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**Sodium Oxide Aerosol Study: NSPP Runs
101-105, Data Record Report**

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Prepared for the U.S. Nuclear Regulatory Commission
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OAK RIDGE NATIONAL LABORATORY
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DATA RECORD REPORT

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SUMMARY

This data record report summarizes the first five sodium oxide aerosol behavior tests in the Nuclear Safety Pilot Plant (NSPP) project, which is a part of the Aerosol Release and Transport (ART) Program at ORNL, sponsored by NRC-ARSR. The initial series of tests in the NSPP consisted of four sodium pool fires and one sodium spray fire. The objective of this first test series was to investigate the single-component (sodium oxide) aerosol behavior in the NSPP vessel, which can be compared with aerosol behavioral models and with tests in larger vessels for assessing scaling effects and later can be compared with NSPP tests using mixtures of sodium and uranium oxides.

The four sodium pool fire tests burned amounts of sodium ranging from 1 to 10 kg and produced maximum sodium oxide aerosol concentrations ranging from 6 to 25 g/m³. The single sodium spray test, which burned 5 kg of sodium, produced an aerosol that was not well mixed within the vessel; the maximum aerosol mass concentration was of the order of 12 g/m³.

In this data record report, a brief description is given of each test followed by test results in the form of tables and graphs. Included are data on aerosol mass concentration, aerosol fallout rate, aerosol plateout rate, aerosol particle size, vessel atmosphere temperatures, thermal gradients near the vessel wall, vessel atmosphere pressure, final aerosol distribution, and sodium material balances.

SODIUM OXIDE AEROSOL STUDY: NSPP RUNS 101-105,
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ABSTRACT

This data record report summarizes the first five sodium oxide aerosol tests conducted in the Nuclear Safety Pilot Plant (NSPP) project at Oak Ridge National Laboratory. The goal of the project is to establish the validity (or level of conservatism) of the aerosol behavioral code, HAARM-2, and follow-on codes under development at the Battelle Columbus Laboratories for the U.S. Nuclear Regulatory Commission (NRC). Included in the report are descriptions of the five tests together with graphs and tables summarizing the results.

1. INTRODUCTION

The Nuclear Safety Pilot Plant (NSPP) project constitutes Task 9 of the Aerosol Release and Transport (ART) Program at ORNL, sponsored by NRC-ARSR. The NSPP, which had been used previously to study the release and behavior of fission products from molten light water reactor fuel, was in inactive standby status for several years. It has recently been reactivated for studying the behavior in secondary containment environments of aerosols released under liquid-metal-cooled fast breeder reactor (LMFBR) accident conditions which involve mixtures of aerosols containing both fuel and sodium oxides, relatively high aerosol concentration, temperature and pressure transients due to sodium burning, possible presence of moisture in the secondary containment air atmosphere, and continuous as well as instantaneous sources.

The NSPP program presently focuses on establishing the validity (or level of conservatism) of the aerosol behavioral code, HAARM-2, and follow-on codes under development for NRC at Battelle Columbus Laboratories.¹ Special emphasis is placed on the applicability of the codes for describing the behavior of mixtures of aerosols and on the model features related to the effects of vessel size.

The initial series of tests, as outlined in the NSPP program plan,² makes use of sodium pool fires and sodium spray fires to produce the aerosols. The objective of these first tests is to investigate the single-component (sodium oxide) aerosol behavior in NSPP, which can be compared with the codes and with tests in larger vessels (e.g., the CSTF at HEDL) for assessing scaling features and for later comparison with experiments using mixtures of aerosols. The intention has been to conduct the single-component tests at increasing levels of concentration up to the presently unknown maximum attainable within the NSPP (expected to be about 100 g/m^3). Since January 1977, a total of five of these single-component experiments have been conducted. These consisted of four pool fires and one spray fire.

The first of these, run 101, burned about 1 kg of sodium in a pool fire and was essentially a system shakedown run. Although all the intended instrumentation was not operative, much useful information was obtained. The maximum aerosol concentration was 6 g/m^3 .

The next two tests, runs 102 and 103, proved to be duplicates of each other. These were pool fire tests in which about 5 kg of sodium was burned in each to produce a maximum airborne concentration of about 11 g/m^3 . Run 103 was the first test in which the cascade impactor system for aerosol size measurements functioned properly.

Run 104 burned 10.1 kg in a pool fire to produce a maximum concentration of 25 g/m^3 .

Run 105 was the first spray fire test. Although this mode of operation was expected to produce a high concentration (about 80 g/m^3) in a short time, the actual measured concentrations were much lower (of the order of 12 g/m^3), because the aerosol apparently was not well distributed within the vessel.

The purpose of this report is to document the results of all five of these single-component tests in the form of a data record. Data interpretation, comparison with model predictions, and discussion of the implications of the results with respect to the physics of aerosol behavior will be made later as the experimental program progresses and as more data are obtained.

The future test program will follow the schedule as outlined in the program plan² by progressing next into the mixed aerosol experiments. However, more single-component sodium oxide experiments will be needed, especially using spray fires to produce the higher concentrations. Single-component uranium oxide experiments will also be required. It is intended to conduct such single-component experiments following an extended period of mixed aerosol tests. If it becomes convenient because of scheduling or equipment difficulties, such tests can be interspersed within the mixed aerosol test program at appropriate times.

2. NUCLEAR SAFETY PILOT PLANT (NSPP)

2.1 NSPP System

The NSPP is composed of a test vessel, aerosol generating equipment, analytical sampling and system parameter measuring equipment, and a water spray decontaminating system. A schematic representation of the system appears as Fig. 1. The NSPP vessel is a stainless steel cylinder with dished ends having a diameter of 3.05 m (10 ft), a total height of 5.49 m (18 ft), and a volume of 38.3 m³ (1350 ft³). The floor area is 7.7 m² (82.9 ft²), and the internal surface area (including top and floor) is 68.9 m² (741.6 ft²). The design temperature limitation is 150°C, and the design pressure limitation is 0.419 MPa (60 psi).

2.1.1 Equipment for measurement of aerosol parameters

Aerosol mass concentration. Aerosol mass concentrations are obtained with two types of filter samplers. The in-vessel sampler is a self-contained unit with 12 filter tubes, a sequential valve, and a stepping motor; mechanical operation is remote from the control room. The other type, the wall aerosol sampler (so-called because the sampler penetrates the vessel wall through a ball valve and flange arrangement), is inserted and retrieved manually. The sampling procedure for either type of sampler requires drawing a measured volume of containment vessel atmosphere through a sampling pack that contains four membrane filters in series. The filter material is Millipore Fluoropore with a 0.5-μ

pore size. The quantity of sodium on each filter paper and associated metal parts is determined by atomic absorption spectroscopy.

The locations of the four in-vessel samplers and the three wall aerosol samplers are noted in Table 1.

Table 1. Locations of aerosol mass concentration samplers

Sampler	Radial direction	Distance from bottom	Radial distance from center line
In-vessel 151	East	4.15 m (13.6 ft)	0.58 m (1.90 ft)
In-vessel 152	East	4.15 m (13.6 ft)	1.06 m (3.48 ft)
In-vessel 153	East	2.80 m (9.2 ft)	1.09 m (3.58 ft)
In-vessel 154	East	1.34 m (4.4 ft)	1.11 m (3.64 ft)
Wall 155	South	4.15 m (13.6 ft)	0.61 m (2.0 ft)
Wall 156	Southeast	2.80 m (9.2 ft)	25 mm (1 in.) from wall
Wall 157	Southeast	2.80 m (9.2 ft)	1.06 m (3.48 ft)

Aerosol fallout rate. Aerosol fallout rate is measured with an incremental, retrievable coupon sampler. This system also penetrates the vessel wall through a ball valve and flange arrangement. The sampler is located in the southwest quadrant near the vessel wall and is approximately 0.56 m (1.83 ft) above the low point of the vessel floor.

Aerosol plateout rate. Aerosol plateout rate is measured with an incremental, retrievable coupon sampler; the coupon is in the form of a disk and fits flush with the vessel wall. This system penetrates the vessel wall through a ball valve and flange arrangement and is located in the northeast quadrant approximately 2.92 m (9.6 ft) above the low point of the vessel floor.

Aerosol particle size. Aerosol particle size is measured with a cascade impactor. Two different models have been used; both models are manufactured by Andersen 2000 Inc. One type, the Andersen Viable Sampler, is a six-stage impactor, which is operated at a gas flow of 4.72×10^{-4} m³/sec (1 cfm) and covers the particle diameter range of 0.65 to 7 μ . The other type, the Andersen Mark III Particle Sizing Stack Sampler, is

an eight-stage impactor, operating at a gas flow of $2.36 \times 10^{-4} \text{ m}^3/\text{sec}$ (0.5 cfm), and covers the particle diameter range of 0.54 to 13.6 μ . The sampling location is in the southwest quadrant approximately 2.92 m (9.6 ft) from the low point of the vessel floor.

2.1.2 Equipment for measurement of system parameters

Temperature of the vessel atmosphere. Twelve thermocouples (Chromel-Alumel) are used for the measurement of the vessel atmospheric temperatures. At each of three elevations in the vessel there are four thermocouples, one in each quadrant. The elevations are 1.22 m (4 ft), 2.74 m (9 ft), and 4.27 m (14 ft). Thermocouple responses are recorded with strip-chart recorders and with a Digitrend data logger.

Wall temperature gradients. Two thermocouple arrays, each having five thermocouples, are mounted near the wall, one at 2.7 m (9 ft) elevation on the east radius and the other at 1.2 m (4 ft) elevation on the north radius. The thermocouples in each array are located at 1.0 cm (0.39 in.), 0.5 cm (0.2 in.), 0.25 cm (0.1 in.), and 0.125 cm (0.05 in.) distance from the wall and on the wall surface; a sixth thermocouple is located on the outer surface of the vessel at approximately the same location. Thermocouple responses are recorded with strip-chart recorders and with the Digitrend data logger.

Vessel gas pressure. Vessel gas pressure is measured with a pressure cell, and the pneumatic signal is converted to an equivalent electrical signal and recorded on a strip-chart recorder and with the Digitrend data logger.

2.2 NSPP Test Procedure

Each of the sodium oxide aerosol tests has followed essentially the same procedure. The sodium inventory, contained in the sodium transfer tank, is heated to about 813 K (540°C) and then transferred to the heated sodium burn pan [0.81 m² (8.7 ft²)] or to the heated spray nozzle with argon pressure. The resulting sodium oxidation produces the oxide aerosol, and its behavior is monitored for about 24 hr. At the conclusion of this period, the vessel is purged with dry, filtered compressed air;

all gases leaving the vessel are discharged into the off-gas disposal system by way of a water scrubber. During this step a gas sample is taken through a filter pack to determine the amount of sodium oxide aerosol contained in these gases. Next, the top of the vessel is opened and the in-vessel samplers recovered. The top is replaced, and the vessel atmosphere is changed out with nitrogen to reduce the oxygen concentration to less than 4% prior to operation of the water sprays for vessel decontamination. The lowered oxygen concentration ensures against an energetic hydrogen-oxygen recombination in the event unoxidized sodium metal has remained in the sodium burn pan. The water spray decontamination proceeds sequentially from the vessel floor to the sodium burn pan, the vessel walls, and the top head of the vessel. Each batch of wash water and rinse water is weighed and sampled for analysis prior to disposal. From these data, a sodium material balance is obtained.

All of the aerosol sampling devices (filter packs, impactors, coupons, etc.) are disassembled, packaged, labeled, and submitted to the ORNL analytical laboratory. The sodium content of each sample is determined by atomic absorption spectroscopy.

3. DESCRIPTION OF SODIUM OXIDE TESTS 101-105

3.1 Sodium Oxide Test 101

The first sodium pool fire experiment was conducted by burning about 1 kg (2.2 lb) of sodium and was primarily a system shakedown run. The vessel atmosphere pressure was set at 7.7 psig prior to introduction of the sodium. Although all of the analytical samplers were not operational, many useful data were obtained. Aerosol parameters studied were aerosol mass concentration and aerosol fallout rate; no data on aerosol size were obtained due to a malfunction of the cascade impactor sampling system. System parameters measured were temperatures and pressure. The sodium burn pan was allowed to cool after the burn was terminated, and no efforts were made to induce aerosol mixing in the vessel atmosphere. Sampling and measurements continued for 21 hr after the start of sodium injection to the burn pan.

3.2 Sodium Oxide Test 102

The second sodium pool fire test differed from the first (test 101) in several ways: the air in the vessel was initially at atmospheric pressure rather than at an overpressure, a larger quantity of sodium was introduced into the burn pan, and the sodium burn pan was allowed to cool to about 423 K (150°C) after the sodium fire and then controlled near that temperature for approximately 8 hr to maintain convection currents within the vessel atmosphere. Aerosol parameters studied were aerosol mass concentration, fallout rate, and plateout rate. No data on aerosol particle size were obtained due to continued problems with the sampling system. System parameters measured were vessel pressure, temperature distribution, and thermal gradients near the vessel wall.

Posttest visual observation of the burn pan and internal surfaces of the vessel indicated that a significant amount of water vapor must have been present during the experiment even though the measured relative humidity of the vessel atmosphere was moderately low prior to the sodium burn. A later examination of vessel penetrations, attached process piping, and the water spray header system revealed several places where water may have been trapped during spray washdown following test 101. These potential areas for trapped water would have been heated by the sodium fire, driving water vapor into the vessel during the test. Steps were taken to eliminate these water traps prior to test 103.

3.3 Sodium Oxide Test 103

The intent of the third sodium pool fire test was to reproduce the second test under a drier atmosphere. This intention was partially successful. It was evident that some control of unwanted water had been accomplished, but a very dry environment still was not attained. Aerosol parameters studied were aerosol mass concentration, fallout rate, plateout rate, and aerosol particle size. System parameters measured were vessel pressure, temperature distribution, and thermal gradients near the vessel wall.

3.4 Sodium Oxide Test 104

This test differed from tests 102 and 103 in that a larger quantity of sodium was introduced and additional moisture control was accomplished. The test was conducted by introducing slightly over 10 kg (22.3 lb) of heated sodium, which is the full capacity of the existing equipment. Aerosol parameters and system parameters measured were the same as for test 103.

Posttest examinations indicated that major sources of water had been eliminated but that a small amount must still have been trapped within the system.

3.5 Sodium Oxide Test 105

The purpose of this test was to produce, via a spray fire mode, a more instantaneous aerosol at a concentration higher than could be produced by the sodium pool fires. Other than the method of aerosol production the test was conducted in the same manner as test 104. Slightly over 5 kg (11.1 lb) of heated sodium was sprayed upward through a single nozzle from near the bottom of the vessel. The average sodium droplet diameter, estimated from the manufacturer's literature on water sprays, was around 480 μ . The experiment did not produce the expected results; the aerosol concentration was not as high as anticipated, and the homogeneity was not as good as that obtained with the sodium pool fires.

4. RESULTS OF SODIUM OXIDE TESTS 101-105

The results from each test are summarized in this section in the form of tables and graphs. At the beginning of each section a table is presented listing test parameters, parameters measured, and a summary of test results. Following this are graphs and tables reporting aerosol mass concentrations, fallout and plateout rates, aerosol particle size data, vessel pressure, vessel atmosphere temperature, and temperature gradients near the vessel wall as functions of time. Time is measured from the start of sodium injection to the burn pan or spray nozzle, with

the exception of run 105, where the time ordinate begins about 6 min before sodium injection. To aid in the interpretation of these tables and graphs, the following comments are offered.

Mass concentration. Results for all seven mass concentration filter samplers are presented in one graph. Values of mass concentration are for Na_2O within the vessel atmosphere computed under vessel atmospheric conditions existing at the sample time. The legend on the graph lists the elevation and the radial distance from centerline for all the samplers. The radial direction of each sampler may be found in Table 1.

Aerosol fallout and plateout rates; cumulative values for fallout and plateout. The data reported in these graphs were obtained from the coupon samplers. An average fallout or plateout rate was computed from the mass of aerosol deposited on the coupon over the time interval of exposure. The sample time is taken as one-half of the time interval of exposure added to the time at the start of the sample.

Values for cumulative mass fallout or plateout were computed by multiplying the fallout and plateout rate by the time of exposure of the coupon and the appropriate area within the vessel.

Aerosol particle size. The data presented are derived from the two types of Andersen impactors used. The raw data were processed to the extent necessary to produce the graphs included in this report.

Vessel gas pressure rise. Vessel gas pressure rise produced by the heat liberated during the sodium burn is plotted as a function of time after start of sodium injection. With the exception of run 101, the vessel gas pressure was atmospheric prior to start of heatup of the sodium burn pan.

Vessel gas temperatures. Three graphs are presented displaying the temperatures within each of the four quadrants at three elevations. The legend on each graph gives the elevation measured from the vessel midplane and the radial distance from the centerline of the vessel. An elevation of +1.5 m from midplane is 4.27 m (14 ft) from the bottom of the vessel, the elevation at centerline (midplane) is 2.74 m (9 ft), and the elevation at -1.5 m is 1.22 m (4 ft) from the bottom of the vessel. For runs 101, 104, and 105, these graphs were produced using data compiled from the data logger tape. The graphs for runs 102 and 103 were

produced from data compiled from recorder strip charts, since the data logger was not operational during these runs.

Temperature gradient at vessel wall. Two graphs are presented that illustrate the temperature gradients near the vessel wall on the north radius (~ 1.5 m from centerline) and on the east radius at centerline. Two thermocouples measure the temperature on the outside and inside vessel wall; the other four couples measure temperatures at varying distances from the inside wall.

Three additional graphs are presented for runs 101, 104, and 105. Two of the graphs display the temperatures at various distances from the wall for selected values of time. A third graph illustrates the magnitude of the temperature gradient ($^{\circ}\text{C}/\text{cm}$) at the two thermocouple rake locations as a function of time.

4.1 Summary and Data Graphs for Test 101

Aerosol source

Type of sodium burn	Pool fire
Mass of sodium introduced	1.1 kg (2.4 lb)
Temperature of sodium	~ 813 K (540°C)
Temperature of sodium burn pan	~ 813 K (540°C)
Duration of sodium burn	~ 4 min

Containment atmosphere prior to sodium burn

Oxygen	21%
Relative humidity	Dry (actual value not measured; vessel was pressurized with dry air)
Pressure	0.154 MPa (7.7 psig)

Duration of test operations

21 hr

Aerosol parameters measured

Mass concentration of aerosol	Fig. 2
Aerosol fallout rate	Fig. 3
Aerosol plateout rate	Not measured
Cumulative fallout	Fig. 4
Aerosol particle size	Not measured

System parameters measured

Vessel atmosphere pressure	Fig. 5
Vessel atmosphere temperatures:	Figs. 6-8
Thermal gradients at vessel wall	Figs. 9-13

Posttest results

Maximum aerosol concentration achieved	6 g/m ³
Conversion of sodium to aerosol	15%
Average temperature rise in vessel atmosphere	26°C
Vessel atmosphere pressure rise	8.96 × 10 ³ Pa (1.3 psi)
Sodium distribution within vessel (as measured by spray washdown)	
Burn pan	85.0%
Floor of vessel	11.6%
Top of vessel	0.4%
Walls of vessel	2.2%
Miscellaneous	0.8%
Sodium recovery	87.0%
Distribution of sodium oxide aerosol at end of test	
Still suspended in vessel atmosphere	0.1%
Plated onto internal surfaces	17.3%
Settled onto vessel floor	82.5%

4.2 Summary and Data Graphs for Test 102Aerosol source

Type of sodium burn	Pool fire
Mass of sodium introduced	5.1 kg (11.2 lb)
Temperature of sodium	~800 K (537°C)
Temperature of sodium burn pan	~800 K (537°C)
Duration of sodium burn	12–14 min

Containment atmosphere prior to sodium burn

Oxygen	21%
Relative humidity	60%
Pressure	Ambient (0 psig)

Duration of test operations

24 hr

Aerosol parameters measured

Mass concentration of aerosol	Fig. 14
Aerosol fallout rate	Fig. 15
Aerosol plateout rate	Fig. 16
Cumulative fallout and plateout	Fig. 17
Aerosol particle size	Not measured

System parameters measured

Vessel atmosphere pressure	Fig. 18
Vessel atmosphere temperatures	Figs. 19–21
Thermal gradients at vessel wall	Figs. 22–23

Posttest results

Maximum aerosol concentration achieved	11 g/m ³
Conversion of sodium to aerosol	13.4%
Average temperature rise in vessel atmosphere	34°C
Vessel atmosphere pressure rise	8.96×10^3 Pa (1.3 psi)
Sodium distribution within vessel (as measured by spray washdown)	
Burn pan	86.6%
Floor of vessel	11.2%
Top of vessel	0.3%
Walls of vessel	1.7%
Miscellaneous	0.2%
Sodium recovery	75.0%
Distribution of sodium oxide aerosol at end of test	
Still suspended in vessel atmosphere	<0.02%
Plated onto internal surfaces	17.5%
Settled onto vessel floor	82.5%

4.3 Summary and Data Graphs for Test 103Aerosol source

Type of sodium burn	Pool fire
Mass of sodium introduced	5.0 kg (11.1 lb)
Temperature of sodium	~813 K (540°C)
Temperature of sodium burn pan	~773 K (500°C)
Duration of sodium burn	12–14 min

Containment atmosphere prior to sodium burn

Oxygen	21%
Relative humidity	6%
Pressure	Ambient (0 psig)

Duration of test operations

24 hr

Aerosol parameters measured

Mass concentration of aerosol	Fig. 24
Aerosol fallout rate	Fig. 25
Aerosol plateout rate	Fig. 26
Cumulative fallout and plateout	Fig. 27
Aerosol particle size	Fig. 28

System parameters measured

Vessel atmosphere pressure	Fig. 29
Vessel atmosphere temperatures	Figs. 30–32
Thermal gradients at vessel wall	Figs. 33–34

Posttest results

Maximum aerosol concentration achieved	10 g/m ³
Conversion of sodium to aerosol	14.8%
Average temperature rise in vessel atmosphere	35°C
Vessel atmosphere pressure rise	8.96 × 10 ³ Pa (1.3 psi)
Sodium distribution within vessel (as measured by spray washdown)	
Burn pan	85.2%
Floor of vessel	13.1%
Top of vessel	0.5%
Walls of vessel	1.1%
Miscellaneous	0.1%
Sodium recovery	96.3%
Distribution of sodium oxide aerosol at end of test	
Still suspended in vessel atmosphere	0.01%
Plated onto internal surfaces	13.99%
Settled onto vessel floor	86.0%

4.4 Summary and Data Graphs for Test 104Aerosol source

Type of sodium burn	Pool fire
Mass of sodium introduced	10.1 kg (22.3 lb)
Temperature of sodium	813 K (540°C)
Temperature of sodium burn pan	750 K (477°C)
Duration of sodium burn	20–22 min

Containment atmosphere prior to sodium burn

Oxygen	21%
Relative humidity	3%
Pressure	Ambient (0 psig)

Duration of test operations

24 hr

Aerosol parameters measured

Mass concentration of aerosol	Fig. 35
Aerosol fallout rate	Fig. 36
Aerosol plateout rate	Fig. 37
Cumulative fallout and plateout	Fig. 38
Aerosol particle size	Fig. 39

System parameters measured

Vessel atmosphere pressure	Fig. 40
Vessel atmosphere temperatures	Figs. 41–43
Thermal gradients at vessel wall	Figs. 44–48

Posttest results

Maximum aerosol concentration achieved	25 g/m ³
Conversion of sodium to aerosol	13%
Average temperature rise in vessel atmosphere	58°C
Vessel atmosphere pressure rise	1.13×10^4 Pa (1.6 psi)
Sodium distribution within vessel (as measured by spray washdown)	
Burn pan	87%
Floor of vessel	11.8%
Top of vessel	0.3%
Walls of vessel	0.8%
Miscellaneous	0.1%
Sodium recovery	86.7%
Distribution of sodium oxide aerosol at end of test	
Still suspended in vessel atmosphere	<0.001%
Plated onto internal surfaces	7.6%
Settled onto vessel floor	92.4%

4.5 Summary and Data Graphs for Test 105Aerosol source

Type of sodium burn	Spray fire
Mass of sodium introduced	5.0 kg (11.1 lb)
Temperature of sodium	773 K (500°C)
Temperature of spray nozzle	510 K (337°C)
Duration of sodium spray	~4 min

Containment atmosphere prior to sodium burn

Oxygen	21%
Relative humidity	5%
Pressure	Ambient (0 psig)

Duration of test operations

24 hr

Aerosol parameters measured

Mass concentration of aerosol	Fig. 49
Aerosol fallout rate	Fig. 50
Aerosol plateout rate	Fig. 51
Cumulative fallout and plateout	Fig. 52
Aerosol particle size	Fig. 53

System parameters measured

Vessel atmosphere pressure	Fig. 54
Vessel atmosphere temperatures	Figs. 55-57
Thermal gradients at vessel wall	Figs. 58-62

Posttest results

Maximum aerosol concentration achieved	12 g/m ³ (estimate)
Range of temperatures in vessel atmosphere	368–477 K (95–204°C)
Vessel atmosphere pressure rise	455 × 10 ⁴ Pa (6.6 psi)
Sodium distribution within vessel (as measured by spray washdown)	
Burn pan	23.4%
Floor of vessel	69.1%
Top of vessel	0.7%
Walls of vessel	6.7%
Miscellaneous	0.1%
Sodium recovery	93.4%
Distribution of sodium oxide aerosol at end of test	
Still suspended in vessel atmosphere	<0.001%
Plated onto internal surfaces	7.5%
Settled onto vessel floor	92.5%

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Fig. 1. Nuclear Safety Pilot Plant flowsheet.

Fig. 2. Experimental data from NSPP run 101: aerosol concentration samplers, concentration vs time.

Fig. 3. Experimental data from NSPP run 101: fallout rate vs time.

Fig. 4. Experimental data from NSPP run 101: cumulative fallout vs time.

Fig. 5. Experimental data from NSPP run 101.

Fig. 6. Experimental data from NSPP run 101.

Fig. 7. Experimental data from NSPP run 101.

Fig. 8. Experimental data from NSPP run 101.

Fig. 9. Experimental data from NSPP run 101.

Fig. 10. Experimental data from NSPP run 101.

Fig. 11. Experimental data from NSPP run 101: thermocouple rake at vertical centerline.

Fig. 12. Experimental data from NSPP run 101: thermocouple rake at -1.5 m elevation.

Fig. 13. Experimental data from NSPP run 101: temperature gradient at the wall.

Fig. 14. Experimental data from NSPP run 102: aerosol concentration samplers, concentration vs time.

Fig. 15. Experimental data from NSPP run 102: fallout rate vs time.

Fig. 16. Experimental data from NSPP run 102: plateout rate vs time.

Fig. 17. Experimental data from NSPP run 102: plateout and fallout vs time.

Fig. 18. Experimental data from NSPP run 102: containment vessel pressure.

Fig. 19. Experimental data from NSPP run 102: containment vessel atmosphere temperatures, thermocouples 1.5 m above centerline.

Fig. 20. Experimental data from NSPP run 102: containment vessel atmosphere temperatures, thermocouples at centerline.

Fig. 21. Experimental data from NSPP run 102: containment vessel atmosphere temperatures, thermocouples 1.5 m below centerline.

Fig. 22. Experimental data from NSPP run 102: containment vessel atmosphere temperatures, thermocouple rake at vertical centerline.

Fig. 23. Experimental data from NSPP run 102: containment vessel atmosphere temperatures, thermocouple rake 1.5 m below centerline.

Fig. 24. Experimental data from NSPP run 103: aerosol concentration samplers, concentration vs time.

Fig. 25. Experimental data from NSPP run 103: fallout rate vs time.

Fig. 26. Experimental data from NSPP run 103: plateout rate vs time.

Fig. 27. Experimental data from NSPP run 103: plateout and fallout vs time.

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Fig. 28. Andersen impactor data, NSPP run 103.

Fig. 29. Experimental data from NSPP run 103: containment vessel pressure.

Fig. 30. Experimental data from NSPP run 103: containment vessel atmosphere temperatures, thermocouples 1.5 m above centerline.

Fig. 31. Experimental data from NSPP run 103: containment vessel atmosphere temperatures, thermocouples at centerline.

Fig. 32. Experimental data from NSPP run 103: containment vessel atmosphere temperatures, thermocouples 1.5 m below centerline.

Fig. 33. Experimental data from NSPP run 103: containment vessel atmosphere temperatures, thermocouple rake at vertical centerline.

Fig. 34. Experimental data from NSPP run 103: containment vessel atmosphere temperatures, thermocouple rake 1.5 m below centerline.

Fig. 35. Experimental data from NSPP run 104: aerosol concentration samplers, concentration vs time.

Fig. 36. Experimental data from NSPP run 104: fallout rate vs time.

Fig. 37. Experimental data from NSPP run 104: plateout rate vs time.

Fig. 38. Experimental data from NSPP run 104: plateout and fallout vs time.

Fig. 39. Andersen impactor data: NSPP run 104.

Fig. 40. Experimental data from NSPP run 104.

Fig. 41. Experimental data from NSPP run 104.

Fig. 42. Experimental data from NSPP run 104.

Fig. 43. Experimental data from NSPP run 104.

Fig. 44. Experimental data from NSPP run 104.

Fig. 45. Experimental data from NSPP run 104.

Fig. 46. Experimental data from NSPP run 104: thermocouple rake at vertical centerline.

Fig. 47. Experimental data from NSPP run 104: thermocouple rake at -1.5 m elevation.

Fig. 48. Experimental data from NSPP run 104: temperature gradient at the wall.

Fig. 49. Experimental data from NSPP run 105: aerosol concentration samplers, concentration vs time.

Fig. 50. Experimental data from NSPP run 105: fallout rate vs time.

Fig. 51. Experimental data from NSPP run 105: plateout rate vs time.

Fig. 52. Experimental data from NSPP run 105: plateout and fallout vs time.

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Fig. 53. Andersen impactor data: NSPP run 105.

Fig. 54. Experimental data from NSPP run 105.

Fig. 55. Experimental data from NSPP run 105.

Fig. 56. Experimental data from NSPP run 105.

Fig. 57. Experimental data from NSPP run 105.

Fig. 58. Experimental data from NSPP run 105.

Fig. 59. Experimental data from NSPP run 105.

Fig. 60. Experimental data from NSPP run 105: thermocouple rake at vertical centerline.

Fig. 61. Experimental data from NSPP run 105: thermocouple rake at -1.5 m elevation.

Fig. 62. Experimental data from NSPP run 105: temperature gradient at the wall.

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