# Investigation of Releases From Santa Susana Sodium Reactor Experiment in July, 1959

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# 1. Introduction

## 1.1. Background

At the request of counsel for defense in the matter of "Lawrence O'Connor, et. al. vs. Boeing North America, Inc.", I have undertaken an investigation to determine whether there was a release of radionuclides form the Sodium Reactor Experiment (SRE) in July 1959, and if so, to determine the quantity and identify the specific radionuclides released.

I have over 30 years experience in nuclear engineering. I graduated from the University of Florida in 1972 with a Bachelor of Science degree in Nuclear Engineering Sciences. My primary areas of expertise are nuclear power plant safety analysis and fission product transport and behavior.

I began my career at United Engineers and Constructors, in Philadelphia, performing nuclear safety analyses for the licensing of nuclear power plants under contract to UE&C. I worked on the Seabrook Nuclear Station, Washington Public Power Supply Systems Units 1 and 4, and Brunswick Power Station. I performed containment pressure-temperature analyses and various analyses for postulated nuclear accidents, including release from fuel and off-site dose analyses. As part of my work, I developed computer codes to assess the performance of safety systems designed to mitigate the consequences of upset and emergency conditions in the plant. I also performed safety assessments of foreign reactor systems, including the Canadian heavy water reactors and the French Phoenix and Super-Phoenix sodium-cooled breeder reactors, as part of a study conducted by the Department of Energy.

In 1978, I joined General Public Utilities, and was at the Three Mile Island facility from April, 1979 until May, 1984, as technical advisor to the Vice President of GPU Nuclear, and as Manager of the TMI-2 Radiological Analyses Group. I was responsible for the assessments of radiological safety for all decontamination operations in the plant and to provide technical support to the recovery team. I also supervised the equipment design and collection of highly radioactive samples to assist the recovery effort.

I joined Science Applications, Inc. while at TMI in 1982, and became the TMI site manager for SAI. I was responsible for the laboratory's contribution to recovery

operations, under contract to Department of Energy. I developed a systematic approach for documenting the fission product release from the fuel and transport through the primary and auxiliary systems, utilizing a combination of specialized sampling, computer modeling and in-situ gamma spectrometer measurements. I made several entries into the TMI reactor building to perform scientific measurements related to the accident sequence and to measure the effectiveness of decontamination efforts.

I founded Daniel & Associates, Inc. in 1984, and now consult to various utilities and governmental agencies. I was the Principal Investigator for an NRC project that developed a correlation between radioactive iodine resuspension and ambient temperature, published as NUREG/CR-4953.

I have written several computer codes, including RADTRAN, a fission product transport code. The RADTRAN code, after review by the NRC, was used to calculate the allowable release rate of radioactive gases from the TMI-2 reactor building during the venting of gases during 1980. I revised a version of the ORIGEN2 radioactive isotopic generation/depletion code and the Oak Ridge National Laboratory (ORNL) shielding code ANISN to operate under the Windows® operating system. I have also written numerous small codes related to dose calculations, gamma-ray shielding, and two phase flow in piping systems.

A list of publications and papers is attached as Appendix A.

### 1.1.1 Prior Testimony

I have not participated in any litigation in the past four years.

### 1.1.2 Compensation

My compensation in this case is $ 120/hr.

## 1.2. Approach

Investigation of the SRE fuel damage incident lends itself to an approach known as "forensic reconstruction", a technique commonly used by investigators of aircraft and other industrial incidents to determine the cause and significance of events leading up to

the failure being investigated. In this technique, mathematical calculations, called "models", are commonly used to compare calculations to data recorded during the incident, and to fill in missing data or gaps in the data that may be relevant to the incident. The "models" use the laws of physics to predict and quantify the outcome of events. On occasion, it may be necessary to make assumptions, due to lack of data, for example. In these instances, the investigator should pursue the validity of the assumption, and then test the generated results against available data. Taken in total, the "reconstruction" must satisfy all data recorded and available from the event, and also must not violate the physical constraints imposed by the plant piping and equipment arrangement.

The approach taken in this investigation was accomplished in two phases. Phase I involved determining an accurate inventory of fission products in the SRE reactor core. Phase II involved determining the inventory of fission products remaining in the reactor core and plant systems after the incident occurred. The difference in inventories, i.e., before and after the incident, provides the best estimate of what may have been released during the incident.

In order to accomplish the forensic "reconstruction", certain system descriptions and operating data were examined and reviewed in detail. Relevant descriptions and data are contained in this report to provide a clear understanding of individual systems and their role in the events that occurred in July, 1959 with respect to release from the SRE. Whenever possible, comparison to SRE data will be made and presented to verify the validity of calculations. Using this generally accepted scientific methodology will result in determining whether a release occurred, and If so, the magnitude of that release.

### 1.3. Organization of Report

Section 2 of this report is a description of the SRE design features that are necessary to understand the operation and pathways available for release to the environment to determine whether or not a release occurred. Descriptions are taken from SRE design documents and drawings. Every attempt has been made to verify that the drawings and descriptions are an accurate representation of the facility during the period in question. This section thus describes the equipment and systems at the time of the fuel damage

incident. As a general rule, only the systems and equipment necessary for an understanding of the events of the incident are discussed. The exceptions to the rule are that descriptions may also be given for systems and pathways identified by plaintiff's expert to fully understand the allegations presented.

Section 3 describes the operating and irradiation history of the SRE fuel, in order to provide a background for determination of fission product inventory in the reactor core during the period July 12 through July 26, 1959. The information in Section 3 was primarily taken from the reports describing the fuel damage incident. [Ref. 1-4]. Section 3 provides the operational history for power runs up to run 14, and provides the background for the problems that developed in Run 14.

Section 4 is a description of Run 14 and presents the thermodynamic aspect of the fuel damage. This section also presents the results of experiments undertaken to determine the root cause of the fuel damage.

Section 5 deals with the radiological aspect of the fuel damage incident, and introduces the calculated fission product inventory and analyses performed to determine the release from the fuel. Comparisons to sample data are used as benchmarks to compute the source term for release. Section 5 contains the details of the release to the environment from the event. This section also presents the results of experiments undertaken by Atomics International to determine the fate of fission products released from the fuel matrix.

Section 6 discusses specific allegations made by plaintiff's expert, contained in the report "Iodine-131 Releases from the July 1959 Accident at the Atomics International Sodium Reactor Experiment", dated January 1959 [Ref. 32].

Section 7 lists the references relied upon to prepare this report.

### 1.4. Summary and Conclusions

#### 1.4.1. Summary of Fuel Failure Incident

During Power Run 14 of the SRE which began July 12, 1959, fluctuations of the core exit sodium temperature were noticed at various fuel channels. Some of these fluctuations were severe, and caused swelling of the fuel such that the stainless steel cladding was

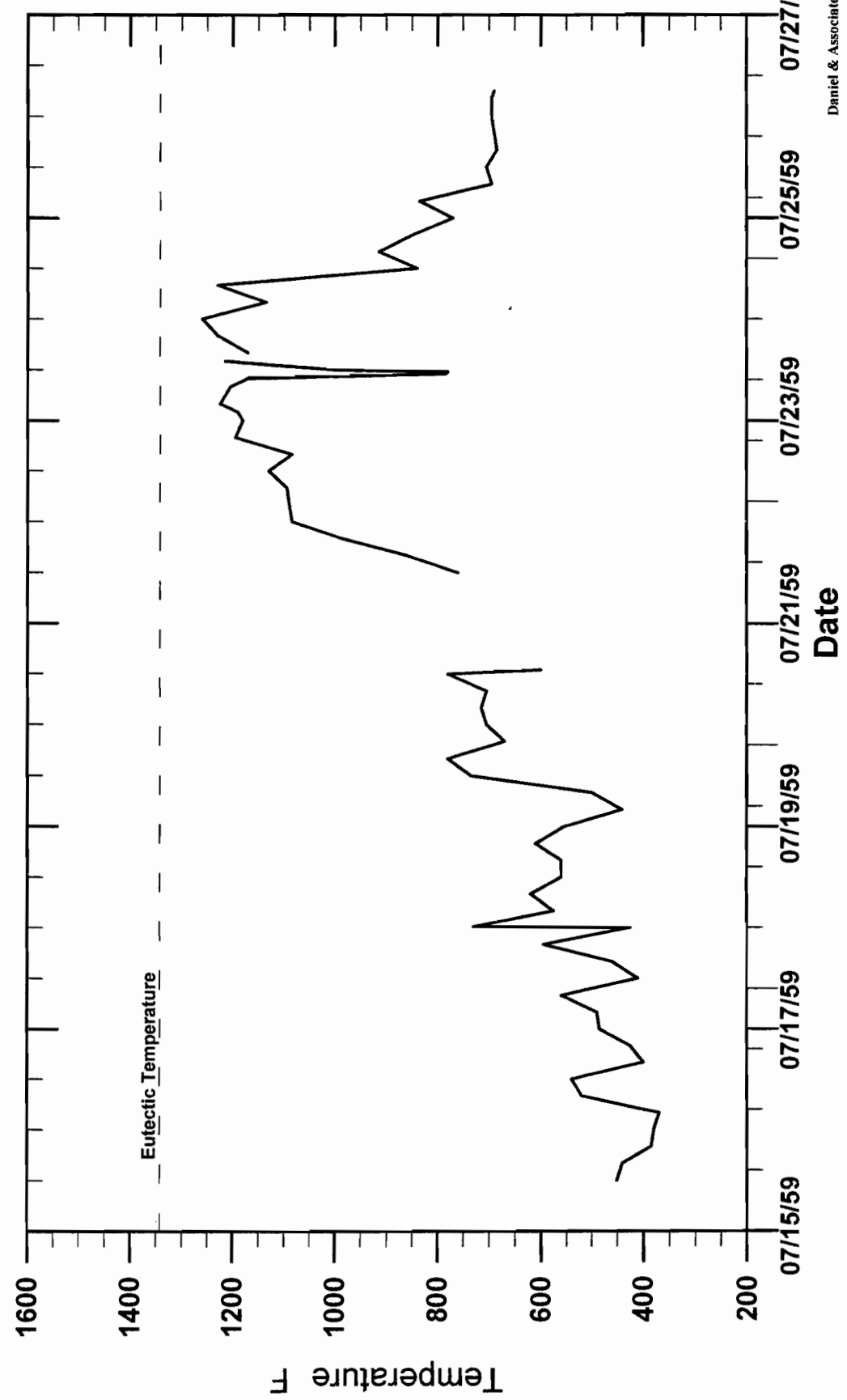


Figure 4.5 Channel 55 Thermocouple Temperature TC10 (21 inches above midplane)



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