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Summary of Lithium-Lead Alloy Safety Compatibility Tests

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ABSTRACT

Lithium-lead alloy (17Li-83Pb) reactions with air, nitrogen, carbon dioxide, concrete, steam, and water have been characterized to identify potential safety concerns associated with the use of this alloy as a breeding material in fusion reactors. Alloy-material reaction tests were conducted at alloy temperatures up to 700 °C to characterize interactions at the highest accident temperatures postulated for most proposed fusion reactors. Test results show that alloy pool-air interactions released limited quantities of heat and aerosols. Alloy spray reactions with air were very mild. Alloy pool reactions with concrete were limited to a reaction with water driven from the concrete. Alloy-steam and water reactions were limited by the lithium present in the alloy. Alloy interactions are considerably less reactive than liquid lithium with these materials in regards to heat generation, material consumption, and aerosol mass generation. Potential radioactive species release from alloy interactions with these materials must be contained. Conventional filtration systems appear adequate to contain the limited quantities of aerosol released. Hydrogen release from alloy interactions with concrete, steam, and water must be controlled.

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SUMMARY OF LITHIUM-LEAD ALLOY SAFETY COMPATIBILITY TESTS

1.0 INTRODUCTION

Lithium-lead alloy (17Li-83Pb) is a favorable fusion reactor breeding material candidate (Smith et al. 1984). Lead in the alloy provides neutron multiplication, which enhances tritium production from lithium and results in a greatly reduced lithium inventory in a fusion blanket. Tritium breeding ratios greater than 1.1 are possible in fusion reactor blankets utilizing this alloy. This low lithium content alloy has a relatively low melting point (235 °C) and has good heat transfer properties as a liquid. However, this high-density (9.5 sp. gr. at 500 °C) alloy would require more pumping energy for a circulating loop application than would liquid lithium, thus reducing the overall reactor efficiency. When a secondary heat transfer loop is considered for use with the alloy, helium and/or steam are prime candidates for the secondary coolant.

Safety considerations play an important role in the current fusion reactor development effort to direct funds toward the development of economically feasible commercial reactors. Results of small-scale, lithium-lead alloy safety compatibility reaction tests have been reported (Kuhlborsch and Reiter 1984; Finn et al. 1980; Jeppson et al. 1983; Kottowski et al. 1988). Lithium-lead alloy safety compatibility studies are being conducted by Westinghouse Hanford Company (Westinghouse Hanford) to identify and characterize potential alloy-coolant material interactions under postulated reactor accident conditions. Test data and results of these studies are presented in this report.

The major safety concern addressed by these Westinghouse Hanford studies is the chemical reactions between the alloy and coolant or other material present in a reactor, which could cause or contribute to the release of activated species under postulated accident conditions. Accident scenarios considered include rupture of breeder material lines or modules allowing breeder material spillage to containment cells and rupture of coolant lines to allow coolant breeder material contact.

Scoping reaction tests of alloy with air, nitrogen, carbon dioxide, steam, sodium-potassium nitrate salt, organic coolants, and concrete have been completed. The alloy reaction tests covered by this report and the main parameters of the tests are summarized in Table 1. Quantities of alloy used in these tests have ranged from a few grams to 200 kg; initial test temperatures range from 400 to 700 °C. These reactions were examined to identify mechanisms which can produce heat, aerosols, corrosive reaction products, pressurization of containment atmospheres, and/or combustible gas that may pose a safety concern in an operating fusion reactor. Where possible, the magnitude of the concern is related to that associated with the use of a reference breeder material, liquid lithium.

Activation products may be produced from the alloy breeder material during reactor operation. Natural lead consists of isotopes 204, 1.5%; 206, 23.6%; 207, 22.6%; and 208, 52.3%. Activation products of lead would be expected to build up in the alloy during reactor operation. Impurities expected in the alloy that will also activate include sodium, potassium, and bismuth. Activation products from first-wall corrosion or sputtering may also be present in the alloy breeder material in a fusion reactor.

Table 1. Summary and Main Parameters of Alloy Reaction Tests. (sheet 1 of 2)

Pool-atmosphere reaction					
Test	Mass alloy (kg)	Surface area exposure (m2)	Initial alloy temperature (°C)	Atmosphere	Stirred
LPA-1	165	0.2	400	Air	No
LPA-2	200	0.2	653	Air	No
LPA-3	200	0.2	714	Air	Yes
LPN-1s[a]	0.5	0.0031	500	Nitrogen	No
LPC-1s[a]	1.55	0.0049	454	Carbon dioxide	Yes
Alloy spray in air					
Test	Mass alloy (kg)	Spray drop size (MMD) μm	Initial alloy temperature (°C)	Atmosphere	Discharge rate (g/s)
ASA-1	22.6	350	720	Air	41
Alloy-concrete reaction					
Test	Mass alloy (kg)	Surface area exposure (m2)	Alloy temperature (°C)	Atmosphere	External heat
ABC-1	200	0.089	600 (initial)	Argon	Yes
ABC-1s, 2s, and 3s	1.4	~0.0039	500 (test)	Argon	Yes
Steam injection into alloy					
Test	Mass alloy (kg)	Pool depth (m)	Initial alloy temperature (°C)	Atmosphere	Steam injection rate (g/s)
AWR-1	200	0.30	500	Argon	7
AWR-1s[a]	200	0.10	500	Argon	--

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Table 1. Summary and Main Parameters of Alloy Reaction Tests. (sheet 2 of 2)

Water injection into alloy					
Test	Mass alloy (kg)	Pool depth (m)	Initial alloy temperature (°C)	Atmosphere	Water injection (g)
WIL-1	200	0.30	520	Argon	~225
WIA-1	200	0.30	531	Argon	450
Miscellaneous alloy scoping reaction tests					
Test	Mass alloy (g)	Initial alloy tempera-ture (°C)	Mixing mode	Atmosphere	
ANS-1s[a]	0.014	450	Alloy added to excess nitrate	Argon	--
ANS-2s[a]	0.235	450	Nitrate added to excess alloy	Argon	--
AD-1s[a]	0.020	400	Alloy added to excess Dowtherm[b] A	Argon	--
AO-1s[a]	0.020	400	Alloy added to excess OS-84[c]	Argon	--
AD-2[a]	1.0	400	Dowtherm A added to excess alloy	Argon	--
AO-2[a]	1.0	403	OS-84 added to excess alloy	Argon	--

[a]Small-scale scoping reaction tests.
[b]Dowtherm A is a trademark of the Dow Chemical Co.
[c]OS-84 is a trademark of the Monsanto Industrial Chemicals Co.
MMD = Median mass diameter.

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2.0 SUMMARY AND CONCLUSIONS

Lithium-lead alloy pool reaction tests with air, nitrogen, and carbon dioxide atmospheres show that nitrogen is the least reactive of these potential cell cover gas candidates for an operating reactor using alloy as the blanket material. The alloy-nitrogen reactions produced no aerosols, very little heat, and no combustible gas. Alloy pool reactions with air at an initial pool temperature of 450 °C produced no aerosols or containment pressurization, very little heat, and no combustible gas; but at 700 °C, some lithium and lead aerosols were released. No measurable corrosion was observed for mild steel, 304 stainless steel (SS), or 316 SS specimens suspended in the reacting alloy during the alloy-air reaction tests. An alloy reaction with a limited quantity of carbon dioxide at an initial alloy temperature of 450 °C was exothermic (sufficient energy was released to heat the 1.5 kg alloy pool to 600 °C in 3 min), but no aerosol generation was visible. Alloy reactions with greater quantities of carbon dioxide or at higher initial alloy temperatures would be expected to release aerosols. Aerosol released from the alloy is of concern because of the production of activated lead or other activated isotopes from natural lead alloy and impurities in a breeder material application. Impurity removal and isotope separation of lead to minimize activation products may prove beneficial. In contrast, lithium pool reaction tests with air produced high temperatures; corrosive reaction products; considerable aerosol; and volatilized, potentially radioactive metallic species that may be present in an operating reactor (Jeppson 1982). Lithium pool reaction tests with nitrogen were very limited for initial pool temperatures up to 538 °C; but at an initial temperature of 840 °C, the reaction went to completion producing lithium nitride and releasing aerosol. Lithium contact with carbon dioxide atmospheres is to be avoided for initial pool temperatures of 540 °C or greater.

The lithium-lead alloy-steam reaction test identified areas of concern for a postulated accidental release of steam into alloy to be pressurization of containment and generation of hydrogen, aerosol, moderately high temperatures, and corrosive reaction products. Hydrogen generation quantities of 0.52 g mol per g atom of lithium reacted were produced. Maximum alloy pool temperatures produced from an alloy pool, initially at 510 °C, were 870 °C. Essentially all of the lithium in the alloy reacted with steam, but the lead did not react at the temperatures of this test. Aerosols produced from the complete steam reaction of lithium in the alloy for an initial alloy temperature of 510 °C amounted to 0.25 mg/kg alloy. At higher initial alloy temperatures, this amount would be expected to be greater, and at lower initial temperatures, it would be expected to be less. Tritium and activation product release would be expected. In contrast, a lithium-steam reaction test has indicated greater safety concerns. Higher lithium pool temperatures can be produced from the same initial pool temperature, and the hydrogen (also tritium) release occurs very abruptly as the lithium pool temperature exceeds 1,000 °C.

The lithium-lead alloy-concrete reaction was very mild. For an initial alloy temperature of 600 °C, it was limited to the reaction of lithium with water driven from the heated concrete. At or below this initial temperature, any alloy spilled to ambient temperature concrete would be expected to cool. Hydrogen release would be limited to the smallest of the following ratios: 1 mol/mol of water evaporated from the concrete or 0.45 moles per mole lithium reacted. Any tritium in the alloy at the time of an alloy-concrete reaction would be expected to be released as tritiated hydrogen gas. Release of activated species other than tritium is not enhanced by an alloy-concrete interaction, since the alloy is cooled by the concrete even though some water from the concrete reacts with the alloy. In contrast, lithium at a similar initial temperature reacts with water and other concrete constituents to produce temperatures in excess of 1,300 °C, aerosols, very corrosive reaction products, hydrogen, and containment atmosphere pressurization. Lithium reacts to completion with basalt concrete at the mass ratio of 3.9 kg concrete per kilogram lithium. Tritium release would be expected as the lithium pool is heated to above 1,000 °C by the reaction. Activated species contained in a lithium breeder spill on concrete would be expected to be partially aerosolized.

Small-scale scoping reaction tests between the lithium-lead alloy and sodium-potassium nitrate salt showed that the reactions are mild but go to completion. Lithium oxide and lead oxide are formed as reaction products. However, localized burning was observed in one test. Larger scale tests would need to be conducted to evaluate aerosol production and possible localized burning if there is additional interest in the nitrate salts as potential fusion reactor coolants to be used in conjunction with a lithium-lead breeder.

The use of liquid lithium as a breeder material in a fusion reactor is expected to require the use of engineered, lithium-air reaction suppression systems, aerosol removal systems, and cell liners to prevent lithium contact with concrete. These engineered systems may not be relied upon to function for all postulated severe accident scenarios. Additional safety questions about lithium-lead, such as activated lead and mercury vapor control, will have to be further evaluated. However, the alloy appears to have several safety advantages over liquid lithium in the area of radioactive material releases under accident conditions. The use of water or steam coolant with the alloy presents some major safety concerns. The recommended liquid breeder-coolant combination from a safe chemical reaction consideration alone is the lithium-lead alloy breeder with helium coolant. The second choice would be an alloy breeder-alloy coolant system. Table 2 summarizes the main results of the intermediate-scale alloy reaction tests.

Table 2. General Results of Intermediate-Scale Reaction Tests.

Test	Alloy temperature increase	Corrosive	Aerosol release	Hydrogen release	Release of potentially radioactive species								Other species release
					Hg	^{3}H	Na	K	Bi	Tl	Pb	Te (Po)	Li
LPA-1	No	No	No	Very minor	E	Y	--	--	--	--	ND	--	ND
LPA 2	No	No	Minor amount	Very minor	E	Y	Y	Y	--	--	Y	--	Y
LPA-3	No	No	Modest amount	Very minor	Y	Y	Y	Y	Y	ND	Y	--	Y
ABC-1	No	Yes	Modest amount	Yes	Y	Y	E	E	--	ND	Y	--	Y
ASA-1	No	No	Modest amount	Very minor	E	Y	Y	Y	--	--	Y	--	Y
AWR-1	Yes	Yes	Modest amount	Yes	E	Y	E	E	E	--	Y	--	Y
WIL-1	No	No	Modest amount	No	--	--	--	--	--	--	Y	--	--
WIA-1	Yes	Yes	Modest amount	Yes	Y	Y	Y	Y	Y	Y	Y	Y	Y

ND = Not Detectable.
-- = Not Measured.
Y = Yes.
E = Expected but Not Tested.

3.0 EXPERIMENTAL FACILITY AND EQUIPMENT

3.1 EXPERIMENTAL FACILITY AND INTERMEDIATE CONTAINMENT VESSEL

The alloy reaction tests reported in this report were performed at the Liquid Metal Fire Facility (LMFF), located in Building 105 DR and the Containment Systems Test Facility (CSTF) located in Building 221T. A plan of the LMFF facility is shown in Figure 1. The tests at the LMFF were performed in the small fires room intermediate containment vessel (ICV). A schematic drawing of the ICV is shown in Figure 2. This containment vessel was 2.13 m dia and 3.7 m high, had a volume of 14.1 m^3, and was rated for a pressure of 138 kPa at 342 °C. The containment vessel was carbon steel with a cylindrical wall thickness of 6.3 mm for the lower 2.4 m and 7.9 mm for the upper wall section. The vessel floor bottom plate thickness was 26.9 mm and the top head thickness was 9.5 mm. The outside wall of the containment vessel was exposed to the room atmosphere. An aerosol-sampling port was mounted 1.2 m above the vessel floor to allow withdrawal of thief samples through a 101-mm dia ball valve. A viewport was provided through a 202-mm dia nozzle on the vessel to allow observation of the reactions and access for photography and video recording during the tests.

An argon-flooding system was connected to the vessel to provide an argon flow rate of 2.8 m^3/min and a total argon delivery of 2,200 m^3. A ventilation system, rated at 175 m^3/min of air, was connected to the small fires room and included a scrubber, high-efficiency particulate air (HEPA) filtration, and discharge through a 61-m stack. The small fires room walls, floor, and ceiling were all concrete. All tests were performed at the LMFF facility, except for the water injection tests. The water injection tests were performed at the CSTF. The ICV was moved to the CSTF and upgraded with heaters and insulation for the tests. A similar argon-flooding system was connected to the ICV, and the ICV ventilation was directed through a submerged gravel bed scrubber and HEPA filters and then discharged to the building ventilation system.

3.2 INSTRUMENTATION AND SAMPLERS

3.2.1 Thermocouples

Temperatures of atmospheres, ICV wall, alloy, and reaction pan walls were measured with Chromel-Alumel* (Type K) thermocouples with SS-sheathed leads and ungrounded junctions. All thermocouple sheaths were 1.6 mm dia and composed of 304 SS except those immersed in alloy pools or located just above alloy pools. Those thermocouples were 316 SS sheathed and 6.4 mm dia. Thermocouple locations are listed in a table of Appendix A for each test.

3.2.2 Pressure Measurements

Gage pressure within the containment vessel was measured continuously by a diaphragm-type transducer. Atmospheric pressure was obtained from values obtained at the 200 West Area Battelle weather station, which were adjusted for the difference in elevation between the weather station and the test facility.

*Chromel-Alumel is a trademark of Richmond Machine Products Corp.

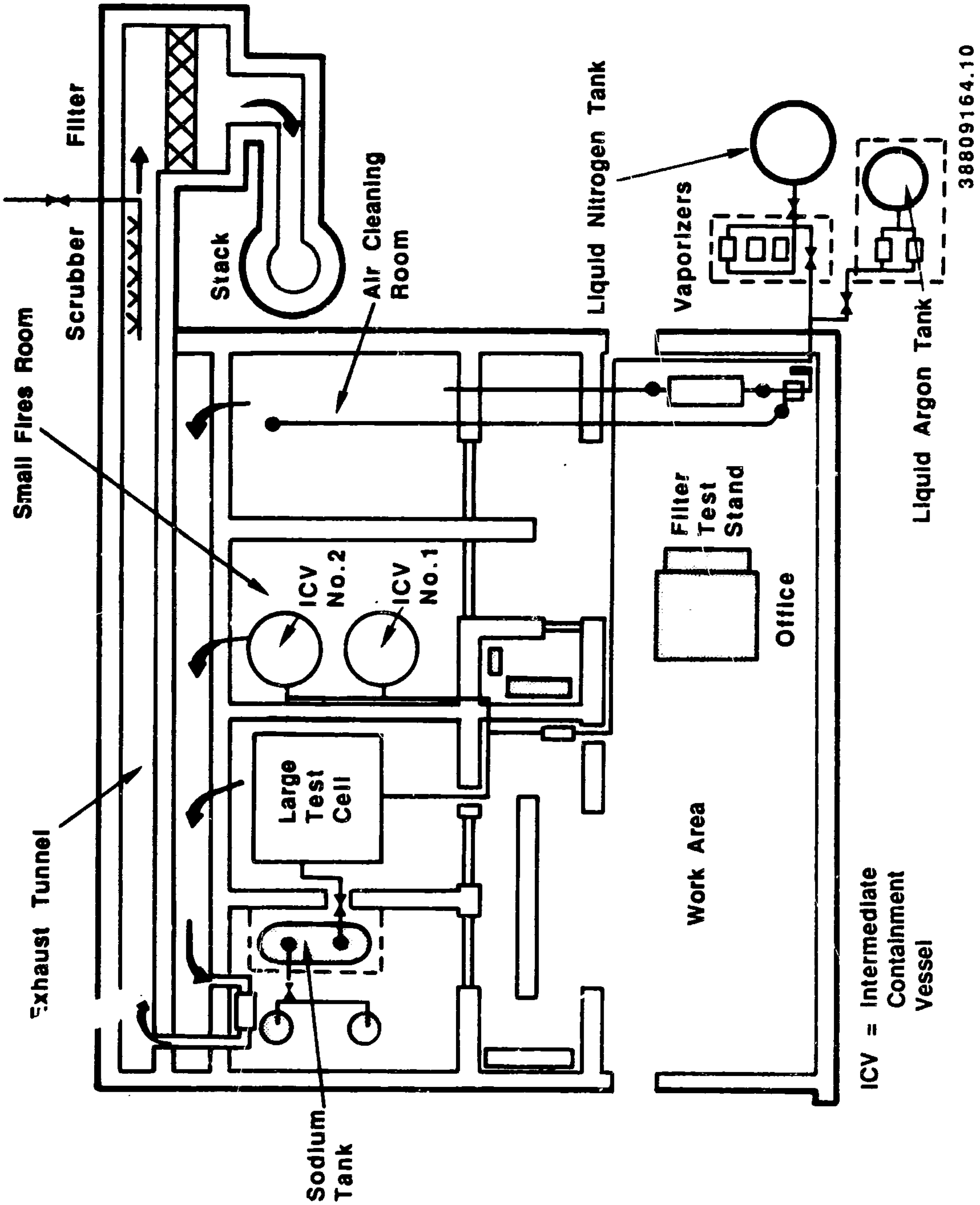

Figure 1. Plan of Liquid Metal Fire Facility, Building 105DR.

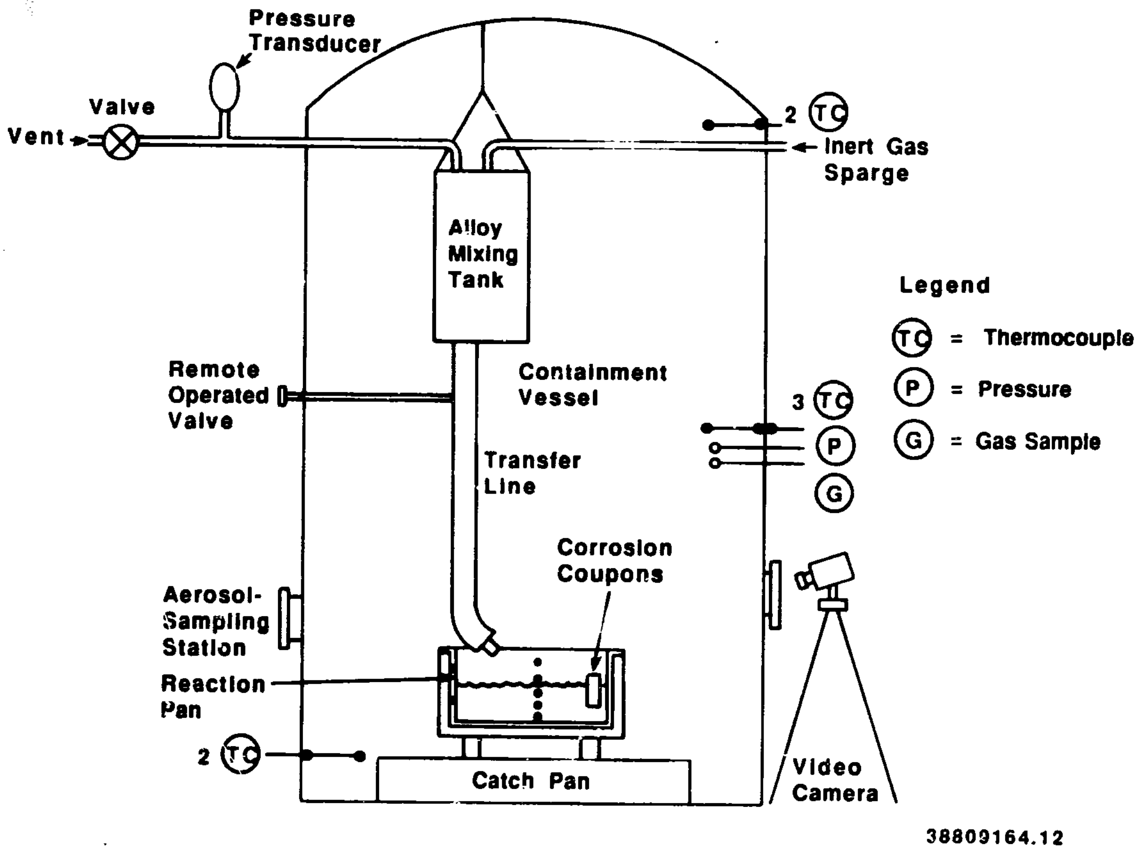

Figure 2. Schematic Drawing of Intermediate Containment Vessel with Equipment Arrangement for Alloy-Air Reaction Test.

3.2.3 Gas Sampling

The containment vessel atmospheres were continuously monitored at two positions in the containment vessel for oxygen concentration and dewpoint. The upper containment atmosphere was sampled at an elevation of 3.7 m above the vessel floor and a radius of 0.91 m, and the lower vessel atmosphere was sampled at an elevation of 1.8 m above the vessel floor and a radius of 0.91 m. For tests involving steam or water injection, hydrogen monitors were also included in the two gas-sampling systems.

The oxygen concentrations were monitored by polarographic sensors, the hydrogen concentration by thermal conductivity cells, and the dewpoint by a condensation-type optical dewpoint hygrometer. Gas was drawn from the containment vessel and discharged to the monitors by diaphragm sample pumps. The sample lines were fitted with filters upstream from the pumps and monitors to prevent aerosols from reaching the pumps and monitors during sampling operations.

Provisions were made on each of the sampling systems to obtain grab samples in special glass sampling bottles. Mass spectrometric analysis was made of these samples as a backup to the online monitors.

The ICV atmosphere dewpoint monitors were backed up by withdrawing a measured amount of gas from an airlock port through a tube of Drierite* and determining the mass increase of the Drierite tube. The airlock port was located 1.2 m above the containment vessel floor at a 90° azimuth.

3.2.4 Aerosol Sampling

Aerosol samples were obtained through the airlock port in the vessel wall. The port was used by inserting filter samplers through a 102-mm dia ball valve and airlock into the ICV atmosphere. A measured amount of gas was withdrawn through the filter paper and then the filter sampler was removed through the airlock. The airlock was located in the ICV wall, 1.2 m above the vessel floor at a 90° azimuth. Two types of filter media were used in the filter holders: (1) Gelman** Type A/E glass fiber filter and (2) a fluorocarbon fiber filter (Mitex[†]).

Aerosol particle size distributions were obtained for some high-temperature tests by inserting a cascade impactor through the airlock port and withdrawing a measured quantity of gas through the impactor. A six-stage rectangular jet impactor (Sierra[§] Model 226 stack sampler) was used for these measurements.

More detailed descriptions of the airlock port, filter holders, and cascade impactor were given in Jeppson 1986.

3.2.5 Data Acquisition System

All online instruments with electronic outputs were connected in parallel to a digital datalogger data acquisition system (DAS)# and to strip chart recorders. The online instruments included thermocouples, pressure transducers, oxygen and hydrogen monitors, and dewpoint monitors. The test data was recorded on the DAS at frequencies from ~7 s to 30 min depending on the projected need for each test and test time period. The DAS number and description for each channel of each test are listed in Appendix A. The datalogger output for each test was recorded on paper tapes and on magnetic diskettes.

3.3 ALLOY MIXING TANK

An alloy mixing tank was used to make up the lithium-lead alloy for most of the tests. The tank consisted of a 508-mm length of 305-mm dia Schedule-40 carbon steel pipe with a 12.7-mm-thick plate welded to the bottom and a flange welded to the top. A schematic of the tank is shown in Figure 3.

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*Drierite is a trademark of W.A. Hammond Drierite Co.
**Gelman Instrument Co.
†Millipore Corp.
§Sierra Instruments Co.
#John Fluke Manufacturing Co., Inc., Datalogger Model 2240.

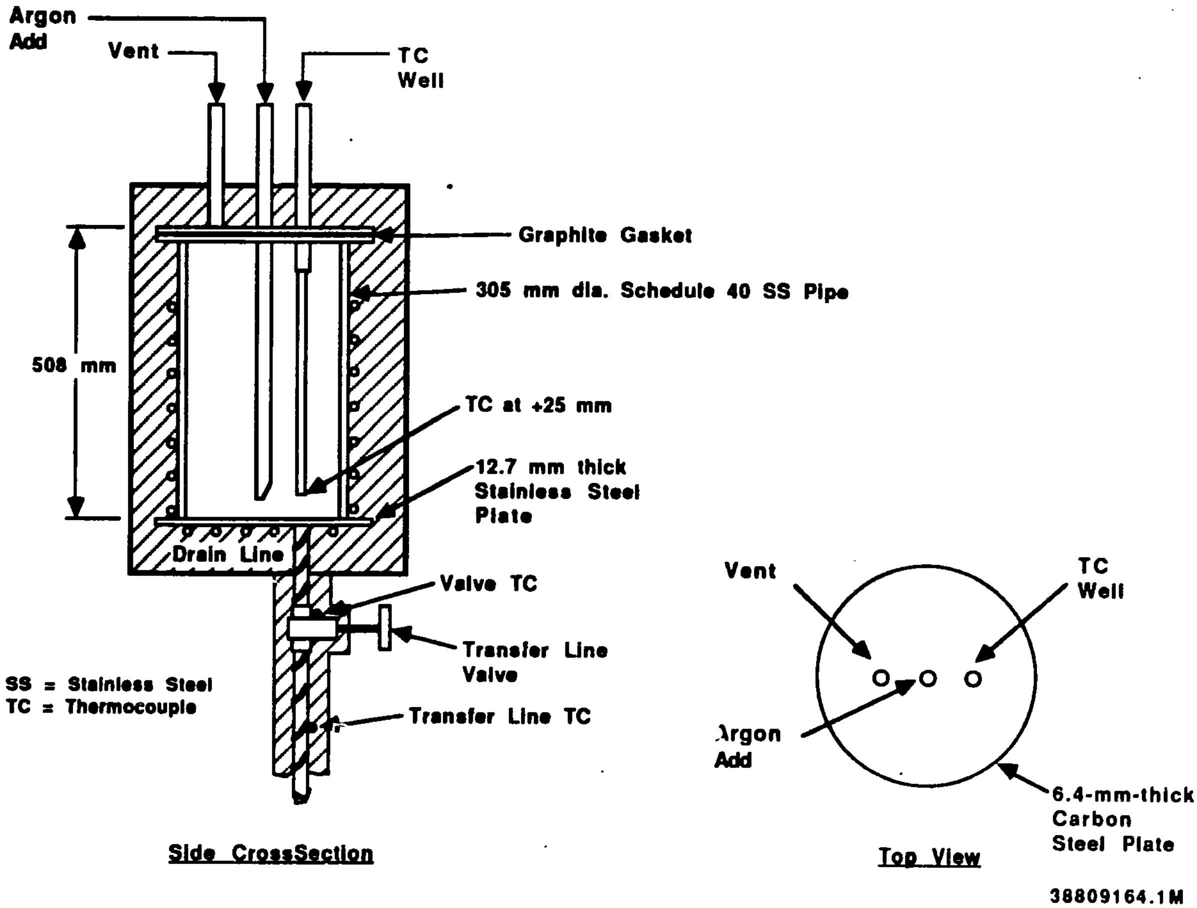

Figure 3. Schematic of Alloy Mixing Tank.

A 12.7-mm dia drain line was welded to the bottom plate of the tank to drain the alloy to the reaction pan. A 6.3-mm-thick carbon steel plate with three penetrations was bolted to the top flange of the tank. A 12.7-mm dia dip tube was inserted through the center penetration to the bottom of the mix tank. This dip tube was used to sparge the liquid metals with argon to ensure mixing of the alloy at high temperatures. A 12.7-mm dia vent line and argon supply line was also located in the top plate to allow pressure control of the mix tank atmosphere. A pressure gauge was connected to the vent line to monitor the pressure of the mixing tank atmosphere.

Heaters, thermocouples, and insulation were attached to the mix tank. A NUPRO* valve with a handle extending through the ICV wall was attached to the drain line to control the alloy discharge. Heaters and control thermocouples were attached to the valve and drain line to allow heating for the desired transfer.

*NUPRO Company, Catalog No. SS8UW-HT.

3.4 LITHIUM AND LEAD

Lithium was obtained in three forms: (1) technical grade solid, 102 mm dia cylinders approximately 454 g each; (2) technical grade solid, 12.7 mm dia rods about 203 mm long, and (3) battery grade solid, 102 mm dia cylinders approximately 454 g each. The lithium was supplied in a metal container under an argon atmosphere for all forms used. Chemical analyses of each of these materials was supplied by the supplier, Lithium Corporation of America. The lot number chemical analyses provided by the supplier are listed in Table 3 along with chemical analyses of a sample of the lithium by the Westinghouse Hanford chemistry laboratory.

Lead bricks with the dimensions 203 mm by 102 mm by 51 mm were used for these tests. The bricks were >99.9 wt% lead. Analyses of samples of these bricks indicated the following impurity content: sodium, 24 p/m; lithium, 0.5 p/m; mercury, 0.005 p/m; potassium, 2.6 p/m; bismuth, 12 p/m; thallium, 5.8 p/m; and tellurium, 5.2 p/m.

Table 3. Supplier Chemical Analyses of Lithium Metal Used in Tests (p/m by weight).

Form	Test used in	Lot No.	Sodium	Potassium	Nitrogen	Calcium	Silicon	Chlorine	Iron
Technical grade 102 mm dia	LPA-1 LPA-2 LSA-1 AWR-1 ABC-1	450-B100	110	30	220	80	30	30	10
Technical grade 12.7 mm dia rods	LPA-3	456-225 --	50 69[a]	100 90[a]	100 -	40 --	30 --	20 --	10 --
Battery grade	WIA-1	452-332A	90	90	200	60	< 20	< 10	< 10

[a]Analysis made by Westinghouse Hanford Company chemical laboratory.

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4.0 ALLOY POOL-ATMOSPHERE REACTIONS

Three intermediate-scale lithium-lead alloy pool-air reaction tests were conducted: LPA-1, LPA-2, and LPA-3. Two small-scale lithium pool-atmosphere reaction tests were conducted, one with a nitrogen atmosphere (LPN-1s) and one with a carbon dioxide atmosphere (LPC-1s). The three intermediate-scale alloy-air reaction tests were conducted in the 14.1 m^3 ICV shown in Figure 2. The two small-scale tests were conducted in the HEDL chemistry laboratory located in the 300 Area.

In the first intermediate-scale test (LPA-1), 165 kg alloy at 450 °C was exposed to ambient temperature air with low humidity. The 450 °C temperature is representative of normal alloy operating temperatures proposed for fusion reactor blankets. Alloy was discharged into an insulated, preheated reaction pan to form a pool with an exposed surface area of 0.2 m^2 and a depth of about 0.10 m.

The second intermediate-scale alloy pool-air reaction test (LPA-2) was conducted with 200 kg alloy at an initial temperature of 700 °C. The 700 °C temperature was selected as 50 °C above the maximum specified operating temperature for an alloy blanket design for a fusion reactor. This alloy-air reaction was very mild.

The third intermediate-scale, high-temperature, stirred, alloy pool-air reaction test (LPA-3) was conducted with 200 kg alloy at an initial temperature of 700 °C. The major conclusion from this test was that lithium-lead alloy under worst-case accident conditions of temperature and agitation does not react with air to increase the pool temperature. The increase in ICV atmosphere temperature and change in pressure were very minor. Corrosion of metals in contact with the alloy pool during the interaction with air or nitrogen was nil.

The behavior of potentially radioactive species associated with lithium-lead alloy blankets in deuterium/tritium (DT) fusion reactors was determined for the high-temperature, stirred, lithium-lead alloy pool-air reaction test. Chemical analyses of aerosol samples were completed to determine the extent at which potential radioactive species such as sodium, potassium, mercury, lead, thallium, and bismuth became aerosolized during the pool-air reaction test. Sodium and potassium are two impurities in lithium and lead metal; mercury, lead, thallium, and bismuth are activation products from lead in a neutron environment. Mass fractions of species released as aerosol were lithium, 0.0000036; lead, 0.00000011; sodium, 0.00034; potassium, 0.00028; mercury, <0.000005; bismuth, 0.000019; and thallium, <0.000001. These aerosols represent a potential safety concern for radiation control, but because of the low masses involved, they could be contained under limited accident conditions by conventional HEPA filtration (charcoal adsorbers may be used for mercury vapor).

4.1 RESULTS OF SMALL-SCALE ALLOY POOL-ATMOSPHERE REACTION TESTS

A small-scale alloy pool reaction test with a nitrogen atmosphere showed that essentially no reaction occurs for initial pool temperatures up to 500 °C. A nonstirred, 0.5 kg pool of alloy, with an exposed surface area of 31.2 cm^2, was heated to test temperature in an enclosed container with an argon atmosphere. The argon was evacuated and replaced with nitrogen to one atmosphere pressure at time zero. The nitrogen inventory was measured over a 30 min period while the alloy temperature was controlled near 500 °C.

Nitrogen consumption was measured to be less than that required to react with 0.05% of the lithium in the alloy. No pool temperature increase or aerosol production was observed during the test. Lithium pool reaction tests showed that lithium-nitrogen reactions were very limited for initial pool temperatures up to 538 °C, but at 840 °C, the reaction went to completion and released considerable aerosol (Jeppson 1979).

An alloy pool reaction test with carbon dioxide demonstrated that a vigorous reaction occurred when the alloy was exposed to carbon dioxide at initial pool temperatures as low as 454 °C. A stirred, 1.55 kg alloy pool, with an exposed surface area of 49 cm^2 and an initial temperature of 454 °C, was placed in contact with carbon dioxide at ambient temperature and subatmospheric pressure. An exothermic reaction occurred, heating the alloy pool to 530 °C, 570 °C, 600 °C, and 615 °C at 1, 2, 3, and 4 min, respectively, after the start of carbon dioxide introduction. Lithium in the alloy reacted with carbon dioxide to form lithium monoxide and elemental carbon. Some carbon monoxide (0.0027 g mol) and a trace quantity of lithium carbide were also detected at the end of the test. The lithium content of the alloy was depleted from 0.68 to 0.11 wt% during the test. The reaction during this test was limited by the carbon dioxide addition rate and quantity. Lithium pool-carbon dioxide reactions were extremely energetic for an initial lithium pool temperature at 540 °C (Jeppson 1982).

4.2 ALLOY-AIR INTERMEDIATE-SCALE REACTION PAN

A schematic of the alloy-air reaction pans used for the intermediate-scale tests LPA-1, LPA-2, and LPA-3 is shown in Figure 4. The reaction pans were 0.50 m long, 0.40 m wide, and 0.25 m deep. They were fabricated from 3.2-mm-thick 316 SS plate by welding at the seams. Thermocouples were attached to the outside surfaces of the reaction pans by spot welding shimstock over the thermocouples to the reaction pan surfaces. Thermocouples were attached to the bottom center; the side, up 60 mm in the center; and the side, up 150 mm in the center. The pan with thermocouples attached to its outer surfaces was placed inside a carbon steel heater pan also shown in Figure 4. This heater pan was fabricated from 6.4-mm-thick carbon steel. Heaters, control thermocouples, and insulation were attached to the outer wall of the heater pan. The insulation attached to the outer walls of the heater pan was 74-mm-thick Kaowool*. This heater pan was used to heat the reaction pan to the test temperature for the start of each test. An insulated cover was placed on the reaction pan to prevent heat loss during the initial heatup. This cover was removed remotely just before the addition of alloy to the reaction pan.

The reaction and heater pans were placed on fire brick in a backup catch pan inside the ICV as shown in Figure 2. The reaction pan was located in the center of the ICV to permit observation through a glass viewport 1.2 m above the vessel floor. Additional thermocouples were placed in the reaction pan to monitor the temperature of the alloy pool and atmosphere above the pool during the tests. Corrosion coupons were also suspended in the reaction pan such that they could be partially immersed in the alloy pool during the tests to measure corrosion of mild steel, 316 SS, HT-9 ferritic steel, and vanadium alloy. For test LPA-3, an agitator with a 60-mm dia blade and rotation rate of 1,700 r/min was positioned in the reaction pan to provide agitation of the alloy pool when desired.

*Kaowool is a trademark of the Babcock & Wilcox Co.

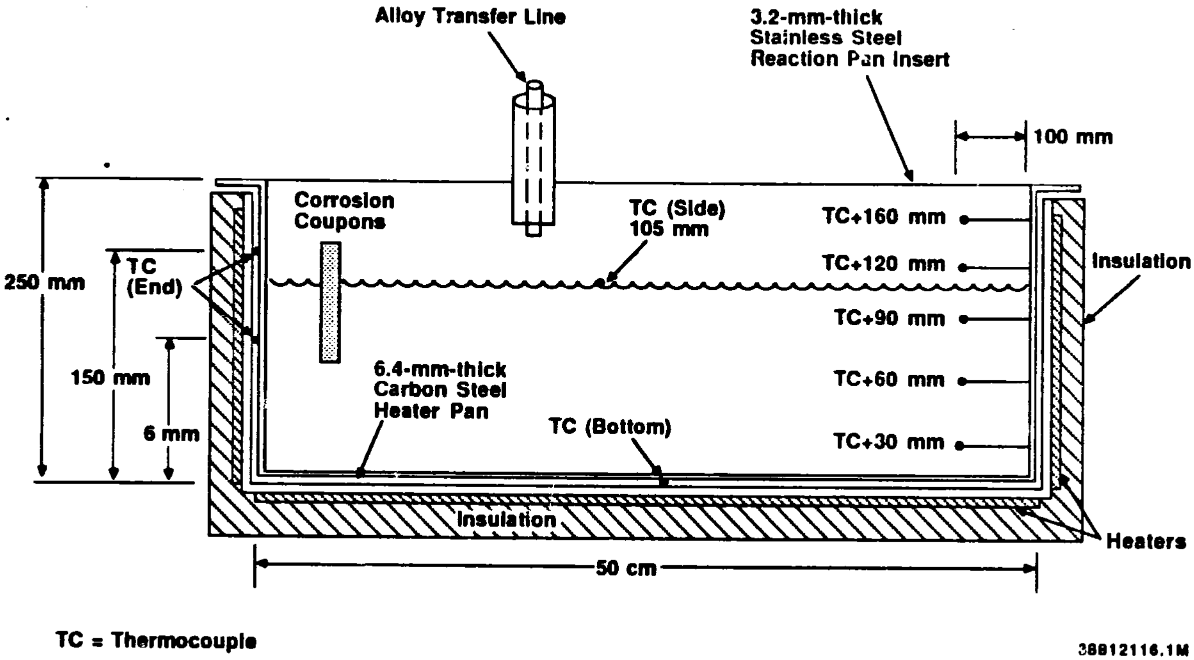

Figure 4. Schematic of Reaction and Heater Pans.

4.3 TEST PROCEDURE

Each intermediate-scale alloy pool-air reaction test was performed according to the general procedure outlined in this section. A 200 kg quantity of alloy was made up in the mix tank suspended above the reaction pan by adding 198.9 kg lead and 1.36 kg lithium. For test LPA-3, 7 g mercury, 135 g bismuth, and 160 g thallium was added. The mercury was added by drilling a small hole in a piece of lead, pouring the mercury in, and then capping the hole with a lead plug to contain the mercury until the lead reached its melting point during heat up. An argon atmosphere was established in the mix tank. The mix tank heaters were activated to heat the metals. When the lead melted, an argon purge through the mix tank dip leg was established to bubble argon through the metal pool and mix the metals. The argon gas was vented from the mix tank through a nitric acid scrubber solution to collect any mercury escaping during the mixing process. The metals were heated to 700 °C and sparged for 30 min to form the alloy. The alloy temperature was then adjusted to test temperature.

An air atmosphere was established in the ICV at a pressure of about 8 kPa above atmospheric and ambient temperature. Atmosphere background samples for aerosol, moisture, and gas composition were obtained. A small helium flow (about 1 L/min) was established through the downstream side of the transfer valve to purge air out of the transfer line before the start of alloy transfer. The transfer line was heated to test temperature. The reaction pan was heated to test temperature using the heater pan heaters. An insulated cover was positioned on the reaction pan during heat up. A few minutes before alloy transfer, the cover was removed.

Just before desired transfer time, the mix tank cover gas pressure was increased to about 40 kPa (gage). At the desired time, the remote-operated transfer line valve was opened and the alloy transferred to the reaction pan. The transfer line, mix tank, and heater pan heaters were deactivated, the helium flow to the transfer line discontinued, and the transfer valve closed at the end of alloy transfer. Temperatures of the alloy, atmosphere, and vessel walls; atmosphere oxygen concentration; and pressure were monitored to measure alloy reaction with the atmosphere. Aerosol samples were obtained from the ICV atmosphere to measure suspended aerosol mass, particle size, and composition. The remaining alloy and reaction product were allowed to cool to room temperature and then sampled to determine the chemical composition of the alloy and reaction products.

4.4 RESULTS OF TEST LPA-1

In the first intermediate-scale test (LPA-1), 165 kg alloy at 450 °C was discharged to the reaction pan and exposed to ambient temperature air with low humidity. Alloy was discharged into an insulated, preheated reaction pan to form a pool with an exposed surface area of 0.2 m^2 and a depth of ~0.085 m. The alloy was transferred to the reaction pan in a 900-s time period. The reaction was very limited; no detectable aerosol was produced, a paper-thin layer of white oxide was formed on the surface, no flame was observed, and the alloy pool began cooling immediately. A video recording of the transfer and early exposure period was obtained. With time, part of the white surface layer turned a gold color. Chemical analysis of the alloy at the end of the test indicated that essentially no lithium depletion of the alloy occurred during the test. Aerosol concentrations in the ICV atmosphere during the test were below the detection limits of 6 µg lithium per cubic meter air and 60 µg lead per cubic meter air. Corrosion coupons suspended in the alloy during the test showed no evidence of corrosion at the end of the test. Photographs of the reaction test sequence are shown in Figure 5.

4.4.1 Heat Release and Temperature Response

The alloy pool temperatures at 30 and 60 mm from the reaction pan bottom are shown in Figure 6. The reaction pan outer surface temperatures are shown in Figure 7. The bottom pan outer surface temperature agrees well with the pool temperatures at 30 and 60 mm from the bottom, indicating that there is essentially no difference in pool temperature as a function of elevation. These measurements show that there was no pool temperature increase due to reaction of the alloy with an air atmosphere. The peak pool temperature was about 400 °C. The heater pan heaters were deactivated at 120 s after the start of alloy transfer. The alloy melt point (235 °C), as indicated by the constant temperature plateau during cooldown in Figure 5 between 5,500 and 12,000 s, agrees well with the literature value reported for the melting point of 17Li-83Pb, 235 °C. This is an indication that lithium did not preferentially react with the air atmosphere to an appreciable extent during this test.

The reaction pan atmosphere temperatures 5, 40, and 80 mm above the alloy pool surface are shown in Figure 8. The ICV atmosphere and wall surface temperatures are shown in Figure 9. The peak ICV atmosphere temperature was 52 °C at about 1,800 s after start of transfer. These mild temperature increases do not pose a threat to containment vessels from atmosphere pressurizations.

4.4.2 Gas Consumption and Alloy Reaction Rate

The ICV atmosphere pressure and oxygen concentration are shown in Figure 10. The ICV atmosphere dewpoint and approximate average temperature are shown in Figure 11. The ICV

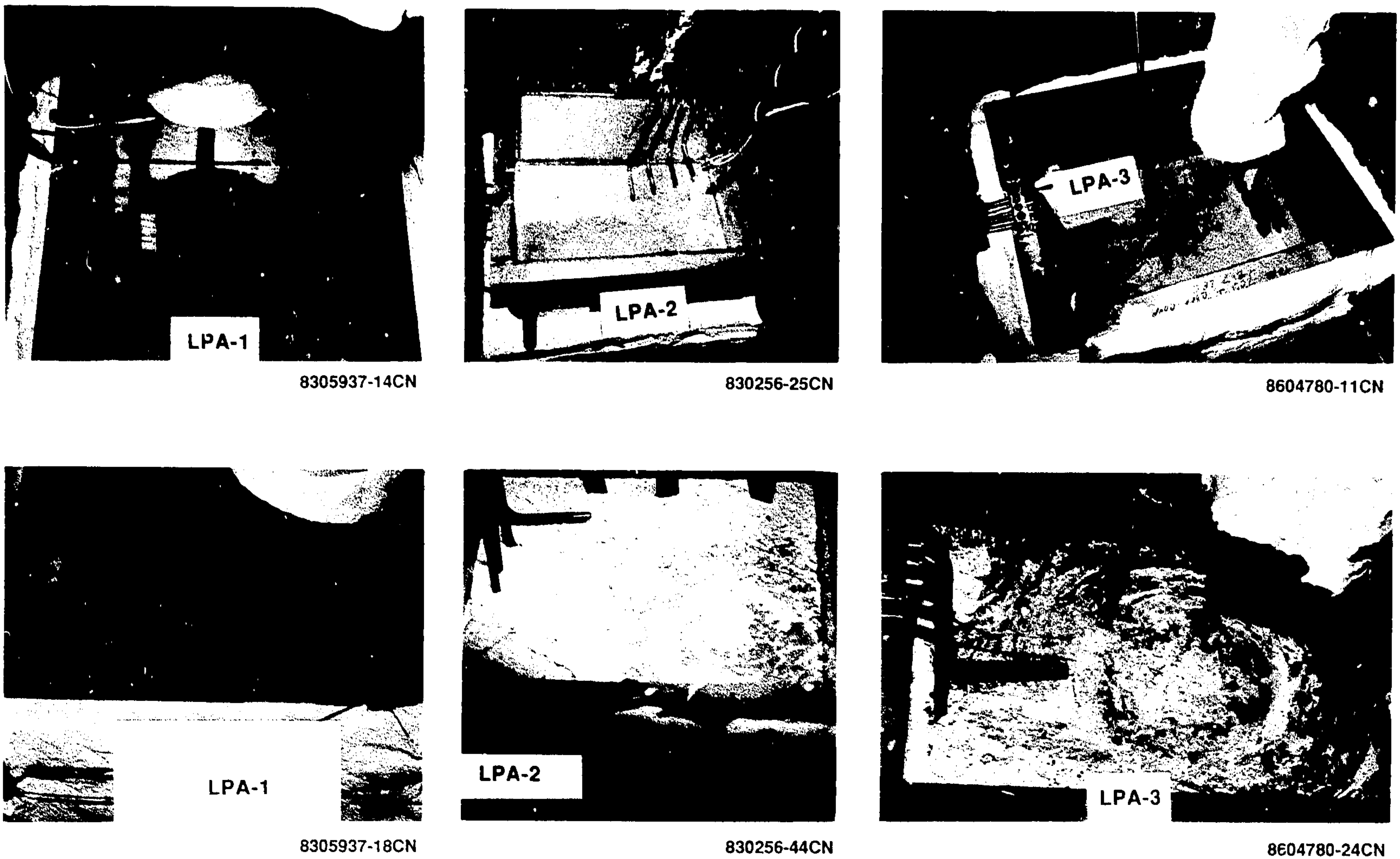

Figure 5. Sequence of Alloy-Air Reaction Tests.

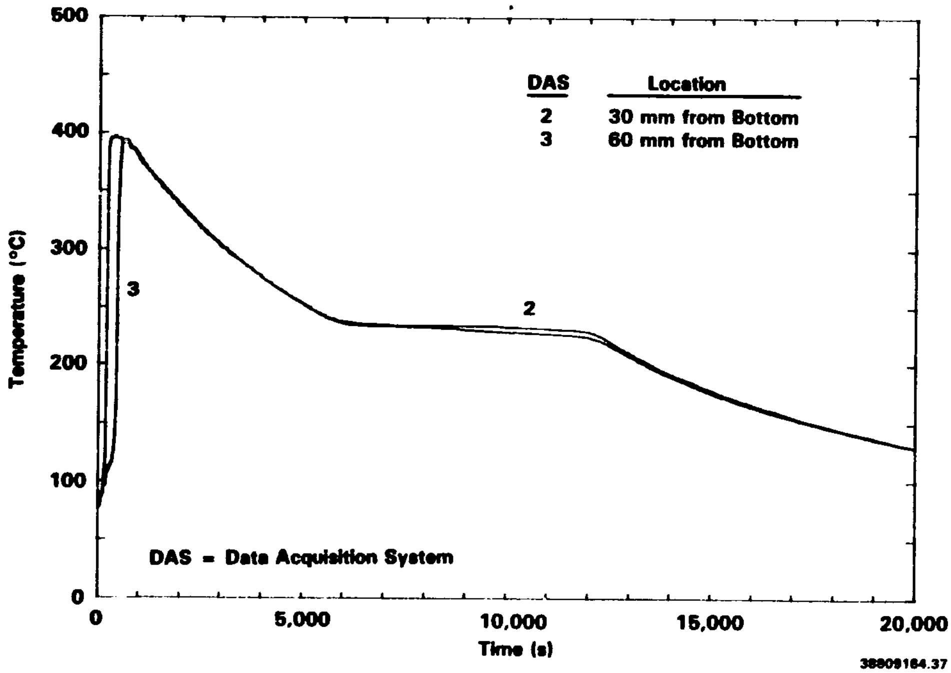

Figure 6. Alloy-Pool Temperatures at 30 and 60 mm from Bottom of Pool--Test LPA-1.

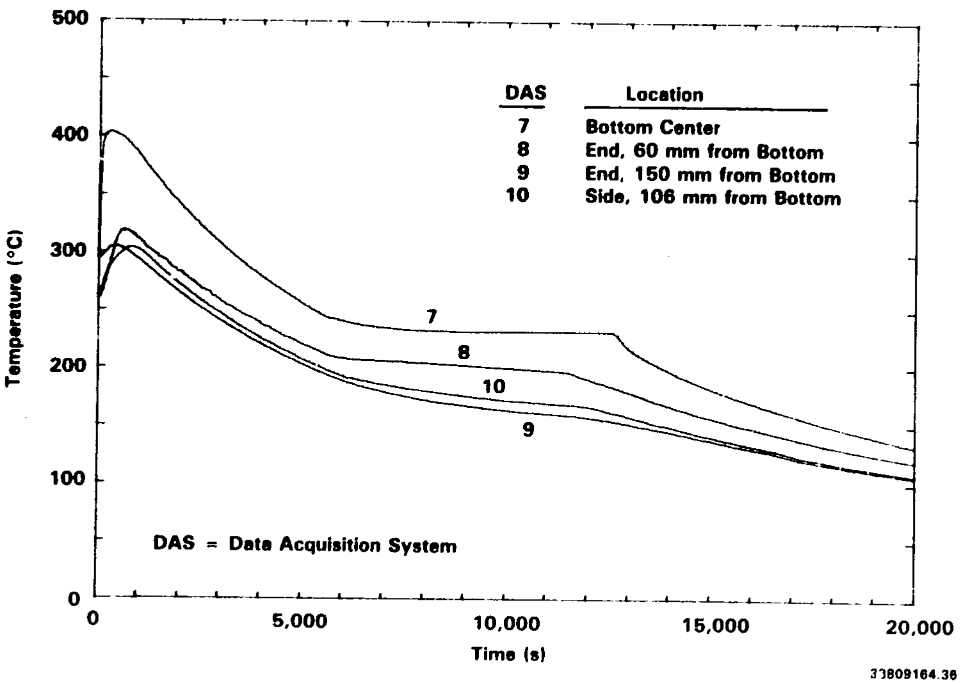

Figure 7. Reaction Pan Outer Surface Temperatures--Test LPA-1.

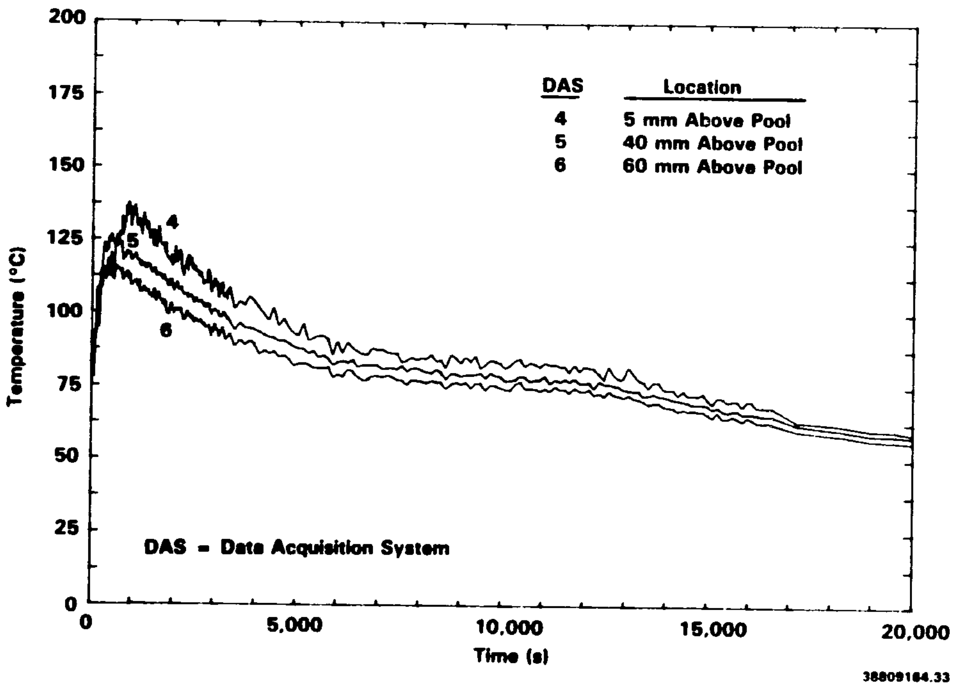

Figure 8. Reaction Pan Atmosphere Temperatures--Test LPA-1.

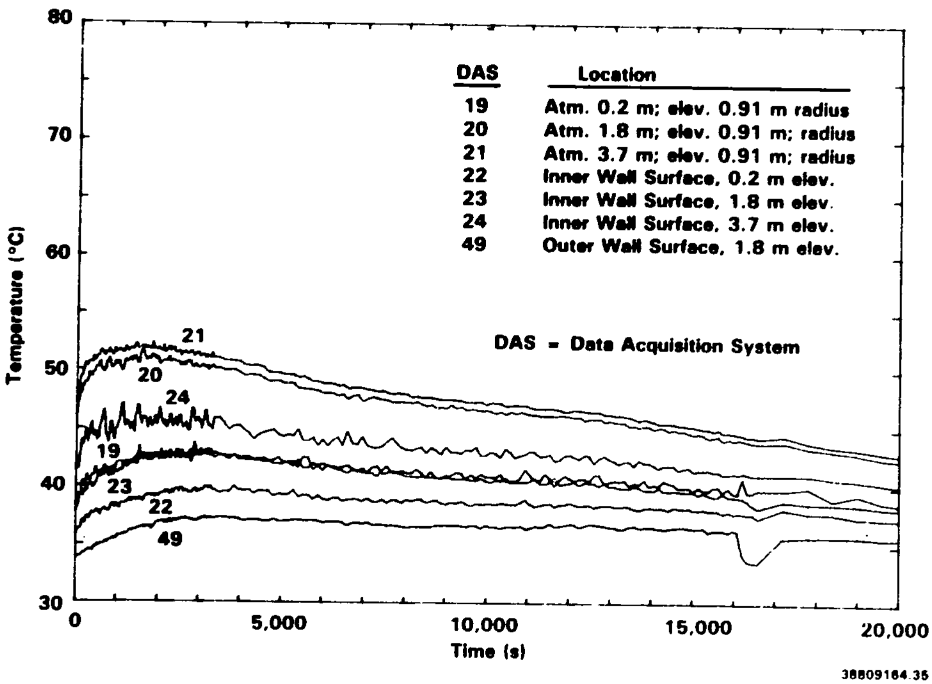

Figure 9. Intermediate Containment Vessel Atmosphere and Wall Surface Temperatures--Test LPA-1.

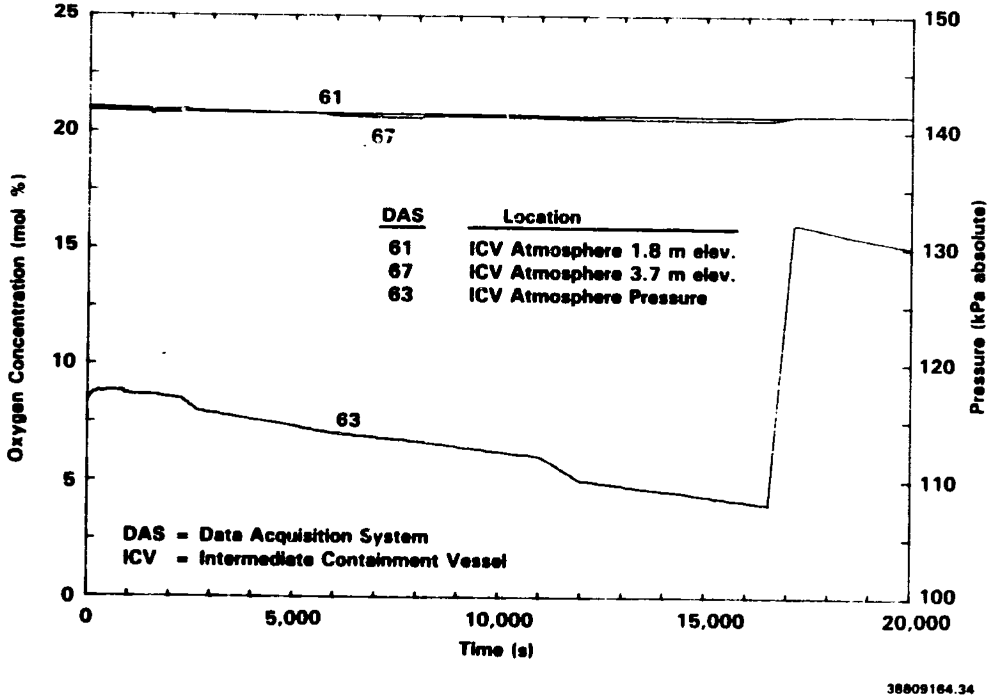

Figure 10. Intermediate Containment Vessel Atmosphere Pressure and Oxygen Concentration -Test LPA 1.

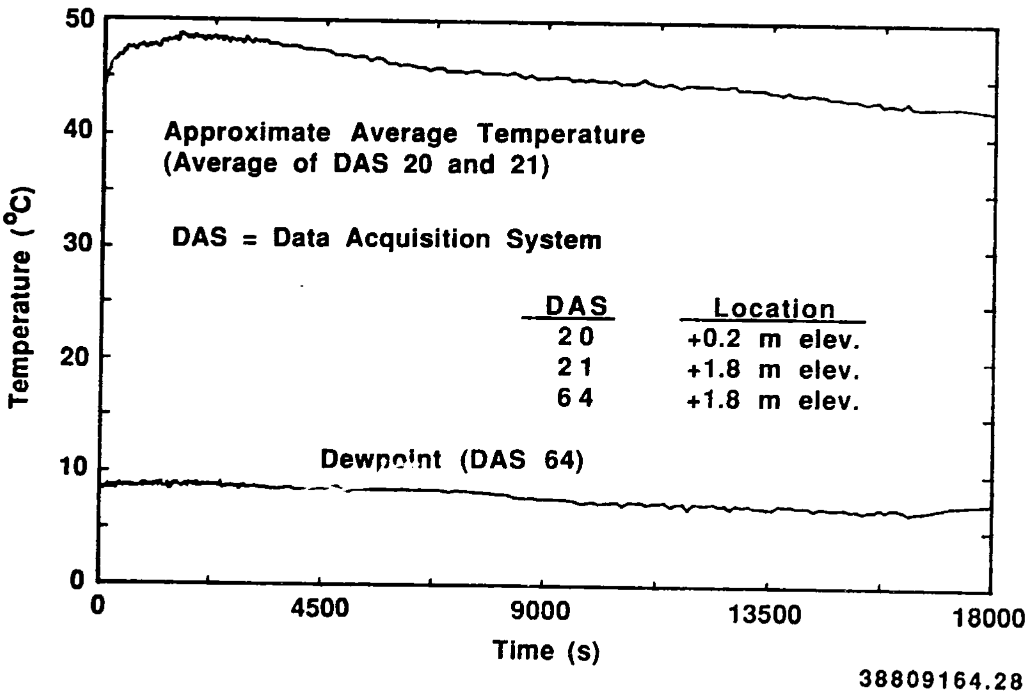

Figure 11. Intermediate Containment Vessel Atmosphere Dewpoint and Approximate Average--Test LPA-1.

atmosphere pressure increased about 2 kPa to its maximum during the first 300 s after start of alloy transfer. This was a very small pressure increase and indicates that there was very little reaction. The atmosphere oxygen concentration, as measured by the continuous monitors, remained nearly constant at 21%. The continuous monitor oxygen concentration was supported by the mass spectrometric sample analyses listed in Table 4. The mass spectrometric analyses also indicate that some water vapor reacted with the lead alloy to release a small amount of hydrogen. A total hydrogen release of 1.02 g mol was measured during the test. The ICV atmosphere dewpoint did not decrease to indicate that water vapor was being consumed; but the ICV temperature increased slowly, which is thought to vaporize water from the ICV wall and increase the ICV atmosphere water vapor content.

Table 4. Mass Spectrometric Analyses of Gas Samples--LPA-1.

Time after start (s)	Location	Concentration (mol %)					
		Oxygen	Nitrogen	Argon	Carbon dioxide	Hydrogen	Helium
600	+ 1.8 m	21.3	77.7	0.96	0.02	0.05	<0.01
5,400	+ 1.8 m	21.1	77.7	0.95	0.03	0.14	<0.01
12,000	+ 1.8 m	21.2	77.7	0.93	0.03	0.17	<0.01

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Assuming 1 mol of water reacted with 2 g atoms of lithium to form 1 mol of lithium monoxide and one 1 mol of hydrogen, then 14 g lithium reacted with water vapor during the test. The water vapor would be expected to react with the lithium rather than the lead because of the difference in Gibbs Free energy of the two oxides, -74 kcal/mol PbO_2 and -246 kcal/mol Li_2O at 400 °C.

The quantity of oxygen reacted from the ICV atmosphere was calculated from the measured ICV atmosphere oxygen concentration, pressure, volume, approximate average temperature, gas sample withdrawal, and ICV leakage. The leakage values are listed in Table 5. The ICV atmosphere oxygen inventory was determined by use of the perfect gas law. Calculations were included to correct the ICV oxygen inventory for water vapor content of the ICV atmosphere based upon the dewpoint measurements made with the dewpoint meter. The ICV atmosphere leakage rate was determined to be 10.1%/d at 37 kPa (gage) before the test. The gas sample volume was measured with a rotameter with appropriate adjustments for temperature and pressure of the sample gas. The results show total oxygen reacted during the first 4,800 s to be 1.75 g mol, or enough oxygen to react with 24 g lithium to form lithium monoxide. This was about 2% of the total lithium in the alloy.

4.4.3 Aerosol Mass Concentration and Particle Size Measurement

No aerosols were visible from the observation port throughout the test. Aerosol samples were taken during the test and analyzed for lithium and lead. All filter sample analytical results were less than detectible for lithium (<0.5 μg) and lead (<5.0 μg). Samples were taken at 330, 1,050, 2,520, and 11,550 s after the start of alloy transfer. These analytical results indicated that the suspended aerosol concentration contained <5.9 μg lithium per cubic meter and <59 μg lead per cubic meter.

Table 5. Oxygen Material Balance (g mol).

Time after start (s)	ICV inventory	ICV leakage	Gas sample volume	Oxygen reacted
0	128.46	--	--	--
600	127.79	0.062	0.31	0.30
1,200	126.95	0.062	0.24	0.54
1,800	126.59	0.062	0.18	0.12
2,400	126.02	0.062	0.18	0.33
3,000	124.94	0.062	0.76	0.26
3,600	124.67	0.062	0.18	0.03
4,200	124.22	0.062	0.18	0.21
4,800	124.02	0.062	0.18	-0.04
Total	--	--	--	1.75

ICV = Intermediate containment vessel.

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These values indicate that for a postulated fusion reactor accident where alloy breeding material at 450 °C was exposed to an air atmosphere, the radioactive lead species released would be less than Table 2 mpc limits of 10 CFR 20 (NRC 1980).

One cascade impactor sample was obtained at 1,050 s after start of alloy transfer. The aerosol collected on all stages of the sample was less than detectible so no particle size determinations were made.

4.4.4 Chemical Composition of Reaction Products

Two samples (RP-1 and RP-2) were obtained from the reaction pan residue after it had cooled to room temperature. One sample of the alloy heel remaining in the mix tank was obtained (RP-0). Sample RP-1 was obtained on the top surface near the discharge point. Sample RP-2 was obtained about 25 mm below the top surface. Chemical analyses of these samples are shown in Table 6. X-ray diffraction of sample RP-1 indicated that Li_2O, PbO, PbO_2, Pb_3O_4, and Pb_2O_3 were not detectable (<3 wt%). The slight decrease in final alloy lithium concentration from 0.68 to 0.66 wt% (sample RP-2) is consistent with the lithium reaction with oxygen and water vapor quantified in the previous section. Both methods indicate that about 3% of the lithium in the alloy reacted. This reaction product formed at the top surface of the alloy where it remained as a paper-thin layer. The nitrogen increase indicated by the difference in mix tank alloy and reaction pan residue alloy indicates that about 2.4 g mol of nitrogen was dissolved or reacted to form a dissolved compound in the alloy.

Table 6. Chemical Analyses of Residue Samples.

Sample No.	Total lithium (wt%)	Total lead (wt%)	Nitrogen (p/m)
RP-0	0.600	97.4	420
RP-1	0.620	98.0	730
RP-2	0.660	99.1	750

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4.4.5 Corrosion

Three corrosion coupons were suspended in the reaction pan as shown in Figure 4 such that they would be partially immersed in the alloy during the test. The three coupons tested were carbon steel, 304 SS, and 316 SS. The coupons which were 25 mm wide and 152 mm long. Thickness measurements were made of the coupons as follows: the carbon steel coupon was 255 mil, the 304-SS coupon was 258 mil, and the 316-SS coupon was 125 mil. After exposure to the alloy for the test period, the thickness measurements were the same, indicating no detectable corrosion (<0.5 mil) on any of the coupons.

4.5 RESULTS OF TEST LPA-2

The second intermediate-scale alloy pool-air reaction test (LPA-2) was conducted with 200 kg alloy at an initial temperature of 700 °C. This test was conducted in the same manner as described in Section 4.3. Alloy transfer was completed in 285 s. The alloy-air reaction was very mild. A thin, white oxide surface coating was formed, but there was no flame, no pool temperature increase, and very little aerosol produced. The maximum lithium aerosol concentration was 388 µg lithium per cubic meter of air at 1,380 s after start of test. This concentration is a factor of 12,000 less than that observed for a similar lithium-air reaction test as described in Section 4.5.3. The maximum lead aerosol concentration was 265 µg lead per cubic meter of air at 660 s after start of test. For radioactivity levels induced in natural lead alloy blankets, this concentration of lead could represent a hazard for reactor workers. However, in the event of an accidental release of lead aerosol from a reactor building, even minimal dilution would appear to be sufficient to prevent a public safety hazard. The oxide coating was analyzed to consist of 66 wt% lithium monoxide, 18 wt% lithium carbonate, and 16 wt% lithium hydroxide. Lithium depletion of the alloy was minor; the lithium content decreased from 0.68 to 0.63 wt% during the test. The carbon steel, HT-9 ferritic steel, 304 SS, and 316 SS corrosion coupons suspended in the alloy during the test showed no weight loss at the end of the test.

4.5.1 Heat Release and Temperature Response

The alloy pool temperatures at 30, 60, and 90 mm from the reaction pan bottom are shown in Figure 12. The reaction pan outer surface temperatures are shown in Figure 13. These temperatures are in good agreement and indicate that there was no temperature increase in the alloy pool due to the reaction of the alloy with the air atmosphere. The peak pool temperature measured was 653 °C at

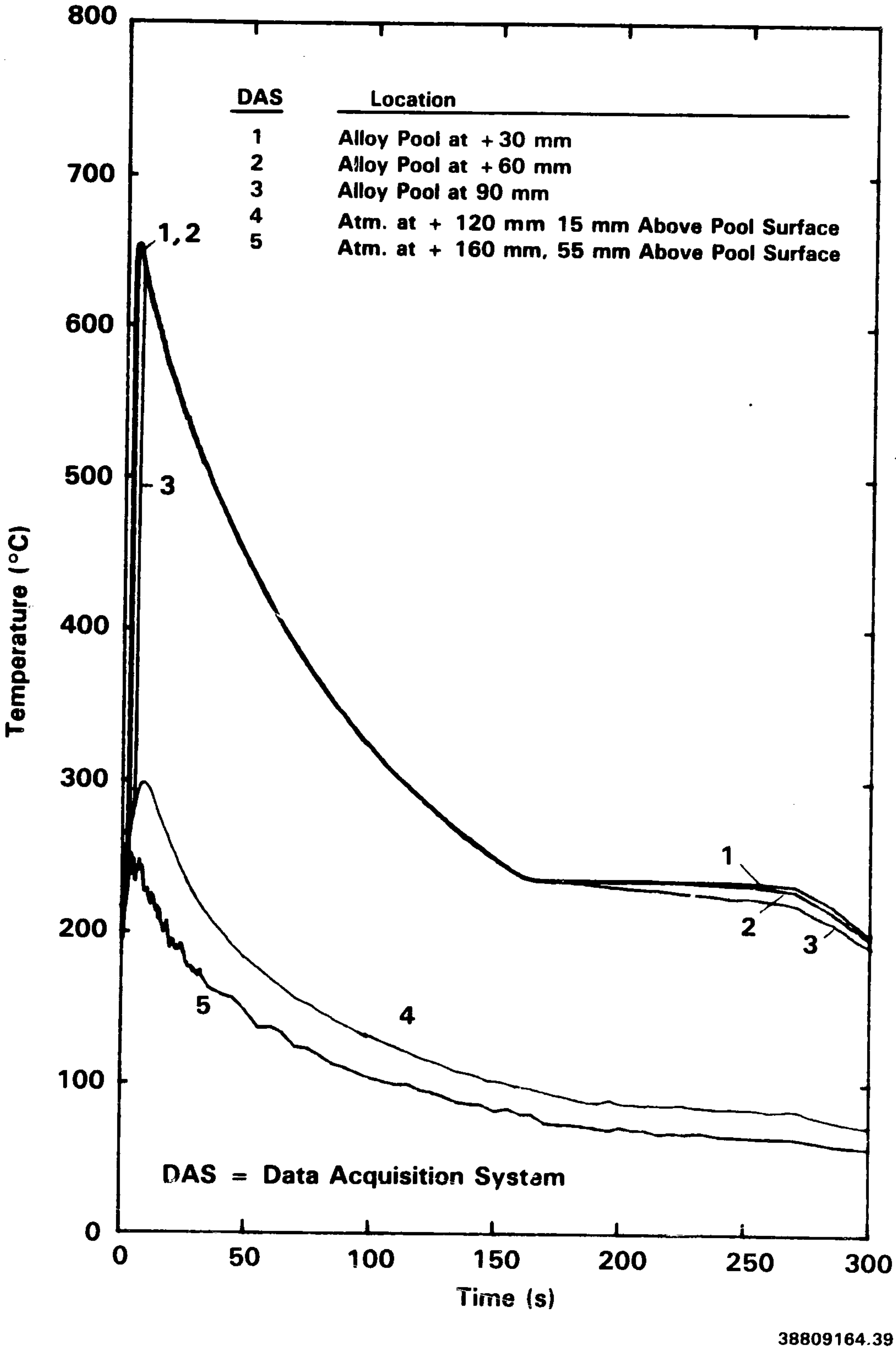

Figure 12. Alloy Pool and Reaction Pan Atmosphere Temperatures--Test LPA-2.

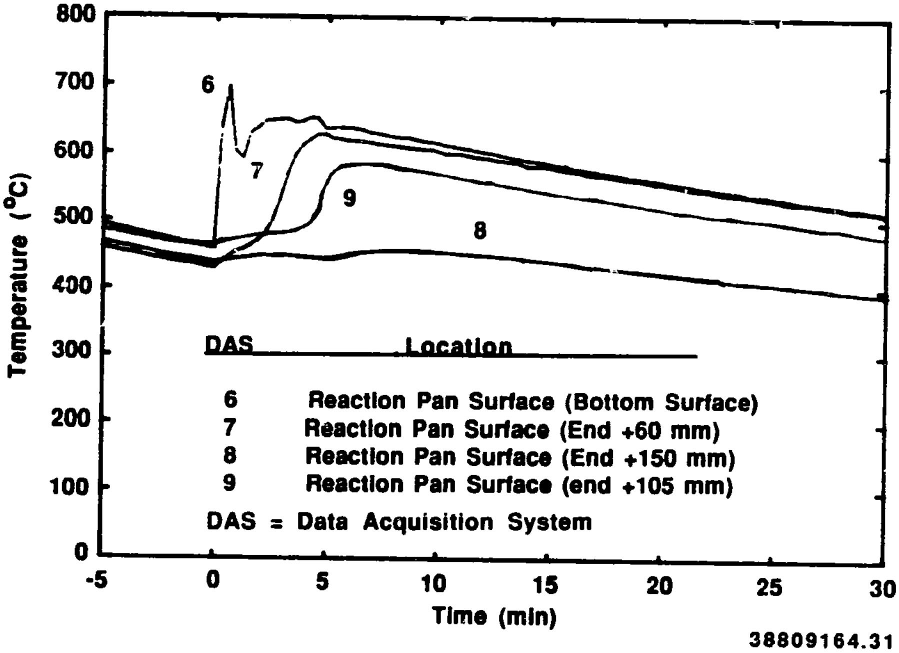

Figure 13. Reaction Pan Outer Surface Temperatures--Test LPA-2.

275 s after the start of alloy transfer. This was the last temperature scan before the completion of transfer. Power to the heater pan heater controllers was terminated at 387 s after start of alloy transfer. The controllers were set to deactivate the heater pan heaters at about 600 °C. The alloy melting point of 235 °C was indicated by the level line of the alloy cooling curve shown in Figure 12 between the time period of about 9,600 s to 16,000 s. This melting point indicated that the lithium in the alloy did not preferentially react with air to a great extent.

The reaction pan atmosphere temperatures at 15 and 55 mm above the alloy pool surface are also shown in Figure 12. The atmosphere temperature 15 mm above the pool surface reached a peak of 300 °C at 800 s after the start of transfer. The ICV atmosphere temperatures are shown in Figure 14 and wall surface temperatures are shown in Figure 15. The peak atmosphere temperature was 67 °C at the 3.7-m elevation at about 1,200 s after start of alloy transfer. These relatively mild temperatures do not pose a major threat to containment vessels from temperature increases or atmosphere pressurization.

4.5.2 Gas Consumption and Alloy Reaction Rate

The ICV atmosphere pressure, oxygen concentration, and dewpoint are shown in Figure 16. The ICV atmosphere pressure increased about 1 kPa to its maximum during the first 300 s after start of the alloy transfer. This was a very minor pressure increase and indicates that there was very little reaction. The atmosphere oxygen concentration decreased from 20.9 to 20.4 mol% during the initial 1,200 s and then slowly decreased to 20.1 mol% during the next 3,000 s. The continuous monitor oxygen concentration results were supported by the mass spectrometric sample analyses listed in Table 7. The mass spectrometric analyses indicate that water vapor reacted with the alloy to produce 1.2 g mol hydrogen. The dewpoint shown in Figure 16 increased a few degrees Celsius as the ICV

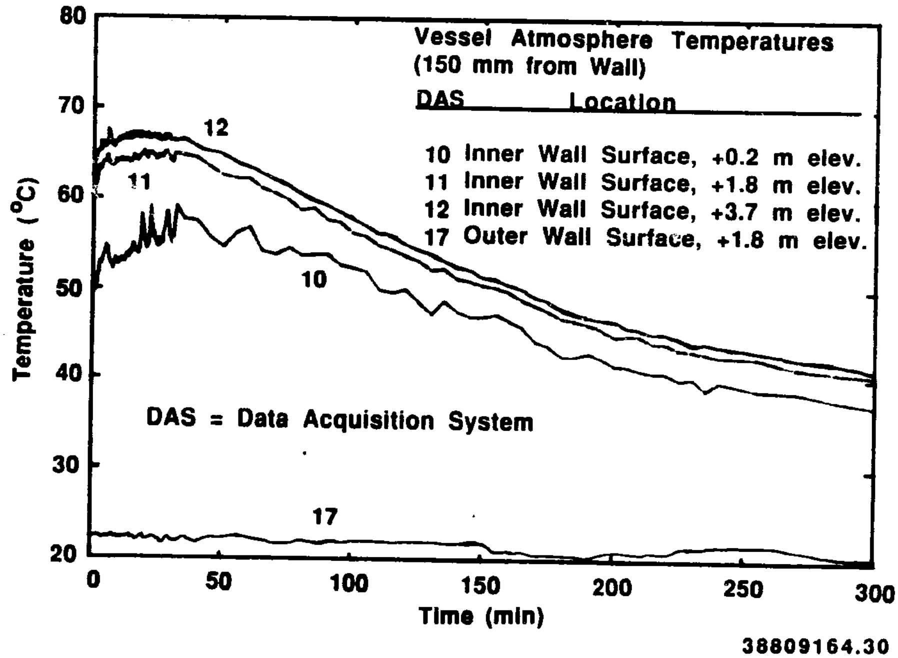

Figure 14. Intermediate Containment Vessel Atmosphere Temperatures--Test LPA-2.

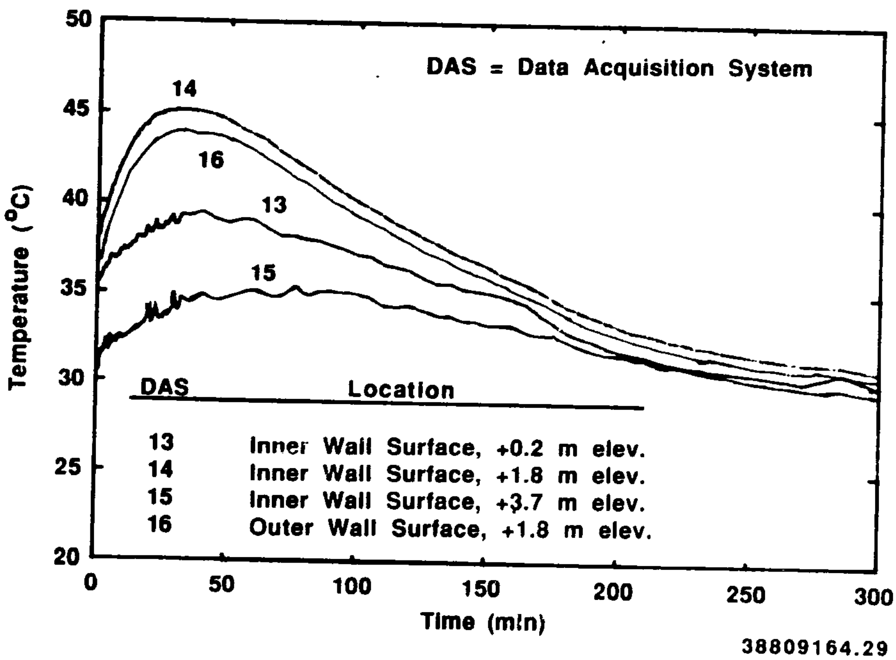

Figure 15. Intermediate Containment Vessel Surface Temperatures--Test LPA-2.

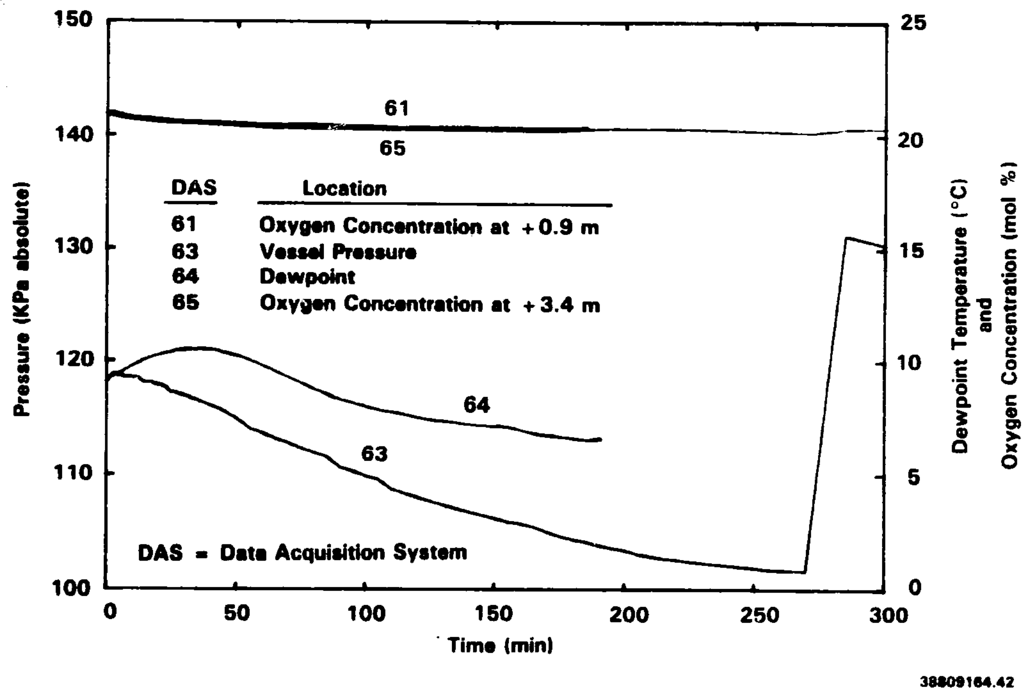

Figure 16. Intermediate Containment Vessel Atmosphere Pressure, Oxygen Concentration, and Dewpoint--Test LPA-2.

Table 7. Mass Spectrometric Analyses of Gas Samples--LPA-2.

Time after start (s)	Location	Concentration (mol %)					
		Oxygen	Nitrogen	Argon	Carbon dioxide	Hydrogen	Helium
-270	+1.8 m	20.9	78.0	0.93	0.11	<0.01	<0.01
+870	+1.8 m	20.9	77.9	0.94	0.18	0.09	0.04
+2,387	+1.8 m	20.7	77.9	0.93	0.22	0.20	0.05

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walls were heated (residual water vaporized from wall surface) and then decreased several degrees as ICV wall temperatures decreased and the water vapor continued to react with the alloy.

Oxygen consumption, water vapor consumption, and hydrogen generation from the reaction are listed in Table 8. These calculations were based upon ICV atmosphere pressure, volume, approximate average temperature, dewpoint, oxygen concentration, and hydrogen concentration measurements. Appropriate adjustments were made for ICV leakage and gas sample volume withdrawal during the test. The ICV atmosphere leakage rate was determined to be 4.9%/d at 18.2 kPa (gage) pressure just prior to the test. The gas sample volumes were measured with rotameters with appropriate adjustments for temperatures and pressures of the sample gases. The results show the total oxygen reacted during the first 5,200 s to be 5.0 g mol, or enough oxygen to react with 139 g lithium (20 g atoms or about 2.5% of the total lithium in the alloy) to form lithium monoxide. Water vapor reacting with lithium in the alloy was determined by the hydrogen gas buildup in the ICV atmosphere. It was assumed that 1 mol of hydrogen gas was released for each mole of water reacted. The results show that 1.2 g mol of water reacted with 2.4 g atoms lithium or about 1.2% of the total lithium in the alloy. Nitrogen consumption from the atmosphere amounted to about 11 g mol. This is enough nitrogen to react with 66 g mol lithium (about 34% of the total lithium in the alloy) to form lithium nitride.

Table 8. Gas Material Balance--LPA-2 (g mol).

Time after start(s)	ICV inventory		ICV leakage	Gas sample volume	Oxygen reacted	Hydrogen released	Nitrogen reacted
	Total gas	Water vapor					
0	604.0	7.1	--	--	--	--	--
400	599.8	7.5	0.135	1.16	1.9	--	--
800	595.5	7.6	0.27	2.01	2.8	0.5	2.5
1,200	594.4	7.6	0.40	4.12	2.9	--	--
1,800	588.0	7.6	0.60	4.97	3.3	--	--
2,400	583.7	7.5	0.80	6.23	3.7	1.2	--
3,000	581.0	7.4	1.00	8.76	4.0	--	--
3,600	574.2	7.2	1.20	12.6	4.3	--	--
4,200	573.4	7.2	1.40	13.8	4.6	--	--
4,800	571.1	6.5	1.60	15.1	4.8	--	--
5,200	565.9	6.3	1.80	18.2	5.0	--	11
7,600	559.0	6.0	2.60	25.8	5.0	--	11

ICV = Intermediate containment vessel.

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4.5.3 Aerosol Mass Concentration and Particle Size Measurement

No aerosols were visible through the viewport during the test. Aerosol samples were obtained during the test and analyzed for lithium and lead. The sample analytical results and calculated suspended aerosol concentration are shown in Table 9. The data is plotted in Figure 17 along with other tests for comparison. The results show a maximum suspended lithium concentration of 388 µg/m³ at 1,380 s after the start of alloy transfer and a maximum suspended lead concentration of 310 µg/m³ at 2,760 s after start of alloy transfer. Assuming settling and plating of aerosols at these low concentrations and small particle size are very slow, the total estimated lithium and lead releases as aerosol were 5.4 mg and 4.34 mg, respectively. The aerosol particle size, as measured with a cascade impactor at 2,760 s after the start of alloy transfer, was 0.37 µm aerodynamic mass median diameter (AMMD) with a geometric standard deviation (σ) of 1.40 based upon lithium analyses and 1.71 µm AMMD with a geometric standard deviation of 1.70 based upon lead analyses. The aerosol impactor data are shown in Tables B-1 and B-2 and plotted in Figure B-1 of Appendix B.

4.5.4 Chemical Composition of Reaction Products

Three samples (RP-1, RP-2, and RP-3) were obtained from the reaction pan residue after it had cooled to room temperature. One sample (MT-1) of the mix tank alloy was obtained. Sample RP-1 was carefully removed from the white surface layer of the alloy. This surface layer was about 1 mm thick and consisted of about 150 g of reaction products. Sample RP-2 was obtained from the solidified froth formation on the pool surface where the alloy was added. Sample RP-3 was obtained at a depth of about 40 mm below the pool top surface. This sample represented the bulk of the remaining alloy. These samples were analyzed by wet chemical methods for lithium, lead, and nitrogen and by X-ray diffraction for lithium monoxide, lithium carbonate, and lithium hydroxide. The analyses are listed in Table 10.

These analyses indicate that lithium from the alloy reacted with oxygen, water vapor, and carbon dioxide to form a thin, white surface layer on the alloy. Sample RP-3 indicates that the lithium content of the alloy was depleted to 0.63 wt%. Assuming an initial lithium content of 0.68 wt% based upon the components added to make up the alloy, about 14.4 g atoms of lithium (about 7% of total lithium) reacted with oxygen, water vapor, or carbon dioxide. Nitrogen content of the alloy increased from 130 to 800 p/m which was enough nitrogen to react with 29 g atoms lithium (about 14% of total

Table 9. Aerosol Sample Analyses and Suspended Concentration.

Time after start (s)	Mass lithium (µg)	Mass lead (µg)	Suspended lithium concentration (µg/m³ STP)	Suspended lead concentration (µg/m³ STP)
-840	0.05	0.8	1.8	28.2
+210	0.60	1.7	85	240
+660	9.3	7.5	328	265
+1,380	11.0	7.1	388	250

STP = Standard temperature and pressure.

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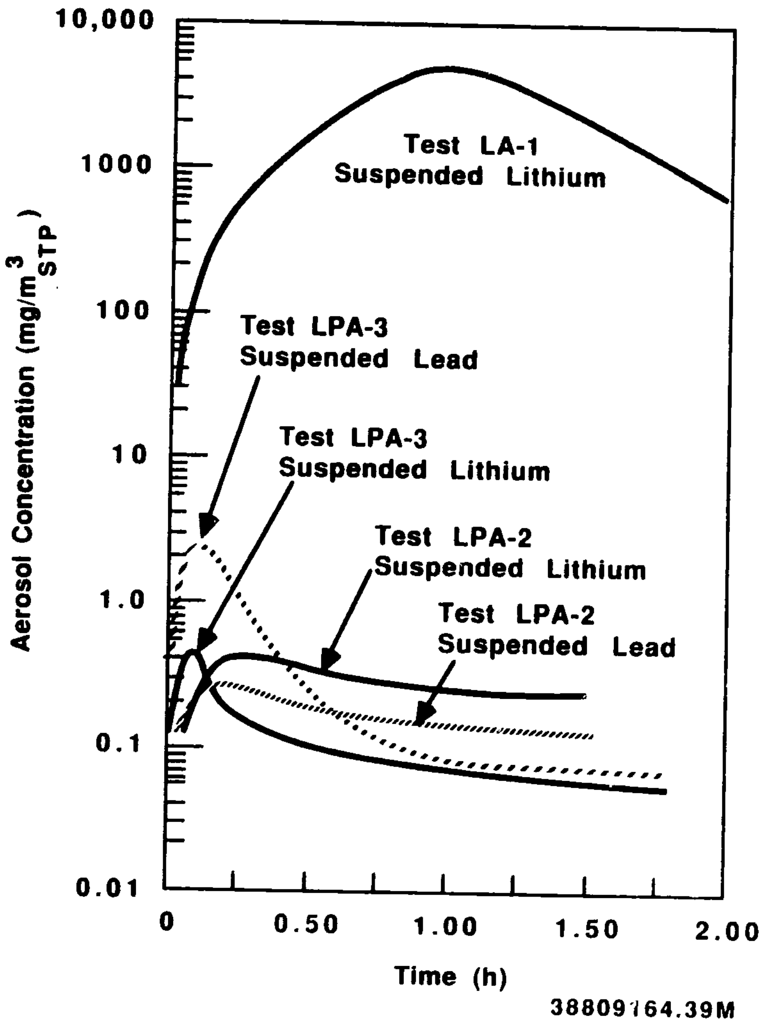

Figure 17. Comparison of Suspended Aerosol Mass Concentration for Alloy and Lithium Pool-Air Reaction Tests.

Table 10. Chemical Analyses of Residue and Mix Tank Samples--LPA-2 (wt%).

Sample	Total Lithium	Lead	Nitrogen	Lithium oxide	Lithium carbonate	Lithium hydride	Lead oxide
RP-1	24.5	10.2	0.021	60-70	15-25	15-25	ND
RP-2	1.40	96.3	0.19	ND	ND	ND	ND
RP-3	0.63	98.7	0.080	--	--	--	--
MT-1	0.64	96.7	0.013	--	--	--	--

ND = Not detectable.

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lithium) to form a lithium-nitrogen compound. This quantity of nitrogen reacted was less than that determined in Section 4.5.2. This method of determining the quantity of nitrogen reacted was considered more accurate.

4.6 RESULTS OF TEST LPA-3

The third intermediate-scale, high-temperature, stirred, lithium-lead alloy pool-air reaction test (LPA-3) was conducted with 200 kg alloy at an initial temperature of 714 °C. The major conclusion from this test was that lithium-lead alloy under worst-case accident conditions of temperature and agitation does not react with air to increase the pool temperature. The increase in ICV atmosphere temperature and change in pressure were very minor. Corrosion of metals in contact with the alloy pool during the interaction with the nitrogen was nil.

4.6.1 Test Description and Procedure

The alloy was made up in a mix tank suspended above the reaction pan in the ICV. The masses of metals added to the mix tank were 199.8 kg lead, 1,372 g lithium, 7 g mercury, 135 g bismuth, and 160 g thallium. A flange was placed on the mix tank with a graphite gasket and an inert atmosphere was established in the mix tank by purging with argon. The metals were then heated to 700 °C and sparged for 30 min to ensure good mixing. An argon sparge rate of 3 L/min was used to sparge the mixture. The offgas from this operation was routed through a nitric acid scrubber solution and then a backup filter to collect any metals from the gas. Results of the scrubber solution and filter analyses are listed in Table 11.

The results indicate that no detectable bismuth or thallium was released to the offgas collection system during argon sparging of the alloy at 700 °C. Mercury collection amounted to 36.5 mg or about 0.5 wt% of the added mercury. The collection fraction of lead was extremely low and that for lithium was very low (0.0004 wt%). The collection fraction of sodium and potassium was very low based on acid solution results.

Table 11. Species Collected from Mix Tank Offgas--LPA-3.

Sample	Time and condition	Results (mg)						
		Lithium	Lead	Sodium	Potassium	Mercury	Bismuth	Thallium
Acid scrubber solution								
SE-1	1.0 L fresh acid solution	0.042	1.0	2.6	0.62	0.030	0.60	<0.10
SS-1	1.0 L acid solution (alloy at 621 °C prior to mixing)	0.52	1.96	12.0	0.62	<0.002	0.56	<0.10
SS-2	0.95 L acid solution (alloy at 700 °C after mixing)	4.9	4.75	1.9	0.57	30.4	0.51	<0.10
Backup filter								
M-1 filter	End of alloy transfer	1.11	0.84	30*	8.1*	6.1	0.023	<0.025
M-1 holder wash	End of alloy transfer	0.0365	0.17	0.16	0.049	0.080	0.048	<0.025
Total collected								
(SS-2) - (SE-1) + (M1 filter and holder wash)		6.0	4.76	29.5*	8.1*	36.5	<0.1	<0.1

*The total sodium and potassium collected may be due to the M-1 filter media background content. Sodium and potassium would be expected to be retained in the 20 wt% nitric acid scrubber solution.

A 200-kg alloy pool, at an initial temperature of 714 °C and with a surface area exposure of 0.20 m^2, was exposed to a normal humidity air atmosphere at ambient temperature and an initial pressure of 115 kPa (absolute). The test equipment arrangement, excluding the agitator, is shown in Figure 4. The bottom of the reaction pan was preheated to 360 °C. Alloy was transferred to the reaction pan during the first 240 s of the test. Five corrosion coupons (carbon steel, 304 SS, 316 SS, vanadium alloy, and HT-9 ferretic steel) were suspended in the pool to measure the corrosion of these metals during the test. A pool agitator was turned on at 600 s after the start of the test to determine the effects of agitation on the reaction rate.

Mercury, thallium, and bismuth were added to 200 kg alloy in a mixing tank before heating to test temperature and discharging to the reaction pan. Species quantities were added to establish initial concentrations of 34 p/m mercury, 799 p/m thallium, and 831 p/m bismuth in the alloy. Sodium and potassium were present as impurities in the lithium metal used to make up the alloy, which resulted in initial alloy concentrations of 15 p/m sodium and 2.4 p/m potassium. The alloy was sparged with argon in the mixing tank while heating to test temperature (714 °C). Mixing tank offgases were scrubbed and the scrubber solutions sampled to determine species released during mixing. Samples of a vent line deposit were obtained. This deposit consisted of carbon from the outer surface of the lithium rods used in this test. This is the only test in which the lithium rods were used. About 6% of the mercury was determined to be in the mix tank offgas scrubber solution and vent line deposit at the end of the test. No other species were present in any significant quantity in the mix tank offgas system.

A sample of the mixed alloy was obtained during discharge to the reaction pan. Samples of the reaction pan alloy were obtained at the end of the test to determine final compositions. Analyses of these samples confirmed that >99% of each species other than mercury was transferred from the mix tank to the reaction pan.

The alloy reacted with the air atmosphere to form a surface crust. The crust formed within several seconds of the start of alloy transfer. Near the start of alloy transfer, fresh alloy surface was exposed to the air at a radius of about 100 mm from the point of alloy entrance to the pool, but the fresh surface exposure decreased to about 20 mm near the end of the transfer. The alloy pool temperature began decreasing. After 600 s, an agitator was turned on, but no temperature increase occurred. The crust formation prevented the exposure of fresh alloy at a radius of >~0.1 m from the agitator shaft, even though the alloy was stirred under the crust.

4.6.2 Heat Release and Temperature Response

The alloy pool temperatures at 30, 60, and 90 mm from the reaction pan bottom are shown in Figure 18. The reaction pan outer surface temperatures are shown in Figure 19. These temperatures are in good agreement and indicate that there was no temperature increase in the alloy pool due to the reaction of the alloy with the air atmosphere. The heat loss from the pool surface was greater than the heat generation due to the reaction. The peak pool temperature measured was 628 °C at 240 s after the start of alloy transfer. This occurred at the completion of the alloy transfer. Power to the heater pan heater controllers was terminated at 300 s after start of lithium transfer.

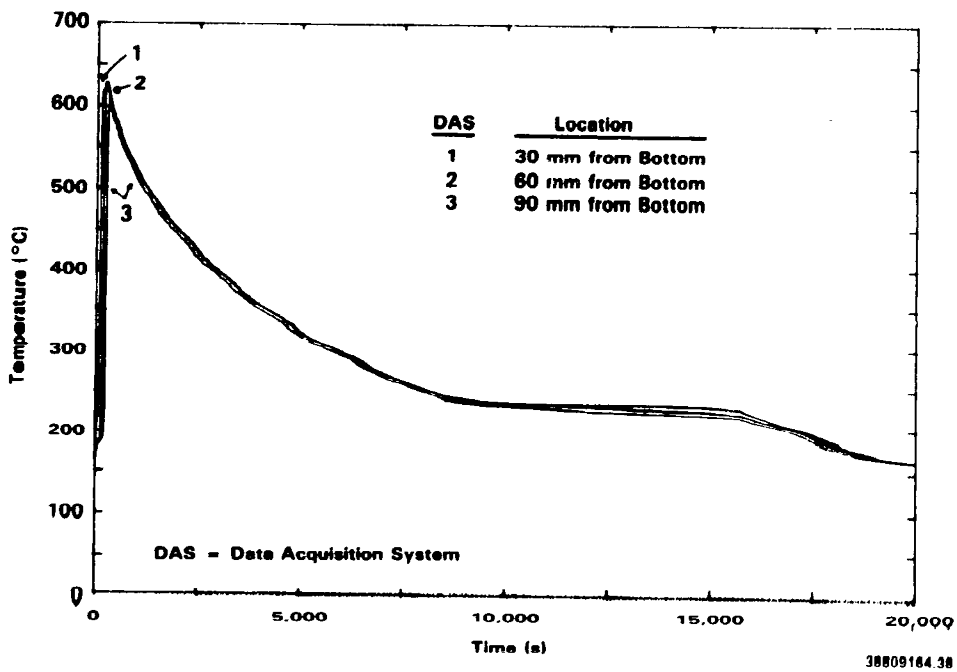

Figure 18. Alloy Pool Temperatures at 30, 60, and 90 mm from Bottom of Intermediate Containment Vessel--Test LPA-3

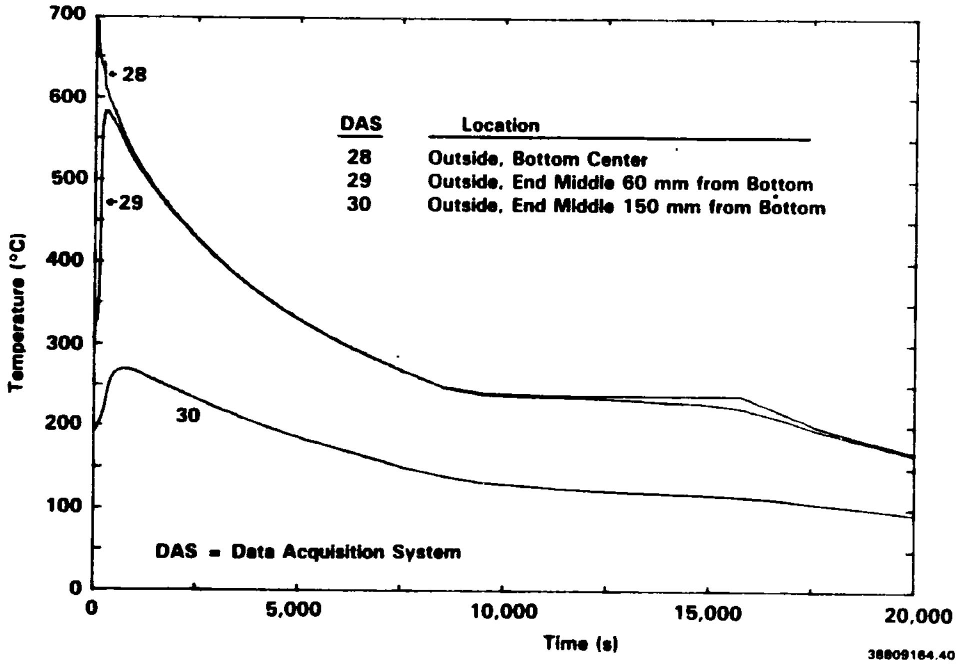

Figure 19. Reaction Pan Outer Surface Temperatures--Test LPA-3.

The reaction pan atmosphere temperatures at 20 and 60 mm above the alloy pool surface are shown in Figure 20. The atmosphere temperature 20 mm above the pool surface reached a peak of 208 °C at 925 s after the start of alloy transfer. The ICV atmosphere temperatures are shown in Figure 21, and wall surface temperatures are shown in Figure 22. The peak atmosphere temperature was 76 °C at the 3.7-m elevation at about 2,100 s after the start of alloy transfer. These relatively mild temperatures do not pose a major threat to containment vessels from temperature increases or atmosphere pressurization.

4.6.3 Gas Consumption and Alloy Reaction Rate

The ICV atmosphere pressure and oxygen concentration are shown in Figure 23. The atmosphere pressure increased about 1.5 kPa to its maximum during the first 400 s after start of alloy transfer. This was a very minor increase and indicates that there was very little reaction. The atmosphere oxygen concentration decreased from 20.9 to 19.6 mol% during the initial 7,000 s. The continuous monitor oxygen concentration results were supported by the mass spectrometric sample analyses listed in Table 12. The mass spectrometric analyses indicate that water vapor reacted with the alloy to produce 1.2 g moles hydrogen. The dewpoint increased a few degrees Celsius as the ICV was heated (residual water vaporized from the wall surface) and then decreased several degrees as ICV wall temperatures decreased and as the water vapor continued to react with the alloy and reaction products.

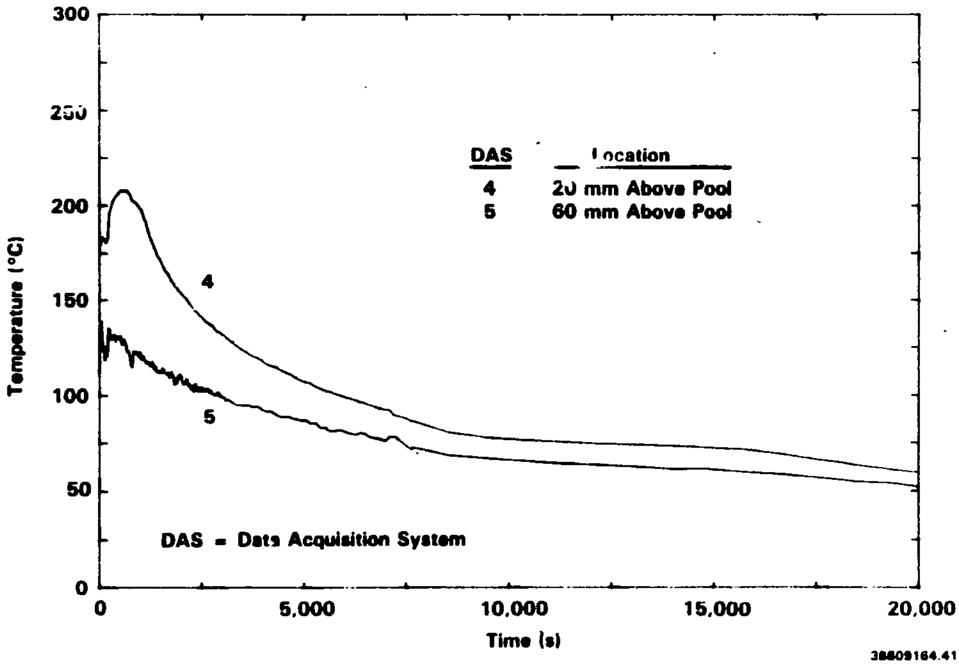

Figure 20. Reaction Pan Atmosphere Temperatures--Test LPA-3.

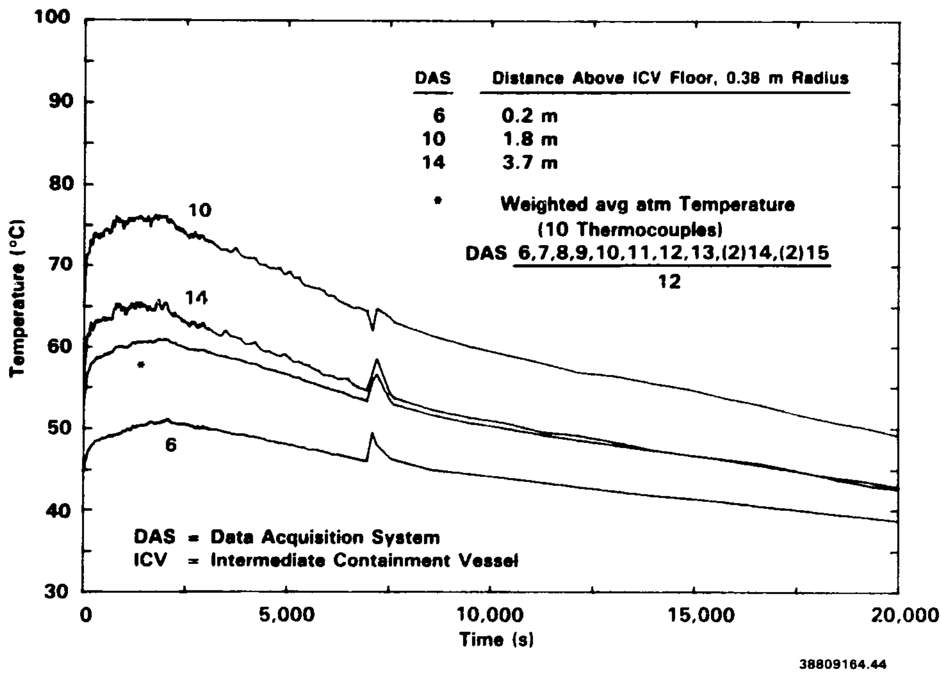

Figure 21. Intermediate Containment Vessel Atmosphere Temperatures--Test LPA-3.

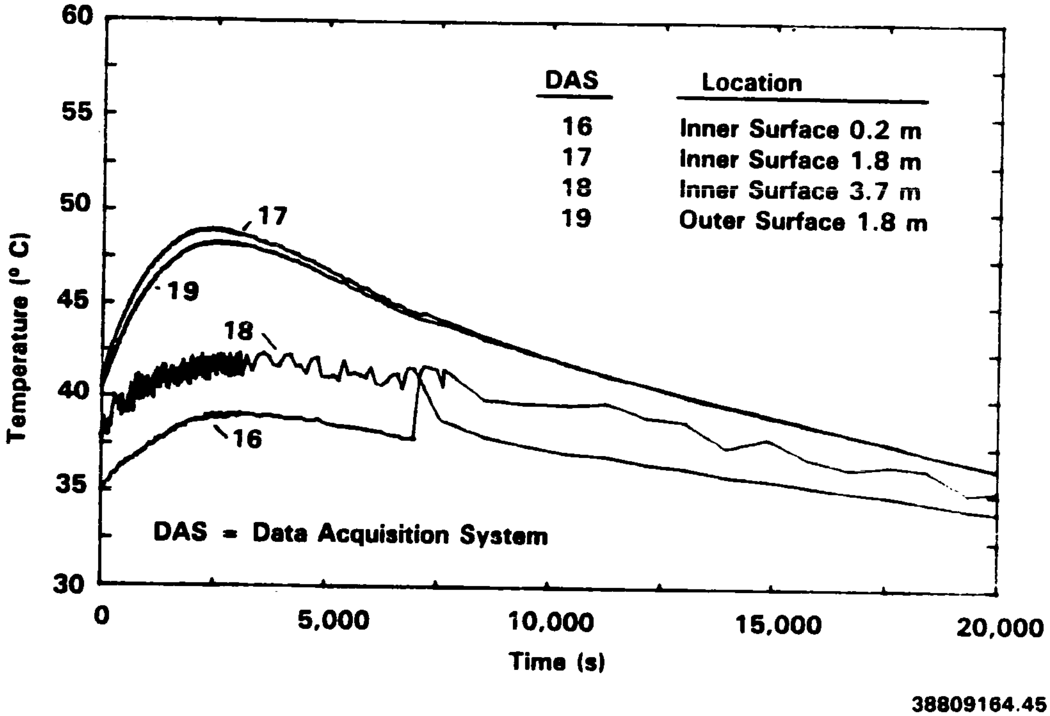

Figure 22. Intermediate Containment Vessel Wall Surface Temperatures--Test LPA-3.

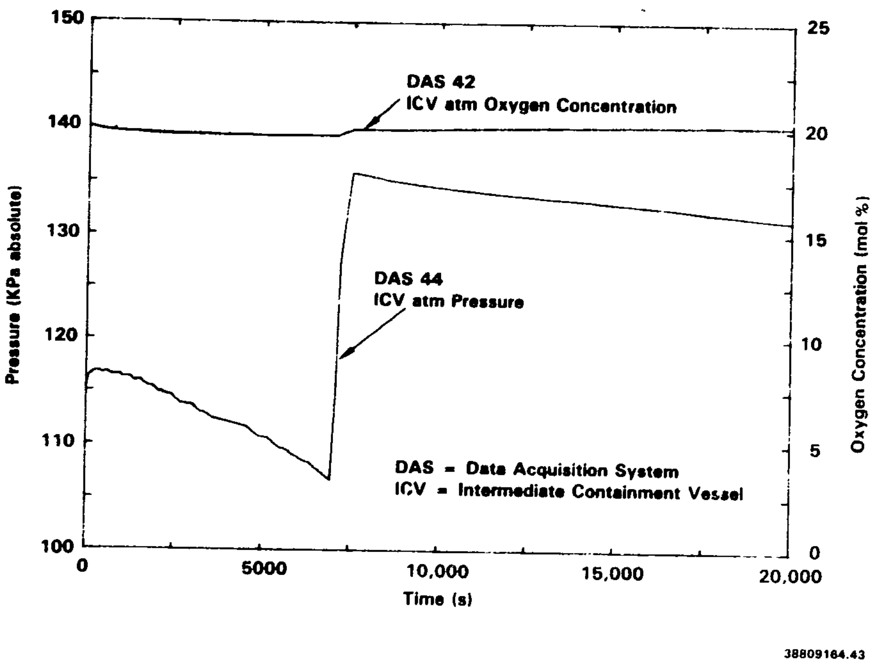

Figure 23. Intermediate Containment Vessel Atmosphere Pressure and Oxygen Concentration-- Test LPA-3

Table 12. Mass Spectrometric Analyses of Gas Samples--LPA-3.

Time after start (s)	Location	Concentration (mol %)					
		Oxygen	Nitrogen	Argon	Carbon dioxide	Hydrogen	Helium
-1,260	+1.8 m	20.7	77.0	0.95	0.41	<0.01	0.96
+660	+1.8 m	20.4	76.9	0.97	0.45	0.06	0.06
+3,600	+1.8 m	20.1	77.0	0.98	0.42	0.21	1.26
+61,320	+1.8 m	20.5	77.2	0.96	0.28	0.16	0.88

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4.6.4 Aerosol and Radioactive Species Behavior

Aerosol samples were taken at various times during the test to measure aerosol particle size, and species concentration as a function of time. The aerosol sample analyses and suspended lithium and lead aerosol concentrations are listed in Table 13. Maximum suspended aerosol concentrations of lithium and lead were observed at 340 s after start of alloy transfer to be 0.35 mg lithium and 2.0 mg lead per cubic meter of ICV atmosphere.

Four aerosol samples were obtained on Mitex filter medium and analyzed for species content. The samples, times taken, and analytical results are listed in Table 14.

The results indicate that no mercury or thallium were detected in the aerosol. Maximum concentrations of other species were measured at 610 s after start of transfer to be 0.26 mg sodium, 0.031 mg potassium, and 0.26 mg bismuth per cubic meter of ICV atmosphere.

The behavior of potentially radioactive species associated with lithium lead alloy blankets in DT fusion reactors was determined for this high temperature, stirred, lithium-lead alloy pool-air reaction test. Chemical analyses of aerosol samples were completed to determine the extent at which potential radioactive species such as sodium, potassium, mercury, lead, thallium, and bismuth became aerosolized during the pool-air reaction test. Sodium and potassium are two impurities in lithium metal; mercury, lead, thallium, and bismuth are activation products from lead in a neutron environment. Mass fractions of species released as aerosol were lithium, 0.0000036; lead, 0.00000011; Sodium, 0.00034; potassium, 0.00028; mercury, <0.000005; bismuth, 0.000019; and thallium, <0.000001. These aerosols represent a potential safety concern for radiation control, but because of the low masses involved, could be contained under limited accident conditions by conventional HEPA filtration.

4.6.5 Chemical Composition of Reaction Products

Four samples (RP-1, RP-2, RP-3, and RP-4) of the reaction pan residue were obtained. Sample RP-1 was from the top crust which varied in thickness from about 1 to 5 mm. This material had a porous texture and was yellow, brown, gray, and white in color. Samples RP-2, RP-3, and RP-4 were

Table 13. Aerosol Sample Analyses and Suspended Aerosol Concentration--Test LPA-3.

Time after start (s)	Mass lithium (μg)		Concentration (mg/m$^3_{STP}$)	
	Lithium	Lead	Lithium	Lead
-4,880	1.6	9.6	0.056	0.339
+340	10	58	0.353	2.047
+940	3.6	44	0.127	1.553
+1,245	3.1	7.6	0.109	0.268
+1,915	4.1	14	0.096	0.329
+2,500	4.9	<5	0.086	<0.088
+4,690	4.8	<5	0.068	<0.071
+5,290	4.7	<5	0.066	<0.071
+6,470	7.7	9.4	0.035	0.066
+57,760	1.3	<5	0.0083	<0.032

STP = Standard temperature and pressure.

Table 14. Analytical Results of Species Samples--LPA-3.

Sample	Time after start (s)	Mass (mg/m$^3_{STP}$)						
		Lithium	Lead	Sodium	Potassium	Mercury	Bismuth	Thallium
S-0	-4,038	0.0092	<0.018	0.028	0.0032	<0.00035	0.039	<0.018
S-1	+610	0.089	0.141	0.259	0.0306	<0.0024	0.259	<0.118
S-2	+1,600	0.101	<0.088	0.194	0.0194	<0.0017	0.212	<0.088
S-3	+3,100	0.056	<0.088	0.194	0.0212	<0.0017	0.150	<0.088

STP = Standard temperature and pressure.

obtained at various depths of the remaining alloy: RP-2 at 6 mm, RP-3 at 51 mm, and RP-3 at 102 mm from the top surface. Sample RP-5 was obtained from the transfer line above the transfer valve to represent alloy transferred to the reaction pan. Samples RP-6 and RP-7 were samples of carbon deposit from the mix tank vent line and walls, respectively. Sample RP-6 was obtained from carbon-like material in the mix tank vent line and Sample RP-7 represented 106.5 g of carbon-like material obtained from the mix tank walls at the end of the test.

The chemical analyses of these samples and samples of lithium metal and lead metal used to make up the alloy for this test are listed in Table 15. The results of these sample analyses indicate that there was a reduction of sodium from 19 to ~10 p/m, potassium from 90 to about 5 p/m, and mercury from 45 to ~14 p/m during the test. These values were determined by comparing the alloy mix analysis (RP-5) to the bulk reaction product analyses RP-1, RP-2, RP-3, and RP-4. No obvious reduction in bismuth or thallium concentrations were observed when making a similar comparison.

4.6.6 Corrosion

Mass and thickness measurements of the corrosion coupons exposed to the alloy during the test show that essentially no corrosion of the coupons occurred. Coupons tested were 76 mm long x 25 mm wide and varied in thickness from 2.6 to 3.2 mm. The total weight loss for all coupons was less than 15 mg, except for carbonated steel, which was 83 mg.

Table 15. Chemical Analyses of Metals and Reaction Products--LPA-3.

Sample	Weight percent (wt%)			Concentration (p/m)				
	Total lithium	Total lead	Carbon	Sodium	Potassium	Mercury	Bismuth	Thallium
Lithium metal	--	--	--	69	90	--	--	--
Lead metal	--	--	--	15	1.8	0.04	160	<9
RP-1	1.20	93.6	--	9.3	1.5	6.6	791	834
RP-2	0.77	95.0	--	10	1.9	15.0	14,700	749
RP-3	0.54	99.9	--	8.7	2.3	12.4	182	760
RP-4	0.46	91.9	--	11	5.3	13.7	98	801
RP-5	0.64	94.9	--	19	5.1	44.8	182	793
RP-6 (2.5 g)	8.56	27.4	4.2	0.35	90	13.5	599	476
RP-7 metal (15.7 g)	1.01	95.3	--	15	3	1.5	1,000	1,300
RP-7 powder (90.8 g)	3.74	85.1	1.7	97	21	--	1,600	940

4.7 COMPARISON OF ALLOY AND LITHIUM REACTIONS WITH AIR

A comparison of pool temperature response for these three alloy tests and a low initial temperature lithium pool-air reaction test (LA-1) is shown in Figure 24. The pool temperatures in the alloy tests began decreasing immediately. The lithium pool temperature in test LA-1 increased mildly during the first 15 min, until visible burning occurred on the surface, and then increased rapidly. A comparison of the aerosol concentration in the ICV atmosphere for test LPA-2, test LPA-3, and lithium-air reaction test LA-1 is shown in Figure 17. Aerosol in test LPA-1 was below the detection limit. Results of these comparisons show some advantages of the alloy over lithium metal. The pool temperatures measured during the alloy-air reaction are low enough not to expect vaporization and/or aerosolization of tritium or radioactive metallic species associated with the breeder material. These potentially radioactive species may be produced in the alloy by isotope activation, sputtering, or corrosion of activated first-wall materials. The high temperatures produced by lithium-air reactions have been shown to release metallic species which may be present as radioactive species in an operating reactor (Jeppson 1982) and would be expected to cause the release of tritium contained in the lithium. The high temperatures and reaction products generated from a lithium-air reaction are very corrosive to mild steel and 316 SS (Jeppson 1979).

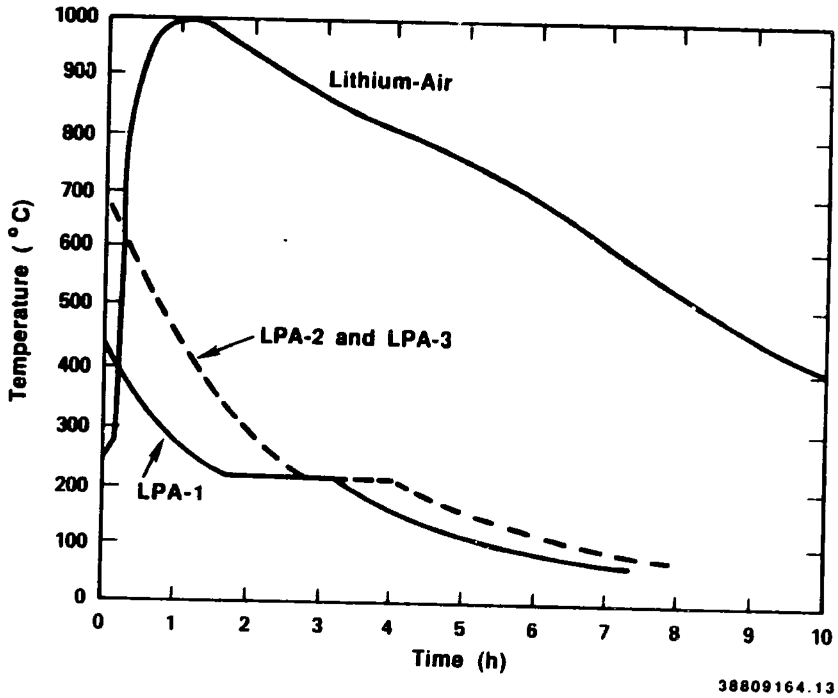

Figure 24. Comparison of Alloy and Lithium Pool Temperatures in Air Atmosphere.

5.0 ALLOY-CONCRETE REACTION TEST

One intermediate-scale lithium-lead alloy-basalt concrete reaction test (ABC-1) was conducted. Three small-scale, alloy-concrete reaction tests ABC-1s, ABC-2s, and ABC-3s and one small-scale lead-concrete reaction test were conducted. The intermediate-scale test confirmed the results of the small-scale tests. The reactions were very mild and were limited to the reaction of water driven from the concrete by heat. Because of the limited chemical reaction, it was necessary to apply external heat to maintain the 600 °C alloy test temperature during the 6-h reaction period. The intermediate-scale test demonstrated that the reaction was also limited by the lithium content of the alloy. Hydrogen release amounted to 0.45 g mol/g atom of lithium reacted. Aerosol release was limited.

5.1 PRELIMINARY SMALL-SCALE SCOPING TESTS

Three alloy-concrete and one lead-concrete small-scale reaction tests were completed to identify reaction parameters prior to conducting an intermediate-scale alloy-concrete test. The small-scale tests were conducted in the apparatus shown in Figure 25. Concrete was contacted with the metal in the sealed container for a set time period while a measured flowrate of gas was swept through the container atmosphere and the hydrogen concentration of the vented gas was measured. Basalt type C1 concrete cured for 2 yr was used in the tests. For each test, 1.40 kg of metal was used in the 480-ml sealed container. Contact time periods and mass of concrete tested are listed in Table 16.

The metal temperature and hydrogen gas concentration for each run are shown in Figures 26 and 27. The concrete weight loss from exposure to lead for 1 h was 0.7 g or about 1.1 wt%. No weight loss of concrete exposed to alloy was made because of the inability to make a clean separation of concrete and alloy. The total hydrogen released for each test was as follows:

Lead	1 h:	0.0024 g mol total	or	0.036 g mol/kg concrete
Alloy	1 h:	0.129 g mol total	or	1.89 g mol/kg concrete
Alloy	4 h:	insufficient data		--
Alloy	24 h:	0.130 g mol total	or	2.18 g mol/kg concrete.

5.2 TEST ABC-1 EXPERIMENTAL EQUIPMENT AND PROCEDURE

Two hundred kilograms (200 kg) of lithium lead alloy at 600 °C was added to the top surface of 0.054 m^3 basalt concrete with an exposed surface area of 0.089 m^2. The test equipment arrangement is shown in Figure 28 and the test article in Figure 29. The test was conducted under an argon atmosphere in the 14.1 m^3 ICV. The alloy was made up in the suspended mix tank. Metals added to the mix tank were 198.6 kg lead, 1,360 g lithium, 10.4 mg mercury, and 37.2 mg thallium. The flange and graphite gasket were bolted to the mix tank and an argon atmosphere was established in the mix tank. The metals were heated to 700 °C and sparged for 3 h to mix the alloy. The offgas was routed through a filter and nitric acid scrubber to collect any metallic species in the offgas.

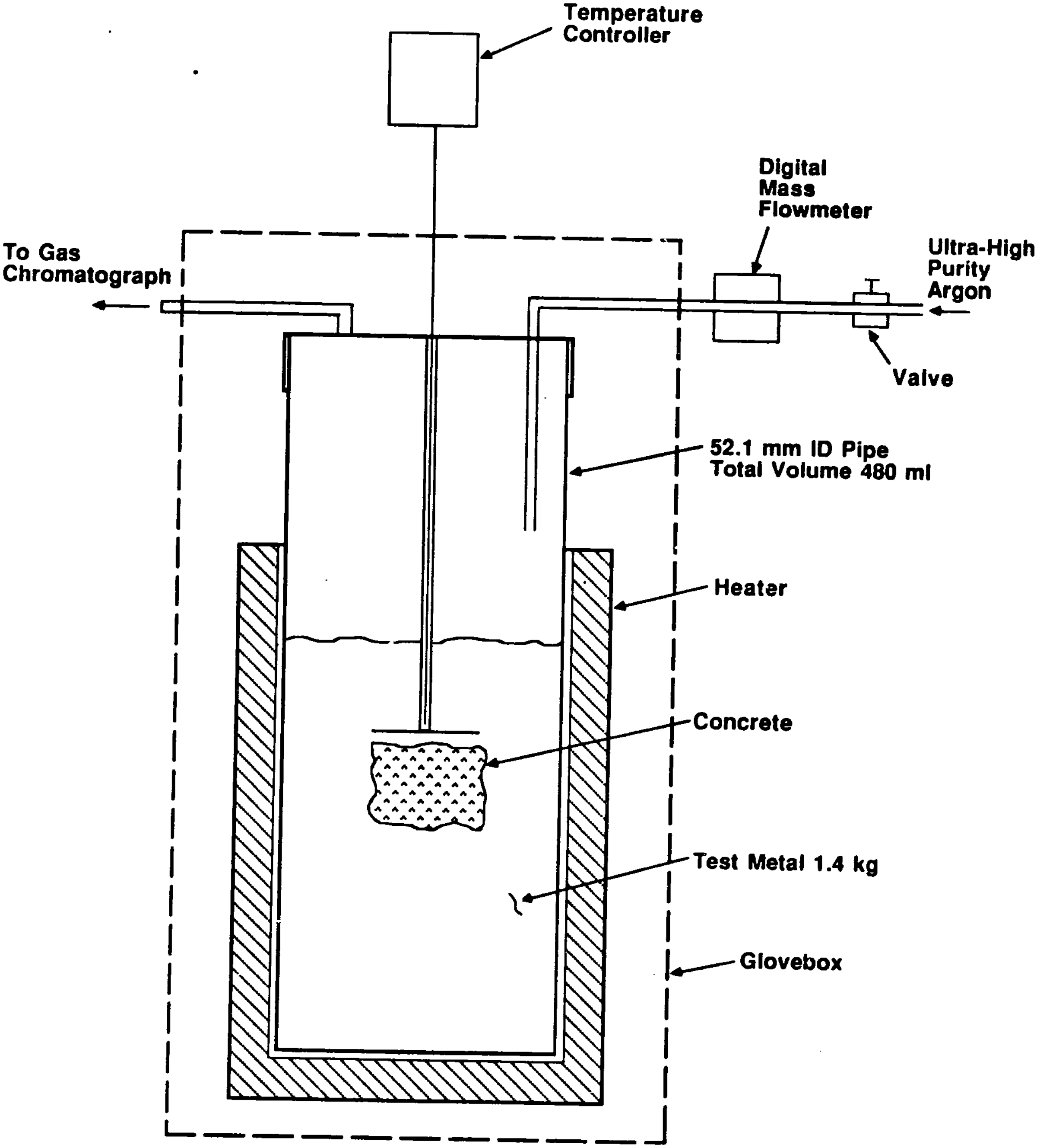

Figure 25. Test Apparatus for Small-Scale Concrete-Metal Tests.

Table 16. Contact Time and Mass of Concrete for Small-Scale Tests.

Test	Metal	Contact time (h)	Concrete mass (g)
--	Lead	4	66.1
ABC-1s	Alloy	1	68.1
ABC-2s	Alloy	4	50.6
ABC-3s	Alloy	24	59.7

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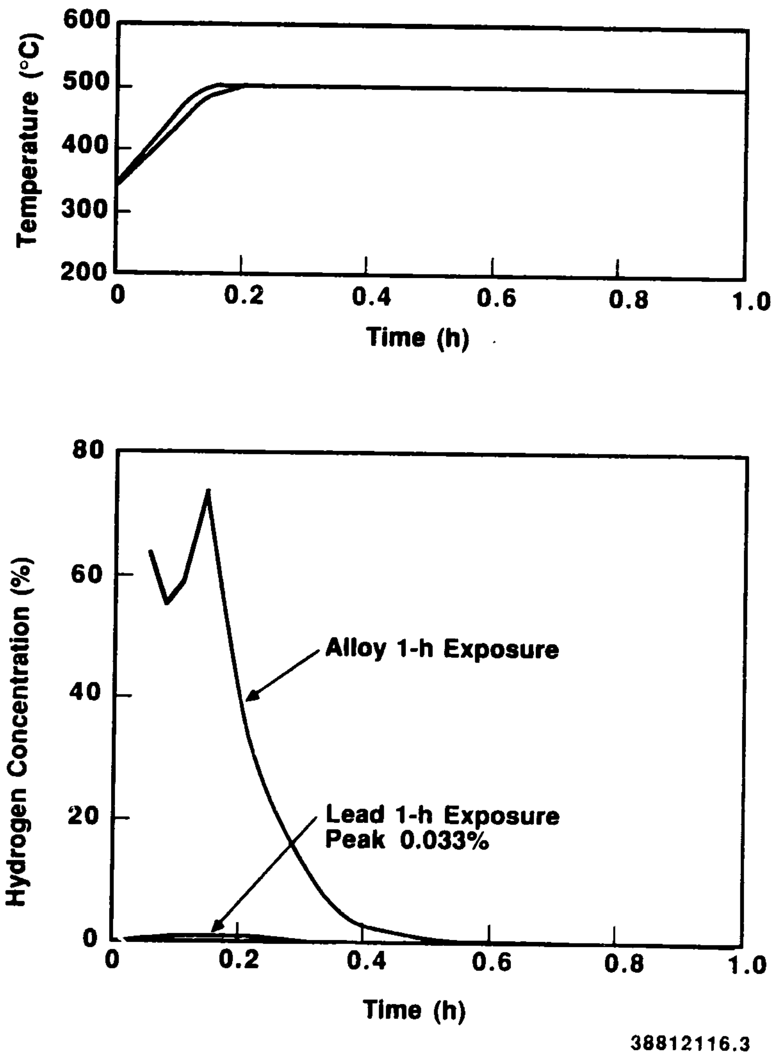

Figure 26. Concrete Exposure to Lead and Alloy for 1-h Small-Scale Tests.

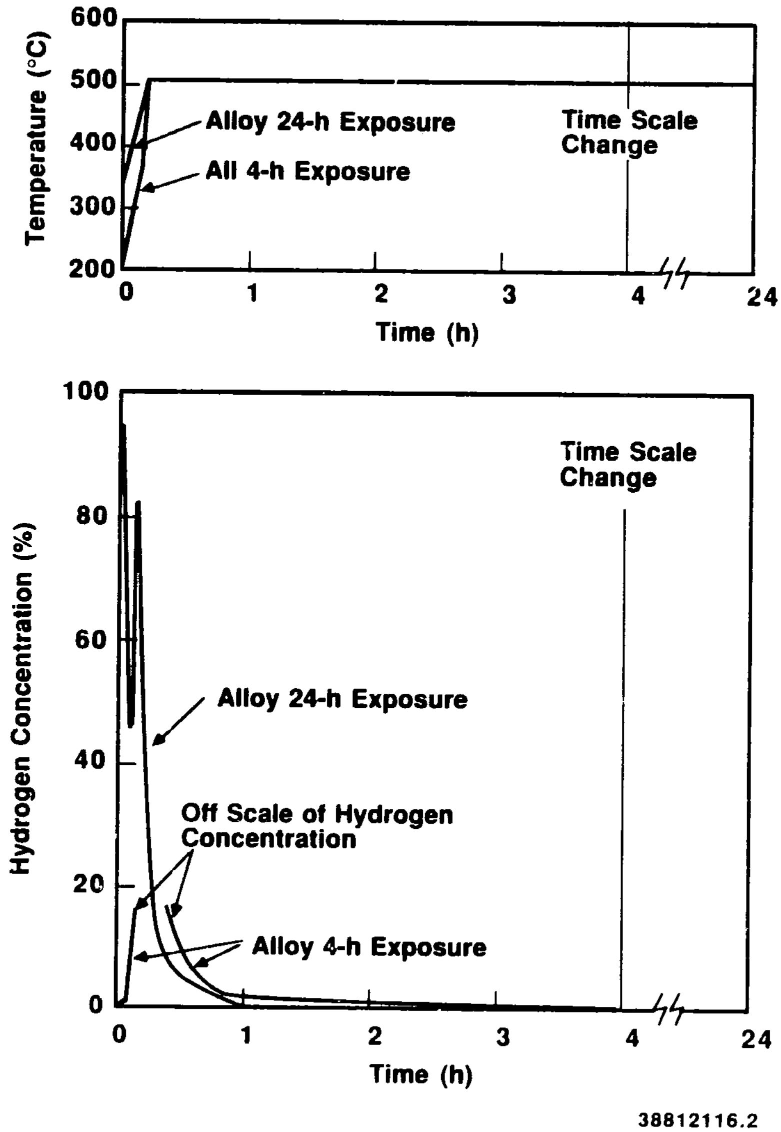

Figure 27. Concrete Exposure to Alloy for 4-h and 24-h Small-Scale Tests.

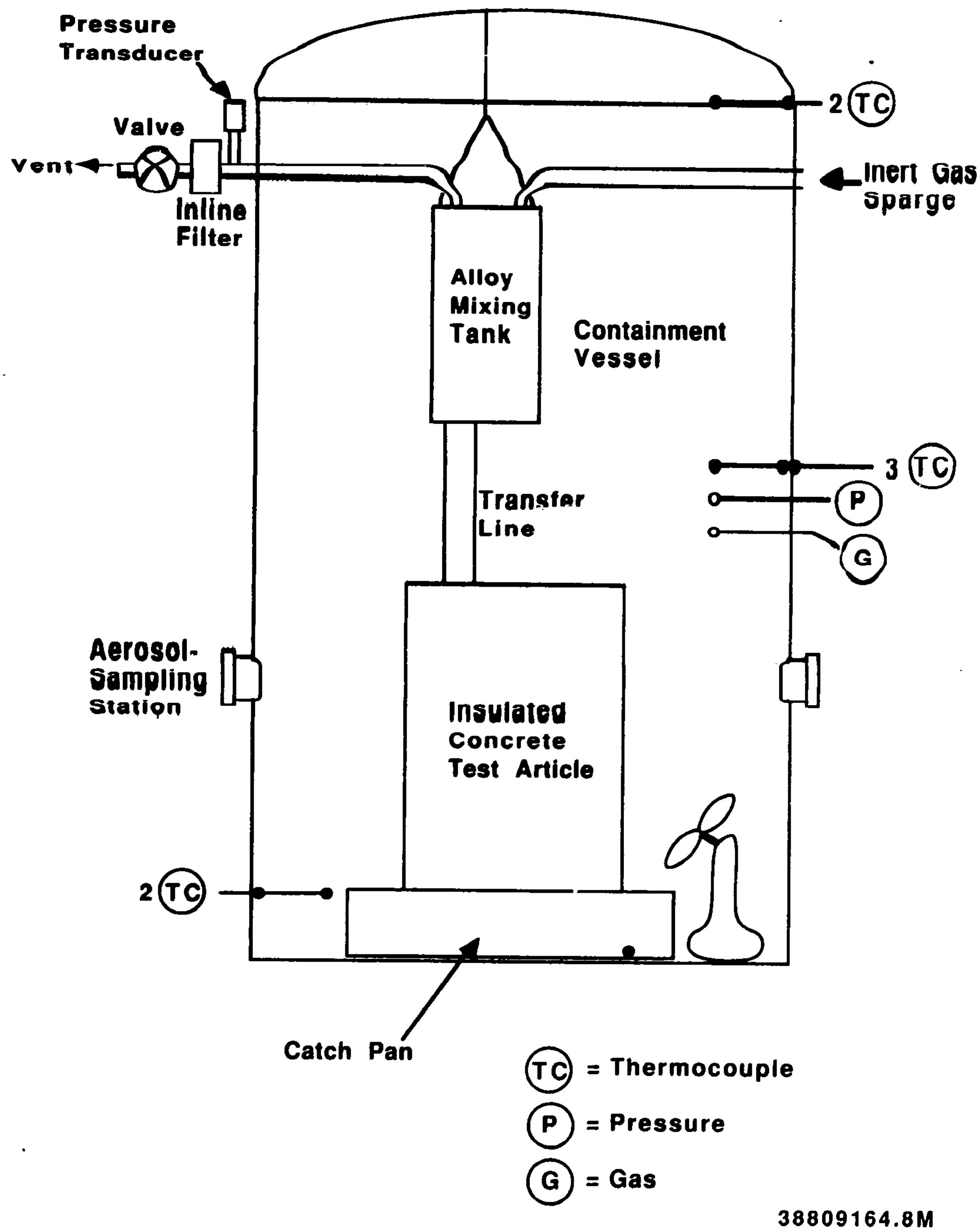

Figure 28. Alloy-Concrete Reaction Test Equipment Arrangement--Test ABC-1.

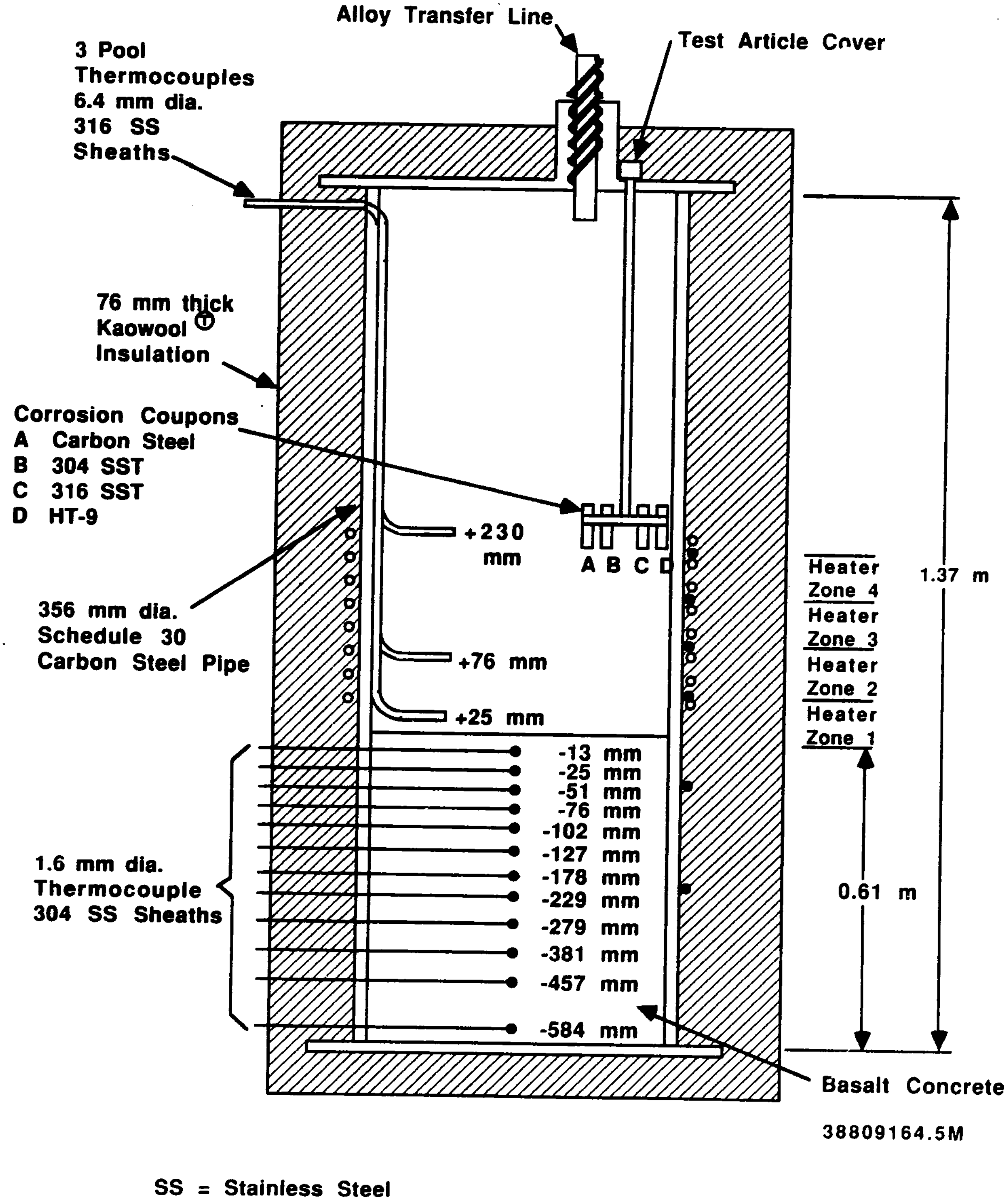

Figure 29. Alloy-Concrete Reaction Test Article--Test ABC-1

A pure lead freeze plug was formed in the transfer line to prevent the need for a transfer line valve. To initiate alloy transfer, the lead plug was heated above the melting point of lead by the transfer line heaters. At the end of transfer, the mix tank was vented and then valved off.

External heat was applied to the alloy pool above the concrete to maintain a test temperature of 600 °C for a 4-h period. Alloy pool, concrete, and ICV atmosphere temperatures were measured throughout the test. The ICV gas concentration and pressure were measured. Aerosol and radioactive species behavior were determined by obtaining various aerosol samples and analyzing them.

The concrete used in this test was basalt type C1. It had cured for almost 4 yr and had a measured 28 d compressive strength of 2.125 kg/mm^2 (3,020 lb/in^2). The concrete mix specifications are listed in Table 17 (Jeppson 1982).

Table 17. Basalt Concrete Mix Specifications.

Concrete component	Composition (kg/m^3)
Cement, portland Type II	261
Pozzolan	46
Sand (No. 4)	840
19 mm Aggregate	1,082
Water	143
Water reducing agent	1.1

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5.3 POOL AND CONCRETE TEMPERATURES FOR TEST ABC-1

Alloy pool temperatures began decreasing immediately after alloy transfer due to heat transfer to the room temperature concrete test article shown in Figure 30. At 15 min from start of alloy addition, the pool temperature had cooled to 410 °C. Test article heaters were activated at this time and the pool temperature increased to 600 °C within 45 min. The alloy pool was held at 600 °C until 6 h from the start of the test. The heaters were then deactivated and the pool temperature decreased. The pool temperature responses at three different pool elevations are shown in Figure 30. The pool cooling curve indicates the presence of lithium hydroxide on top of the metal pool by the constant temperature at 8 h from start of the test. The temperature of this 1/2-h plateau corresponds to the solidification of lithium hydroxide on top of the metal pool at its melting point (445 °C). The constant pool temperature between ~14 and 17 h indicates that lithium was removed from the alloy, which left the lead to solidify at its melting point of 327 °C.

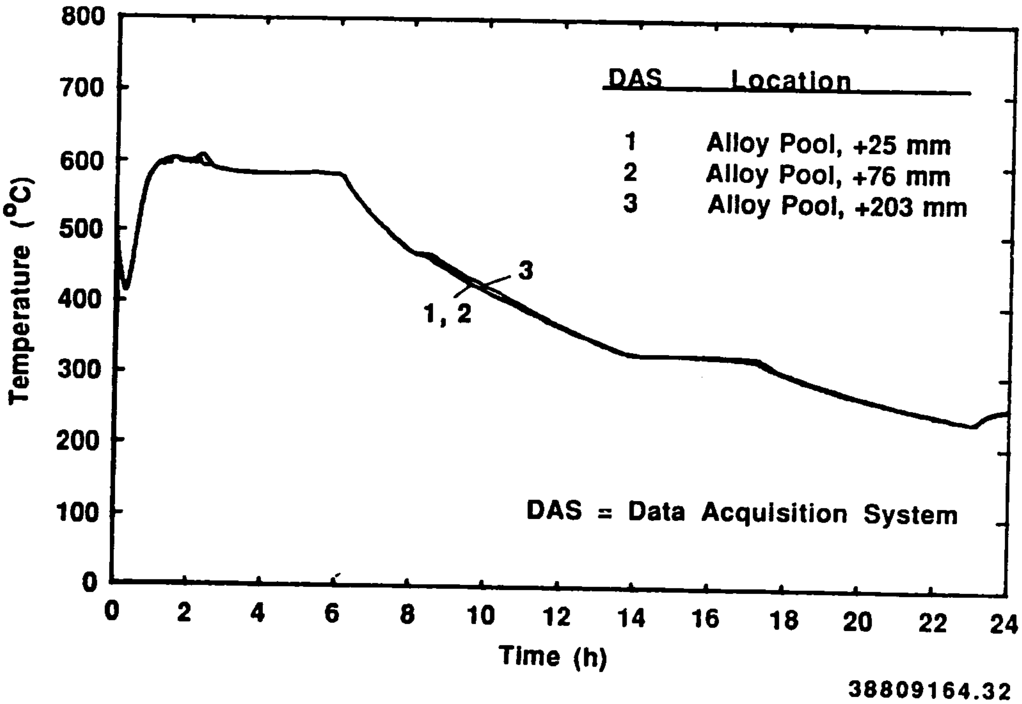

Figure 30. Alloy Pool Temperatures--Test ABC-1.

The concrete temperature responses at various elevations are shown in Figure 31. These temperatures indicate that almost all of the water was released from the concrete during the first 12 h of the test. Most of the water is driven from the concrete as the concrete temperature exceeds 130 °C (Claybrook 1985).

5.4 CONTAINMENT ATMOSPHERE RESPONSE FOR TEST ABC-1

The ICV atmosphere pressure and approximate average temperature response are shown in Figure 32. The ICV atmosphere temperature remained near the initial temperature of 27 °C throughout the test. It reached a peak temperature of 32 °C at the end of the 6-h period with the concrete test article heaters on. Very little heat was released from the test article as compared to the lithium-basalt concrete tests conducted for which atmosphere temperatures above 300 °C were produced (Jeppson 1979 and Jeppson 1982). The ICV atmosphere pressure increased from 103 to about 114 kPa (absolute) due to hydrogen production during the first 3 h of the test. Argon was added to the ICV atmosphere after the 6-h heating period when the heaters were turned off. This increased the ICV atmosphere pressure from 109 to 130 kPa (absolute). The pressure decreases noted in Figure 32 are due to gas sampling and ICV leakage.

Gas samples were obtained for mass spectrometric analysis to supplement the continuous gas oxygen and hydrogen monitors. The results of the mass spectrometric samples are listed in Table 18.

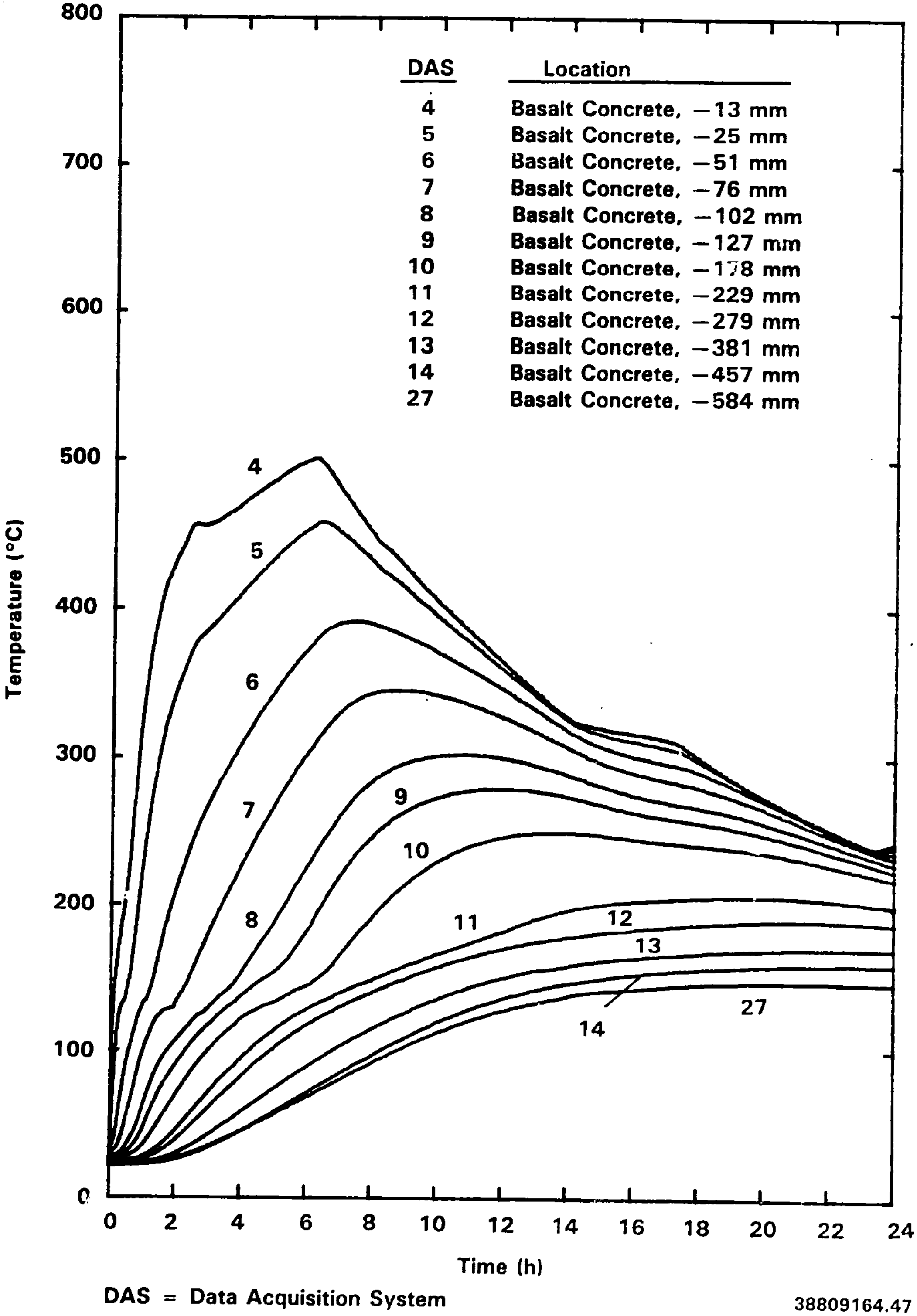

Figure 31. Concrete Temperatures--Test ABC 1.

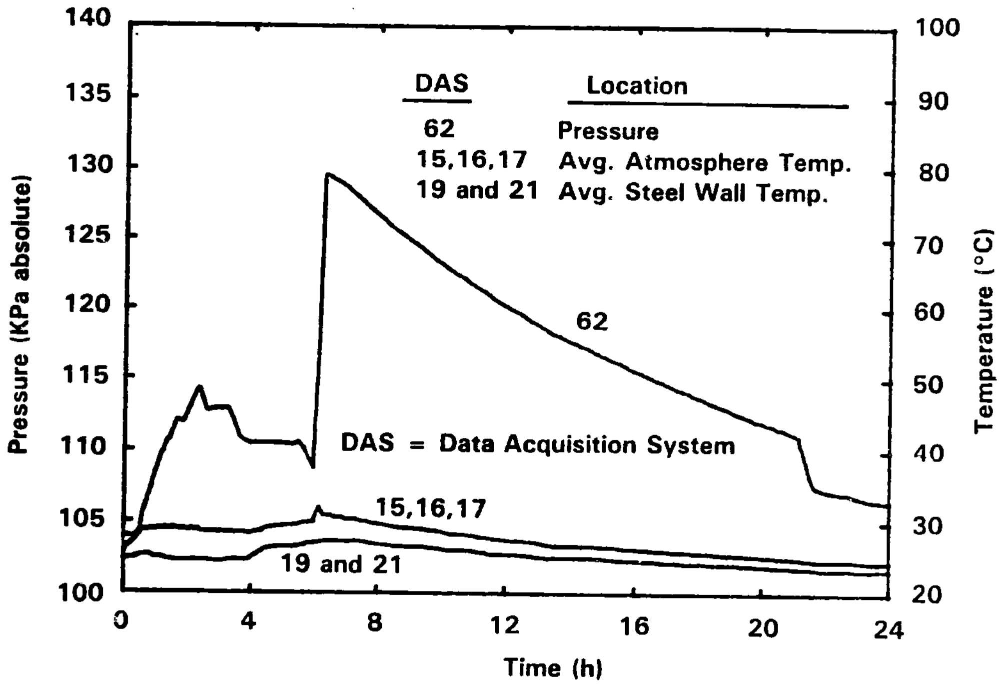

Figure 32. Intermediate Containment Vessel Atmosphere Pressure, Approximate Average Atmosphere, and Inside Wall Surface Temperature--Test ABC-1.

Table 18. Mass Spectrometric Analyses of Test ABC-1 Gas Samples.

Time after start (s)	Location	Concentration (mol %)					
		Oxygen	Nitrogen	Argon	Carbon dioxide	Hydrogen	Helium
-3,000	+1.8 m	0.89	5.54	93.6	0.02	<0.01	<0.01
+600	+1.8 m	1.17	6.52	91.8	0.03	0.52	<0.01
+1,200	+1.8 m	0.87	5.50	92.7	0.03	0.90	<0.01
+3,600	+1.8 m	0.80	5.56	92.0	0.04	1.55	<0.01
+21,600	+1.8 m	0.24	5.05	82.0	0.06	ˑ2.6	<0.01
+93,600	+1.8 m	0.02	4.27	85.3	0.03	10.4	<0.01

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The hydrogen release is shown in Figure 33. The hydrogen gas released was calculated from the perfect gas law with the measured atmosphere pressure, temperature, and hydrogen concentration. Appropriate adjustments were made for gas samples withdrawn from the ICV atmosphere and the measured ICV leakage rate. An atmosphere mixing fan was used in the ICV to mix the atmosphere and minimize hydrogen stratification. Steam released from the test article was assumed to condense very quickly on the inside ICV walls. Hydrogen release occurred during the first 3 h of the test.

5.5 AEROSOL AND RADIOACTIVE SPECIES RELEASE FOR TEST ABC-1

Aerosol was released from the top surface of the pool during the test. The suspended aerosol mass concentrations of lithium and lead in the ICV atmosphere are shown in Figure 34. The suspended lithium concentration reached a maximum of about 280 mg/m^3 standard temperature and pressure (STP) near the end of the 6-h heating period. This time period corresponded with the time that the alloy pool temperature was held at 600 °C and a layer of liquid lithium hydroxide was formed on top of the depleted alloy. The suspended lead concentration reached a maximum of about 10 $mg/m3_{STP}$ and remained near this value from approximately 2 to 5 h after the start of the test. The concentrations of lithium and lead decreased when the heaters were turned off and the pool temperature began decreasing.

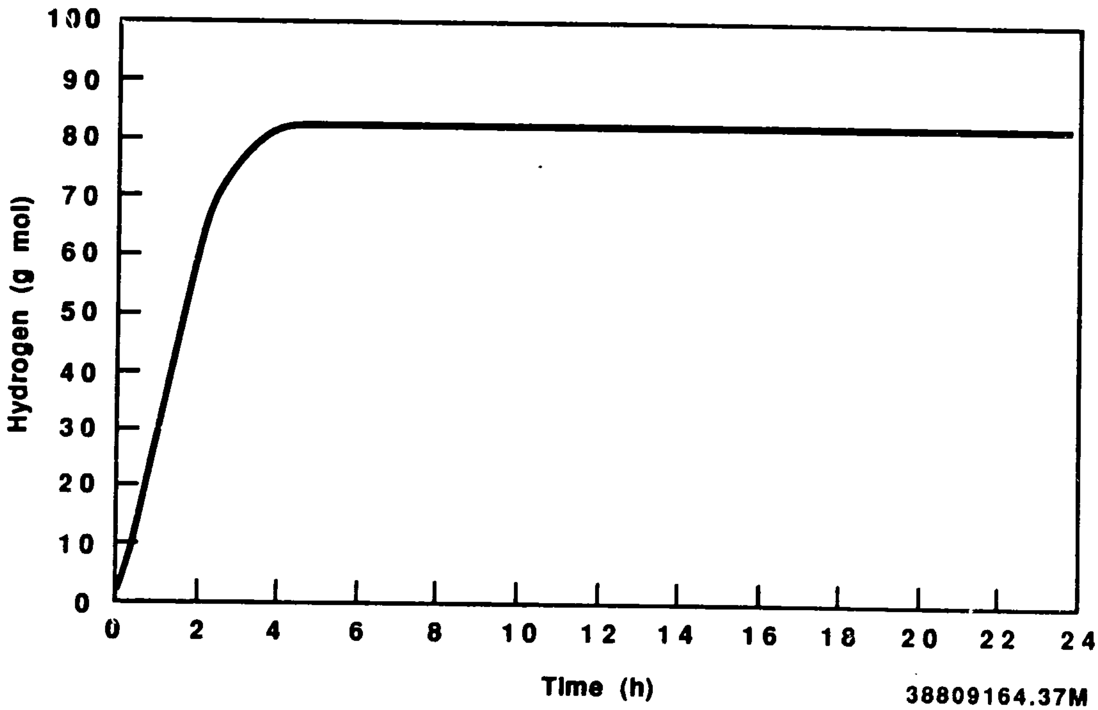

Figure 33. Hydrogen Released--Test ABC-1.

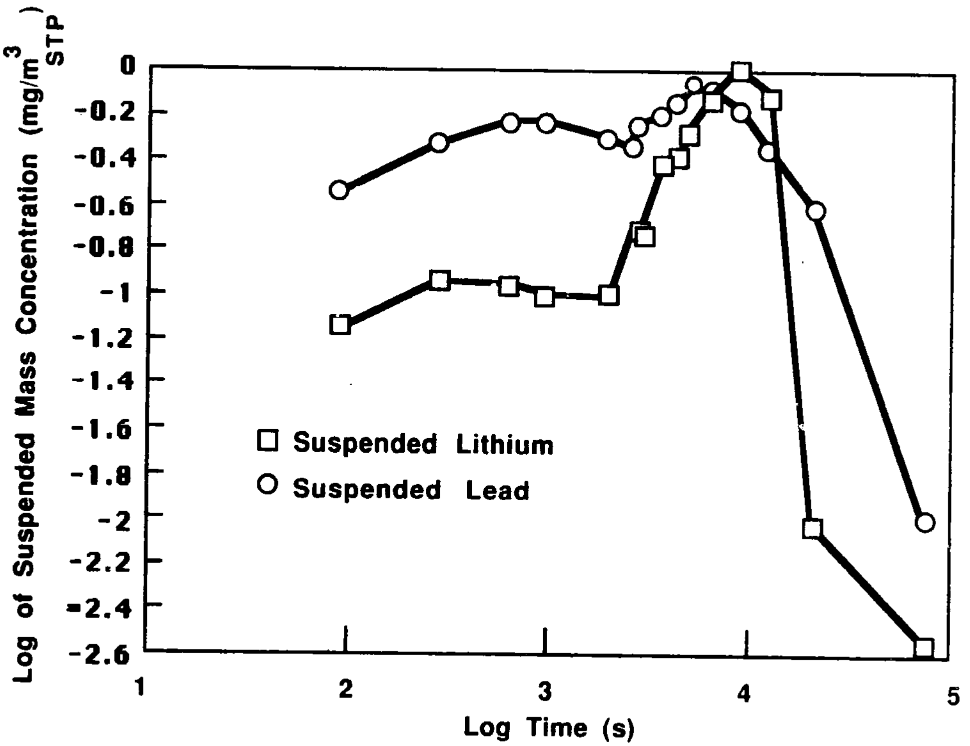

Figure 34. Suspended Aerosol Mass Concentration--Test ABC-1.

Figure 34 shows that during the first part of the test, lead aerosol mass suspended in the ICV atmosphere was greater than the lithium aerosol mass; but at the later part of the heating period, the suspended lithium mass was greater than the suspended lead mass. This is thought to be due to the formation of lithium hydroxide on top of the alloy; lithium hydroxide has a higher vapor pressure than lithium. At 600 °C, the vapor pressure of lithium is about 0.0001 atm and the vapor pressure of pure lithium hydroxide is about 0.01 atm. The vapor pressure of lithium over the lithium-lead alloy would be less than that for pure lithium.

Two aerosol impactor samples were taken to measure aerosol particle size. For the first sample obtained at 1,230 s after the start of the test, the lithium and lead collected on each stage of the impactor were at or below the detection limit. No meaningful size determinations were made from this sample. For the second sample obtained at 3,030 s after the start of the test, the AMMD of the aerosol was determined to be 3.08 µm with a standard deviation of 2.30 for lead and 0.56 um with a standard deviation of 1.58 for lithium. The impactor data is listed in Tables B-5 through B-8 of Appendix B.

Mercury and thallium, two potentially radioactive species which may be present in an operating fusion plant, were added to the alloy before contact with the concrete. Special aerosol samples were collected to determine the tendency of these metals to form aerosol and be transported during the alloy-concrete reaction. Results of the mercury analyses indicated that 0.1% of the mercury was collected in the offgas during the initial heatup and alloy mixing, 0.1% was collected with the aerosols during the alloy-concrete reaction period, 4.9% collected in the lithium hydroxide layer on top of the alloy, and 12% of the mercury remained in the depleted alloy at the end of the test. Most of the mercury is thought to have condensed on the vessel walls. About 0.017% of the thallium was released in the offgas during the initial heatup and alloy mixing, <0.038% was released with the aerosols during the alloy-concrete reaction period, and the bulk of the thallium remained in the depleted alloy and hydroxide layer. All aerosol samples taken of the ICV atmosphere were analyzed to contain <3.0 μg thallium and ≤0.25 μg mercury.

5.6 SOLID REACTION PRODUCT ANALYSIS FOR TEST ABC-1

The reaction product residue remaining in the test article is shown in Figure 35. A solid, crystalline reaction product layer was observed on top of the lead metal during posttest inspection. The thickness of this layer varied from 57 to 95 mm. Two samples of this material were analyzed for lithium, lead, mercury, and thallium. The results of these analyses are shown in Table 19. This material was analyzed by X-ray diffraction to be >90% lithium hydroxide. This layer of reaction products had a mass of 5,139 g. The reaction product layers are shown in the posttest disassembly photographs in Figure 36.

The second layer of reaction product was the depleted alloy layer between the concrete and the lithium hydroxide. It was 0.21 m thick. A sample (RP-3) taken near the top of the layer indicated that very little lithium remained in this material. The mass of this layer was assumed to be the mass of lead used in the test (198.6 kg).

There was no reaction penetration into the concrete; the thickness of the concrete was the same at the end of the test as at the beginning. There was about 1.5 L of water collected on the floor of the ICV at the end of the test. This was an indication that the lithium in the alloy was depleted by the water reaction prior to the end of water release from the heated concrete. The reaction $2Li + H_2O \rightarrow Li_2O + H_2$ appears to be predominant in the presence of excess lithium; the reaction $Li_2O + H_2O \rightarrow 2LiOH$ occurs as lithium is depleted from the alloy and steam continues to bubble through the pool. The LiOH formed during the test collected on the surface of the alloy, since it is considerably less dense than the alloy. It formed as a liquid, but solidified on cooling, as can be seen in Figure 30 by the constant temperature at approximately 8 h. The melting point of LiOH is 445 °C; it must lose its heat of fusion as it cools through this point. The depleted alloy melting point is also indicated by the constant temperature period between 14 and 17 h in Figure 30. This melting point (328 °C) is that of pure lead, indicating that essentially all lithium in the alloy reacted.

Material balances for lithium, lead, mercury, thallium, and water are shown in Table 20. Material balances are based on the known masses used in the start of the test and are compared to the masses determined for various locations at the end of the test.

5.7 CORROSION OF METAL TEST COUPONS FOR TEST ABC-1

Four preweighed corrosion coupons were suspended in the alloy pool during the test. The coupons were suspended 0.23 m above the top surface of the concrete so that they would be immersed in the pool throughout the test. The coupons were 19.1 mm wide by 50.8 mm tall by 3.2 mm thick. At the end of the test, the coupons were at the top of the lead just below the lithium hydroxide layer. The weight loss of each coupon was 56.0 g/m^2 for carbon steel, 210 g/m^2 for 304 SS, 147 g/m^2 for 316 SS, and 93.5 g/m^2 for HT-9 ferritic steel.

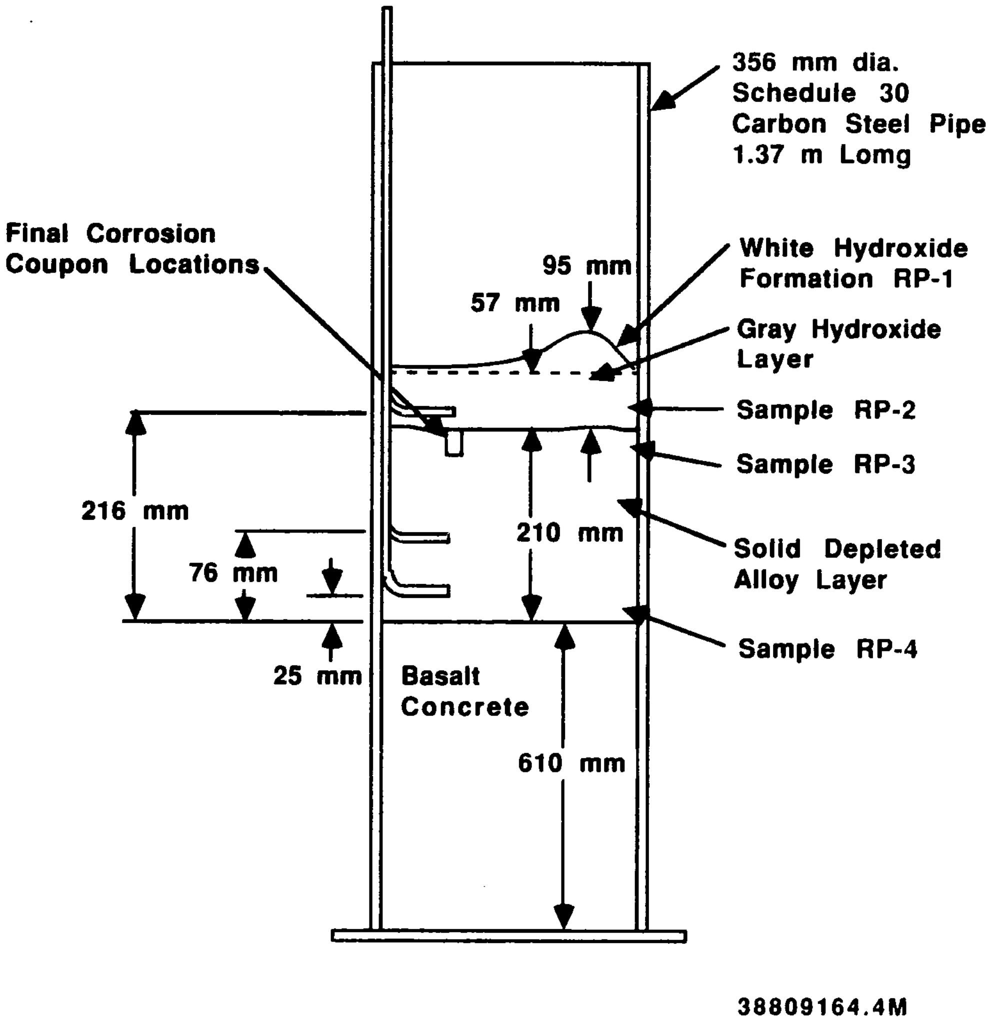

Figure 35. Reaction Product Residue--Test ABC-1.

Table 19. Reaction Product Analyses of Test ABC-1 Samples.

Sample	Lithium (wt%)	Lead (wt%)	Mercury (µg/g)	Thallium (µg/g)
RP-1	27.4	0.55	0.19	87
RP-2	28.2	2.3	0.17	124
RP-3	0.00196	~95.0	0.011	<5.0

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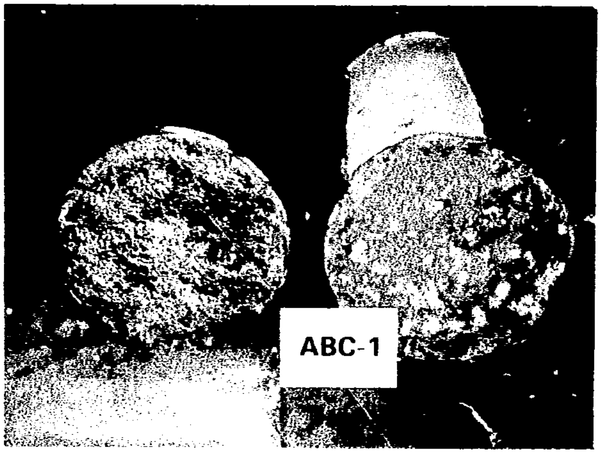
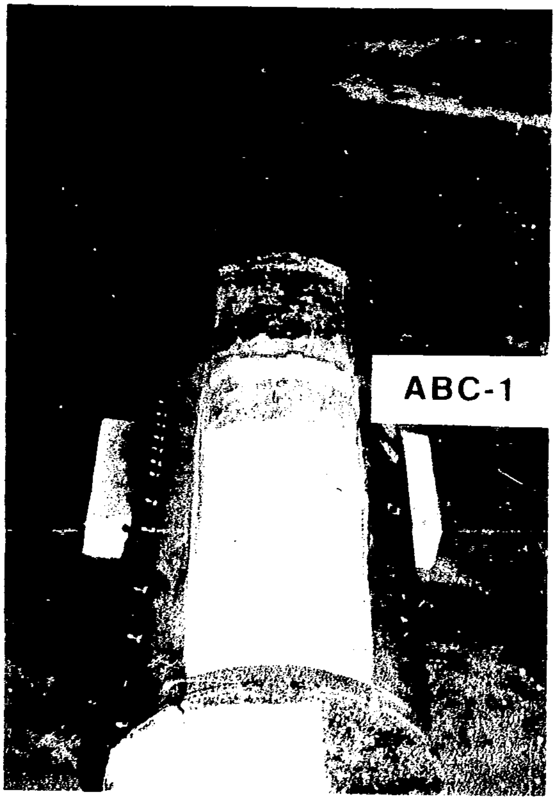
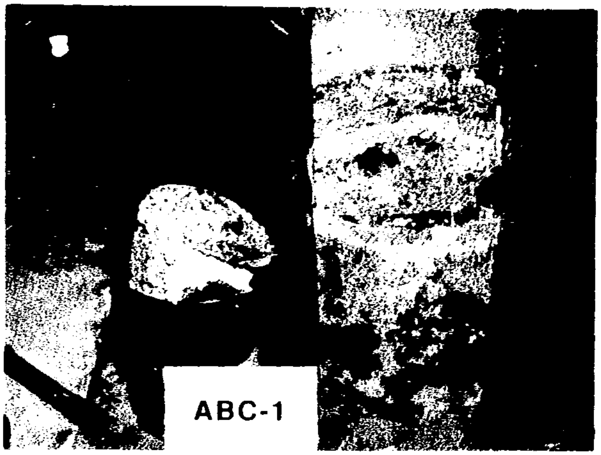


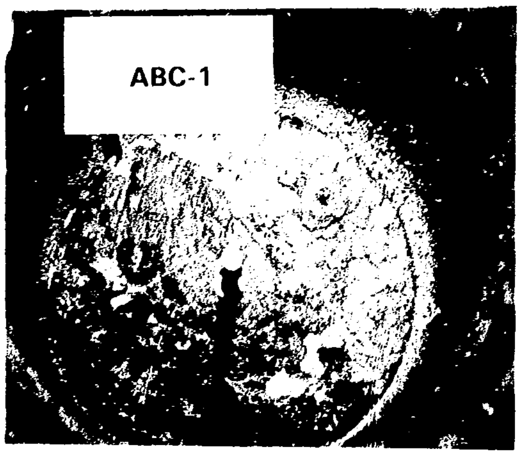
Reaction Interface
8407133-22CN



Side Exposure
8407133-21CN



Reaction Products Removed from Alloy
8407133-24CN



Top Surface of Reaction Products
8407133-19CN

Figure 36 Test Equipment and Reaction Products During Disassembly--Test ABC-1

Table 20. Material Balance for Test ABC-1.

Sample	Lithium (g)	Lead (kg)	Mercury (mg)	Thallium (mg)	Water (kg)
Initial Mass					
Added	1,360	198.6	10.4	37.2	--
Lead impurity	0.6	--	8.0	<993	--
Concrete content	--	--	--	--	7.8
Total added	1,361	198.6	18.4	<1030	7.8
Final mass					
Concrete	--	--	--	--	0
Depleted alloy	3.9	198.5	2.2	<993	--
Crystalline layer	1,449	0.1	0.9	637	3.5[a]
Aerosol	3.9	0.1	0.024	<0.24	0.0025
ICV floor	--	--	--	--	~2.0
Mix tank offgas	--	--	0.015	0.11	--
Total	1,457	198.5	3.1	<1640	~5.5
Percent accounted for	109	100	17	62 - 159	~71

[a]Calculated by amount of water required to form measured amount of lithium hydroxide.

PST88-9369-13

6.0 ALLOY SPRAY-IN-AIR REACTIONS

One lithium-lead alloy spray test (ASA-1) was conducted by spraying high-temperature alloy in an air atmosphere. The test was conducted under conditions which may approximate a worst-case alloy breeder material spray leak situation (spray with droplet size about 350 µm median mass diameter (MMD) and initial alloy temperature at 720 °C. The conclusions from this spray test were that (1) the alloy spray reacted very mildly with air, (2) the increase in ICV atmosphere pressure and temperature resulting from the spray was mild, and (3) the aerosol release was significant. Consequently, the major chemical reactivity safety concern identified for a lithium-lead alloy spray in an air atmosphere was the aerosol released.

6.1 EXPERIMENTAL EQUIPMENT AND PROCEDURE

This test was performed at the LMFF in the ICV described in Section 3.0. The equipment arrangement is shown in Figure 37 and the alloy reservoir and spray line are shown in Figure 38. The spray nozzle was located at an elevation to provide a spray fall height of 1.68 m. The spray nozzle used in this test was a hollow cone Spraying Systems* nozzle. The nozzle was made of 316 SS and was specified by the vendor to produce water spray droplets with a MMD of 400 µm for water at room temperature and at a pressure drop of 138 kPa across the nozzle.

The spray tank reservoir consisted of a 360-mm length of 152-mm dia 316-SS pipe with an end cap welded to the bottom end, a 25.4-mm-thick flange welded to the top end, and a 25-mm-thick blind flange bolted to the top flange. A graphite gasket was used between the flanges. The pipe, end cap, and flanges were all 316 SS. An argon sparge and vent line was connected through the top flange. A spray line was connected from the bottom of the end cap to the spray nozzle. Heaters, thermocouples, and insulation were attached to the reservoir to heat the alloy to the test temperature. Argon gas pressure was applied to the reservoir to provide the motive force to spray the alloy and control the pressure drop across the spray nozzle.

A carbon steel plate 9.5-mm thick with a 0.90-m radius was located on the floor of the ICV to catch the spray droplets. Twelve spray drop collectors were placed on the catch plate: three each at 0°, 90°, 180°, and 270° azimuth and four each at 660 mm, 760 mm, and 860 mm radius. The drop collector locations are shown in Figure 33.

The test was conducted according to the procedure listed below.

1. Load 155 g lithium and 22.5 kg lead into the supply reservoir.

2. Attach the reservoir lid and inert with argon.

3. Arrange the test equipment in the ICV as shown in Figure 37.

4. Establish an air atmosphere in the ICV with an initial pressure of 105 kPa (absolute).

5. Heat the alloy in the reservoir to 700 °C and sparge with argon for 30 min to form the alloy

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*Spraying Systems Co., nozzle Catalog No. 1/4 A 1 SS).

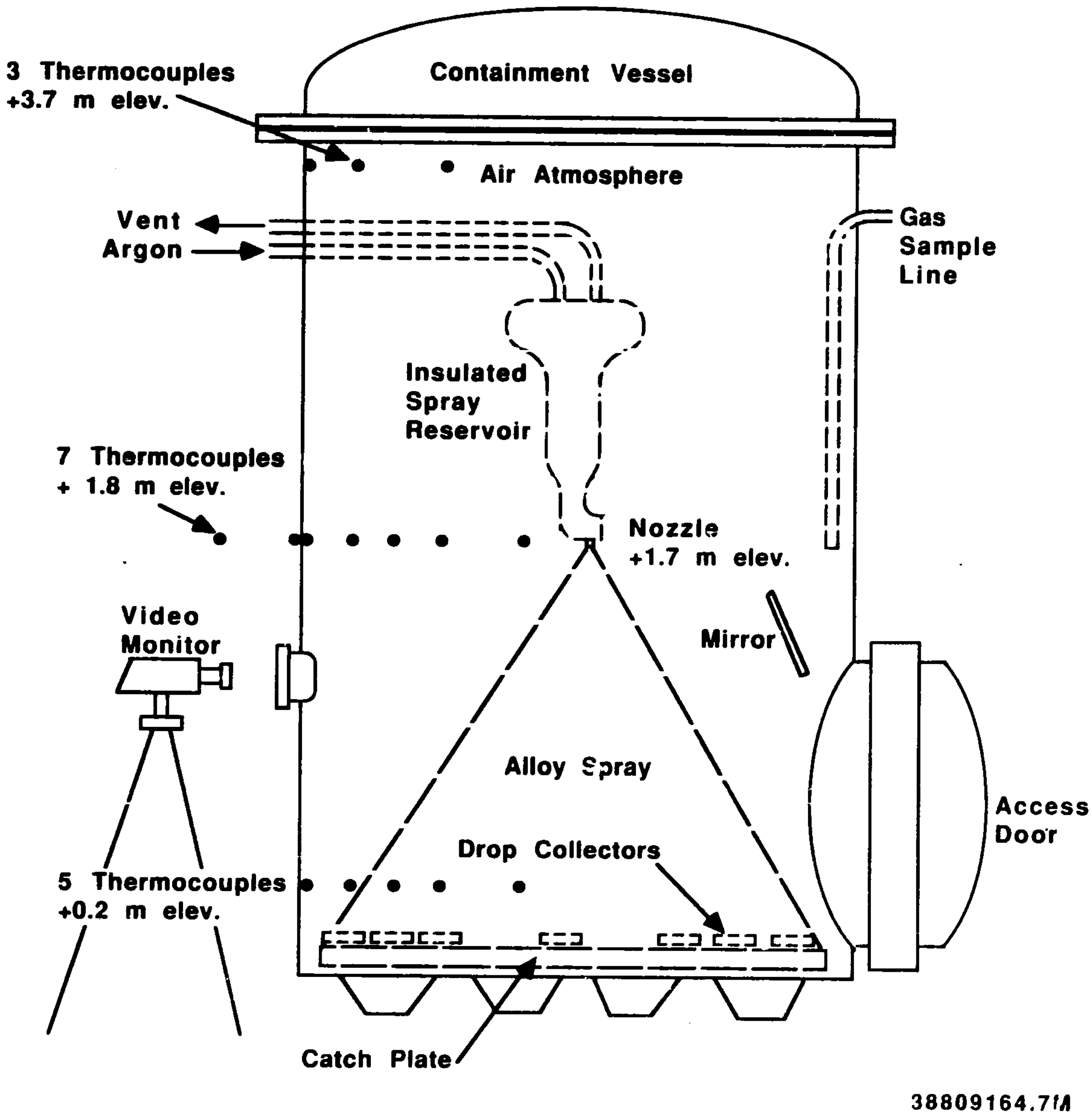


Figure 37. Alloy Spray-in-Air Test Equipment Arrangement--Test ASA-1.

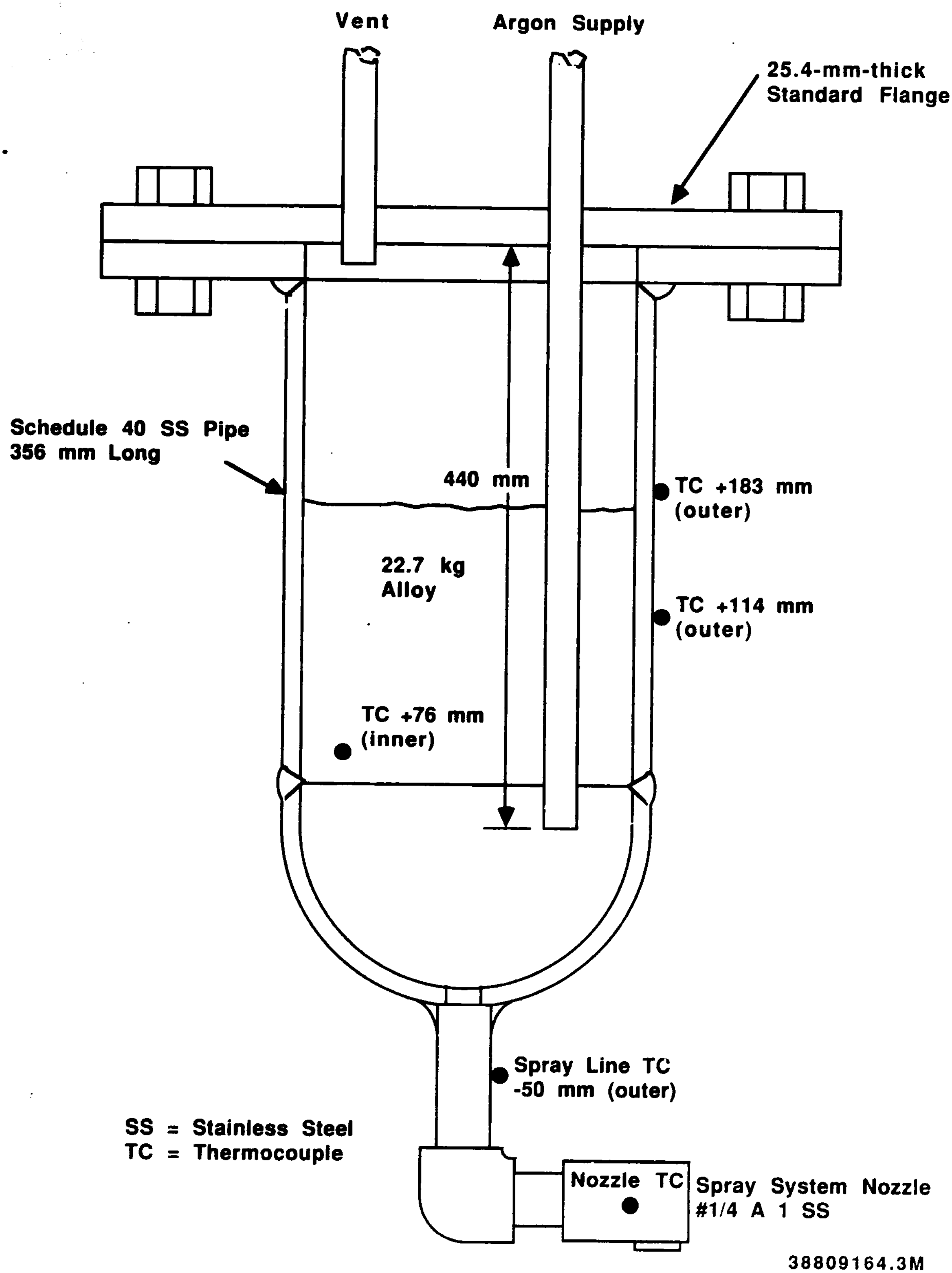


Figure 38. Alloy Spray Reservoir and Nozzle--Test ASA-1.

6. Apply an argon cover gas pressure of 356 kPa (absolute).

7. Heat the spray line freeze plug to above 327 °C at time zero.

8. Spray the alloy at about 40 g/s.

9. Measure the ICV atmosphere pressure, temperature, and oxygen concentration during the test.

10. Obtain aerosol samples to determine the aerosol concentration, aerosol particle size, and chemical composition of the aerosol.

11. Obtain posttest samples to determine final composition of alloy collected on the catch plate and spray drop size.

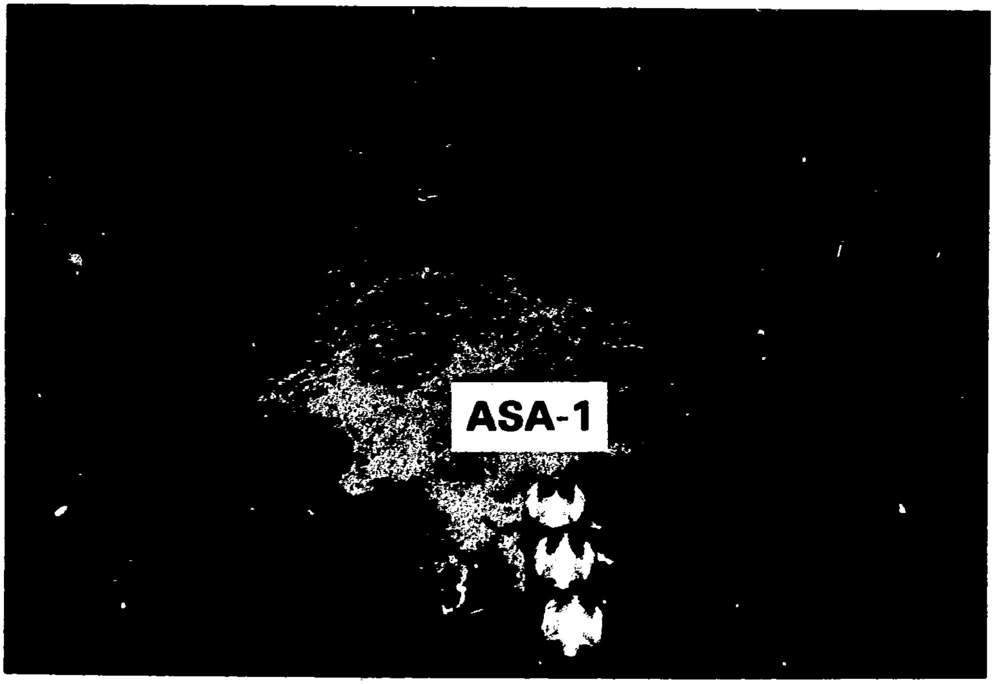
6.2 RESULTS OF TEST ASA-1

Lithium-lead alloy (22.6 kg) at 720 °C was discharged in 458 s through a spray nozzle as shown in Figure 36. A spray was obtained during the first 130 s of the test. A stream flow formed thereafter, and a good spray was not reestablished even with application of higher pressure to the supply reservoir. The average alloy flow rate during the 130 s spray period was about 41 g/s. It occurred with a nozzle pressure drop of about 327 kPa. The spray droplet size was approximated by collecting individual drops from the steel plate on the floor and determining their mass by weighing. This resulted in a MMD of about 350 μm. The pressure drop across the spray nozzle during the test is shown in Figure A-1 of Appendix A. A photograph of the spray droplets and residue collected on the ICV floor at the end of the test is shown in Figure 39. A video of the spray test was taped through the ICV viewport.

The mass of alloy collected in the drop collectors indicated that >97.5% of the alloy fell to the catch plate within a radius of 0.61 m. Less than 1% of the alloy fell to the catch plate at a radius >0.71 m.

6.2.1 ICV Atmosphere Gas Consumption, Pressure, and Temperature Response

The ICV atmosphere gas consumption, pressure, and approximate average temperature responses are shown in Figure 40. The pressure peaked at 109 kPa (absolute) at 120 s from the start of spray and the average temperature peaked at 31 °C at 150 s from start of spray. The atmosphere temperatures measured at 10 locations representing equal cylindrical volumes of gas at three elevations are listed in Table A-8 of Appendix A as DAS 6 through 15. These 10 thermocouple measurements were used to determine the approximate average atmosphere temperature shown in Figure 40. Included in Figure 40 for comparison are the gas consumption, pressure, and average temperature response of a lithium spray test (LSA-2) in an air atmosphere in which lithium was sprayed at an average rate of 1.64 g/s and a temperature of 650 °C. This lithium spray test was run with a lower mass flow rate than the alloy spray test but with a similar volumetric flow rate and spray droplet size. The alloy test resulted in much less gas consumption and ICV atmosphere temperature and pressure increase than did the similar lithium spray test.



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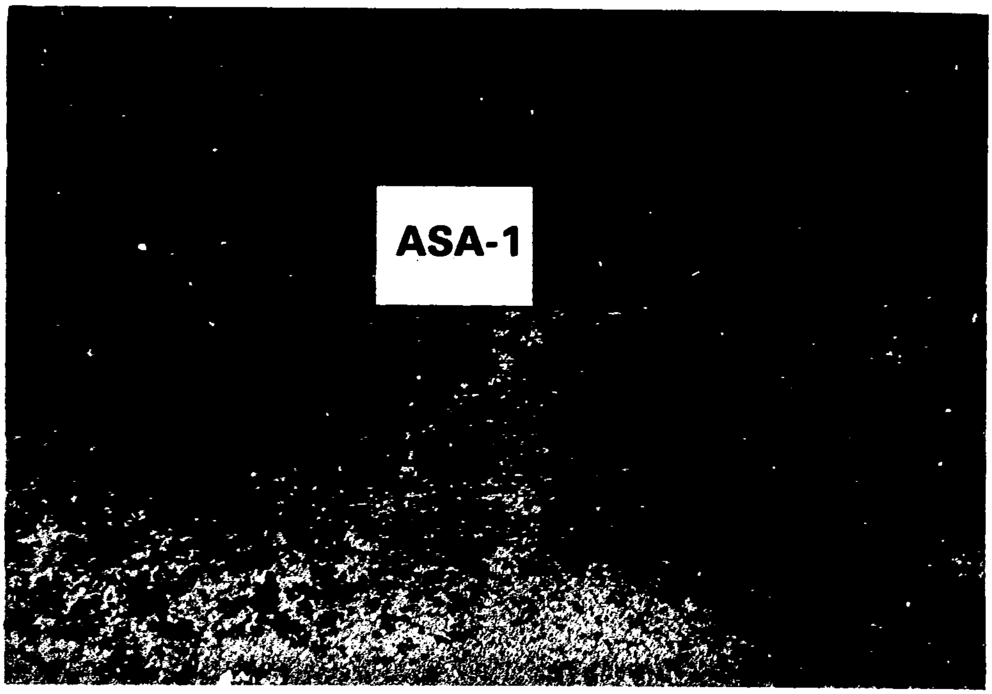

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Figure 39. Alloy Spray Droplets Collected on Floor--Test ASA-1 (lower photograph is closeup of floor plate).

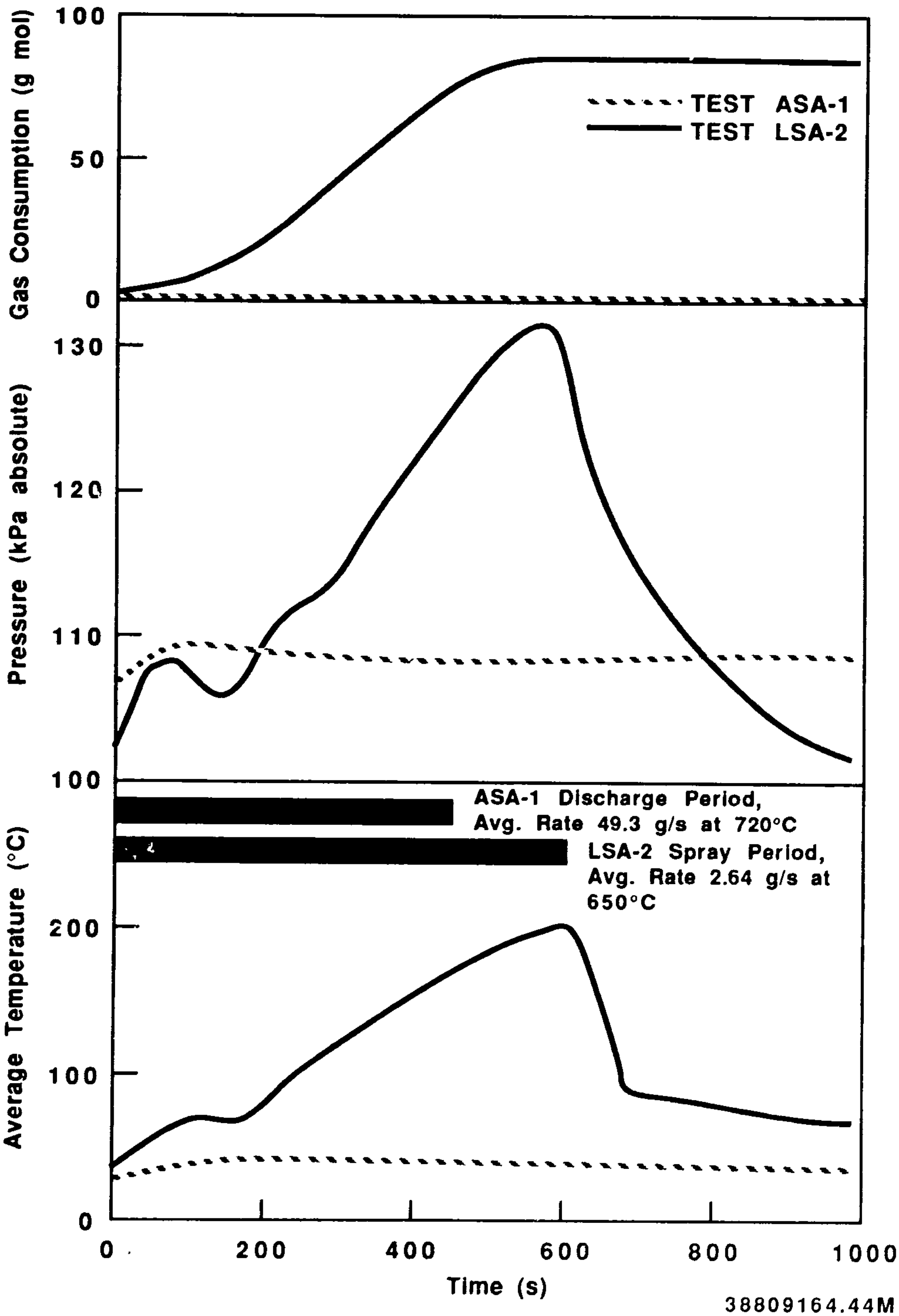

Figure 40. Intermediate Containment Vessel Atmosphere Pressure, Temperature, and Gas Consumption for Alloy Spray-in-Air Test ASA-1 and Lithium Spray-in-Air Test LSA-2.

The ICV wall and floor surface temperatures are also listed in Table A-8 of Appendix A. The atmosphere oxygen concentration and dewpoint were measured at 1.8 m above the ICV floor. The continuous monitor indicated an oxygen concentration of 20.9 mol% from the start of spray until 676 s after start of spray, when it decreased to 20.8 mol% and remained. Mass spectrometric sample analysis of atmosphere samples confirmed the oxygen monitor results. The mass spectrometric sample analysis results are listed in Table 21.

Table 21. Mass Spectrometric Analyses of Gas Samples--ASA-1.

Time after start (s)	Location (m)	Concentration (mol%)					
		Oxygen	Nitrogen	Argon	Carbon dioxide	Hydrogen	Helium
-1,390	+1.8	20.8	78.2	0.94	0.12	<0.01	<0.01
+260	+1.8	20.8	78.1	0.96	0.12	0.01	<0.01
+600	+1.8	20.8	77.7	1.36	0.12	0.03	<0.01
+1,200	+1.8	20.8	77.7	1.32	0.11	0.03	<0.01
+3,600	+1.8	20.7	77.8	1.33	0.12	0.04	<0.01

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These mass spectrometric results agree well with the continuous oxygen monitor results and indicate that oxygen reaction with the alloy spray was limited to 0.4 g mol. The mass spectrometric results of 0.40 mol% increase in argon concentration and 0.3 mol% decrease in nitrogen concentration indicate the argon addition at the end of spray (458 s). A hydrogen increase to 0.04 mol% was indicated by the mass spectrometric results showing that about 0.18 g mol of hydrogen was produced from the reaction of lithium with moisture in the ICV. This small amount of hydrogen does not present a safety hazard but supports the need to evaluate the possible presence of significant amounts of water in reactor cells for which safety analyses may be performed. The continuous dewpoint monitor indicated a dewpoint of almost 4 °C throughout the test. Three moisture samples taken indicated that the dewpoint of the ICV atmosphere was <0 °C throughout the test. The results of the moisture samples are listed in Table 22.

Table 22. Moisture Analysis of Intermediate Containment Vessel Atmosphere Samples.

Time after start (s)	Location (m)	Moisture content (g/m3)
-2,700	+1.8	0.53
+3,720	+1.8	0.51
+9,600	+1.8	0.66

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6.2.2 Alloy Reaction

Chemical analysis of the spray droplets collected on the bottom plate indicated a lithium content of 0.56 wt%. X-ray diffraction results identified only lead metal with lithium metal as a likely constituent and lead oxide as a possible constituent. Auger analysis of spray droplets collected from the bottom steel plate at the end of the test indicated an oxygen content of 0.35 atom percent and nitrogen content of <0.04 atom percent. This spray droplet analysis verifies the conclusion from the atmosphere balance that there was very little chemical reaction of high temperature alloy spray droplets with an air atmosphere.

6.2.3 Aerosol Mass Concentration and Particle Size Measurements

Aerosol suspended in the ICV atmosphere was at a low enough concentration that it was not visible through the viewport during the test. The suspended aerosol lithium and lead content reached peak concentrations of 1.9 mg/m^3_{STP} and 203 mg/m^3_{STP}, respectively, at 560 s after start of spray. A peak total aerosol concentration of 367 mg/m^3_{STP} was measured at the same time. The aerosol concentrations of lithium, lead, and total aerosol are shown in Figure 41 as a function of time during the test. The ratios of lithium to lead atoms and of lithium plus lead to total aerosol are shown in Figure 42. It is interesting to note that after about 4,000 s, the ratio of lithium to lead atoms increased, suggesting that lead may settle at a greater rate than does lithium.

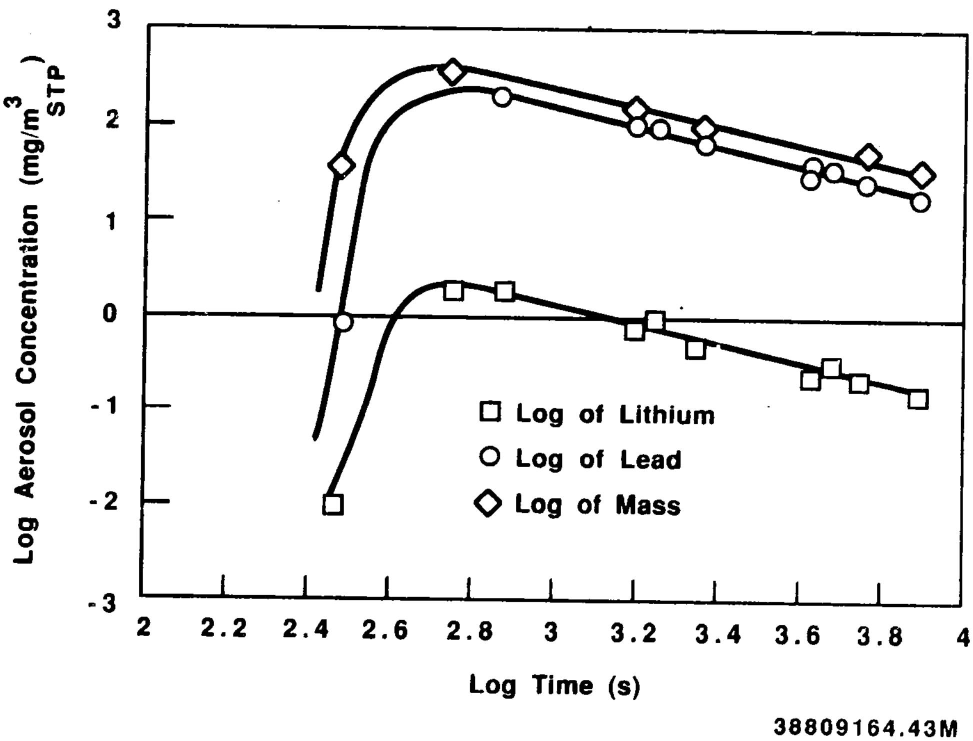

Figure 41. Intermediate Containment Vessel Suspended Aerosol Concentration-- Test ASA-1.

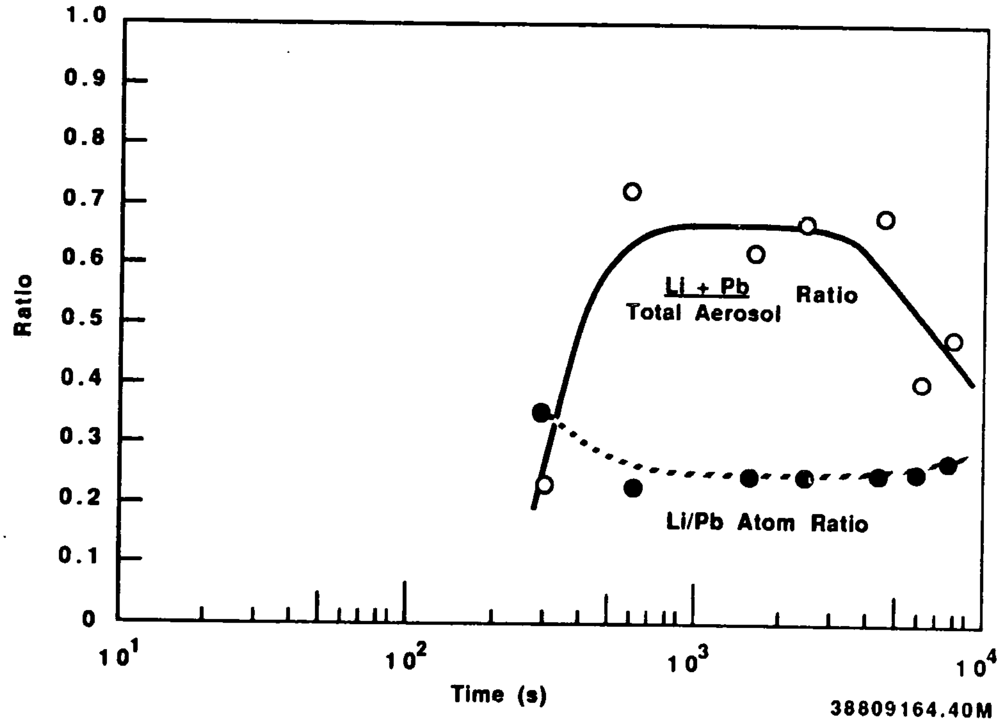

Figure 42. Atom Ratio of Lithium to Lead in Suspended Aerosol--Test ASA-1.

Aerosol particle size samples were taken three times during the test. The sample stages were analyzed for both lithium and lead. The aerosol particle size calculations were in good agreement for both lithium and lead analyses. Results of the particle size analysis are summarized in Table 23. The data for these samples are listed in Tables B-9 through B-14 and plotted in Figures B-5 through B-7 of Appendix B.

Table 23. Aerosol Particle Sizes--Test ASA-1.

Time after start (s)	AMMD (μm)		Geometric standard deviation (σ)	
	Lithium	Lead	Lithium	Lead
750	4.59	4.84	2.16	2.18
1,770	3.29	3.41	1.83	1.75
4,680	2.49	2.62	1.72	1.63

AMMD = Aerodynamic mass median diameter.

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7.0 ALLOY-STEAM REACTION

One intermediate-scale lithium-lead alloy-steam reaction test (AWR-1) was completed. Major conclusions from this test include the following: (1) the maximum alloy pool temperature produced by sparging steam into 510 °C lithium-lead alloy is 870 °C, (2) steam can react with all of the lithium in the alloy to form Li_2O and/or LiOH, (3) hydrogen is generated at the rate of 0.52 g mol per g atom of lithium reacted, (4) steam does not react with lead, and (5) lithium and lead aerosols can be released during steam reactions with the alloy.

7.1 EXPERIMENTAL EQUIPMENT AND PROCEDURE

The test was conducted in the ICV previously described in Section 3.1. The equipment arrangement is shown in Figure 43. The equipment included a reaction vessel, a steam condensate system, and a steam supply system. The supply system was designed to provide a controlled temperature and flow rate of steam to the alloy in the reaction vessel. It consisted of inline heaters, a flow orifice, thermocouples, a test supply line, and a bypass line to valve the established steam flow from the bypass line to the test supply line. The desired steam flow rate and temperature were established through the bypass line with an appropriate backpressure, and the steam flow was then switched to the test vessel at the desired time. Offgas from the reaction vessel was routed through the condenser to condense any steam and allow the noncondensed gas to be returned to the ICV where the hydrogen could be measured. The mass of water condensed was determined by weighing.

The reaction vessel and condensate system are shown in Figure 44 with the location of the pool thermocouples, steam discharge line, and offgas vent line. The reaction vessel heaters, controlling thermocouples, and insulation are also shown in this figure. The reaction vessel was made from 0.305 m dia Schedule-40 pipe. The pipe and flanges were 316 SS and the gasket material on the top flange was graphite. The steam discharge line was 13 mm dia and was extended to within 25 mm from the bottom of the reaction vessel. A preweighed HT-9 corrosion coupon was located just below the steam discharge point. The condenser was to condense any water vapor and allow hydrogen to be returned to the mixed atmosphere in the ICV. A fan was located in the ICV to provide atmosphere mixing and minimize any stratification of the hydrogen and argon in the ICV atmosphere.

The test was conducted according to the general procedure listed below.

1. Load 1,362 g lithium and 198.6 kg lead in the reaction vessel.
2. Position the graphite gasket, bolt on the top flange, and inert the reaction vessel with argon.
3. Arrange the test equipment as shown in Figure 43.
4. Establish an argon atmosphere in the ICV at 102.8 kPa (absolute) pressure.
5. Heat the lithium and lead to 510 °C, and mix the metals with an argon sparge for 30 min to form the alloy.
6. Establish the steam flow through the bypass line with a backpressure of 27.6 kPa, and measure the condensate buildup rate.
7. Start the ICV atmosphere mixing fan.

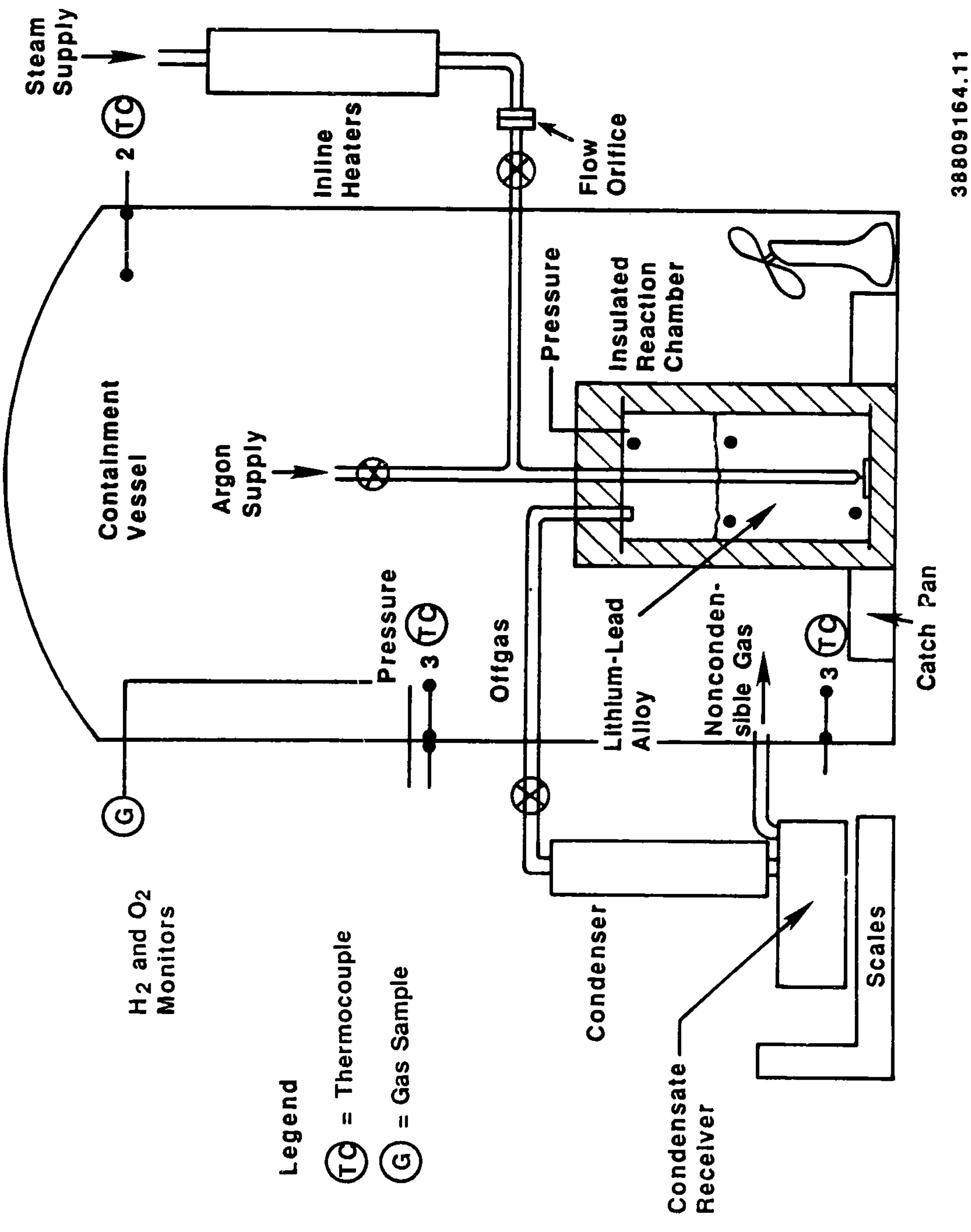

Figure 43. Steam Injection into Alloy Test Equipment Arrangement--Test AWR-1.

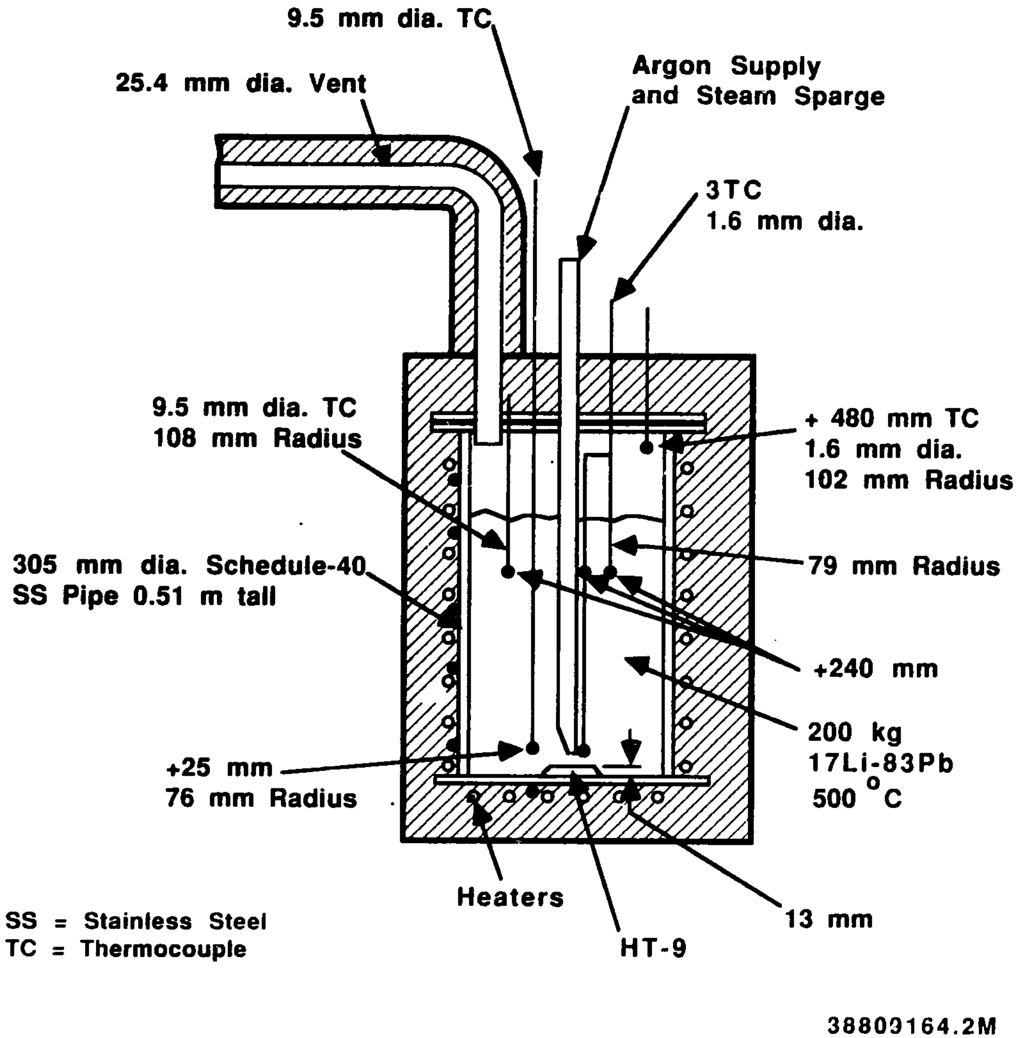

Figure 44. Steam Injection Test Reaction Vessel--Test AWR-1.

8. Obtain background gas and aerosol samples.

9. Turn off all reaction vessel heaters.

10. Valve the steam flow to the reaction vessel.

11. Obtain gas and aerosol samples, and measure condensate buildup.

12. Obtain alloy temperatures, ICV atmosphere temperatures, pressure, and hydrogen concentration as a function of time.

13. Discontinue steam flow after 330 s.

14. Allow reaction chamber to cool.

15. Establish an air atmosphere in the ICV, open the ICV, and obtain photographs and samples of the reaction product residue.

7.2 RESULTS OF TEST AWR-1

The test consisted of sparging steam at about 7 g/s for 330 s into a 200 kg alloy pool at 510 °C. The temperature of steam injected into the alloy was about 335 °C. The actual temperature of the steam during the injection period is shown in Figure 42. The steam flow rate was determined from the measured pressure drop across a 7.16-mm dia orifice. The measured pressure drop is also shown in Figure 45. The reaction chamber (see Figure 43) was covered with 76 mm of insulation to minimize heat loss. Steam reacted with lithium in the alloy producing Li_2O and hydrogen and generating heat by Equation 1, with a heat release of 85 kcal/g mol of Li_2O.

$$2Li + H_2O \longrightarrow Li_2O + H_2 \qquad (1)$$

The Li_2O accumulated on the top suraface of the alloy as it was formed, since it is much less dense than lead. As lithium was depleted from the alloy, steam bubbled through the remaining molten depleated alloy and reacted with Li_2O to form LiOH by Equation 2, with a heat release of 16.4 kcal/g mol LiOH. The steam flow was terminated before reacting all of the Li_2O to LiOH. The Li_2O is a solid at these temperatures. For this intermediate-sized test (0.30-m dia reaction vessel), significant contacting occurred.

$$Li_2O(s) + H_2O(g) \longrightarrow 2LiOH(l) \qquad (2)$$

The Li_2O and LiOH reaction products accumulated on the surface of the depleted alloy. The LiOH is a liquid at these test temperatures and would tend to float on the top of the depleated alloy because of the density differences. Condensate collected in the condenser at the end of the test was determined to have a mass of 453 g. Hydrogen release was measured in the ICV atmosphere. Reaction product compositions were determined by chemical analyses of test samples. Suspended aerosol mass concentrations were measured in the ICV atmosphere.

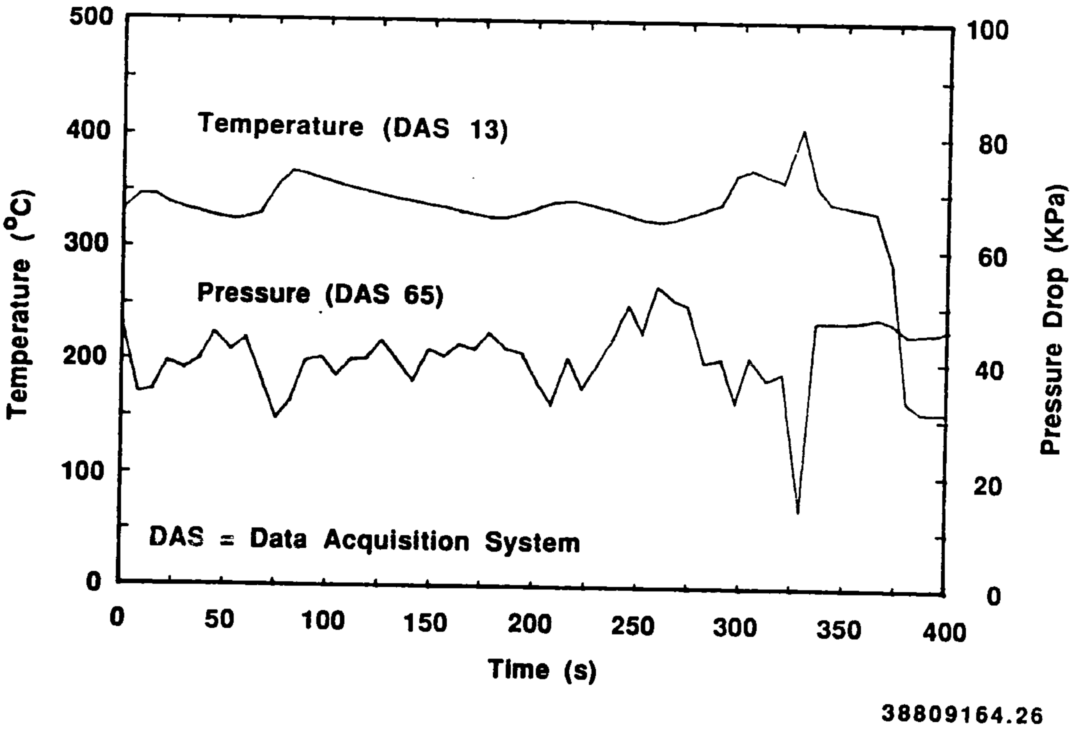

Figure 45. Steam Temperature and Pressure Drop Across Steam Supply Orifice--Test AWR-1.

In a postulated accident situation involving steam leakage into a pool of alloy, solid Li_2O would be expected to be formed on the surface of the alloy early in the accident sequence. As hydrogen leaves the alloy surface, it tends to push the Li_2O away from the pool surface area where gas is escaping. This may, depending on the geometry of the accident, prevent or limit the contact of steam (bubbled through the alloy only after lithium was depleted) with the Li_2O on the alloy pool surface to form LiOH.

7.2.1 Alloy Pool Temperature Response

Most of the pool temperature increase occurred during the first 240 s of the steam sparge. Lithium in the alloy reacted with the injected steam to form Li_2O during this time. The peak alloy pool bulk and local temperatures reached a maximum of 870 °C at about 240 s into the steam sparge. The alloy pool temperatures at various locations throughout the test are shown in Figure 46. The alloy temperature at the point of steam injection was considerably higher during the early times of injection than the bulk temperatures of the alloy as shown by thermocouple 1 in Figure 46. This implies that (1) the steam-lithium reaction occurred near the area of injection and (2) the lithium in the alloy was depleted at the time the temperature at the point of injection equaled the temperature of the rest of the alloy.

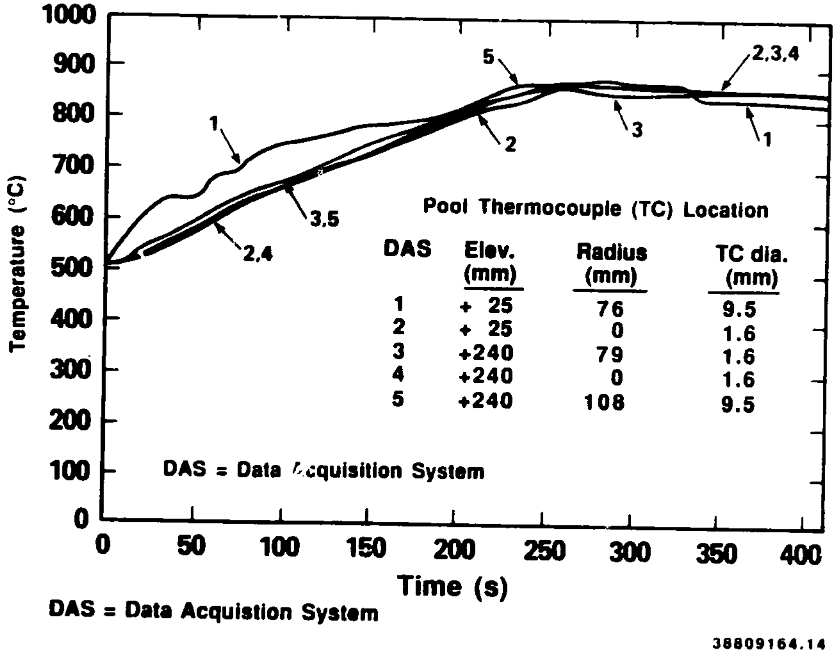

Figure 46. Alloy Pool Temperatures--Test AWR-1.

7.2.2 Hydrogen Release

Hydrogen released during the test is shown in Figure 47. The hydrogen release was calculated to be 98.6 g mol using the ideal gas law from the measured ICV atmosphere pressure and temperature and the assumption that all of the noncondensable gas discharged to the ICV atmosphere was hydrogen. The temperature of the gas discharged from the condenser to the ICV was measured to be 24 to 25 °C throughout the test (DAS 22). The ICV atmosphere pressure and approximate average temperature are shown in Figure 48. The ICV atmosphere temperature measurement at 1.8 m above the vessel floor was used as the approximate average ICV atmosphere temperature. The mass spectrometric analyses of gas samples taken during the test are shown in Table 24. The hydrogen released based upon mass spectrometric analyses and measured ICV atmosphere pressure and temperature was 96.6 g mol. The amount of hydrogen release calculated by these two methods are in good agreement and indicate that the hydrogen released amounted to 0.51 to 0.52 g mol hydrogen per g atom of lithium reacted. The hydrogen concentration indicated by the hydrogen monitor (Table A-9 of Appendix A, DAS 60) was less than that indicated by the mass spectrometric results.

After the steam injection was completed, the reaction vessel was isolated from the ICV atmosphere by closing the reaction vessel vent valve. The pressure in the reaction vessel increased, and it was necessary to vent the pressure several times. A mass spectrometric sample of the gas was obtained and determined to consist of 90% hydrogen and about 10% argon. A total hydrogen release of 0.58 g mol of hydrogen was calculated over a 20-min period following the termination of steam flow. This slow hydrogen release is thought to occur because of the LiOH reaction with iron at this high temperature.

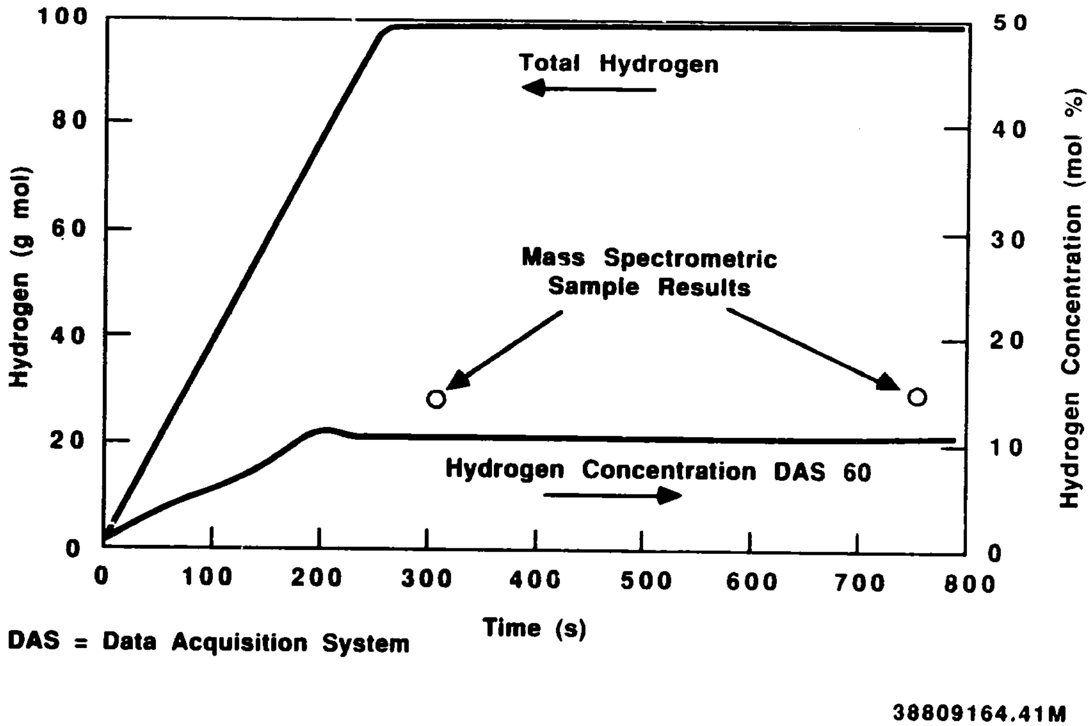

Figure 47. Hydrogen Released--Test AWR-1

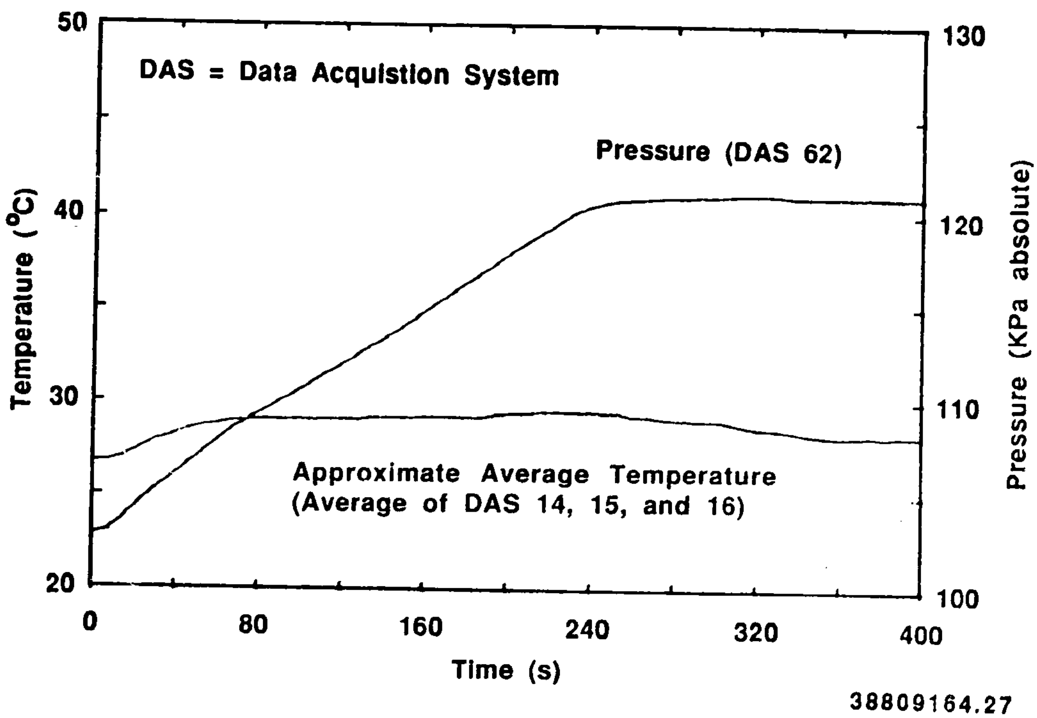

Figure 48. Intermediate Containment Vessel Atmosphere Pressure and Approximate Average Temperature--Test AWR 1

Table 24. Mass Spectrometric Analyses of Test AWR-1 Gas Samples.

Time after start (s)	Location (m)	Concentration (mol%)					
		Oxygen	Nitrogen	Argon	Carbon dioxide	Hydrogen	Helium
-300	+1.8	0.82	99.1	0.05	<0.01	<0.01	<0.01
+300	+1.8	0.25	85.4	0.10	<0.01	14.2	<0.01
+720	+1.8	0.20	85.1	0.09	<0.01	14.6	<0.01
+3,600	+1.8	0.15	85.1	0.10	<0.01	14.6	<0.01

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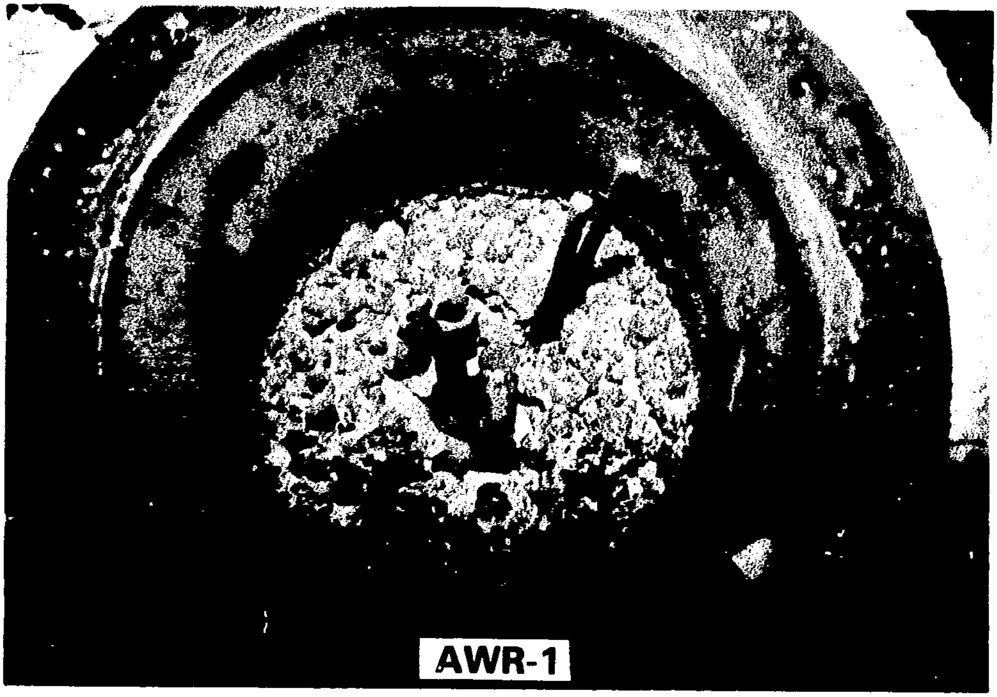
7.2.3 Solid Reaction Product Evaluation

Results of the reaction product chemical analyses show that the lithium content of the alloy was depleted from 0.68 to 0.0025 wt% during the test. Two samples of the depleted alloy were analyzed for lithium content. One obtained within 25 mm of the top surface indicated a final lithium content of 0.0029 wt% and one from the bottom 25 mm of the depleted alloy indicated 0.0022 wt% lithium. About 99.6% of the lithium in the alloy reacted with steam to form Li_2O, LiOH, and hydrogen gas. Hydrogen release amounted to about 0.52 g mol per g atom of lithium reacted. Hydrogen was released from the steam-lithium reaction (forming Li_2O) and from the reaction of LiOH with iron from the reaction chamber. The fact that essentially all of the lithium was depleted from the alloy was supported by the melting point of the final metal at 327 °C, the same as pure lead.

The solid reaction products, found on top of the metal during posttest inspection, were porous and contained spherical droplets of metal dispersed throughout. A photograph of the top surface of the reaction products is shown in Figure 49. The porous reaction products were about 76 mm thick at the outer wall and tapered to 0 mm at a radius of about 50 mm. The presence of metal droplets in the porous solids and the indented top surface of the metal, observed during disassembly, implied that the reaction products solidified before the alloy pool solidified on cooldown. This observation supports the fact that LiOH has a higher melting point than does lead metal. The solid reaction product removed from the top of the metal had a mass of 4,095 g. It was separated into two fractions for analyses. One fraction consisted of a gray-colored, porous material which accounted for about 95 vol%; the other fraction consisted of a white-colored material which accounted for about 5 vol%. Small beads of alloy about 2-mm dia were suspended in the white and gray, porous material. Wet chemical analysis results of the gray material indicated 0.37 mass fraction lead and 0.24 mass fraction lithium. Wet chemical analysis of the white material indicated 0.12 mass fraction lead and 0.33 mass fraction lithium. X-ray diffraction analysis of the gray material separated from the larger alloy droplets indicated 29 wt% LiOH, 65 wt% Li_2O, and 6 wt% lead. X-ray diffraction analysis of the porous white material indicated 41 wt% LiOH, 56 wt% Li_2O, and 3 wt% lead. The suspended beads were analyzed to contain 0.11 wt% lithium with the remainder being lead. There were no oxide or hydroxide compounds of lead identified by X-ray diffraction.

The mass of Li_2O remaining at the end of the test was about 1,895 g and the mass of LiOH generated was about 832 g, based upon chemical analysis of reaction products. The quantity of water required to react with lithium to form this quantity of Li_2O and LiOH was 1,767 g. The water



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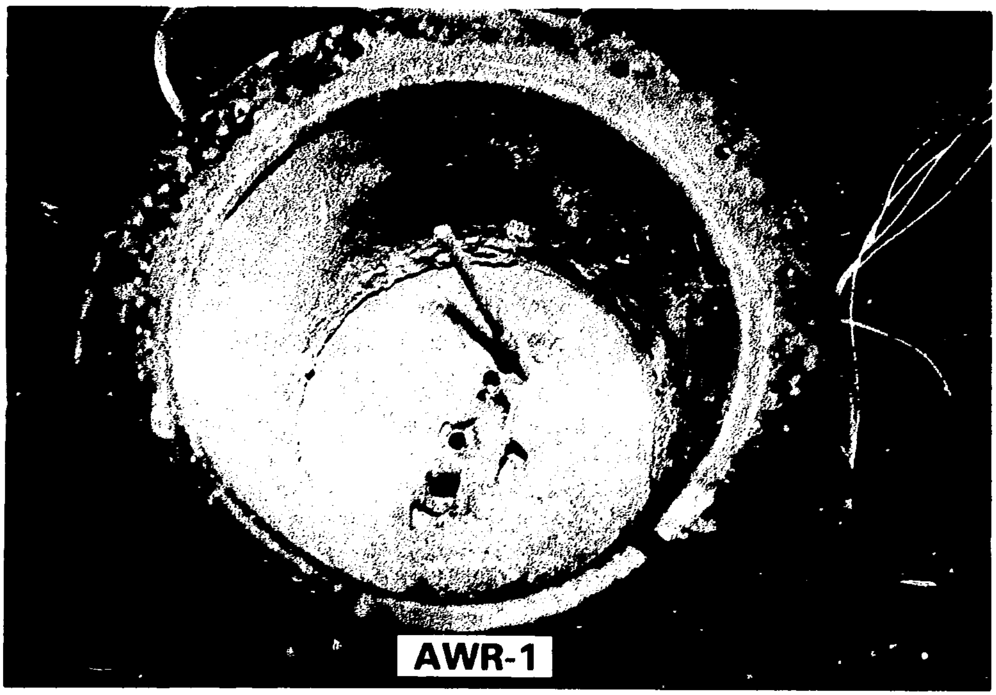

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Figure 49. Reaction Products Residue--Test AWR-1.

condensate collected in the condenser was 453 g. The total water accounted for was 2,220 g. This agrees well with the measured steam injection of 2,310 g. The mass fraction of lithium accounted for in the reaction products was only 83%.

7.2.4 Aerosol Mass Concentration

The results of ICV atmosphere aerosol samples obtained and analyzed for mass concentrations of lead and lithium are listed in Table 25. These results are also plotted in Figure 50 as a function of time. The peak suspended lead mass concentration measured (3.90 mg/m$^3{}_{STP}$) was 960 s after the steam sparge was started. The peak suspended lithium mass concentration measured (983 µg/m$^3{}_{STP}$) was at 600 s after the start. Much of the aerosol released from the reaction vessel was collected in the condenser. The mass of condensate collected was 453 g. The condensate was analyzed to contain 0.20 g lithium and 0.039 g lead. No suspected aerosol particle size samples were taken. It is interesting to note that during this test the suspended lead concentration in the ICV atmosphere was much greater than the suspended lithium concentration throughout the test, even though lithium hydroxide was formed on the top surface of the alloy near the end of the steam injection period. The reason for this is that the aerosol was routed through the condenser, which removed more lithium than lead, since lithium hydroxide is much more soluble in water than lead.

7.2.5 Corrosion

The reaction products severely corroded a HT-9 ferritic steel corrosion coupon included in the test. The 76.2-mm by 25.4-mm by 3.0-mm-thick coupon lost 28 wt% during the test. This was 0.274 g/cm^2. The coupon was attached to the steam injection line so that the steam would be directed onto the coupon during the test. At the end of the test, the coupon was still attached to the injection line, but it had floated to the top of the depleated alloy pool. The final position of the coupon is shown in the photograph in Figure 49.

Table 25. Suspended Aerosol Mass Concentration for Test AWR-1.

Time after start of steam flow (s)	Sample	Lead concentration (µg/m$^3{}_{STP}$)	Lithium concentration (µg/m$^3{}_{STP}$)	Atom ratio lithium/lead
-240	FO	<71	92	>38.8
150	F1	623	156	7.5
390	F2	2,750	657	7.1
600	Mitex[a]	1,942	983	15.1
960	F3	3,897	840	6.4

[a]Mitex is a trademark of the Millipore Corp.

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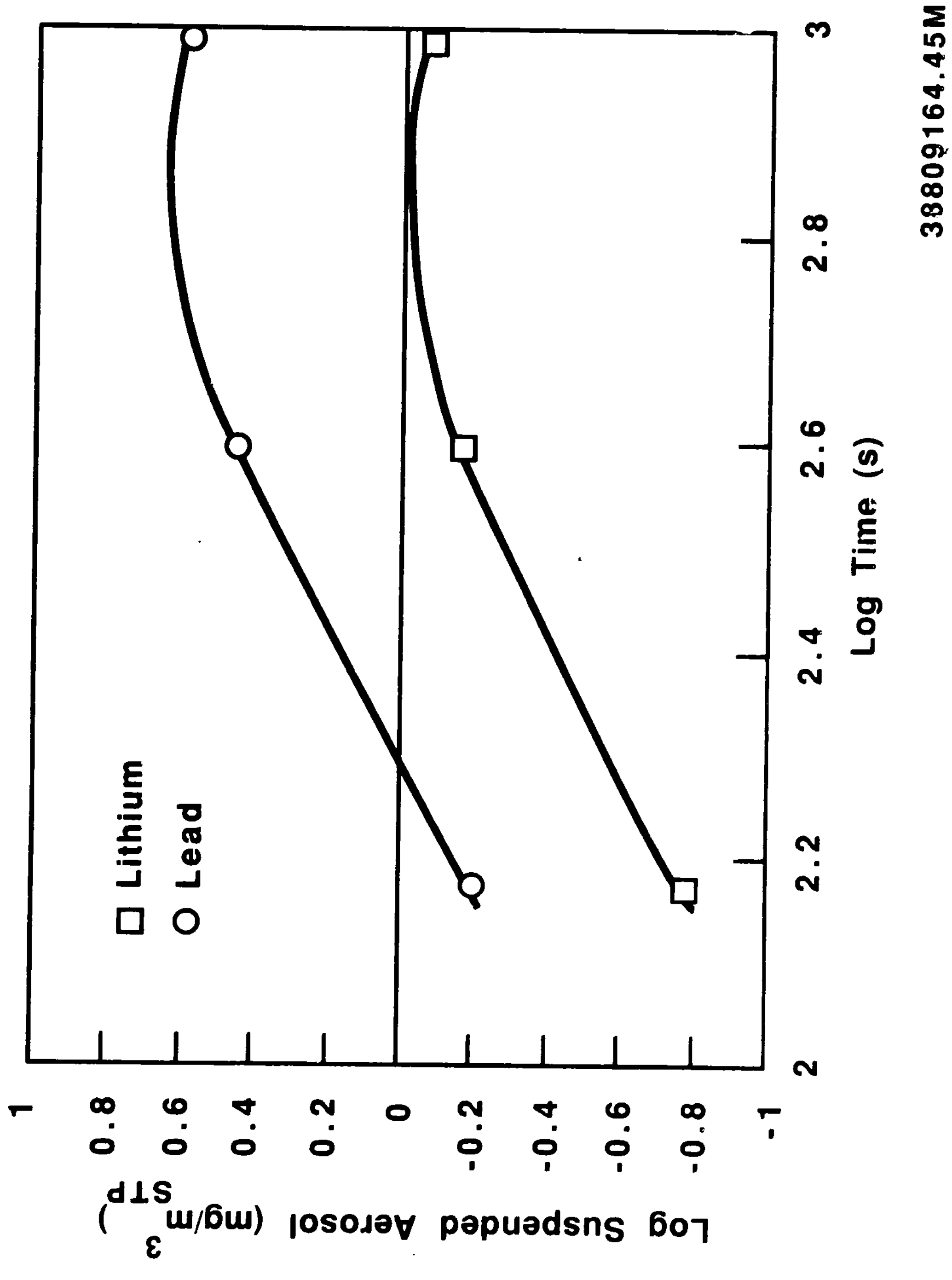

Figure 50. Suspended Aerosol Concentration - Test AWR 1.

8.0 WATER INJECTION INTO LEAD AND LITHIUM-LEAD ALLOY

Water injection into lead and lithium-lead alloy tests were conducted to determine energy production, reaction product composition, hydrogen gas production, containment atmosphere temperature and pressure response, and aerosol and activation product behavior. The two tests were each conducted with a liquid metal mass of about 200 kg to allow comparison for determination of the effects of lithium in the alloy. The test designations were WIL-1 for the water injection into lead test and WIA-1 for the water injection into alloy test. The results of these tests support safety evaluations for the use of lithium-lead alloy as a breeder material in a fusion reactor when water is considered for use as a coolant in a limiter, diverter, and/or secondary loop. Results of these tests indicate that safety concerns associated with a water-leakage-to-alloy accident scenario include hydrogen production and radioactive species release. The radioactive species of concern include mercury vapor under operating and postulated accident conditions and lead, sodium, potassium, and possibly polonium aerosol under postulated accident conditions.

8.1 EXPERIMENTAL EQUIPMENT AND PROCEDURE

8.1.1 Intermediate Containment Vessel

These tests were conducted in the canyon of the CSTF located in Building 221T. These tests were performed in the 2.1-m dia by 3.7-m high ICV described in Section 3.1. This vessel was moved from Building 105 DR to the CSTF. Heaters and insulation were attached to the floor and outer walls of the ICV to maintain a controlled steam atmosphere in the vessel during a test. Heaters with a total capacity of 48 kW were installed with controllers and thermocouples. The ICV was insulated with 51-mm-thick insulation. A photograph of the insulated ICV is shown in Figure 51.

8.1.2 Reaction Vessel

The reaction vessel used for tests WIL-1 and WIA-1 is shown in Figure 52. It consisted of a 0.356-m dia Schedule-40 carbon steel pipe with a flat plate welded on the bottom and a flanged collar welded to the top. Three 12.7-mm dia couplings and one 25.4-mm dia coupling were welded to the bottom plate to allow water injection to the lead or alloy. Rupture disks, which relieved at 3.31 MPa (at 500 °C), were positioned in the ends of two of the 12.7-mm dia couplings, and a rupture disk, which relieved at 1.61 MPa (at 500 °C), was positioned at the end of the 25.4-mm dia coupling.

8.1.3 Water Injector

The water injector consisted of a hydraulic ram which was powered with bottled gas. A measured amount of water could be added to the ram to be injected by high pressure through a rupture disk and into the lead alloy. A remote-operated electric valve was used to control the time of injection. The injector arrangement is shown in Figure 53. A pressure gage and recorder were used to record the pressure of the water injector discharge during the test. The discharge line was filled with water before loading the amount of water into the injector. The discharge line and electric valves were cooled by water jackets inside the ICV. The water cooling line and valves were also insulated.

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Figure 51. Insulated Intermediate Containment Vessel with Heaters and Controllers.

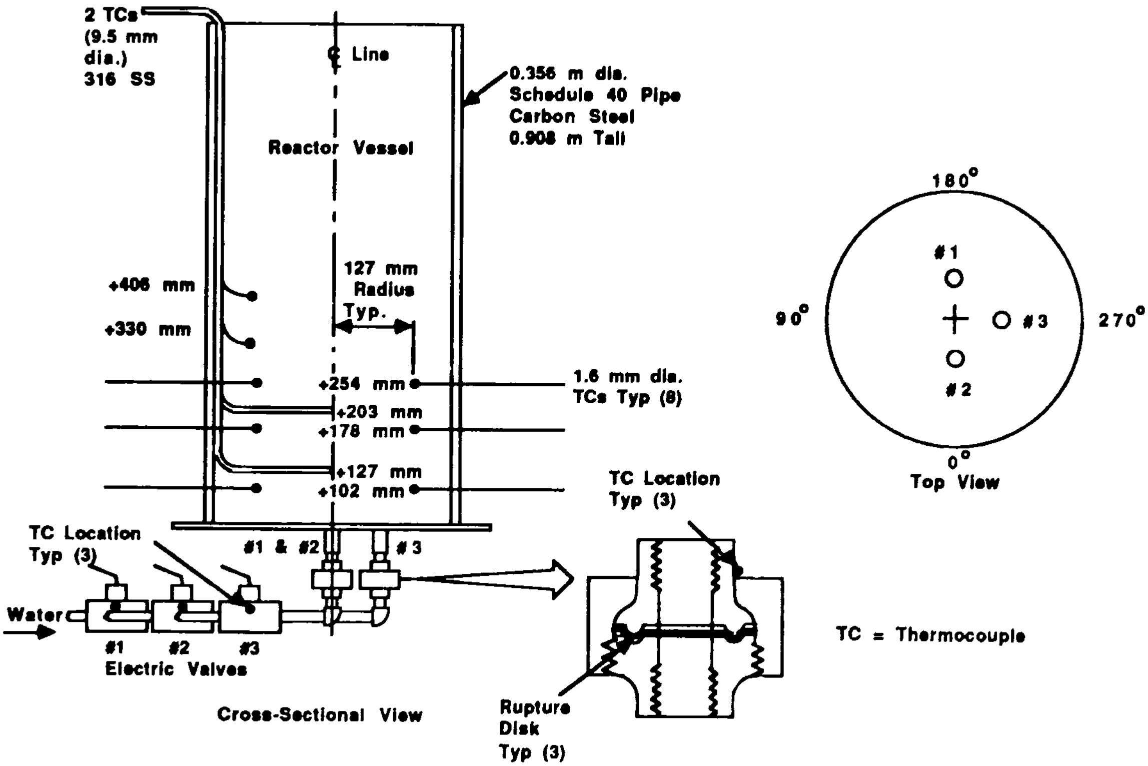

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Figure 52. Reaction Vessel for Water Injection Tests.

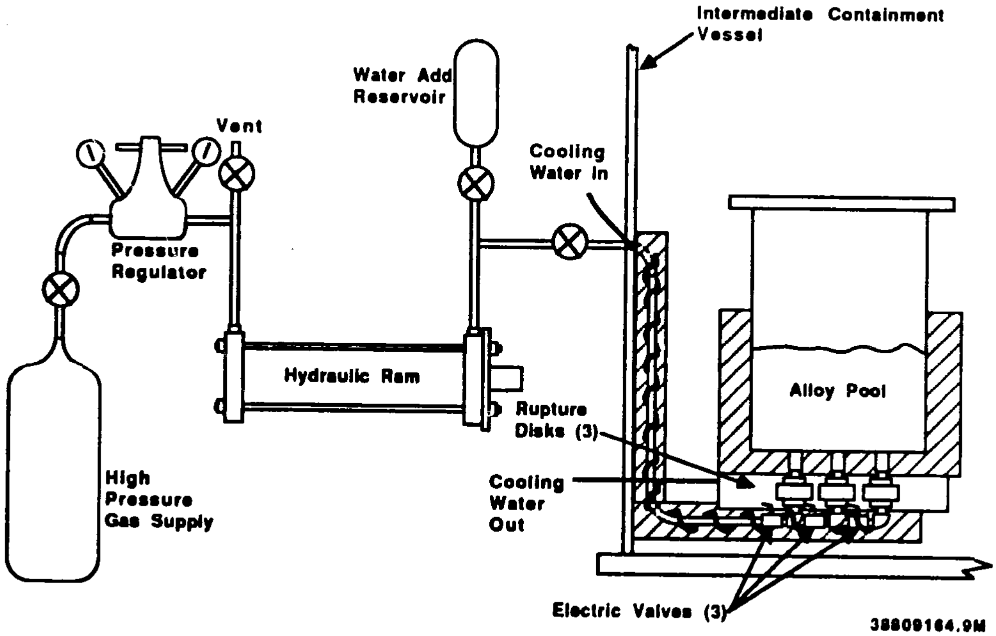


Figure 53. Water Injection System--Test WIL-1.

8.1.4 Procedure

Test WIL-1 was conducted according to the general procedure listed below.

1. Load 200 kg lead in the reaction vessel.
2. Purge the ICV with argon to reduce the oxygen concentration below 1%.
3. Start cooling water flow to the water injection line and electric valves.
4. Heat the ICV atmosphere to about 158 °C.
5. Heat the lead in the reaction vessel to 520 °C.
6. Adjust the ICV atmosphere to ~113.5 kPa (absolute) by adding or venting argon.
7. Load the hydraulic ram for a 225 g water discharge.
8. Increase the hydraulic ram pressure to 4.2 MPa (gage), open electric valve number three, and discharge the water.
9. Close the electric valve when the ram piston reaches the stop point, and record the discharge time.
10. Obtain gas and aerosol samples; monitor temperatures and gas concentrations.

11. Allow the lead to cool below 60 °C, establish an air atmosphere in the ICV, open the ICV, and photograph and obtain samples of the remaining lead.

12. Remove the lead from the ICV floor.

Test WIA-1 was conducted according to the procedure listed below.

1. Replace rupture disks in the three discharge lines.

2. Add 5.3 kg lead, 1,372 g lithium, 0.7 g mercury, 135 g bismuth, 160 g thallium, and 1.3 g tellurium to the lead remaining in the reaction vessel from test WIL-1. (Add murcury by drilling a small hole in the lead, pouring the mercury in the hole, and plugging the hole with a lead plug.)

3. Establish an argon atmosphere in the ICV with an oxygen concentration at $< 1\%$.

4. Start cooling water flow to the water injection line and eletric valves.

5. Heat the ICV atmosphere to ~163 °C.

6. Heat the lead and other metals in the reaction vessel to 700 °C.

7. Mix the alloy by sparging argon through rupture disk number 1 into the lead and other metals for 30 min.

8. Obtain ICV atmosphere samples for mercury during mixing process.

9. Allow the alloy temperature to cool to 532 °C.

10. Load the hydraulic ram for a 225 g water discharge.

11. Increase the hydraulic ram pressure to 5 MPa absolute, open electric valve number three, and discharge the water through disk number three.

12. Close the electric valve when the ram piston reaches the stop point, and vent the ram gas pressure to the atmosphere.

13. Load the hydraulic ram for another 225 g water discharge.

14. Increase the hydraulic ram pressure to 5 MPa absolute, open electric valve number three, and discharge the water.

15. Close the electric valve when the ram piston reaches the stop point, and record the discharge time.

16. Obtain gas and aerosol samples; monitor temperatures and gas concentrations.

17. Allow the depleted alloy to cool below 60 °C, establish an air atmosphere in the ICV, open the ICV, and photograph and obtain samples of remaining material.

8.2 POOL TEMPERATURE RESPONSE

The test WIL-1 lead pool temperature decreased about 18.5 °C during a 10-s period as the 225 g of water was injected. The lead pool temperatures measured at four locations are shown in Figure 54 for the initial 600 s after start of water injection. The slow temperature increase after water injection until about 900 s was due to the reaction vessel heaters, which had been set at 520 °C. The heaters were turned off at about 900 s after water injection and the pool was allowed to cool as shown in Figure 55 by the lead pool temperatures measured at the same four locations. The reaction between the water and the lead appeared to be a physical exchange of heat with no evidence of a chemical reaction. The lead pool and reaction vessel wall latent heat decreased by 603 kJ during the water injection period as calculated from the change in temperatures. The water enthalpy increased during the same period by about 589 kJ as determined for the 225 g water change in state from liquid to gas and temperature increase to the lead pool temperature. This heat balance is in good agreement and suggests that no exothermic reactions such as the formation of lead oxide occurred.

For test WIA-1, the alloy pool temperature increased about 52 °C during the water injection periods. Water injection of 225 g of water occurred during the first 235 s, and 225 g of water was injected between 422 and 457 s after the start of the test. The alloy pool temperatures measured at four locations are shown in Figure 56 for the first 600 s after the start of water injection and in Figure 57 for 0 to 50,000 s. The reason for the extended water injection times encountered for this test was determined to be a partially blocked water delivery line. After the argon sparging process to mix the alloy was completed, valve number one failed to close. Alloy drained down the line to the cold tee and partially blocked the water flowpath.

Energy production from the water interaction with lithium in the alloy amounted to about 39 kcal/mol water. This energy release measured during the test agrees with the theoretical energy expected for complete water reaction with the lithium lead alloy. This energy production is mild and the total energy produced in a large water discharge would be limited by the lithium content of the alloy. If all of the lithium in the alloy were reacted with water, a maximum expected alloy temperature would be 740 °C if the initial alloy temperature were 500 °C. The maximum temperature produced by complete water reaction with alloy is actually less than that produced by complete steam reaction with alloy (same mass of water and steam), because with water, some of the chemical heat produced is used in evaporating water to steam. Water injection beyond that required to deplete the lithium from the alloy would be expected to cool the remaining lead toward the equilibrium temperature of the water.

8.3 CHEMICAL COMPOSITION OF REACTION PRODUCTS

Chemical analysis of the reaction products indicated that the water reacted to completion forming lithium monoxide and small amounts of lithium hydroxide. Hydrogen gas release was determined by mass spectrometric analyses to be sufficient to support this conclusion. About 1 mol of hydrogen was formed for each mole of water injected. Provisions must be made in a fusion reactor to control this hydrogen gas release under these postulated accident conditions. The maximum hydrogen gas production would be limited to the lesser of 1 mol/mol of water injected or 0.5 mol of hydrogen per g atom of lithium in the alloy which could contact the injected water. The equipment arrangement and reaction products of tests WIL-1 and WIA-1 are shown in Figure 58.

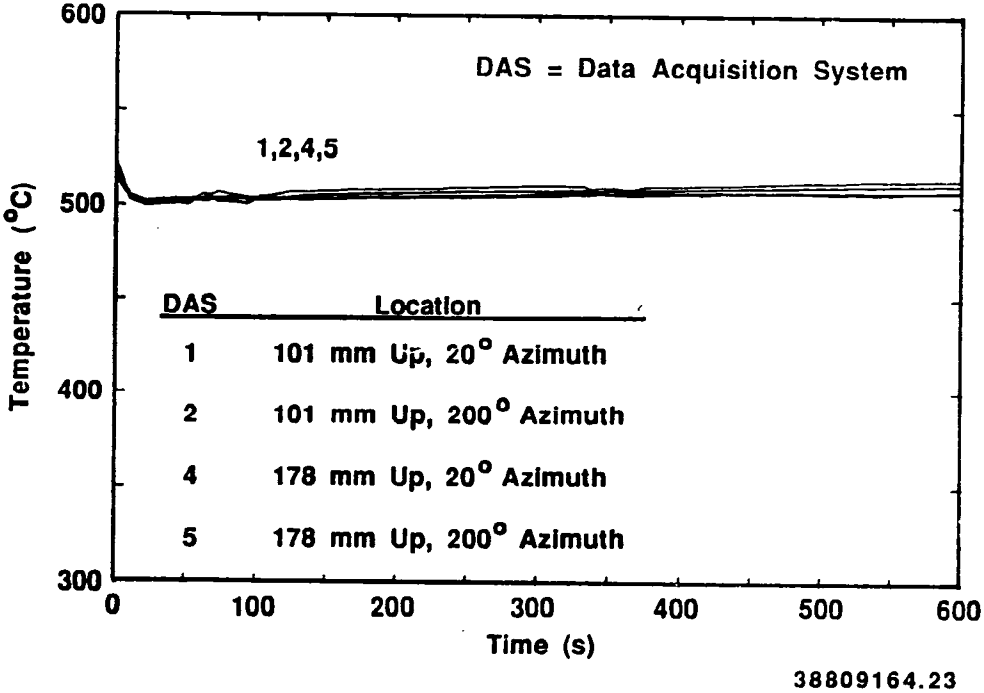


Figure 54. Lead Pool Temperatures for Initial 600 s--Test WIL 1.

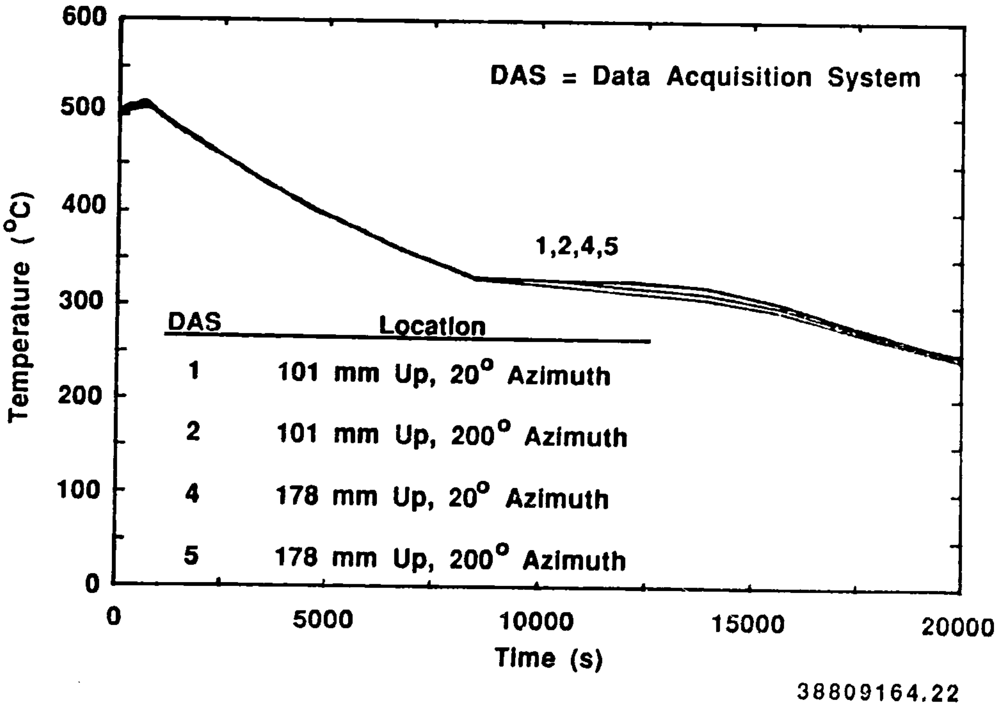


Figure 55. Lead Pool Temperatures for 20,000 s--Test WIL-1

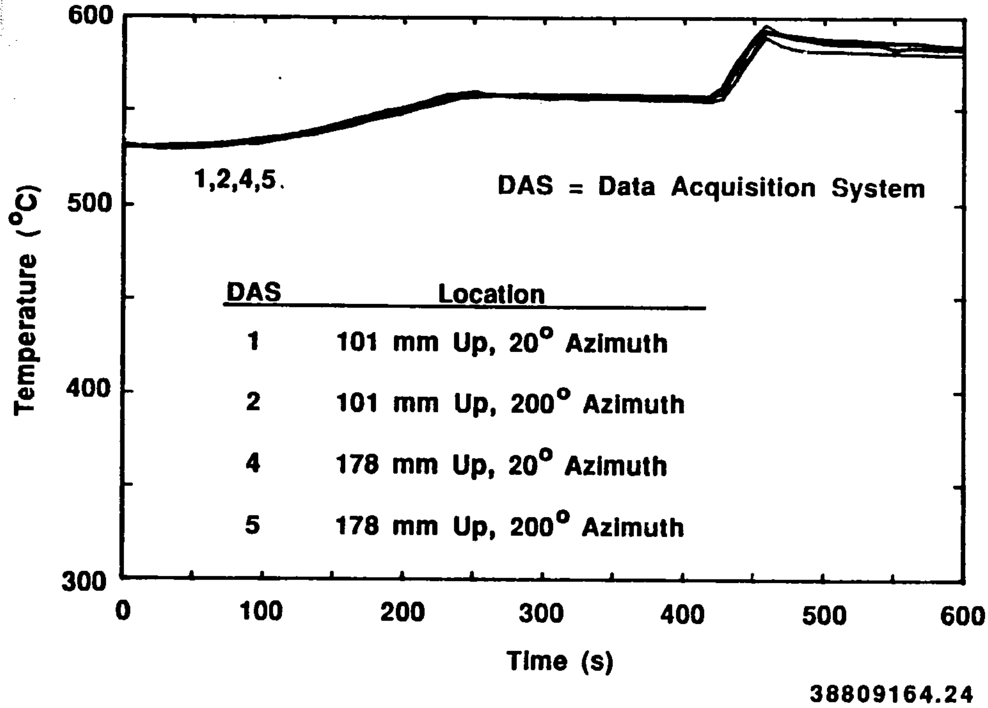


Figure 56. Alloy Pool Temperatures for Initial 600 s--Test WIA-1.

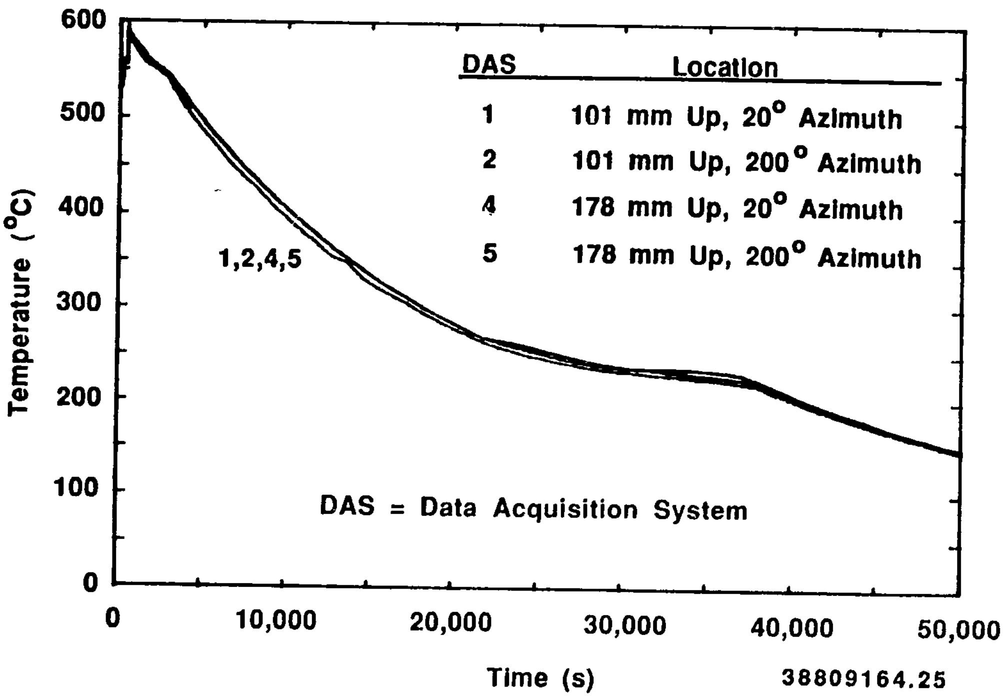
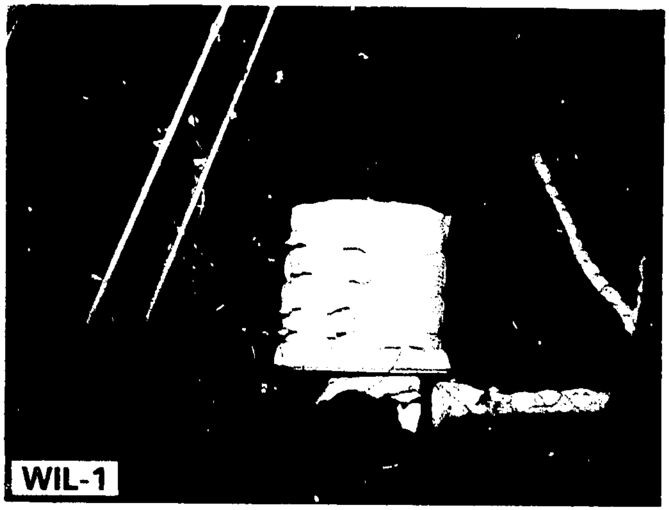


Figure 57. Alloy Pool Temperatures for 50,000 s--Test WIA-1.



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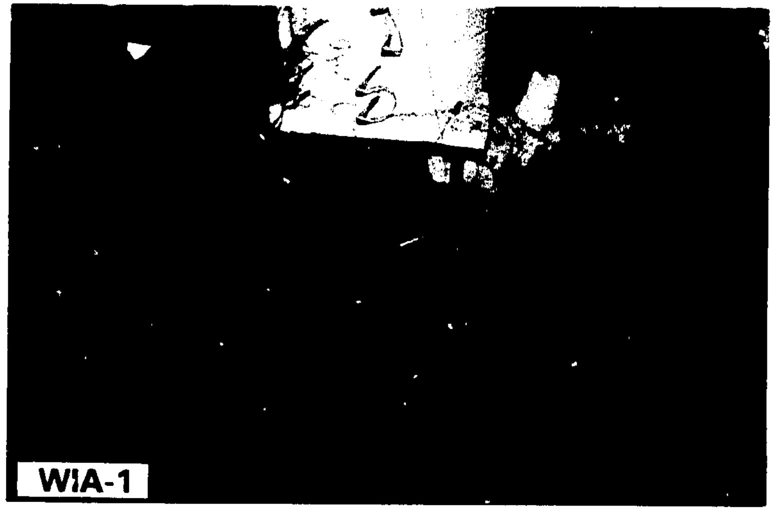

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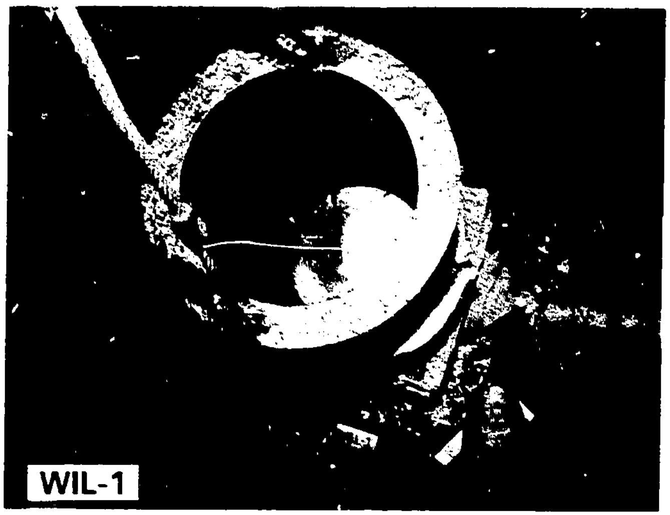

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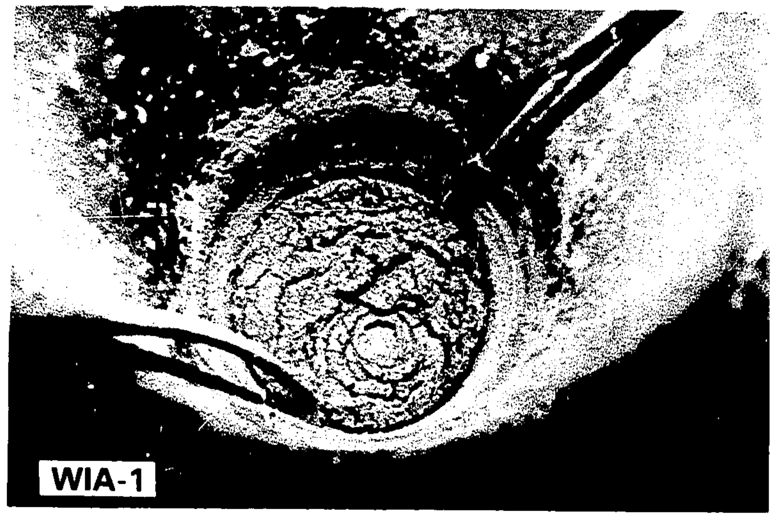

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Figure 58. Equipment Arrangement and Reaction Products for Tests WIL-1 and WIA-1.

X-ray diffraction analysis of the gray, porous material on top of the depleted alloy (sample WIA-RP-1 with metallic beads removed) indicated ~80 wt% lead, ~15 wt% lithium monoxide, ~5 wt% lithium hydroxide, and possibly a trace of lead oxide (PbO). X-ray fluorescence analysis of this material indicated that the metallic ions present, excluding lithium (atoms with a mass less than boron), were 92 wt% lead, 7 wt% iron, 1 wt% zinc, and 0.2 wt% zirconium. Wet chemical analysis results of sample WIA-PR-1 with metallic beads present indicated 3.07 wt% lithium.

X-ray diffraction analysis of the red flakes on top of the lead at the end of test WIL-1 (Sample WIL-PR-1) indicated that there was about 57 g lead oxide (PbO) and 19 g iron oxide (Fe_2O_3) present.

8.4 INTERMEDIATE CONTAINMENT VESSEL ATMOSPHERE RESPONSE

Test WIL-1 ICV atmosphere pressure and approximate average temperature response to the water injection are shown in Figure 59. The peak atmosphere temperature and pressure occurred within 30 s of the start of water injection. The pressure increased about 6.5 kPa, and the approximate average temperature increased about 6 °C. An ICV atmosphere material balance before and after water injection indicated that about 4.5 g mol (81 g) of steam was released during this time. No hydrogen was detected in the ICV atmosphere after water injection by the continuous hydrogen monitor or by analysis of the mass spectrometric samples. The mass spectrometric gas sample analyses are shown in Table 26.

Test WIA-1 ICV atmosphere pressure and approximate average temperature are shown in Figure 60. The pressure and temperature increases corresponded with the two periods of water injection. The first period of water injection was for 235 s in which 225 g of water was injected to the alloy. The second period of water injection was for 37 s beginning 422 s after the start of the first water injection period. During the second water injection period, 225 g of water was injected. By the end of the second injection period, the ICV atmosphere pressure had increased by about 11 kPa and the temperature had increased by about 10 °C. Hydrogen gas was released by the reaction. The hydrogen gas concentration is shown in Figure 61. Mass spectrometric analyses of gas samples taken during the test are listed in Table 27. Calculations using the perfect gas law and the measured hydrogen concentration indicated that 25.9 g mol hydrogen was in the ICV atmosphere at +1,107 s after start of water injection. Sample of the ICV atmosphere showed that the water content of the atmosphere decreased slightly during the test. Samples HO taken at -2,300 s indicated 12.5 g/m^3_{STP}, H1 taken at +630 s indicated 11.1 g/m^3_{STP}, H2 taken at +1,830 s indicated 7.4 g/m^3_{STP}, and H3 taken at +5,910 s indicated 6.9 g/m^3_{STP}. The measured hydrogen release during the reaction supports the conclusion that the injected water reacted with the lithium in the alloy to form lithium monoxide and hydrogen. Essentially 1.0 mol hydrogen was formed for each mole of water injected. Some of the moisture in the ICV atmosphere apparently reacted with the lithium monoxide to form lithium hydroxide.

For a postulated accident involving alloy-water interaction in a containment building, the containment atmosphere temperature and pressure responses are affected by the hydrogen and water vapor released. The water vapor released could condense on cold cell surfaces and minimize the impact on containment pressure. Hydrogen released into an air atmosphere could burn as it is released to form water vapor, as long as oxygen is available. Hydrogen could also build up in the containment atmosphere to increase the pressure if no oxygen is present or hydrogen could be released at a low enough temperature that no combustion occurs even in the presence of oxygen. Appropriate atmosphere pressure and temperature mitigation control methods would be required to control hydrogen from these postulated accident conditions.

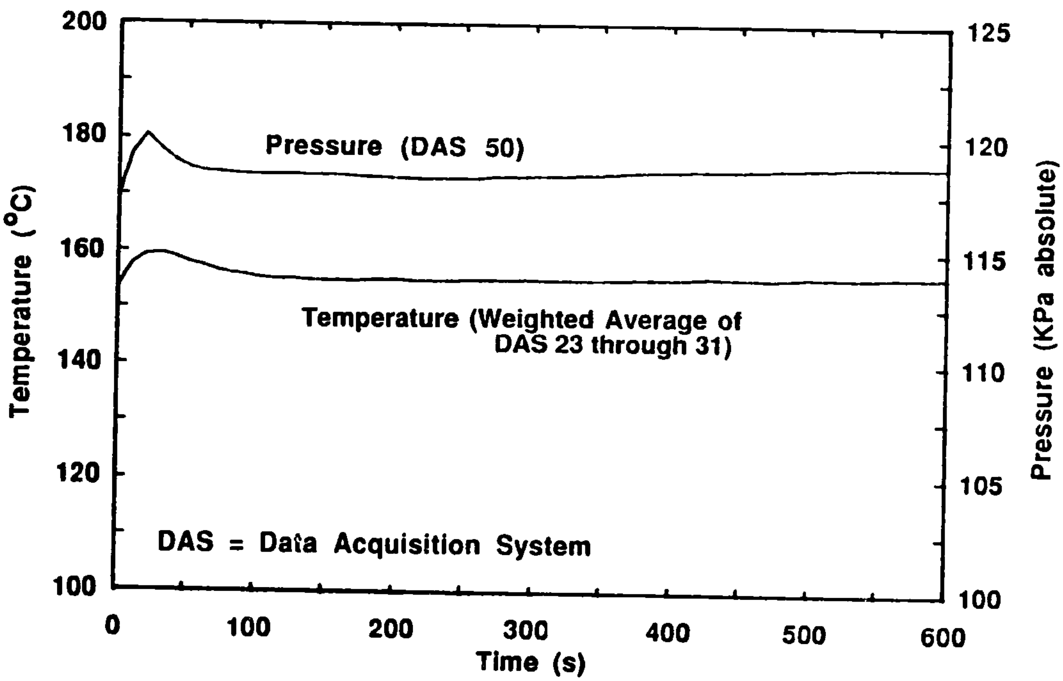

Figure 59. Intermediate Containment Vessel Atmosphere Pressure and Approximate Average Temperature--Test WIL-1.

Table 26. Mass Spectrometric Analyses of Test WIL-1 Gas Samples.

Time after start (s)	Location (m)	Concentration (mol%)					
		Oxygen	Nitrogen	Argon	Carbon dioxide	Hydrogen	Helium
-3,240	+1.8	0.02	0.78	99.2	0.04	<0.01	<0.01
+3,000	+1.8	0.09	0.88	98.9	0.09	<0.01	<0.01

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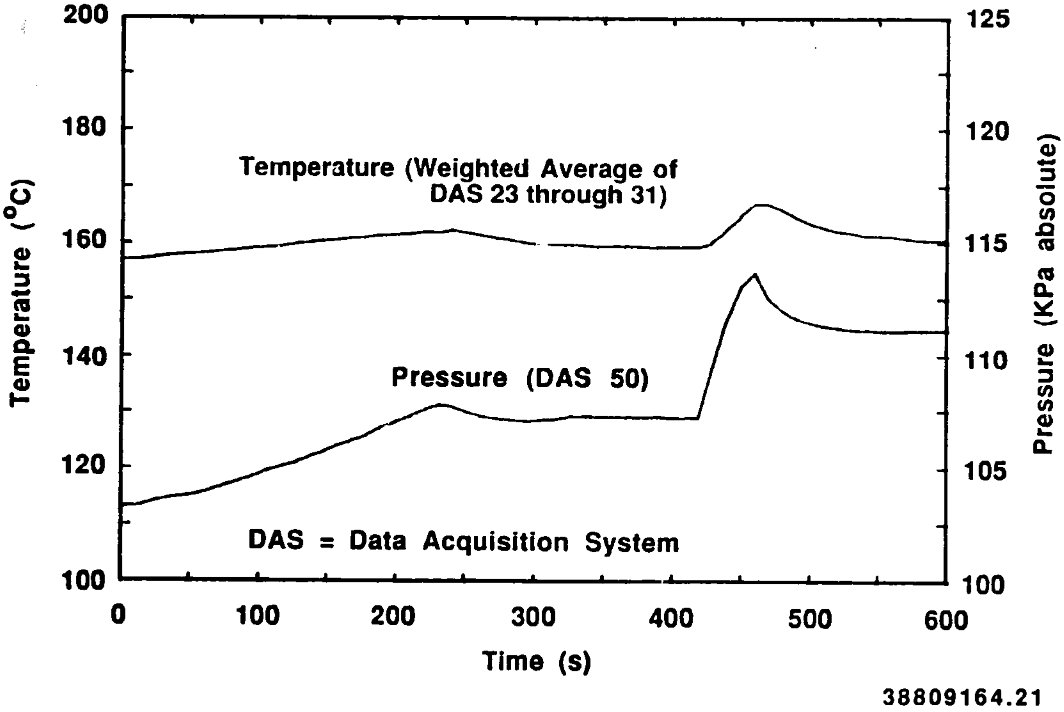

Figure 60. Intermediate Containment Vessel Atmosphere Pressure and Approximate Average Temperature--Test WIA-1.

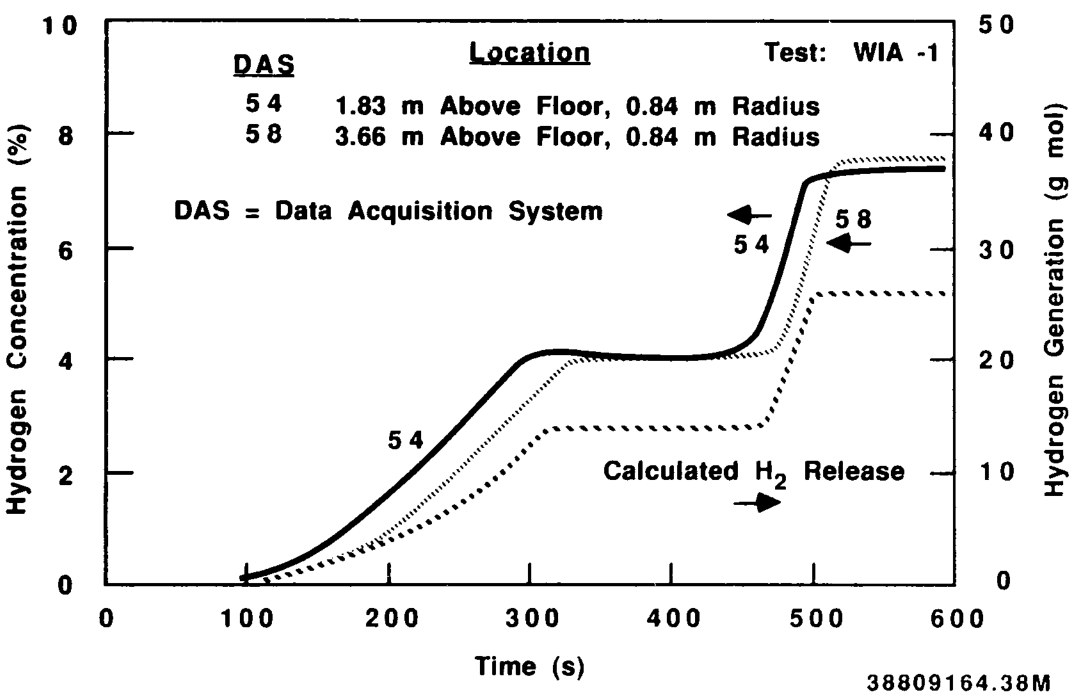

Figure 61. Intermediate Containment Vessel Atmosphere Hydrogen Gas Concentration and Rate of Hydrogen Release--Test WIA-1.

Table 27. Mass Spectrometric Analyses of Test WIA-1 Gas Samples.

Time after start (s)	Location (m)	Concentration (mol%)					
		Oxygen	Nitrogen	Argon	Carbon dioxide	Hydrogen	Helium
+1,107	+1.8	<0.01	0.94	93.0	0.01	6.10	<0.01
+1,980	+1.8	<0.01	1.14	92.8	0.01	6.02	<0.01

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8.5 AEROSOL AND RADIOACTIVE SPECIES RELEASE

The WIA-1 test alloy was prepared so that it would have simulated radioactive species concentrations of sodium, potassium, mercury, bismuth, thallium, and lead at concentrations similar to those that may be expected in a fusion reactor operating at a neutron wall load of 5 MW/m^2 and irradiation time of 5 yr (Piet 1985). Tellurium was also added as an impurity at an atom ratio expected for the radioactive species polonium for the above reactor alloy exposure. Tellurium was used in place of polonium for these tests because it has similar chemical properties but is not radioactive.

The initial species content of the alloy used in test WIA-1 was determined by summing the species in the lead, species in the lithium, and separately added species. Chemical analysis of a sample of the lead used to make up the alloy; the sodium and potassium impurities in the lithium used to make up the alloy (as provided by the vendors); and the amounts of mercury, bismuth, thallium, and tellurium added are shown in Table 28. The concentration and total mass of each species in the final alloy were determined by summing up each constituent. These values for test WIA-1 are shown at the bottom of Table 28.

Table 28. Species Content of Initial Alloy--Test WIA-1.

Description	Lead	Lithium	Sodium	Potassium	Mercury	Bismuth	Thallium	Tellurium
Lead (g)	200,000	0.1	4.8	0.52	0.001	2.4	1.2	1.0
(p/m)	--	0.50	24	26	0.005	12	5.8	5.2
Lithium (g)	--	1,372	0.12	0.12	--	--	--	--
(p/m)	--	--	90	90	--	--	--	--
Other (g)	--	--	--	--	0.7	135	160	1.3
Alloy (g)	200,000	1,372	4.9	0.64	0.7	137	161	2.3
(p/m)	--	6,826	24	3.2	3.5	682	801	11

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Samples were obtained to determine species behavior during alloy mixing and during and after water injection. During alloy mixing, ICV atmosphere samples were obtained to determine suspended aerosol species and mercury vapor concentrations. Gelman filter papers were used to collect aerosols, and backup carbon filter paper was used to collect mercury vapor. The concentrations of aerosol and mercury vapor, as determined from the analyses of the mixing samples, are shown in Table 29. The total maximum suspended mass in the ICV atmosphere and the fraction of each species suspended are included. Sample FO was obtained when the alloy was at 500 °C. Sample FM-1 was obtained when the alloy was at 527 °C. Sample FM-2 was obtained after a 30-min argon sparge to mix the alloy while the alloy was at 531 °C.

Table 29. Species Suspended in Intermediate Containment Vessel Atmosphere During Alloy Preparation--Test WIA-1.

Sample	Time (s)	Species present (mg) [mg/m^{3}STP]								
		Lead	Lithium	Mercury		Sodium	Potassium	Bismuth	Thallium	Tellurium
				Aerosol	Vapor					
F0	Pretest -9,240	(0.028) [0.99]	(0.096) [3.4]	(0.00015) [0.0053]	(0.0031) [0.109]	(0.56) [19.8]	(0.049) [1.73]	(0.008) [0.21]	(0.003) [0.106]	(0.0047) [0.168]
FM-1	Heatup -5,700	(1.3) [49.4]	(0.23) [8.74]	(0.0001) [0.0038]	(0.0038) [0.14]	(0.59) [22.4]	(0.036) [1.37]	(0.017) [0.65]	(0.004) [0.15]	(0.0052) [0.20]
FM-2	Sparge -3,060	(0.38) [16.0]	(0.10) [4.2]	(0.0001) [0.0042]	(0.0014) [0.185]	(0.59) [24.8]	(0.034) [1.43]	(0.006) [0.25]	(0.001) [0.042]	(0.0042) [0.177]

STP = Standard temperature and pressure.

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During alloy preparation, the maximum suspended mass concentrations of lead, lithium, bismuth, thallium, and tellurium were measured as the alloy was heated to near the maximum temperature (sample FM-1). The maximum mercury vapor concentration was measured at the end of the sparge period (sample FM-2). Mercury was determined to be (1) present mainly as a vapor, rather than a suspended liquid or (2) associated with the suspended solid aerosol particles, since it was collected on the backup charcoal filter paper rather than the Gelman paper. Suspended sodium and potassium concentrations were about the same for each of the aerosol samples. An estimate of the total species released during alloy preparation was estimated from the maximum aerosol suspended, since the total mass was very small and settling or plating of aerosol would occur very slowly. The total species mass released during alloy preparation was estimated to be sodium, 7%; potassium, 3%; tellurium, 0.12%; lithium, 0.009%; bismuth, 0.0067%; thallium, 0.0013%; and lead, 0.00037%. The maximum mercury suspended in the ICV atmosphere was 0.38%. Additional mercury probably was released and condensed on the ICV walls. The ICV wall temperature was below the boiling point of mercury throughout the alloy preparation period. In general, the fractions of species released were related to their boiling points. The species with low boiling points had greater fractions released than those with higher boiling points. The melting and boiling points of each of the species of interest are listed in Table 30.

Species released during water injection and suspended aerosol concentration after injection were measured by obtaining aerosol samples from the ICV atmosphere during and after water injection. The samples taken, the time the samples were taken, the analytical results, and the calculated suspended concentrations in the ICV atmosphere are listed in Table 31.

Table 30. Melting and Boiling Points of Species.

Metal	Melting point (°C)	Boiling point (°C)
Mercury	-38.9	357
Potassium	63.5	758
Sodium	97.8	883
Polonium	254	962
Tellurium	450	994
Lithium	178	1336
Thallium	304	1470
Bismuth	271	1560
Lead	327	1751

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Table 31. Intermediate Containment Vessel Atmosphere Sample Results and Calculated Concentrations During and After Water Injection--Test WIA-1.

Sample	Time (s)	Species present (μg) [$mg/m^3{}_{STP}$]								
		Lead	Lithium	Mercury		Sodium	Potassium	Bismuth	Thallium	Tellurium
				Aerosol	Vapor					
F-1	+180	(400) [13.1]	(370) [12.1]	(0.026) [0.0009]	(3.2) [0.105]	(560) [18.4]	(31) [1.0]	(9) [0.3]	(2) [0.07]	(4.7) [0.15]
F-2	+1,050	(130) [9.2]	(400) [28.3]	(0.023) [0.0016]	(2.8) [0.20]	(560) [39.6]	(30) [2.1]	(15) [1.1]	(<1) [<0.07]	(3.8) [0.27]
F-3	+1,350	(100) [6.7]	(330) [22.1]	(0.016) [0.0011]	(2.0) [0.13]	(580) [38.8]	(29) [1.9]	(15) [1.0]	(<1) [<0.07]	(5.8) [0.39]
F-4	+2,640	(130) [4.4]	(510) [17.3]	(0.026) [0.0009]	(2.3) [0.08]	(550) [18.7]	(29) [0.99]	(22) [0.75]	(<1) [<0.03]	(5.4) [0.18]
F-5	+3,240	(110) [3.9]	(470) [16.6]	(0.025) [0.0009]	(2.7) [0.09]	(500) [17.7]	(27) [0.95]	(17) [0.60]	(<1) [<0.04]	(3.0) [0.11]
F-6	+5,100	(230) [2.6]	(1,100) [12.5]	(0.045) [0.0005]	(4.7) [0.054]	(540) [6.2]	(31) [0.35]	(43) [0.49]	(<1) [<0.010]	(4.9) [0.056]
F-8	+6,780	(220) [1.9]	(1,150) [10.2]	(0.082) [0.0007]	(5.4) [0.048]	(520) [4.6]	(29) [0.26]	(45) [0.40]	(<1) [<0.009]	(3.8) [0.034]
F-9	+43,980	(31) [0.22]	(240) [1.70]	(0.082) [0.0006]	(81) [0.57]	(380) [2.7]	(28) [0.20]	(12) [0.085]	(<1) [<0.007]	(5.4) [0.038]

STP = Standard temperature and pressure.

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The peak species suspended aerosol concentrations measured during and after water injection occurred just after water injection at + 1,050 s for lithium, mercury, sodium, potassium, bismuth, and thallium. The peak suspended concentration of lead was measured at + 180 s and the peak tellurium at + 1,350 s. The maximum mercury vapor concentration occurred at + 43,980 s after start of test when the alloy and ICV atmosphere had cooled below 180 °C and 75 °C, respectively. All species of aerosol reached a peak suspended mass concentration early and then began settling out of the atmosphere slowly. The slow settling rate is expected because of the low concentrations of aerosol measured and small particle sizes.

A cascade impactor sample was taken 2,040 s after start of water injection to measure suspended aerosol particle size. The results of the sample based upon lithium and lead analyses are listed in Tables B-16 and B-17 and are plotted in Figure B-8 of Appendix B. The AMMD of the suspended aerosol at 2,040 s was 0.31 μm based upon lithium and 1.82 μm based upon lead. The results based upon lithium are expected to be more accurate, since there was 0.57 mg lithium collected in the sample and only 0.18 mg lead. A cascade impactor sample obtained during test WIL-1 at 3,240 s after start of water injection indicated that the AMMD based upon lead analysis was 2.57 μm. The results of this sample are listed in Table B-15 and plotted in Figure B-7 of Appendix B.

The total species released as aerosol during water injection were estimated from the peak concentrations of suspended aerosol. The total species released as aerosol during water injection were estimated to be sodium, 7.8%; potassium, 3.1%; tellurium, 0.16%; lithium, 0.020%; bismuth, 0.0080%; thallium, 0.00040%; and lead, 0.00006% of the initial alloy species content.

The residual material remaining in the ICV at the end of test WIA-1 consisted of a gray, porous material (about 90 mm thick) on top of the depleted alloy (176 mm thick). The grey porous material had a funnel-shaped hole through it, directly above the position where the water was injected. The funnel-shaped hole through the porous material had a diameter of ~38 mm at the top surface of the depleted alloy and ~130 mm at the top of the porous material.

Samples of the porous material, depleted alloy, and material ejected from the reaction chamber during mixing were obtained and analyzed to determine the final species content of these materials. The results of these analyses are listed in Table 32.

A material balance is listed in Table 33 for each species by summing the species content of the porous material, depleted alloy, ejected material, and aerosol.

Table 32. Species Content of Final Reaction Products--Test WIA-1.

Sample	Material	Mass (g)	Sample analysis (p/m)						
			Lithium	Sodium	Potassium	Mercury	Bismuth	Thallium	Tellurium
RP-1	Porous (including metallic beads)	9,500	30,700	14	1.7	1.6	1,100	770	28
RP-2	Depleted alloy	188,000	6,000	17	2.0	1.1	25	720	4.5
RP-4	Depleted alloy	--	3,300	--	--	0.78	300	--	--
RP-3	Ejected	2,500	73,600	18	2.0	1.3	5,700	5,100	40
DEP-2	Ejected	--	26,600	19	5.5	1.2	74,500	9,500	--

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Table 33. Species Mass and Fraction of Initial Alloy Content--Test WIA-1.

Material	Mass (g)							
	Lead	Lithium	Sodium	Potassium	Mercury	Bismuth	Thallium	Tellurium
Porous	8,850	291	0.13	0.016	0.015	10.45	7.3	0.26
Depleted alloy	187,000	874	3.2	0.35	0.21	4.7	135	0.85
Ejected material	2,230	125	0.05	0.009	0.003	100	18.3	0.1
Aerosol	0.12	0.27	0.38	0.020	0.0020	0.011	0.00064	0.0037
Total (fraction of initial)	198,000 (1.0)	1290 (0.94)	3.76 (0.82)	0.43 (0.67)	0.23 (0.33)	115 (0.84)	161 (1.0)	1.2 (0.52)

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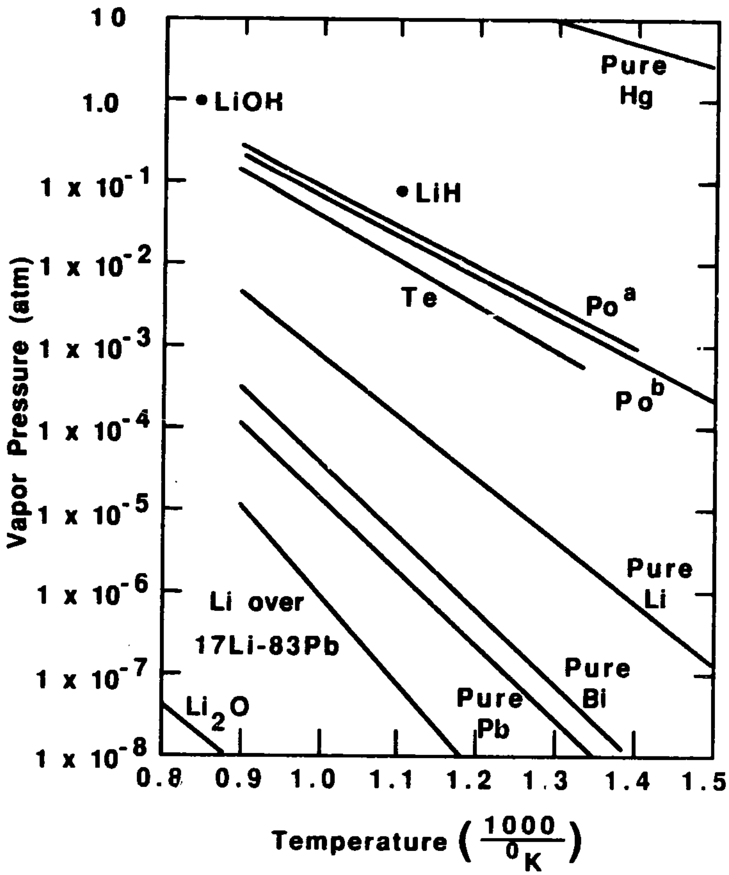
The material balance indicates that most of each species (except mercury) was accounted for in the solid reaction products. Mercury may have vaporized from the high temperature alloy and condensed on the relatively cold ICV walls. No samples of the ICV walls were obtained, since this potential mechanism was not considered until after the chemical analysis was completed. Future tests may be used to evaluated this possible mechanism. Another observation of interest is that most of the bismuth was found in the ejected material at the end of the test. This implies that the bismuth content of the alloy was less than that used in determining the fraction of bismuth becoming an aerosol. Calculations using this adjusted content would result in a greater fraction (about 0.032 instead of 0.008) being released as an aerosol during water injection.

Activation species behavior results indicated that sodium and potassium (two impurities in lithium and lead) appeared to have the greatest fraction of initial species suspended in the atmosphere. Tellurium (a substitute for polonium) and mercury each had the next greatest fraction suspended by about an order of magnitude less than sodium or potassium. Tellurium is a reasonable substitute for polonium, because it is in the same group of the periodic table. It is located just above polonium in group VIa. However, it is classed as a nonmetal, while polonium is classed as a metal. The boiling points of tellurium and polonium are about the same as shown in Table 30.

Reduction of the quantity of sodium and potassium impurities in the initial alloy used as a breeder may effectively reduce the aerosol content of these potential activation species to an acceptable level under postulated accident conditions. Mercury was found to be released as a vapor from the breeder material during the mixing period as well as the water injection period. Mercury appears to be a safety concern during plant operations and in the event of a postulated water-injection-into-an-alloy accident. Mercury poses concerns from radioactivity and chemical toxicity considerations. The relatively high fraction of tellurium suspended in the containment atmosphere implies that there may be some concern about the behavior of polonium during the postulated accident conditions. Further understanding of polonium would need to be obtained by performing tests using polonium, which exists only as a radioactive isotope. The vapor pressure of polonium is shown in Figure 62 along with the vapor pressures of pure lead and lithium over lithium-lead alloy. The vapor pressures of lithium oxide, lithium hydroxide, lithium hydride, mercury, and bismuth are shown for points of reference.



[a] Abakumov and Ershova 1974.

[b] Brooks 1955.

38809164.36M

Figure 62. Vapor Pressure of Fusion Alloy Related Materials.

9.0 SCOPING REACTION TESTS BETWEEN ALLOY AND MISCELLANEOUS COOLANTS

9.1 SCOPING REACTION TESTS BETWEEN ALLOY AND ORGANIC COOLANTS

Scoping reaction tests between lithium-lead alloy and organic coolants were completed. Two sets of tests were conducted, one in which organic was added to excess alloy and a second where alloy was added to excess organic. Tests substituting lead for alloy were included in each set for comparison. The organic coolants tested were OS-84* fluid and Dowtherm A.** Fluid OS-84 is a modified terphenyl with a specific gravity of 1.00 and a boiling point of 343 °C. Dowtherm A is a 73.5% diphenyl oxide and 26.5% biphenyl mixture with a specific gravity of 1.06 and a boiling point of 257 °C.

For the first set of tests in which organic was added to metal, 2.7 g of organic was added to ~1,000 g of metal heated to 400 °C in a chamber that had an atmosphere volume of about 1.60 L. The test chamber was preheated to ~380 °C inside a furnace to minimize heat losses. Fluid OS-84 at 325 °C was added to alloy and to lead. Dowtherm A at 225 °C was added to alloy and to lead. The organics were added through a hypodermic needle. An argon atmosphere was established in the reaction chamber prior to metal heatup and organic addition. The test results are listed in Table 34 as reaction chamber pressure increase, total gas release, hydrogen release, and light hydrocarbon release. The organic addition and the reaction chamber atmosphere pressure increase occurred within 30 s for each test.

Table 34. Test Results of Reaction from Organic Addition to Metal.

Organic	Metal	Initial and final temperature (°C)		Chamber pressure increase (kPa)	Total gas release (g mol)	Hydrogen (mL)	Methane (mL)	Ethylene (mL)	Ethane (mL)	Propylene (mL)	Propane (mL)
		Metal	Gas								
Dowtherm A[a]	Lead	400	365	18.2	0.014	0.0	<0.1	<0.1	<0.1	<0.1	<0.1
Dowtherm A	Alloy	400	375	44.8	0.013	48	0.7	0.2	0.1	--	-
OS-84 Fluid[b]	Lead	397	375	24.5	0.0073	0.2	0.5	0.2	--	--	-
OS-84 Fluid[b]	Alloy	403	384	27.8	0.0081	13.0	2.0	0.3	1.0	1.0	1.4

[a]Dowtherm A is a trademark of the Dow Chemical Co.
[b]OS-84 is a trademark of the Monsanto Industrial Chemicals Co.

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Less total gas and about one third as much hydrogen was released from the alloy interaction with OS-84 than with Dowtherm A, even though OS-84 was added at a 100 °C higher temperature. Little or no hydrogen was released from the organics when added to lead. Some light hydrocarbons are released from interaction of alloy with either organic. Hydrogen release from these reactions where organics were added to the top surface of excess alloy amounted to 0.79 g mol per kg of Dowtherm A and 0.21 g mol per kg of OS-84.

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*OS-84 fluid is a trademark of the Monsanto Industrial Chemicals Co.
**Dowtherm A is a trademark of the Dow Chemical Co.

For the second set of tests, 20 g of metal was heated to 400 °C and dropped into a 0.120 L pool of organic in a reaction chamber that had an atmosphere volume of 1.30 L. Lead and alloy were tested separately with Dowtherm A at an initial temperature of 224 ± 1 °C and with Fluid OS-84 at an initial temperature of 325 ± 1 °C. The test equipment was inside a furnace to provide an initial atmosphere and equipment test temperature of 275 °C for the tests with Dowtherm A and 375 °C for tests with Fluid OS-84. An argon atmosphere was established in the reaction chamber prior to heatup for all tests. The test results are listed in Table 35 as reaction chamber gas temperature and pressure increase, total gas release, hydrogen release, and light hydrocarbon release. The atmosphere temperature and pressure increases occurred within 30 s for all tests.

Table 35. Test Results for Reaction of Metal Addition to Organic.

Metal	Organic	Gas temperature (°C)		Pressure change (kPa)	Total gas release (g mol)	Hydrogen (mL)	Methane (mL)	Ethylene (mL)	Ethane (mL)
		Initial	Final						
Lead	Dowterm A[a]	225.0	229.0	15.2	0.0049	<0.001	<0.001	<0.001	<0.001
Alloy	Dowterm A	223.0	225.7	12.4	0.0037	<0.001	0.003	<0.001	<0.001
Lead	Fluid OS-84[b]	326.0	328.0	15.8	0.0040	<0.001	0.01	<0.001	<0.001
Alloy	Fluid OS-84	324.0	325.0	11.0	0.0028	1.4	0.3	0.002	0.002

[a]Dowtherm A is a trademark of the Dow Chemical Co.
[b]OS-84 is a trademark of the Monsanto Industrial Chemicals Co.

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Less gas was released from the interactions of alloy with the organics than of lead with the organics under these conditions. Some hydrogen and light organics were released from the reaction when alloy was added under these conditions. Little or no hydrogen or light hydrocarbons were released from the lead interaction with these organics. Hydrogen release for Fluid OS-84 in this alloy test where alloy was added to excess organic equaled 0.0031 g mol per kg of alloy.

9.2 REACTION TESTS BETWEEN ALLOY AND SODIUM-POTASSIUM NITRATE SALTS

Two scoping lithium-lead alloy-draw salt (46 $NaNO_3$ - 54 KNO_3) reaction tests were completed. The conclusions from these tests are that both lithium and lead from the alloy reacted with the nitrate salts to form Li_2O and PbO, at 450 °C. The reactions were exothermic but were mild for these small-scale tests. Lithium reacted to completion when limited alloy was added to excess salt, and the nitrate salt reacted to near completion when salt was added to excess alloy. Because of the possible aerosol production (potential release of radioactive species) from the localized glowing observed on the surface of the second test, additional tests may be needed if the use of this nitrate salt is to be pursued.

In the first test, alloy and salt were reacted by dropping about 4 g alloy at 450 °C onto the surface of 100 mL of draw salt at 450 °C. A magnetic stirrer was used in the salt container to provide good contact between the alloy and salt. An argon atmosphere was maintained above the salt to prevent air from interacting with the alloy or salt. The reaction was mild with the salt temperature increasing 2 °C over a 4-min period. A gray film formed on the alloy when first introduced and the stirrer broke the alloy into pieces of 1 to 2 mm dia. The film on the alloy became thicker and turned a yellow-brown color by 2 min after introduction of the alloy. The stirrer was turned off at that time, and some bubbles surfaced (about 2 mL/min). The bubbles stopped by 4 min after introduction of the alloy. The granular solids on the bottom of the container appeared to be nonmetallic.

An additional 10 g alloy was added after 4 min from the initial introduction of alloy, and again no vigorous reaction was observed. One minute later, the nitrate temperature remained at 452 °C, but a thermocouple located in the alloy at the bottom of the salt read 468 °C. The reaction was very modest. Bubbles were again observed and the alloy was coated with a yellow-brown surface layer. Three minutes after the addition of the 10 g of alloy, the alloy appeared to be changed to nonmetallic solids at the bottom of the salt. The salt temperature had increased to 455 °C, but no additional bubbles were formed.

The solids were collected and analyzed by X-ray diffraction and wet chemical methods. The solid reaction product composition was PbO, 46 wt%; metallic lead, 26 wt%; Li_2O, 0.8 wt%; total combined sodium, 4 wt%; total combined potassium, 7 wt%; total NO_2, 0.03 wt%; and total NO_3, 13 wt%. The metallic lead fraction contained 0.002 wt% metallic lithium. No nitride (<5 p/m) was detected in the residue.

In the second scoping test, about 4 g nitrate salt was added to the top surface of 235 g alloy at 450 °C. The nitrate formed liquid balls on the alloy surface. Alloy under the nitrate quickly produced a film. The film absorbed the nitrate, thus increasing the reaction rate. No gas bubbles were observed during the initial stages. At 1 min after the addition of nitrate, a few gas bubbles were observed. The alloy temperature had increased to 454 °C, and a dull, yellow-green scum covered most of the alloy surface. Brief glowing sparks (1 to 2 s) were observed in the thicker areas of the scum. At 1 min after the nitrate addition, the alloy temperature was 460 °C, and the nitrate was consumed. An additional 8 g nitrate was added below the alloy surface but immediately floated to the top. Yellow, powdery lumps and brief, glowing sparks were observed again on the surface 1 min later. The alloy temperature had increased to 480 °C. Two minutes after the second nitrate addition, the alloy temperature had risen to 502 °C, but there was less glowing observed. The alloy reached a peak temperature of 518 °C at 3 min after the second nitrate addition, but the glowing sparks had discontinued by this time, and the alloy began cooling immediately.

The results showed the product composition to be metallic lead, 52 wt%; PbO, 32 wt%; Li_2O·, 6.4 wt%; total combined potassium, 3.8 wt%; total combined sodium, 2 wt%; NO_3, 1.5 wt%; and NO_2, 0.1 wt%. The metallic lead in the reaction product was determined to have a lithium content of 0.07 wt% metallic lithium. The remaining alloy had 0.29 wt% lithium.

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Appendix A

Data Acquisition System Channel Identification and Supportive Data for Alloy Tests

CONTENTS

Tables

Appendix A

Data Acquisition System Channel Identification and Supportive Data for Alloy Tests

The identification and location of each Data Acquisition System (DAS) channel is given in Tables A-1 through A-7 for tests LPA-1, LPA-2, LPA-3, ABC-1, ASA-1, AWR-1, WIL-1, and WIA-1. The Intermediate Containment Vessel (ICV) coordinates used in describing locations within the vessel were the following: (1) the inside floor of the vessel was zero elevation and (2) the 0° azimuth was the center of the access opening with the degrees increasing clockwise as one looked down into the vessel. The frequency of channel data logging ranged from 7 to 15 s for test times of expected rapid changes to as much as 30 min for overnight surveillance.

Tables of all data channels are listed for the critical times of tests ASA-1, AWR-1, WIL-1, and WIA-1. Tables of data for the other tests were not included because of the limited space available.

Table A-1. Alloy-Air Reaction Test Instrumentation--Test LPA-1.

DAS No.	Program	Description and Location
0	°F	DAS rack temperature
1	°F	Alloy mixing temp. (25 mm from bottom)
2	°F	Reaction pan pool temp. (+ 30 mm)
3	°F	Reaction pan pool temp. (+ 60 mm)
4	°F	Reaction pan pool temp. (+ 90 mm)
5	°F	Reaction pan atm temp. (+ 120 mm)
6	°F	Reaction pan atm temp. (+ 160 mm)
7	°F	Reaction pan surface (bottom center)
8	°F	Reaction pan surface (end + 60 mm)
9	°F	Reaction pan surface (end + 150 mm)
10	°F	Reaction pan surface (side + 105 mm)
11	°F	Transfer line temp.
12	°F	Mixing tank heater zone 1 (0-76 mm)
13	°F	Mixing tank heater zone 2 (76-178 mm)
14	°F	Mixing tank heater zone 3 (178-279 mm)
15	°F	Mixing tank heater zone 4 (279 mm - top)
16	°F	Heater pan heater zone 1 (pan bottom center)
17	°F	Heater pan heater zone 2 (side, 70 mm from bottom)
18	°F	Heater pan heater zone 3 (side, 146 mm from bottom)
19	°F	ICV atm temp. (+ 0.2 m)
20	°F	ICV atm temp. (+ 1.8 m)
21	°F	ICV atm temp. (+ 3.7 m)
22	oF	ICV inner surface temp. (+ 0.2 m)
23	°F	ICV inner surface temp. (+ 1.8 m)
24	°F	ICV inner surface temp. (+ 3.7 m)
49	°F	ICV outer surface temp. (+ 1.8 m)
61	10 mV = 25%	ICV O_2 low (Teledyne #1) (+ 1.8 m)
63	10 mV = 10 psig	ICV pressure
64	10 mV = 100 °F	ICV dewpoint
67	10 mV = 25%	ICV O_2 high (Teledyne #2) (+ 3.7 m)

DAS = Data Acquisition System.
ICV = Intermediate Containment Vessel.

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Table A-2. Alloy-Air Reaction Test Instrumentation--Test LPA-2.

DAS No.	Program	Description and Location
0	°F	DAS rack temperature
1	°F	Reaction pan pool temp. (+ 30 mm above bottom)
2	°F	Reaction pan pool temp. (+ 60 mm above bottom)
3	°F	Reaction pan pool temp. (+ 90 mm above bottom)
4	°F	Reaction pan atm temp. (+ 120 mm above bottom)
5	°F	Reaction pan atm temp. (+ 160 mm above bottom)
6	°F	Reaction pan surface (bottom center)
7	°F	Reaction pan surface (end + 60 mm above bottom)
8	°F	Reaction pan surface (end + 150 mm above bottom)
9	°F	Reaction pan surface (side + 105 mm above bottom)
10	°F	ICV atm temp. (+ 0.2 m, 0.92 m radius)
11	°F	ICV atm temp. (+ 1.8 m, 0.92 m radius)
12	°F	ICV atm temp. (+ 3.7 m, 0.92 m radius)
13	°F	ICV inner surface temp. (+ 0.2 m)
14	°F	ICV inner surface temp. (+ 1.8 m)
15	°F	ICV inner surface temp. (+ 3.7 m)
16	°F	ICV outer surface temp. (+ 1.8 m)
17	°F	Atm temp. of room (1.8 m elev., 0.15 m from ICV wall)
18	°F	Alloy mixing temp. (25 mm from bottom)
19	°F	Transfer line temp.
20	°F	Mixing tank heater zone 1 (bottom)
21	°F	Mixing tank heater zone 2 (0-76 mm)
22	°F	Mixing tank heater zone 3 (76-178 mm)
23	°F	Mixing tank heater zone 4 (178-279 mm)
24	°F	Mixing tank heater zone 5 (279 mm - top)
25	°F	Heater pan heater zone 1 (pan bottom)
26	°F	Heater pan heater zone 2 (side, 70 mm from bottom)
27	°F	Heater pan heater zone 3 (side, 146 mm from bottom)
28	°F	ICV floor
61	10 mV = 25%	Oxygen concentration vessel atmosphere (0.9 m elev.)
62	10 mV = 10 psig	Mixing tank atmosphere pressure
63	10 mV = 10 psig	ICV atmosphere (0.9 m elev.)
64	10 mV = 100°F	Dewpoint (0.9 m elev.)
65	10 mV = 25%	Oxygen concentration, ICV atmosphere (3.4 m elev.)

DAS = Data Acquisition System.
ICV = Intermediate Containment Vessel.

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Table A-3. Lithium-Lead Alloy Pool-Air Reaction Test Instrumentation--Test LPA-3. (sheet 1 of 2)

DAS No.	Program	Description and Location
0	°F	DAS rack temperature
1	°F	Alloy pool (+30 mm)
2	°F	Alloy pool (+60 mm)
3	°F	Alloy pool, (+90 mm)
4	°F	Pan atmosphere (+120 mm)
5	°F	Pan atmosphere (+160 mm)
6	°F	ICV atm temp. (+0.2 m, 38 mm radius)
7	°F	ICV atm temp. (+0.2 m, 65 mm radius)
8	°F	ICV atm temp. (+0.2 m, 84 mm radius)
9	°F	ICV atm temp. (+0.2 m, 99 mm radius)
10	°F	ICV atm temp. (+1.8 m, 38 mm radius)
11	°F	ICV atm temp. (+1.8 m, 65 mm radius)
12	°F	ICV atm temp. (+1.8 m, 84 mm radius)
13	°F	ICV atm temp. (+1.8 m, 99 mm radius)
14	°F	ICV atm temp. (+3.7 m, 38 mm radius)
15	°F	ICV atm temp. (+3.7 m, 84 mm radius)
16	°F	ICV inner surface temp. (+0.2 m)
17	°F	ICV inner surface temp. (+1.8 m)
18	°F	ICV inner surface temp. (+3.7 m)
19	°F	ICV outer surface temp. (+1.8 m)
21	°F	Transfer line (valve)
22	°F	Transfer line (end)
23	°F	Atmosphere temp. of room (+1.8 m elev., 0.15 m from ICV wall)
24	°F	Catch pan temp. (0.5 m radius)
25	°F	Heater pan, zone 1 (bottom center)
26	°F	Heater pan, zone 2
27	°F	Heater pan, zone 3
28	°F	Insert pan temp. (bottom)
29	°F	Insert pan end temp. (60 mm from bottom)
30	°F	Insert pan end temp. (150 mm from bottom)
31	°F	Reservoir heater zone 1 (0-76 mm)
32	°F	Reservoir heater zone 2 (76-178 mm)
33	°F	Reservoir heater zone 3 (178-279 mm)
34	°F	Reservoir heater zone 4 (279 mm - top)

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Table A-3. Lithium-Lead Alloy Pool-Air Reaction Test Instrumentation--Test LPA-3. (sheet 2 of 2)

DAS No.	Program	Description and Location
35	°F	Reservoir bottom cartridge
36	°F	Reservoir bottom cartridge
37	°F	Alloy in reservoir (25 mm from bottom)
42	25 mV = 25 mol%	O_2 concentration in ICV 1.8 m elev.
44	10 V = 10 psig	Pressure in ICV
44	10 V = 10 psig	Pressure in reservoir

DAS = Data Acquisition System.
ICV = Intermediate Containment Vessel.

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Table A-4. Alloy-Basalt Concrete Reaction Test Instrumentation--Test ABC-1. (sheet 1 of 2)

DAS No.	Program	Description and Location
0	°F	DAS rack temperature
1	°F	Alloy pool temp. (+ 25 mm, 67 mm radius)
2	°F	Alloy pool temp. (+ 76 mm, 67 mm radius)
3	°F	Alloy pool temp. (+ 203 mm, 67 mm radius)
4	°F	Concrete temp. (-13 mm, center)
5	°F	Concrete temp. (-25 mm, center)
6	°F	Concrete temp. (-51 mm, center)
7	°F	Concrete temp. (-76 mm, center)
8	°F	Concrete temp. (-102 mm, center)
9	°F	Concrete temp. (-127 mm, center)
10	°F	Concrete temp. (-178 mm, center)
11	°F	Concrete temp. (-229 mm, center)
12	°F	Concrete temp. (-279 mm, center)
13	°F	Concrete temp. (-381 mm, center)
14	°F	Concrete temp. (-457 mm, center)
15	°F	ICV atm temp. (+ 0.2 m, 0.92 m radius)
16	°F	ICV atm temp. (+ 1.8 m, 0.92 m radius)
17	°F	ICV atm temp. (+ 3.7 m, 0.92 m radius)
18	°F	ICV inner surface temp. (+ 0.2 m)
19	°F	ICV inner surface temp. (+ 1.8 m)
20	°F	ICV inner surface temp. (+ 3.7 m)
21	°F	ICV outer surface temp. (+ 1.8 m)
22	°F	Atmosphere temp. of room (1.8 m elev., 0.15 m from vessel wall)
23	°F	Mixing tank alloy temp. (+ 25 mm)
24	°F	Catch pan temperature
25	°F	Transfer line temp. (0.20 m from AMT)
26	°F	Transfer line temp. (0.35 m from AMT)
27	°F	Concrete temperature (-584 mm, center)
28	°F	Concrete test article, outer surface (-51 mm)
29	°F	Concrete test article, outer surface (-230 mm)
30	°F	Concrete test article, heater zone 1 (+ 25 mm)
31	°F	Concrete test article, heater zone 2 (+ 76 mm)
32	°F	Concrete test article, heater zone 3 (+ 133 mm)
33	°F	Concrete test article, heater zone 4 (+ 187 mm)

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Table A-4. Alloy-Basalt Concrete Reaction Test Instrumentation--Test ABC-1. (sheet 2 of 2)

DAS No.	Program	Description and Location
60	10 mV = 10 mol%	H_2 concentration in ICV (1.8 m elev.)
61	10 mV = 10 mol%	O_2 concentration in ICV (1.8 m elev.)
62	10 V = 10 psig	Pressure in ICV
63	10 V = 10 psig	Mixing tank pressure

AMT = Alloy Mix Tank.
DAS = Data Acquisition System.
ICV = Intermediate Containment Vessel.

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Table A-5. Lithium-Lead Spray Reaction Test Instrumentation--Test ASA-1.

DAS No.	Program	Description and Location
0	°F	DAS rack temperature
1	°F	Reservoir temp. (+ 114 mm from bottom, outer)
2	°F	Reservoir temp. (+ 183 mm from bottom, outer)
3	°F	Reservoir temp. (+ 76 mm from bottom, inner)
4	°F	Spray line temp. (-50 mm from bottom, outer)
5	°F	Nozzle temp. (outer)
6	°F	ICV atm temp. (+ 0.2 m, 0.38 m radius)
7	°F	ICV atm temp. (+ 0.2 m, 0.65 m radius)
8	°F	ICV atm temp. (+ 0.2 m, 0.84 m radius
9	°F	ICV atm temp. (+ 0.2 m, 0.99 m radius)
10	°F	ICV atm temp. (+ 1.8 m, 0.38 m radius)
11	°F	ICV atm temp. (+ 1.8 m, 0.65 m radius)
12	°F	ICV atm temp. (+ 1.8 m, 0.84 m radius)
13	°F	ICV atm temp. (+ 1.8 m, 0.99 m radius)
4	°F	ICV atm temp. (+ 3.7 m, 0.38 m radius)
15	°F	ICV atm temp. (+ 3.7 m, 0.84 m radius)
16	°F	ICV inner surface temp. (+ 0.2 m)
17	°F	ICV inner surface temp. (+ 1.8 m)
18	°F	ICV inner surface temp. (+ 3.7 m)
19	°F	ICV outer surface temp. (+ 1.8 m)
20	°F	ICV atmosphere temp. of room (+ 1.8 m elev., 15 cm outside ICV wall)
21	°F	Catch pan temperature (center)
22	°F	Catch pan temperature (0.5 m radius)
60	10 mV = 25 mol%	O_2 concentration in ICV 1.8 m elev.
61	0-5 mV = 100°F	Dewpoint (0-100°F)
62	0-10 mV = 10 psig	Pressure in ICV (0-10 psig)
63	0-100 mV = 100 psig	Pressure in reservoir (0-100 psig)

DAS = Data Acquisition System.
ICV = Intermediate Containment Vessel.

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Table A-6. 17Li83Pb-Water Reaction Test Instrumentation--
Test AWR-1.

DAS No.	Program	Description and Location
0	°F	DAS rack temperature
1	°F	Alloy pool temp. (+25 mm, radius)
2	°F	Alloy pool temp. (+25 mm, center)
3	°F	Alloy pool temp. (+240 m, 79 mm radius)
4	°F	Alloy pool temp. (+240 mm, center)
5	°F	Alloy pool temp. (+240 m, 110 mm diameter)
6	°F	Reaction chamber atmosphere (+0.48 m)
7	°F	Reaction chamber heater zone 1 (bottom center)
8	°F	Reaction chamber heater zone 2 (0-80 mm) +25 mm
9	°F	Reaction chamber heater zone 3 (80-180 mm) +127 mm
10	°F	Reaction chamber heater zone 4 (180-280 mm) +229 mm
11	°F	Reaction chamber heater zone 5 (280 mm top) +318 mm
12	°F	Steam supply line zone 1
13	°F	Steam supply after inline heaters
14	°F	ICV atm temp. (+0.2 m, 0.92 m radius)
15	°F	ICV atm temp. (+1.8 m, 0.92 m radius)
16	°F	ICV atm temp. (+3.7 m, 0.92 m radius)
17	°F	ICV inner surface temp. (+0.2 m)
18	°F	ICV inner surface temp. (+1.8 m)
19	°F	ICV inner surface temp. (+3.7 m)
20	°F	ICV outer surface temp. (+1.8 m)
21	°F	Atmosphere temp. of rooom (1.8 elev., 0.15 m from vessel wall)
22	°F	Noncondensible gas to ICV temp.
23	°F	Catch pan temperature
60	10 mV = 10%	H_2 concentration in ICV (1.8 m elev.)
61	10 mV = 10%	0_2 concentration in ICV (1.8 m elev.)
62	10 mV = 10 psig	Pressure in ICV
63	10 mV = 10 psig	Reaction chamber pressure
64	10 V = 10 kg	Water mass
65	10 V = 20 psig	Steam flow to reaction chamber

DAS = Data Acquisition System.
ICV = Intermediate Containment Vessel.

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Table A-7. Water Injection Into Lead and Alloy Pools--Tests WIL-1 and WIA-1. (sheet 1 of 2)

DAS No.	Program	Description and Location
0	°F	DAS rack temperature
1	°F	+ 102 mm pool temp. at 20 deg and 127 mm radius
2	°F	+ 102 mm pool temp. at 200 deg and 127 mm radius
3	°F	+ 127 mm pool temp. at CL (9.5 mm dia TC)
4	°F	+ 178 mm pool temp. at 20 deg and 127 mm radius
5	°F	+ 178 mm pool temp. at 200 deg and 127 mm radius
6	°F	+ 203 mm pool temp. at CL (9.5 mm dia TC)
7	°F	+ 254 mm pool temp. at 20 deg and 127 mm radius
8	°F	+ 254 mm pool temp. at 200 deg and 127 mm radius
9	°F	Rupture disk #1 at 180 deg, 51 mm radius (13 mm dia)
10	°F	Rupture disk #2 at 0 deg, 51 mm radius (13 mm dia)
11	°F	Rupture disk #3 at 270 deg, 51 mm radius (13 mm dia)
12	°F	Valve #1
13	°F	Valve #2
14	°F	Valve #3
15	°F	Heater zone #1 (bottom)
16	°F	Heater zone #2 and 3 (side)
17	°F	Heater zone #4 and 5 (side)
18	°F	Atmosphere temp. at 90 deg (+ 330 mm)
19	°F	Atmosphere temp. at 90 deg (+ 406 mm)
20	°F	Pressure trans at 180 deg (+ 203 mm)
22	°F	Rupture disk #2 heater cartridge TC
23	°F	ICV atm (0.15 m elev., 0.38 m radius)
24	°F	ICV atm (0.15 m elev., 0.65 m radius)
25	°F	ICV atm (0.15 m elev., 0.84 m radius)
26	°F	ICV atm (0.15 m elev., 0.99 m radius)
27	°F	ICV wall inner surface (0.15 m above floor)
28	°F	ICV atm (1.83 m elev., 0.38 m radius)
29	°F	ICV atm (1.83 m elev., 0.65 m radius)
30	°F	ICV atm (1.83 m elev., 0.84 m radius)
31	°F	ICV atm (1.83 m elev., 0.99 m radius)
32	°F	ICV wall inner surface (1.83 m above floor, 180)
33	°F	ICV wall outer surface (1.83 m above floor, 180)
34	°F	Room atmosphere temp. (1.83 m, 1.8 m above ICV floor)

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Table A-7. Water Injection Into Lead and Alloy Pools--Tests WIL-1 and WIA-1. (sheet 2 of 2)

DAS No.	Program	Description and Location
35	°F	ICV atm (3.66 m elev., 0.65 m radius)
36	°F	ICV atm (3.66 m elev., 0.99 m radius)
37	°F	ICV wall inner surface (3.66 m above floor, 180)
38	°F	ICV floor inner surface (0.65 m radius, 180)
50	10 V = 10 psig	ICV atm pressure (upper)
51	6 V = 600 psig	Water injection pres
53	10 mV = 5 mol%	Oxygen concentration (1.83 m above floor, 0.84 m radius)
54	1 V = 100 mol%	Hydrogen concentration (1.83 m above floor, 0.84 m radius)
55	100 mV = 100°F	Dewpoint (1.83 m above floor, 0.84 m radius, 0-100°F)
56	100 mV = 100°F	Dewpoint (366 m above floor, 0.84 m radius, 0-100°F)
57	10 mV = 5 mol%	Oxygen concentration (3.66 m above floor, 0.84 m radius)
58	1 V = 10 mol%	Hydrogen concentration (3.66 m above floor, 0.84 m radius)

CL = centerline.
DAS = Data Acquisition System.
ICV = Intermediate Containment Vessel.
TC = thermocouple.

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TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 0-8
TEST: ASA-1 DATA
(sheet 1 of 12)

TIME SECONDS	DAS# 0 DEG C	DAS# 1 DEG C	DAS# 2 DEG C	DAS# 3 DEG C	DAS# 4 DEG C	DAS# 5 DEG C	DAS 6 DEG C	DAS# 7 DEG C	DAS# 8 DEG C
-284.0	25.3	763.1	757.8	676.2	697.2	199.8	20.6	20.9	18.1
-254.0	25.7	766.1	759.7	681.0	709.6	219.2	20.6	20.9	18.2
-224.0	26.2	770.6	762.9	686.1	719.0	236.7	20.7	20.9	18.2
-194.0	26.1	775.7	766.1	691.0	729.2	253.1	20.7	20.9	18.2
-164.0	26.2	780.6	769.2	696.7	738.7	269.1	20.7	20.9	18.2
-134.0	25.4	785.1	772.2	701.9	736.8	284.4	20.7	20.9	18.2
-104.0	25.4	790.5	774.9	707.6	731.6	299.3	20.7	21.0	18.2
-74.0	25.3	796.9	777.8	712.8	723.4	313.5	20.7	21.0	18.3
-44.0	25.4	798.4	779.8	717.6	720.9	326.9	20.8	20.9	18.3
-14.0	24.9	799.6	781.2	720.8	711.6	340.8	20.7	21.0	18.3
16.0	25.1	797.9	781.3	724.8	732.9	383.0	20.9	21.1	18.3
46.0	25.3	796.8	781.3	726.7	734.1	514.6	22.7	23.0	19.7
76.0	25.0	795.8	781.4	727.4	734.1	586.4	25.9	25.4	22.0
106.0	25.3	795.9	781.6	727.3	733.7	623.9	27.7	27.2	24.0
151.0	26.2	795.8	781.3	726.4	754.9	672.8	29.1	27.2	24.4
158.0	25.9	795.7	781.5	726.0	758.7	696.4	28.6	27.1	24.4
165.0	25.6	795.6	781.2	725.7	762.2	721.8	28.2	26.9	24.2
172.0	25.5	795.3	780.9	725.4	765.7	746.7	28.0	26.7	24.1
179.0	25.5	795.3	780.9	724.8	768.9	769.1	27.7	26.6	23.9
186.0	25.4	795.3	781.0	724.6	772.2	787.9	27.4	26.3	23.8
193.0	25.4	795.1	780.8	723.9	775.1	803.9	27.2	26.1	23.5
200.0	25.3	794.8	780.3	723.8	777.8	818.0	26.9	25.9	23.2
207.0	25.2	794.7	780.4	723.3	779.4	830.1	26.8	25.8	23.1
214.0	25.2	794.6	780.2	722.8	780.6	838.6	26.6	25.7	22.9
221.0	25.1	794.6	780.1	722.2	781.8	841.3	26.4	25.5	22.7
228.0	25.0	794.6	780.1	721.3	783.1	835.8	26.3	25.4	22.6
235.0	25.0	794.3	779.8	720.1	784.3	823.8	26.3	25.4	22.6
242.0	25.1	794.2	779.7	718.7	785.5	810.7	26.1	25.6	22.6
249.0	25.2	794.2	779.6	715.3	786.6	798.7	26.1	25.3	22.4
256.0	25.1	794.3	779.6	712.7	787.7	787.9	26.0	25.2	22.5
263.0	25.0	794.2	779.6	710.2	788.6	778.6	25.9	25.2	22.4
270.0	25.1	793.8	779.2	708.8	789.7	770.2	26.3	25.1	22.3
277.0	25.3	793.9	779.3	707.4	790.6	763.2	27.0	25.1	22.3
284.0	25.2	793.9	779.2	706.4	791.4	757.2	27.2	25.1	22.3
291.0	25.3	793.8	779.1	705.6	792.4	751.9	27.2	25.1	22.3
298.0	25.6	793.7	778.9	704.5	792.9	747.3	27.2	25.1	22.4
305.0	25.7	793.7	778.3	704.2	793.8	743.2	27.0	24.9	22.3
312.0	25.8	793.7	778.8	704.2	794.6	739.4	26.8	24.9	22.2
319.0	25.7	793.6	779.1	703.7	795.3	736.2	26.8	25.0	22.2
326.0	25.6	793.6	778.7	703.3	795.9	733.3	26.7	25.1	22.2

TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 0-8
TEST: ASA-1 DATA
(sheet 2 of 12)

TIME SECONDS	DAS# 0 DEG C	DAS# 1 DEG C	DAS# 2 DEG C	DAS# 3 DEG C	DAS# 4 DEG C	DAS# 5 DEG C	DAS 6 DEG C	DAS# 7 DEG C	DAS# 8 DEG C
333.0	25.3	793.7	778.6	703.3	796.6	730.3	26.5	25.0	22.2
340.0	25.1	793.7	778.8	703.1	797.1	728.5	26.4	25.0	22.3
347.0	25.1	793.7	778.8	702.6	797.4	726.5	26.4	25.1	22.3
354.0	24.9	793.6	778.5	702.5	797.9	724.8	26.3	25.1	22.3
361.0	24.7	793.7	778.4	702.3	798.5	723.2	26.3	25.1	22.3
368.0	24.5	793.7	778.5	701.9	799.1	721.9	26.2	25.2	22.4
375.0	24.6	793.7	778.5	702.5	799.4	720.7	26.2	25.2	22.5
382.0	24.8	793.7	778.6	701.8	799.8	719.6	26.3	25.2	22.4
389.0	24.8	793.7	778.6	701.7	800.0	718.6	26.3	25.3	22.4
396.0	25.0	793.6	778.4	701.8	799.7	717.7	26.3	25.3	22.4
403.0	25.2	793.4	778.6	701.6	799.5	717.0	26.2	25.4	24.3
410.0	25.4	793.4	778.6	701.6	799.5	716.3	26.4	25.5	24.0
417.0	25.3	793.3	778.7	701.3	799.6	715.6	27.1	25.5	23.6
424.0	25.2	793.3	778.6	701.3	799.5	715.1	27.3	25.5	23.6
431.0	25.3	793.3	778.8	700.7	799.6	714.5	27.3	25.6	23.6
438.0	25.3	793.3	778.4	701.2	799.9	714.0	27.4	25.7	23.6
445.0	25.3	793.2	778.6	701.2	799.9	713.6	27.6	25.8	23.6
452.0	25.1	793.1	778.6	701.1	800.1	713.2	27.7	26.0	23.7
459.0	24.9	793.0	778.5	700.4	804.9	712.5	28.4	26.4	24.4
466.0	25.0	792.8	778.7	699.2	813.1	711.5	28.9	27.2	24.9
473.0	25.0	792.8	778.5	698.2	820.1	710.2	29.1	27.6	25.2
480.0	25.0	792.8	778.8	697.6	826.0	708.7	29.1	28.1	25.3
487.0	25.2	792.6	778.6	697.2	831.5	706.9	29.2	28.3	25.6
494.0	25.3	792.5	778.5	697.1	836.7	705.2	29.3	28.3	25.5
501.0	25.1	792.5	778.3	697.3	841.9	703.6	29.6	28.6	25.4
508.0	25.2	792.4	778.7	697.8	847.2	702.1	29.7	28.6	25.4
515.0	25.2	792.3	778.7	698.4	852.4	700.9	29.2	28.5	25.3
522.0	25.0	792.2	778.6	699.7	857.4	699.8	28.8	28.2	25.0
531.0	24.9	791.9	778.7	697.9	863.5	698.8	28.7	28.1	25.0
537.0	24.9	791.8	778.5	699.3	867.6	698.2	28.9	28.1	25.0
544.0	24.9	791.8	778.8	700.4	871.8	697.8	28.6	27.9	24.8
551.0	25.1	791.7	778.7	701.3	875.9	697.4	28.2	27.8	24.8
557.0	25.2	791.6	778.6	700.8	880.1	697.2	27.9	27.6	24.6
564.0	25.3	791.2	778.4	697.9	883.4	696.9	27.7	27.4	24.4
571.0	25.3	791.1	778.3	694.6	886.1	696.7	27.8	27.2	24.2
578.0	25.2	791.2	778.3	693.9	888.4	696.4	27.8	27.2	24.1
585.0	25.1	791.3	778.3	694.2	890.9	696.1	27.8	27.3	24.2
592.0	25.1	791.3	778.3	694.6	893.8	695.9	27.8	27.4	24.4
599.0	25.1	791.2	778.7	695.1	896.9	695.7	28.2	27.6	24.4
606.0	25.2	791.2	778.4	695.3	900.0	695.6	28.4	27.6	24.4

TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 0-8
TEST: ASA-1 DATA
(sheet 3 of 12)

TIME SECONDS	DAS# 0 DEG C	DAS# 1 DEG C	DAS# 2 DEG C	DAS# 3 DEG C	DAS# 4 DEG C	DAS# 5 DEG C	DAS 6 DEG C	DAS# 7 DEG C	DAS# DEG C
613.0	25.2	790.1	778.7	696.1	903.4	695.6	28.2	27.4	24.
620.0	25.1	786.8	776.6	697.0	906.4	695.2	28.1	27.1	24.
627.0	25.1	778.0	773.3	697.9	908.2	695.2	27.8	27.0	23.
634.0	24.9	771.1	769.8	698.8	906.7	694.8	27.6	26.8	23.
641.0	24.9	765.9	766.4	699.3	904.5	694.1	27.3	26.6	23.
648.0	24.8	761.5	763.4	700.1	902.4	693.3	27.2	26.4	23.
655.0	25.0	757.7	760.4	700.6	900.6	692.5	27.0	26.3	23.
662.0	25.3	754.4	757.8	701.1	898.8	691.8	26.8	26.1	23.
669.0	25.6	751.3	755.1	701.2	897.2	691.1	26.7	26.1	23.
676.0	25.7	748.4	752.4	701.1	895.9	690.5	26.6	26.0	23.
683.0	25.9	745.9	750.2	701.3	894.1	689.8	26.4	25.9	23.
690.0	26.1	743.5	747.7	701.1	892.0	689.2	26.3	25.8	22.
697.0	26.2	741.2	745.3	700.9	889.7	688.5	26.2	25.6	22.
704.0	26.3	739.1	743.1	700.8	887.8	687.9	26.1	25.6	22.
711.0	26.3	737.1	740.9	700.5	885.7	687.2	26.0	25.5	22.
718.0	26.1	735.2	738.8	699.9	883.7	686.6	25.9	25.4	22.
725.0	25.7	733.3	736.7	699.7	882.0	685.9	25.8	25.3	22.
732.0	25.6	731.6	734.7	698.9	880.4	685.3	25.7	25.2	22.
739.0	25.7	729.8	732.7	698.4	878.4	684.7	25.7	25.2	22.
746.0	25.8	728.2	730.8	697.9	876.0	684.0	25.6	25.2	22.
753.0	25.6	726.6	728.8	697.2	873.7	683.4	25.5	25.1	22.
760.0	25.6	724.9	726.9	696.4	871.3	682.8	25.4	25.1	22.
767.0	25.6	723.5	725.1	695.8	869.1	682.2	25.4	25.1	22.
774.0	25.6	722.0	723.2	695.2	867.1	681.6	25.4	25.0	22.
781.0	25.6	720.5	721.4	694.3	864.8	681.0	25.3	24.9	22.
788.0	25.4	719.1	719.6	693.6	862.2	680.4	25.3	24.9	22.
795.0	25.3	717.8	718.1	692.8	860.1	679.8	25.3	24.9	22.
802.0	25.2	716.4	716.3	692.1	857.8	679.2	25.2	24.8	22.
809.0	25.3	715.0	714.6	691.3	855.8	678.6	25.2	24.8	22.
816.0	25.3	713.7	712.9	690.6	853.8	677.9	25.2	24.8	22.
823.0	25.2	712.4	711.3	689.7	851.5	677.3	25.2	24.8	22.
830.0	25.4	711.2	709.7	689.0	849.3	676.6	25.1	24.8	22.
837.0	25.2	709.9	708.2	688.3	847.1	676.1	25.1	24.8	22.
844.0	24.9	708.7	706.6	687.4	844.8	675.4	25.1	24.7	22.
851.0	24.8	707.5	705.1	686.6	842.8	674.8	25.1	24.8	22.
858.0	24.9	706.2	703.6	686.1	840.6	674.2	25.0	24.7	22.
865.0	25.1	705.1	702.1	685.2	838.3	673.6	25.0	24.8	22.
872.0	25.2	703.8	700.6	684.3	836.2	672.9	24.9	24.8	22.
879.0	25.3	702.7	699.2	683.7	834.3	672.3	25.0	24.7	22.
886.0	25.1	701.6	697.7	682.9	832.3	671.7	25.0	24.7	22.

TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 0-8
TEST: ASA-1 DATA
(sheet 4 of 12)

TIME SECONDS	DAS# 0 DEG C	DAS# 1 DEG C	DAS# 2 DEG C	DAS# 3 DEG C	DAS# 4 DEG C	DAS# 5 DEG C	DAS 6 DEG C	DAS# 7 DEG C	DAS# 8 DEG C
893.0	25.2	700.4	696.3	681.9	830.2	671.0	25.0	24.7	22.0
900.0	25.0	699.3	695.0	681.1	828.2	670.3	25.0	24.7	22.1
907.0	24.8	698.2	693.6	680.4	826.1	669.7	24.9	24.7	22.1
914.0	24.8	697.1	692.3	679.7	824.2	669.1	25.0	24.7	22.1
921.0	24.7	696.0	690.9	678.8	822.1	668.3	25.0	24.7	22.1
928.0	24.9	694.9	689.6	678.1	820.0	667.6	25.0	24.7	22.1
935.0	25.0	693.9	688.4	677.2	818.1	666.9	24.9	24.7	22.2
942.0	25.3	692.8	687.1	676.4	816.0	666.2	24.9	24.7	22.1
949.0	25.4	691.8	685.7	675.5	814.0	665.4	24.9	24.7	22.1
956.0	25.4	690.8	684.6	674.7	812.1	664.7	24.9	24.7	22.1
963.0	25.4	689.7	683.3	674.2	810.0	663.9	24.9	24.7	22.1
970.0	25.6	688.7	682.1	673.5	808.1	663.1	24.9	24.7	22.0
977.0	25.7	687.7	680.9	672.7	806.2	662.3	24.9	24.7	22.0
984.0	25.6	686.7	679.7	671.8	804.3	661.4	24.9	24.7	22.1
991.0	25.4	685.7	678.5	670.8	802.3	660.6	24.8	24.7	22.1
998.0	25.3	684.7	677.4	670.1	800.5	659.8	24.8	24.7	22.1
1005.0	25.3	683.8	676.2	669.7	798.7	658.9	24.9	24.8	22.1
1012.0	25.2	682.8	675.1	668.8	796.8	658.1	24.9	24.8	22.1
1019.0	25.3	681.8	673.9	668.1	795.1	657.2	24.8	24.8	22.1
1026.0	25.3	680.9	672.8	667.2	793.2	656.3	24.8	24.8	22.1
1033.0	25.1	679.9	671.7	666.4	791.4	655.4	24.9	24.7	22.1
1040.0	25.1	679.0	670.6	665.4	789.7	654.5	24.9	24.7	22.0
1047.0	25.1	678.1	669.6	664.5	787.9	653.6	24.8	24.7	22.0
1054.0	25.0	677.1	668.4	664.4	786.2	652.6	24.8	24.7	21.9
1061.0	24.9	676.2	667.4	663.7	784.5	651.7	24.8	24.7	22.0
1068.0	24.9	675.3	666.4	662.8	782.8	650.7	24.8	24.8	22.0
1075.0	25.0	674.4	665.3	662.1	781.1	649.7	24.8	24.8	22.0
1082.0	24.9	673.5	664.3	661.6	779.4	648.8	24.8	24.8	22.0
1089.0	25.0	672.6	663.3	660.7	777.7	647.7	24.9	24.7	21.9
1096.0	24.9	671.7	662.3	660.1	775.9	646.7	24.8	24.7	21.8
1103.0	25.0	670.8	661.3	659.1	774.3	645.7	24.8	24.7	21.9
1110.0	25.3	669.9	660.2	658.2	772.6	644.7	24.8	24.7	21.9
1117.0	25.4	669.1	659.3	657.3	771.1	643.7	24.9	24.7	22.0
1124.0	25.6	668.2	658.3	656.6	769.4	642.7	24.8	24.7	22.0
1133.0	25.7	667.1	657.0	656.0	767.3	641.4	24.8	24.7	21.9
1140.0	25.5	666.2	656.1	654.9	765.8	640.4	24.8	24.7	21.9
1146.0	25.4	665.4	655.2	654.3	764.2	639.4	24.8	24.7	21.9
1153.0	25.4	664.6	654.3	653.6	762.7	638.4	24.8	24.7	22.0
1160.0	25.3	663.8	653.3	652.8	761.2	637.4	24.8	24.7	21.9
1166.0	25.3	662.9	652.4	652.1	759.6	636.5	24.8	24.7	22.0

TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 9-17
TEST: ASA-1 DATA
(sheet 5 of 12)

TIME SECONDS	DAS# 9 DEG C	DAS# 10 DEG C	DAS# 11 DEG C	DAS# 12 DEG C	DAS# 13 DEG C	DAS# 14 DEG C	DAS 15 DEG C	DAS# 16 DEG C	DAS# 17 DEG C
-284.0	18.1	20.4	25.1	29.4	24.4	23.1	23.3	19.4	19.9
-254.0	18.1	20.6	25.3	29.6	24.5	23.4	23.4	19.4	19.8
-224.0	18.1	20.6	25.7	30.0	24.7	23.6	23.7	19.4	19.8
-194.0	18.1	20.7	26.1	30.6	24.7	23.7	23.8	19.4	19.8
-164.0	18.2	20.8	26.4	30.6	24.9	23.8	24.1	19.4	19.9
-134.0	18.2	20.8	26.6	30.6	24.9	23.9	24.2	19.4	19.9
-104.0	18.2	20.9	26.7	30.8	25.1	24.0	24.3	19.4	19.9
-74.0	18.2	20.9	26.9	30.7	25.2	24.1	24.3	19.4	19.9
-44.0	18.2	21.1	27.0	30.6	25.3	24.2	24.4	19.4	20.0
-14.0	18.2	21.1	27.2	30.4	25.3	24.3	24.4	19.4	20.0
16.0	18.3	21.5	27.3	31.4	25.3	24.8	24.6	19.4	20.1
46.0	19.9	25.1	28.5	32.8	27.3	26.3	26.1	19.7	20.2
76.0	22.2	27.3	30.4	33.9	29.4	28.8	28.4	20.1	20.4
106.0	24.3	29.8	32.2	35.8	31.5	31.9	31.2	20.4	20.7
151.0	24.6	29.7	32.4	37.2	32.2	32.9	32.3	20.7	20.8
158.0	24.6	29.3	32.4	37.2	32.1	32.9	32.2	20.9	20.8
165.0	24.4	28.9	32.1	37.1	31.9	32.7	32.2	20.8	20.8
172.0	24.2	28.7	31.9	37.3	31.7	32.4	32.0	20.7	20.8
179.0	24.1	28.6	32.0	37.2	31.4	32.3	31.8	20.6	20.8
186.0	23.8	28.4	31.9	37.2	31.2	32.1	31.7	20.4	20.8
193.0	23.6	28.2	31.8	37.3	30.9	31.8	31.6	20.4	20.8
200.0	23.5	28.1	31.8	37.3	30.8	31.7	31.4	20.4	20.8
207.0	23.3	27.9	31.7	37.2	30.7	31.4	31.3	20.3	20.9
214.0	23.2	27.7	31.7	37.2	30.5	31.3	31.2	20.3	20.8
221.0	26.5	27.6	31.6	37.3	30.4	31.1	31.1	20.3	20.8
228.0	24.9	27.4	31.6	37.4	30.3	30.9	30.9	20.3	20.9
235.0	24.2	27.4	31.6	37.4	30.3	30.8	30.8	20.3	20.9
242.0	23.7	27.4	31.5	37.4	30.3	30.7	30.7	20.3	20.9
249.0	23.4	27.3	31.4	37.6	30.3	30.7	30.7	20.3	20.9
256.0	23.2	27.3	31.3	37.7	30.3	30.6	30.6	20.3	20.9
263.0	23.1	27.2	31.2	37.8	30.3	30.6	30.6	20.3	20.9
270.0	22.9	27.1	31.1	37.7	30.3	30.4	30.5	20.3	20.9
277.0	22.9	27.0	31.2	37.9	30.3	30.4	30.4	20.3	20.9
284.0	22.8	27.0	31.2	38.2	30.3	30.4	30.4	20.3	20.9
291.0	22.8	27.2	31.1	38.1	30.3	30.3	30.3	20.3	20.9
298.0	22.7	27.2	30.9	37.6	30.2	30.3	30.3	20.3	21.0
305.0	22.7	27.3	30.8	37.7	30.2	30.2	30.3	20.3	21.0
312.0	22.7	27.5	30.8	37.6	30.2	30.2	30.3	20.4	21.1
319.0	22.7	27.6	30.7	37.7	30.2	30.2	30.3	20.4	21.1
326.0	22.7	27.7	30.7	37.5	30.3	30.3	30.4	20.4	21.1

TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 9-17
TEST: ASA-1 DATA
(sheet 6 of 12)

TIME SECONDS	DAS# 9 DEG C	DAS# 10 DEG C	DAS# 11 DEG C	DAS# 12 DEG C	DAS# 13 DEG C	DAS# 14 DEG C	DAS# 15 DEG C	DAS# 16 DEG C	DAS# 17 DEG C
333.0	22.7	27.8	30.7	36.9	30.3	30.3	30.4	20.4	21.1
340.0	22.7	28.0	30.7	36.7	30.4	30.4	30.4	20.4	21.1
347.0	22.7	28.2	30.7	37.2	30.4	30.4	30.5	20.5	21.1
354.0	22.8	28.2	30.7	37.2	30.4	30.5	30.6	20.7	21.2
361.0	22.8	28.4	30.8	36.9	30.4	30.5	30.6	20.8	21.2
368.0	22.8	28.3	30.9	37.1	30.6	30.7	30.7	20.7	21.2
375.0	22.8	28.7	30.9	37.3	30.7	30.9	30.9	20.7	21.2
382.0	22.9	28.8	31.1	37.4	30.7	30.9	30.9	20.6	21.2
389.0	22.9	28.7	31.2	37.4	30.7	31.1	30.9	20.6	21.2
396.0	23.0	28.7	31.3	37.6	30.8	31.2	31.2	20.6	21.3
403.0	23.0	28.8	31.5	37.8	30.9	31.3	31.2	20.6	21.3
410.0	23.1	28.8	31.6	38.1	31.2	31.4	31.2	22.5	21.3
417.0	23.2	28.7	31.6	38.1	31.2	31.6	31.3	22.1	21.3
424.0	23.3	28.7	31.6	38.1	31.3	31.5	31.2	21.8	21.3
431.0	23.4	28.8	31.7	38.3	31.4	31.5	31.2	21.7	21.4
438.0	23.6	28.8	31.8	38.1	31.4	31.7	31.2	21.5	21.4
445.0	23.8	28.9	32.1	38.0	31.5	31.9	31.3	21.3	21.4
452.0	23.8	28.9	32.3	38.2	31.6	31.9	31.4	21.2	21.4
459.0	24.6	29.1	32.5	38.2	31.7	32.0	31.6	21.2	21.4
466.0	25.3	29.1	32.7	38.1	31.8	32.0	31.6	21.6	21.5
473.0	25.4	29.1	32.9	38.3	31.8	32.1	31.6	21.7	21.5
480.0	25.6	29.1	33.0	38.9	31.8	32.1	31.6	21.7	21.5
487.0	25.9	29.0	32.9	38.8	31.7	32.1	31.6	21.5	21.5
494.0	25.4	28.8	32.9	38.9	31.6	32.0	31.6	21.3	21.5
501.0	25.3	28.8	32.7	38.3	31.6	31.8	31.5	21.3	21.5
508.0	25.2	28.7	32.6	38.2	31.6	31.7	31.3	21.2	21.5
515.0	25.2	28.7	32.4	37.9	31.4	31.5	31.2	21.1	21.6
522.0	25.0	28.6	32.2	37.8	31.2	31.4	31.0	21.1	21.6
531.0	24.8	28.4	32.1	37.4	31.1	31.4	30.9	21.1	21.6
537.0	24.8	28.4	31.9	37.4	31.1	31.6	30.9	21.0	21.6
544.0	24.7	28.3	32.0	37.2	31.1	31.6	30.9	21.0	21.6
551.0	24.5	28.2	31.7	37.6	31.1	31.4	30.8	20.9	21.6
557.0	24.4	28.1	31.7	37.4	31.1	31.3	30.6	20.9	21.6
564.0	24.3	28.0	31.7	37.4	30.9	31.1	30.5	20.9	21.6
571.0	24.3	27.9	31.9	37.3	30.9	31.0	30.5	20.9	21.6
578.0	24.1	27.8	32.1	37.5	31.0	30.9	30.4	20.9	21.6
585.0	24.3	27.6	32.1	37.6	30.8	30.7	30.3	20.9	21.6
592.0	24.4	27.4	31.7	37.6	30.7	30.6	30.2	20.9	21.6
599.0	24.3	27.3	31.4	37.5	30.6	30.5	30.2	20.9	21.7
606.0	24.3	27.2	31.1	37.4	30.5	[illegible]	30.1	20.9	21.7

TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 9-17
TEST: ASA-1 DATA
(sheet 7 of 12)

TIME SECONDS	DAS# 9 DEG C	DAS# 10 DEG C	DAS# 11 DEG C	DAS# 12 DEG C	DAS# 13 DEG C	DAS# 14 DEG C	DAS 15 DEG C	DAS# 16 DEG C	DAS# DEG C
613.0	24.2	27.2	30.9	36.7	30.4	30.2	30.0	20.9	21.
620.0	24.1	27.1	30.6	36.4	30.3	30.1	29.9	20.9	21.
627.0	23.9	27.2	30.6	35.8	30.2	30.2	29.7	20.9	21.
634.0	23.8	27.3	30.4	35.4	30.2	30.3	29.7	20.9	21.
641.0	23.7	27.2	30.4	35.4	30.2	30.3	29.6	20.9	21.
648.0	23.7	27.2	30.7	35.4	30.2	30.2	29.6	20.9	21.
655.0	23.6	27.1	30.8	35.6	29.9	30.0	29.5	20.8	21.
662.0	23.6	26.9	30.8	35.8	29.9	29.9	29.6	20.8	21.
669.0	23.5	26.8	30.8	35.9	29.8	29.8	29.6	20.8	21.
676.0	23.4	26.7	30.7	36.1	29.8	29.7	29.6	20.8	21.
683.0	23.3	26.6	30.7	36.3	29.8	29.6	29.5	20.8	21.
690.0	23.2	26.5	30.7	36.4	29.8	29.4	29.4	20.8	21.
697.0	23.1	26.4	30.7	36.2	29.8	29.3	29.3	20.8	21.
704.0	23.1	26.3	30.7	36.5	29.8	29.3	29.2	20.8	21.
711.0	22.9	26.3	30.7	36.4	29.7	29.2	29.2	20.8	21.
718.0	22.9	26.3	30.7	36.6	29.8	29.2	29.2	20.8	21.
725.0	22.9	26.2	30.7	36.5	29.9	29.2	29.1	20.8	21.
732.0	22.8	26.1	30.7	36.5	29.8	29.1	29.1	20.8	21.
739.0	22.7	26.1	30.7	36.3	29.7	29.0	29.0	20.8	21.
746.0	22.7	26.1	30.6	36.0	29.6	28.8	28.8	20.8	21.
753.0	22.7	26.0	30.4	35.9	29.4	28.8	28.8	20.8	21.
760.0	22.6	25.9	30.5	35.7	29.6	28.7	28.7	20.8	21.
767.0	22.6	25.9	30.7	35.9	29.6	28.7	28.6	20.8	21.
774.0	22.5	25.8	30.6	35.6	29.6	28.6	28.6	20.8	21.
781.0	22.5	25.8	30.5	35.6	29.6	28.6	28.6	20.8	21.
788.0	22.4	25.7	30.6	35.4	29.4	28.5	28.6	20.8	21.
795.0	22.4	25.7	30.7	35.3	29.3	28.4	28.5	20.8	21.
802.0	22.4	25.7	30.7	35.3	29.3	28.4	28.4	20.7	21.
809.0	22.4	25.7	30.8	35.5	29.4	28.4	28.4	20.8	21.
816.0	22.3	25.6	30.7	35.5	29.4	28.4	28.4	20.7	21.
823.0	22.3	25.6	30.7	35.3	29.3	28.4	28.3	20.8	21.
830.0	22.3	25.7	30.5	35.2	29.3	28.4	28.3	20.8	21.
837.0	22.3	25.7	30.7	35.4	29.3	28.3	28.3	20.8	21.
844.0	22.3	25.7	30.8	35.2	29.2	28.3	28.3	20.8	21.
851.0	22.3	25.7	30.8	35.0	29.1	28.3	28.3	20.8	21.
858.0	22.3	25.7	30.8	34.8	29.2	28.3	28.2	20.8	21.
865.0	22.3	25.7	30.6	34.6	29.1	28.2	28.1	20.8	21.
872.0	22.3	25.6	30.6	35.1	29.0	28.2	28.1	20.8	21.
879.0	22.2	25.5	30.4	35.0	29.0	28.2	28.1	20.7	21.
886.0	22.2	25.5	30.6	34.8	28.9	28.1	28.1	20.8	21.

TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 9-17
TEST: ASA-1 DATA
(sheet 8 of 12)

TIME SECONDS	DAS# 9 DEG C	DAS# 10 DEG C	DAS# 11 DEG C	DAS# 12 DEG C	DAS# 13 DEG C	DAS# 14 DEG C	DAS 15 DEG C	DAS# 16 DEG C	DAS# 17 DEG C
893.0	22.2	25.5	30.7	35.1	28.9	28.1	28.1	20.8	21.9
900.0	22.2	25.5	30.8	35.0	28.7	28.1	28.1	20.8	21.9
907.0	22.2	25.5	30.7	34.9	28.9	28.1	28.0	20.8	21.9
914.0	22.2	25.5	30.8	34.9	28.9	28.1	28.0	20.8	21.9
921.0	22.2	25.4	30.9	35.2	28.9	28.1	28.1	20.8	21.9
928.0	22.2	25.4	30.7	35.2	28.9	28.1	28.1	20.8	21.9
935.0	22.2	25.4	30.6	35.4	28.8	28.0	27.9	20.8	21.9
942.0	22.3	25.4	30.6	35.6	28.9	28.0	27.8	20.8	21.9
949.0	22.2	25.5	30.6	35.3	28.9	28.0	27.8	20.8	21.9
956.0	22.2	25.4	30.4	35.6	28.9	28.0	27.8	20.8	21.9
963.0	22.2	25.4	30.2	35.7	28.8	28.1	27.8	20.8	21.9
970.0	22.2	25.3	30.2	35.3	28.9	28.2	27.8	20.8	21.9
977.0	22.2	25.3	30.3	35.1	28.8	28.2	27.9	20.8	21.9
984.0	22.2	25.3	30.5	35.1	28.8	28.2	27.9	20.8	21.9
991.0	22.1	25.3	30.4	35.2	28.8	28.1	27.9	20.8	21.9
998.0	22.1	25.3	30.6	35.3	28.8	28.1	27.9	20.8	21.9
1005.0	22.1	25.3	30.3	35.4	28.7	28.1	27.9	20.8	21.9
1012.0	22.1	25.3	30.3	35.4	28.7	28.1	27.9	20.8	22.0
1019.0	22.1	25.3	30.2	35.6	28.8	28.0	27.8	20.8	22.0
1026.0	22.1	25.3	30.3	35.5	28.8	28.0	27.8	20.8	22.0
1033.0	22.1	25.3	30.6	35.4	29.0	28.1	27.8	20.8	22.0
1040.0	22.1	25.4	30.7	35.3	29.1	28.0	27.8	20.8	22.0
1047.0	22.1	25.3	30.7	35.3	29.1	28.1	27.9	20.8	22.0
1054.0	22.1	25.3	30.6	35.7	29.1	28.1	27.9	20.8	22.0
1061.0	22.1	25.3	30.4	35.7	29.1	28.1	27.9	20.8	22.0
1068.0	22.1	25.3	30.4	35.8	29.1	28.1	28.0	20.8	22.0
1075.0	22.1	25.3	30.4	35.7	28.9	28.1	28.0	20.8	22.0
1082.0	22.1	25.3	30.6	35.8	28.8	28.0	27.9	20.8	22.0
1089.0	22.1	25.3	30.6	35.6	28.8	28.0	27.9	20.8	22.0
1096.0	22.1	25.2	30.7	35.5	28.8	28.1	27.9	20.8	22.0
1103.0	22.1	25.3	30.5	35.8	28.8	28.0	27.9	20.8	22.1
1110.0	22.1	25.3	30.3	36.1	28.7	28.2	27.8	20.8	22.0
1117.0	22.2	25.3	30.3	35.9	28.8	28.1	27.9	20.8	22.1
1124.0	22.2	25.3	30.1	35.9	28.9	28.1	27.8	20.8	22.1
1133.0	22.2	25.3	30.3	35.8	28.9	28.1	27.8	20.8	22.1
1140.0	22.2	25.3	30.4	36.1	29.0	28.0	27.8	20.8	22.1
1146.0	22.1	25.3	30.6	36.0	28.9	27.9	27.8	20.8	22.1
1153.0	22.2	25.2	30.6	35.8	28.8	27.9	27.7	20.8	22.1
1160.0	22.2	25.2	30.5	35.8	28.8	27.9	27.6	20.8	22.1
1166.0	22.2	25.3	30.4	36.1	28.9	27.9	27.7	20.8	22.1

TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 18-63
TEST: ASA-1 DATA
(sheet 9 of 12)

TIME SECONDS	DAS# 18 DEG C	DAS# 19 DEG C	DAS# 20 DEG C	DAS# 21 DEG C	DAS# 22 DEG C	DAS# 60 O2 %	DAS# 61 DEG C	DAS# 62 KPa A	DAS# KPa
-284.0	19.9	19.6	21.3	18.3	21.6	21.0	3.0	105.2	124
-254.0	19.9	19.7	21.4	18.6	21.6	21.0	3.3	105.3	124
-224.0	19.9	19.7	21.5	18.8	21.6	21.0	3.6	105.3	124
-194.0	19.9	19.7	21.6	18.6	21.6	21.0	3.7	105.3	124
-164.0	19.9	19.7	21.6	18.3	21.6	21.0	3.8	105.3	124
-134.0	19.9	19.8	21.7	18.2	21.6	21.0	3.9	105.3	124
-104.0	19.9	19.8	21.8	18.2	21.6	21.0	3.9	105.3	125
-74.0	19.9	19.8	21.8	18.4	21.6	21.0	4.0	105.4	124
-44.0	20.0	19.9	21.9	26.3	21.6	21.0	4.0	105.4	125
-14.0	20.0	19.9	21.9	19.8	21.6	21.0	4.1	105.4	124
16.0	20.1	19.9	22.3	23.9	21.8	21.0	4.1	106.2	356
46.0	20.3	19.9	25.4	24.6	32.9	21.0	4.2	107.5	357
76.0	20.6	20.0	28.7	25.9	24.6	21.0	4.2	108.4	506
106.0	21.1	20.1	31.2	26.3	24.0	21.0	4.2	108.8	505
151.0	21.1	20.3	31.6	58.0	23.7	21.0	4.1	108.2	536
158.0	21.0	20.3	31.4	54.3	23.7	21.0	4.2	108.0	629
165.0	20.9	20.3	31.2	53.8	23.7	21.0	4.2	107.9	634
172.0	20.9	20.3	30.8	54.6	23.7	21.0	4.2	107.8	634
179.0	20.8	20.3	30.6	77.4	23.7	21.0	4.2	107.7	631.
186.0	20.8	20.3	30.4	83.3	23.7	21.0	4.2	107.7	631.
193.0	20.8	20.3	30.2	93.5	23.6	21.0	3.1	107.6	629.
200.0	20.8	20.4	29.8	98.1	23.7	21.0	4.2	107.5	631.
207.0	20.8	20.4	29.6	101.6	23.7	21.0	4.2	107.5	629.
214.0	20.8	20.4	29.4	103.9	23.7	21.0	4.2	107.5	630.
221.0	20.8	20.4	29.2	105.4	23.7	21.0	4.3	107.5	629.
228.0	20.7	20.4	29.1	106.4	23.7	21.0	4.2	107.5	630.
235.0	20.7	20.4	29.0	106.8	23.7	21.0	5.0	107.6	631.
242.0	20.8	20.4	28.8	107.6	23.7	21.0	3.7	107.5	632.
249.0	20.7	20.5	28.8	107.1	23.7	21.0	4.0	107.6	631.
256.0	20.7	20.5	28.8	106.1	23.8	21.0	4.2	107.5	630.
263.0	20.7	20.6	28.7	105.3	23.8	21.0	4.3	107.5	631.
270.0	20.7	20.6	28.6	104.1	23.8	21.0	4.2	107.5	629.
277.0	20.7	20.6	28.4	102.8	23.8	21.0	4.2	107.5	629.
284.0	20.7	20.6	28.4	101.6	23.8	20.9	1.4	107.5	632.
291.0	20.7	20.6	28.3	100.2	23.8	20.2	7.1	107.5	631.
298.0	20.7	20.6	28.4	98.8	23.9	20.4	8.7	107.5	629.
305.0	20.7	20.6	28.4	97.5	23.9	20.8	6.4	107.5	632.
312.0	20.7	20.6	28.3	96.6	23.9	20.9	5.1	107.6	633.
319.0	20.7	20.6	28.4	95.6	23.9	21.0	4.6	107.6	632.
326.0	20.7	20.7	28.5	94.5	23.9	21.0	4.4	107.6	631.

TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 18-63
TEST: ASA-1 DATA
(sheet 10 of 12)

TIME SECONDS	DAS# 18 DEG C	DAS# 19 DEG C	DAS# 20 DEG C	DAS# 21 DEG C	DAS# 22 DEG C	DAS# 60 O2 %	DAS 61 DEG C	DAS# 62 KPa A	DAS# 63 KPa A
333.0	20.8	20.7	28.5	93.6	23.9	21.0	4.4	107.6	632.1
340.0	20.7	20.7	28.6	92.7	23.9	21.0	4.4	107.7	633.1
347.0	20.8	20.7	28.7	91.8	24.0	21.0	4.4	107.7	634.6
354.0	20.8	20.7	28.8	91.2	24.1	21.0	4.4	107.7	632.9
361.0	20.8	20.7	28.7	90.3	24.1	21.0	3.1	107.7	631.4
368.0	20.8	20.7	28.7	89.5	24.1	21.0	4.4	107.8	632.7
375.0	20.8	20.8	28.8	88.8	24.1	21.0	4.4	107.8	633.3
382.0	20.8	20.8	28.8	88.5	24.2	21.0	4.3	107.8	633.2
389.0	20.8	20.8	28.9	88.4	24.3	21.0	4.3	107.8	632.6
396.0	20.8	20.8	28.9	87.6	24.3	21.0	4.3	107.8	632.3
403.0	20.9	20.8	28.9	86.3	24.4	21.0	4.3	107.9	632.5
410.0	20.9	20.8	29.1	125.3	26.5	21.0	4.3	107.9	633.8
417.0	20.9	20.9	29.1	122.8	25.3	21.0	4.3	108.0	633.7
424.0	20.9	20.9	29.2	117.8	24.9	21.0	4.3	108.1	632.3
431.0	20.9	20.9	29.4	117.0	24.8	21.0	4.3	108.1	631.9
438.0	21.0	20.9	29.6	116.8	24.7	21.0	4.3	108.2	633.7
445.0	21.0	20.9	29.7	116.6	24.7	21.0	4.3	108.3	633.2
452.0	21.1	20.9	30.0	116.6	24.7	21.0	4.3	108.3	634.8
459.0	21.1	21.0	30.3	116.2	25.2	21.0	4.3	108.4	602.4
466.0	21.2	21.0	30.5	115.5	25.1	21.0	4.3	108.4	577.3
473.0	21.1	21.0	30.6	114.2	25.1	21.0	4.3	108.4	528.7
480.0	21.0	21.0	30.6	112.2	25.1	21.0	4.4	108.3	434.4
487.0	21.0	21.0	30.6	109.2	25.1	21.0	4.3	108.3	358.7
494.0	21.0	21.1	30.4	106.1	25.1	21.0	4.3	108.3	296.4
501.0	21.0	21.1	30.2	104.0	25.2	21.0	4.3	108.2	243.7
508.0	21.0	21.1	30.1	102.7	25.2	21.0	4.3	108.2	203.3
515.0	21.0	21.1	30.0	101.3	25.1	21.0	4.3	108.2	170.7
522.0	21.0	21.1	29.9	100.3	25.1	21.0	4.3	108.1	160.7
531.0	21.1	21.2	29.8	99.1	25.1	21.0	4.3	108.1	263.4
537.0	21.1	21.1	29.8	97.8	25.1	21.0	4.3	108.0	218.2
544.0	21.1	21.2	29.7	96.9	25.1	21.0	4.3	108.0	182.4
551.0	21.1	21.2	29.6	95.9	25.1	21.0	4.3	107.9	154.6
557.0	20.9	21.2	29.4	95.2	25.1	21.0	4.3	107.9	366.8
564.0	20.9	21.2	29.3	94.3	25.2	21.0	4.3	107.9	390.4
571.0	20.9	21.3	29.2	93.5	25.2	21.0	4.3	107.9	492.1
578.0	20.9	21.2	29.0	92.2	25.3	21.0	4.3	107.9	413.9
585.0	20.8	21.3	28.9	91.3	25.4	21.0	4.3	107.9	345.9
592.0	20.9	21.3	28.8	90.5	25.4	21.0	4.2	107.9	288.2
599.0	20.9	21.3	28.7	89.7	25.4	21.0	4.3	107.9	240.2
606.0	20.9	21.3	28.6	89.0	25.4	21.0	4.3	107.9	202.9

TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 18-63
TEST: ASA-1 DATA
(sheet 11 of 12)

TIME SECONDS	DAS# 18 DEG C	DAS# 19 DEG C	DAS# 20 DEG C	DAS# 21 DEG C	DAS# 22 DEG C	DAS# 60 O2 %	DAS 61 DEG C	DAS# 62 KPa A	DAS# KPa
613.0	20.8	21.3	28.6	88.3	25.4	21.0	4.3	107.9	169
620.0	20.8	21.3	28.6	87.6	25.4	21.0	4.2	107.8	145
627.0	20.8	21.3	28.5	86.8	25.4	21.0	4.2	107.8	126
634.0	20.8	21.3	28.4	86.3	25.4	21.0	3.9	107.8	113
641.0	20.8	21.3	28.3	85.7	25.4	21.0	3.9	107.7	104
648.0	20.8	21.3	28.2	85.2	25.5	21.0	4.1	107.7	100
655.0	20.8	21.3	28.2	84.7	25.6	20.9	4.3	107.6	99
662.0	20.8	21.4	28.2	84.1	25.5	21.0	4.3	107.6	99
669.0	20.8	21.3	28.1	83.4	25.6	21.0	4.3	107.6	99
676.0	20.8	21.4	28.1	82.8	25.6	20.9	4.2	107.6	99
683.0	20.8	21.4	27.9	82.3	25.6	20.9	2.1	107.5	99
690.0	20.7	21.4	27.9	81.8	25.6	20.7	8.8	107.5	99
697.0	20.7	21.4	27.8	81.2	25.6	20.7	15.0	107.4	99
704.0	20.7	21.4	27.7	80.8	25.6	20.8	12.9	107.4	99
711.0	20.8	21.4	27.7	80.3	25.7	20.9	8.2	107.4	99
718.0	20.7	21.4	27.6	79.8	25.7	20.9	5.5	107.4	99
725.0	20.7	21.4	27.5	79.3	25.7	20.9	4.8	107.3	99
732.0	20.7	21.4	27.4	78.7	25.7	20.9	4.7	107.3	99
739.0	20.7	21.4	27.4	78.4	25.7	20.9	4.7	107.3	99
746.0	20.7	21.4	27.4	77.9	25.8	20.9	4.8	107.3	99
753.0	20.7	21.5	27.3	77.5	25.8	20.9	4.9	107.3	99
760.0	20.7	21.5	27.3	77.1	25.8	20.9	4.8	107.2	99
767.0	20.7	21.5	27.2	76.7	25.8	20.9	4.8	107.2	99
774.0	20.7	21.5	27.2	76.2	25.8	20.9	4.7	107.2	99
781.0	20.7	21.4	27.1	75.8	25.9	20.8	4.6	107.2	99
788.0	20.7	21.5	27.1	75.3	25.9	20.9	4.5	107.2	99
795.0	20.7	21.5	27.1	74.8	25.9	20.9	4.5	107.2	99
802.0	20.6	21.5	27.1	74.5	25.9	20.9	4.5	107.2	98
809.0	20.6	21.6	27.0	74.1	25.9	20.9	4.5	107.2	99
816.0	20.6	21.5	27.0	73.6	25.9	20.9	4.5	107.2	99
823.0	20.6	21.5	26.9	73.1	26.0	20.9	4.4	107.2	99
830.0	20.7	21.6	26.9	72.7	26.0	20.9	4.4	107.1	99
837.0	20.7	21.6	26.9	72.4	26.1	20.9	4.4	107.1	99.
844.0	20.7	21.6	26.8	72.1	26.1	20.9	4.4	107.1	99.
851.0	20.6	21.6	26.8	71.7	26.1	20.9	4.4	107.1	99.
858.0	20.7	21.6	26.8	71.3	26.1	20.9	4.4	107.1	99.
865.0	20.6	21.6	26.8	71.0	26.1	20.9	4.4	107.1	99.
872.0	20.6	21.6	26.8	70.7	26.1	20.9	4.3	107.1	99.
879.0	20.6	21.6	26.8	70.4	26.1	20.9	4.3	107.1	99.
886.0	20.6	21.6	26.8	69.9	26.2	20.9	4.3	107.1	99.

TABLE A-8
DIGITAL OUTPUT FOR DAS #'s 18-63
TEST: ASA-1 DATA
(sheet 12 of 12)

TIME SECONDS	DAS# 18 DEG C	DAS# 19 DEG C	DAS# 20 DEG C	DAS# 21 DEG C	DAS# 22 DEG C	DAS# 60 O2 %	DAS 61 DEG C	DAS# 62 KPa A	DAS# 63 KPa A
893.0	20.7	21.6	26.7	69.7	26.2	20.9	4.3	107.1	99.2
900.0	20.7	21.6	26.7	69.5	26.2	20.9	4.3	107.1	99.5
907.0	20.7	21.6	26.7	69.1	26.2	20.9	4.3	107.1	99.2
914.0	20.6	21.6	26.7	68.7	26.2	20.9	4.3	107.1	99.5
921.0	20.7	21.7	26.7	68.4	26.3	20.9	4.3	107.1	99.2
928.0	20.6	21.7	26.7	68.3	26.3	20.9	4.3	107.1	99.1
935.0	20.7	21.7	26.7	68.1	26.3	20.9	4.3	107.1	99.1
942.0	20.6	21.7	26.7	67.7	26.3	20.9	4.2	107.1	99.3
949.0	20.6	21.7	26.7	67.3	26.4	20.8	4.3	107.1	99.3
956.0	20.6	21.7	26.7	66.9	26.4	20.9	4.3	107.1	99.1
963.0	20.6	21.7	26.7	66.5	26.4	20.9	4.3	107.1	99.4
970.0	20.6	21.7	26.6	66.1	26.4	20.9	4.2	107.1	99.3
977.0	20.6	21.7	26.6	65.8	26.4	20.9	4.2	107.1	99.2
984.0	20.7	21.7	26.6	65.6	26.4	20.9	4.2	107.1	99.1
991.0	20.6	21.7	26.7	65.3	26.5	20.9	5.0	107.1	99.2
998.0	20.6	21.7	26.7	65.0	26.5	20.9	4.2	107.1	99.3
1005.0	20.6	21.7	26.6	64.7	26.6	20.9	4.2	107.1	99.4
1012.0	20.6	21.7	26.6	64.3	26.6	20.9	4.2	107.1	99.4
1019.0	20.6	21.7	26.6	64.1	26.6	20.9	4.2	107.1	99.1
1026.0	20.6	21.7	26.6	63.8	26.6	20.9	4.2	107.1	99.0
1033.0	20.6	21.7	26.6	63.7	26.6	20.9	4.8	107.1	99.2
1040.0	20.6	21.7	26.6	63.3	26.6	20.9	4.2	107.1	99.6
1047.0	20.6	21.8	26.6	63.1	26.6	20.9	4.2	107.1	99.3
1054.0	20.6	21.8	26.6	62.9	26.7	20.9	4.2	107.1	99.1
1061.0	20.6	21.8	26.6	62.7	26.7	20.9	4.2	107.1	99.1
1068.0	20.6	21.8	26.5	62.4	26.7	20.9	4.2	107.1	99.2
1075.0	20.6	21.8	26.5	62.2	26.7	20.7	4.3	107.1	98.6
1082.0	20.6	21.8	26.5	61.9	26.8	20.9	4.2	107.1	99.1
1089.0	20.6	21.8	26.4	61.6	26.8	20.9	4.1	107.1	99.2
1096.0	20.6	21.8	26.4	61.3	26.8	20.9	4.2	107.1	99.2
1103.0	20.6	21.8	26.4	61.2	26.8	20.9	4.2	107.1	99.4
1110.0	20.6	21.8	26.4	61.0	26.8	20.9	4.1	107.1	98.9
1117.0	20.6	21.8	26.4	60.7	26.8	20.9	4.2	107.1	98.9
1124.0	20.6	21.8	26.5	60.6	26.8	20.9	4.2	107.1	99.3
1133.0	20.6	21.8	26.5	60.5	26.8	20.9	4.1	107.0	99.3
1140.0	20.6	21.8	26.4	60.3	26.9	20.9	4.2	107.0	99.2
1146.0	20.5	21.8	26.5	60.1	26.9	20.9	4.2	107.0	99.2
1153.0	20.6	21.8	26.4	59.8	26.9	20.7	4.2	107.0	99.0
1160.0	20.6	21.8	26.4	59.5	26.9	20.9	4.1	107.0	99.3
1166.0	20.5	21.8	26.4	59.2	26.9	20.9	4.1	107.1	99.3

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 1-10
TEST: AWR-1 DATA
(sheet 1 of 12)

TIME SECONDS	DAS 1 DEG C	DAS 2 DEG C	DAS 3 DEG C	DAS 4 DEG C	DAS 5 DEG C	DAS 6 DEG C	DAS 7 DEG C	DAS 8 DEG C	DAS 9 DEG C	DAS 10 DEG C
-51	512.3	509.0	512.3	509.1	509.2	457.9	503.7	[illegible]	510.8	507.1
-44	512.3	509.0	512.3	509.1	509.2	458.3	503.7	514.4	510.9	507.2
-36	512.3	509.1	512.2	508.9	508.9	458.2	503.7	514.3	510.9	507.2
-29	512.4	509.1	512.2	509.1	509.1	458.4	503.8	514.3	510.8	[illegible]
-22	512.4	509.0	512.2	509.1	509.3	458.1	503.7	514.4	510.9	507.0
-14	512.4	508.9	512.3	509.4	508.9	458.2	503.8	514.5	510.9	507.0
-7	512.4	508.9	512.3	509.2	508.9	458.3	503.8	514.6	511.0	507.2
0	512.4	508.8	512.2	508.9	508.8	458.4	503.8	514.5	511.1	507.2
8	512.4	561.1	512.7	518.1	517.5	468.0	503.8	514.4	511.2	507.3
15	514.6	597.7	517.3	532.1	532.8	484.2	503.8	515.4	511.9	508.1
22	525.3	603.9	530.4	547.3	551.6	494.7	505.3	522.3	518.2	515.4
30	538.7	639.7	545.4	562.3	567.4	495.2	509.1	532.3	528.7	526.8
38	552.0	614.3	558.4	575.7	580.6	515.3	514.2	544.6	540.7	538.9
45	566.4	624.7	571.9	589.9	593.0	539.1	520.8	558.0	553.9	551.0
53	581.4	651.7	586.3	603.0	608.3	529.8	529.7	573.2	569.1	565.5
60	594.9	691.2	599.6	615.8	621.8	539.5	539.2	588.3	583.1	578.2
67	608.2	681.4	614.0	632.4	635.6	571.1	548.9	602.2	596.7	591.9
75	621.7	681.4	627.3	643.9	646.0	565.4	558.8	615.4	609.6	605.1
82	634.2	717.8	639.7	651.2	655.7	589.6	568.8	626.6	621.2	617.1
89	644.6	707.4	649.9	662.4	665.7	629.1	579.1	636.4	632.0	628.1
97	653.2	746.8	659.6	668.4	673.4	602.6	588.3	646.3	642.2	638.1
104	664.7	737.9	668.8	679.9	683.4	632.3	597.1	656.4	651.9	648.1
111	675.2	737.4	678.8	691.9	693.7	641.7	606.0	666.8	661.8	658.2
119	685.2	770.7	690.0	695.8	704.3	632.5	615.6	676.7	671.6	668.1
126	695.4	761.6	699.2	707.8	713.2	677.9	626.9	686.9	681.3	678.3
133	706.4	753.7	710.4	722.6	724.1	683.8	637.7	697.6	690.9	688.1
141	714.3	779.3	720.3	732.0	734.2	666.8	648.9	707.3	700.6	698.3
149	726.5	796.9	731.7	741.4	747.3	726.6	660.5	717.9	711.8	709.6
156	735.5	801.1	741.6	756.3	756.1	693.5	671.1	728.2	722.2	719.9
163	746.2	791.8	752.6	763.2	766.0	710.6	682.6	737.7	732.2	730.3
171	756.8	814.9	763.8	770.4	779.7	738.9	693.8	746.5	742.4	740.7
178	766.2	806.6	775.2	784.4	789.4	753.8	704.2	755.0	751.5	750.0
186	777.9	814.3	785.3	792.4	800.7	773.5	713.6	764.5	760.8	759.6
194	789.3	823.3	797.1	803.6	813.3	760.3	723.3	774.6	771.3	770.4
201	799.0	818.3	807.7	817.4	823.6	793.2	733.2	785.2	782.4	780.8
208	808.9	831.6	818.5	827.3	833.1	784.1	742.2	794.5	792.4	790.5
216	818.8	829.2	828.5	832.1	845.1	773.1	751.1	803.8	798.4	797.1
223	827.3	832.3	840.3	841.7	854.5	800.6	759.6	[illegible]	801.1	804.3
230	825.5	823.9	851.3	847.8	863.2	796.3	767.3	814.6	808.4	813.4
238	835.3	852.6	861.1	856.2	868.5	804.7	774.2	825.0	817.9	820.3

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 1-10
TEST: AWR-1 DATA
(sheet 2 of 12)

TIME SECONDS	DAS 1 DEG C	DAS 2 DEG C	DAS 3 DEG C	DAS 4 DEG C	DAS 5 DEG C	DAS 6 DEG C	DAS 7 DEG C	DAS 8 DEG C	DAS 9 DEG C	DAS 10 DEG C
245	347.0	354.3	367.5	364.6	369.3	797.5	781.4	831.5	326.2	325.5
252	855.2	853.9	871.9	861.8	868.1	808.7	790.4	840.7	835.9	831.2
259	361.1	854.7	872.3	362.3	367.3	305.3	801.1	347.7	344.9	334.3
267	867.3	863.2	871.9	860.1	866.2	818.2	813.3	853.0	849.7	857.6
274	369.0	365.1	369.8	357.8	866.3	340.1	322.2	853.9	351.9	341.0
282	868.4	876.4	870.1	851.7	863.7	848.3	830.0	855.6	852.5	843.3
290	367.0	368.1	366.7	851.6	362.4	327.2	835.2	358.0	352.6	345.2
297	865.9	865.8	868.2	853.4	863.0	841.7	838.4	858.3	852.3	846.0
304	864.8	867.6	864.2	852.6	361.2	336.9	840.7	357.9	352.1	346.3
312	863.9	870.9	865.1	851.9	859.7	830.7	842.2	856.9	852.0	846.8
320	363.1	375.3	864.0	848.8	859.7	836.4	843.2	854.3	851.2	346.9
329	863.3	864.8	863.2	854.7	858.2	834.9	843.8	855.2	851.4	847.5
336	362.7	341.1	862.9	358.8	358.2	322.0	844.5	355.8	351.6	348.5
343	862.4	842.8	862.7	858.8	857.7	822.7	844.8	855.3	851.4	849.1
351	361.6	340.9	362.5	358.0	857.2	820.0	844.8	354.1	850.8	349.4
358	860.8	838.5	862.2	857.3	856.2	917.3	844.7	854.4	850.6	849.5
365	860.0	336.7	861.7	356.6	856.1	314.8	844.4	354.4	350.4	349.4
373	860.8	835.0	861.2	856.2	855.2	812.3	844.0	854.4	850.2	849.3
380	360.9	833.8	860.3	855.2	354.9	310.2	844.0	354.2	349.9	349.1
387	859.9	832.7	860.4	855.1	855.0	808.2	843.9	854.0	849.8	848.8
395	359.0	831.6	860.0	855.3	854.1	306.2	843.2	354.1	349.7	348.6
402	859.1	830.6	859.8	854.8	853.7	804.2	842.4	853.3	849.5	848.3
410	358.8	829.2	359.7	354.2	353.4	302.1	841.6	852.1	849.2	348.2
417	855.4	828.2	859.6	853.8	853.1	800.2	840.7	851.7	848.9	848.1
425	354.3	327.2	359.3	853.8	352.9	798.6	839.8	350.1	348.5	348.0
432	853.4	825.8	859.0	853.4	852.6	796.7	839.0	848.8	848.2	847.8
440	852.5	324.9	858.9	853.2	352.6	795.1	838.4	[illegible]8.1	347.9	347.6
447	851.2	823.9	858.9	853.2	852.4	793.4	837.7	847.3	847.6	847.3
455	850.4	822.9	858.8	853.3	852.3	791.8	337.0	346.4	347.3	347.0
462	850.9	821.7	858.7	853.1	851.9	790.3	836.4	845.6	847.2	846.8
470	350.7	320.8	858.5	852.7	351.8	788.8	835.8	344.8	847.1	346.7
477	850.2	819.6	858.4	852.2	851.8	787.4	835.3	844.3	846.9	846.6
484	849.4	318.7	858.2	852.3	351.2	786.1	834.8	843.7	846.8	346.4
492	348.6	817.6	858.1	852.4	851.1	784.8	834.1	342.9	846.7	346.3
499	348.0	316.6	857.9	352.5	850.9	783.5	833.4	342.4	346.4	846.2
506	347.3	315.6	857.8	852.3	850.7	782.3	832.8	341.9	346.2	846.1
514	346.4	314.6	357.6	352.1	850.4	781.1	332.2	341.7	346.1	346.0
521	845.8	813.7	857.4	851.8	850.3	780.0	831.5	841.3	845.8	845.8
529	845.0	312.6	857.2	351.4	350.4	778.8	330.9	340.9	845.6	345.7
536	844.5	311.8	857.1	851.1	849.7	777.8	830.3	840.8	845.4	845.7

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 1-10
TEST: AWR-1 DATA
(sheet 3 of 12)

TIME SECONDS	DAS 1 DEG C	DAS 2 DEG C	DAS 3 DEG C	DAS 4 DEG C	DAS 5 DEG C	DAS 6 DEG C	DAS 7 DEG C	DAS 8 DEG C	DAS 9 DEG C	DAS 10 DEG C
543	844.3	810.9	857.0	850.7	849.8	776.8	829.6	840.3	845.2	845.5
551	843.7	810.0	856.8	850.2	849.5	775.7	828.9	839.9	844.9	845.4
559	843.2	809.1	856.6	850.1	849.4	774.7	828.3	839.4	844.7	845.2
566	842.9	808.2	856.4	850.1	849.4	773.8	827.7	838.9	844.4	845.1
574	842.4	807.3	856.2	849.9	849.1	772.8	827.2	838.6	844.1	844.9
581	842.1	806.6	856.0	849.8	848.7	771.9	826.7	838.4	843.8	844.7
588	841.6	805.6	855.8	849.4	848.7	771.1	826.3	838.1	843.5	844.7
596	841.3	804.9	855.6	849.1	848.3	770.3	825.8	837.7	843.2	844.4
603	840.9	804.1	855.4	848.7	847.8	769.5	825.5	837.4	843.0	844.2
610	840.6	803.4	855.2	848.4	847.9	768.7	825.1	837.1	842.8	844.1
618	840.2	802.6	854.9	848.4	847.5	767.9	824.7	836.9	842.6	843.9
625	839.9	801.8	854.8	848.1	847.6	767.2	824.3	836.6	842.3	843.7
632	839.7	801.2	854.6	847.6	847.4	766.5	823.9	836.2	842.0	843.6
640	839.4	800.4	854.4	847.2	846.9	765.7	823.7	835.9	841.8	843.4
647	839.1	799.5	854.1	846.9	846.8	765.1	823.4	835.7	841.6	843.2
655	838.9	798.9	853.9	846.8	846.4	764.4	823.1	835.4	841.3	843.1
662	838.5	798.2	853.7	846.4	846.4	763.7	822.8	835.2	841.1	842.8
670	838.2	797.4	853.6	846.3	845.9	763.1	822.6	835.0	840.8	842.7
677	837.9	792.8	853.3	833.1	845.0	761.2	822.2	834.7	840.7	842.5
684	837.6	788.9	853.1	822.7	843.3	759.6	821.9	834.4	840.4	842.3
692	837.6	790.9	852.7	839.7	842.9	759.5	821.7	834.2	840.2	842.1
700	837.4	788.7	852.4	835.8	842.4	758.6	821.6	834.0	839.9	841.9
707	836.9	789.1	852.1	829.4	843.6	758.2	821.3	833.9	839.6	841.6
715	836.7	788.9	851.8	842.0	842.9	757.8	821.3	833.7	839.4	841.4
722	836.7	789.2	851.5	843.9	842.8	757.3	821.2	833.0	839.1	841.1
730	836.2	789.4	851.1	844.3	843.0	756.8	820.9	833.2	838.8	840.8
737	836.2	789.4	850.8	844.1	843.1	756.4	820.7	833.3	838.4	840.6
744	836.1	789.1	850.5	843.3	843.0	755.9	820.4	832.8	838.2	840.3
751	835.3	788.9	850.3	843.1	842.9	755.5	820.1	832.6	837.9	840.1
759	835.4	782.2	850.2	818.6	841.8	753.6	819.9	832.5	837.6	839.8
766	835.1	785.6	849.9	834.4	840.3	754.1	819.7	832.1	837.6	839.6
773	835.1	788.9	849.7	840.1	840.9	753.7	819.4	831.8	837.3	839.4
780	834.9	787.8	849.4	841.4	840.8	753.3	819.3	831.6	837.1	839.2
788	834.2	784.6	849.2	842.2	839.9	752.9	819.1	831.4	836.8	838.9
795	834.9	787.9	849.0	839.7	840.4	752.3	818.9	831.1	836.4	838.7
802	834.4	789.2	848.8	837.6	840.9	751.9	818.7	830.6	836.2	838.5
810	833.8	785.7	848.5	837.7	839.9	751.4	818.4	830.9	836.0	838.2
818	833.7	787.9	848.3	838.7	839.2	751.1	818.3	830.7	835.8	838.0
825	833.3	786.0	847.9	839.3	839.3	750.7	818.2	830.4	835.6	837.8
833	833.1	789.2	847.7	839.5	839.0	750.3	818.0	830.0	835.4	837.6

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 1-10
TEST: AWR-1 DATA
(sheet 4 of 12)

TIME SECONDS	DAS 1 DEG C	DAS 2 DEG C	DAS 3 DEG C	DAS 4 DEG C	DAS 5 DEG C	DAS 6 DEG C	DAS 7 DEG C	DAS 8 DEG C	DAS 9 DEG C	DAS 10 DEG C
840	833.1	787.3	847.6	839.8	838.8	749.8	817.8	829.9	835.2	837.4
847	832.7	786.4	847.3	839.9	839.1	749.4	817.6	829.7	835.1	837.2
854	832.5	786.0	847.1	839.4	839.3	749.1	817.4	829.5	834.9	837.0
862	832.3	788.9	846.8	838.6	839.2	748.8	817.3	829.3	834.7	836.7
869	832.1	787.4	846.6	838.4	838.9	748.4	817.1	829.2	834.5	836.5
876	831.9	779.6	846.4	824.9	838.1	747.1	816.9	829.0	834.3	836.3
883	831.7	782.7	846.2	836.1	836.8	747.8	816.8	828.8	834.1	836.0
891	831.6	788.3	846.0	838.4	836.7	747.5	816.5	828.6	833.9	835.8
898	831.2	789.9	845.7	838.8	836.9	747.2	816.3	828.3	833.6	835.6
905	831.0	787.4	845.5	839.3	837.2	746.8	816.2	828.2	833.4	835.4
912	831.1	788.5	845.3	839.1	837.6	746.6	816.0	827.9	833.1	835.1
920	830.7	780.5	845.1	830.1	837.1	745.7	815.7	827.7	832.9	834.9
929	830.3	790.2	844.8	836.4	836.1	745.9	815.6	827.6	832.7	834.7
937	830.3	795.2	844.5	837.7	836.1	745.6	815.4	827.4	832.4	834.4
944	829.9	790.1	844.3	837.8	836.1	745.3	815.3	827.2	832.2	834.2
952	829.8	786.2	844.1	837.6	836.3	745.0	815.1	826.9	832.0	833.9
959	829.8	792.3	843.8	837.3	835.7	744.7	815.0	826.7	831.9	833.8
966	829.3	796.3	843.6	837.0	836.2	744.5	814.8	826.5	831.7	833.6
974	829.1	788.4	843.4	836.4	835.6	744.2	814.6	826.4	831.5	833.3
981	829.1	780.2	843.2	828.8	835.0	743.4	814.4	826.2	831.3	833.1
988	828.7	782.2	842.9	833.6	834.6	743.7	814.4	826.1	831.1	832.9
996	828.8	638.3	842.6	833.7	835.1	743.5	814.2	825.9	830.6	832.7
1003	828.4	696.1	842.3	834.9	834.4	743.2	814.0	825.7	830.7	832.4
1010	828.2	794.8	842.1	835.1	834.3	742.9	813.8	825.4	830.4	832.2
1185	823.8	916.9	836.7	830.6	817.8	738.1	809.7	821.3	825.8	826.8
1193	823.6	904.4	836.6	826.4	821.0	737.5	809.6	821.2	825.6	826.7
1200	823.6	1073.0	836.4	819.9	822.3	737.7	809.4	820.8	825.3	826.4
1207	823.5	1067.7	836.0	826.6	827.3	737.6	809.3	820.8	825.2	826.3
1215	823.5	1005.3	835.6	828.5	824.0	737.4	809.2	820.6	824.9	826.0
1222	822.9	887.5	835.3	829.0	827.5	737.3	809.1	820.4	824.7	825.8
1229	822.8	927.9	835.1	829.1	824.3	737.1	808.8	820.4	824.5	825.6
1236	822.8	871.3	834.8	828.9	823.9	736.9	808.7	820.1	824.2	825.3
1244	822.4	858.6	834.6	828.7	826.1	736.7	808.5	819.8	824.1	825.1
1251	822.3	831.9	834.4	828.5	826.9	736.6	808.3	819.7	823.9	824.8
1258	822.2	899.7	834.2	828.2	827.7	736.5	808.2	819.6	823.7	824.7
1265	821.9	906.2	834.1	827.9	825.4	736.3	808.1	819.4	823.4	824.4
1273	821.7	834.9	833.9	827.7	820.7	736.2	807.9	819.3	823.3	824.2
1280	821.6	829.3	833.7	827.5	820.8	736.1	807.7	819.1	823.1	824.0
1288	821.4	728.8	833.5	820.6	823.2	735.2	807.6	818.9	823.0	823.8
1295	821.2	839.7	833.3	816.3	818.8	735.6	807.3	818.6	822.7	823.6

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 11-20
TEST: AWR-1 DATA
(sheet 5 of 12)

TIME SECONDS	DAS 11 DEG C	DAS 12 DEG C	DAS 13 DEG C	DAS 14 DEG C	DAS 15 DEG C	DAS 16 DEG C	DAS 17 DEG C	DAS 18 DEG C	DAS 19 DEG C	DAS 20 DEG C
-51	487.6	160.7	328.5	27.8	26.7	24.8	26.6	24.6	23.4	24.3
-44	487.6	160.8	326.3	27.7	26.7	25.1	26.7	24.6	24.2	24.3
-36	487.6	160.8	324.1	27.8	26.7	24.9	26.7	24.6	24.0	24.3
-29	487.6	160.8	321.9	27.7	26.8	24.2	26.6	24.6	24.0	24.3
-22	487.5	160.8	321.6	27.8	26.8	26.7	26.6	24.7	23.9	24.3
-14	487.5	160.8	324.3	27.8	26.7	25.2	26.6	24.5	23.1	24.3
-7	487.6	160.8	328.1	27.7	26.7	24.7	26.7	24.6	24.4	24.3
0	487.6	160.9	332.4	27.8	26.7	26.3	26.7	24.7	24.6	24.3
8	487.8	160.9	345.8	27.7	26.8	26.3	26.7	24.6	25.0	24.3
15	485.7	160.9	346.2	28.0	27.0	26.4	26.8	24.6	24.9	24.3
22	499.1	160.8	338.3	28.6	27.4	27.2	27.0	24.7	23.2	24.3
30	514.8	160.9	333.1	28.8	27.9	27.1	27.2	24.7	25.1	24.3
38	531.7	160.9	329.6	29.2	28.1	27.7	27.3	24.7	23.8	24.3
45	548.2	160.9	326.7	29.5	28.4	29.0	27.4	24.7	24.4	24.3
53	565.7	160.9	324.4	29.8	28.7	27.7	27.6	24.8	24.1	24.3
60	580.8	160.9	326.2	29.9	28.8	29.2	27.6	24.8	24.3	24.3
67	596.7	160.8	330.2	29.9	28.9	26.2	27.6	24.7	23.2	24.3
75	610.6	160.9	354.2	30.0	28.9	27.0	27.7	24.7	24.8	24.3
82	623.1	160.9	367.2	30.2	29.0	28.1	27.8	24.8	24.3	24.3
89	633.6	160.9	363.8	30.2	28.9	28.3	27.7	24.7	22.7	24.4
97	643.4	160.9	359.9	30.1	29.0	26.1	27.8	24.7	23.6	24.4
104	653.6	161.0	356.2	30.2	28.9	29.5	27.8	24.8	23.6	24.3
111	664.1	161.1	352.6	30.3	29.0	28.7	27.8	24.9	24.4	24.4
119	674.3	161.0	349.1	30.2	29.0	28.3	27.7	24.8	23.1	24.4
126	684.7	160.9	346.2	30.3	28.9	28.4	27.8	24.8	22.6	24.3
133	694.9	161.1	343.2	30.3	29.1	27.9	27.8	24.8	23.9	24.4
141	706.1	161.1	340.2	30.2	29.1	26.7	27.9	24.7	23.8	24.4
149	717.4	161.1	337.4	30.4	29.1	27.4	27.9	24.8	22.9	24.4
156	728.0	161.2	335.1	30.4	29.2	29.7	28.0	24.9	24.8	24.4
163	738.4	161.1	332.3	30.6	29.2	28.8	28.1	24.9	23.9	24.4
171	748.9	161.1	329.4	30.7	29.2	29.1	28.1	24.9	23.2	24.4
178	758.3	161.1	327.1	30.7	29.1	27.8	28.1	24.8	22.8	24.4
186	768.4	161.2	328.2	30.6	29.1	26.9	28.2	24.8	24.3	24.4
194	779.7	161.2	332.2	30.6	29.3	27.3	28.2	24.8	24.6	24.4
201	790.7	161.1	336.5	30.9	29.3	29.3	28.2	24.9	23.9	24.4
208	800.3	161.2	341.3	30.9	29.3	29.6	28.3	24.9	23.9	24.4
216	808.4	161.1	343.2	31.0	29.4	28.8	28.2	24.9	23.8	24.4
223	815.9	161.2	340.2	31.1	29.4	28.4	28.4	25.0	24.4	24.4
230	824.2	161.2	336.9	31.0	29.4	28.1	28.4	24.9	24.4	24.4
238	829.7	161.2	333.5	31.2	29.4	29.1	28.4	25.1	24.4	24.4

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 11-20
TEST: AWR-1 DATA
(sheet 6 of 12)

TIME SECONDS	DAS 11 DEG C	DAS 12 DEG C	DAS 13 DEG C	DAS 14 DEG C	DAS 15 DEG C	DAS 16 DEG C	DAS 17 DEG C	DAS 18 DEG C	DAS 19 DEG C	DAS 20 DEG C
245	833.4	161.1	329.8	31.2	29.3	29.5	28.4	24.9	23.2	24.4
252	836.7	161.1	326.8	31.0	29.4	27.7	28.3	24.9	24.1	24.5
259	840.1	161.2	324.7	30.9	29.2	27.2	28.4	24.9	24.4	24.6
267	842.8	161.1	327.3	31.0	29.2	27.5	28.3	24.9	22.7	24.5
274	845.1	161.2	331.1	30.8	29.1	26.7	28.4	24.8	24.3	24.5
282	845.9	161.1	336.0	30.7	29.0	25.7	28.3	24.9	24.2	24.5
290	846.9	161.2	340.9	30.5	28.9	26.6	28.2	24.9	23.9	24.6
297	847.6	161.2	367.4	30.2	28.9	27.7	28.3	25.0	24.9	24.5
304	848.3	161.2	370.9	30.2	28.9	29.1	28.2	25.0	24.1	24.6
312	848.5	161.1	365.8	30.1	28.7	26.6	28.2	24.9	22.6	24.6
320	848.7	161.2	360.7	30.0	28.6	28.0	28.3	25.0	24.0	24.6
329	849.3	161.2	408.8	29.9	28.5	28.8	28.1	25.0	23.7	24.6
336	849.2	161.2	356.7	29.8	28.4	26.1	28.0	24.9	24.2	24.6
343	847.9	161.2	340.9	29.6	28.3	25.3	28.1	24.9	24.1	24.6
351	846.6	161.3	338.3	29.7	28.2	27.4	28.1	25.0	24.2	24.6
358	845.4	161.2	335.9	29.7	28.1	27.8	28.0	24.9	22.7	24.6
365	844.2	161.3	334.2	29.6	28.2	25.6	28.1	24.9	23.7	24.6
373	843.1	161.3	288.1	29.6	28.2	26.5	28.1	24.9	25.1	24.6
380	841.9	161.2	166.8	29.6	28.1	28.1	27.9	25.0	23.7	24.6
387	840.8	161.2	156.6	29.6	28.2	28.3	27.9	25.1	24.1	24.6
395	839.7	161.2	156.9	29.6	28.2	27.1	27.9	25.0	22.8	24.6
402	838.7	161.3	156.6	29.6	28.1	28.3	28.1	25.0	24.2	24.6
410	837.5	161.2	156.0	29.7	28.1	27.6	28.0	25.1	23.0	24.6
417	836.6	161.3	155.7	29.6	28.1	27.1	28.1	25.0	25.0	24.6
425	835.6	161.2	155.6	29.6	28.1	28.8	28.1	25.1	24.6	24.6
432	834.6	161.2	155.3	29.4	28.2	25.9	28.1	25.0	25.2	24.7
440	833.6	161.2	155.3	29.6	28.1	26.8	28.1	25.1	24.6	24.6
447	832.7	161.1	155.1	29.6	28.1	27.7	27.9	25.1	23.8	24.6
455	831.7	161.1	154.9	29.6	28.1	27.3	27.9	25.0	23.8	24.7
462	830.7	161.1	154.7	29.5	28.0	25.7	28.1	25.0	24.3	24.6
470	829.8	161.1	154.6	29.7	28.1	27.9	28.1	25.2	23.7	24.6
477	828.9	161.1	158.1	29.6	28.1	26.9	28.0	25.0	23.8	24.7
484	828.0	161.2	164.8	29.5	28.1	25.3	28.1	25.0	24.1	24.6
492	827.1	161.3	170.4	29.6	28.1	26.3	28.2	25.1	25.1	24.7
499	826.2	161.3	175.3	29.6	28.1	28.4	28.0	25.1	24.1	24.7
506	825.4	161.4	179.3	29.5	28.2	26.3	28.0	25.1	24.2	24.7
514	824.5	161.6	182.8	29.5	28.2	27.9	28.2	25.1	25.0	24.7
521	823.6	161.6	185.5	29.6	28.1	27.4	28.1	25.0	23.3	24.7
529	822.7	161.7	187.8	29.5	28.1	25.4	28.1	25.1	23.6	24.7
536	821.9	161.7	189.5	29.7	28.2	26.6	28.1	25.1	23.8	24.7

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 11-20
TEST: AWR-1 DATA
(sheet 7 of 12)

TIME SECONDS	DAS 11 DEG C	DAS 12 DEG C	DAS 13 DEG C	DAS 14 DEG C	DAS 15 DEG C	DAS 16 DEG C	DAS 17 DEG C	DAS 18 DEG C	DAS 19 DEG C	DAS 20 DEG C
543	821.1	161.8	190.8	29.7	28.2	28.1	28.1	25.2	23.8	24.7
551	820.2	162.0	192.1	29.6	28.2	26.2	28.2	25.1	24.7	24.7
559	819.4	162.1	192.9	29.5	28.1	27.6	28.2	25.1	24.8	24.7
566	818.6	162.1	193.5	29.6	28.1	27.1	28.1	25.2	23.7	24.8
574	817.7	162.2	194.1	29.8	28.1	28.2	28.1	25.2	23.1	24.7
581	816.9	162.2	194.4	29.7	28.1	26.0	28.1	25.1	22.8	24.8
588	816.2	162.4	194.7	29.6	28.1	26.5	28.2	25.2	25.3	24.7
596	815.4	162.5	194.9	29.7	28.1	28.9	28.2	25.2	24.8	24.7
603	814.6	162.5	195.0	29.6	28.0	26.3	28.1	25.1	23.1	24.7
610	813.8	162.6	195.1	29.6	28.1	25.3	28.2	25.1	23.9	24.8
618	813.2	162.7	195.2	29.7	28.1	28.4	28.2	25.3	25.1	24.8
625	812.4	162.7	195.2	29.7	28.1	28.3	28.1	25.2	23.7	24.8
632	811.6	162.8	195.2	29.7	28.1	25.7	28.3	25.1	24.0	24.8
640	810.9	162.9	195.2	29.8	28.2	28.6	28.2	25.3	24.6	24.8
647	810.2	162.9	195.2	29.6	28.2	27.8	28.3	25.3	24.3	24.8
655	809.5	163.0	195.2	29.6	28.1	26.9	28.2	25.1	23.9	24.8
662	808.8	163.0	195.1	29.7	28.1	25.7	28.2	25.1	23.1	24.8
670	808.1	163.1	195.1	29.9	28.2	28.0	28.2	25.3	23.8	24.8
677	807.3	163.2	195.0	29.8	28.2	25.3	28.3	25.2	24.4	24.8
684	806.7	163.4	194.9	29.8	28.2	27.4	28.3	25.2	25.7	24.8
692	805.8	163.4	194.9	29.8	28.2	28.7	28.3	25.2	23.9	24.8
700	805.2	163.4	194.8	29.7	28.3	25.9	28.3	25.2	24.9	24.8
707	804.3	163.4	194.8	29.8	28.2	25.8	28.3	25.2	23.1	24.8
715	803.7	163.6	194.7	29.9	28.3	26.4	28.3	25.2	24.3	24.8
722	802.9	163.7	194.7	29.9	28.3	27.6	28.4	25.2	24.5	24.8
730	802.3	163.7	194.6	29.8	28.3	26.2	28.3	25.2	24.2	24.8
737	801.7	163.7	194.6	29.9	28.3	28.2	28.3	25.2	23.9	24.8
744	801.1	163.8	194.5	29.9	28.3	28.5	28.3	25.2	23.6	24.8
751	800.4	163.8	194.4	29.9	28.3	28.4	28.3	25.2	23.1	24.8
759	799.8	163.9	194.3	29.8	28.3	28.4	28.4	25.3	25.2	24.9
766	799.2	164.0	194.3	29.9	28.3	28.3	28.4	25.3	24.5	24.8
773	798.6	164.0	194.2	29.9	28.3	28.3	28.4	25.3	23.9	24.9
780	798.0	164.1	194.2	29.9	28.3	27.8	28.4	25.3	24.1	24.8
788	797.4	164.1	194.1	29.8	28.3	26.3	28.3	25.2	23.4	24.9
795	796.9	164.1	194.0	29.8	28.4	26.3	28.4	25.2	23.2	24.9
802	796.3	164.2	193.9	29.9	28.4	28.0	28.4	25.3	23.0	24.9
810	795.7	164.3	194.3	29.8	28.4	28.4	28.5	25.3	24.3	[illegible]
818	795.2	164.4	194.4	29.9	28.4	27.2	28.5	25.3	24.6	24.9
825	794.7	164.4	194.2	29.9	28.4	26.4	28.5	25.3	24.5	24.9
833	794.2	164.4	194.1	30.1	28.4	28.1	28.4	25.3	23.1	24.9

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 11-20
TEST: AWR-1 DATA
(sheet 8 of 12)

TIME SECONDS	DAS 11 DEG C	DAS 12 DEG C	DAS 13 DEG C	DAS 14 DEG C	DAS 15 DEG C	DAS 16 DEG C	DAS 17 DEG C	DAS 18 DEG C	DAS 19 DEG C	DAS 20 DEG C
840	793.7	164.4	193.9	30.0	28.5	28.1	28.4	25.3	24.1	24.9
847	793.1	164.4	193.8	30.0	28.4	27.1	28.4	25.4	23.4	24.9
854	792.7	164.5	193.6	29.9	28.4	27.0	28.4	25.3	24.1	24.9
862	792.1	164.6	193.6	29.9	28.4	25.7	28.5	25.3	23.6	25.0
869	791.7	164.6	193.4	30.1	28.5	27.8	28.4	25.3	24.1	24.9
876	791.2	164.6	193.3	30.1	28.6	26.9	28.4	25.4	23.9	25.0
883	790.6	164.7	193.3	30.2	28.4	27.9	28.5	25.3	23.1	25.0
891	790.1	164.7	193.2	30.2	28.4	28.4	28.5	25.4	23.1	25.0
898	789.7	164.9	193.1	30.1	28.5	29.1	28.6	25.4	25.1	25.0
905	789.3	164.8	193.1	30.2	28.6	28.5	28.6	25.4	24.1	24.9
912	788.7	164.9	193.0	30.2	28.4	28.6	28.6	25.4	23.3	24.9
920	788.2	164.9	192.8	30.0	28.5	27.1	28.5	25.4	24.1	25.0
929	787.7	165.0	192.8	30.0	28.4	29.3	28.5	25.4	24.5	25.0
937	787.2	165.0	192.7	30.0	28.4	28.8	28.6	25.4	23.9	25.0
944	786.8	165.1	192.6	29.9	28.4	28.4	28.6	25.4	25.5	25.1
952	786.3	165.0	192.5	30.2	28.4	26.9	28.6	25.3	22.9	25.1
959	785.9	165.0	192.4	30.3	28.5	27.0	28.6	25.4	23.6	25.0
966	785.5	165.2	192.3	30.2	28.5	27.5	28.7	25.4	24.8	25.1
974	785.1	165.2	192.2	30.3	28.5	27.4	28.7	25.4	24.4	25.0
981	784.6	165.2	192.2	30.3	28.5	28.2	28.7	25.5	23.9	25.0
988	784.3	165.3	192.1	30.3	28.5	29.2	28.6	25.5	24.5	25.1
996	783.8	165.2	192.0	30.3	28.5	27.7	28.6	25.4	22.9	25.1
1003	783.4	165.3	191.9	30.2	28.4	25.5	28.7	25.4	24.0	25.0
1010	783.0	165.3	191.8	30.2	28.5	28.3	28.7	25.4	23.0	25.1
1185	774.4	165.5	189.7	30.6	28.7	28.8	28.9	25.6	23.7	25.2
1193	774.2	165.5	189.6	30.4	28.8	29.6	28.8	25.6	24.7	25.2
1200	773.8	165.4	189.4	30.6	28.8	28.4	28.9	25.7	23.6	25.2
1207	773.6	165.6	189.3	30.6	28.8	29.6	28.9	25.7	25.2	25.2
1215	773.2	165.5	189.3	30.6	28.8	28.5	28.9	25.7	24.0	25.2
1222	772.9	165.5	189.2	30.6	28.8	29.4	28.9	25.6	24.2	25.2
1229	772.6	165.4	189.1	30.5	28.8	28.4	28.9	25.7	23.6	25.2
1236	772.3	165.5	189.0	30.6	28.8	29.5	28.9	25.6	24.3	25.2
1244	772.0	165.4	188.8	30.7	28.8	28.5	28.9	25.7	23.8	25.2
1251	771.7	165.5	188.8	30.6	28.8	28.4	28.9	25.6	23.2	25.2
1258	771.4	165.4	188.7	30.6	28.9	28.0	28.9	25.7	23.9	25.2
1265	771.1	165.4	188.6	30.6	28.9	26.4	28.9	25.6	23.2	25.3
1273	770.8	165.6	188.5	30.6	28.9	27.1	29.1	25.6	24.9	25.2
1280	770.5	165.6	188.4	30.7	28.9	26.8	29.1	25.7	25.7	25.2
1288	770.3	165.6	188.3	30.7	28.9	28.8	29.1	25.7	25.7	25.2
1295	769.9	165.6	188.2	30.6	28.9	26.3	29.1	25.6	25.5	25.3

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 21-65
TEST: AWR-I DATA
(sheet 9 of 12)

TIME SECONDS	DAS 21 DEG C	DAS 22 DEG C	DAS 23 DEG C	DAS 60 H2 MOLE %	DAS 61 O2 MOLE %	DAS 62 Kpa ABS.	DAS 63 Kpa ABS.	DAS 64 Kg	DAS 65 [illegible]
-51	21.11	24.06	29.78	-0.11	0.27	102.85	129.54	0.01	48.42
-44	21.17	24.06	29.72	-0.11	0.27	102.87	130.07	0.01	49.60
-36	21.11	24.17	29.67	-0.11	0.27	102.87	129.69	0.02	49.58
-29	21.11	24.22	29.72	-0.11	0.26	102.86	129.52	0.03	50.49
-22	21.00	24.06	29.72	-0.11	0.26	102.85	130.17	0.02	48.62
-14	21.00	24.11	29.72	-0.11	0.26	102.85	129.93	0.03	48.95
-7	20.94	24.06	29.89	-0.11	0.26	102.87	129.99	0.02	47.67
0	21.00	24.17	29.89	-0.11	0.26	102.86	129.82	0.03	46.20
8	21.00	24.28	29.89	-0.11	0.26	103.05	173.05	0.66	33.99
15	20.94	24.61	29.94	-0.11	0.26	103.72	159.01	0.49	34.61
22	21.06	24.22	29.89	-0.12	0.26	104.52	140.98	0.41	39.44
30	21.00	24.39	29.94	-0.12	0.26	105.28	140.00	0.41	38.27
38	21.06	24.67	29.94	-0.12	0.26	105.95	137.93	0.41	40.24
45	21.00	24.72	30.06	-0.02	0.26	106.58	139.07	0.41	44.80
53	21.00	24.67	30.28	0.49	0.26	107.27	137.37	0.42	41.62
60	20.94	24.61	30.39	1.20	0.27	107.88	138.58	0.42	43.91
67	20.89	24.50	30.44	1.83	0.28	108.48	136.81	0.41	37.04
75	20.94	24.44	30.50	2.47	0.28	109.01	132.05	0.29	29.61
82	21.06	24.44	30.61	3.03	0.28	109.46	129.29	0.29	32.72
89	21.00	24.28	30.78	3.61	0.28	109.91	129.38	0.30	39.60
97	20.94	24.33	31.00	4.09	0.27	110.37	132.74	0.30	40.45
104	21.00	24.22	31.00	4.58	0.27	110.85	130.38	0.40	37.00
111	20.89	24.11	31.11	5.09	0.27	111.35	133.32	0.41	39.96
119	21.00	24.17	31.22	5.46	0.27	111.84	133.98	0.40	40.20
126	21.00	24.00	31.22	5.82	0.27	112.35	136.57	0.41	43.41
133	21.00	23.83	31.28	5.82	0.27	112.86	135.71	0.42	39.95
141	20.94	23.83	31.50	6.08	0.26	113.37	138.27	0.42	36.09
149	21.00	23.89	31.44	6.46	0.26	113.96	137.16	0.42	41.77
156	21.00	23.89	31.50	6.75	0.26	114.50	139.71	0.42	40.42
163	21.06	23.61	31.67	7.07	0.26	115.06	141.65	0.43	42.76
171	21.06	23.72	31.78	7.48	0.26	115.64	140.34	0.43	41.74
178	21.11	23.67	31.78	7.96	0.26	116.22	140.42	0.43	44.89
186	21.11	23.50	31.72	8.56	0.26	116.80	145.04	0.45	41.39
194	21.11	23.56	31.83	9.34	0.26	117.46	143.64	0.45	41.15
201	21.22	23.56	31.78	10.37	0.25	118.01	141.27	0.43	36.49
208	21.22	23.50	32.00	10.74	0.26	118.53	140.21	0.44	33.25
215	21.17	23.56	32.11	10.23	0.25	119.05	142.23	0.44	40.52
223	21.17	23.78	32.39	10.11	0.25	119.57	135.93	0.44	35.11
230	21.22	23.72	32.39	10.06	0.25	120.05	136.13	0.44	39.15
238	21.22	23.83	32.56	10.01	0.25	120.47	131.28	0.39	44.31

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 21-65
TEST: AWR-1 DATA
(sheet 10 of 12)

TIME SECONDS	DAS 21 DEG C	DAS 22 DEG C	DAS 23 DEG C	DAS 60 H2 MOLE %	DAS 61 O2 MOLE %	DAS 62 Kpa ABS.	DAS 63 Kpa ABS.	DAS 64 %g	DAS 65 %pa
245	21.11	23.89	32.61	9.97	0.25	120.70	130.62	0.31	50.11
252	21.17	23.94	32.83	9.94	0.25	120.83	130.27	0.29	45.69
259	21.22	24.00	33.00	9.93	0.24	120.88	130.15	0.29	53.49
267	21.22	24.06	33.06	9.92	0.25	120.92	122.74	0.29	50.90
274	21.22	24.06	33.00	9.92	0.24	120.95	125.12	0.30	49.88
282	21.22	24.00	32.83	9.92	0.24	120.97	122.73	0.29	39.83
290	21.22	23.94	32.83	9.93	0.24	121.02	128.30	0.36	40.63
297	21.28	24.11	38.33	9.95	0.24	121.03	120.35	0.30	32.89
304	21.28	24.06	37.28	9.96	0.24	121.08	124.21	0.29	40.90
312	21.22	24.06	37.06	8.79	0.24	121.09	125.35	0.32	36.90
320	21.22	24.00	36.78	9.51	0.24	121.12	124.05	0.29	38.14
329	21.22	23.94	36.72	9.59	0.24	121.05	102.34	0.39	13.93
336	21.17	23.94	36.44	9.68	0.24	120.97	117.19	0.40	47.37
343	21.17	23.94	36.28	9.97	0.24	120.98	131.63	0.41	47.35
351	21.17	24.11	36.11	10.00	0.24	120.99	132.95	0.42	47.40
358	21.11	23.94	36.11	9.18	0.29	120.99	132.40	0.42	47.74
365	21.17	24.06	35.89	10.32	2.91	120.97	133.37	0.41	48.09
373	21.17	24.06	35.78	10.05	1.13	120.99	133.00	0.42	47.19
380	21.22	24.17	35.61	10.09	0.56	120.98	133.76	0.40	45.30
387	21.17	24.06	35.44	10.08	0.37	120.97	135.07	0.39	45.36
395	21.17	24.06	35.28	10.06	0.30	120.95	135.76	0.30	45.60
402	21.17	24.11	35.11	10.07	0.27	120.92	137.81	0.36	46.33
410	21.28	24.06	34.89	10.08	0.26	120.92	138.81	0.35	46.18
417	21.28	24.00	34.83	10.09	0.25	120.90	140.45	0.35	45.20
425	21.39	24.17	34.72	10.11	0.24	120.88	142.75	0.34	43.67
432	21.33	24.17	34.56	10.13	0.24	120.85	144.04	0.33	42.69
440	21.33	24.22	34.44	10.11	0.24	120.82	145.79	0.32	42.02
447	21.28	24.11	34.33	10.09	0.24	120.81	147.46	0.32	42.51
455	21.28	24.11	34.33	10.21	0.24	120.82	150.12	0.34	43.62
462	21.33	24.22	34.22	10.28	0.24	120.83	152.21	0.34	44.16
470	21.39	24.28	34.11	10.29	0.24	120.83	153.94	0.33	3.33
477	21.33	24.11	34.06	10.28	0.24	120.82	156.14	0.24	3.02
484	21.39	24.28	33.94	10.29	0.24	120.83	157.81	0.24	3.02
492	21.33	24.33	33.94	10.29	0.24	120.84	160.16	0.25	2.90
499	21.33	24.17	33.83	10.28	0.24	120.83	161.23	0.19	2.91
506	21.28	24.17	33.78	10.29	0.24	120.83	163.20	0.29	[illegible]
514	21.33	24.28	33.72	10.29	0.24	120.83	165.32	0.30	2.79
521	21.39	24.17	33.67	10.31	0.23	120.83	167.91	0.32	[illegible]
529	21.44	24.17	33.61	10.31	0.24	120.82	169.32	0.33	2.76
536	21.44	24.39	33.56	10.32	0.23	120.82	171.54	0.34	[illegible]

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 21-65
TEST: AWR-1 DATA
(sheet 11 of 12)

TIME SECONDS	DAS 21 DEG C	DAS 22 DEG C	DAS 23 DEG C	DAS 60 H2 MOLE %	DAS 61 O2 MOLE %	DAS 62 Kpa ABS.	DAS 63 Kpa ABS.	DAS 64 Kg	DAS 65 Kpa
543	21.33	24.22	33.56	10.33	0.24	120.81	172.97	0.36	2.76
551	21.44	24.22	33.44	10.33	0.23	120.77	174.93	0.35	2.81
559	21.39	24.39	33.44	10.34	0.23	120.75	176.99	0.36	2.83
566	21.33	24.17	33.39	10.34	0.23	120.73	178.84	0.35	2.69
574	21.33	24.39	33.39	10.35	0.24	120.70	180.04	0.29	2.66
581	21.33	24.22	33.28	10.36	0.23	120.68	182.31	0.29	2.65
588	21.33	24.39	33.28	10.35	0.24	120.66	183.01	0.29	2.72
596	21.39	24.33	33.17	10.36	0.23	120.64	185.10	0.30	2.70
603	21.33	24.39	33.11	10.43	0.23	120.61	186.34	0.30	2.73
610	21.33	24.33	33.06	10.52	0.24	120.60	187.12	0.30	2.66
618	21.28	24.33	33.06	9.97	0.23	120.59	187.80	0.30	2.63
625	21.22	24.28	33.06	10.00	0.24	120.58	187.63	0.30	2.62
632	21.33	24.28	33.00	10.01	0.23	120.56	188.37	0.30	2.65
640	21.28	24.39	33.06	9.99	0.24	120.56	188.29	0.39	2.66
647	21.22	24.33	33.06	10.04	0.24	120.54	188.83	0.39	2.66
655	21.28	24.22	32.94	10.23	0.24	120.54	189.00	0.39	2.68
662	21.22	24.33	32.94	10.19	0.81	120.51	189.95	0.40	2.70
670	21.22	24.33	32.94	10.10	2.43	120.53	185.53	0.30	2.70
677	21.28	24.28	32.94	10.06	0.94	120.53	159.62	0.30	2.73
684	21.33	24.44	32.94	10.19	0.50	120.54	130.27	0.40	2.70
692	21.28	24.28	32.83	10.39	0.35	120.55	137.56	0.39	2.68
700	21.28	24.33	32.83	10.31	0.29	120.55	125.70	0.39	2.70
707	21.22	24.44	32.89	10.31	0.26	120.55	132.52	0.30	2.73
715	21.22	24.28	32.83	10.31	0.25	120.55	138.89	0.30	2.80
722	21.11	24.33	32.83	10.31	0.25	120.56	143.81	0.30	2.70
730	21.22	24.28	32.78	10.29	0.24	120.55	149.86	0.39	2.68
737	21.22	24.28	32.78	10.31	0.24	120.57	154.00	0.39	2.66
744	21.33	24.28	32.72	10.31	0.24	120.55	158.41	0.39	2.69
751	21.33	24.33	32.72	10.31	0.24	120.55	160.90	0.39	2.74
759	21.33	24.39	32.83	10.30	0.24	120.56	117.17	0.39	2.73
766	21.28	24.44	32.78	10.32	0.24	120.56	123.06	0.39	2.72
773	21.28	24.33	32.72	10.31	0.24	120.56	128.15	0.39	2.66
780	21.33	24.44	32.67	10.31	0.24	120.56	133.43	0.39	2.73
788	21.22	24.33	32.67	10.32	0.23	120.56	138.88	0.39	2.66
795	21.28	24.33	32.67	10.31	0.23	120.58	132.96	0.39	2.70
803	21.28	24.39	32.67	10.30	0.23	120.57	130.46	0.30	2.66
810	21.33	24.28	32.61	10.30	0.23	120.56	129.53	0.40	2.52
818	21.39	24.39	32.67	10.31	0.23	120.57	129.90	0.30	2.47
825	21.33	24.28	32.72	10.30	0.23	120.57	129.64	0.30	2.45
833	21.28	24.11	32.72	10.31	0.23	120.57	130.58	0.30	2.45

TABLE A-9
DIGITAL OUTPUT FOR DAS #'s 21-65
TEST: AWR-1 DATA
(sheet 12 of 12)

TIME SECONDS	DAS 21 DEG C	DAS 22 DEG C	DAS 23 DEG C	DAS 60 H2 MOLE %	DAS 61 O2 MOLE %	DAS 62 Kpa ABS.	DAS 63 Kpa ABS.	DAS 64 Kg	DAS 65 Kpa
840	21.33	24.11	32.67	10.31	0.23	120.57	131.26	0.30	2.39
847	21.28	24.17	32.72	10.30	0.23	120.57	131.00	0.30	2.33
854	21.33	24.11	32.72	10.31	0.23	120.57	132.57	0.39	2.30
862	21.39	24.17	32.72	10.32	0.23	120.58	133.36	0.39	2.30
869	21.33	24.17	32.72	10.31	0.23	120.57	133.39	0.29	2.28
876	21.33	24.17	32.72	10.31	0.23	120.57	113.14	0.40	2.26
883	21.28	24.11	32.72	10.30	0.23	120.56	118.53	0.39	2.28
891	21.33	24.06	32.72	10.30	0.23	120.56	122.90	0.39	2.26
898	21.28	24.11	32.72	10.28	0.23	120.57	127.27	0.39	2.26
905	21.28	24.17	32.72	10.26	0.23	120.54	131.29	0.39	2.50
912	21.28	24.17	32.78	10.27	0.23	120.51	134.96	0.39	2.37
920	21.33	24.06	32.72	10.27	0.23	120.48	112.29	0.39	2.33
929	21.28	24.11	32.72	10.26	0.23	120.46	117.97	0.39	2.30
937	21.39	24.22	32.72	10.25	0.23	120.43	121.59	0.40	2.30
944	21.33	24.17	32.78	10.25	0.23	120.42	125.63	0.39	2.37
952	21.39	24.06	32.78	10.25	0.23	120.42	129.86	0.39	2.32
959	21.39	24.22	32.78	10.26	0.23	120.39	133.16	0.39	2.30
966	21.39	24.06	32.72	10.25	0.23	120.38	136.71	0.39	2.32
974	21.39	24.28	32.72	10.24	0.23	120.37	139.65	0.39	2.36
981	21.33	24.22	32.72	10.25	0.23	120.35	106.59	0.30	2.36
988	21.33	24.11	32.78	10.26	0.23	120.32	111.86	0.30	2.40
996	21.39	24.28	32.72	10.26	0.23	120.31	115.84	0.30	2.40
1003	21.33	24.11	32.72	10.26	0.23	120.28	119.67	0.30	2.37
1010	21.33	24.11	32.67	10.25	0.23	120.28	122.62	0.31	2.36
1185	20.72	24.11	32.94	10.21	0.23	120.26	138.94	0.40	2.41
1193	20.61	24.11	32.89	10.21	0.23	120.28	106.20	0.40	2.41
1200	20.56	24.00	32.94	10.21	0.23	120.28	110.45	0.39	2.40
1207	20.67	24.11	32.89	10.21	0.23	120.27	114.09	0.29	2.41
1215	20.61	24.11	32.94	10.21	0.23	120.27	117.56	0.30	2.44
1222	20.61	24.17	32.94	10.21	0.23	120.28	120.19	0.30	2.41
1229	20.61	24.00	33.00	10.20	0.23	120.28	122.61	0.31	2.43
1236	20.61	24.06	32.94	10.20	0.23	120.28	126.03	0.30	2.47
1244	20.56	24.06	33.00	10.20	0.23	120.27	128.52	0.30	2.47
1251	20.56	24.00	33.00	10.19	0.23	120.27	130.94	0.29	2.41
1258	20.56	23.94	33.00	10.19	0.23	120.28	132.46	0.29	2.41
1265	20.61	24.00	33.06	10.19	0.22	120.28	135.48	0.30	2.44
1273	20.56	24.06	33.06	10.19	0.23	120.28	137.28	0.29	2.40
1280	20.56	24.00	33.06	10.19	0.23	120.29	139.82	0.29	2.45
1288	20.50	24.11	33.06	10.19	0.22	120.28	106.30	0.29	2.48
1295	20.50	24.00	33.06	10.19	0.23	120.28	110.53	0.29	2.47

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 1-9
TEST: WIL-1 DATA
(sheet 1 of 15)

TIME SECONDS	DAS# 1 DEG C	DAS# 2 DEG C	DAS# 3 DEG C	DAS# 4 DEG C	DAS# 5 DEG C	DAS# 6 DEG C	DAS# 7 DEG C	DAS# 8 DEG C	DAS# 9 DEG C
-229	515.94	516.44	523.94	524.67	522.72	519.72	364.39	528.06	362.8
-218	515.72	516.56	523.67	524.44	522.33	519.78	367.56	528.00	362.8
-208	516.11	516.44	523.89	524.61	522.89	519.78	367.72	528.28	362.
-198	516.11	516.33	523.17	524.56	522.78	519.78	364.67	528.06	362.7
-187	516.06	516.33	523.89	524.44	522.78	519.78	366.06	528.28	362.
-126	516.11	516.39	524.06	524.78	522.61	519.94	368.72	528.44	363.0
-116	516.17	516.56	524.06	524.61	522.39	519.78	370.17	527.83	363.3
-106	516.39	516.61	524.22	524.61	522.83	519.78	363.50	528.28	363.3
-96	516.22	516.67	524.11	524.72	522.67	519.78	365.67	528.06	363.3
-86	515.94	516.72	523.89	524.50	523.17	519.67	359.67	528.11	363.4
-76	516.33	516.56	523.83	524.39	522.89	519.61	360.22	528.39	363.4
-66	516.11	516.78	523.33	524.33	522.72	519.56	362.94	528.22	363.4
-55	516.17	516.67	523.83	524.50	522.94	519.50	356.11	528.11	363.5
-43	515.89	516.78	523.33	524.56	522.72	519.39	357.39	528.39	363.5
-33	516.22	516.72	524.11	524.50	522.72	519.72	359.44	528.17	363.5
-22	516.11	516.78	524.06	524.44	522.78	519.78	361.39	528.11	363.5
-11	516.06	516.61	523.89	524.28	522.83	519.78	362.22	527.94	363.5
-1	516.11	516.67	524.06	524.50	523.00	519.72	365.78	528.39	363.
10	502.78	504.17	511.33	502.28	503.89	512.11	462.56	503.39	363.7
20	501.56	501.50	503.78	499.28	501.44	505.00	470.17	498.61	363.
31	501.28	502.22	502.39	500.28	502.22	499.89	427.22	490.39	363.9
41	501.67	501.39	502.33	500.78	502.67	494.39	403.28	466.33	364.1
51	502.56	502.67	502.56	500.06	503.00	488.44	386.61	452.50	364.1
62	501.44	502.17	502.94	505.72	502.33	482.72	376.44	440.28	364.1
72	503.33	503.22	503.33	501.56	506.56	477.17	370.72	425.22	364.1
82	502.67	503.78	503.28	501.44	504.94	471.33	370.44	426.67	364.1
93	503.17	502.33	503.33	500.61	503.22	466.56	368.22	427.44	364.
103	503.39	502.44	503.33	504.50	502.94	462.06	363.17	424.11	363.9
114	502.94	502.72	503.44	505.44	503.22	457.72	358.94	427.78	363.8
124	503.28	502.67	503.39	507.06	503.67	453.00	360.67	427.11	363.8
134	503.00	503.06	504.11	506.94	504.89	448.83	363.94	429.94	363.7
145	503.33	503.33	504.67	507.50	505.17	445.00	361.94	432.22	363.6
155	503.50	503.39	504.83	507.78	505.33	441.50	362.72	431.11	363.6
165	503.33	503.94	504.39	508.61	505.72	439.44	360.61	429.67	363.5
176	503.72	504.06	505.33	508.67	506.22	435.44	362.67	429.44	363.4
186	504.17	503.72	505.67	508.61	506.33	432.78	361.67	428.06	363.3
197	504.28	503.89	505.72	508.11	506.28	430.11	361.72	426.78	363.2
207	504.44	504.11	505.33	509.28	506.61	428.28	363.33	424.67	363.17
217	504.72	504.33	506.33	509.33	506.89	426.22	363.06	424.17	363.1
228	504.78	504.39	506.61	509.39	507.22	424.06	363.61	428.61	363.00

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 1-9
TEST: WIL-1 DATA
(sheet 2 of 15)

TIME SECONDS	DAS# 1 DEG C	DAS# 2 DEG C	DAS# 3 DEG C	DAS# 4 DEG C	DAS# 5 DEG C	DAS# 6 DEG C	DAS# 7 DEG C	DAS# 8 DEG C	DAS# 9 DEG C
238	504.83	504.39	506.78	509.94	507.17	421.67	363.33	429.00	362.39
248	504.94	504.50	507.17	510.06	507.56	419.83	366.78	428.06	362.83
259	505.11	504.83	507.39	510.33	507.28	418.17	365.78	429.28	362.72
269	505.06	504.89	507.33	510.56	507.72	415.83	361.33	429.33	362.67
280	505.22	504.83	507.17	510.83	507.50	413.72	361.83	430.00	362.56
290	505.61	505.06	507.50	511.06	507.89	411.44	358.56	431.33	362.44
300	506.11	505.44	507.67	511.00	507.94	409.44	356.33	430.06	362.33
311	506.50	505.44	508.06	511.00	507.94	407.33	358.28	430.56	362.33
321	506.11	505.67	508.28	510.83	508.11	405.78	361.39	431.22	362.22
331	507.44	505.78	508.11	510.94	508.39	404.67	361.78	424.67	362.17
342	507.61	506.39	508.33	506.72	509.39	404.11	366.94	428.33	362.06
352	508.29	505.78	508.11	505.78	509.50	403.22	362.39	428.94	362.00
362	506.50	505.28	508.06	508.33	508.28	402.17	361.50	429.67	361.94
373	506.78	505.72	508.00	510.00	508.17	400.94	354.06	431.94	361.33
383	507.39	505.72	508.56	510.72	508.11	399.17	353.22	429.44	361.78
394	506.06	506.17	508.56	510.33	508.11	397.83	355.39	430.94	361.72
404	506.67	506.44	508.67	510.50	508.61	396.72	358.78	430.17	361.67
414	506.67	506.00	509.67	511.22	508.67	395.94	360.67	431.72	361.61
425	506.50	506.56	509.72	511.00	508.94	395.06	359.94	429.29	361.50
435	506.33	506.17	510.00	511.33	509.28	394.44	361.11	431.61	361.44
445	506.67	506.50	510.44	511.61	509.56	393.61	362.00	431.67	361.39
456	506.61	506.17	510.67	512.11	509.39	392.61	356.11	432.61	361.33
466	506.50	506.56	510.94	512.00	509.44	391.72	358.83	432.33	361.22
476	506.72	507.22	511.28	512.61	509.89	391.44	359.72	430.06	361.22
487	506.72	506.39	511.61	512.89	510.00	391.61	261.06	430.78	361.11
497	506.72	506.44	511.83	513.17	510.06	391.39	358.61	429.17	361.11
507	506.39	506.33	511.89	513.11	510.22	390.61	360.44	431.72	361.06
518	507.06	506.56	512.00	513.50	510.50	390.17	360.44	431.33	360.94
528	506.94	506.28	512.23	513.33	510.61	389.33	364.00	430.17	360.94
539	507.06	506.44	512.28	514.06	510.50	388.94	360.06	430.50	360.89
549	507.17	506.94	512.11	514.11	511.17	388.11	360.33	427.33	360.78
561	507.11	507.28	512.22	514.17	510.89	387.94	360.56	429.29	360.72
571	507.33	507.28	512.28	514.56	510.89	387.61	363.39	430.50	360.67
582	507.44	507.50	512.17	514.67	511.44	387.28	362.33	432.28	360.67
592	507.67	507.33	512.00	514.56	511.29	386.61	362.72	433.11	360.61
602	507.67	507.72	512.44	514.61	511.22	386.17	360.28	431.22	360.50
613	508.06	507.89	512.22	514.28	510.39	385.67	361.78	430.72	360.44
623	508.06	508.17	512.44	513.89	510.33	385.78	361.94	431.00	360.39
633	508.17	507.94	512.33	513.33	510.28	385.67	356.33	429.28	360.33
644	507.89	507.78	512.50	513.56	510.89	384.94	356.56	422.17	360.28

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 1-9
TEST: WIL-1 DATA
(sheet 3 of 15)

TIME SECONDS	DAS# 1 DEG C	DAS# 2 DEG C	DAS# 3 DEG C	DAS# 4 DEG C	DAS# 5 DEG C	DAS# 6 DEG C	DAS# 7 DEG C	DAS# 8 DEG C	DAS# 9 DEG C
654	508.06	507.94	512.11	513.11	510.89	384.61	357.06	422.28	360.2[illegible]
665	508.00	508.00	512.22	512.33	510.78	384.00	354.11	427.67	360.2[illegible]
675	508.00	507.61	512.17	512.56	510.06	383.22	356.39	426.39	360.1[illegible]
685	507.94	507.78	511.83	512.22	510.06	383.50	362.83	422.06	360.1[illegible]
696	507.78	507.83	511.72	511.78	510.06	384.00	367.00	419.06	360.1[illegible]
706	507.78	507.61	511.56	511.33	510.06	384.11	360.72	424.39	360.1[illegible]
716	507.39	507.11	511.33	510.83	509.56	383.61	355.00	423.61	359.9[illegible]
727	507.22	506.11	510.50	510.56	509.61	383.28	356.67	424.50	359.3[illegible]
737	507.17	507.06	510.06	510.11	509.61	383.11	357.50	423.44	359.9[illegible]
747	506.39	506.94	509.67	509.61	509.00	383.00	360.17	425.44	359.7[illegible]
758	506.56	506.33	508.94	508.94	508.56	382.61	359.17	424.33	359.7[illegible]
768	506.44	506.33	508.28	508.61	508.39	382.50	357.39	425.50	359.7[illegible]
778	506.11	506.17	508.17	507.89	508.39	382.28	357.22	419.89	359.3[illegible]
789	505.83	505.50	507.33	507.28	507.78	381.33	348.33	420.39	359.6[illegible]
799	505.78	505.39	507.06	506.94	507.44	380.89	352.06	420.00	359.3[illegible]
810	505.39	505.44	506.56	506.78	507.17	380.28	351.00	416.56	359.5[illegible]
820	505.11	504.89	506.22	506.22	506.94	379.78	352.28	414.17	359.5[illegible]
830	504.83	504.56	506.28	505.67	506.56	379.39	351.50	418.00	359.4[illegible]
841	504.56	504.17	505.28	505.56	506.28	378.89	353.89	415.67	359.3[illegible]
851	504.17	503.94	504.33	505.22	506.06	378.61	354.11	409.00	359.3[illegible]
861	504.06	503.83	504.67	504.72	505.33	378.61	350.00	413.11	359.2[illegible]
872	503.61	503.22	505.11	503.33	504.78	378.17	347.89	410.61	359.2[illegible]
882	503.39	503.00	503.94	502.94	504.61	377.94	347.61	411.17	359.2[illegible]
892	503.11	503.22	503.56	502.33	504.17	377.56	347.22	409.33	359.1[illegible]
903	502.83	502.56	503.67	501.89	503.78	377.11	343.00	408.89	359.1[illegible]
913	502.67	502.56	503.28	502.50	503.22	376.61	346.61	411.39	359.0[illegible]
924	502.44	501.94	503.22	502.11	503.00	376.17	343.78	411.06	359.0[illegible]
934	502.50	501.44	503.06	501.33	502.61	375.78	346.33	407.39	359.0[illegible]
945	502.00	501.61	502.50	501.50	502.39	375.44	345.33	405.11	359.0[illegible]
955	501.72	501.39	501.94	500.28	502.00	374.72	342.78	405.06	358.8[illegible]
965	501.17	501.28	501.50	500.22	501.56	374.06	342.72	404.11	358.9[illegible]
976	501.00	500.94	501.28	499.61	501.33	373.33	337.00	407.33	358.3[illegible]
986	500.50	500.33	501.28	499.83	500.33	372.44	341.16	404.17	358.8[illegible]
997	499.94	499.89	500.67	498.83	500.11	372.17	339.56	403.61	358.7[illegible]
1007	500.00	499.56	500.39	496.39	499.94	371.22	338.39	400.67	358.7[illegible]
1017	499.17	499.33	499.39	498.39	499.33	370.67	335.94	402.39	358.7[illegible]
1028	499.11	498.33	500.22	498.44	499.33	371.11	337.11	405.56	[illegible]
1038	498.61	498.33	500.00	498.22	498.39	369.61	340.00	401.17	358.6[illegible]
1049	498.39	498.44	499.72	497.00	498.56	369.56	341.44	399.56	358.3[illegible]
1059	497.72	497.94	499.44	497.39	498.28	369.11	340.83	400.22	358.5[illegible]

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 10-18
TEST: WIL-1 DATA
(sheet 4 of 15)

TIME SECONDS	DAS# 10 DEG C	DAS# 11 DEG C	DAS# 12 DEG C	DAS# 13 DEG C	DAS# 14 DEG C	DAS# 15 DEG C	DAS# 16 DEG C	DAS# 17 DEG C	DAS# 18 DEG C
-229	381.44	386.56	137.06	139.33	136.78	492.67	510.06	532.83	310.17
-218	381.44	386.61	137.17	139.44	136.78	492.67	510.00	532.83	310.11
-208	381.50	386.61	137.33	139.50	136.94	492.67	510.06	532.72	313.67
-198	381.44	386.61	137.50	139.72	137.17	492.67	510.11	532.72	312.44
-187	381.39	386.67	137.67	139.78	137.22	492.72	510.17	532.83	312.06
-126	381.61	386.89	138.06	140.44	137.56	492.78	510.22	532.83	317.06
-116	381.94	387.17	138.17	141.28	137.78	493.11	510.39	532.83	315.78
-106	381.94	387.17	138.28	141.33	137.78	493.11	510.50	532.89	315.17
-96	381.94	387.22	138.39	141.33	137.89	493.11	510.56	532.78	315.50
-86	382.00	387.22	138.39	141.39	137.89	493.17	510.50	532.89	311.61
-76	382.00	387.22	138.39	141.44	137.83	493.11	510.44	532.89	313.33
-66	382.11	387.33	138.33	141.50	137.89	493.17	510.50	532.89	313.22
-55	382.11	387.28	138.11	141.44	137.89	493.22	510.44	532.89	309.56
-43	382.11	387.28	138.00	141.33	137.83	493.22	510.50	532.83	309.39
-33	382.11	387.39	137.83	141.44	137.61	493.22	510.50	532.89	312.17
-22	382.11	387.28	137.72	141.33	137.72	493.22	510.56	532.89	314.39
-11	382.17	387.33	137.56	141.33	137.78	493.22	510.50	532.83	314.72
-1	382.22	387.33	137.44	141.44	137.83	493.28	510.56	532.83	317.67
10	382.67	359.50	137.39	140.56	125.11	494.28	510.06	532.22	455.33
20	382.67	356.11	137.72	140.17	115.28	493.67	508.67	530.00	419.06
31	382.44	373.72	137.67	140.11	111.17	493.44	507.28	527.94	376.50
41	382.28	381.78	137.61	140.17	109.89	493.33	506.39	526.50	363.78
51	382.06	391.39	137.50	140.00	109.44	493.33	505.94	525.56	353.33
62	381.83	394.50	137.56	140.06	109.33	493.28	505.67	524.89	339.44
72	381.67	393.39	137.61	140.00	109.39	493.22	505.56	524.39	331.72
82	381.39	397.67	137.72	140.00	109.50	493.11	505.67	524.00	330.06
93	381.17	397.94	137.39	140.11	109.61	493.00	505.39	523.83	326.72
103	380.94	396.83	137.94	140.06	109.67	492.83	505.83	523.67	320.50
114	380.72	395.67	138.11	140.22	109.61	492.72	505.56	523.61	318.22
124	380.50	394.67	138.28	140.11	109.78	492.61	505.33	523.67	319.28
134	380.28	393.78	138.44	140.28	109.78	492.50	505.28	523.67	320.39
145	380.06	393.00	138.56	140.28	109.72	492.33	505.28	523.56	318.33
155	379.83	392.28	138.72	140.44	109.67	492.17	505.50	523.50	319.94
165	379.56	391.67	138.78	140.44	109.61	492.00	505.44	523.56	320.28
176	379.44	391.11	138.89	140.56	109.56	491.83	505.50	523.67	318.33
186	379.28	390.67	139.00	140.61	109.61	491.67	505.33	523.78	320.72
197	379.06	390.17	139.11	140.67	109.44	491.50	505.39	523.89	317.11
207	378.89	389.78	139.17	140.83	109.44	491.33	505.39	524.00	315.33
217	378.67	389.33	139.33	140.83	109.50	491.11	505.50	524.11	316.33
228	378.50	388.94	139.44	140.89	109.67	490.89	505.39	524.22	315.94

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 10-18
TEST: WIL-1 DATA
(sheet 5 of 15)

TIME SECONDS	DAS# 10 DEG C	DAS# 11 DEG C	DAS# 12 DEG C	DAS# 13 DEG C	DAS# 14 DEG C	DAS# 15 DEG C	DAS# 16 DEG C	DAS# 17 DEG C	DAS# [illegible] DEG [illegible]
238	378.28	388.44	139.61	140.94	109.61	490.72	505.44	524.39	317.[illegible]
248	378.11	388.00	139.67	141.11	109.78	490.56	505.44	524.56	313.[illegible]
259	377.94	387.56	139.72	141.11	109.94	490.39	505.39	524.61	315.[illegible]
269	377.72	387.22	139.94	141.17	109.89	490.28	505.44	524.78	311.[illegible]
280	377.61	386.89	140.00	141.33	110.00	490.11	505.39	524.94	313.[illegible]
290	377.44	386.50	140.17	141.39	110.17	490.00	505.50	525.11	314.[illegible]
300	377.22	386.17	140.22	141.44	110.39	489.83	505.44	525.22	316.[illegible]
311	377.00	385.89	140.28	141.44	110.44	489.72	505.56	525.39	315.[illegible]
321	376.94	385.72	140.39	141.67	110.67	489.56	505.56	525.56	315.[illegible]
331	376.78	387.56	140.44	141.50	110.83	469.44	505.50	525.67	314.[illegible]
342	376.61	387.44	140.56	141.61	111.06	489.28	505.50	525.89	316.[illegible]
352	376.44	387.28	140.72	141.67	111.22	489.22	505.56	525.74	318.[illegible]
362	376.28	386.78	140.83	141.78	111.39	489.06	505.56	525.94	318.[illegible]
373	376.11	386.39	141.00	142.00	111.56	488.94	505.50	525.83	313.[illegible]
383	376.00	386.06	141.06	142.06	111.33	488.83	505.72	525.94	313.[illegible]
394	375.33	385.83	141.22	142.06	112.06	488.78	505.56	525.94	314.[illegible]
404	375.67	385.50	141.28	142.17	112.17	486.72	505.39	525.94	316.[illegible]
414	375.56	385.28	141.39	142.28	112.44	488.61	505.39	526.11	315.[illegible]
425	375.44	385.06	141.50	142.33	112.67	488.50	505.39	526.22	315.[illegible]
435	375.28	384.78	141.61	142.33	112.83	488.44	505.39	526.33	316.[illegible]
445	375.11	384.56	141.72	142.44	112.89	488.33	505.50	526.44	316.[illegible]
456	375.00	384.33	141.78	142.56	113.17	488.22	505.44	526.56	311.[illegible]
466	374.83	384.11	141.83	142.56	113.17	486.17	505.50	526.67	313.[illegible]
476	374.72	383.89	141.94	142.67	113.39	488.06	505.44	526.83	312.[illegible]
487	374.61	383.72	142.00	142.67	113.67	487.94	505.39	526.94	313.[illegible]
497	374.44	383.50	142.11	142.72	113.83	487.39	505.50	527.17	315.[illegible]
507	374.33	383.28	142.22	142.83	114.00	487.78	505.44	527.28	316.[illegible]
518	374.22	383.06	142.28	142.83	114.11	487.67	505.39	527.39	317.[illegible]
528	374.11	382.89	142.33	142.89	114.33	487.56	505.44	527.56	318.[illegible]
539	374.00	382.61	142.33	143.00	114.50	487.50	505.44	527.72	314.[illegible]
549	373.83	382.28	142.28	142.94	114.67	487.33	505.39	527.83	314.[illegible]
561	373.72	382.06	142.28	143.06	114.39	487.22	505.44	528.00	315.[illegible]
571	373.61	381.89	142.22	143.11	115.22	487.11	505.39	528.17	313.[illegible]
582	372.94	381.61	142.22	143.17	115.33	486.44	505.50	528.28	316.[illegible]
592	372.83	381.39	142.17	143.22	115.44	466.39	504.33	527.44	314.[illegible]
602	372.72	381.28	142.11	143.22	115.61	486.28	504.39	527.17	312.[illegible]
613	372.61	381.11	142.22	143.28	115.83	486.17	504.22	526.72	313.[illegible]
623	372.50	380.94	142.28	143.39	116.00	486.11	504.11	526.17	314.[illegible]
633	372.33	380.78	142.22	141.33	116.22	486.06	504.06	525.50	314.[illegible]
644	372.22	380.61	142.28	143.44	116.33	486.00	503.94	524.72	312.[illegible]

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 10-18
TEST: WIL-1 DATA
(sheet 6 of 15)

TIME SECONDS	DAS# 10 DEG C	DAS# 11 DEG C	DAS# 12 DEG C	DAS# 13 DEG C	DAS# 14 DEG C	DAS# 15 DEG C	DAS# 16 DEG C	DAS# 17 DEG C	DAS# 18 DEG C
654	372.17	380.44	142.28	143.50	116.56	485.94	503.78	523.33	310.56
665	372.06	380.28	142.33	143.50	116.67	485.89	503.67	522.83	313.00
675	372.00	380.17	142.39	143.72	116.94	485.83	503.56	521.78	311.94
685	371.89	380.00	142.44	143.50	117.17	485.78	503.44	520.61	313.44
696	371.78	379.83	142.50	143.61	117.28	485.72	503.39	519.44	311.67
706	371.67	379.67	142.50	143.67	117.39	485.67	503.33	518.22	312.78
716	371.56	379.50	142.50	143.78	117.56	485.56	503.22	[illegible]	309.22
727	371.50	379.39	142.56	143.67	117.83	485.61	503.11	515.61	307.78
737	371.39	379.22	142.67	143.83	118.06	485.56	503.00	514.17	309.44
747	371.28	379.11	142.67	143.78	118.17	485.50	502.89	512.83	311.72
758	371.22	379.00	142.78	143.89	118.39	485.44	502.83	511.56	311.67
768	371.11	378.89	142.78	143.89	118.67	485.39	502.72	510.11	311.33
778	371.06	378.83	142.83	143.83	118.72	485.39	502.67	508.78	308.61
789	370.94	378.67	142.94	144.00	118.94	485.33	502.56	507.39	307.83
799	370.89	378.56	142.94	143.94	119.11	485.28	502.44	505.94	309.72
810	370.78	378.39	143.00	143.94	119.17	485.22	502.39	504.56	306.72
820	370.72	378.28	143.06	144.00	119.39	485.17	502.22	503.17	309.06
830	370.61	378.17	143.11	144.06	119.56	485.11	502.06	501.83	309.72
841	370.56	378.06	143.22	144.00	119.72	485.11	502.00	500.50	307.33
851	370.44	377.89	143.28	144.06	119.89	485.06	501.89	499.22	306.22
861	370.39	377.83	143.33	144.17	120.06	484.94	501.72	498.00	304.28
872	370.33	377.72	143.39	144.11	120.28	484.94	501.56	496.72	304.00
882	370.22	377.61	143.50	144.17	120.33	484.89	501.44	495.50	304.61
892	370.17	377.50	143.56	144.17	120.50	484.94	501.28	494.22	302.44
903	370.06	377.39	143.78	144.17	120.61	484.83	501.11	493.06	303.00
913	370.00	377.28	143.78	144.11	120.83	484.78	500.94	491.33	305.39
924	369.94	377.17	143.83	144.22	120.89	484.78	500.72	490.67	303.72
934	369.83	377.11	143.89	144.11	121.11	484.78	500.61	489.56	306.22
945	369.78	377.00	143.89	144.17	121.33	484.78	500.39	488.44	303.50
955	369.72	376.89	144.00	144.17	121.39	484.78	500.22	487.33	301.94
965	369.61	376.78	144.00	144.17	121.56	484.72	500.00	486.22	302.89
976	369.50	376.67	144.06	144.22	121.56	484.56	499.78	485.22	301.78
986	369.50	376.61	144.11	144.11	121.78	484.56	499.61	483.94	300.33
997	369.44	376.44	144.11	144.28	121.89	484.44	499.33	483.11	300.61
1007	369.33	376.44	144.17	144.33	122.00	484.44	499.22	482.11	302.11
1017	369.28	376.39	144.22	144.11	122.17	484.39	499.00	481.17	301.78
1028	369.22	376.28	144.28	144.17	122.22	484.28	498.78	480.22	302.56
1038	369.17	376.22	144.33	144.17	122.33	484.22	498.56	479.22	300.44
1049	369.06	376.11	144.39	144.22	122.56	484.17	498.28	478.39	301.39
1059	369.00	376.00	144.39	144.17	122.67	484.11	498.06	477.50	301.67

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 19-29
TEST: WIL-1 DATA
(sheet 7 of 15)

TIME SECONDS	DAS# 19 DEG C	DAS# 20 DEG C	DAS# 23 DEG C	DAS# 24 DEG C	DAS# 25 DEG C	DAS# 26 DEG C	DAS# 27 DEG C	DAS# 28 DEG C	DAS# 2 DEG
-229	297.44	159.00	156.94	155.06	154.83	154.39	137.28	157.00	158.
-218	295.33	159.00	157.06	154.94	154.72	154.11	137.17	156.83	157.
-208	299.33	159.17	157.00	154.61	154.56	154.17	137.22	156.89	157.
-198	300.78	159.39	157.06	154.39	154.17	153.89	137.28	157.00	158.
-187	297.22	159.50	157.17	154.72	154.39	154.06	137.28	157.11	158.
-126	301.33	159.61	157.06	155.17	154.33	154.11	137.78	156.89	157.
-116	297.72	159.94	157.67	155.22	154.94	154.78	138.61	158.06	158.
-106	299.06	160.06	157.78	155.22	155.22	154.89	138.67	157.56	158.
-96	299.33	160.33	157.78	155.22	154.94	154.94	138.67	157.89	158.2
-86	299.39	160.22	157.94	155.61	154.61	155.22	138.78	157.83	158.
-76	299.94	160.44	157.83	155.44	154.83	155.17	138.72	158.11	158.
-66	299.67	160.50	158.11	155.56	154.78	155.22	138.78	158.22	158.3
-55	297.17	160.61	158.17	155.89	155.28	155.33	138.89	157.89	158.5
-43	295.39	160.44	158.22	155.94	155.39	155.11	138.89	158.22	158.7
-33	297.11	160.44	158.22	155.56	155.17	155.11	139.00	158.06	159.
-22	301.61	160.39	158.33	155.61	155.39	155.06	139.30	158.17	159.2
-11	300.83	160.44	158.28	155.56	155.33	155.28	139.06	158.11	159.
-1	302.44	160.56	158.11	155.67	155.44	155.11	139.06	158.33	158.6
10	446.06	162.61	163.78	161.44	161.67	159.94	140.56	166.67	161.
20	437.94	163.44	165.61	163.00	162.78	161.06	140.33	167.17	163.
31	387.11	163.11	164.89	162.78	162.72	161.06	140.39	166.22	163.1
41	357.94	163.28	163.06	161.72	161.94	160.61	140.17	164.61	163.2
51	343.83	163.61	161.61	161.11	161.22	159.67	140.00	163.28	163.
62	329.11	163.28	161.17	160.72	160.83	159.33	140.06	162.22	162.5
72	320.50	163.00	160.00	160.22	160.56	158.94	139.94	161.50	161.4
82	318.67	162.72	159.17	159.61	159.83	158.22	140.06	160.72	161.5
93	317.06	163.06	158.94	158.50	159.50	157.83	140.11	160.17	161.1
103	311.28	162.50	158.22	158.17	158.73	157.11	140.00	159.39	160.2
114	310.67	162.44	158.50	158.22	158.44	156.89	140.11	159.17	160.1
124	308.50	161.89	158.89	158.39	159.22	157.61	140.28	159.06	160.4
134	309.89	162.39	159.00	158.50	159.22	157.67	140.28	158.83	160.2
145	308.00	162.39	159.00	158.22	158.56	157.33	140.39	158.50	160.2
155	307.06	162.06	159.06	158.50	158.89	157.61	140.44	158.78	160.5
165	305.39	162.06	158.78	158.56	158.94	157.61	140.50	158.50	159.7
176	305.39	162.28	158.61	158.39	158.89	157.33	140.56	158.78	160.1
186	308.11	162.33	159.00	158.33	158.94	157.11	140.56	158.83	160.3
197	313.78	162.44	158.72	158.37	158.56	157.00	140.67	158.61	160.1
207	310.06	162.28	158.44	158.39	158.17	157.11	140.67	158.78	159.3
217	299.89	162.56	158.33	158.61	158.17	157.11	140.72	158.50	159.5
228	301.22	161.94	158.89	158.56	158.17	157.00	140.78	158.22	159.2

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 19-29
TEST: WIL-1 DATA
(sheet 8 of 15)

TIME SECONDS	DAS# 19 DEG C	DAS# 20 DEG C	DAS# 23 DEG C	DAS# 24 DEG C	DAS# 25 DEG C	DAS# 26 DEG C	DAS# 27 DEG C	DAS# 28 DEG C	DAS# 29 DEG C
238	302.67	162.50	159.06	158.39	158.28	156.56	140.78	158.61	159.56
248	298.94	162.89	159.28	158.44	158.50	156.89	140.39	158.39	159.56
259	303.17	162.33	159.56	158.72	158.39	157.11	140.94	158.44	159.78
269	301.78	[illegible]	159.22	158.89	158.78	157.28	141.06	158.61	160.17
280	303.39	163.22	159.17	158.39	159.22	157.28	140.94	158.78	160.11
290	304.83	163.50	159.61	159.11	159.33	157.39	141.17	158.61	160.17
300	306.44	163.11	159.72	158.94	159.17	157.28	141.22	159.06	160.39
311	306.61	163.28	159.67	159.00	159.39	157.00	141.22	159.28	160.50
321	306.33	163.72	159.56	159.39	159.33	157.17	141.28	159.11	160.67
331	303.72	163.83	159.50	159.17	158.94	156.89	141.22	159.06	160.56
342	305.78	163.39	159.44	159.11	158.78	157.17	141.39	158.72	160.17
352	303.94	163.56	159.72	158.94	158.94	157.17	141.44	158.94	160.28
362	304.39	163.94	159.67	159.06	159.00	157.22	141.56	159.11	160.50
373	305.72	164.44	159.83	159.11	158.94	157.39	141.56	159.78	161.17
383	304.78	164.22	159.61	158.94	158.83	157.22	141.44	159.78	161.11
394	305.50	163.83	159.83	159.11	159.22	157.44	141.61	159.61	161.11
404	307.11	163.28	159.94	159.39	159.44	157.61	141.72	159.67	161.00
414	306.06	163.22	160.28	159.44	159.67	157.83	141.89	159.72	161.28
425	304.61	162.94	160.44	159.61	159.83	157.72	141.83	159.33	161.44
435	306.39	163.06	160.06	159.56	159.61	157.83	141.89	159.72	161.11
445	307.44	163.28	160.28	159.61	159.56	157.83	141.94	159.83	161.11
456	304.44	163.50	160.61	159.39	159.56	157.89	142.00	159.56	161.06
466	302.94	163.44	160.06	159.33	159.33	157.78	142.06	159.33	160.50
476	300.56	163.50	159.72	159.56	159.06	157.89	142.06	159.78	160.61
487	300.39	163.56	160.00	159.33	159.06	157.94	142.22	160.22	161.00
497	301.83	163.44	160.33	159.11	159.50	158.33	142.22	159.78	160.83
507	302.06	163.33	160.44	159.28	159.00	158.11	142.28	159.72	160.83
518	303.22	163.78	160.39	159.56	159.28	156.06	142.33	159.44	160.72
528	304.94	163.61	160.28	159.33	159.17	157.78	142.44	159.56	160.78
539	302.72	164.11	160.28	159.67	159.56	158.06	142.44	159.50	160.78
549	301.17	163.94	160.33	159.78	159.61	158.06	142.50	159.50	160.56
561	302.33	163.78	160.44	159.83	159.67	158.11	142.50	159.67	161.22
571	305.17	164.00	160.94	159.72	159.33	158.00	142.56	159.39	161.33
582	304.89	164.00	161.17	159.83	159.39	158.22	142.61	159.61	161.28
592	304.33	164.67	161.00	159.39	159.61	158.33	142.67	159.78	161.33
602	302.39	164.89	161.17	159.78	159.28	158.22	142.78	160.00	161.28
613	303.33	165.11	161.11	159.94	159.33	159.39	142.83	159.78	160.94
623	302.72	164.67	160.78	160.06	159.78	158.56	142.78	159.72	160.50
633	303.89	164.50	160.94	159.78	159.78	158.22	142.78	160.33	161.00
644	302.44	164.00	160.78	159.72	159.67	158.17	142.83	160.11	160.56

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 19-29
TEST: WIL-1 DATA
(sheet 9 of 15)

TIME SECONDS	DAS# 19 DEG C	DAS# 20 DEG C	DAS# 23 DEG C	DAS# 24 DEG C	DAS# 25 DEG C	DAS# 26 DEG C	DAS# 27 DEG C	DAS# 28 DEG C	DAS# DEG
654	299.78	164.17	160.72	159.72	159.78	158.39	142.89	159.72	160.
665	302.17	163.94	160.94	159.67	159.33	158.33	143.06	160.33	161.5
675	300.06	163.56	160.67	159.61	160.00	157.78	142.94	159.83	161.
685	298.39	163.33	160.67	159.78	159.94	158.00	143.06	159.44	160.
696	296.39	163.78	160.89	159.67	159.67	158.17	143.11	159.50	160.9
706	297.69	163.33	160.50	159.22	159.50	157.83	143.00	159.56	160.
716	295.56	163.83	160.44	159.39	158.56	157.67	143.06	159.56	160.
727	293.44	163.22	160.78	159.67	158.67	157.61	143.06	159.78	161.
737	296.83	162.78	160.78	159.44	159.22	157.89	143.22	159.83	160.
747	297.11	162.56	160.44	159.11	158.94	157.67	143.17	159.39	160.9
758	299.83	162.50	160.72	159.06	159.28	157.56	143.22	159.50	160.
768	296.22	162.17	160.78	159.11	159.39	157.67	143.22	159.50	160.7
778	293.67	162.17	160.17	159.06	159.39	158.06	143.28	159.44	160.1
789	296.06	161.39	160.44	159.39	159.44	158.28	143.39	159.72	160.
799	296.17	162.06	160.22	159.28	159.61	158.00	143.50	159.67	160.5
810	295.61	162.33	159.83	158.89	159.11	157.89	143.44	159.06	160.3
820	295.17	162.28	160.11	158.83	159.22	157.83	143.56	159.50	160.7
830	296.28	161.78	160.22	159.06	159.28	157.67	143.50	159.28	160.2
841	293.00	162.00	160.22	158.83	159.00	157.56	143.50	159.06	159.7
851	290.61	161.67	160.11	158.72	158.39	157.50	143.61	159.11	159.8
861	288.06	161.83	159.56	158.89	159.22	157.67	143.44	158.94	159.3
872	287.33	162.33	159.67	158.78	158.89	157.50	143.56	158.61	159.5
882	287.28	162.06	159.94	158.83	158.61	157.11	143.56	158.50	159.7
892	287.67	161.89	159.94	158.61	158.33	157.00	143.50	158.33	159.1
903	290.33	161.78	160.00	158.39	158.56	156.94	143.61	158.28	158.8
913	290.61	161.72	159.83	158.28	158.50	156.83	143.61	158.33	159.0
924	290.17	161.67	159.67	157.83	158.50	156.72	143.61	158.17	158.7
934	292.67	161.44	159.83	158.11	157.89	156.39	143.56	158.17	159.1
945	290.11	161.67	159.94	158.06	157.89	156.22	143.56	157.78	159.0
955	290.39	161.67	159.83	158.22	158.11	156.67	143.61	157.78	159.3
965	292.44	161.50	159.61	158.33	158.22	156.67	143.67	157.78	159.2
976	291.11	161.78	159.61	157.94	158.28	156.61	143.67	157.44	158.9
986	289.72	161.72	159.56	157.83	157.94	156.50	143.72	157.99	159.2
997	290.28	161.67	159.61	157.72	157.72	156.44	143.78	157.56	158.3
1007	289.67	161.61	159.44	157.83	157.78	156.61	143.83	157.67	159.1
1017	290.22	161.50	159.16	157.83	157.44	156.17	143.67	157.33	158.5
1028	291.00	161.44	159.11	157.78	157.72	155.89	143.78	157.28	158.4
1038	291.00	161.39	159.06	157.33	157.56	155.83	143.78	157.33	158.6
1049	290.39	161.44	159.06	157.61	157.50	155.94	143.78	157.11	158.5
1059	290.61	161.06	159.00	157.56	157.33	155.94	143.39	157.22	158.1

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 30-38
TEST: WIL-1 DATA
(sheet 10 of 15)

TIME SECONDS	DAS# 30 DEG C	DAS# 31 DEG C	DAS# 32 DEG C	DAS# 33 DEG C	DAS# 34 DEG C	DAS# 35 DEG C	DAS# 36 DEG C	DAS# 37 DEG C	DAS# 38 DEG C
-229	159.50	159.72	162.73	160.72	24.61	140.00	142.33	93.61	129.78
-218	159.44	159.61	162.78	160.78	24.83	139.78	142.00	93.39	129.83
-208	159.50	162.61	162.22	160.33	24.89	140.22	141.72	93.78	129.83
-198	159.44	159.61	162.89	160.89	24.94	140.33	141.67	93.67	130.11
-187	159.56	159.67	162.89	160.39	25.11	141.78	142.11	94.00	129.39
-126	159.50	159.78	163.17	161.17	24.67	141.22	142.56	94.22	130.28
-116	160.22	160.67	163.83	161.83	25.17	141.83	143.39	94.94	131.22
-106	160.50	160.56	163.83	161.89	25.00	142.50	143.61	94.94	131.22
-96	160.56	160.72	163.39	161.89	24.78	142.28	143.72	95.06	131.33
-86	160.39	160.78	163.94	161.94	24.61	142.44	144.00	95.17	131.39
-76	160.50	160.67	163.94	161.94	24.44	142.06	143.94	95.17	131.50
-66	160.67	160.83	164.00	162.06	24.50	142.39	143.78	95.06	131.56
-55	160.50	160.94	164.06	162.06	24.39	142.28	143.44	95.17	131.56
-43	160.50	160.94	164.06	162.06	24.22	142.50	143.50	95.17	131.56
-33	160.50	160.78	164.11	162.11	24.28	142.33	143.33	95.17	131.67
-22	160.50	160.78	164.06	162.11	24.17	142.67	144.17	95.33	131.72
-11	160.61	161.00	164.17	162.22	24.11	142.61	143.89	95.28	131.78
-1	160.56	161.11	164.22	162.22	24.06	142.78	143.78	95.33	131.83
10	164.11	164.78	164.39	162.33	24.06	145.00	147.56	95.33	137.78
20	164.61	165.39	164.44	162.39	24.11	149.28	150.39	95.28	139.39
31	164.00	164.33	164.39	162.39	24.11	150.94	150.94	95.28	136.39
41	164.00	164.56	164.44	162.50	24.17	150.61	150.00	95.50	136.06
51	163.61	164.28	164.56	162.56	24.33	148.94	149.17	96.00	135.22
62	163.22	163.83	164.67	162.61	24.44	148.06	148.61	95.33	135.11
72	162.50	162.78	164.56	162.67	24.44	146.72	147.33	96.06	134.94
82	162.67	163.11	164.61	162.67	24.44	146.67	146.72	95.83	134.83
93	162.39	162.94	164.67	162.72	24.33	146.33	146.39	95.67	134.72
103	161.89	162.78	164.78	162.78	24.17	145.94	146.33	96.17	134.89
114	161.39	162.78	164.78	162.33	24.17	145.33	146.11	96.17	134.94
124	161.94	162.61	164.83	162.83	24.11	144.72	146.28	95.94	135.00
134	161.56	162.44	164.83	162.94	24.00	144.50	145.39	96.00	135.11
145	161.67	162.44	164.89	162.94	23.94	144.61	144.61	96.00	134.89
155	161.94	162.72	164.94	163.00	24.00	144.83	144.94	95.89	135.17
165	161.33	162.11	164.94	163.00	24.00	144.44	145.11	96.17	135.28
176	161.61	162.39	165.00	163.06	23.94	144.33	145.94	96.39	135.33
186	161.67	162.56	164.94	163.06	24.00	144.67	146.28	96.33	135.33
197	161.56	162.28	165.06	163.17	23.94	145.06	146.33	96.61	135.50
207	161.39	162.11	165.11	163.17	23.89	144.67	146.39	96.67	135.39
217	161.50	162.33	165.17	163.17	23.89	144.78	146.22	96.56	135.50
228	161.50	162.33	165.17	163.22	23.89	144.94	146.61	96.67	135.56

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 30-38
TEST: WIL-1 DATA
(sheet 11 of 15)

TIME SECONDS	DAS# 30 DEG C	DAS# 31 DEG C	DAS# 32 DEG C	DAS# 33 DEG C	DAS# 34 DEG C	DAS# 35 DEG C	DAS# 36 DEG C	DAS# 37 DEG C	DAS# DEG
238	161.67	162.44	165.28	163.28	23.94	145.11	146.11	96.67	135.
248	161.56	162.39	165.28	163.33	24.06	144.83	146.78	96.78	135.
259	161.56	162.44	165.28	163.39	24.11	145.22	146.06	96.89	135.
269	161.50	162.17	165.33	163.39	24.17	145.28	145.94	96.72	135.
280	161.72	162.39	165.33	163.39	24.17	145.00	145.89	96.78	135.
290	161.83	162.44	165.39	163.50	24.17	144.67	146.33	96.94	135.
300	161.94	162.61	165.39	163.44	24.11	144.22	146.22	97.17	135.
311	162.06	162.78	165.50	163.50	24.06	143.89	146.22	96.94	135.
321	161.89	162.61	165.50	163.56	24.11	144.11	145.89	97.11	135.
331	161.94	162.67	165.56	163.61	24.00	144.11	145.83	97.11	135.
342	161.83	162.72	165.56	163.61	23.94	144.33	146.06	97.17	135.
352	161.94	162.89	165.61	163.67	24.11	144.33	146.33	97.22	135.
362	161.89	162.78	165.67	163.67	24.11	144.28	146.22	97.22	135.
373	162.22	162.89	165.67	163.72	24.00	144.44	146.11	97.11	135.
383	162.39	163.06	165.72	163.78	24.00	144.83	145.94	97.11	136.
394	162.33	163.00	165.78	163.83	24.06	144.83	145.83	97.28	136.
404	162.39	162.94	165.78	163.83	24.00	144.67	145.83	97.39	136.
414	162.50	163.06	165.83	163.89	24.00	144.50	146.39	97.44	136.
425	162.50	163.17	165.89	163.89	24.00	144.50	146.78	97.50	136.
435	162.50	163.11	165.89	163.94	23.89	144.78	146.11	97.56	136.
445	162.50	163.11	165.94	164.00	23.89	144.39	145.72	97.61	136.
456	162.44	162.94	165.94	164.00	24.00	144.94	145.89	97.67	136.
466	162.44	162.94	165.94	164.06	24.06	145.22	145.50	98.00	136.
476	162.44	163.17	166.06	164.06	24.06	145.11	146.50	97.89	136.
487	162.72	163.33	166.06	164.11	24.17	145.06	146.44	97.72	136.
497	162.56	163.28	166.11	164.17	24.56	145.39	146.67	97.83	136.
507	162.39	163.28	166.11	164.22	24.72	145.83	146.33	97.89	136.
518	162.39	163.11	166.17	164.22	24.78	145.39	146.17	98.28	136.
528	162.67	163.39	166.22	164.28	24.67	146.00	146.00	97.94	136.
539	162.67	163.28	166.22	164.28	24.56	145.33	146.28	98.28	136.
549	162.61	163.33	166.22	164.28	24.44	145.22	147.11	98.33	136.
561	162.89	163.61	166.33	164.39	24.33	145.33	147.44	98.06	136.7
571	162.89	163.61	166.33	164.39	24.17	145.28	146.61	98.11	136.
582	162.83	163.44	166.39	164.39	24.22	145.33	146.33	98.22	136.5
592	162.83	163.50	166.39	164.44	24.17	145.50	146.89	98.33	136.
602	162.78	163.39	166.33	164.44	24.11	145.11	146.78	98.33	136.5
613	162.56	163.22	166.44	164.50	23.94	145.11	146.50	98.50	136.
623	162.56	163.33	166.44	164.50	23.89	145.17	146.67	98.56	136.5
633	162.83	163.56	166.50	164.56	23.89	145.33	147.06	98.17	136.5
644	162.83	163.61	166.56	164.56	23.94	145.56	147.33	98.50	136.5

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 30-38
TEST: WIL-1 DATA
(sheet 12 of 15)

TIME SECONDS	DAS# 30 DEG C	DAS# 31 DEG C	DAS# 32 DEG C	DAS# 33 DEG C	DAS# 34 DEG C	DAS# 35 DEG C	DAS# 36 DEG C	DAS# 37 DEG C	DAS# 38 DEG C
654	162.61	163.56	166.50	164.61	23.94	145.39	147.22	98.33	136.56
665	162.83	163.56	166.61	164.61	24.11	145.22	147.39	98.67	136.83
675	162.33	163.50	166.61	164.67	24.22	145.78	147.11	98.61	136.76
685	162.44	163.17	166.67	164.67	24.33	145.56	146.61	98.67	136.61
696	162.56	163.33	166.67	164.67	24.39	145.72	146.83	98.61	136.61
706	162.44	163.17	166.61	164.72	24.33	145.89	146.78	98.67	136.67
716	162.33	163.11	166.67	164.72	24.28	145.22	146.78	98.33	136.56
727	162.44	163.17	166.72	164.72	24.22	144.83	146.83	98.83	136.67
737	162.28	163.00	166.72	164.78	24.22	145.56	146.50	98.72	136.72
747	162.11	162.78	166.72	164.78	24.11	145.22	146.61	99.00	136.72
758	162.22	162.78	166.78	164.78	24.17	145.17	146.72	98.94	136.78
768	162.06	162.67	166.78	164.83	24.17	145.56	146.61	98.94	136.67
778	161.89	162.50	166.72	164.83	24.06	144.78	146.17	99.28	136.72
789	162.11	162.67	166.83	164.83	24.06	145.28	146.17	99.06	136.72
799	161.39	162.50	166.83	164.83	24.06	145.39	145.72	99.00	136.39
810	161.83	162.44	166.83	164.89	24.06	145.44	145.83	99.22	136.83
820	161.94	162.61	166.83	164.89	24.06	145.11	146.28	99.11	136.94
830	161.61	162.33	166.83	164.89	24.00	145.00	146.22	99.22	136.89
841	161.50	162.28	166.83	164.89	23.94	145.61	145.94	99.06	136.83
851	161.50	162.33	166.83	164.89	23.94	146.00	146.00	99.11	136.83
861	161.33	162.00	166.89	164.89	24.11	146.44	146.11	99.06	136.83
872	161.33	161.89	166.83	164.89	24.17	145.67	145.61	99.28	136.67
882	161.22	161.94	166.89	164.94	24.17	145.61	145.72	99.50	136.83
892	160.94	161.78	166.83	164.94	24.06	145.39	145.44	99.61	136.89
903	160.94	161.83	166.89	164.94	24.00	145.00	145.61	99.56	136.83
913	160.94	161.61	166.83	164.94	24.06	144.61	146.00	99.50	136.89
924	160.56	161.50	166.83	164.89	24.33	144.22	146.06	99.56	136.78
934	160.83	161.72	166.83	164.89	24.33	144.56	145.89	99.39	136.89
945	160.67	161.67	166.83	164.89	24.44	144.39	145.94	99.61	136.89
955	160.61	161.39	166.83	164.89	24.56	144.50	145.83	99.61	136.89
965	160.44	161.17	166.78	164.89	24.33	144.50	145.67	99.56	136.89
976	160.33	161.11	166.83	164.89	24.28	144.33	145.78	99.72	137.06
986	160.39	161.17	166.78	164.89	24.28	144.33	145.61	99.72	136.94
997	160.28	161.00	166.78	164.89	24.22	144.22	145.28	99.89	136.89
1007	160.17	161.00	166.78	164.89	24.06	143.94	145.33	99.83	136.89
1017	159.89	160.61	166.72	164.83	23.83	143.78	145.72	99.94	136.94
1028	159.94	160.72	166.72	164.83	23.67	143.44	145.67	99.83	136.78
1038	159.94	160.61	166.72	164.83	23.61	143.72	145.50	99.83	136.89
1049	159.72	160.50	166.72	164.83	23.61	143.44	145.78	99.94	136.94
1059	159.56	160.22	166.67	164.83	23.78	143.22	145.33	99.83	136.94

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 50-58
TEST: WIL-1 DATA
(sheet 13 of 15)

TIME SECONDS	DAS# 50 KPa	DAS# 51 KPa	DAS# 53 O2%	DAS# 54 H2 (V)	DAS# 55 DEG C	DAS# 56 DEG C	DAS# 57 O2%	DAS# 58 H2 (V)
-229	112.64	152.72	0.19	0.02	7.71	8.08	0.14	0.02
-218	112.64	158.52	0.19	0.02	7.72	8.17	0.14	0.02
-208	112.69	164.45	0.18	0.02	7.74	8.25	0.14	0.02
-198	112.74	170.65	0.18	0.02	7.75	8.47	0.14	0.02
-187	112.76	178.24	0.18	0.02	7.76	8.27	0.14	0.02
-126	112.88	218.57	0.19	0.02	7.86	8.34	0.14	0.02
-116	113.31	197.13	0.18	0.02	8.09	8.51	0.14	0.02
-106	113.33	366.81	0.18	0.02	8.10	8.66	0.14	0.02
-96	113.36	2274.59	0.18	0.02	8.12	8.63	0.14	0.02
-86	113.40	2893.83	0.18	0.02	8.13	8.59	0.14	0.02
-76	113.39	3290.71	0.18	0.02	8.14	8.71	0.14	0.02
-66	113.42	3591.74	0.18	0.02	8.15	8.68	0.14	0.02
-55	113.46	3825.00	0.18	0.02	8.17	8.88	0.14	0.02
-43	113.50	3970.69	0.18	0.02	8.19	8.99	0.14	0.02
-33	113.51	4085.77	0.18	0.02	8.20	8.95	0.14	0.02
-22	113.55	4180.30	0.18	0.02	8.22	8.89	0.14	0.02
-11	113.56	4262.01	0.18	0.02	8.22	8.99	0.14	0.02
-1	117.22	156.72	0.18	0.02	8.23	8.91	0.14	0.02
10	119.32	125.14	0.18	0.02	8.37	8.95	0.14	0.02
20	120.13	124.11	0.18	0.02	8.43	9.06	0.14	0.02
31	119.45	124.39	0.18	0.02	8.43	9.16	0.14	0.02
41	118.97	124.04	0.18	0.02	8.41	9.18	0.14	0.02
51	118.65	123.63	0.18	0.02	8.41	9.25	0.14	0.02
62	118.49	123.08	0.18	0.02	8.42	9.25	0.14	0.02
72	118.43	122.39	0.18	0.02	8.48	9.24	0.14	0.02
82	118.39	122.67	0.18	0.02	8.61	9.29	0.14	0.02
93	118.37	122.39	0.18	0.02	8.85	9.35	0.14	0.02
103	118.37	123.35	0.18	0.02	9.17	9.64	0.14	0.02
114	118.40	123.83	0.18	0.02	9.58	10.03	0.13	0.03
124	118.39	124.32	0.17	0.03	10.04	10.48	0.13	0.03
134	118.37	124.32	0.17	0.03	10.49	10.84	0.13	0.03
145	118.35	124.73	0.17	0.03	10.94	11.01	0.13	0.03
155	118.35	125.01	0.17	0.03	11.38	11.13	0.13	0.03
165	118.33	125.83	0.17	0.03	11.80	11.32	0.13	0.03
176	118.27	126.04	0.17	0.03	12.14	11.60	0.13	0.04
186	118.27	127.07	0.17	0.03	12.46	11.74	0.13	0.04
197	118.25	127.28	0.17	0.04	12.90	11.30	0.13	0.04
207	118.25	127.90	0.17	0.04	13.11	11.15	0.13	0.04
217	118.22	128.87	0.17	0.04	13.38	11.13	0.13	0.04
228	118.25	130.04	0.17	0.04	13.62	10.81	0.13	0.04

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 50-58
TEST: WIL-1 DATA
(sheet 14 of 15)

TIME SECONDS	DAS# 50 KPa	DAS# 51 KPa	DAS# 53 O2%	DAS# 54 H2 (V)	DAS# 55 DEG C	DAS# 56 DEG C	DAS# 57 O2%	DAS# 58 H2 (V)
238	118.23	130.11	0.17	0.04	13.85	11.06	0.13	0.04
248	118.25	130.59	0.17	0.04	14.06	11.23	0.13	0.04
259	118.25	131.63	0.17	0.04	14.29	11.63	0.13	0.04
269	118.31	132.32	0.17	0.04	14.50	12.10	0.13	0.04
280	118.33	131.63	0.17	0.04	14.66	12.44	0.13	0.04
290	118.35	132.30	0.17	0.04	14.32	13.01	0.13	0.04
300	118.35	133.76	0.18	0.04	14.97	13.65	0.13	0.04
311	118.35	134.31	0.17	0.04	15.11	14.17	0.13	0.04
321	118.36	134.59	0.17	0.04	15.25	14.85	0.13	0.05
331	118.41	135.14	0.17	0.04	15.34	15.32	0.13	0.05
342	118.40	134.18	0.17	0.05	15.46	15.49	0.13	0.05
352	118.43	133.21	0.17	0.05	15.59	14.94	0.13	0.05
362	118.50	131.90	0.17	0.05	15.73	14.97	0.13	0.05
373	118.53	131.14	0.17	0.05	15.85	15.32	0.13	0.05
383	118.56	130.25	0.17	0.05	15.95	15.89	0.13	0.05
394	118.57	130.38	0.17	0.05	16.08	16.60	0.13	0.05
404	118.57	130.25	0.17	0.05	16.16	18.04	0.13	0.05
414	118.59	130.52	0.17	0.05	16.24	18.99	0.13	0.05
425	118.60	130.18	0.17	0.05	16.31	19.01	0.13	0.05
435	118.61	130.04	0.17	0.05	16.41	18.53	0.13	0.05
445	118.61	129.83	0.17	0.05	16.50	18.03	0.13	0.05
456	118.66	129.76	0.17	0.05	16.56	17.55	0.13	0.05
466	118.66	129.83	0.17	0.05	16.63	17.39	0.13	0.05
476	118.69	129.63	0.17	0.05	16.71	17.69	0.13	0.05
487	118.70	129.69	0.17	0.05	16.78	18.12	0.13	0.05
497	118.75	129.90	0.17	0.05	16.35	18.31	0.13	0.05
507	118.74	126.87	0.17	0.05	16.92	18.30	0.13	0.05
518	118.75	132.45	0.17	0.05	16.99	18.28	0.13	0.05
528	118.79	132.45	0.17	0.05	17.07	18.34	0.13	0.05
539	118.81	132.94	0.17	0.05	17.14	18.40	0.13	0.05
549	118.80	133.14	0.17	0.05	17.20	18.44	0.13	0.05
561	118.82	133.21	0.17	0.05	17.27	18.49	0.13	0.05
571	118.82	133.14	0.17	0.05	17.33	18.58	0.13	0.05
582	118.82	133.14	0.17	0.05	17.38	18.62	0.13	0.05
592	118.82	132.73	0.17	0.05	17.42	18.64	0.13	0.05
602	118.82	132.18	0.17	0.05	17.46	18.68	0.13	0.05
613	118.81	132.18	0.17	0.05	17.49	18.71	0.13	0.05
623	118.82	131.63	0.17	0.05	17.54	18.75	0.13	0.05
633	118.87	131.07	0.17	0.05	17.59	18.79	0.13	0.05
644	118.83	130.45	0.17	0.05	17.64	18.83	0.13	0.05

TABLE A-10
DIGITAL OUTPUT FOR DAS #'s 50-58
TEST: WIL-1 DATA
(sheet 15 of 15)

TIME SECONDS	DAS# 50 KPa	DAS# 51 KPa	DAS# 53 O2%	DAS# 54 H2 (V)	DAS# 55 DEG C	DAS# 56 DEG C	DAS# 57 O2%	DAS# 58 H2 (V)
654	118.80	130.18	0.17	0.05	17.80	18.86	0.13	0.05
665	118.79	129.49	0.18	0.05	17.91	18.93	0.13	0.05
675	118.80	129.14	0.17	0.05	17.95	18.94	0.13	0.05
685	118.79	129.07	0.17	0.05	17.98	18.96	0.13	0.05
696	118.75	128.80	0.17	0.05	18.04	19.01	0.13	0.05
706	118.77	128.73	0.17	0.05	18.09	19.03	0.13	0.05
716	118.75	128.38	0.17	0.05	18.16	19.09	0.13	0.05
727	118.75	128.45	0.17	0.05	18.23	19.12	0.13	0.05
737	118.74	128.25	2.18	0.05	18.31	19.15	0.13	0.05
747	118.72	127.70	2.02	0.35	18.40	19.15	0.13	0.05
758	118.73	127.56	0.57	0.23	18.38	19.21	0.13	0.05
768	118.73	127.35	0.30	0.09	18.35	19.16	0.13	0.05
778	118.70	127.28	0.22	0.06	18.36	19.13	0.13	0.05
789	118.69	127.28	0.20	0.06	18.38	19.11	0.13	0.05
799	118.73	126.94	0.19	0.06	18.41	19.13	0.13	0.05
810	118.72	126.25	0.19	0.05	18.44	19.11	0.13	0.05
820	118.70	126.18	0.18	0.05	18.47	19.13	0.13	0.05
830	118.72	125.42	0.18	0.05	18.50	19.14	0.13	0.05
841	118.69	125.28	0.08	0.05	18.55	19.15	0.13	0.05
851	118.68	125.01	0.18	0.05	18.58	19.10	0.13	0.05
861	118.74	124.94	0.18	0.05	18.63	19.13	0.13	0.05
872	118.72	124.87	0.18	0.05	18.67	19.13	0.13	0.05
882	118.68	125.01	0.18	0.05	18.69	19.08	0.13	0.05
892	118.67	124.52	0.18	0.05	18.70	19.06	0.13	0.05
903	118.67	124.39	0.18	0.05	18.72	19.03	0.13	0.05
913	118.64	124.39	0.18	0.05	18.74	19.03	0.13	0.05
924	118.62	124.18	0.18	0.05	18.76	19.02	0.13	0.05
934	118.66	123.97	0.18	0.05	18.77	19.02	0.13	0.05
945	118.66	123.63	0.18	0.06	18.78	19.03	0.13	0.05
955	118.66	123.56	0.18	0.06	18.78	19.04	0.13	0.05
965	118.66	123.42	0.18	0.06	18.78	19.06	0.13	0.05
976	118.66	123.14	0.18	0.05	18.81	19.03	0.13	0.05
986	118.65	122.94	0.18	0.05	18.82	19.01	0.13	0.05
997	118.63	122.94	0.18	0.05	18.83	18.99	0.13	0.05
1007	118.61	122.32	0.17	0.05	18.83	18.99	0.13	0.05
1017	118.61	122.52	0.17	0.05	18.83	19.02	0.13	0.05
1028	118.59	121.33	0.17	0.05	18.82	19.02	0.13	0.05
1038	118.60	121.97	0.17	0.05	18.83	19.07	0.13	0.05
1049	118.59	121.63	0.17	0.06	18.83	18.95	0.13	0.05
1059	118.59	121.28	0.17	0.05	18.83	18.97	0.13	0.05

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 1-9
TEST: WIA-1 DATA
(sheet 1 of 20)

TIME SECONDS	DAS# 1 DEG C	DAS# 2 DEG C	DAS# 3 DEG C	DAS# 4 DEG C	DAS# 5 DEG C	DAS# 6 DEG C	DAS# 7 DEG C	DAS# 8 DEG C	DAS# 9 DEG C
-134	530.06	530.22	532.33	531.00	531.39	415.11	411.83	458.72	416.44
-123	530.22	530.28	532.44	530.78	531.33	415.00	410.72	457.22	416.39
-112	530.61	530.28	532.61	531.17	531.67	414.94	409.11	456.56	416.33
-102	530.39	530.33	532.56	531.06	531.44	414.72	411.89	457.50	416.28
-92	530.06	530.28	532.11	530.83	531.94	415.00	409.83	456.44	416.22
-81	530.17	530.50	532.39	530.89	531.72	414.72	408.06	455.89	416.17
-70	530.00	530.39	532.67	530.83	531.56	414.89	411.72	456.39	416.11
-60	530.72	530.22	532.56	531.33	531.17	415.22	408.83	456.28	416.00
-50	530.39	530.33	532.61	530.94	531.72	415.22	407.56	457.17	416.28
-40	530.17	530.39	532.61	531.33	532.17	415.22	412.11	458.61	416.39
-29	530.72	530.11	532.33	530.56	532.11	415.33	411.83	457.72	416.28
-18	530.72	530.39	532.33	531.33	531.28	415.33	411.72	457.78	416.39
-9	530.72	530.11	532.39	531.33	531.78	415.50	410.50	457.89	416.44
2	530.50	530.22	532.11	530.67	531.44	415.61	410.78	457.67	416.39
13	529.61	530.50	531.06	530.39	530.83	455.67	439.00	486.17	416.33
24	530.39	530.72	531.06	529.39	531.17	479.50	449.17	492.39	416.39
34	530.44	530.89	530.72	529.22	531.39	508.94	434.44	477.56	416.67
44	530.39	531.17	531.06	529.50	531.78	522.00	418.78	468.39	417.11
54	530.72	531.39	531.39	529.83	531.89	527.28	412.39	498.94	417.94
65	531.33	532.11	531.78	530.72	532.56	529.78	421.44	488.56	418.61
75	531.83	532.72	532.22	531.22	533.28	531.50	428.56	498.61	419.33
85	532.72	533.39	532.83	532.17	534.00	532.39	447.72	505.39	420.17
95	533.39	534.22	533.72	532.11	534.89	533.22	448.56	509.00	421.17
105	534.11	535.44	534.67	533.44	536.06	534.39	483.00	521.11	422.33
116	535.11	536.56	535.72	534.94	537.22	535.28	449.56	505.33	423.72
126	536.94	538.00	536.94	536.44	538.56	536.78	464.94	514.39	425.44
136	537.11	539.17	538.39	537.61	540.00	538.39	489.33	528.44	426.94
146	539.89	540.89	539.94	539.44	541.78	540.00	509.00	530.17	429.28
156	541.72	543.11	541.83	540.94	544.06	541.89	512.00	532.67	430.89
166	543.78	545.11	543.78	542.83	545.89	544.00	503.39	534.56	432.50
177	545.44	546.61	546.11	545.17	547.94	546.28	513.94	534.78	434.22
187	547.78	549.33	548.11	546.72	550.06	548.61	528.06	522.17	436.50
199	550.17	551.22	549.94	548.00	551.61	550.50	538.78	531.83	438.56
210	552.22	553.22	552.06	551.17	554.17	552.78	541.72	543.94	440.61
220	554.28	555.50	554.11	552.83	556.17	554.72	553.67	547.89	442.78
230	556.00	557.22	556.11	555.28	558.78	557.00	550.39	542.06	444.89
240	557.50	558.78	557.78	556.83	559.50	558.44	515.00	526.44	446.56
250	558.17	558.83	559.28	557.33	560.44	555.94	490.17	519.17	447.72
261	558.78	558.67	559.33	558.06	558.61	548.72	474.33	515.33	448.89
272	558.11	558.39	559.22	557.72	558.44	540.39	463.50	514.39	447.06

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 1-9
TEST: WIA-1 DATA
(sheet 2 of 20)

TIME SECONDS	DAS# 1 DEG C	DAS# 2 DEG C	DAS# 3 DEG C	DAS# 4 DEG C	DAS# 5 DEG C	DAS# 6 DEG C	DAS# 7 DEG C	DAS# 8 DEG C	DAS# 9 DEG C
282	558.06	558.50	559.06	557.22	559.00	532.28	458.44	511.39	450.3
292	557.72	558.61	558.78	557.11	559.11	525.33	445.78	509.89	450.7
303	556.83	558.06	558.33	555.94	558.61	529.39	455.44	528.61	451.39
314	557.56	558.44	558.22	556.78	558.83	545.50	473.78	511.94	451.8
324	557.06	557.94	558.44	556.00	558.78	548.22	483.83	515.22	452.1
335	557.39	558.28	558.22	556.50	558.83	545.56	478.39	508.89	452.4
345	557.33	558.22	558.33	556.44	558.50	538.72	467.61	507.50	452.78
355	557.00	558.11	558.28	555.94	558.56	531.61	457.44	505.22	453.0
365	557.00	558.06	558.22	555.89	558.56	524.78	453.89	503.94	453.3
375	556.89	558.00	558.17	555.72	558.22	518.39	450.44	501.33	453.6
386	556.72	557.83	558.00	555.39	558.22	512.11	448.89	500.61	454.0
397	556.44	557.56	557.61	555.44	558.06	506.56	444.06	498.50	454.2
408	556.17	557.39	557.83	554.94	557.94	501.33	444.00	496.83	454.5
418	556.11	557.17	557.72	554.72	557.67	496.72	439.06	495.28	454.6
428	559.28	562.22	559.00	556.39	562.72	505.39	562.56	554.00	455.1
438	571.33	572.61	564.06	566.56	576.11	546.78	572.94	573.00	455.7
449	580.50	584.94	573.83	579.50	586.78	567.72	583.06	579.33	457.0
459	591.00	592.61	584.00	588.61	595.83	581.56	590.11	590.22	458.83
469	589.83	590.33	589.72	584.11	590.83	587.50	596.83	563.67	461.11
479	587.72	588.17	589.39	582.33	589.56	587.56	595.17	560.78	462.4
489	586.83	587.44	588.06	581.61	588.72	586.78	592.28	559.56	463.39
499	585.39	586.78	587.00	581.44	587.94	585.83	590.11	559.50	463.5
509	585.06	586.39	586.33	581.28	587.50	584.67	587.33	557.94	463.78
519	584.89	586.00	585.94	581.11	587.11	583.17	583.78	556.17	464.0
529	584.50	585.72	585.50	580.83	586.67	581.50	579.72	554.33	464.56
540	584.17	585.50	585.17	580.61	586.33	579.72	575.56	552.89	465.11
550	582.56	585.17	584.67	580.44	585.94	577.78	571.44	551.61	465.61
560	583.22	585.11	584.28	580.06	585.78	575.89	567.44	550.17	465.89
570	582.67	584.67	583.50	579.83	585.17	573.89	563.61	548.83	466.06
580	582.56	583.89	583.11	579.61	584.22	571.83	559.94	547.50	466.67
590	582.28	583.67	582.94	579.50	584.00	569.72	556.56	546.06	466.94
600	582.28	583.17	583.11	579.22	583.44	567.56	553.11	544.67	467.44
610	582.06	583.28	582.94	578.94	583.50	565.50	550.11	543.44	467.89
621	581.67	583.06	582.67	578.83	583.56	563.44	547.17	542.00	468.00
631	581.22	583.00	582.44	578.61	583.39	561.50	544.33	540.94	468.17
641	581.22	582.83	582.33	578.33	583.00	559.22	541.56	539.83	468.39
651	581.17	582.50	582.11	578.17	583.11	557.28	538.83	538.56	468.61
661	580.94	582.28	581.94	578.00	582.61	555.33	536.28	537.56	468.67
671	580.67	581.78	581.78	577.78	582.44	553.33	533.83	536.44	468.78
682	580.56	581.83	581.72	577.56	582.06	551.33	531.39	535.00	468.83

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 1-9
TEST: WIA-1 DATA
(sheet 3 of 20)

TIME SECONDS	DAS# 1 DEG C	DAS# 2 DEG C	DAS# 3 DEG C	DAS# 4 DEG C	DAS# 5 DEG C	DAS# 6 DEG C	DAS# 7 DEG C	DAS# 8 DEG C	DAS# 9 DEG C
693	580.50	581.83	581.61	577.33	581.44	549.22	529.11	534.17	468.89
703	580.22	581.33	581.39	577.11	581.33	547.39	527.06	532.83	469.28
713	580.22	581.11	581.11	576.94	580.83	545.61	525.06	531.83	469.44
723	579.94	581.00	580.78	576.50	580.83	543.67	522.83	530.83	469.72
734	579.67	580.72	580.56	576.28	580.33	541.89	520.72	529.50	469.72
745	579.28	580.72	580.28	575.94	580.50	540.11	518.67	528.28	469.94
755	578.78	580.06	580.11	575.67	580.11	538.28	516.44	527.39	470.17
765	578.67	580.17	579.94	575.39	579.67	536.56	514.67	526.56	470.00
775	578.17	579.78	579.61	575.28	579.72	534.83	513.00	525.50	470.06
785	578.00	579.50	579.44	575.00	579.17	532.94	511.17	524.11	470.17
798	577.94	579.33	579.17	574.67	579.22	531.22	509.61	523.22	470.28
808	577.89	579.22	578.89	574.39	578.89	529.61	508.06	522.22	470.39
819	577.11	578.78	578.72	574.11	578.56	527.94	506.50	520.94	470.44
830	577.06	578.50	578.61	573.94	578.67	526.39	504.83	519.89	470.33
840	576.89	578.33	578.39	573.72	578.11	524.72	503.39	519.11	470.44
850	576.78	578.22	578.11	573.50	577.94	523.28	502.11	518.06	470.61
861	576.61	578.06	577.72	573.17	577.94	521.78	500.83	517.17	470.67
872	575.94	578.00	577.50	573.00	577.83	520.33	499.56	516.33	470.83
882	576.22	577.78	577.33	572.67	577.78	518.83	498.39	515.17	470.89
893	575.89	576.83	577.17	572.39	576.94	517.39	497.22	514.22	471.06
903	575.89	577.17	577.11	572.06	577.33	516.06	496.11	513.22	470.89
913	575.94	577.06	576.94	571.94	577.00	514.78	494.89	512.33	470.78
924	575.72	576.83	576.89	571.61	577.11	513.50	493.89	511.22	470.61
935	575.44	576.67	576.83	571.50	576.39	512.17	492.61	510.33	470.83
945	575.22	576.44	576.67	571.22	576.67	510.89	491.67	509.22	470.78
955	574.94	576.22	576.39	571.22	576.00	509.72	490.61	508.39	470.78
965	574.94	575.94	576.28	571.00	576.39	508.56	489.78	507.39	470.83
976	574.56	575.89	576.11	570.44	575.11	507.33	488.67	506.28	470.78
987	574.00	575.67	575.94	570.33	575.00	506.22	487.50	505.44	470.72
997	574.17	575.22	575.61	570.06	575.56	505.06	486.39	504.44	470.56
1007	573.83	575.22	575.44	569.94	575.11	504.00	485.56	503.56	470.44
1018	573.61	574.89	575.17	570.00	574.28	502.83	484.72	502.39	470.28
1029	573.22	574.44	574.94	569.67	574.06	501.72	483.83	501.72	470.17
1039	573.06	574.44	574.72	569.06	573.83	500.61	482.94	500.78	470.06
1050	573.06	574.00	574.39	568.89	573.89	499.50	481.94	499.44	470.06
1060	572.89	574.00	574.22	568.50	573.33	498.50	481.06	498.67	470.00
1071	572.61	573.83	574.06	568.33	573.67	497.50	480.28	498.17	469.94
1082	572.11	573.78	573.94	568.17	573.28	496.50	479.22	497.44	469.83
1092	572.22	573.56	573.78	568.28	573.11	495.33	478.33	496.56	469.72
1102	572.00	573.33	573.56	567.50	573.44	494.44	477.61	495.33	469.56

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 1-9
TEST: WIA-1 DATA
(sheet 4 of 20)

TIME SECONDS	DAS# 1 DEG C	DAS# 2 DEG C	DAS# 3 DEG C	DAS# 4 DEG C	DAS# 5 DEG C	DAS# 6 DEG C	DAS# 7 DEG C	DAS# 8 DEG C	DAS# 9 DEG C
1112	571.78	573.06	573.33	567.17	573.44	493.61	476.94	494.39	469.56
1122	571.72	572.72	573.17	567.22	573.22	492.83	476.28	493.06	469.67
1133	571.56	572.44	572.94	567.17	572.94	491.94	475.61	492.72	469.44
1144	571.11	572.22	572.67	566.89	572.78	491.11	474.72	491.89	469.22
1154	570.72	572.22	572.44	566.72	572.61	490.33	474.00	490.67	469.06
1165	570.56	571.94	572.33	566.61	572.39	489.61	473.39	490.06	468.72
1175	570.33	571.56	572.11	566.28	572.28	488.78	472.72	489.06	468.56
1185	569.94	571.44	571.89	566.06	571.94	488.06	472.06	487.72	468.56
1196	569.89	571.33	571.61	565.67	571.67	487.39	471.28	487.61	468.33
1207	569.61	571.06	571.39	565.44	571.44	486.56	470.61	486.89	468.11
1217	569.56	570.78	571.22	565.33	571.17	485.78	470.00	485.39	468.00
1227	569.28	570.61	571.06	564.94	571.00	484.94	469.33	484.56	467.83
1237	568.94	570.44	570.83	564.83	570.67	484.33	468.67	484.06	467.72
1248	568.56	570.22	570.61	564.44	570.44	483.72	467.94	483.17	467.67
1259	568.44	569.83	570.39	564.33	570.11	483.06	467.39	482.67	467.67
1269	568.28	569.67	570.17	563.94	569.56	482.50	466.83	481.67	467.56
1279	568.00	569.56	569.83	564.00	569.44	481.94	466.22	480.44	467.39
1289	567.83	569.22	569.50	563.67	569.67	481.22	465.67	480.11	467.28
1299	567.39	569.06	569.28	563.44	569.56	480.56	465.17	479.61	467.17
1309	567.44	568.89	569.11	562.94	569.33	479.78	464.56	478.94	467.00
1320	567.28	568.78	568.17	562.83	568.78	479.22	463.83	478.39	466.78
1330	566.94	568.56	568.33	562.33	568.83	478.61	463.17	477.50	466.56
1340	566.50	568.33	568.28	562.06	568.06	478.00	462.39	476.72	466.33
1351	565.56	568.22	568.06	561.67	568.06	477.39	461.78	475.33	466.17
1361	565.89	567.83	567.78	561.33	567.67	476.87	461.17	474.94	465.94
1372	565.83	567.56	567.67	561.11	567.61	476.33	460.61	474.50	465.72
1383	565.50	567.33	567.39	560.94	567.50	475.72	459.78	473.44	465.56
1394	565.17	567.11	567.17	560.56	566.89	475.17	459.17	473.00	465.39
1404	564.94	566.61	567.00	560.17	567.22	474.72	458.50	472.28	465.17
1414	565.06	566.28	566.94	560.17	566.94	474.22	457.83	471.39	464.78
1424	564.94	565.94	566.67	559.72	566.61	473.72	457.28	471.11	464.67
1435	564.72	565.78	566.50	559.89	566.44	473.28	456.67	470.56	464.50
1445	564.50	565.67	566.11	559.61	566.28	472.67	456.06	470.06	464.33
1455	564.00	565.39	565.94	559.56	566.00	472.22	455.44	469.50	464.22
1465	563.56	565.17	565.67	559.72	565.78	471.67	454.89	468.67	464.06
1475	563.72	565.06	565.22	559.28	565.56	471.22	454.39	467.56	463.89
1485	563.61	564.89	565.06	559.28	565.33	470.72	453.83	467.06	463.67
1495	563.33	564.56	564.89	558.56	565.00	470.28	453.39	466.50	463.50
1505	563.00	564.33	564.67	558.83	564.28	469.78	452.89	465.89	463.22
1515	562.72	564.22	564.39	558.50	563.67	469.22	452.33	465.44	463.06

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 10-18
TEST: WIA-1 DATA
(sheet 5 of 20)

TIME SECONDS	DAS# 10 DEG C	DAS# 11 DEG C	DAS# 12 DEG C	DAS# 13 DEG C	DAS# 14 DEG C	DAS# 15 DEG C	DAS# 16 DEG C	DAS# 17 DEG C	DAS# 18 DEG C
-134	435.11	403.72	163.44	149.39	157.11	531.72	534.39	530.61	342.39
-123	435.06	403.72	163.56	149.56	157.06	531.78	534.50	530.67	342.61
-112	435.17	403.78	163.56	149.44	156.94	531.72	534.39	530.67	344.39
-102	435.22	403.78	163.56	149.56	156.89	531.78	534.44	530.61	340.50
-92	435.39	403.78	163.61	149.61	156.83	531.78	534.50	530.61	340.28
-81	435.39	403.78	163.61	149.72	156.78	531.67	534.39	530.67	338.61
-70	435.44	403.83	163.67	149.72	156.78	531.72	534.44	530.61	337.00
-60	435.39	403.89	163.61	149.83	156.72	531.72	534.50	530.61	340.50
-50	435.17	403.89	163.56	149.78	156.67	531.78	534.56	530.61	340.11
-40	435.33	404.22	163.44	149.72	156.67	531.78	534.72	530.67	340.56
-29	435.06	404.17	163.39	149.67	156.67	531.72	534.61	530.67	342.61
-18	435.06	404.17	163.33	149.56	156.61	531.50	534.50	530.61	343.22
-8	435.06	404.22	163.22	149.33	156.56	531.61	534.50	530.61	343.17
2	435.11	404.17	163.22	149.28	156.39	531.67	534.39	530.67	344.50
13	435.33	429.22	163.28	149.11	155.00	531.89	534.72	530.50	349.17
24	435.33	446.39	163.11	148.94	153.78	532.00	534.83	530.11	348.61
34	435.61	478.17	163.00	148.83	153.00	531.94	534.72	529.94	349.83
44	436.06	502.94	162.89	148.61	152.33	531.94	534.56	529.89	347.06
54	436.17	523.00	162.78	148.44	151.72	532.00	534.67	529.89	346.28
65	436.61	541.83	162.78	148.22	150.89	532.11	534.89	529.89	347.78
75	436.83	565.11	162.67	148.11	149.94	532.06	535.11	530.00	350.94
85	437.28	592.28	162.61	147.94	148.56	532.06	535.44	530.28	354.94
95	437.83	615.94	162.56	147.78	146.83	532.33	535.94	530.50	357.39
105	438.28	638.67	162.44	147.61	144.89	532.22	536.50	531.11	357.22
116	438.89	662.44	162.44	147.50	142.67	532.33	537.17	531.44	358.56
126	439.61	681.28	162.44	147.39	140.22	532.83	538.06	532.17	359.83
136	440.11	698.67	162.33	147.28	137.72	533.11	538.89	532.89	360.94
146	441.22	713.50	162.28	147.17	135.00	533.67	540.00	533.67	368.44
156	442.11	722.83	162.22	147.06	132.33	534.44	541.11	535.00	368.83
166	443.22	734.61	162.17	146.94	129.72	535.11	542.39	536.28	374.83
177	444.28	745.11	162.17	146.89	127.06	536.00	543.78	537.67	380.33
187	445.50	755.89	162.06	146.78	123.94	537.11	545.50	539.17	387.94
199	446.83	764.56	162.00	146.67	121.11	538.22	547.11	540.61	399.67
210	448.11	771.61	161.94	146.61	118.39	539.22	548.83	542.22	394.11
220	449.33	776.11	161.89	146.56	115.89	540.22	550.50	543.89	411.11
230	450.61	779.94	161.78	146.50	113.22	541.39	552.17	545.61	401.89
240	451.83	777.56	162.00	146.39	109.17	542.83	553.78	547.06	391.06
250	453.28	743.72	161.78	146.39	104.22	543.61	554.72	548.28	376.83
261	454.56	717.17	161.50	146.22	101.06	544.22	555.28	549.11	369.61
272	455.50	696.94	161.28	146.22	99.33	544.78	556.06	549.83	367.56

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 10-18
TEST: WIA-1 DATA
(sheet 6 of 20)

TIME SECONDS	DAS# 10 DEG C	DAS# 11 DEG C	DAS# 12 DEG C	DAS# 13 DEG C	DAS# 14 DEG C	DAS# 15 DEG C	DAS# 16 DEG C	DAS# 17 DEG C	DAS# 18 DEG C
282	456.22	678.39	161.11	146.22	98.28	545.17	556.61	550.28	364.33
292	457.11	664.39	161.06	146.00	97.67	545.44	557.06	550.61	364.33
303	457.94	660.67	161.00	146.11	97.28	545.89	557.44	550.83	365.94
314	458.39	653.94	160.89	146.06	97.17	546.83	557.36	550.72	365.22
324	459.00	642.89	160.83	146.06	97.17	547.78	557.50	550.61	365.39
335	459.56	630.06	160.67	146.00	97.33	548.39	557.39	550.39	364.28
345	460.11	621.67	160.44	145.94	97.61	548.83	557.11	550.17	362.67
355	460.39	614.61	160.17	145.94	97.94	548.83	557.06	550.00	358.78
365	460.89	608.78	159.89	145.89	98.39	548.78	557.22	549.78	357.78
375	461.39	603.11	159.67	145.94	98.89	548.83	557.33	549.50	356.61
386	461.89	598.11	159.50	146.00	99.44	548.89	557.44	549.17	357.28
397	462.33	593.39	159.33	146.00	99.94	548.94	557.39	548.78	361.22
408	462.61	588.78	159.17	146.00	100.56	548.83	557.28	548.33	358.72
418	463.06	585.28	159.00	145.94	101.06	548.83	557.28	547.89	358.56
428	463.33	592.06	158.72	145.89	100.72	548.22	557.33	547.89	509.39
438	463.50	627.33	157.11	145.89	98.83	549.33	559.61	549.78	537.39
449	464.11	649.67	156.39	145.83	96.67	551.72	564.72	553.61	518.17
459	465.17	663.72	156.17	145.72	94.06	555.56	571.44	558.72	543.89
469	466.17	666.89	156.22	145.56	88.89	560.78	577.11	563.72	471.00
479	467.00	656.39	156.28	145.33	83.06	562.67	579.61	566.72	435.94
489	468.06	643.22	156.28	145.11	79.50	564.83	580.78	568.78	419.72
499	468.94	633.61	156.00	144.94	78.06	566.39	581.39	570.22	411.06
509	469.56	625.67	155.89	144.78	77.56	567.61	581.89	571.39	400.67
519	470.28	616.72	155.89	144.61	77.83	568.56	582.17	572.22	398.72
529	471.11	609.22	155.94	144.44	77.67	568.78	582.39	572.83	395.61
540	471.67	603.50	156.17	144.22	78.00	569.00	582.56	573.33	395.33
550	472.11	599.39	156.17	144.06	78.39	569.00	582.67	573.67	390.94
560	472.89	595.78	156.11	143.89	78.78	568.94	582.78	573.89	393.50
570	473.61	592.67	155.39	143.72	79.17	568.78	582.72	573.94	387.61
580	474.00	589.83	154.78	143.50	79.44	568.78	582.78	573.89	383.83
590	474.44	587.39	154.61	143.33	79.78	569.11	582.67	573.83	381.06
600	474.94	585.11	151.56	143.22	80.11	569.61	582.72	573.72	380.22
610	475.00	583.17	150.61	143.11	80.56	569.89	582.56	573.50	379.94
621	475.44	581.22	150.39	143.00	81.17	570.11	582.39	573.28	377.89
631	475.83	579.44	150.33	142.83	81.83	570.33	582.11	572.94	380.17
641	476.33	577.83	150.33	142.67	82.50	570.44	581.94	572.61	379.33
651	476.67	576.11	150.39	142.56	83.33	570.39	581.78	572.22	379.33
661	476.94	574.44	150.50	142.44	84.22	570.44	581.61	571.78	377.89
671	477.33	572.78	150.72	142.39	85.06	570.39	581.44	571.44	374.11
682	477.72	571.17	150.89	142.28	86.06	570.33	581.17	570.94	370.61

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 10-18
TEST: WIA-1 DATA
(sheet 7 of 20)

E NDS	DAS# 10 DEG C	DAS# 11 DEG C	DAS# 12 DEG C	DAS# 13 DEG C	DAS# 14 DEG C	DAS# 15 DEG C	DAS# 16 DEG C	DAS# 17 DEG C	DAS# 18 DEG C
93	477.83	569.67	151.11	142.17	87.11	570.33	581.11	570.44	371.61
703	478.11	568.17	151.22	142.17	88.11	570.28	580.94	570.00	369.56
13	478.22	566.67	151.28	142.00	89.06	570.33	580.78	569.44	369.06
723	478.56	565.39	151.22	142.00	90.06	570.28	580.72	568.94	370.28
34	478.89	564.00	151.22	141.83	91.00	570.28	580.50	568.33	364.00
745	478.89	562.67	151.39	141.67	91.89	570.28	580.28	567.83	364.94
55	479.17	561.72	151.56	141.72	92.78	570.22	580.11	567.28	364.33
765	479.22	560.72	151.78	141.72	93.61	570.28	579.89	566.72	367.11
75	479.44	559.89	152.11	141.61	94.44	570.33	579.67	566.11	366.89
785	479.72	558.61	152.33	141.67	95.39	570.17	579.50	565.50	367.11
98	479.94	557.61	152.56	141.56	96.22	569.94	579.28	564.89	367.78
008	479.94	556.33	152.61	141.50	97.00	569.72	579.06	564.28	364.11
19	480.11	556.00	152.72	141.50	97.72	569.56	578.94	563.72	360.44
039	480.22	555.50	152.83	141.44	98.44	569.44	578.67	563.06	358.83
40	480.28	555.06	153.11	141.50	99.06	569.33	578.39	562.44	361.61
50	480.72	554.83	153.61	141.44	99.61	569.33	578.22	561.89	361.72
61	481.06	554.28	154.22	141.33	100.22	569.33	577.94	561.28	364.22
872	481.39	553.61	154.56	141.39	100.83	569.22	577.72	560.67	363.00
82	481.61	552.44	154.94	141.33	101.33	569.06	577.50	560.06	359.06
893	481.83	551.22	155.22	141.33	101.89	568.89	577.39	559.44	360.94
03	482.06	549.83	155.44	141.28	102.44	568.78	577.17	558.83	360.26
913	482.22	548.67	155.89	141.33	102.89	568.61	577.06	558.28	357.06
24	482.44	547.39	156.22	141.22	103.33	568.44	576.83	557.67	356.44
935	482.61	546.22	155.39	141.33	103.89	568.33	576.61	557.06	356.00
45	482.72	545.22	155.06	141.28	104.39	568.11	576.44	556.50	355.33
955	482.89	544.22	155.06	141.33	104.89	567.94	576.22	555.89	356.22
65	483.00	543.17	155.06	141.28	105.33	567.78	576.00	555.33	357.11
976	483.11	542.22	155.11	141.28	105.83	567.67	575.83	554.83	353.22
87	483.22	541.33	155.22	141.28	106.28	567.50	575.61	554.11	354.06
997	483.33	541.56	155.33	141.33	106.78	567.33	575.50	553.61	352.17
07	483.39	541.00	155.39	141.28	107.22	567.17	575.22	553.00	349.56
18	483.50	539.89	155.44	141.33	107.67	566.83	575.11	552.44	346.61
29	483.56	538.83	155.33	141.39	108.17	566.83	574.83	551.89	345.33
39	483.67	537.83	155.39	141.28	108.56	566.61	574.61	551.28	349.83
50	483.72	536.94	155.39	141.39	108.94	566.39	574.39	550.72	348.94
60	483.78	536.22	155.28	141.17	109.28	566.17	574.06	550.11	350.17
71	483.83	535.33	155.44	141.33	109.72	566.00	573.83	549.56	351.00
82	483.89	534.11	155.72	141.44	110.11	565.83	573.67	549.00	348.33
92	483.89	533.22	156.00	141.39	110.50	565.67	573.50	548.44	347.06
02	483.94	532.28	156.06	141.50	110.89	565.56	573.33	547.94	347.17

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 10-18
TEST: WIA-1 DATA
(sheet 8 of 20)

TIME SECONDS	DAS# 10 DEG C	DAS# 11 DEG C	DAS# 12 DEG C	DAS# 13 DEG C	DAS# 14 DEG C	DAS# 15 DEG C	DAS# 16 DEG C	DAS# 17 DEG C	DAS# 18 DEG C
1112	483.94	531.33	156.00	141.56	111.22	565.33	573.06	547.67	346.11
1122	483.94	530.44	156.17	141.56	111.61	565.17	572.83	547.61	345.17
1133	484.00	529.44	156.39	141.67	112.00	564.94	572.61	547.44	346.39
1144	484.06	528.50	156.61	141.67	112.39	564.78	572.44	547.39	348.06
1154	484.00	527.44	156.78	141.83	112.89	564.44	572.17	547.33	346.39
1165	484.00	526.50	157.11	141.83	113.33	564.39	571.78	547.17	346.67
1175	484.00	525.50	157.33	142.00	113.89	564.11	571.44	546.83	346.39
1185	483.94	524.61	158.00	142.11	114.33	563.89	571.22	546.00	345.50
1196	483.94	523.61	159.06	142.28	114.78	563.61	571.06	545.06	346.17
1207	483.89	522.67	159.33	142.39	115.33	563.44	570.83	544.22	342.61
1217	483.89	521.78	158.89	142.50	115.89	563.33	570.56	543.44	342.50
1227	483.89	520.83	159.50	142.61	116.39	563.17	570.28	542.72	342.22
1237	483.33	519.94	159.72	142.83	116.89	562.94	570.00	542.06	339.06
1248	483.83	519.06	159.94	142.89	117.39	562.72	569.78	541.33	340.56
1259	483.78	518.11	160.06	143.11	117.83	562.44	569.61	540.78	341.67
1269	483.72	517.22	160.17	143.22	118.33	562.28	569.33	540.17	341.22
1279	483.72	516.39	160.22	143.33	118.83	562.17	569.11	539.61	338.28
1289	483.61	515.50	160.33	143.50	119.28	561.89	568.83	539.06	338.06
1299	483.56	514.67	160.44	143.56	119.78	561.78	568.61	538.50	336.50
1309	483.50	513.83	160.56	143.83	120.22	561.56	568.44	538.06	337.94
1320	483.44	513.06	160.61	143.94	120.61	561.39	568.17	537.50	337.50
1330	483.39	512.22	160.67	144.28	121.06	561.11	568.06	537.00	334.67
1340	483.33	511.39	160.72	144.33	121.50	560.83	567.89	536.50	332.61
1351	483.28	510.56	160.78	144.44	121.89	560.56	567.83	535.94	335.11
1361	483.22	509.72	160.78	144.61	122.33	560.28	567.61	535.44	335.94
1372	483.11	508.83	160.78	144.78	122.72	560.06	567.39	535.00	331.67
1383	483.06	507.94	160.89	144.89	123.22	559.78	567.11	534.33	332.78
1394	482.94	507.17	160.94	145.00	123.56	559.61	566.94	533.94	333.33
1404	482.89	506.44	161.00	145.17	123.94	559.56	566.83	533.50	334.33
1414	482.83	505.67	161.00	145.33	124.33	559.44	566.61	533.06	334.00
1424	482.78	504.94	161.06	145.44	124.72	559.33	566.28	532.56	332.83
1435	482.67	504.17	161.11	145.50	125.06	559.28	565.89	532.11	331.61
1445	482.61	503.44	161.17	145.67	125.39	559.06	565.72	531.72	333.44
1455	482.56	502.72	161.17	145.83	125.78	558.78	565.39	531.22	335.83
1465	482.44	502.00	161.22	146.00	126.06	558.50	565.22	530.83	335.89
1475	482.33	501.33	161.28	146.06	126.39	558.22	564.89	530.39	334.39
1485	482.22	500.56	161.33	146.11	126.78	558.06	564.78	529.94	334.50
1495	482.11	499.89	161.33	146.28	127.11	557.83	564.56	529.56	334.56
1505	482.00	499.22	161.33	146.44	127.50	557.50	564.22	529.06	332.83
1515	481.94	498.50	161.39	146.50	127.83	557.22	564.00	528.72	331.33

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 19-28
TEST: WIA-1 DATA
(sheet 9 of 20)

TIME SECONDS	DAS# 19 DEG C	DAS# 20 DEG C	DAS# 22 DEG C	DAS# 23 DEG C	DAS# 24 DEG C	DAS# 25 DEG C	DAS# 26 DEG C	DAS# 27 DEG C	DAS# 28 DEG C
-134	290.94	164.67	431.28	165.39	162.78	160.56	160.00	146.17	164.33
-123	290.06	164.72	431.33	165.39	162.94	160.33	160.06	146.17	164.17
-112	293.06	164.78	431.28	165.56	162.94	160.28	160.17	146.22	164.56
-102	289.67	164.67	431.39	165.56	163.17	160.61	160.33	146.33	164.39
-92	289.44	164.78	431.33	165.61	163.11	160.89	160.28	146.33	164.22
-81	289.67	164.78	431.39	165.72	163.17	160.56	160.50	146.33	164.33
-70	287.56	164.33	431.44	165.28	162.72	160.06	160.11	146.39	163.78
-60	286.17	163.78	431.44	164.89	162.28	159.50	159.50	146.39	163.22
-50	288.50	163.67	431.39	165.00	162.22	159.78	159.56	146.44	163.44
-40	289.61	163.94	431.44	165.28	162.44	160.33	159.72	146.56	163.50
-29	290.44	164.22	431.56	165.39	162.61	159.83	159.94	146.56	163.67
-18	289.17	164.44	431.50	165.61	162.83	160.39	160.17	146.67	163.72
-8	289.94	164.72	431.22	165.61	163.00	160.78	160.22	146.72	163.94
2	289.61	164.78	431.50	165.61	163.33	160.83	160.28	146.72	164.11
13	293.78	164.94	431.78	165.67	163.33	160.33	160.33	146.72	164.61
24	296.11	165.33	432.39	165.94	163.56	160.94	160.72	146.89	164.83
34	297.56	165.94	433.44	166.17	163.67	161.33	160.94	146.94	165.06
44	296.22	166.11	435.22	166.33	163.83	162.00	161.28	147.00	165.11
54	297.00	166.22	437.33	166.61	164.17	162.33	161.67	147.17	165.56
65	295.89	166.39	439.83	166.67	164.17	162.28	161.83	147.06	165.67
75	296.11	166.72	443.00	166.83	164.39	162.39	161.94	147.17	166.17
85	306.11	166.94	446.72	167.11	164.78	162.56	162.28	147.28	166.28
95	313.94	167.39	451.11	167.28	165.17	162.83	162.50	147.33	166.61
105	313.00	167.56	455.83	167.39	165.39	163.06	162.56	147.33	166.67
116	312.00	167.83	461.11	167.61	165.56	163.28	162.72	147.39	166.94
126	313.00	168.00	467.06	167.72	165.39	163.72	162.78	147.56	167.11
136	316.50	168.17	473.50	167.94	165.56	164.06	163.06	147.61	167.22
146	325.17	168.50	480.56	168.06	165.83	164.17	163.11	147.61	167.33
156	327.78	168.78	487.56	168.11	165.78	163.89	163.39	147.67	167.83
166	322.72	169.00	494.50	168.39	166.33	164.33	163.44	147.72	168.44
177	349.06	169.22	501.67	168.61	166.33	164.39	163.67	147.83	168.39
187	333.89	169.28	510.22	168.56	166.44	164.56	163.83	147.83	168.56
199	327.11	169.56	517.89	168.83	166.72	164.89	164.28	147.94	168.61
210	335.72	169.61	525.50	168.72	166.83	165.17	164.00	147.94	169.06
220	341.22	169.78	532.44	169.11	167.06	164.94	164.22	148.00	169.44
230	344.72	169.94	539.67	169.11	167.22	165.50	164.11	148.06	169.22
240	337.39	170.00	546.11	169.22	167.06	165.28	164.11	148.06	169.06
250	323.44	169.78	550.67	169.00	166.94	165.17	164.11	148.11	168.44
261	315.22	169.44	553.44	168.67	166.94	164.56	163.94	148.22	168.00
272	312.22	168.83	555.28	168.44	166.44	163.67	163.56	148.17	168.00

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 19-28
TEST: WIA-1 DATA
(sheet 10 of 20)

TIME SECONDS	DAS# 19 DEG C	DAS# 20 DEG C	DAS# 22 DEG C	DAS# 23 DEG C	DAS# 24 DEG C	DAS# 25 DEG C	DAS# 26 DEG C	DAS# 27 DEG C	DAS# 28 DEG C
282	307.00	168.56	556.22	168.22	166.33	163.28	163.50	148.22	167.39
292	306.61	168.33	556.72	168.00	166.22	163.78	163.50	148.33	166.50
303	310.89	167.94	556.83	167.94	166.06	163.17	163.11	148.28	166.33
314	307.50	167.83	556.39	167.78	165.78	163.39	163.06	148.28	166.39
324	308.39	167.78	556.50	167.89	166.00	163.50	163.06	148.44	166.61
335	306.22	167.56	555.78	167.83	165.72	163.83	163.33	148.50	166.33
345	305.06	167.44	554.56	167.83	165.44	163.39	163.11	148.50	166.00
355	302.17	167.28	553.39	167.78	165.22	163.06	162.89	148.50	166.22
365	300.72	167.17	552.11	167.44	165.28	162.72	162.78	148.56	166.39
375	300.72	167.33	550.67	167.44	165.56	163.22	162.78	148.61	166.33
386	295.06	167.11	548.89	167.28	165.50	163.28	163.06	148.78	166.33
397	298.11	167.11	547.11	167.39	165.39	162.67	162.83	148.72	166.39
408	295.89	167.11	545.44	167.39	165.39	163.39	163.00	148.83	166.11
418	299.56	167.11	543.78	167.61	165.33	163.28	162.94	148.83	166.11
428	363.72	167.56	542.22	168.00	165.44	163.89	163.17	148.39	166.44
438	417.61	169.72	542.28	168.83	166.56	165.44	164.17	149.06	168.72
449	429.17	171.89	543.56	170.22	168.00	167.28	165.50	149.33	171.20
459	418.33	173.56	545.67	171.72	169.83	168.78	167.00	149.50	173.33
469	377.00	174.00	547.67	171.94	169.78	169.11	167.28	149.50	172.83
479	351.67	173.17	548.83	171.50	169.50	167.89	166.78	149.50	172.94
489	338.83	172.28	549.11	170.72	169.22	167.78	166.22	149.44	171.89
499	333.06	171.44	549.22	170.39	168.56	166.78	165.56	149.44	170.50
509	328.83	170.67	548.94	169.78	168.06	166.17	164.78	149.39	169.33
519	330.11	169.94	548.50	169.56	167.67	165.78	164.33	149.50	168.67
529	324.17	169.67	548.00	169.50	167.56	165.22	164.33	149.56	167.94
540	322.72	169.22	547.33	169.22	167.06	165.17	164.50	149.61	167.72
550	321.78	169.00	546.50	169.11	166.78	164.83	164.28	149.67	167.22
560	321.17	168.44	545.78	168.72	166.56	164.89	164.11	149.61	167.33
570	318.89	168.39	545.00	168.61	166.50	164.00	163.83	149.61	167.67
580	316.00	168.44	544.11	168.61	166.44	164.44	163.94	149.67	167.56
590	315.67	168.28	543.22	168.50	166.28	164.39	163.89	149.78	167.33
600	317.83	168.33	542.28	168.28	166.28	164.61	163.78	149.89	167.39
610	313.50	168.44	541.44	168.50	166.28	164.44	163.83	149.83	167.33
621	309.33	168.39	540.56	168.44	166.39	164.67	163.89	149.89	167.33
631	311.61	168.50	539.61	168.44	166.67	164.67	164.00	149.94	167.00
641	311.61	168.33	538.72	168.67	166.72	165.00	163.67	150.00	166.50
651	314.50	168.39	537.72	168.78	166.61	164.33	163.94	150.36	166.33
661	311.83	168.44	536.89	168.78	166.72	164.06	163.83	150.11	166.39
671	306.56	168.33	536.00	168.78	166.67	164.39	163.89	150.17	166.72
682	306.67	168.39	535.06	168.67	166.67	164.44	164.06	150.22	166.83

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 19-28
TEST: WIA-1 DATA
(sheet 11 of 20)

TIME SECONDS	DAS# 19 DEG C	DAS# 20 DEG C	DAS# 22 DEG C	DAS# 23 DEG C	DAS# 24 DEG C	DAS# 25 DEG C	DAS# 26 DEG C	DAS# 27 DEG C	DAS# 28 DEG C
693	307.44	168.33	534.17	168.72	166.67	164.22	163.89	150.22	167.39
703	308.67	168.22	533.33	168.78	166.78	164.28	163.83	150.28	167.39
713	309.56	168.00	532.56	168.61	166.67	164.72	164.06	150.39	167.17
723	309.89	168.17	531.72	168.67	166.83	164.28	164.00	150.33	167.22
734	307.17	168.33	530.89	168.94	166.72	164.11	164.17	150.44	167.56
745	304.33	168.61	530.11	168.83	166.72	164.17	164.22	150.50	167.89
755	304.56	168.44	529.33	168.72	166.72	164.44	164.22	150.56	167.67
765	304.61	168.28	528.72	168.83	166.72	164.72	164.17	150.56	167.72
775	305.28	168.61	528.06	168.83	166.78	164.56	164.06	150.56	167.78
785	303.44	168.50	527.22	168.94	166.72	164.61	164.39	150.67	167.83
798	305.50	168.50	526.56	169.00	166.83	164.61	164.17	150.61	167.83
808	306.33	168.67	525.94	169.22	166.83	164.44	164.17	150.78	167.61
819	305.61	168.78	525.28	169.39	166.89	164.39	164.17	150.89	167.67
830	301.94	168.78	524.67	169.33	166.67	164.39	164.39	150.83	168.00
840	305.83	168.78	524.28	168.44	166.17	164.22	163.39	150.61	168.11
850	303.39	168.56	523.94	167.67	165.78	163.67	162.33	150.56	167.72
861	305.06	168.06	523.67	167.17	165.56	163.44	161.67	150.61	167.89
872	301.39	168.11	523.39	166.39	164.94	162.83	160.78	150.56	166.56
882	302.33	168.06	523.06	166.33	164.67	162.44	160.28	150.50	167.33
893	304.61	167.72	522.78	166.22	164.33	161.72	159.72	150.50	167.00
903	306.72	167.61	522.50	166.28	164.50	161.39	159.50	150.50	168.22
913	306.17	167.67	522.22	165.83	163.83	160.94	158.89	150.44	168.22
924	299.00	167.39	521.89	165.72	164.11	161.00	158.72	150.44	168.00
935	302.33	167.39	521.61	166.11	164.33	160.83	158.83	150.56	167.61
945	300.50	167.56	521.33	166.33	164.61	160.72	158.61	150.50	167.83
955	302.33	167.94	521.00	165.89	164.28	160.61	158.22	150.50	167.56
965	302.39	167.94	520.72	165.89	164.28	160.83	158.50	150.56	167.22
976	299.61	167.72	520.44	166.22	164.72	160.72	158.56	150.61	168.50
987	302.22	167.78	520.06	166.56	164.56	160.67	158.39	150.61	168.61
997	301.11	167.67	519.78	166.28	164.28	160.06	158.00	150.56	167.89
1007	300.11	167.61	519.44	166.44	164.50	161.00	158.61	150.67	168.17
1018	295.06	167.67	519.17	166.72	164.78	161.33	158.67	150.72	168.00
1029	295.61	167.56	518.83	166.44	164.33	160.67	158.28	150.67	168.22
1039	298.61	167.44	518.50	166.67	164.94	160.89	158.44	150.72	167.89
1050	295.94	167.56	518.17	166.11	165.00	160.39	158.39	150.72	167.94
1060	299.67	167.72	517.78	165.67	164.61	159.72	157.89	150.67	167.72
1071	299.56	167.89	517.39	165.50	164.39	160.22	157.94	150.72	167.89
1082	299.39	168.17	517.06	165.56	164.39	159.94	158.00	150.72	167.50
1092	301.11	168.06	516.61	166.06	164.61	160.06	158.11	150.72	168.17
1102	301.06	168.22	516.28	166.28	164.56	159.72	157.89	150.72	167.94

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 19-28
TEST: WIA-1 DATA
(sheet 12 of 20)

TIME SECONDS	DAS# 19 DEG C	DAS# 20 DEG C	DAS# 22 DEG C	DAS# 23 DEG C	DAS# 24 DEG C	DAS# 25 DEG C	DAS# 26 DEG C	DAS# 27 DEG C	DAS# 28 DEG C
1112	300.22	168.33	515.89	166.06	164.22	159.50	157.67	150.72	167.67
1122	302.94	168.22	515.50	166.39	164.33	159.50	157.44	150.78	167.94
1133	301.39	168.33	515.06	166.22	164.33	159.56	157.50	150.78	167.72
1144	299.67	168.00	514.67	166.00	164.00	159.33	157.39	150.83	168.17
1154	299.17	168.11	514.22	166.56	164.50	160.28	157.83	150.94	168.89
1165	299.33	168.00	513.83	166.67	165.00	161.11	158.44	151.00	168.06
1175	300.67	168.17	513.39	167.17	165.33	161.39	159.00	151.00	168.33
1185	299.28	168.33	513.00	166.83	164.50	161.00	158.56	150.94	167.83
1196	297.39	168.33	512.56	167.17	165.06	160.94	158.39	151.00	167.28
1207	297.11	168.56	512.17	167.17	165.28	161.39	158.67	151.00	167.33
1217	295.00	168.61	511.72	167.28	165.67	161.78	159.11	151.11	168.22
1227	295.50	168.33	511.33	166.50	164.78	161.06	158.44	150.94	168.89
1237	291.39	168.22	510.94	166.33	164.67	160.56	158.17	151.06	169.22
1248	291.39	168.22	510.50	166.50	164.61	160.72	158.33	151.11	168.78
1259	294.17	168.39	510.06	166.67	165.11	161.50	158.61	151.17	169.56
1269	291.61	168.78	509.67	166.89	164.67	161.22	158.44	151.17	169.67
1279	289.50	168.78	509.28	166.39	164.44	160.67	158.11	151.11	170.06
1289	291.89	168.72	508.83	166.28	164.39	160.83	158.56	151.22	169.33
1299	292.33	168.72	508.44	166.67	164.39	161.06	158.89	151.22	168.61
1309	292.00	168.78	508.06	167.17	165.00	161.00	158.89	151.22	168.11
1320	293.17	168.72	507.61	167.33	164.89	160.72	158.72	151.22	168.06
1330	292.83	168.83	507.22	167.39	165.44	161.61	159.28	151.33	168.39
1340	291.22	168.94	506.83	166.78	164.61	161.33	159.33	151.33	169.06
1351	290.44	169.11	506.39	166.89	164.33	161.00	159.17	151.28	168.83
1361	292.22	169.11	505.94	167.44	165.00	161.50	159.39	151.39	168.83
1372	289.94	169.17	505.56	167.33	165.50	161.61	159.67	151.44	168.94
1383	288.33	168.94	505.06	167.33	165.44	161.11	159.06	151.39	168.72
1394	290.50	169.06	504.67	167.50	165.89	161.61	159.44	151.50	169.17
1404	289.83	169.06	504.33	167.33	165.72	161.28	159.17	151.50	168.94
1414	290.94	169.39	503.94	167.00	165.22	160.89	158.78	151.50	169.11
1424	289.39	169.39	503.56	166.56	164.78	161.11	159.00	151.50	168.72
1435	291.22	169.17	503.11	167.00	165.28	161.44	159.28	151.61	168.50
1445	293.89	169.39	502.78	167.44	165.44	161.39	159.44	151.61	169.33
1455	289.22	169.50	502.39	167.17	165.28	161.50	158.89	151.56	170.28
1465	288.22	169.50	502.00	166.56	165.22	161.39	158.89	151.61	170.56
1475	287.61	169.17	501.61	166.61	164.67	161.39	159.00	151.67	169.61
1485	292.06	169.06	501.22	167.06	164.94	161.33	159.00	151.67	169.83
1495	292.89	169.39	500.83	166.89	165.28	161.94	159.39	151.78	170.39
1505	289.89	169.22	500.50	166.67	164.78	161.61	159.39	151.78	169.72
1515	287.89	169.22	500.11	166.89	165.11	161.61	159.28	151.78	169.00

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 29-37
TEST: WIA-1 DATA
(sheet 13 of 20)

TIME SECONDS	DAS# 29 DEG C	DAS# 30 DEG C	DAS# 31 DEG C	DAS# 32 DEG C	DAS# 33 DEG C	DAS# 34 DEG C	DAS# 35 DEG C	DAS# 36 DEG C	DAS# 37 DEG C
-134	164.33	161.39	160.56	165.56	163.67	28.33	144.50	145.83	96.61
-123	164.22	161.78	161.11	165.61	163.67	28.33	144.78	146.06	96.61
-112	164.72	161.89	160.94	165.61	163.72	28.22	145.00	145.89	96.78
-102	164.28	161.56	160.67	165.67	163.78	28.22	145.33	145.94	96.72
-92	164.06	161.28	160.28	165.67	163.83	28.33	145.00	145.50	96.83
-81	164.17	161.72	160.72	165.72	163.83	28.56	144.89	146.28	96.39
-70	163.61	160.89	160.44	165.72	163.89	28.28	144.72	145.28	96.83
-60	163.06	160.72	160.33	165.78	163.89	28.28	144.17	144.83	96.39
-50	163.44	160.83	160.56	165.78	163.94	28.44	144.17	144.67	96.89
-40	163.78	161.28	160.94	165.83	164.00	28.61	144.22	144.78	97.06
-29	163.78	161.22	160.44	165.89	164.00	28.83	144.61	145.33	97.00
-18	164.11	161.00	159.83	165.89	164.06	28.83	144.83	145.28	97.06
-8	164.17	161.39	160.56	166.00	164.06	28.78	145.22	145.22	97.00
2	163.83	161.28	160.17	165.94	164.11	28.67	145.50	145.72	97.00
13	164.33	161.94	161.00	166.06	164.17	28.56	145.28	146.22	97.11
24	164.72	162.39	161.17	166.06	164.22	28.61	145.67	146.33	97.22
34	165.11	162.89	161.78	166.11	164.22	28.50	146.06	146.33	97.33
44	165.39	163.06	161.83	166.11	164.28	28.72	145.67	146.56	97.56
54	165.67	162.94	162.33	166.17	164.33	28.61	145.89	146.44	97.44
65	166.11	163.39	162.89	166.28	164.33	28.33	145.94	146.72	97.44
75	166.33	163.61	163.28	166.33	164.39	28.06	146.44	147.22	97.50
85	166.06	163.78	163.17	166.33	164.44	28.11	146.83	147.28	97.50
95	166.39	164.00	163.39	166.39	164.50	28.11	147.39	147.39	97.56
105	166.28	163.94	162.89	166.39	164.50	28.22	147.67	147.89	97.56
116	166.33	163.89	162.94	166.44	164.56	28.33	148.33	148.39	97.61
126	166.56	164.39	163.56	166.50	164.61	28.28	149.00	148.83	97.72
136	167.00	164.94	164.39	166.50	164.61	28.50	149.11	149.06	97.89
146	167.17	165.33	164.72	166.56	164.61	28.50	149.17	149.39	97.83
156	167.67	165.72	165.33	166.61	164.72	28.61	149.11	149.72	97.89
166	167.89	166.11	165.67	166.72	164.78	28.61	149.44	150.11	98.00
177	167.94	165.72	165.28	166.72	164.83	28.67	150.00	150.39	98.11
187	168.00	166.56	166.28	166.83	164.89	28.67	150.44	150.39	98.11
199	168.11	166.83	166.50	166.89	164.94	28.72	151.11	150.56	97.94
210	168.78	166.44	166.56	166.94	164.94	28.78	151.44	150.61	98.17
220	169.00	166.22	165.89	166.94	165.00	28.78	151.89	151.56	98.33
230	168.78	166.22	165.61	167.00	165.06	28.67	151.67	151.28	98.22
240	168.94	166.89	166.61	167.06	165.11	28.50	152.56	152.00	98.39
250	168.28	166.33	165.72	167.11	165.17	28.33	152.39	151.61	98.39
261	167.89	166.06	165.39	167.11	165.22	28.44	151.17	151.11	98.56
272	167.50	165.33	164.72	167.11	165.22	28.11	150.28	150.33	98.67

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 29-37
TEST: WIA-1 DATA
(sheet 14 of 20)

TIME SECONDS	DAS# 29 DEG C	DAS# 30 DEG C	DAS# 31 DEG C	DAS# 32 DEG C	DAS# 33 DEG C	DAS# 34 DEG C	DAS# 35 DEG C	DAS# 36 DEG C	DAS# 37 DEG C
282	167.28	165.72	165.39	167.22	165.28	27.67	149.56	149.56	98.61
292	166.56	164.67	163.67	167.17	165.33	27.83	148.83	149.00	98.83
303	166.33	164.50	163.72	167.28	165.39	27.89	148.17	148.83	98.89
314	166.50	165.11	164.61	167.28	165.39	28.00	147.89	148.78	98.94
324	166.89	164.22	164.00	167.28	165.44	28.28	148.33	148.61	98.83
335	166.33	163.72	163.17	167.33	165.50	28.11	148.22	148.39	98.83
345	166.33	164.11	163.17	167.39	165.56	28.44	148.17	148.17	99.00
355	166.50	164.17	163.67	167.44	165.56	28.33	148.44	148.61	98.94
365	166.28	163.89	163.89	167.50	165.61	28.44	148.72	148.39	98.89
375	166.17	164.11	164.00	167.50	165.67	28.56	148.11	148.44	99.11
386	165.94	164.17	163.11	167.50	165.67	28.56	147.78	148.00	99.22
397	166.33	165.11	164.50	167.56	165.72	28.28	147.78	148.06	99.22
408	166.22	164.94	164.44	167.61	165.72	27.94	147.50	148.28	99.11
418	165.89	164.22	163.67	167.61	165.78	27.94	147.67	148.50	99.17
428	166.11	164.83	164.11	167.72	165.83	28.00	148.83	149.89	99.33
438	168.28	167.44	167.06	167.83	165.89	27.94	152.06	152.44	99.44
449	170.94	170.00	169.72	168.00	165.94	28.11	155.83	156.17	99.56
459	173.17	171.11	171.22	168.00	166.06	28.39	159.33	159.67	99.94
469	172.83	171.00	170.50	168.06	166.11	28.61	159.61	159.00	99.83
479	172.00	169.72	169.39	168.06	166.17	28.28	158.72	157.61	99.89
489	170.67	168.22	167.83	168.06	166.17	28.11	156.72	155.33	99.72
499	169.28	167.00	166.56	168.06	166.28	28.11	155.00	154.00	99.83
509	168.83	166.44	166.06	168.06	166.28	28.06	153.72	152.67	99.89
519	168.39	166.39	166.17	168.17	166.33	28.22	152.50	151.72	100.11
529	167.78	166.06	165.94	168.28	166.33	28.39	151.89	151.83	100.17
540	167.50	165.28	164.56	168.22	166.44	28.33	151.06	151.28	100.06
550	167.56	165.89	166.00	168.33	166.50	28.28	151.00	150.61	100.17
560	167.06	165.44	165.22	168.28	166.50	28.11	150.94	150.83	100.17
570	167.28	165.00	164.33	168.39	166.56	27.94	150.44	150.28	100.00
580	166.89	164.50	164.28	168.44	166.56	28.00	150.00	149.78	100.11
590	166.94	164.94	164.11	168.39	166.67	28.00	149.39	[illegible]0.17	100.28
600	167.17	165.00	164.50	168.56	166.67	27.72	149.56	149.83	100.17
610	167.28	165.22	165.50	168.56	166.72	27.56	149.50	149.50	100.28
621	167.28	165.33	165.50	168.61	166.78	27.61	149.44	149.11	100.28
631	167.00	164.39	164.17	168.56	166.78	28.00	149.17	149.11	100.22
641	166.89	164.50	164.22	168.61	166.83	28.28	149.17	149.00	100.56
651	166.61	164.50	164.22	168.67	166.89	28.22	149.72	149.06	100.50
661	166.33	164.00	163.67	168.67	166.89	28.44	149.78	149.50	100.67
671	166.50	163.50	163.33	168.72	166.94	28.56	150.22	149.39	100.61
682	166.50	164.17	163.67	168.67	167.00	28.44	149.78	149.28	100.78

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 29-37
TEST: WIA-1 DATA
(sheet 15 of 20)

TIME SECONDS	DAS# 29 DEG C	DAS# 30 DEG C	DAS# 31 DEG C	DAS# 32 DEG C	DAS# 33 DEG C	DAS# 34 DEG C	DAS# 35 DEG C	DAS# 36 DEG C	DAS# 37 DEG C
693	166.61	163.72	163.22	168.78	167.00	28.56	150.00	149.28	100.56
703	166.94	164.22	163.50	168.83	167.00	28.50	150.06	149.22	100.67
713	167.06	164.67	164.11	168.89	167.11	28.56	149.94	149.39	100.83
723	167.06	164.78	163.83	168.78	167.11	28.50	149.83	149.83	100.89
734	167.28	164.78	164.50	168.89	167.17	28.50	149.78	149.89	101.11
745	167.44	164.83	164.72	168.94	167.17	28.50	149.50	149.44	101.06
755	167.50	164.22	164.28	169.00	167.17	28.39	149.44	149.39	101.17
765	167.11	165.11	164.50	169.00	167.22	28.33	149.50	149.72	101.22
775	167.17	164.11	163.89	169.11	167.28	28.22	149.06	149.78	101.22
785	167.28	164.72	164.83	169.11	167.33	28.22	149.72	150.06	101.33
798	167.44	164.72	164.72	169.11	167.33	28.06	149.83	149.72	101.22
808	167.06	165.06	164.56	169.17	167.39	28.00	149.78	149.83	101.22
819	167.33	164.33	163.67	169.17	167.39	28.17	149.83	150.39	101.33
830	167.44	164.78	164.83	169.33	167.44	28.11	150.44	150.89	101.22
840	167.50	166.28	166.28	169.33	167.50	28.00	151.11	150.50	100.78
850	167.33	166.61	166.89	169.39	167.50	27.89	151.44	150.17	100.67
861	167.11	166.61	166.78	169.39	167.56	27.78	152.28	151.22	100.67
872	167.89	166.94	167.22	169.50	167.61	27.67	152.56	150.78	100.72
882	167.39	166.50	166.44	169.50	167.67	27.56	153.06	151.06	100.78
893	166.78	165.39	164.94	169.44	167.67	27.56	153.39	151.11	100.83
903	167.11	165.50	165.67	169.56	167.72	27.39	153.89	151.44	100.83
913	167.22	165.39	165.89	169.61	167.78	27.50	153.78	151.00	100.89
924	167.17	165.28	165.22	169.56	167.78	27.61	154.17	151.06	100.94
935	166.83	164.39	164.17	169.67	167.78	27.56	154.89	151.39	101.00
945	167.28	165.56	165.83	169.83	167.89	27.50	154.61	151.22	100.94
955	167.17	165.44	165.50	169.78	167.89	27.50	154.39	151.39	101.11
965	167.11	165.83	165.50	169.78	167.89	27.94	154.61	151.78	101.17
976	167.50	166.39	166.67	169.89	168.00	27.89	154.67	151.56	101.22
987	167.50	166.39	166.61	169.89	168.00	28.22	154.67	151.56	101.39
997	167.67	166.28	166.28	169.89	168.06	28.28	154.83	151.94	101.33
1007	167.33	165.33	165.89	170.00	168.06	28.39	154.83	151.78	101.39
1018	167.22	165.00	165.56	170.00	168.11	28.56	154.94	152.06	101.39
1029	167.11	165.17	165.94	170.06	168.17	28.78	155.11	151.94	101.39
1039	166.72	165.11	165.83	170.11	168.17	28.44	155.17	152.28	101.56
1050	166.83	165.39	166.00	170.11	168.22	28.44	155.33	152.61	101.50
1060	167.22	165.67	166.22	170.17	168.28	28.72	155.28	152.39	101.61
1071	167.44	166.11	166.50	170.22	168.28	28.78	155.06	152.28	101.72
1082	167.39	166.11	165.89	170.22	168.33	28.89	155.28	152.39	101.61
1092	167.56	166.11	166.67	170.28	168.33	28.78	154.78	151.94	101.67
1102	167.44	165.94	166.89	170.33	168.39	28.61	155.22	152.28	101.78

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 29-37
TEST: WIA-1 DATA
(sheet 16 of 20)

TIME SECONDS	DAS# 29 DEG C	DAS# 30 DEG C	DAS# 31 DEG C	DAS# 32 DEG C	DAS# 33 DEG C	DAS# 34 DEG C	DAS# 35 DEG C	DAS# 36 DEG C	DAS# 37 DEG C
1112	167.28	165.44	166.06	170.33	168.44	28.44	155.39	152.06	101.78
1122	167.39	165.39	165.44	170.33	168.50	28.72	155.44	152.39	101.83
1133	167.22	165.72	165.78	170.33	168.50	28.67	155.33	152.22	101.89
1144	167.61	166.28	166.06	170.44	168.50	28.56	155.50	151.94	101.94
1154	167.56	166.72	166.50	170.50	168.56	28.50	155.44	151.94	101.94
1165	167.39	166.61	166.83	170.56	168.61	28.39	155.67	151.89	101.94
1175	167.78	166.94	167.50	170.61	168.67	28.39	155.50	151.89	102.00
1185	167.67	166.61	167.33	170.67	168.67	28.28	155.06	152.00	102.17
1196	167.28	166.06	166.44	170.67	168.72	28.39	154.94	152.11	102.17
1207	167.11	165.61	166.39	170.78	168.78	28.50	155.56	152.44	102.33
1217	167.78	166.44	166.89	170.78	168.78	28.50	156.00	152.83	102.39
1227	168.22	166.50	166.44	170.78	168.83	28.56	155.94	152.83	102.33
1237	168.56	166.56	166.39	170.78	168.83	28.61	155.83	152.72	102.33
1248	168.44	166.72	166.56	170.83	168.89	28.17	155.50	152.83	102.44
1259	168.39	167.28	167.56	170.94	168.94	27.83	155.56	152.72	102.50
1269	169.00	167.78	167.83	171.00	169.00	27.78	155.56	152.78	102.56
1279	169.00	167.89	167.83	171.00	169.06	27.61	155.67	152.67	102.44
1289	168.83	167.33	167.44	170.94	169.06	27.44	155.89	152.50	102.56
1299	168.67	168.06	168.33	171.06	169.06	27.44	155.83	152.61	102.61
1309	168.28	167.72	168.72	171.17	169.17	27.61	155.94	153.06	102.67
1320	168.33	167.61	168.56	171.06	169.17	27.72	156.28	153.17	102.78
1330	168.61	168.11	169.17	171.22	169.11	27.78	156.17	153.39	102.72
1340	168.94	167.94	168.94	171.22	169.22	28.00	156.00	153.17	102.78
1351	168.56	167.28	168.00	171.22	169.28	27.83	155.78	152.72	102.83
1361	168.50	167.06	168.17	171.28	169.28	27.83	155.94	153.11	102.94
1372	168.33	167.22	167.89	171.33	169.33	27.89	155.56	152.56	103.00
1383	167.89	166.61	167.17	171.33	169.39	27.89	155.61	153.11	103.06
1394	167.78	166.06	166.44	171.33	169.44	27.78	155.72	153.17	103.06
1404	168.11	166.61	166.83	171.44	169.44	27.67	156.33	153.17	103.06
1414	168.33	166.78	167.00	171.44	169.50	27.39	155.94	152.83	103.11
1424	168.28	166.28	166.33	171.44	169.50	27.28	156.11	152.67	103.17
1435	167.89	165.89	165.72	171.50	169.50	27.28	156.44	153.11	103.28
1445	168.22	165.89	166.17	171.56	169.56	27.22	156.61	153.33	103.22
1455	168.89	167.06	167.33	171.61	169.61	27.17	156.61	153.22	103.28
1465	169.11	167.44	167.61	171.67	169.67	27.22	156.89	153.17	103.44
1475	169.06	167.39	167.11	171.61	169.72	27.11	156.44	153.44	103.50
1485	169.17	167.78	168.11	171.78	169.72	27.22	156.39	153.33	103.50
1495	169.50	168.28	168.06	171.72	169.78	27.56	156.33	153.39	103.67
1505	169.28	168.22	168.17	171.72	169.83	27.83	156.44	153.56	103.61
1515	169.00	167.28	167.83	171.78	169.83	28.11	156.56	153.44	103.61

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 38-58
TEST: WIA-1 DATA
(sheet 17 of 20)

TIME SECONDS	DAS# 38 DEG C	DAS# 50 KPa	DAS# 51 KPa	DAS# 53 O2%	DAS# 54 H2 (V)	DAS# 55 DEG C	DAS# 56 DEG C	DAS# 57 O2%	DAS# 58 H2 (V)
-134	141.17	104.34	190.72	0.06	0.04	8.61	29.14	0.02	0.05
-123	141.17	104.34	191.82	0.05	0.04	8.98	29.16	0.01	0.05
-112	141.28	104.40	223.88	0.06	0.04	9.34	29.15	0.02	0.05
-102	141.33	104.42	241.39	0.06	0.04	9.45	29.12	0.02	0.05
-92	141.39	104.45	319.54	0.06	0.04	8.77	29.05	0.01	0.05
-81	141.44	104.45	2316.24	0.23	0.04	8.23	29.04	0.02	0.05
-70	141.44	102.26	2987.26	0.06	0.04	7.77	29.04	0.02	0.05
-60	141.56	102.59	3427.23	0.06	0.04	7.32	29.02	0.02	0.05
-50	141.61	102.79	3738.61	0.06	0.04	7.25	29.04	0.02	0.05
-40	141.67	102.87	3968.97	0.06	0.04	7.21	28.98	0.02	0.05
-29	141.72	103.00	4157.20	0.06	0.04	7.19	28.94	0.02	0.05
-18	141.78	103.05	4307.17	0.06	0.04	7.09	28.97	0.02	0.05
-8	141.83	103.11	4433.35	0.06	0.04	7.20	28.94	0.02	0.05
2	141.89	103.31	4280.14	0.06	0.04	7.38	28.93	0.02	0.05
13	141.94	103.37	4515.88	0.06	0.04	7.40	28.96	0.01	0.05
24	142.00	103.56	4476.85	0.06	0.04	7.59	28.93	0.02	0.05
34	142.06	103.67	4539.94	0.06	0.04	7.93	28.93	0.02	0.05
44	142.11	103.76	4588.00	0.06	0.04	8.06	28.90	0.01	0.05
54	142.22	103.85	4651.99	0.06	0.04	7.37	28.93	0.01	0.05
65	142.22	104.03	4958.40	0.06	0.04	7.91	28.89	0.02	0.05
75	142.28	104.24	5180.90	0.06	0.04	7.86	28.89	0.02	0.05
85	142.33	104.42	5321.42	0.06	0.04	7.73	28.89	0.02	0.05
95	142.39	104.63	5411.06	0.06	0.04	7.69	28.87	0.01	0.05
105	142.50	104.88	5476.01	0.06	0.05	7.59	28.89	0.02	0.05
116	142.50	105.09	5521.73	0.06	0.05	7.51	28.85	0.02	0.05
126	142.56	105.25	5547.51	0.06	0.06	7.44	28.86	0.01	0.05
136	142.61	105.49	5565.92	0.06	0.07	7.55	28.80	0.01	0.06
146	142.67	105.69	5582.33	0.06	0.08	7.77	28.84	0.02	0.06
156	142.72	105.96	5590.12	0.06	0.09	7.87	28.88	0.01	0.07
166	142.83	106.16	5595.84	0.06	0.11	7.90	28.83	0.01	0.08
177	142.89	106.40	5595.22	0.06	0.13	7.98	28.83	0.01	0.09
187	142.78	106.73	5553.10	0.06	0.15	7.77	28.79	0.01	0.11
199	142.83	107.04	5546.34	0.06	0.18	7.69	28.77	0.01	0.12
210	143.00	107.29	5470.29	0.06	0.21	7.64	28.72	0.01	0.14
220	143.11	107.58	5444.02	0.06	0.24	7.70	28.71	0.01	0.16
230	143.22	107.81	5393.48	0.06	0.26	7.65	28.68	0.01	0.19
240	143.28	107.69	4854.36	0.06	0.29	7.57	28.64	0.02	0.21
250	143.28	107.41	4875.59	0.06	0.31	7.62	28.60	[illegible]	0.24
261	143.39	107.20	4893.11	0.06	0.34	7.32	28.57	0.02	0.27
272	143.44	107.15	4908.41	0.06	0.37	10.97	28.51	0.01	0.30

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 38-58
TEST: WIA-1 DATA
(sheet 18 of 20)

TIME SECONDS	DAS# 38 DEG C	DAS# 50 KPa	DAS# 51 KPa	DAS# 53 O2%	DAS# 54 H2 (V)	DAS# 55 DEG C	DAS# 56 DEG C	DAS# 57 O2%	DAS# 58 H2 (V)
282	143.44	107.08	4922.20	0.06	0.40	18.61	28.50	0.02	0.3
292	143.56	107.00	4933.58	0.06	0.42	20.88	28.46	0.02	0.36
303	143.56	107.11	4943.99	0.06	0.44	21.14	28.44	0.02	0.33
314	143.61	107.15	785.00	0.06	0.43	20.41	28.43	0.02	0.41
324	143.72	107.25	211.19	0.06	0.43	20.58	28.40	0.02	0.41
335	143.78	107.25	217.33	0.06	0.43	21.79	28.37	0.02	0.44
345	143.83	107.22	247.74	0.06	0.43	19.30	28.39	0.02	0.44
355	143.83	107.21	250.63	0.05	0.43	17.01	28.40	0.01	0.44
365	143.94	107.23	249.60	0.05	0.43	15.26	28.37	0.01	0.44
375	144.00	107.23	249.53	0.06	0.43	13.31	28.34	0.02	0.44
386	144.06	107.27	2133.52	0.06	0.44	12.69	28.45	0.02	0.44
397	144.11	107.18	4079.50	0.05	0.44	12.20	28.40	0.02	0.45
408	144.17	107.21	4581.80	0.06	0.44	11.88	28.40	0.01	0.45
418	144.22	107.24	4937.79	0.06	0.44	11.51	28.41	0.02	0.45
428	144.33	109.32	4799.33	0.06	0.44	11.37	28.42	0.01	0.45
438	144.39	111.40	4713.35	0.05	0.44	3.44	28.40	0.01	0.45
449	144.44	113.06	4273.52	0.05	0.44	-3.69	28.37	0.01	0.45
459	144.50	113.68	1349.90	0.05	0.44	-7.79	28.35	0.01	0.45
469	144.61	112.57	1065.00	0.05	0.47	-9.96	28.30	0.01	0.45
479	144.67	112.04	1034.94	0.05	0.61	-11.09	28.30	0.02	0.46
489	144.72	111.65	1017.36	0.05	0.70	-11.66	28.27	0.01	0.51
499	144.78	111.45	1002.81	0.05	0.78	-11.83	28.17	0.01	0.61
509	144.78	111.29	990.60	0.05	0.79	-11.80	28.15	0.02	0.73
519	144.83	111.22	980.19	0.05	0.79	-11.70	28.12	0.01	0.81
529	144.89	111.15	971.09	0.05	0.79	-11.56	28.07	0.01	0.81
540	144.94	111.11	963.02	0.05	0.79	-11.39	28.10	0.01	0.81
550	145.00	111.07	956.13	0.05	0.79	-11.24	28.14	0.01	0.81
560	145.06	111.08	949.92	0.05	0.79	-11.06	28.13	0.01	0.81
570	145.11	111.13	944.27	0.05	0.79	-10.91	28.09	0.01	0.81
580	145.00	111.13	939.37	0.05	0.79	-10.74	28.08	0.01	0.81
590	145.00	111.13	934.96	0.05	0.79	-10.57	28.07	0.01	0.81
600	145.61	111.14	930.39	0.05	0.79	-10.41	28.03	0.01	0.82
610	145.22	111.13	928.00	0.05	0.79	-10.25	28.02	0.01	0.82
621	145.39	111.13	925.79	0.05	0.79	-10.08	28.07	0.01	0.82
631	145.44	111.17	923.86	0.05	0.79	-9.92	28.06	0.01	0.82
641	145.50	111.11	922.83	0.05	0.79	-9.76	28.03	0.02	0.82
651	145.61	111.13	922.14	0.05	0.79	-9.59	28.04	0.01	0.82
661	145.67	111.15	922.07	0.05	0.79	-9.43	28.01	0.01	0.82
671	145.67	111.17	922.69	0.05	0.79	-9.26	28.04	0.01	0.82
682	145.72	111.17	923.52	0.05	0.79	-9.08	28.02	0.01	0.82

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 38-58
TEST: WIA-1 DATA
(sheet 19 of 20)

TIME SECONDS	DAS# 38 DEG C	DAS# 50 KPa	DAS# 51 KPa	DAS# 53 O2%	DAS# 54 H2 (V)	DAS# 55 DEG C	DAS# 56 DEG C	DAS# 57 O2%	DAS# 58 H2 (V)
693	145.78	111.21	924.76	0.05	0.79	-8.90	28.05	0.01	0.82
703	145.83	111.23	926.07	0.05	0.79	-8.75	28.05	0.01	0.82
713	145.94	111.22	927.45	0.05	0.79	-8.59	28.01	0.01	0.82
723	145.94	111.24	928.83	0.05	0.79	-8.43	27.99	0.01	0.82
734	146.00	111.25	930.55	2.33	0.79	-8.22	28.00	0.01	0.82
745	146.06	111.26	932.14	0.89	0.69	-7.71	27.96	0.01	0.82
755	146.06	111.27	933.86	0.21	0.79	-6.95	27.95	0.01	0.82
765	146.17	111.28	935.31	0.10	0.79	-6.56	27.97	0.01	0.82
775	146.22	111.26	937.10	0.08	0.79	-6.43	27.99	0.01	0.82
785	146.28	111.30	938.89	0.06	0.79	-6.37	27.98	0.01	0.82
798	146.33	111.33	940.68	0.06	0.79	-6.33	27.98	0.01	0.82
808	146.39	111.35	942.53	0.06	0.79	-6.32	27.99	0.01	0.82
819	146.44	111.35	944.06	0.06	0.79	-6.26	28.01	0.01	0.82
830	146.50	111.33	945.99	0.05	0.79	-6.24	28.00	0.01	0.82
840	146.44	111.33	947.44	0.05	0.79	-6.17	28.01	0.01	0.82
850	146.44	111.31	949.30	0.05	0.79	-6.13	28.02	0.01	0.82
861	146.56	111.32	951.10	0.05	0.79	-6.05	28.00	0.01	0.82
872	146.56	111.33	952.89	0.05	0.79	-5.99	28.04	0.01	0.82
882	146.56	111.31	954.54	0.05	0.79	-5.92	28.03	0.01	0.82
893	146.56	111.36	956.27	0.05	0.79	-5.84	28.04	0.01	0.82
903	146.61	111.40	957.85	0.05	0.79	-5.76	28.06	0.01	0.82
913	146.61	111.41	959.72	0.05	0.79	-5.70	28.07	0.01	0.82
924	146.67	111.42	961.37	0.05	0.79	-5.62	28.01	0.01	0.82
935	146.72	111.42	963.09	0.05	0.79	-5.51	28.01	0.01	0.82
945	146.72	111.47	964.96	0.05	0.79	-5.44	28.00	0.01	0.82
955	146.72	111.45	966.54	0.05	0.79	-5.35	27.99	0.01	0.82
965	146.78	111.47	968.33	0.05	0.79	-5.28	27.94	0.01	0.82
976	146.89	111.51	969.99	0.05	0.79	-5.19	27.93	0.01	0.82
987	147.06	111.52	971.78	0.05	0.79	-5.09	27.95	0.01	0.82
997	147.17	111.53	973.37	0.05	0.79	-5.15	27.91	0.01	0.82
1007	146.83	111.52	975.09	0.05	0.79	-5.22	27.89	0.01	0.82
1018	146.89	111.53	976.68	0.05	0.79	-5.05	27.86	0.01	0.82
1029	147.06	111.53	978.47	0.05	0.79	-4.93	27.84	0.01	0.82
1039	147.06	111.51	980.06	0.05	0.79	-4.88	27.81	0.01	0.82
1050	147.11	111.49	981.78	0.05	0.79	-4.80	27.84	0.01	0.82
1060	147.17	111.49	983.57	0.05	0.79	-4.75	27.83	0.01	0.82
1071	147.17	111.45	985.16	0.05	0.79	-4.67	27.80	0.01	0.82
1082	147.22	111.44	163.27	0.05	0.79	-4.60	27.80	0.01	0.82
1092	147.22	111.49	169.27	0.05	0.79	-4.52	27.83	0.02	0.82
1102	147.28	111.49	169.20	0.05	0.79	-4.46	27.85	0.01	0.82

TABLE A-11
DIGITAL OUTPUT FOR DAS #'s 39-58
TEST: WIA-1 DATA
(sheet 20 of 20)

TIME SECONDS	DAS# 38 DEG C	DAS# 50 KPa	DAS# 51 KPa	DAS# 53 O2%	DAS# 54 H2 (V)	DAS# 55 DEG C	DAS# 56 DEG C	DAS# 57 O2%	DAS# 58 H2 (V)
1112	147.33	111.50	168.10	0.05	0.79	-4.64	27.84	0.01	0.82
1122	147.39	111.51	165.39	0.05	0.79	-4.46	27.83	0.01	0.82
1133	147.39	111.53	164.45	0.05	0.79	-4.35	27.85	0.01	0.82
1144	147.44	111.54	164.24	0.05	0.79	-4.27	27.83	0.01	0.82
1154	147.44	111.57	164.24	0.05	0.79	-4.23	27.81	0.01	0.82
1165	147.50	111.60	164.10	0.05	0.79	-4.17	27.80	0.01	0.82
1175	147.56	111.60	164.31	0.05	0.79	-4.10	27.80	0.01	0.82
1185	147.56	111.60	164.31	0.05	0.79	-4.03	27.78	0.01	0.82
1196	147.61	111.65	164.72	0.07	0.79	-3.91	27.77	0.01	0.82
1207	147.61	111.75	164.65	0.53	0.81	-3.89	27.76	0.01	0.82
1217	147.67	111.71	164.79	0.14	0.83	-3.73	27.74	0.01	0.82
1227	147.67	111.71	164.86	0.07	0.80	-3.63	27.72	0.01	0.82
1237	147.72	111.71	165.00	0.06	0.79	-3.57	27.71	0.01	0.82
1248	147.72	111.71	165.20	0.06	0.79	-3.46	27.73	0.01	0.82
1259	147.83	111.73	165.20	0.05	0.79	-3.46	27.72	0.01	0.82
1269	147.83	111.75	165.27	0.05	0.79	-3.42	27.70	0.01	0.82
1279	147.83	111.80	165.34	0.05	0.79	-3.34	27.67	0.01	0.82
1289	147.89	111.80	165.62	0.05	0.79	-3.30	27.64	0.01	0.82
1299	147.94	111.83	165.55	0.05	0.79	-3.29	27.64	[illegible]	0.82
1309	147.94	111.83	165.55	0.05	0.79	-3.24	27.66	0.01	0.82
1320	148.00	111.83	165.62	0.05	0.79	-3.19	27.61	0.01	0.82
1330	148.00	111.79	165.96	0.05	0.79	-3.14	27.58	0.01	0.82
1340	148.11	111.77	166.17	0.05	0.79	-3.00	27.58	0.01	0.82
1351	148.11	111.76	166.17	0.05	0.79	-3.20	27.60	0.01	0.82
1361	148.17	111.75	166.45	0.05	0.79	-2.91	27.63	0.01	0.82
1372	148.17	111.76	166.51	0.05	0.79	-2.79	27.65	0.01	0.82
1383	148.06	111.80	166.86	0.05	0.79	-2.98	27.62	0.01	0.82
1394	148.11	111.83	166.93	0.05	0.79	-3.00	27.60	0.02	0.82
1404	148.22	111.84	167.20	0.05	0.79	-2.84	27.56	0.01	0.82
1414	148.33	111.84	167.41	0.05	0.79	-2.83	27.57	0.02	0.82
1424	148.33	111.84	167.69	0.05	0.79	-2.79	27.58	0.01	0.82
1435	148.39	111.86	168.31	0.05	0.79	-2.72	27.59	0.01	0.82
1445	148.39	111.84	168.86	0.05	0.79	-2.65	27.56	0.02	0.82
1455	148.44	111.86	169.55	0.05	0.79	-2.62	27.60	0.01	0.82
1465	148.50	111.85	170.07	0.05	0.79	-2.58	27.58	0.02	0.82
1475	148.50	111.83	170.72	0.05	0.79	-2.55	27.69	0.01	0.82
1485	148.56	111.85	171.55	0.05	0.79	-2.61	27.55	0.01	0.82
1495	148.61	111.88	172.51	0.05	0.79	-2.59	27.53	0.02	0.82
1505	148.61	111.89	173.34	0.05	0.79	-2.51	27.51	0.02	0.82
1515	148.67	111.91	174.44	0.05	0.79	-2.47	27.48	0.01	0.82

Table A-12. Intermediate Containment Vessel Atmosphere, Approximate Average Temperature, and Gas Concentration. (sheet 1 of 5)

Time (s)	Approximate average temperature (°C)	Pressure (kPa absolute)	Average oxygen concentration (mol%)	Mass spectrometric hydrogen concentration (mol%)	Steam concentration (mol%)[a]
-3180.0	--	--	--	--	0.881
-105.0	152.7	113.3	0.16	<0.01	--
-95.0	152.7	113.4	0.16	<0.01	--
-85.0	152.8	113.4	0.16	<0.01	--
-75.0	152.8	113.4	0.16	<0.01	--
-65.0	152.9	113.4	0.16	<0.01	--
-54.0	152.8	113.5	0.16	<0.01	--
-42.0	152.9	113.5	0.16	<0.01	--
-32.0	153.0	113.5	0.16	<0.01	--
-21.0	153.1	113.5	0.16	<0.01	--
-11.0	153.0	113.6	0.16	<0.01	--
-1.0	153.0	117.2	0.16	<0.01	--
10.0	157.5	119.3	0.16	<0.01	--
20.0	159.3	120.1	0.16	<0.01	--
31.0	159.4	119.4	0.16	<0.01	--
41.0	158.8	119.0	0.16	<0.01	--
51.0	157.8	118.6	0.16	<0.01	--
62.0	157.3	118.5	0.16	<0.01	--
72.0	156.4	118.4	0.16	<0.01	--
82.0	156.0	118.4	0.16	<0.01	--
93.0	155.6	118.4	0.16	<0.01	--
103.0	155.1	118.4	0.16	<0.01	--
114.0	154.9	118.4	0.15	<0.01	--
124.0	155.0	118.4	0.15	<0.01	--
134.0	154.8	118.4	0.15	<0.01	--

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Table A-12. Intermediate Containment Vessel Atmosphere, Approximate Average Temperature, and Gas Concentration. (sheet 2 of 5)

Time (s)	Approximate average temperature (°C)	Pressure (kPa absolute)	Average oxygen concentration (mol%)	Mass spectrometric hydrogen concentration (mol%)	Steam concentration (mol%)[a]
145.0	154.5	118.4	0.15	<0.01	--
155.0	154.8	118.4	0.15	<0.01	--
165.0	154.6	118.3	0.15	<0.01	--
176.0	154.7	118.3	0.15	<0.01	--
186.0	154.9	118.3	0.15	<0.01	--
197.0	154.9	118.2	0.15	<0.01	--
207.0	154.7	118.2	0.15	<0.01	--
217.0	154.7	118.2	0.15	<0.01	--
228.0	154.8	118.2	0.15	<0.01	--
238.0	154.8	118.2	0.15	<0.01	--
248.0	154.9	118.2	0.15	<0.01	--
259.0	154.9	118.2	0.15	<0.01	--
269.0	154.9	118.3	0.15	<0.01	--
280.0	154.9	118.3	0.15	<0.01	--
290.0	155.0	118.3	0.15	<0.01	--
300.0	155.0	118.4	0.16	<0.01	--
311.0	155.0	118.4	0.15	<0.01	--
321.0	153.0	118.4	0.15	<0.01	--
331.0	157.5	118.4	0.15	<0.01	--
342.0	159.3	118.4	0.15	<0.01	--
352.0	159.4	118.4	0.15	<0.01	--
362.0	158.8	118.5	0.15	<0.01	--
373.0	154.5	118.5	0.15	<0.01	--
383.0	154.8	118.6	0.15	<0.01	--
394.0	154.8	118.6	0.15	<0.01	--

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Table A-12. Intermediate Containment Vessel Atmosphere, Approximate Average Temperature, and Gas Concentration. (sheet 3 of 5)

Time (s)	Approximate average temperature (°C)	Pressure (kPa absolute)	Average oxygen concentration (mol%)	Mass spectrometric hydrogen concentration (mol%)	Steam concentration (mol%)[a]
404.0	155.3	118.6	0.15	<0.01	--
414.0	155.5	118.6	0.15	<0.01	--
425.0	155.6	118.6	0.15	<0.01	--
435.0	155.4	118.6	0.15	<0.01	--
445.0	155.3	118.6	0.15	<0.01	--
456.0	155.4	118.7	0.15	<0.01	--
466.0	155.3	118.7	0.15	<0.01	--
476.0	155.5	118.7	0.15	<0.01	--
487.0	155.6	118.7	0.15	<0.01	--
497.0	155.7	118.8	0.15	<0.01	--
507.0	155.6	118.7	0.15	<0.01	--
518.0	154.9	118.8	0.15	<0.01	--
528.0	154.9	118.8	0.15	<0.01	--
539.0	154.9	118.8	0.15	<0.01	--
549.0	155.0-	118.8	0.15	<0.01	--
561.0	155.0	118.8	0.16	<0.01	--
571.0	155.0	118.8	0.15	<0.01	--
582.0	153.0	118.8	0.15	<0.01	--
592.0	157.5	118.8	0.15	<0.01	--
602.0	159.3	118.8	0.15	<0.01	--
613.0	159.4	118.8	0.15	<0.01	--
623.0	158.8	118.8	0.15	<0.01	--
633.0	154.5	118.9	0.15	<0.01	--
644.0	154.8	118.8	0.15	<0.01	--
654.0	154.8	118.8	0.15	<0.01	--

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Table A-12. Intermediate Containment Vessel Atmosphere, Approximate Average Temperature, and Gas Concentration. (sheet 4 of 5)

Time (s)	Approximate average temperature (°C)	Pressure (kPa absolute)	Average oxygen concentration (mol%)	Mass spectrometric hydrogen concentration (mol%)	Steam concentration (mol%)[a]
665.0	156.0	118.8	0.15	<0.01	--
675.0	155.9	118.8	0.15	<0.01	--
685.0	155.7	118.8	0.15	<0.01	--
696.0	155.8	118.8	0.15	<0.01	--
706.0	155.7	118.8	0.15	<0.01	--
716.0	155.5	118.8	0.15	<0.01	--
727.0	155.5	118.8	0.15	<0.01	--
737.0	155.6	118.7	1.15[b]	<0.01	--
747.0	155.4	118.7	1.07[b]	<0.01	--
758.0	155.5	118.7	0.35[b]	<0.01	--
768.0	155.5	118.7	0.21[b]	<0.01	--
778.0	155.2	118.7	0.18[b]	<0.01	--
789.0	155.5	118.7	0 16	<0.01	--
799.0	155.3	118.7	0.16	<0.01	--
810.0	155.2	118.7	0.16	<0.01	--
820.0	155.3	118.7	0.16	<0.01	--
830.0	155.2	118.7	0.16	<0.01	--
841.0	155.1	118.7	--	<0.01	--
851.0	155.2	118.7	0.16	<0.01	--
861.0	155.2	118.7	0.15	<0.01	--
872.0	155.9	118.7	0.15	<0.01	--
882.0	155.9	118.7	0.15	<0.01	--
892.0	155.6	118.7	0.15	<0.01	--
903.0	155.6	118.7	0.15	<0.01	--
913.0	155.6	118.6	0.15	<0.01	--

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Table A-12. Intermediate Containment Vessel Atmosphere, Approximate Average Temperature, and Gas Concentration. (sheet 5 of 5)

Time (s)	Approximate average temperature (°C)	Pressure (kPa absolute)	Average oxygen concentration (mol%)	Mass spectrometric hydrogen concentration (mol%)	Steam concentration (mol%)[a]
924.0	154.4	118.6	0.15	<0.01	--
934.0	154.4	118.7	0.15	<0.01	--
945.0	154.3	118.7	0.15	<0.01	--
955.0	154.4	118.7	0.15	<0.01	--
965.0	154.3	118.7	0.15	<0.01	--
976.0	154.2	118.7	0.15	<0.01	--
985.0	154.2	118.6	0.15	<0.01	--
997.0	154.0	118.6	0.15	<0.01	--
1007.0	154.1	118.6	0.15	<0.01	--
2370.0	--	--	--	--	3.34
3990.0	--	--	--	--	3.56

[a]Moisture sample results.
[b]Gas sample obtained at this time.

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Table A-13. Intermediate Containment Vessel Atmosphere, Approximate Average Temperature, and Gas Concentration. (sheet 1 of 5)

Time (s)	Approximate average temperature (°C)	Pressure (kPa)	Average oxygen concentration (mol%)	Average hydrogen concentration (mol%)[a]	Steam concentration (mol%)[b]
-2260.0	--	--	--	--	1.34
-102.0	156.9	104.4	0.08	0.00	--
-92.0	156.7	104.4	0.07	0.00	--
-81.0	156.9	104.4	0.25	0.00	--
-70.0	156.4	102.3	0.07	0.00	--
-60.0	156.0	102.6	0.08	0.00	--
-50.0	156.0	102.8	0.08	0.00	--
-40.0	156.3	102.9	0.08	0.00	--
-29.0	156.4	103.0	0.08	0.00	--
-18.0	156.5	103.1	0.08	0.00	--
-8.0	156.7	103.1	0.08	0.00	--
2.0	156.8	103.3	0.08	0.00	--
13.0	157.0	103.4	0.08	0.00	--
24.0	157.4	103.6	0.08	0.00	--
34.0	157.6	103.7	0.08	0.00	--
44.0	157.8	103.8	0.08	0.00	--
54.0	158.0	103.9	0.08	0.00	--
65.0	158.2	104.0	0.08	0.00	--
75.0	158.5	104.2	0.08	0.00	--
85.0	158.7	104.4	0.08	0.00	--
95.0	159.0	104.6	0.07	0.00	--
105.0	154.9	118.4	0.15	0.02	--
116.0	155.0	118.4	0.15	0.04	--
126.0	154.8	118.4	0.15	0.08	--

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Table A-13. Intermediate Containment Vessel Atmosphere, Approximate Average Temperature, and Gas Concentration. (sheet 2 of 5)

Time (s)	Approximate average temperature (°C)	Pressure (kPa)	Average oxygen concentration (mol%)	Average hydrogen concentration (mol%)[a]	Steam concentration (mol%)[b]
136.0	160.0	105.5	0.07	0.14	--
146.0	160.2	105.7	0.07	0.22	--
156.0	160.4	106.0	0.07	0.30	--
166.0	160.8	106.2	0.07	0.40	--
177.0	160.9	106.4	0.07	0.52	--
187.0	161.2	106.7	0.07	0.69	--
199.0	161.5	107.0	0.07	0.85	--
210.0	161.6	107.3	0.07	1.05	--
220.0	161.9	107.6	0.07	1.25	--
230.0	161.8	107.8	0.07	1.46	--
240.0	162.2	107.7	0.07	1.66	--
250.0	161.8	107.4	0.07	1.86	--
261.0	161.3	107.2	0.07	2.10	--
272.0	160.7	107.1	0.07	2.34	--
282.0	160.4	107.1	0.07	2.55	--
292.0	159.9	107.0	0.07	2.77	--
303.0	159.6	107.1	0.07	2.93	--
314.0	153.0	107.1	0.07	3.01	--
324.0	159.7	107.3	0.07	3.08	--
335.0	159.5	107.3	0.07	3.11	--
345.0	159.3	107.2	0.07	3.13	--
355.0	159.5	107.2	0.07	3.14	--
365.0	159.4	107.2	0.07	3.16	--
375.0	159.4	107.2	0.07	3.17	--
386.0	159.2	107.3	0.07	3.19	--

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Table A-13. Intermediate Containment Vessel Atmosphere, Approximate Average Temperature, and Gas Concentration. (sheet 3 of 5)

Time (s)	Approximate average temperature (°C)	Pressure (kPa)	Average oxygen concentration (mol%)	Average hydrogen concentration (mol%)[a]	Steam concentration (mol%)[b]
397.0	159.4	107.2	0.07	3.20	--
408.0	159.4	107.2	0.07	3.21	--
418.0	159.3	107.2	0.07	3.22	--
428.0	160.0	109.3	0.07	3.22	--
438.0	162.1	111.4	0.07	3.22	--
449.0	164.7	113.1	0.07	3.23	--
459.0	167.0	113.7	0.07	3.23	--
469.0	167.0	112.6	0.07	3.35	--
479.0	166.0	112.0	0.07	3.95	--
489.0	164.7	111.7	0.07	4.50	--
499.0	163.6	111.5	0.07	5.23	--
509.0	162.7	111.3	0.07	5.76	--
519.0	162.1	111.2	0.07	6.06	--
529.0	161.8	111.1	0.07	6.07	--
540.0	161.3	111.1	0.07	6.05	--
550.0	161.2	111.1	0.07	6.05	--
560.0	161.1	111.1	0.07	6.06	--
570.0	160.7	111.1	0.07	6.07	1.21
580.0	160.5	111.1	0.07	6.07	--
590.0	160.5	111.1	0.07	6.09	--
600.0	160.5	111.1	0.07	6.09	--
610.0	160.5	111.1	0.07	6.10	--
621.0	160.5	111.1	0.07	6.10	--
631.0	160.2	111.2	0.07	6.10	--
641.0	160.2	111.1	0.07	6.10	--

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Table A-13. Intermediate Containment Vessel Atmosphere, Approximate Average Temperature, and Gas Concentration. (sheet 4 of 5)

Time (s)	Approximate average temperature (°C)	Pressure (kPa)	Average oxygen concentration (mol%)	Average hydrogen concentration (mol%)[a]	Steam concentration (mol%)[b]
651.0	160.2	111.1	0.07	6.10	--
661.0	160.2	111.2	0.07	6.10	--
671.0	160.3	111.2	0.07	6.11	--
682.0	160.3	111.2	0.07	6.10	--
693.0	160.3	111.2	0.07	6.11	--
703.0	160.4	111.2	0.07	6.11	--
713.0	160.5	111.2	0.07	6.11	--
723.0	160.5	111.2	0.07	6.11	--
734.0	160.6	111.3	2.34[c]	6.10	--
745.0	160.6	111.3	0.91[c]	5.72[c]	--
755.0	160.5	111.3	0.22[c]	6.11	--
765.0	160.6	111.3	0.12[c]	6.11	--
775.0	160.4	111.3	0.09[c]	6.11	--
785.0	160.7	111.3	0.08[c]	6.11	--
798.0	160.7	111.3	0.07	6.11	--
808.0	160.7	111.4	0.07	6.11	--
819.0	160.7	111.4	0.07	6.11	--
830.0	161.0	111.3	0.07	6.11	--
840.0	161.1	111.3	0.07	6.11	--
850.0	160.9	111.3	0.07	6.11	--
861.0	161.1	111.3	0.07	6.11	--
872.0	161.0	111.3	0.07	6.11	--
882.0	160.8	111.3	0.07	6.11	--
893.0	160.4	111.3	0.07	6.11	--
903.0	160.7	111.4	0.07	6.11	--

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Table A-12. Intermediate Containment Vessel Atmosphere, Approximate Average Temperature, and Gas Concentration. (sheet 5 of 5)

Time (s)	Approximate average temperature (°C)	Pressure (kPa)	Average oxygen concentration (mol%)	Average hydrogen concentration (mol%)[a]	Steam concentration (mol%)[b]
935.0	160.5	111.4	0.07	6.11	--
945.0	160.7	111.5	0.06	6.11	--
955.0	160.5	111.5	0.06	6.11	--
965.0	160.7	111.5	0.06	6.11	--
976.0	161.0	111.5	0.06	6.11	--
987.0	161.0	111.5	0.07	6.11	--
997.0	160.9	111.5	0.06	6.11	--
1007.0	160.9	111.5	0.06	6.11	--
1830.0	--	111.5	--	--	0.82
5910.0	--	--	--	--	0.76

[a]Average of two hydrogen monitor values calibrated with mass spectrometric results.
[b]Moisture sample results.
[c]Gas sample obtained at this time.

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APPENDIX B

CASCADE IMPACTOR DATA

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APPENDIX B

CASCADE IMPACTOR DATA

Data for individual cascade impactor samples taken at the intermediate containment vessel (ICV) thief station (90° azimuth and 1.2 m above ICV floor) for tests LPA-2, LPA-3, ABC-1, ASA-1, WIL-1, and WIA-1 are listed in Tables B-1 through B-17 and are shown in Figures B-1 through B-9. The aerosol aerodynamic mass median diameter (AMMD) and geometric standard deviation for each aerosol sample were determined from the lithium and lead results and are listed in the tables. The calculational procedures used to determine the size data from the sampler stage deposits are presented in detail by Marshall.*

*Marshall, W. R., Jr., 1954, Atomization and Spray Drying, Chemical Engineering Progress Monograph Series, Vol. 50, No. 2, American Institute of Chemical Engineers, New York, New York.

Table B-1. Aerosol Sample Results Based Upon Lithium Analysis--Test LPA-2.

LPA-2 T1-I1 46 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 11 DEG F	122.40	ROTOMETER RDG., SCFM	0.50
FIRST BACKGROUND	0.00005	CV PRESSURE, PSIA	16.80
SECOND BACKGROUND	0.00005	SAMPLE DURATION, MIN.	2.00

STAGE NUMBER	LAB MG LITHIUM	NET MG LITHIUM	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00020	0.00000	0.000		
P	0.00010	0.00000	0.000		
1	0.00006	0.00001	0.001	0.999	12.789
2	0.00006	0.00001	0.001	0.997	7.815
3	0.00035	0.00030	0.044	0.953	3.126
4	0.00048	0.00043	0.063	0.891	1.883
5	0.00042	0.00037	0.054	0.836	1.208
6	0.00093	0.00088	0.128	0.708	0.675
BU	0.00490	0.00485	0.708		
TOTAL		0.00685	1.000		

AMMD	0.37	GEOMETRIC STD. DEV.	1.40
84.1% INTERCEPT	1.28	R SQUARED	0.99
ACTUAL FLOW, ACFM	0.51	CORRECTED TEMP. DEG F	122.40
VISCOSITY, MICROPOISE	194.06	SETTLING MEAN DIAM.	1.72

Table B-2. Aerosol Sample Results Based Upon Lead Analysis--Test LPA-2.

LPA-2 T1-I1 46 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 11 DEG F	122.40	ROTOMETER RDG., SCFM	0.50
FIRST BACKGROUND	0.00040	CV PRESSURE, PSIA	16.80
SECOND BACKGROUND	0.00040	SAMPLE DURATION, MIN.	2.00

STAGE NUMBER	LAB MG LEAD	NET MG LEAD	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00130	0.00000	0.000		
P	0.00040	0.00000	0.000		
1	0.00041	0.00001	0.002	0.998	12.789
2	0.00080	0.00040	0.072	0.926	7.815
3	0.00041	0.00001	0.002	0.924	3.126
4	0.00250	0.00210	0.380	0.543	1.883
5	0.00210	0.00170	0.308	0.236	1.208
6	0.00080	0.00040	0.072	0.163	0.675
BU	0.00130	0.00090	0.163		
TOTAL		0.00552	1.000		

AMMD	1.71	GEOMETRIC STD. DEV.	1.70
84.1% INTERCEPT	3.62	R SQUARED	0.92
ACTUAL FLOW, ACFM	0.51	CORRECTED TEMP. DEG F	122.40
VISCOSITY, MICROPOISE	194.06	SETTLING MEAN DIAM.	3.01

Table B-3. First Aerosol Sample Results Based Upon Lithium Analysis--Test LPA-3.

LPA-3 T1-I1 58 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 13 DEG F	138.30	ROTOMETER RDG., SCFM	0.25
FIRST BACKGROUND	0.00025	CV PRESSURE, PSIA	18.40
SECOND BACKGROUND	0.00025	SAMPLE DURATION, MIN.	4.00

STAGE NUMBER	LAB MG LITHIUM	NET MG LITHIUM	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00025	0.00000	0.000		
P	0.00025	0.00000	0.000		
1	0.00026	0.00001	0.005	0.995	17.078
2	0.00026	0.00001	0.005	0.989	10.437
3	0.00026	0.00001	0.005	0.984	4.175
4	0.00030	0.00005	0.027	0.956	2.514
5	0.00060	0.00035	0.191	0.765	1.613
6	0.00080	0.00055	0.301	0.464	0.901
BU	0.00110	0.00085	0.464		
TOTAL		0.00183	1.000		

AMMD	0.79	GEOMETRIC STD. DEV.	1.44
84.1% INTERCEPT	2.30	R SQUARED	0.82
ACTUAL FLOW, ACFM	0.29	CORRECTED TEMP. DEG F	138.30
VISCOSITY, MICROPOISE	197.83	SETTLING MEAN DIAM.	2.47

Table B-4. Second Aerosol Sample Results Based Upon Lithium Analysis--Test LPA-3.

LPA-3 T1-I2 98 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 13 DEG F	130.50	ROTOMETER RDG., SCFM	0.25
FIRST BACKGROUND	0.00025	CV PRESSURE, PSIA	16.90
SECOND BACKGROUND	0.00025	SAMPLE DURATION, MIN.	10.00

STAGE NUMBER	LAB MG LITHIUM	NET MG LITHIUM	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00025	0.00000	0.000		
P	0.00025	0.00000	0.000		
1	0.00030	0.00005	0.012	0.988	16.530
2	0.00030	0.00005	0.012	0.975	10.101
3	0.00030	0.00005	0.012	0.963	4.041
4	0.00070	0.00045	0.111	0.852	2.434
5	0.00110	0.00085	0.210	0.642	1.561
6	0.00140	0.00115	0.284	0.358	0.872
BU	0.00170	0.00145	0.358		
TOTAL		0.00405	1.000		

AMMD	1.06	GEOMETRIC STD. DEV.	1.64
84.1% INTERCEPT	3.09	R SQUARED	0.90
ACTUAL FLOW, ACFM	0.31	CORRECTED TEMP. DEG F	130.50
VISCOSITY, MICROPOISE	195.99	SETTLING MEAN DIAM.	3.31

Table B-5. First Aerosol Sample Results Based Upon Lithium Analysis--Test ABC-1.

ABC-1 T1-I1 20.5 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 16 DEG F	80.40	ROTOMETER RDG., SCFM	0.20
FIRST BACKGROUND	0.00005	CV PRESSURE, PSIA	15.04
SECOND BACKGROUND	0.00005	SAMPLE DURATION, MIN.	1.00

STAGE NUMBER	LAB MG LITHIUM	NET MG LITHIUM	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00006	0.00000	0.000		
P	0.00006	0.00000	0.000		
1	0.00006	0.00001	0.038	0.962	17.653
2	0.00006	0.00001	0.038	0.923	10.788
3	0.00006	0.00001	0.038	0.885	4.315
4	0.00006	0.00001	0.038	0.846	2.599
5	0.00006	0.00001	0.038	0.808	1.667
6	0.00006	0.00001	0.038	0.769	0.932
BU	0.00025	0.00020	0.769		
TOTAL		0.00026	1.000		

AMMD	0.09	GEOMETRIC STD. DEV.	2.01
84.1% INTERCEPT	3.82	R SQUARED	0.99
ACTUAL FLOW, ACFM	0.26	CORRECTED TEMP. DEG F	80.40
VISCOSITY, MICROPOISE	183.95	SETTLING MEAN DIAM.	108201.96

Table B-6. Second Aerosol Sample Results Based Upon Lithium Analysis--Test ABC-1.

ABC-1 T1-I2 50.5 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 16 DEG F	82.60	ROTOMETER RDG., SCFM	0.20
FIRST BACKGROUND	0.00005	CV PRESSURE, PSIA	15.58
SECOND BACKGROUND	0.00005	SAMPLE DURATION, MIN.	1.00

STAGE NUMBER	LAB MG LITHIUM	NET MG LITHIUM	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00006	0.00000	0.000		
P	0.00006	0.00000	0.000		
1	0.00006	0.00001	0.008	0.992	17.517
2	0.00006	0.00001	0.008	0.985	10.705
3	0.00010	0.00005	0.038	0.947	4.282
4	0.00010	0.00005	0.038	0.908	2.579
5	0.00010	0.00005	0.038	0.870	1.654
6	0.00049	0.00044	0.336	0.534	0.925
BU	0.00075	0.00070	0.534		
TOTAL		0.00131	1.000		

AMMD	0.56	GEOMETRIC STD. DEV.	1.58
84.1% INTERCEPT	2.29	R SQUARED	0.90
ACTUAL FLOW, ACFM	0.26	CORRECTED TEMP. DEG F	82.60
VISCOSITY, MICROPOISE	184.49	SETTLING MEAN DIAM.	4.10

Table B-7. First Aerosol Sample Results Based Upon Lead Analysis--Test ABC-1.

ABC-1 T1-I1 20.5 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 16 DEG F	80.40	ROTOMETER RDG., SCFM	0.20
FIRST BACKGROUND	0.00040	CV PRESSURE, PSIA	15.04
SECOND BACKGROUND	0.00040	SAMPLE DURATION, MIN.	1.00

STAGE NUMBER	LAB MG LEAD	NET MG LEAD	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00150	0.00000	0.000		
P	0.00150	0.00000	0.000		
1	0.00150	0.00110	0.143	0.857	17.653
2	0.00150	0.00110	0.143	0.714	10.788
3	0.00150	0.00110	0.143	0.571	4.315
4	0.00150	0.00110	0.143	0.429	2.599
5	0.00150	0.00110	0.143	0.286	1.667
6	0.00150	0.00110	0.143	0.143	0.932
BU	0.00150	0.00110	0.143		
TOTAL		0.00770	1.000		

AMMD	3.87	GEOMETRIC STD. DEV.	2.62
84.1% INTERCEPT	16.34	R SQUARED	0.98
ACTUAL FLOW, ACFM	0.26	CORRECTED TEMP. DEG F	80.40
VISCOSITY, MICROPOISE	183.95	SETTLING MEAN DIAM.	30.77

Table B-8. Second Aerosol Sample Results Based Upon Lead Analysis--Test ABC-1.

ABC-1 T1-I2 50.5 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 16 DEG F	82.60	ROTOMETER RDG., SCFM	0.20
FIRST BACKGROUND	0.00040	CV PRESSURE, PSIA	15.58
SECOND BACKGROUND	0.00040	SAMPLE DURATION, MIN.	1.00

STAGE NUMBER	LAB MG LEAD	NET MG LEAD	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00150	0.00000	0.000		
P	0.00290	0.00000	0.000		
1	0.00150	0.00110	0.098	0.902	17.517
2	0.00150	0.00110	0.098	0.804	10.705
3	0.00150	0.00110	0.098	0.705	4.282
4	0.00380	0.00340	0.304	0.402	2.579
5	0.00150	0.00110	0.098	0.304	1.654
6	0.00150	0.00110	0.098	0.205	0.925
BU	0.00270	0.00230	0.205		
TOTAL		0.01120	1.000		

AMMD	3.02	GEOMETRIC STD. DEV.	2.30
84.1% INTERCEPT	11.29	R SQUARED	0.97
ACTUAL FLOW, ACFM	0.26	CORRECTED TEMP. DEG F	82.60
VISCOSITY, MICROPOISE	184.49	SETTLING MEAN DIAM.	17.24

Table B-9. First Aerosol Sample Results Based Upon Lithium Analysis--Test ASA-1.

ASA-1 T1-I1 12.5 MIN, SIERRA IMPACTOR

TEMP. AT DAS # 13 DEG F	85.50	ROTOMETER RDG., SCFM	0.25
FIRST BACKGROUND	0.00005	CV PRESSURE, PSIA	15.80
SECOND BACKGROUND	0.00005	SAMPLE DURATION, MIN.	2.00

STAGE NUMBER	LAB MG LITHIUM	NET MG LITHIUM	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00190	0.00000	0.000		
P	0.00055	0.00000	0.000		
1	0.00130	0.00125	0.058	0.942	16.438
2	0.00370	0.00365	0.169	0.773	10.045
3	0.00630	0.00625	0.289	0.485	4.018
4	0.00530	0.00525	0.243	0.242	2.420
5	0.00330	0.00325	0.150	0.092	1.552
6	0.00150	0.00145	0.067	0.025	0.868
BU	0.00058	0.00053	0.025		
TOTAL		0.02163	1.000		

AMMD	4.59	GEOMETRIC STD. DEV.	2.16
84.1% INTERCEPT	10.69	R SQUARED	0.99
ACTUAL FLOW, ACFM	0.30	CORRECTED TEMP. DEG F	85.50
VISCOSITY, MICROPOISE	185.19	SETTLING MEAN DIAM.	9.39

Table B-10. Second Aerosol Sample Results Based Upon Lithium Analysis--Test ASA-1.

ASA-1 T1-I2 29.5 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 13 DEG F	86.90	ROTOMETER RDG., SCFM	0.25
FIRST BACKGROUND	0.00005	CV PRESSURE, PSIA	15.80
SECOND BACKGROUND	0.00005	SAMPLE DURATION, MIN.	2.00

STAGE NUMBER	LAB MG LITHIUM	NET MG LITHIUM	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00055	0.00000	0.000		
P	0.00018	0.00000	0.000		
1	0.00020	0.00015	0.013	0.987	16.432
2	0.00085	0.00080	0.069	0.918	10.042
3	0.00280	0.00275	0.236	0.682	4.017
4	0.00410	0.00405	0.348	0.335	2.419
5	0.00260	0.00255	0.219	0.116	1.552
6	0.00090	0.00085	0.073	0.043	0.867
BU	0.00055	0.00050	0.043		
TOTAL		0.01165	1.000		

AMMD	3.29	GEOMETRIC STD. DEV.	1.83
84.1% INTERCEPT	6.86	R SQUARED	0.99
ACTUAL FLOW, ACFM	0.30	CORRECTED TEMP. DEG F	86.90
VISCOSITY, MICROPOISE	185.53	SETTLING MEAN DIAM.	5.64

Table B-11. Third Aerosol Sample Results Based Upon Lithium Analysis--Test ASA-1.

ASA-1 T1-I3 78 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 13 DEG F	80.60	ROTOMETER RDG., SCFM	0.25
FIRST BACKGROUND	0.00005	CV PRESSURE, PSIA	15.50
SECOND BACKGROUND	0.00005	SAMPLE DURATION, MIN.	10.00

STAGE NUMBER	LAB MG LITHIUM	NET MG LITHIUM	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00058	0.00000	0.000		
P	0.00025	0.00000	0.000		
1	0.00025	0.00020	0.009	0.991	16.302
2	0.00050	0.00045	0.020	0.971	9.962
3	0.00330	0.00325	0.144	0.827	3.985
4	0.00790	0.00785	0.349	0.478	2.400
5	0.00580	0.00575	0.256	0.222	1.540
6	0.00340	0.00335	0.149	0.073	0.860
BU	0.00170	0.00165	0.073		
TOTAL		0.02250	1.000		

AMMD	2.49	GEOMETRIC STD. DEV.	1.72
84.1% INTERCEPT	5.22	R SQUARED	0.99
ACTUAL FLOW, ACFM	0.30	CORRECTED TEMP. DEG F	80.60
VISCOSITY, MICROPOISE	184.00	SETTLING MEAN DIAM.	4.31

Table B-12. First Aerosol Sample Results Based Upon Lead Analysis--Test ASA-1.

ASA-1 T1-I1 12.5 MIN, SIERRA IMPACTOR

TEMP. AT DAS # 13 DEG F	85.50	ROTOMETER RDG., SCFM	0.25
FIRST BACKGROUND	0.00040	CV PRESSURE, PSIA	15.80
SECOND BACKGROUND	0.00040	SAMPLE DURATION, MIN.	2.00

STAGE NUMBER	LAB MG LEAD	NET MG LEAD	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.14000	0.00000	0.000		
P	0.01500	0.00000	0.000		
1	0.16000	0.15960	0.060	0.940	16.438
2	0.47000	0.46960	0.178	0.762	10.045
3	0.78000	0.77960	0.295	0.466	4.018
4	0.64000	0.63960	0.242	0.224	2.420
5	0.38000	0.37960	0.144	0.080	1.552
6	0.18000	0.17960	0.068	0.012	0.868
BU	0.03300	0.03260	0.012		
TOTAL		2.64020	1.000		

AMMD	4.84	GEOMETRIC STD. DEV.	2.18
84.1% INTERCEPT	10.78	R SQUARED	0.99
ACTUAL FLOW, ACFM	0.30	CORRECTED TEMP. DEG F	85.50
VISCOSITY, MICROPOISE	185.19	SETTLING MEAN DIAM.	9.19

Table B-13. Second Aerosol Sample Results Based Upon Lead Analysis--Test ASA-1.

ASA-1 T1-I2 29.5 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 13 DEG F	86.90	ROTOMETER RDG., SCFM	0.25
FIRST BACKGROUND	0.00040	CV PRESSURE, PSIA	15.80
SECOND BACKGROUND	0.00040	SAMPLE DURATION, MIN.	2.00

STAGE NUMBER	LAB MG LEAD	NET MG LEAD	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00430	0.00000	0.000		
P	0.00450	0.00000	0.000		
1	0.00800	0.00760	0.006	0.994	16.432
2	0.08700	0.08660	0.063	0.931	10.042
3	0.33000	0.32960	0.241	0.690	4.017
4	0.51000	0.50960	0.373	0.317	2.419
5	0.33000	0.32960	0.241	0.076	1.552
6	0.07900	0.07860	0.058	0.018	0.867
BU	0.02500	0.02460	0.018		
TOTAL		1.36620	1.000		

AMMD	3.41	GEOMETRIC STD. DEV.	1.75
84.1% INTERCEPT	6.41	R SQUARED	0.99
ACTUAL FLOW, ACFM	0.30	CORRECTED TEMP. DEG F	86.90
VISCOSITY, MICROPOISE	185.53	SETTLING MEAN DIAM.	5.08

Table B-14. Third Aerosol Sample Results Based Upon Lead Analysis--Test ASA-1.

ASA-1 T1-I3 78 MIN. SIERRA IMPACTOR

TEMP. AT DAS # 13 DEG F	80.60	ROTOMETER RDG., SCFM	0.25
FIRST BACKGROUND	0.00040	CV PRESSURE, PSIA	15.50
SECOND BACKGROUND	0.00040	SAMPLE DURATION, MIN.	10.00

STAGE NUMBER	LAB MG LEAD	NET MG LEAD	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00400	0.00000	0.000		
P	0.00400	0.00000	0.000		
1	0.00400	0.00360	0.001	0.999	16.302
2	0.02300	0.02260	0.009	0.990	9.762
3	0.41000	0.40960	0.162	0.828	3.985
4	0.98000	0.97960	0.387	0.440	2.400
5	0.70000	0.69960	0.277	0.163	1.540
6	0.35000	0.34960	0.138	0.025	0.860
BU	0.06400	0.06360	0.025		
TOTAL		2.52820	1.000		

AMMD	2.62	GEOMETRIC STD. DEV.	1.63
84.1% INTERCEPT	4.70	R SQUARED	1.00
ACTUAL FLOW, ACFM	0.30	CORRECTED TEMP. DEG F	80.60
VISCOSITY, MICROPOISE	184.00	SETTLING MEAN DIAM.	3.69

Table B-15. Aerosol Sample Results Based Upon Lead Analysis--Test WIL-1.

WIL T1-I1 54 MIN. SIERRA IMPACTOR

TEMP. AT DAS #999 DEG F	286.00	ROTOMETER RDG., SCFM	0.20
FIRST BACKGROUND	0.00040	CV PRESSURE, PSIA	16.80
SECOND BACKGROUND	0.00040	SAMPLE DURATION, MIN.	4.00

STAGE NUMBER	LAB MG LEAD	NET MG LEAD	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00640	0.00000	0.000		
P	0.00180	0.00000	0.000		
1	0.00250	0.00210	0.022	0.978	17.249
2	0.00300	0.00260	0.027	0.951	10.541
3	0.01100	0.01060	0.111	0.840	4.216
4	0.02900	0.02860	0.299	0.541	2.539
5	0.02800	0.02760	0.288	0.253	1.629
6	0.01600	0.01560	0.163	0.090	0.910
BU	0.00900	0.00860	0.090		
TOTAL		0.09570	1.000		

AMMD	2.57	GEOMETRIC STD. DEV.	1.84
84.1% INTERCEPT	5.92	R SQUARED	0.97
ACTUAL FLOW, ACFM	0.34	CORRECTED TEMP. DEG F	286.00
VISCOSITY, MICROPOISE	231.63	SETTLING MEAN DIAM.	5.15

Table B-16. Aerosol Sample Results Based Upon Lead Analysis--Test WIA-1.

WIA T1-I1 34 MIN. SIERRA IMPACTOR

TEMP. AT DAS #999 DEG F	334.00	ROTOMETER RDG., SCFM	0.25
FIRST BACKGROUND	0.00040	CV PRESSURE, PSIA	16.20
SECOND BACKGROUND	0.00040	SAMPLE DURATION, MIN.	4.00

STAGE NUMBER	LAB MG LEAD	NET MG LEAD	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00420	0.00000	0.000		
P	0.00250	0.00000	0.000		
1	0.00180	0.00140	0.008	0.992	15.777
2	0.00480	0.00440	0.025	0.967	9.642
3	0.03500	0.03460	0.195	0.773	3.857
4	0.03600	0.03560	0.200	0.573	2.323
5	0.03700	0.03660	0.206	0.367	1.490
6	0.02000	0.01960	0.110	0.256	0.833
BU	0.04600	0.04560	0.256		
TOTAL		0.17780	1.000		

AMMD	1.82	GEOMETRIC STD. DEV.	1.75
84.1% INTERCEPT	4.55	R SQUARED	0.99
ACTUAL FLOW, ACFM	0.42	CORRECTED TEMP. DEG F	334.00
VISCOSITY, MICROPOISE	242.18	SETTLING MEAN DIAM.	4.20

Table B-17. Aerosol Sample Results Based Upon Lithium Analysis--Test WIA-1.

WIA T1-I1 34 MIN. SIERRA IMPACTOR

TEMP. AT DAS #999 DEG F	334.00	ROTOMETER RDG., SCFM	0.25
FIRST BACKGROUND	0.00005	CV PRESSURE, PSIA	16.20
SECOND BACKGROUND	0.00005	SAMPLE DURATION, MIN.	4.00

STAGE NUMBER	LAB MG LITHIUM	NET MG LITHIUM	MASS FRACTION	FRACTION LESS THAN CUT SIZE	CUT DIAM MICRO-METERS
N	0.00260	0.00000	0.000		
P	0.00050	0.00000	0.000		
1	0.00050	0.00045	0.001	0.999	15.777
2	0.00200	0.00195	0.003	0.996	9.642
3	0.00720	0.00715	0.012	0.984	3.857
4	0.01300	0.01295	0.022	0.961	2.323
5	0.03900	0.03895	0.067	0.894	1.490
6	0.07800	0.07795	0.135	0.759	0.833
BU	0.44000	0.43995	0.759		
TOTAL		0.57935	1.000		

AMMD	0.31	GEOMETRIC STD. DEV.	1.31
84.1% INTERCEPT	1.08	R SQUARED	0.99
ACTUAL FLOW, ACFM	0.42	CORRECTED TEMP. DEG F	334.00
VISCOSITY, MICROPOISE	242.18	SETTLING MEAN DIAM.	1.44

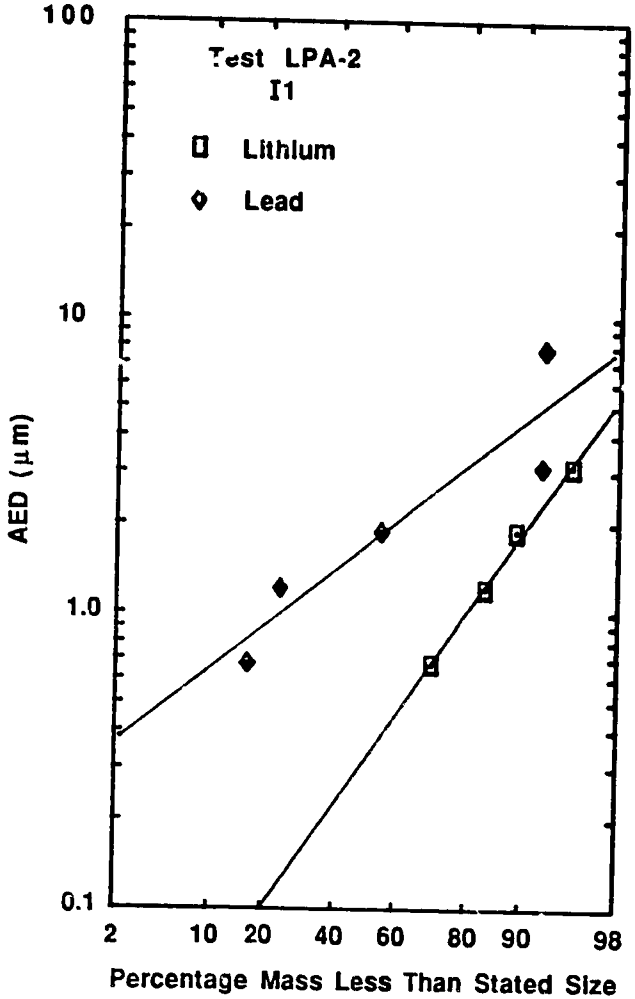
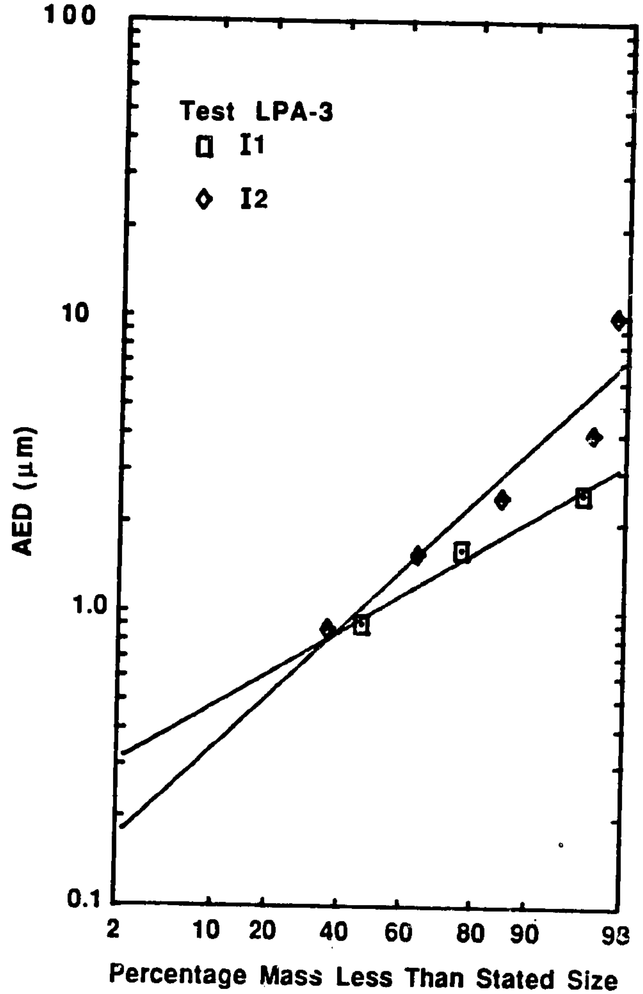


Figure B-1. Log Probability Plot of
Test LPA-2 Impactor Sample Results.



38809164.15

Figure B-2. Log Probability Plot of
Test LPA-3 Impactor Sample Results.

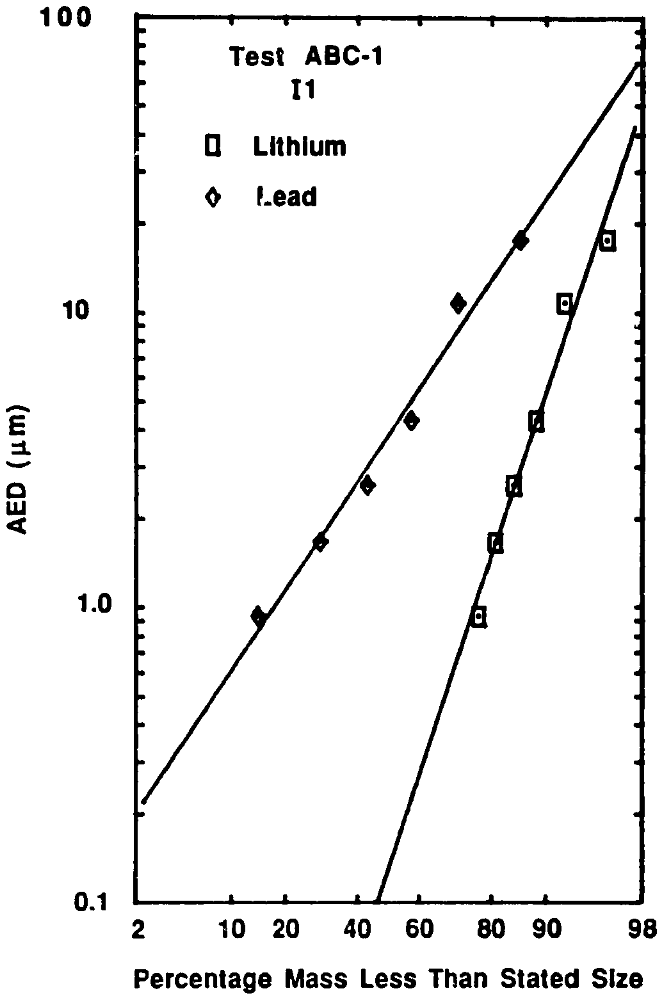


Figure B-3. Log Probability Plot of Test ABC-1 Impactor Sample Results.

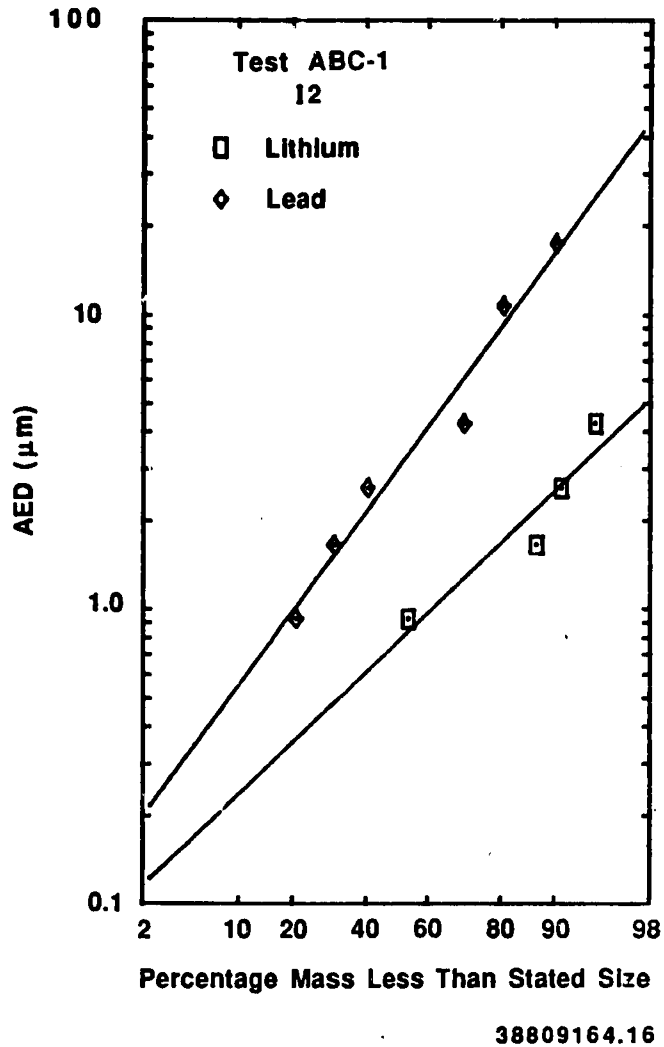


Figure B-4. Log Probability Plot of Test ABC-1 Impactor Sample Results.

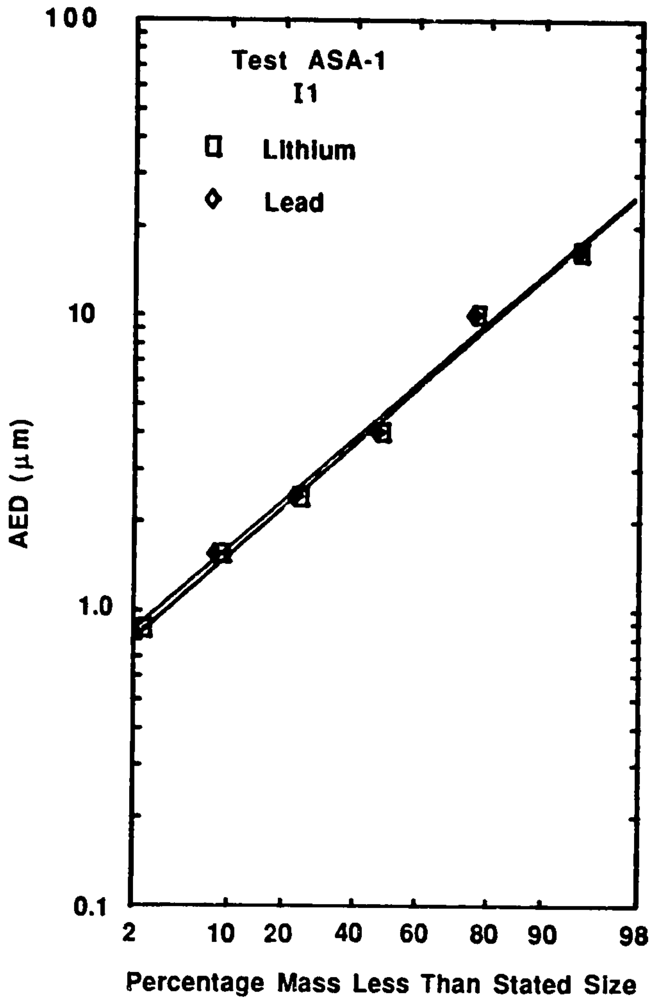


Figure B-5. Log Probability Plot of Test ASA-1 Impactor Sample Results.

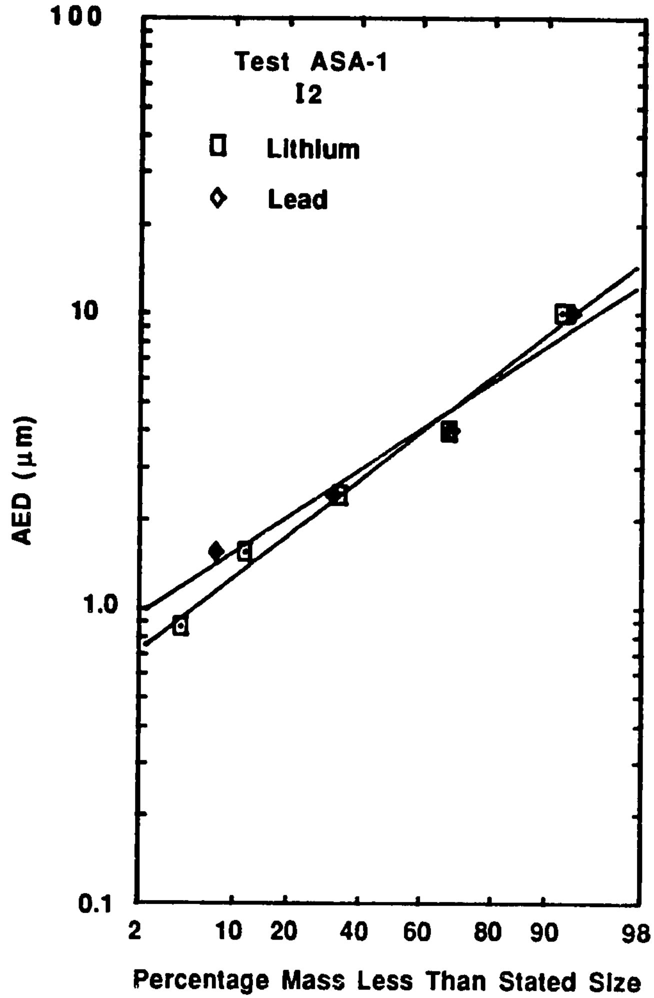


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Figure B-6. Log Probability Plot of Test ASA-1 Impactor Sample Results.

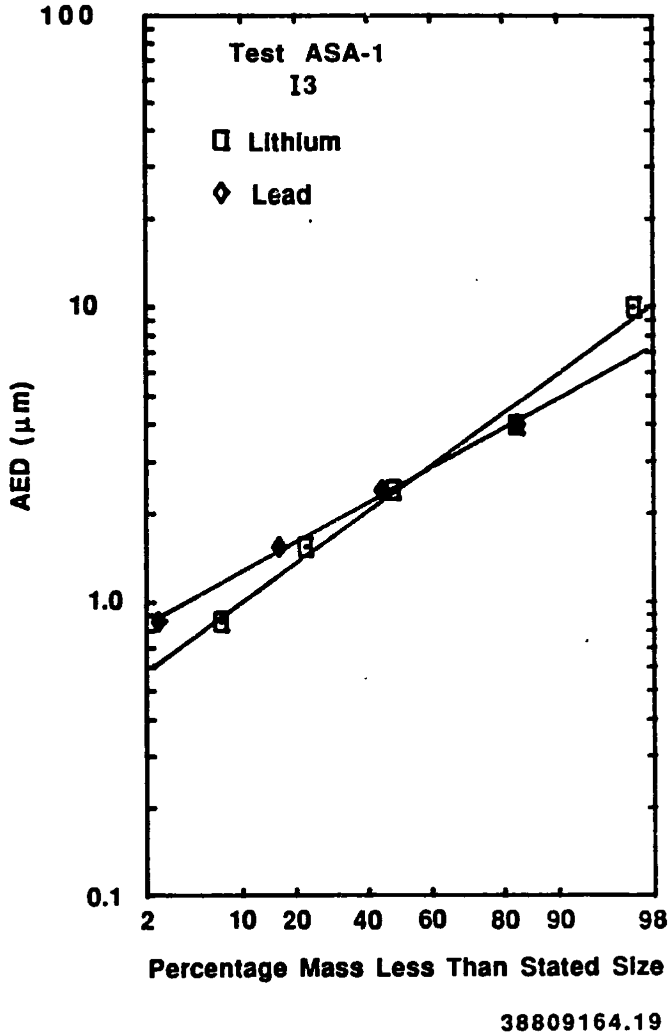

Figure B-7. Log Probability Plot of Test ASA-1 Impactor Sample Results.

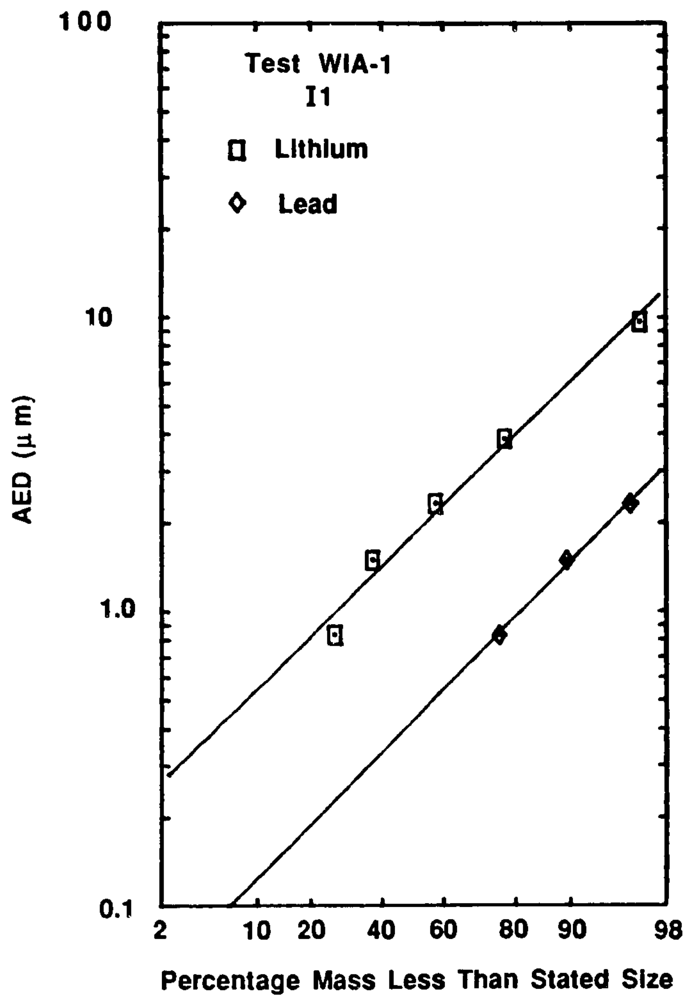

Figure B-8. Log Probability Plot of Test WIA-1 Impactor Sample Results.

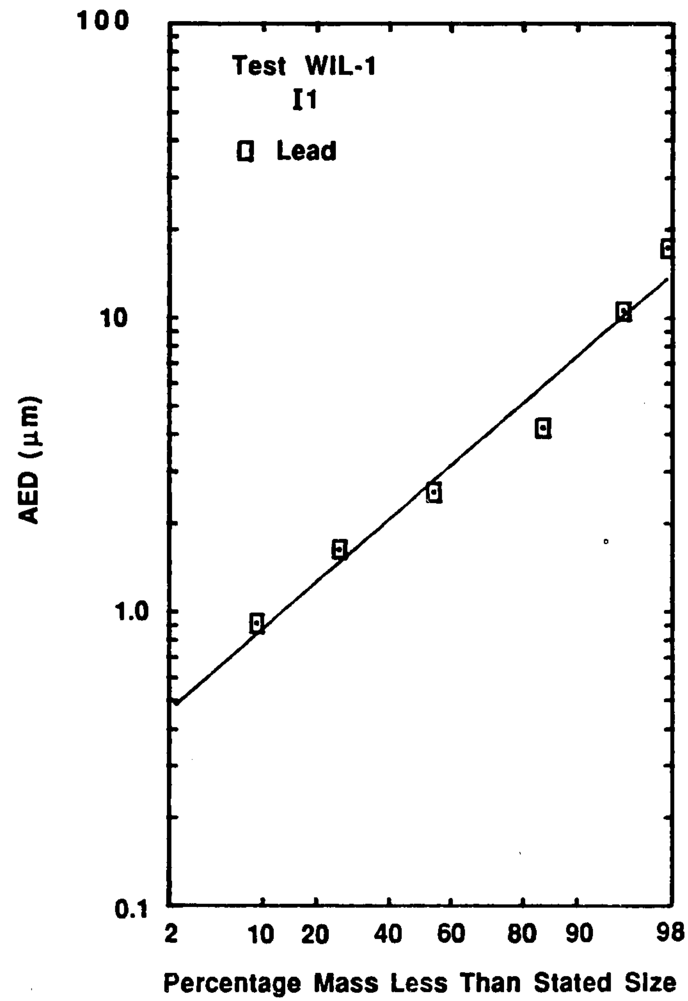

Figure B-9. Log Probability Plot of Test WIL-1 Impactor Sample Results.

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