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ESG-DOE-13281

QUARTERLY TECHNICAL PROGRESS REPORT

REACTOR SAFETY

JANUARY — MARCH 1979

DOE Research and Development Report

*Prepared for the United States
Department of Energy,
Division of Reactor Research and Technology,
under Contract Number DE-AT-03-76SF74028*

MASTER

Rockwell International

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The preceding Progress Report was ESG-DOE-13264

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Program: LMFBR Safety			
DOE Task: Task 28, Reactor Safety — AI LOA Integration Tasks, Subtask A			
Program Manager: R. E. Schnurstein		Project Manager: H. A. Morewitz	
Reporting Period: January-March 1979		Category:	
General Order: 09321	Budget Activity: AG-10-20-41-5	WPPA Number: SA048	

Principal Investigators: H. A. Morewitz, E. U. Vaughan, J. Mills

I. PROJECT OBJECTIVES

The project objectives are to provide licensing support to the working groups and to participate in SACRD as required.

II. ACCOMPLISHMENTS DURING REPORT PERIOD

H. A. Morewitz and J. Hartung attended a LOA-3 meeting at SRI.
H. A. Morewitz attended a LOA-4 meeting at San Diego.

Program: LMFBR Safety		
DOE Task: Task 28, Reactor Safety — AI LOA Integration Tasks, Subtask B		
Program Manager: R. E. Schnurstein	Project Manager: H. A. Morewitz	
Reporting Period: January-March 1979	Category:	
General Order: 09321	Budget Activity: AG-10-20-41-5	WPPA Number: SA048

Principal Investigator: C. J. Meisl

I. PROJECT OBJECTIVES

The project objectives are to conduct risk assessments and cost benefit analyses as required for the direction of AI safety activities.

II. MAJOR ACCOMPLISHMENTS DURING FISCAL YEAR 1979

Program planning in the LOA-3 and LOA-4 areas has been established on a risk-based approach. This makes it possible to rank each task according to its cost effectiveness in reducing LMFBR risks.

III. PROGRESS DURING REPORT PERIOD

The R&D program planning effort for the AI LOA-3 and LOA-4 tasks was concluded and it accomplished the following during the report period:

- 1) Based on the risk-based planning method described in the last quarterly program report, a detailed R&D program plan was established. Eleven specific R&D tasks were defined by work scope, schedule, manpower, and equipment requirements, and their total cost was determined.
- 2) The tasks were rated with respect to their completeness of fulfilling accident barrier goals.
- 3) The tasks were evaluated with respect to their effectiveness, using these three criteria: utility, technical feasibility and cost.

- 4) The final step consisted of ranking the R&D tasks based on a "Task Desirability Index." This Index employs an algorithm which combines multiplicatively the risk-weighted ratings of task relevance with the ratings for task completeness and for task relevance.

The ranking method resulted in the following list of priorities:

<u>Priority</u>	<u>R&D Tasks</u>
(highest) 1	<ul style="list-style-type: none"> III — Na spray-fire tests in enclosed air environments V — SOMIX code development
2	<ul style="list-style-type: none"> II — Atmospheric sodium combustion product aerosol tests VI — COMRADEX code development
3	<ul style="list-style-type: none"> I — High-temperature, high-concentration UO_2 + Na aerosol tests IV — HAA code development
4	<ul style="list-style-type: none"> VIII — Molten fuel + molten stainless steel-retention bed interaction tests XI — Thermal modeling of molten core debris
(lowest) 5	<ul style="list-style-type: none"> VII — Molten fuel-retention bed interaction tests X — Molten fuel + molten stainless steel + sodium-retention bed interaction tests IX — Sodium-retention bed interaction tests

The program planning method and its results were documented in an internal report, Ref. 1.

IV. NEXT REPORT PERIOD ACTIVITIES

No further work is planned for the next quarter except for continued monitoring of AI safety activities.

REFERENCE

1. N001PP130003, "Program Plan for Atomics International's LOA-3 and LOA-4 Tasks," C. J. Meisl, May 1979

Program: LMFBR Safety

DOE Task: Task 28, Reactor Safety — AI LOA-4; WBS A4.1, Subtask A

Program Manager: R. E. Schnurstein

Project Manager: H. A. Morewitz

Reporting Period: January-March 1979

Category:

General Order: 09320

Budget Activity: 10-20-41-4

WPPA Number: SA047

Task Title: AI-LOA-4 Tasks

Subtask Title: Attenuation in Faulted Containment: High Density
Aerosol Depletion

Principal Investigators: C. T. Nelson and E. U. Vaughan

I. SUBTASK A-1 OBJECTIVES

The objectives for this subtask are to investigate mechanism that will lead to rapid attenuation of aerosol within reactor containment, and to continue development of the HAA-3 Code in order to calculate the rate of depletion of high concentration aerosols.

II. MAJOR ACCOMPLISHMENTS DURING FISCAL YEAR 1979

A technique for producing mixed UO_2 and sodium aerosols has been developed. Dense UO_2 aerosols are produced within the containment tank of a large arc furnace. The arc is turned off, and liquid sodium is sprayed into the crucible containing the molten UO_2 , where the sodium is vaporized. Sodium vapor then condenses on the previously produced UO_2 aerosol.

III. PROGRESS DURING REPORT PERIOD

A. SUBTASK A-1 — EXPERIMENTS ON HIGH-TEMPERATURE CONCENTRATION AEROSOLS

Certain types of hypothetical reactor accidents in LMFBR's could produce large amounts of aerosolized fuel debris mixed with sodium vapor and fission gas. The accompanying sodium slug motion would stretch the head tiedown bolts, allowing the debris to escape in the reactor containment building. The radiological hazard associated with the debris is reduced by the plugging of leaks by the aerosol.

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Figure 1. Aerosol Buildup in 30.5 cm Duct

B. SUBTASK A-2 — HAA-3 DEVELOPMENT

FORTTRAN coding for introducing inertial and shear turbulent agglomeration models and a size-dependent collision efficiency model into the HAA-3B code was developed.

The HAARM-3 has been implemented on the CDC 7600 at Berkeley. The sample problem has been run to completion. The HAA-3B code has been implemented on the CDC 7600 at Berkeley and a test problem run successfully. Modifications to HAA-3B are in process.

A model for the plugging of ducts by deposition from flowing aerosols has been presented previously.^(1,2) Subsequent testing and extension of this model are reported here.

Figure 1 is a photograph⁽³⁾ of a 30.5 cm duct through which sodium carbonate aerosol at a concentration of about 23 g per standard cubic meter had been flowing at 7.1 standard cubic meters per minute for ~8 h. The distance between the successive rings of maximal deposition is reported as about two pipe diameters. This picture supports the model assumption of local concentration of deposits, but the striking multiplicity of such regions of concentration had not been anticipated by the model. It is believed to constitute an elaboration rather than a contradiction of the model, however.

The model predicts that the suspended mass that passes the plug up to the time it closes the duct is proportional to the cube of the duct diameter. Figure 2 gives the current status of experimental support for this prediction. It contains two new points, one of which represents the fact that the duct shown in Figure 1 plugged completely when the time of flow at the stated rate and concentration reached ~24 h. The other represents the plugging of the first straight section of the multiple-bend leak path previously reported.⁽⁴⁾

The coefficient K in the rule predicted by the model,

$$\bar{M} = KD^3, \quad \dots(1)$$

is not provided by the model, but can be read from Figure 2 as

$$K = 10 \text{ g/cm}^3. \quad \dots(2)$$

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Figure 2. Duct Diameter vs Plugging Mass

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Since actual leak paths do not necessarily have the circular cross section employed in the duct-plugging model, extension of the model is necessary. Examples are cracks in concrete, the eccentric annular leaks developed through the head seals during an HCDA, and the possibility that louvers will be used in the Reactor Service Building. Insight into these cases can be provided by a plugging model for a duct whose cross section is a long narrow slit. The result of such an extension, using essentially the same argument as for the cylinder, is that the mass $\bar{M}$ that passes through the slit up to the time it is plugged is

$$\bar{M} = K' L W^2, \quad \dots(3)$$

where L is the length and W the width of the slit.

The model rules, Equations 1 and 3, have the appearance and much of the significance of results of dimensional analysis, the coefficients K and K' containing a common dimensional factor ρ , the effective density of the plug. The assumptions of the model, especially that regarding the maintenance of geometrical similarity by the plug during its growth, are such as to eliminate from the result all parameters other than ρ and those appearing in Equations 1 and 3, whose form is accordingly determined by dimensional considerations. In the case of Equation 3, the further assumption is required that deposition is uniform along the length L of the slit, so that $\bar{M}$ and L can occur only in the combination $\bar{M}/L$. The justification for this assumption, in the face of the random fluctuations expected in the deposition process, is that the plugging is not complete until the entire length L is blocked.

It is also of interest to consider the relative magnitudes of the coefficients K and K' , especially just now when there is experimental information on K but not on K' . The analytic expressions provided by the model are

$$K = \frac{\pi}{4} \alpha \rho \int_0^1 dx (2 - 3 \beta x) / [(2 - x)E(x)], \quad \dots(4)$$

$$K' = \alpha' \rho \int_0^1 dx / E'(x), \quad \dots(5)$$

where

α, α' = respective ratios of the cross-sectional area of the plug to the square of its height,

x = ratio of height of the growing plug to its final value, at which the duct is blocked,

$E(x), E'(x)$ = respective efficiencies of collection of aerosol material by the plug,

β = ratio of height of center of mass of the plug to height of the plug.

If the change in duct geometry has a minor effect on the shape of the plug and on the streamlines of the flow past it, then $\alpha' \sim \alpha$ and $E'(x) \sim E(x)$ may hold. The principal difference between K and K' will then arise from the factor $(2 - 3\beta x)/(2 - x)$ in the integrand of K , whose behavior is determined by the value of β . If, in particular, $\beta \sim 1/3$, then

$$K' \sim 4K/\pi \sim K, \quad \dots(6)$$

the last step reflecting the probability that $\pi \sim 4$ holds with accuracy similar to $\alpha' \sim \alpha$ or $E'(x) \sim E(x)$.

The possible values of β have been explored by writing its definition in the form

$$\beta = \frac{\int_0^1 dy \, y \, z(y)}{\int_0^1 dy \, z(y)}, \quad \dots(7)$$

where

y = coordinate normal to duct wall

= 0 at duct wall

= 1 at highest point of plug,

$z(y)$ = length of plug parallel to flow direction in duct, measured at distance y from duct wall.

The unit in which y is measured is thus the plug height, while that of z is arbitrary, since z enters Equation 7 homogeneously of order zero. Since it is more usual to give $y(z)$ than $z(y)$, it is convenient to transform Equation 7 by integrating by parts, getting

$$\beta = \frac{1}{2} \int_{z_-}^{z_+} dz y^2(z) \left/ \int_{z_-}^{z_+} dz y(z) \right., \quad \dots(8)$$

where

$$z_{\pm} = \text{values of } z \text{ at which } y(z) = 0.$$

Since the plug is approximately parabolic at the top, which is weighted heavily by the factor y in the numerator integrand of Equation 7, the parabolic plug is a convenient reference case. It gives with Equation 8:

$$y = 1 - z^2, \quad z_{\pm} = \pm 1, \quad \beta = \frac{1}{2} \frac{1 - \frac{2}{3} + \frac{1}{5}}{1 - \frac{1}{3}} = \frac{2}{5} = 0.400. \quad \dots(9)$$

Still simpler is the triangular plug, represented by

$$y = 1 - |z|, \quad z_{\pm} = \pm 1, \quad \beta = \frac{1}{2} \frac{1 - 1 + \frac{1}{3}}{1 - \frac{1}{2}} = \frac{1}{3} = 0.333, \quad \dots(10)$$

which is the value that leads to Equation 6.

The value for the rectangular plug,

$$y = 1, \quad y^2 = 1, \quad \beta = \frac{1}{2} = 0.500, \quad \dots(11)$$

is presumably an upper bound, since larger values of β can only be obtained for "overhanging" plugs, whose greatest dimension parallel to the flow is not in contact with the duct wall.

For the sinusoidal plug, suggested by Figure 1, the calculation gives

$$y = \cos z, z_{\pm} = \pm\pi/2, \beta = \frac{1}{2} \frac{\pi/4}{1} = \frac{\pi}{8} = 0.393, \quad \dots(12)$$

close to the parabolic plug.

The Gaussian plug gives

$$y = e^{-z^2}, z_{\pm} = \pm\infty, \beta = \frac{1}{2} \frac{2 \int_0^{\infty} dz e^{-2z^2}}{2 \int_0^{\infty} dz e^{-z^2}} = \frac{1}{2\sqrt{2}} = 0.354. \quad \dots(13)$$

A similar shape is the hyperbolic secant, for which

$$y = \operatorname{sech} z, z_{\pm} = \pm\infty,$$

$$\beta = \frac{1}{2} \frac{2 \int_0^{\infty} dz / \cosh^2(z)}{2 \int_0^{\infty} dz / \cosh(z)} = \frac{\int_0^{\infty} dz / (e^z + e^{-z})^2}{\int_0^{\infty} dz / (e^z + e^{-z})} = \frac{\int_0^{\infty} e^{2z} dz / (e^{2z} + 1)^2}{\int_0^{\infty} e^z dz / (e^{2z} + 1)}$$

$$\beta = \frac{1}{2} \frac{\int_1^{\infty} dx / (x + 1)^2}{\int_1^{\infty} dx / (x^2 + 1)} = \frac{1}{2} \frac{\frac{1}{2}}{\arctan x \Big|_1^{\infty}} = \frac{1}{\pi} = 0.318. \quad \dots(14)$$

This is the first case that has appeared having β less than 1/3.

A range of shapes is represented by the form

$$y = 1/(1 + z^2)^n, \quad z_{\pm} = \pm\infty, \quad \beta = \frac{1}{2} I_{2n}/I_n, \quad \dots(15)$$

$$I_n = \int_0^{\infty} dz/(1 + z^2)^n. \quad \dots(16)$$

There follows

$$\begin{aligned} I_{2n} &= \int_0^{\infty} dz/(1 + z^2)^{2n} = \int_0^{\infty} dz/(\alpha + z^2)^{2n} \Big|_{\alpha=1} \\ &= \frac{(n-1)!}{(2n-1)!} \left(-\frac{d}{d\alpha}\right)^n \int_0^{\infty} dz/(\alpha + z^2)^n \Big|_{\alpha=1} \\ &= \frac{(n-1)!}{(2n-1)!} \left[\left(-\frac{d}{d\alpha}\right)^n \left(\frac{1}{\alpha}\right)^{n-\frac{1}{2}} \right]_{\alpha=1} I_n, \quad \dots(17) \end{aligned}$$

and consequently

$$\beta_n = \frac{1}{2} \frac{(n-1)!}{(2n-1)!} \frac{(2n-3/2)!}{(n-3/2)!}. \quad \dots(18)$$

Numerical results are

n	1	2	3	4	∞
β_n	0.250	0.3125	0.328	0.335	0.354

The value given for $n \rightarrow \infty$, which is obtained by using Stirling's approximation for the factorials in Equation 18, is seen to agree with the Gaussian plug of Equation 13. In fact, for large n , y of Equation 15 vanishes unless z is very small, in which case $1 + z^2 \sim \exp(z^2)$, and y can be approximated as

$$y = (1 + z^2)^{-n} \sim e^{-nz^2}, \quad \dots(19)$$

which is indeed a Gaussian.

For most of the interesting shapes, it appears that

$$0.250 < \beta < 0.400. \quad \dots(20)$$

The factor $(2 - 3\beta x)/(2 - x)$ of Equation 14 is bounded by its values of unity at $x = 0$ and $(2 - 3\beta)$ at $x = 1$. The condition of Equation 20 then imposes the bounds

$$0.8 < 2 - 3\beta < 1.25, \quad \dots(21)$$

which are fairly close to unity. It is thus unlikely that the value of β will be such as to make the integrands of Equation 4 and 5 differ materially. It is then probable that the actual shape of the plug will be such as to justify Equation 6.

IV. NEXT REPORT PERIOD ACTIVITIES

A. SUBTASK A-1

Further mixed sodium and UO_2 aerosol tests will be performed using the improved instrumentation developed in the first and second quarters.

B. SUBTASK A-2

Continued modifications to the HAA-3 code will be made. The effect of these modifications on sample problems will be made.

REFERENCES

1. Quarterly Technical Progress Report, LMFBR Safety Program, October-December 1977, AI-DOE-13223 (1978)
2. E. U. Vaughan, TANSO 28, 507 (1978)
3. A. E. Stewart, private communication (AI, November 1978)
4. Quarterly Technical Progress Report, LMFBR Safety Program, January-March 1978, AI-DOE-13234 (1978)

Program:	LMFBR Safety		
DOE Task:	Task 28, Reactor Safety — AI LOA-3; WBS A3.1, Subtask A		
Program Manager:	R. E. Schnurstein	Project Manager:	H. A. Morewitz
Reporting Period:	January-March 1979	Category:	
General Order:	09319	Budget Activity:	AG-10-20-41-3 WPPA Number: SA046
Task Title:	AI LOA-3 Tasks		
Subtask Title:	Energetics Effects of Sodium Spray Fires		

Principal Investigators: M. P. Heisler, K. Mori

I. SUBTASK A OBJECTIVES

Subtask A objectives are to provide a means of analysis of sodium spray fires in air atmospheres in confined spaces. For Subtask B a computer code, SOMIX-II, will be developed which will extend a previous code, SOMIX-I, to the air environment of the secondary heat transfer vault and the secondary containment envelope. Pressure rise is the principal variable to be calculated. The analysis is to be supported by experiments in sodium drop and spray burning.

II. MAJOR ACCOMPLISHMENTS DURING FISCAL YEAR 1979

None.

III. PROGRESS DURING REPORT PERIOD

A. SUBTASK A-1

No experimental work was performed on this subtask during this quarter.

B. SUBTASK A-2 — SOMIX-II DEVELOPMENT

SOMIX-I was designed primarily to evaluate sodium spray fires in very low oxygen atmospheres, such as the inerted atmospheres of the primary heat transfer

equipment vaults. However, current sodium fire accident analysis is being directed more and more toward high intensity spray fires in the high oxygen air atmospheres of the secondary heat transfer vaults.

The SOMIX code has been revised for sodium spray fires in air atmospheres by use of a modified Krolikowski version of the Baker and Tevebaugh sodium combustion model.^(1,2) The combustion model uses the following equations to solve for the combustion temperature and oxygen reaction rate.

Heat balance equation

$$Y_k \frac{(X_0 - X_{OB})}{1 - X_{OB}} H_c = \sigma F_g (T_c^4 - T_g^4) + \sigma F_{cw} (T_c^4 - T_{wall}^4) + h(T_c - T_g)$$

Chemical-equilibrium relationship

$$\Delta F = RT_c \ln [16(P_g X_{OB})^{2.5}]$$

Relationship between standard free energy of reaction and temperature

$$\Delta F = 57.41 T_c - 128030$$

where

Y_k = mass transfer coefficient

X_0, X_{OB} = oxygen mole fraction in ambient and burning zones

H_c = heat of combustion

σ = Stefan-Boltzmann constant

F_g, F_{cw} = emissivity of gas, combustion zone to wall

T_c, T_g, T_{wall} = temperatures: combustion, gas, and wall

h = heat transfer coefficient

R = gas constant

P_g = gas pressure

ΔF = free energy of reaction

A modification of an existing ANL FORTRAN subroutine RXRATE⁽¹⁾ was developed for this burning model. This subroutine was programmed and incorporated into the SOMIX-II code with the following modifications for oxygen mole fractions greater than 0.05: (1) add heat loss to the walls due to radiation, (2) modify the Newton-Raphson successive approximation procedure so as to improve the convergence properties of the iteration loop, (3) use SOMIX-I nitrogen gas properties, and (4) use the JANAF tables for the thermochemical properties of the combustion products.⁽³⁾

A two-dimensional drag force subroutine was programmed to determine the force exerted on the gas field by the sodium droplets. The subroutine is based on the following drag functional model of the KACHINA code.⁽⁴⁾

$$K = \frac{6 \rho_g \alpha_d}{\alpha_g \bar{D}^2} \left[3 \nu_g + \frac{C_D \bar{D}}{8} (|\vec{u}_g - \vec{u}_d|) \right]$$

where

ρ_g = gas density

α_d, α_g = drop and gas void fractions

$\bar{D}$ = mean drop diameter

ν_g = kinematic gas viscosity

C_D = drag coefficient

$\vec{u}_g, \vec{u}_d$ = gas and drop velocity vectors

A generalized convection transport subroutine was programmed to update the sodium drop momentum, mass and number densities, and gas temperature and oxygen mass density for the next time cycle. Appropriate velocities and dependent variables need to be supplied to this "upwind" finite differencing routine.

In order to incorporate a two-dimensional sodium droplet transport model into SOMIX, subroutines were programmed for the transport momentum, mass and number density equations. The droplet motion will be calculated separately for each mean droplet diameter. Equations for the drop field consist of the following:

Momentum:

Axial direction

$$\frac{\partial \overline{\rho u}_d}{\partial t} + \frac{\partial \overline{\rho u}_d u_d}{\partial X} + \frac{1}{r} \frac{\partial r \overline{\rho u}_d v_d}{\partial r} = K_X (u_g - u_d) - g \rho_d$$

Radial direction

$$\frac{\partial \overline{\rho v}_d}{\partial t} + \frac{\partial \overline{\rho v}_d u_d}{\partial X} + \frac{1}{r} \frac{\partial r \overline{\rho v}_d v_d}{\partial r} = K_R (v_g - v_d)$$

where

$\overline{\rho u}_d, \overline{\rho v}_d$ = drop momentum

u_d, v_d = drop velocity

K_X, K_R = drag function

ρ_d = mass density

g = gravity constant

Continuity

$$\frac{\partial \rho_d}{\partial t} + \frac{\partial \rho_d u_d}{\partial X} + \frac{1}{r} \frac{\partial r \rho_d v_d}{\partial r} = 0$$

Number density, QND

$$\frac{\partial QND}{\partial t} + \frac{\partial QND \cdot u_d}{\partial x} + \frac{1}{r} \frac{\partial r QND \cdot v_d}{\partial r} = 0$$

IV. NEXT REPORT PERIOD ACTIVITIES

Programming of SOMIX will continue. Experiments in sodium drop and spray burning will be delayed until the last quarter of the fiscal year because of scheduling difficulties.

REFERENCES

1. Krolikowski, T. S., "Violently Sprayed Sodium-Air Reaction in an Enclosed Volume," ANL-7472, September 1968
2. Baker, L. and Tevebaugh, A. D., "Sodium Air Reactions," ANL-7055, October 1965, pp 208-211
3. JANAF Thermochemical Tables, The Dow Chemical Company, Midland, Michigan (1965)
4. Amsden, A. A. and Harlow, F. H., "KACHINA: An Eulerian Computer Program for Multifield Fluid Flows," LA-5680, December 1974

Program:	LMFBR Safety		
DOE Task:	Task 28, Reactor Safety — AI LOA-3; WBS A3.2, Subtask B		
Program Manager:	R. E. Schnurstein	Project Manager:	H. A. Morewitz
Reporting Period:	January - March 1979	Category:	
General Order:	09319	Budget Activity:	AG-10-20-41-3 189a Number: SA046
Task Title:	AI-LOA-3 Tasks		
Subtask Title:	Core Debris Accommodation — Ex-Vessel Retention in Reactor Cell		

Principal Investigators: C. A. Guderjahn

I. SUBTASK B OBJECTIVES

Subtask B objectives are to conduct tests that will determine the effect of molten core debris on underlying structural or sacrificial material. A large arc furnace is available for melting UO_2 and steel for this purpose.

II. MAJOR ACCOMPLISHMENTS DURING FY 1979

There were no major accomplishments during this period.

III. PROGRESS DURING REPORT PERIOD

A. SUBTASK B: LARGE-SCALE MOLTEN FUEL TESTS

This subtask involves the arc-melting and pouring of UO_2 onto reactor structural materials to simulate the aftermath of an LMFBR CDA. Results of earlier tests have been previously reported.⁽¹⁾

The improved cooling water system was checked out and found to perform satisfactorily. Improved power controllers have been specified and ordered.

IV. NEXT REPORT PERIOD ACTIVITIES

An investigation of methods of pouring molten UO_2 into sodium will be initiated. It is planned to pour molten material through a nozzle located beneath the furnace into a large tank of sodium.

Program:	LMFBR Safety		
DOE Task:	Task 28, Reactor Safety — AI LOA-4; WBS A4.2, Subtask B		
Program Manager:	R. E. Schnurstein	Project Manager:	H. A. Morewitz
Reporting Period:	January - March 1979	Category:	
General Order:	99320	Budget Activity:	AG-10-20-41-4 189a Number: SA047
Task Title:	AI-LOA-4 Tasks		
Subtask Title:	Attenuation in Environment — Aerosol Depletion During Atmospheric Transport		

Principal Investigators: R. P. Johnson, C. T. Nelson, J. Otter

I. SUBTASK B OBJECTIVES

Subtask B objectives are as follows:

- 1) Calculate the atmosphere release tests and compare analytical with experimental results. Make improvements in the computer codes as needed to better predict the behavior of any sodium combustion product aerosols released to the atmosphere following a hypothetical reactor accident.
- 2) Release sodium combustion product aerosols in the open atmosphere and determine rate and amount of fallout, change of chemical species particle size, and behavior of plume.

II. MAJOR ACCOMPLISHMENTS IN GFY 1979

Further LOA-4 experiments, involving the release of sodium combustion product aerosols to the atmosphere, have been conducted at the Idaho National Engineering Laboratory (INEL). These tests* have investigated the behavior of the aerosols released by sodium spray fires under stable atmospheric conditions.

*These tests were conducted jointly with the Air Resources Laboratory (ARL) of the National Oceanic and Atmospheric Administration.

III. PROGRESS DURING REPORT PERIOD

A. SUBTASK B-1: ATTENUATION IN THE ENVIRONMENT

The COMET code was modified to include, as an option, the calculation of the total deposition summed over down wind distance. Simple numerical integration formulas are used as a first cut. Cases were run for dry deposition without gravitation. The calculated deposition was properly limited to the amount released. However, the plume above the release height was fractionally depleted the same amount as that below the release height, so that the deposition was overcalculated for nearer distances. Thus, other mechanisms must be examined to explain the underevaluation of deposition compared to the experiments.

B. SUBTASK B-2: ATMOSPHERIC SODIUM RELEASE TESTS

The reduction of the test data is essentially completed. See test report N707TR130028 Interim Test Report for the Characterization of Released Particle Tests conducted at INEL during FY 1979.

IV. NEXT REPORT PERIOD ACTIVITIES

Various improvements to the COMET code will be made in order to bring it into better agreement with experimental results.