sample, different solutions/environment and different duration samples. The conclusion was that the samples appear to have greater quantity of residue on the bottom side of the samples. The current explanation for this phenomenon is some sort of bubbling action or bubble induced precipitation that accumulated at the bottom of the sample. Also, the samples that were in the vessels for a longer duration tend to have more residue and appear to have a higher percentage with visible residue, for example the 9.5 year samples have more residue present than the 5-year samples.

In this above statement, DOE announces for the first time that this organic residue also contaminates the five-year test samples. On page 6 in item 7, Extent of Condition, reports that:

The only samples which have been evaluated at this point are the weight-loss and crevice coupons which were made from Alloy 22, Alloy 825, Alloy G3, and Alloy C4. Alloy 22 samples from 5 years were not evaluated as they have already been chemically cleaned.

It follows from this statement that the five-year samples other than Alloy-22 have the organic residue problems and that DOE does not know if the Alloy-22 samples also have this problem because these samples have already been process-cleaned prior to this condition report. Therefore, it can be concluded that it is likely that the five-year general corrosion Alloy-22 samples have also been contaminated.

DEN001614731 is a Condition Report that indicates on page 1 that an inorganic oxide deposit was observed occurring under the Teflon washer (crevice) on five-year Alloy-22 corrosion coupons. On page 5 of this document, DOE states that the oxide is most likely due to a deposition process rather than corrosion of Alloy-22, because it is composed of much higher concentrations of magnesium, silicon and organics (C<sub>2</sub>H) than the darker exposed surfaces, and Alloy-22 does not contain these substances.

On page 6 of this report DOE reports that the oxides are clearly thicker on the 9.5-year samples than for the 5-year samples. DOE attributes these deposits to increases in concentration of the organic contaminants with time in these test vessels. On page 8 of this document DOE states:

Considering that the corrosion of other materials in the vessels is occurring as a function of time, it is reasonable that this would result in increasing concentration of these constituents. Furthermore, increased organics both in terms of quantity and prevalence were also observed in CR 12868.

*[Note: CR 12868 is the previous condition report discussed above.]*

This preliminary DOE conclusion emphasizes acceptance of the existence and significance of experimental contamination, including organics and inorganics, and attributes this contamination to the presence of other materials in the testing vessels. This is clearly an experimental design issue.

The two Condition Reports outline in variable detail the contamination of test coupons and solutions in the 5-year and 9.5-year long-term general corrosion experiments. The actual trace element and major element compositions of the bath waters that came into contact with the Alloy-22 are unknown, and were likely materially different from their starting compositions. The long-term reactions that took place are not reactions that can be attributable to simulated aqueous test solutions (SDW, SCW, and SAW) because these solutions have interacted with

other unknown components and have changed the aqueous conditions by doing so. These changes are not changes that can be attributable to the service environment. These changes with respect to time and components are apparently uncharacterized by the DOE. Consequently, no confidence can be assigned to the experimental results, and the description and claims provided in the SAR are unsubstantiated wherever they are based on the findings from these experiments. There are apparently no corrective actions that can be taken by the DOE to resolve this issue of experimental contamination.

6. There must be sufficient information to show that there is a genuine dispute with DOE, along with specific references to the portions of the LA being controverted

The available DOE procedures, i.e., SITP-02-WP-001 (5.3.1.1, long term corrosion studies), TIP-CM-01 (receiving, handling, and storage of specimens for long-term corrosion testing), TIP-CM-49 (long term corrosion test facility specimen weighing procedure), TIP-CM-48 (specimen removal procedure), and TIP-CM-51 RO 0, CN 3 (de-scaling procedure), appear to cover most of the experimental methods needed to acquire quality data concerning the rates of general corrosion under simulated aqueous conditions. However, the basic nature of the experimental design utilized in the tests described here and used to underpin the arguments in the SAR had built in flaws, which contributed to analytical failure and the resulting experimental contamination. DOE concludes that these miscalculations have no bearing on the general corrosion rates of Alloy-22. The State of Nevada finds that the experiments are not definable with respect to input-reaction parameters and components and on that basis finds that the general corrosion rates do not represent SAR claims, as well as not being representative of the in-drift service conditions that the waste canister may experience in Yucca Mountain. Further, the State of Nevada concludes that the reacting fluids with Alloy-22 in the long-term testing bath tanks are unknown to DOE. They are not standard SDW, SCW, and SAW solutions due to test

contamination. DOE has admitted to this in the two Condition Reports. The time and extent of aqueous contamination are undefined. The actual causes of contamination are uncertain. The long-term corrosion tests have no compelling value and do not contribute to an understanding of waste package performance that can be utilized in support of the License Application. In sum, this contention raises a genuine dispute with the applicant because it challenges the basis for SAR Subsections 2.3.6.2.2, 2.3.6.3 and similar subsections, as well as the underlying experimental procedures, which deal with waste package degradation and general corrosion testing, and are relied on to show compliance with NRC's requirements in Part 63.

# Exhibit 1

BEFORE THE U.S. NUCLEAR REGULATORY COMMISSION

\_\_\_\_\_) )  
 In the Matter of ) )  
 ) )  
 U.S. DEPARTMENT OF ENERGY ) )  
 ) )  
 License Application to Construct a ) )  
 Geologic Repository at Yucca Mountain ) )  
 \_\_\_\_\_)

Docket No. 63-001

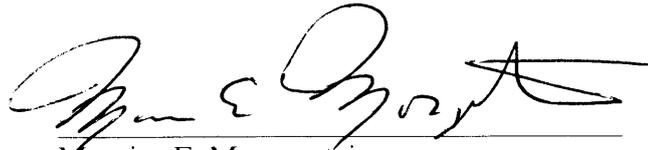
**AFFIDAVIT OF MAURICE E. MORGENSTEIN**

I, Maurice E. Morgenstein, the undersigned affiant, do hereby make the following statements based upon my own knowledge, information, and belief.

1. My name is Maurice E. Morgenstein, and my curriculum vitae is attached to this Affidavit as Attachment A. I am executing this Affidavit in support of the State of Nevada's Contention NEV-SAFETY-206 in the above-captioned proceeding.

2. I hereby adopt as my own opinions the statements contained within Paragraphs 5 and 6 of this contention.

Further, the affiant sayeth not.



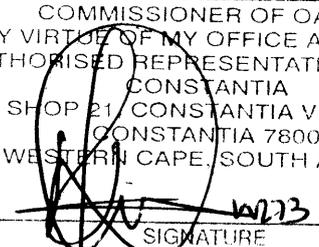
\_\_\_\_\_  
 Maurice E. Morgenstein

The above-named affiant personally appeared before me this 13 day of August, 2009, and executed this affidavit.

\_\_\_\_\_  
 Notary Public

My Commission expires: N/A.

COMMISSIONER OF OATHS  
 BY VIRTUE OF MY OFFICE AS A DULY  
 AUTHORISED REPRESENTATIVE OF FNB  
 CONSTANTIA  
 SHOP 21/ CONSTANTIA VILLAGE  
 CONSTANTIA 7800  
 WESTERN CAPE, SOUTH AFRICA



\_\_\_\_\_  
 SIGNATURE

**ATTACHMENT A**

**CURRICULUM VITAE**

**MAURICE E. MORGENSTEIN**

**Maurice E. Morgenstein**

Maury Morgenstein  
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 510-295-3216  
 450 S. Walnut Drive  
 Monmouth, OR 97361 USA

**EDUCATION:**

- 1974 Ph.D., in Geology and Geophysics, University of Hawaii.  
 1969 M.Sc., in Geology, Syracuse University.  
 1967 B.A., in Geology, Queens College, City University of New York.  
 New Mexico Institute of Mining and Technology, Socorro, N.M.

**OVERVIEW:**

Trained at Lamont Doherty Geological Observatory of Columbia University and University of Hawaii Institute of Geophysics as a Deep Sea Geological Oceanographer/Sedimentologist specializing in authigenic mineralization reactions, metallic enrichment deposits (ocean mining) and hydration reactions of volcanic glass (sideromelane). Served at sea aboard research vessels as chief scientist and chief geologist.

Taught undergraduate and graduate classes (as appropriate) at the University of California, Berkeley; Syracuse University; Utica College; University of Hawaii, Hawaii Pacific College, and Rutgers NSF summer institute for geoscience teachers: Introduction to Oceanography, Geological Oceanography, Marine Sedimentation, Introduction to Geology, Laboratory in Geology, Sedimentology, Sedimentary Geochemistry, Clay and Zeolite Mineralogy, Geoarchaeology, Provenance of Ceramics and Lithics, Optical Petrography, Archaeology of Fire, Geomorphology, Advanced Archaeological Ceramics and Field School in Geoarchaeology.

Mining geologist in deep ocean manganese nodules, terrestrial placer gold and lithium pegmatite deposits. Partner in TM& Mining Ltd based in Tanzania.

**RESEARCH INTERESTS:**

- Hydration of natural (obsidian and sideromelane) and man-made glass (such as borosilicate glass)
- Provenance of ceramics and chert lithic artifacts (geochemical and Petrographic studies)
- Micromorphology of soils-geochemical and physical sedimentology of sediments
- Stable isotope geographic patterns in meteoric water and plant and mammal consumers
- Neomineralization of zeolites and clays
- Development of new geochemical tools for chronology
- Isolation of High-Level Nuclear Waste
- Ocean mining (near shore and deep sea)
- Gemstone mining (metamorphic and igneous occurrences)

**PRESENT POSITIONS:**

President, Geosciences Management International, Inc. (GMI, Inc.) 450 S. Walnut Drive, Monmouth, OR 97361 USA

Adjunct Research Professor, Department of Archaeology, University of Cape Town, (UCT), Cape Town, South Africa

Adjunct Professor, Near Eastern Studies Department, 250 Barrows Hall, University of California, Berkeley 94720-1940, USA

Co-Director, El-Hibeh Project, Egypt, University of California, Berkeley  
<http://neareastern.berkeley.edu/hibeh/explore.htm>

Member, Archaeological Research Facility, University of California, Berkeley

Partner, TM& Mining Ltd., Tanzania

**ACADEMIC CLASSES TAUGHT WITHIN LAST 36 MONTHS (at University of California, Berkeley):**

Graduate Seminar Spring 2005- NES Department, Pottery – Co-Taught with Prof Carol Redmount

Graduate Seminar Fall 2005 – NES Department, Archaeology of Fire

Graduate Class Fall 2005 – NES Department, Optical Petrography for Archaeologists

Graduate Seminar Spring 2006 – NES Department, Geochemistry and Petrography as Applied to Provenance Studies (Advanced Pottery Seminar)

**PROFESSIONAL GEOLOGICAL ARCHAEOLOGY EXPERIENCE:**

2008-Present Adjunct Research Professor, Department of Archaeology, UCT

2007-Present Geoarchaeologist, Morgantina, Sicily

2006-Present Partner and Senior Geologist, Metamorphic gemstone mining, Tanzania

2005-Present Adjunct Professor, Near Eastern Studies Department, University of California, Berkeley

2000-Present Co-Director and Geoarchaeologist, El-Hibeh Project, Egypt, University of California, Berkeley

1998-2003 Visiting Scholar, Archaeological Research Facility, University of Cal., Berkeley

2004-2005 Visiting Scholar, Eastern Studies Department, University of California, Berkeley

1998-2002 Geoarchaeologist, Nemea Project, Greece, University of California, Berkeley.

1993-2000 Geoarchaeologist, Tel I el-Muqdam Project, Egypt, Univ. of Cal., Berkeley.

1993-1997 Geoarchaeologist, Consultant to State Parks, Research Fellowship, Utah.

Humanities Council via Utah State Parks, Anasazi State Park, Coomb's Site.

1992-2003 Geoarchaeologist, BOAS, Inc., Seattle, WA.

- 1991-Present President and Geoarchaeologist, Geosciences Management Institute, Inc. (GMI), Boulder City, Nevada.
- 1974-1982 President and Geoarchaeologist, Hawaii Marine Research, Corporation, Honolulu, Hawaii.
- 1976-1979 Affiliate Faculty of the Graduate School of the University of Hawaii. (Anthropology Department, Geoarchaeology).
- 1977 Consultant - Historic Building Materials Restoration, and Geoarchaeology, State of Hawaii, Department of Land and Natural Resources, Division of State Parks.
- 1969-1976 Consultant, geoarchaeologist, Pacific Basin.

#### **OTHER EXPERIENCE:**

- 1993-1998 Magnetic Survey Geophysics and Nile Delta Coring Program, Tell el-Muqdam Project Geologist - Geophysicist, Egypt, University of California, Berkeley.
- 1992-1998 Geophysics - EM, Ground Radar, and Magnetics, Geophysicist, BOAS, Inc., Seattle, WA.
- 1991-1998 Sedimentologist, Mineralogist, Geosciences Management Institute, Inc. (GMI), Boulder City, Nevada.
- 1982-1984 Senior Geologist, Geophysicist, Director of Operations, Gold Mine, Brim Partnership, Lake Havasu, Arizona.
- 1974-1982 Seismic Geophysicist, Hawaii Marine Research, Corporation, Honolulu, Hawaii.
- 1974-1982 Ocean Mining Geologist, Hawaii Marine Research, Corporation, Honolulu, Hi.
- 1974-1975 Assistant Researcher, Research Corporation of the University of Hawaii.
- 1965-1969 Chief Geologist - R/V Conrad, Lamont-Doherty Geological Observatory of Columbia University.
- 1964-1969 Assistant in Research, Lamont-Doherty Geological Observatory of Columbia Univ.
- 1975 Assistant Oceanographer, University of Hawaii.
- 1973-1975 Ferromanganese Program Coordinator, State Program, University of Hawaii.
- 1972-1974 Research Assistant, Research Corporation of the University of Hawaii.
- 1970-1974 Chief Scientist - R/V Teritu and R/V Kana Keoke.
- 1969-1972 Assistant in Geophysics, University of Hawaii.
- 1964-1969 Assistant in Research, Lamont-Doherty Geological Observatory of Columbia University.
- 1971&1972 Lecturer - Hawaii Pacific College and University of Hawaii (Geological Oceanography).
- 1967-1969 Teaching Assistant - Syracuse University (Geology); Lecturer Utica College (Geology).
- 1967 Lecturer - Department of Geology, Rutgers University, NSF Summer Institute.

**SELECTED PUBLICATIONS:**

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- Morgenstein, M. and P. D. LeTourneau. Characterization of Fourth – Eighth Millennium BP Chert Artifacts from the Northwestern Cascades: Utilization of EDXRF, ICP, and ICP-MS Geochemistry and Optical and SEM Petrography for Provenance Analysis. Poster Session Abstract SAA 66th Annual Meeting, April 2001.
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- Blundy, J. D., R. G. Burns, and M. Morgenstein, 1987. Authigenic Minerals in Rhyolite Tuff at Yucca Mountain. Nevada: Diagenesis In A Proposed Nuclear Waste Repository; [Abstract, poster paper], GSA Annual Meeting, p. 19, 592-3 (136950), Phoenix, Arizona.

### **Selected Nuclear Waste Presentations:**

- Morgenstein, 2006 (September) United States Nuclear Waste Technical Review Board, Workshop on Localized Corrosion of Alloy 22 in Yucca Mountain Environments, Las Vegas, Nevada
- Morgenstein, 2005 (June) Nuclear Regulatory Commission, Advisory Committee on Nuclear Waste, 151<sup>st</sup> ACNW meeting, Rockville, Maryland
- Morgenstein, 2003 (March) Nuclear Regulatory Commission, Advisory Committee on Reactor Safeguards 140<sup>th</sup> meeting, Rockville, Maryland
- Morgenstein, 2000 (October) Nuclear Regulatory Commission, Advisory Committee on Nuclear Waste (ACNW), Rockville, Maryland

**Patents:**

## 2 U.S. Patents in Deep-Sea Mining Equipment:

- 1) Morgenstein, M., May 11, 1976. Elevator apparatus for towed deep-sea particle harvester, U.S. Patent 3,955,294.
- 2) Andrews, J. E. and M. Morgenstein, April 6, 1976. Process and apparatus for deep-sea particle harvesting, U.S. Patent 3,947,980.

# Exhibit 2

BEFORE THE U.S. NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
U.S. DEPARTMENT OF ENERGY	)	Docket No. 63-001
	)	
License Application to Construct a	)	
Geologic Repository at Yucca Mountain	)	

**AFFIDAVIT OF MICHAEL C. THORNE**

I, Michael C. Thorne, the undersigned affiant, do hereby make the following statements based upon my own knowledge, information, and belief.

1. My name is Michael C. Thorne, and my curriculum vitae is attached to this Affidavit as Attachment A. I am executing this Affidavit in support of the State of Nevada's Contention NEV-SAFETY-206 in the above-captioned proceeding.

2. I hereby adopt as my own opinions the statements contained within Paragraphs 5 and 6 of this contention.

Further, the affiant sayeth not.

Michael C Thorne  
Michael C. Thorne

The above-named affiant personally appeared before me this 14<sup>th</sup> day of August, 2009, and executed this affidavit.

Hilary Gamett  
Notary Public

My Commission expires: on death

Sworn by MICHAEL CHARLES THORNE,  
identified to me by his British  
passport no. 060267866, this  
14<sup>th</sup> August 2009, before me,

Hilary Gamett

HILARY JANE GARNETT  
NOTARY PUBLIC  
13 STATION STREET  
HUDDERSFIELD  
HD1 1LY  
WEST YORKSHIRE  
ENGLAND



**ATTACHMENT A**  
**CURRICULUM VITAE**  
**MICHAEL C. THORNE**

*Michael C Thorne*

*Hilary Garnett*

HILARY JANE GARNETT  
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**(Director: Dr M C Thorne)**

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Michael Charles Thorne

Qualifications: PhD FSRP    Year of birth: 1950    Nationality:    British

**PROFESSIONAL ACTIVITIES AND MEMBERSHIP**

Visiting Fellow at the Climatic Research Unit, School of Environmental Sciences, University of East Anglia

Fellow of the Society for Radiological Protection and a Past President of the Society

Member of the Editorial Board of the Journal of Radiological Protection

Member of the National Dose Assessment Working Group (NDAWG) and Chairman of the Habits Subgroup

Member of the Eco-ethics International Union

Consultant to the Institute for Energy and Environmental Research, Washington DC.

Quintessa Associate

Director, Mike Thorne and Associates Limited

**ACADEMIC RESPONSIBILITIES**

Formal supervision of two PhD students at the University of East Anglia:

P Burgess, Future Climatic and Cryospheric Change on Millennial Timescales: An Assessment using Two-dimensional Climate Modelling Studies, PhD awarded 1998.

M Hoar, Reconstructing Climate Gradients across Europe for the Last Glacial-interglacial Cycle, PhD awarded 2004.

Informal supervision of PhD students at the University of Edinburgh (development and retreat of ice sheets) and at Imperial College of Science, Technology and Medicine (radionuclide transport in vegetated soil columns – experimental studies and modelling interpretations).

Teaching on the MSc course on Environmental Radioactivity at the University of Surrey.

Teaching on the MSc course in Environmental Technology at Imperial College of Science, Technology and Medicine.

Supervision of Post-doctoral research activities at the Universities of East Anglia; University of Newcastle and Imperial College of Science, Technology and Medicine on behalf of various commercial clients.

## **CAREER HISTORY (Selection of Projects)**

### **Mike Thorne and Associates Limited, 2001 onward**

***Development of Climate and Landscape Change Scenarios, Biosphere Factors and Characteristics of Potentially Exposed Groups for the LLWR near Drigg, West Cumbria***  
***Client - Nexia Solutions Ltd***

Project building on previous work for BNFL relating to the LLWR and for the NDA relating to vulnerabilities of various sites.

***Radiological Impact of NORM Discharges to the Marine Environment***  
***Client - Scotoil Services Ltd***

Support to an appeal against a SEPA decision to curtail such discharges from North Pier, Aberdeen.

***Development of Proposals for Setting Radiation Protection Standards based on Consideration of More Sensitive Individuals in a Population***  
***Client – Institute for Energy and Environmental Research, Washington DC***

Overall project review and development of techniques for calculating radiation doses to the early embryo from internally incorporated radionuclides.

***Review of Impacts of Coastal Erosion at Hunterston***  
***Client – ERM Limited***

Evaluation of the potential radiological implications of coastal erosion on the VLLW pits at Hunterston Nuclear Power Station.

***Advice on Dose Reconstruction***  
***Client – S A Cohen & Associates for NIOSH***

Advice on dose reconstructions for workers at DOE facilities from 1941 onward.

***Advice on Effects of Radionuclides on Organisms other than Man***  
***Client – Nuclear Safety Solutions Limited, Canada***

Provision of guidance on dosimetry, reference levels and effects relevant to selected protected species.

***Participation in Safety Assessment Studies for the Baita Bihor Repository, Romania***  
***Client – Quintessa/for the European Union***

Compilation of inventory data, shielding studies and development of both operational and post-closure safety cases.

***Review of the Yucca Mountain Project***  
***Client – State of Nevada***

Co-ordination of technical activities involved in a review of the proposed License Application by US DOE for disposal of radioactive wastes at Yucca Mountain.

***Co-ordination of biosphere research and participation in BIOCLIM***  
***Client – UK Nirex Ltd (NDA/RWMD)***

Co-ordination of research on climate change, ice-sheet development, near-surface hydrology and radionuclide transport, as well as participation in an international programme on the implications of climate change for radioactive waste disposal. Also includes development of new models for radionuclide transport in the biosphere and for the gas pathway.

***Development of a Handbook on Radionuclide Behaviour in the Environment***  
***Client – Serco Assurance***

Development of a handbook for Environment Agency staff outlining the behaviour of a wide variety of radionuclides in terrestrial and aquatic environments.

***Development of a Simplified Dose Assessment Model***  
***Client – Serco Assurance***

Development of a simplified spreadsheet-based dose assessment tool for use by Environment Agency staff in determining Authorisations.

***Provision of Biosphere Advice***  
***Client – Ciemat, Spain***

Provision of advice on models and data relevant to geological disposal of radioactive wastes

***Provision of Advice on Safety***  
***Client – NNC Ltd/Defra***

Provision of expert advice to the UK Committee on Radioactive Waste Management (CoRWM).

***Effects of Radiation on Organisms Other Than Man***  
***Client – AEA Technology/Serco Assurance***

Study for ANDRA to identify appropriate indicator organisms and develop appropriate dosimetry and effects models for those organisms.

***Member of the Site Investigation Expert Review Group (SIERG)***  
***Client – SKB***

Oversight reviews of site investigation activities and the associated research and assessment programmes.

***Advice on the Short-, Medium- and Long-term Effects of Climate Change on Nuclear Licensed Sites***

***Client – BNFL and Nexia Solutions Ltd***

Interpretation of results from the international BIOCLIM project in relation to decommissioning and solid radioactive waste management, with particular emphasis on the potential significance of sea-level changes. Review of information on coastal vulnerabilities at NDA sites.

***Advice on Submarine Reactor Accidents and the Development of Detailed Emergency Planning Zones***

***Client – Electrowatt-Ekono***

Assistance to MoD in revising emergency planning criteria in the light of recent changes of views on Emergency Reference Levels and other technical developments. Also studies on tritium analyses and migration from transfer tanks.

***Review of Continuing Operational Safety Cases***

***Client – Electrowatt-Ekono***

Review of COSRs developed by BNFL for contaminated land.

***Development of a New Soil-Plant Model for use in Radiological Assessments***

***Client – Food Standards Agency/Quintessa***

Development of the specification for a new soil-plant model (PRISM) to replace that implemented in the SPADE suite of codes (implementation of the model has been by Quintessa) and extension of that work to new models for  $^3\text{H}$  and  $^{14}\text{C}$ .

***Review of Probabilistic Safety Assessment and Criticality Issues relating to a Proposed Surface Storage Facility for Spent Nuclear Fuel***

***Client – State of Utah***

Review of the potential for criticality in breached storage casks and of the probability of breaching by aircraft impacts. Also, supervision of various criticality and radiation shielding calculations.

***Development of Models for Radionuclide Transfers to Sewage Sludge and for Evaluating the Radiological Impact of Sludge applied to Agricultural Land***

***Client – Food Standards Agency***

Includes a review of literature and the development and implementation of probabilistic models for such transfers.

***Development of Biokinetic Models for Radionuclides in Animals***  
***Client – Serco Assurance***

Development of updated biokinetic models for use by the Food Standards Agency in their SPADE and PRISM modelling systems.

***Review Studies for the Proposed Australian National Radioactive Waste Repository***  
***Client – RWE NUKEM***

Reviews of reports on animal transfer factors and of the potential effects of climate change on the repository plus development of a model for the biokinetics of the  $^{226}\text{Ra}$  decay chain in grazing animals.

***Development and Application of a Model for Assessing the Radiological Impacts of  $^3\text{H}$  and  $^{14}\text{C}$  in Sewage Sludge***  
***Client – NNC Ltd***

Development of a model based on physical, chemical and biochemical principles for the uptake of  $^3\text{H}$  and  $^{14}\text{C}$  into sewage sludge and their subsequent distribution and transport after application of the sludge to agricultural land.

***Support for development of the Drigg Post-closure Radiological Safety Assessment***  
***Client - BNFL***

Support in the areas of FEP analysis, biosphere characterisation, human intrusion assessment and the effects of natural disruptive events. In addition, provision of advice of future research initiatives that should be pursued by BNFL.

***Review of Parameter Values***  
***Client – AEA Technology/Serco Assurance***

Review of biosphere parameter values for use in the ANDRA assessment model AQUABIOS.

***Development of a Database related to Emergency Planning***  
***Client – AEA Technology (Rail)***

Identification of relevant international, overseas and national legislation, regulations and guidance, and production of brief summaries of the documents.

***Dose Reconstruction for Workers on a Uranium Plant***  
***Client - McMurry and Talbot***

Dose reconstruction for the plaintiffs in a case relating to the Paducah Gaseous Diffusion Plant.

***Dose Reconstruction for a Worker Exposed to Pu and Am***  
***Client – Pattinson and Brewer***

Dose reconstruction for a worker exposed by a puncture wound in the finger while working at a glove box.

**AEA Technology, 1998-2001**

***Revision of Exemption Orders Made Under the Radioactive Substances Act***  
**Client – DETR**

Review of requirements for revision and preparation of a draft text for the purposes of consultation.

***Assessment of Remediation Options for Uranium Liabilities in Eastern Europe***  
**Client - European Commission**

Studies of remediation requirements relating to mines, waste heaps and hydrometallurgical plant in Bulgaria, Slovakia and Albania.

***Evaluation of Unusual Pathways for Radionuclide Transport from Nuclear Installations***  
**Client – Environment Agency**

Review of literature and conduct of formal elicitation meetings to determine potential pathways and evaluate their radiological significance.

***Support Studies on the Drigg Post-closure Performance Assessment***  
**Client - BNFL**

Support in the areas of FEP analysis, biosphere characterisation, human intrusion assessment and the effects of natural disruptive events. In addition, provision of advice of future research initiatives that should be pursued by BNFL.

***Development of Models for the Biokinetics of H-3, C-14 and S-35 in Farm Animals***  
**Client - FSA**

Review of relevant literature, development of appropriate biokinetic models and implementation in stand-alone software.

***Integration of Aerial and Ground-based Monitoring in the Event of a Nuclear Accident***  
**Client - FSA**

Desk-based review and simulation study designed to determine optimum monitoring strategies for different types of accidents.

***Elicitation of Parameter Values for use in Radiological Impact Assessment Models***  
**Client - FSA**

Expert elicitation study to provide distributions of parameter values for use in the suite of assessment models currently used by the FSA for routine and accidental releases.

***Biosphere Research Co-ordination and Assessment Studies***

***Client - United Kingdom Nirex Ltd***

Continuation of a programme of work originally undertaken at Electrowatt Engineering (UK) Ltd

***Site Investigation and Risk Assessment - Hilesea Lines***

***Client - Portsmouth City Council***

Radiological assessment of a radium-contaminated site.

**Electrowatt Engineering (UK) Ltd, 1987-1998**

***Development of a Siting Policy for Nuclear Installations: Harbinger Project and Follow-up Study***

***Client - HSE/NSD***

Review of existing policy and development of alternatives as a precursor to application to a wide range of installations, not restricted to commercial reactors.

***Support to the Rock Characterisation Facility Public Enquiry***

***Client - UK Nirex Ltd***

Preparation of position papers and rebuttals of evidence.

***Rongelap Resettlement Project***

***Client - Marshall Islands Government***

Participation in an oversight committee evaluating the radiological safety of Rongelap in the context of resettlement by its evacuated community.

***Evaluation of Inhalation Doses from Uranium***

***Client - Baron & Budd***

Provision of expert witness support in a class action relating to environmental exposure from a uranium plant.

***Biosphere Studies Relating to Drigg***

***Client - BNFL***

Provision of advice on time-dependent biosphere modelling for the Drigg low-level radioactive waste disposal facility.

***Radiation Doses to an Individual as a Consequence of Working on the San Onofre Nuclear Power Plant***

***Client - Howarth & Smith***

Interpretation of personal and area monitoring data for legal purposes.

***Interpretation of Uranium in Urine Data for the Fernald, Ohio Feed Materials Processing Center***

***Client - Institute for Energy and Environmental Research***

Interpretation of urinalysis and lung counting data, and appearance as an expert witness in the associated trial.

***Determination of Failure Probabilities for use in PRA***

***Client - Nuclear Installations Inspectorate***

Development of new approaches to the use of Bayes Theorem in defining component failure probabilities for use in PRA when statistics on actual failures are limited.

***Review of Inventory Information***

***Client - UK Nirex Ltd***

Review of uncertainties in inventories of individual radionuclides.

***ALARP Study of Options for the Treatment, Packaging, Transport and Disposal of Plutonium Contaminated Material***

***Client - UK Nirex Ltd***

Use of multi-attribute utility analysis to establish which option is preferred.

***Expert Judgement Estimation of Intrusion Model Parameters***

***Client - British Nuclear Fuels plc***

Project Manager of a study assessing the risks of human intrusion into Drigg radioactive disposal site using expert judgement techniques.

***Brainstorming Study of Risks Associated with Building Structures***

***Client - Building Research Establishment***

Participation in a classification study of the health risks associated with buildings including both injuries and disease.

***Radiological Consequences of Deferred Decommissioning of Hunterston A***

***Client - Scottish Nuclear Ltd***

Project Manager of a study of the radiological impacts of groundwater transport of radionuclides, releases to atmosphere and intrusion.

***Reviews of Safety Documentation***

***Client - UK Nirex Ltd***

Review of safety related documentation for Packaging and Transport Branch.

***The Sheltering Effectiveness of Buildings in Hong Kong***

***Client - Ove Arup & Partners***

Project Manager of a study evaluating the shielding effectiveness of all types of building in Hong Kong for volume sources of photons in air and surface deposition sources.

***Assessment of the Radiological Impact of Releases of Radionuclides from Premises other than Licensed Nuclear Sites***

***Client - Ministry of Agriculture, Fisheries and Food***

Project Manager of a study to identify representative premises, obtain data on their releases of radionuclides and assess radiological impacts using a new methodology developed for the project.

***Assessment of the Radiological Implications of Uranium and its Radioactive Daughters in Foodstuffs***

***Client - Ministry of Agriculture, Fisheries and Food***

Project Manager of a review study of concentrations of uranium and its daughters in foodstuffs, taking local and regional variations in uranium concentrations in soils, sediments and waters into account.

***Radionuclides in Sewage***

***Client - Her Majesty's Inspectorate of Pollution***

Project Manager of a study including a desk review on alternative methods of disposal of sewage sludges, interpretation of monitoring data relating to radionuclide discharges from Amersham International to the public sewer system, development of a model for radionuclide transport in sewers, and collection and analysis of effluent, foul water, sediment, sludge and other samples suitable for use in model validation studies.

***Accident Consequence Calculations***

***Client - Nuclear Installations Inspectorate***

Project Manager of a study to assess the radiological consequences of various atmospheric releases using the MARC code.

***Definition of Threshold Recording Levels for Drums of ILW***

***Client - UK Nirex Ltd***

Project Manager of a study of the implications of post-closure radiological impacts of radioactive waste disposal in defining Threshold Recording Levels for radionuclides in individual waste drums.

***Definition of Expert Judgment Exercises Relating to Nuclear Safety***

***Client - Commission of the European Communities***

Project Manager for a study defining expert judgment exercises relating to conceptualisation, representation and input data specification. Included a comprehensive review of available formal expert judgment procedures, and mathematical and behavioural aggregation techniques.

***Definition of Research Requirements Relating to the Use of Expert Judgment in Parameter Value Elicitation for Reactor Safety Studies in a UK Context***

***Client - Nuclear Safety Research Management Unit, HSE***

Development of proposals for using combined behavioural and mathematical aggregation procedures in formal elicitations of expert judgment.

***Development Priorities for the Drigg Technical Development Programme***

***Client - British Nuclear Fuels plc***

Provision of detailed advice to BNFL on future design options, and research and development priorities, in relation to radioactive waste disposal at Drigg.

***Channel Tunnel Safety Studies***

***Client - Channel Tunnel Safety Authority***

Provision of advice and guidance on safety criteria appropriate to the Fixed Link, on the classes of Dangerous Goods that may properly be carried and on the overall characteristics of the proposed Safety Case.

***Development of Societal Risk Criteria***

***Client - Marathon Oil***

Interpretation of F-N curves in the context of the offshore oil/gas industry, taking risk aversion into account.

***Impacts of Salt Dispersal on Plant Communities***

***Client - Sir William Halcrow***

Evaluation of salt dispersal from a major road in winter in relation to adjacent Sites of Special Scientific Interest.

***Offsite Consequence Assessments  
Client - Nuclear Electric***

Studies of the offsite radiological impacts of atmospheric and liquid releases of radioactive materials from Magnox stations.

***Dry Run 3  
Client - Her Majesty's Inspectorate of Pollution***

Uncertainty and bias studies involving formal expert judgment procedures to develop a conceptual model of those factors and interrelationships which are of significance in determining the post-closure radiological impact of a deep geological repository for radioactive wastes. This project also included advice on data and models to be used for post-closure radiological assessments.

***Radiological Assessments of Drigg  
Client - British Nuclear Fuels plc***

Project Manager for post-closure radiological impact assessments of the Drigg LLW disposal site. Also included specification and development of computer codes relating to the radiological impact of fires, releases of radioactive gases produced by microbial action and metal corrosion, and human intrusion.

***Biosphere Co-ordination  
Client - UK Nirex Ltd***

Co-ordination of the UK Nirex Ltd Biosphere Research Programme from its inception, including requirements definition, technical management of all projects and QA surveillance as the Client's Representative.

***Biosphere Support for the Nirex Disposal Safety Assessment Team  
Client - AEA Technology***

Development of approaches for assessing the radiological impact of releases of radionuclides to the biosphere, plus advice on radiological protection criteria, definition of individual risk, implications of conventionally toxic chemicals in wastes and a variety of other matters.

***Evaluation and Radiological Assessment of Liquid Effluent Releases from Various Premises  
Client - Her Majesty's Inspectorate of Pollution***

Reviews of monitoring data and evaluations of radiological impact, primarily related to Harwell, Aldermaston, Capenhurst and Amersham International.

***Evaluation of the Radiological Impact of Overseas Nuclear Accidents  
Client - Her Majesty's Inspectorate of Pollution***

Studies of the impact of potential overseas nuclear accidents on the UK, with emphasis on survey and monitoring requirements, and the selection of appropriate radiation detection equipment for monitoring.

***Bilsthorpe Power Station***

***Client - British Coal/East Midlands Electricity***

Preparation of an Environmental Statement with emphasis on atmospheric dispersion of SO<sub>2</sub> and NO<sub>x</sub>.

***Gas Generation in Radioactive Waste Disposal Facilities***

***Client - AEA Technology***

Development of a coupled microbial degradation and corrosion model for gas generation in repositories for LLW and ILW.

***Effects of Chernobyl on Drinking Water Supplies***

***Client - Her Majesty's Inspectorate of Pollution***

Evaluation of the radiological implications of enhanced concentrations of radionuclides in water supplies in England and Wales subsequent to the Chernobyl accident.

***Sea Disposal of Radioactive Wastes***

***Client - UK Nirex Ltd***

Participation in an Environmental Impact Assessment of the proposed resumption of sea-dumping of radioactive wastes.

***UK Research Related to Radioactive Waste Management***

***Client - Her Majesty's Inspectorate of Pollution***

Identification of gaps in the UK national research effort related to radioactive waste management.

***Research Requirements for Repository Design and Site Investigations***

***Client - UK Nirex Ltd***

Review of research requirements for repository design and site investigations in relation to LLW and ILW disposal in near-surface and deep repositories.

***International Commission on Radiological Protection, Sutton, Surrey, England, 1985-1986***

Scientific Secretary responsible for arranging and minuting meetings, administrative arrangements, technical review of reports, editing of the Commission's journal, liaison with other international organisations and public relations.

**ANS Consultants Ltd, Epsom, Surrey, England, 1979-1985**

Reviews of data on the distribution and transport of radionuclides in terrestrial and aquatic ecosystems (see publications list).

Development of a dynamic model for radionuclide transport in agricultural ecosystems and implementation of the model on various microcomputer systems.

Photon and neutron shielding studies of radiochemical plant, together with area classification and ALARA studies.

A review of UK use of the criticality code MONK and other approaches to criticality safety assessment.

Radiological and conventional safety aspects of Magnox reactor decommissioning.

Development of metabolic models for inclusion in ICRP Publication 30.

Development of pharmacodynamic models for toxic chemicals.

Review of neutron activation analysis in studies of radionuclide transport in soils and plants.

Experimental studies on radionuclide transport in soils and plants using various photon-emitting radionuclides.

Support for DoE work on probabilistic risk assessment of LLW and ILW disposal.

Review of UK research requirements for HLW disposal.

Post-closure radiological impact assessment of the proposed LLW and ILW facility at Elstow, Bedfordshire.

Development of a generalised biosphere model for use in probabilistic risk assessments of solid radioactive waste disposal.

Initial development of a mathematical model for use in assessing the radiological impact of contaminated groundwater.

Development, computer implementation and comprehensive documentation of a model to calculate the radiological impact of intrusion into radioactive waste repositories.

Development of a general-purpose computer code for solving first-order differential equations using a hybrid Predictor-Corrector/Runge-Kutta method.

Studies on the potential radiological consequences of Magnox reactor accidents.

**Medical Research Council Radiobiology Unit, Chilton, Didcot, Oxon, England, 1974-1979**

Development of dosimetric and metabolic models for use in ICRP Publication 30.

Studies on the metabolism of plutonium in bone and relationships to blood flow.

Theoretical studies on radionuclide metabolism and dosimetry.

Development of techniques in neutron-induced autoradiography and alpha imaging.

Image analysis studies of plutonium in bone, uranium in lungs, lysosomal inclusions in cells and heterochromatin.

Studies on the clearance of inhaled  $\text{UO}_2$ .

Alpha spectroscopy in support of toxicity studies with Ra-224.

Data analysis in connection with experimental animal studies on the potential efficacy of neutron therapy using 42 MeV neutrons.

**University of Sheffield, 1971-1974**

Experimental studies on the reaction  $\gamma + p \rightarrow \pi^0 + p$  at photon energies between 1 and 3 GeV, using a linearly polarised photon beam.

**SELECTION OF PUBLICATIONS**

A measurement of the beam asymmetry parameter for neutral pion photoproduction in the energy range 1.2 - 2.8 GeV. P.J. Bussey, C. Raine, J.G. Rutherglen, P.S.L. Booth, L. Carroll, G.R. Court, A.W. Edwards, R. Gamet, C.J. Hardwick, P.J. Hayman, J.R. Holt, J.N. Jackson, J. Norem, W.H. Range, F.H. Combley, W. Galbraith, V.H. Rajaratnam, C. Sutton and M.C. Thorne. London Conference (1974) Abstract 997.

The measurement of the polarisation parameters  $\Sigma$ ,  $P$  and  $T$  for positive pion photoproduction between 500 and 1700 MeV. P.J. Bussey, C. Raine, J.G. Rutherglen, P.S.L. Booth, L.J. Carroll, P.R. Daniel, C.J. Hardwick, J.R. Holt, J.N. Jackson, J.H. Norem, W.H. Range, F.H. Combley, W. Galbraith, V.H. Rajaratnam, C. Sutton, M.C. Thorne and P. Waller. Nuclear Physics, B104, (1976) 253-276.

The polarised beam asymmetry in photoproduction of eta mesons from protons 2.5 GeV and 3.0 GeV. P.J. Bussey, C. Raine, J.G. Rutherglen, P.S.L. Booth, L.J. Carroll, P.R. Daniel, A.W. Edwards, C.J. Hardwick, J.R. Holt, J.N. Jackson, J. Norem, W.H. Range, W. Galbraith, V.H. Rajaratnam, C. Sutton, M.C. Thorne and P. Waller. Physics Letters, 61B, (1976) 479-482.

Aspects of the dosimetry of plutonium in bone. M.C. Thorne. Nature, 259, (1976) 539-541.

The toxicity of Sr-90, Ra-226 and Pu-239. M.C. Thorne and J. Vennart. *Nature* 263, (1976) 555-558.

Radiation dose to mouse testes from Pu-239. D. Green, G.R. Howells, E.H. Humphreys and J. Vennart with Appendix by M.C. Thorne. Published in "The Health Effects of Plutonium and Radium", Ed. W.S.S. Jee, (J.W. Press, Salt Lake City, Utah, 1976).

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Theoretical aspects of the distribution and retention of radionuclides in biological systems. M.C. Thorne. *J. Theor. Biol.*, 65, (1977) 743-754.

Aspects of the dosimetry of emitting radionuclides in bone with particular emphasis on Ra-226 and Pu-239. M.C. Thorne. *Phys. Med. Biol.*, 22, (1977) 36-46.

A new method for the accurate localisation of Pu-239 in bone. D. Green, G. Howells and M.C. Thorne. *Phys. Med. Biol.*, 22, (1977) 284-297.

The measurement of blood flow in mouse femur and its correlation with Pu-239 deposition. E.R. Humphreys, G. Fisher and M.C. Thorne. *Calcif. Tiss. Res.*, 23, (1977) 141-145.

The distribution of plutonium-239 in the skeleton of the mouse. D. Green, G.R. Howells, M.C. Thorne and J. Vennart. In "Proceedings of the IVth International Congress of the International Radiation Protection Association Vol. 2 (Paris 1977).

The visualisation of fissionable radionuclides in rat lung using neutron induced autoradiography. D.J. Gore, M.C. Thorne and R.H. Watts. *Phys. Med. Biol.*, 23 (1978) 149-153.

Lymphoid tumours and leukaemia induced in mice by bone-seeking radionuclides. J.F. Loutit and T.E.F. Carr with an appendix by M.C. Thorne. *Int. J. Radiat. Biol.*, 33, (1978) 245-263.

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Techniques for studying the distribution of alpha emitting and fissionable radionuclides in histological lung sections. T. Jenner and M.C. Thorne. *Phys. Med. Biol.*, 25, 357-364 (1980).

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**UNITED STATES OF AMERICA  
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**Atomic Safety and Licensing Board**

<b>In the Matter of</b>	)	
	)	
<b>U.S. DEPARTMENT OF ENERGY</b>	)	<b>Docket No. 63-001-HLW</b>
	)	
<b>(High Level Waste Repository)</b>	)	<b>August 24, 2009</b>

**CERTIFICATE OF SERVICE**

I hereby certify that the foregoing State of Nevada's Motion for Leave to File New Contention Based on Newly Available Information has been served upon the following persons by the Electronic Information Exchange:

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