AIIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

WESTINGHOUSE SAVANNAH RIVER COMPANY
SAFETY ANALYSIS AND RISK MANAGEMENT

WSRC-TR-92-87
Revision 0

Savannah River Laboratory

Key Words: AACS, K Area Smoke
Tests, Downwash,
Smoke Canisters

Retention: Lifetime

SRS REACTOR STACK PLUME MARKING TESTS (U)

By

S. F. PETRY

MARCH 1992

Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

SAVANNAH RIVER SITE

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. DE-AC09-87SR18035

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Document:

WSRC-TR-92-87, Revision 0

Title:

**SRS REACTOR
STACK PLUME MARKING TESTS (U)**

APPROVALS

S. F. Petry, Author

2/18/92
Date

B. G. Kingery, Technical Reviewer

2/19/92
Date

N. D. Woody, Derivative Classifier

2/19/92
Date

R. L. Olson, Manager RAG

2/21/92
Date

M. J. Hitchler, Manager RSR

3/8/92
Date

SUMMARY

Tests performed in 105-K in 1987 and 1988 demonstrated that the stack plume can successfully be made visible (i.e., marked) by introducing smoke into the stack breech. The ultimate objective of these tests is to provide a means during an emergency evacuation so that an evacuee can readily identify the stack plume and evacuate in the opposite direction, thus minimizing the potential of severe radiation exposure. The EPA has also requested DOE to arrange for more tests to settle a technical question involving the correct calculation of stack downwash.

New test canisters were received in 1988 designed to produce more smoke per unit time; however, these canisters have not been evaluated, because normal ventilation conditions have not been reestablished in K Area. Meanwhile, both the authorization and procedure to conduct the tests have expired.

The tests can be performed during normal reactor operation. It is recommended that appropriate authorization and procedure approval be obtained to resume testing after K Area restart.

DISCUSSION

1.0 INTRODUCTION

The airborne activity confinement System (AACS) for the SRS reactor 105 buildings was created to prevent atmospheric release of radichalogens and radioactive particulates in the unlikely event of a fuel melting accident. Reduction of potential dose at the site boundary and beyond was a major objective in retrofitting the AACS to the original 105 building ventilation design. Although the AACS lessens the onsite as well as the offsite releases from an accident, a major contribution to the lessening of potential doses to 105 building evacuees and onsite personnel remains the elevated release from the stack 200' above ground level.

In case of a fuel melt accident, the AACS will not prevent the release of noble gases or tritium into the atmosphere. These releases within the stack plume pose a substantial radioactive hazard to those evacuating the 105 Building¹. In recognition of this potential hazard, a program was initiated in 1986 to develop a means to temporarily make the stack plume visible by marking it with smoke.

2.0 OBJECTIVE

Ultimately the objective was to develop a plume marking system to be activated from the central control room (CCR) and used as an integral part of the building evacuation procedure. Thus, an evacuee leaving the building could simply look at the top of the stack, determine which way the plume was drifting, and avoid walking beneath the plume by evacuating in the opposite direction.

3.0 PREPARATION FOR TEST PROGRAM

3.1 Location of Point of Smoke Introduction to Stack

The first step in the program was to locate a place and create a means to introduce smoke into the stack. It was found that a manway opening was made into the stack breach in L, K, & C Areas during the modifications made when the AACS was installed. This opening was sealed with a 52" square steel plate on the side of the breach next to filter compartment (FC) #4. To be certain that the opening behind the steel plate was not obstructed in some way, an inspection was made in C Area on 8/29/86 according to Job Plan JP 1310². The opening and breach were found clear when T&T rigged the cover plate away, and it was decided to design a means to introduce test smoke devices through this opening.

3.2 Selection of Smoke-Producing Canisters

After reviewing available means of generating test smoke, pyrotechnic devices were chosen, which are fired by electrical squib igniters. Two kinds of smoke generating canisters were selected. The main ingredient in one canister, routinely used by the military, is zinc chloride. The principal element in the other canister, often used in theatrics (e.g., parachutists marking their descent), is food dye.

The military-type canisters were ordered from Superior Signal Company, Inc. in Spotswood N. J. These were designated as Superior White Smoke Pots, 4-1/4" in diameter and 6" high metal containers, which were designed to emit approximately 500,000 cubic feet of white smoke in 6 minutes. The Material Safety Data Sheet³ for these canisters is given in the Appendix, Item 1.

The theatric-type canisters were not immediately available with enough capacity, but MP Associates, Inc. in Oakland, California, agreed to develop test canisters large enough to adequately mark the SRS reactor stack plume. Colored smoke is preferable in this application, because white smoke might be

misinterpreted under true reactor accident conditions. The Material Safety Data Sheet⁴ for these canisters is given in the Appendix, Item 2.

Plans were then made to set off the canisters first in an open field to gain experience in battery ignition and to subjectively observe the smoke generation, dissipation, and residue. The onsite Wackenhut Advanced Tactical Training Area (ATTA) was selected for the initial trials. The proposed test program was submitted⁵ for NEPA evaluation and NEPA clearance⁶ was granted. These preliminary tests were conducted at the ATTA range in October, 1986 according to a special approved procedure. The military-type canister ignited readily with a 9-volt battery and produced a large volume of smoke (see Figure 1), leaving only a small residue on the ground immediately around the metal container. A representative small 2-1/2" diameter smoke candle of the theatric-type was tested (from MP Associates) while larger canisters were being created. The small canister also ignited readily and produced red smoke with little residue.

3.3 Initial Smoke Canister Holder

MP Associates gave the size of the initial test canisters at ~8-1/2" diameter by ~12" long. (These smoke generating devices appeared to be housed in white ice cream cartons.) The hand-drawn sketch in Figure 2 was used to guide the fabrication of the first holder for the test smoke canisters. The holder was fabricated in the SRL Maintenance Shop and installed by Reactor Maintenance in K Area (see Figure 3).

4.0 SEPARATE PROGRAM BY ENVIRONMENTAL TECHNOLOGY

During this period, the SRL Environmental Transport Group in the Environmental Technology Division was subcontracting wind tunnel experiments by Colorado State University. The objectives of these experiments were to determine the effects of stack plume interaction with the 105 Building structure itself, the effect of irregular terrain, and the effects of unstable and stable thermal stratification. A better understanding of these effects was needed to generate a more accurate appraisal of the potential value of increasing the height of a 105 Building stack. The plume marking tests provided an ideal opportunity to compare full scale testing results with the experimental wind tunnel testing results. Accordingly, the Environmental Transport Group was invited to join in the plume marking test program.

One interactive phenomenon of particular interest to Environmental Technology is downwash. Downwash is caused by a low pressure area formed downwind behind the stack. As it exits the top of the stack, the plume tends to be drawn

down into this low pressure area. Downwash thus reduces the effective height of the stack. One solution considered to this problem is to cap the top of the stack with a device to cone down the exit diameter, increasing the exit exhaust velocity to force the plume upward, thus reducing or eliminating downwash.

5.0 FIRST TESTING IN K AREA

Test Authorization (TA) 1-2253⁷ was issued on December 2, 1986, authorizing plume marking tests in the 105 Building stacks. TA 1-2253 required that the reactor be shut down when canisters were inserted and removed from the holder. Ventilation conditions were required to be the same as during normal reactor operation, however, to provide a representative stack air flow of $100,000 \pm 20,000$ cfm. Special Procedure SP-2408⁸ was prepared to guide the specific testing in 105-K authorized under TA 1-2253.

Four tests were conducted in 105-K on 3/11/87 in which the plume from a normal stack exhaust flow of about 115,000 cfm was marked with smoke. The first test with a military-type canister was made at 9:36 AM with a strong (~14 mph) wind. Directly behind the stack were dense grey-white clouds. The canister produced smoke for about 6 minutes. As the smoke first exited the stack, it was readily visible. It seemed to blend in more with the cloudy background after the first minute, although it remained legibly visible throughout the test.

The second test was made at 11:08 AM with the first of the theatric-type test canisters. Food dye was intended to sublime and produce yellow smoke from this canister. Instead, the canister caught fire and burned for about a minute, producing a rich black smoke, very apparent (see Figure 4) but highly undesirable. It was decided not to test more of these canisters until the problem of ignition could be corrected. Note that the downwash phenomenon described above was very pronounced during this brief test.

The third test on 3/11/87 was conducted with a military-type smoke canister at 3:08 PM with the wind 7 to 8 mph. The sky was overcast with thin white clouds through which the blue sky background could be seen and sunlight was shining through. The white plume was clearly visible as it rose from the top of the stack (see Figure 5), but then the plume broke up and descended toward the ground. This phenomenon resulted from strong convection conditions, wherein the ground is heated by the sun, which causes updrafts of warm air and downdrafts of cooler air. The existence of such downdrafts was clearly demonstrated by the smoke-marked plume. Following this test widespread smoke was observed hovering near the ground between the K Area exclusion area fence and the perimeter fence (see Figure 6).

From this test it is clear that the existing 105 Building stacks do not provide protection downwind to evacuating personnel under strongly convection conditions. The need for plume marking during emergency evacuations is further emphasized, since an evacuee would be at far greater risk walking through a potentially radioactive plume as compared with walking beneath it.

The fourth and final test on 3/11/87 was saved until after dark beginning at 7:39 PM. The military-type canister produced smoke for only about three minutes with the wind at ~7 mph. Before dark, a lighting trailer was borrowed from Construction and parked between the 110 Building and the stack area. The trailer lamps were tilted in the general direction of the top of the stack. This technique worked very well. Although the background sky was cloudy, it was clear near the ground and the artificial lighting illuminated the plume near the top of the stack very well. A time-exposed photograph was made of this test as given in Figure 7. Of course, such lighting would not be successful on a night in which a dense fog obscured the top of the stack from ground view, which is a weakness in the program to visually mark the plume. In such a case, the existing method of directing evacuation upwind by voice announcement (from reading the CCR wind instrumentation) would still be in effect.

5.0 DEVELOPMENT OF YELLOW SMOKE CANISTERS

5.1 Tests at Ford Building

Although the first stack plume marking tests in 105-K were technically successful using conventional military smoke pots, plume marking with colored smoke is still preferred. Colored smoke is more readily visible and more obviously an intentional plume mark. MP Associates, Inc., who had earlier agreed to develop a satisfactory colored smoke canister for us, was informed of the unsatisfactory burning of the first of their test canisters during the 3/11/87 tests in 105-K. MP Associates then redesigned the canisters and sent tests models which they expected to sublime directly to smoke without flaming. They recommended yellow smoke, but they also furnished us with some red smoke test canisters.

To gain confidence in the redesigned canisters before testing them in a reactor breach, tests were conducted on 9/9/87 on the gravel surface outside of the Ford Building (near Central Shops). In the first two tests with a yellow and a red smoke canister, both burst into flame very quickly (see Figure 8), producing a thick black smoke near the canister (which began changing into color about 20' downwind). Two more test canisters (one yellow and one red) produced brightly colored smoke for several minutes before also catching on fire and producing black smoke.

When MP Associates were told that the test canisters were still catching on fire, they were surprised but insistent that they could correct this problem with the addition of flame suppressant to the mix. They redesigned the test canisters again, and conducted a number of tests themselves to be sure the canisters did not catch fire. The new design included increased air cooling provisions and improved internal insulation as well as additional flame retardant in the mixture.

These canisters arrived inside a metal can which was further contained inside a metal foil pouch. The waterproof foil pouch is used by the vendor to pass stringent moisture resistance requirements imposed in some military applications. In view of the high humidity of the 105 Building stack exhaust air in wet weather, this protection should eventually prove valuable to protect smoke canisters located inside a stack breach awaiting a potential emergency evacuation.

Two of the waterproofed canisters were successfully set off on 11/6/87 in the parking lot near the Ford Building. Both generated yellow smoke for about seven minutes, and there was no sign of the flaming experience in earlier tests. Before testing the second canister, water was poured over it (see Figure 9) to add a brief waterproofing check. As seen in Figure 10, this canister produced a good volume of smoke (yellow) after being set off with ease.

5.2 Change in Canister Size

As described above, the new test canisters were housed in metal cans inside of a foil pouch (see Figures 9 & 10). The metal can itself is about 9-1/2" in diameter. Because the diameter of the first test canisters was only about 8-1/2", the expanded metal holder (see Figure 1) had a nominal expanded metal diameter of 10". This was installed in 105-K stack breach (Figure 3). It was recognized that the new canisters, even without the foil pouch, were too large for the initial holder design. To continue the test program, the test canisters were subsequently removed from the metal cans (see Figure 11).

5.3 Smoke Filtration

The initial test program in K Area on 3/11/87 was conducted during reactor shutdown conditions. Testing during shutdown is inconvenient, primarily because the tests interfere with many other activities both directly and indirectly. For example, the plume tests must be conducted with 105 Building ventilation configured the same as it is during normal reactor operation, thus producing a representative stack exhaust of roughly 100,000 cfm. However, during shutdown, the ventilation configuration is changed (i.e., a 910 exhaust

fan operates), and the stack flow is substantially higher and therefore nonrepresentative.

The only concern preventing plume marking tests during reactor operation was that the smoke might affect the Kanne monitoring instrumentation. The Kanne chambers are normally protected by permanent metallic filters sized to protect against particles in the sample stream ≥ 5 microns. A representative of MP Associates said that the spectrum of particles generated by the smoke canisters ranged well below 5 microns. He guessed at a minimum particle size of 2 to 3 microns, but was not certain.

Special Cuno filters (see Figure 12) were ordered to substitute for the standard metallic filter in the Kanne sample lines. These were disposable polypropylene filter cartridges rated to filter out particles as small as 0.6 microns or 1.2 microns. These special Cuno filters were thoroughly tested during the 9/9/87 tests at the Ford Building. During the initial testing, the 0.6 micron filter was installed in the sample line to a portable Kanne instrument. The Kanne sample hose was taped to a metal stand, such that the hose sampling end could be placed directly into the smoke rising from a test canister as seen in Figure 8. Although the filter medium turned black from the burning canister smoke, the Kanne instrument reading was unaffected.

The 1.2 micron filter was tested next, which turned yellow from test canister smoke. Again the Kanne instrument reading was unaffected. Finally the standard Kanne 5 micron metal filter was installed in the sample line which was placed directly in red smoke from a test canister. Immediately the Kanne instrument reading rose far upscale. The metal filter was then quickly replaced with the 1.2 micron filter used during the previous test. After the hose tip was again placed directly in the test smoke, the Kanne instrument continued dropping from upscale, confirming good instrument protection with this filter.

Figure 13 is given for reference, showing a portion of the stack air sampling line including the Cuno filter housing protecting the Kanne chamber in the 105-K far sampling room. This is the specific location for the special filter cartridges installed in subsequent tests.

6.0 SECOND TESTING IN K AREA

6.1 Preparation

Having demonstrated that either a 0.6 or 1.2 micron special Cuno filter cartridge would protect the stack sampling line to the Kanne chamber, the only

remaining obstacle to conducting plume marking tests during reactor operation was resolved. Accordingly the test authorization⁹ was revised on 10/14/87 to permit testing during reactor operation.

Subsequently the special procedure was also revised first¹⁰ to permit testing during reactor operation and again¹¹ to strengthen certain safety provisions.

As explained earlier, MP Associates were fabricating the new test smoke canisters in larger diameter cans. The existing smoke canister holder (see Figures 2 and 3) was too small to accommodate the larger canisters, so a new holder was designed (see Figure 14) and fabricated (see Figure 15) by SRL maintenance. This holder has now been installed in the 105-K stack breech by K-Area maintenance. For the second testings in K Area, however, the original canister holder was used for expediency. The inner canister was removed from the outer metal canister (see Figure 11) to permit use of the smaller diameter holder. The outer canister and the annulus between the canisters are designed to control the air supply to the inner canister as it sublimates after ignition.

6.2 Description of Second K-Area Tests

Two stack plume marking tests were conducted in 105-K Building on 4/6/88, one using a yellow smoke canister and the other using a red smoke canister. A photograph of the top of the stack during the yellow smoke test is given in Figure 16. The plume was clearly visible, satisfying the major objectives of the tests.

For unknown reasons, the yellow test canister produced yellow smoke for less than two minutes, while the red smoke continued for more than 5 minutes as expected. (Perhaps testing the inner canister without the outer metal canister affected the duration of smoke production by the yellow test canister.) Atmospheric conditions were overcast during both tests, which tended to lessen the smoke visibility that might have been expected on a clear day. Nevertheless, in both tests, the direction of the plume away from the stack was clearly evident (Figure 16). Thus, the objective was accomplished to demonstrate a plume marking technique that would indicate the direction to avoid when evacuating the 105 Building during a potential fuel-melting accident.

As explained earlier, a special 0.6 micron Cuno filter was installed (Figure 11) to permit the smoke tests to be conducted during reactor operation without interfering with the protection provided by the stack monitors. The special filter successfully protected the stack activity and tritium (STM) monitors as expected.

7.0 NEED FOR ADDITIONAL TESTING

7.1 New Canisters - Hollow Technology

Although the K-Area tests of 4/6/88 were satisfactory, more smoke was desirable (see Figure 16) to mark the stack exhaust plume more distinctly. Accordingly, MP Associates was asked if they could make a canister that produced more smoke per unit time. In response, MP Associates made additional test canisters using what they termed their "hollow technology". Thus a cross-section through the smoke producing mixture becomes a donut instead of a solid circle. The objective of this hollow configuration is to produce more surface area from which to emit smoke, thus increasing the production of smoke from the canister per unit time.

Three yellow smoke canisters having the new hollow core arrived onsite on 9/14/88. Unfortunately, K Area has been shut down ever since, and the priorities of restart have precluded any attempt to consider establishing normal operating ventilation conditions (as opposed to shutdown ventilation conditions) in order to conduct more tests. Both TA 1-2253A⁹ and SP-2408, Rev. 2¹¹ reached their two-year expiration date in late 1989. Efforts to "grandfather" these documents for renewal failed, even though they had been successfully demonstrated. Instead, a procedure having a new format is now required to be written. Other priorities preclude preparing the necessary test procedure until after restart. The former Test Authorization (TA) system has also been discontinued so that a Test Conclusion (TC) was prepared to close this subject out in that system. It is understood that the new procedure will be subject to an Unreviewed Safety Question Determination (USQD). Hopefully, an appropriate USQD and procedure will be prepared soon after restart to reopen this subject so that testing can be resumed.

7.2 Verification of Wind-Tunnel Measurements

In late 1988, A. H. Weber published a report¹² summarizing the results of wind tunnel modeling of the reactor stacks at Colorado State University. As described in Section 4.0, downwash was of major interest in these studies.

On 3/19/90, the chief of the Fluid Modeling Branch of the U.S. Environmental Protection Agency (EPA) wrote¹³ to the DOE of SRS requesting that further tests be conducted onsite in a program to make measurements of downwash. This letter¹³ is given in the Appendix, Item 3. As already explained, no further testing is being considered until after restart. Presumably, the EPA will remain interested in the results if and when testing is resumed in the future.

8.0 REFERENCES

- 1 J. B. Price, "Onsite Radiation Doses from Postulated Reactor Accidents", DPST-86-204, September 2, 1986.
- 2 R. C. Lewis, "Remove Plate in Stack Breech", JP 1310, 8-25-86.
- 3 Superior Signal Company, Inc., "Material Safety Data Sheet" for Screening Smoke, 8/1/86 (see Appendix, Item 1).
- 4 MP Associates, Inc., "Material Safety Data Sheet" for Smoke Pot (see Appendix, Item 2).
- 5 J. D. Menna/S. F. Petry, "Stack Plume Marking Tests - 105 Buildings", NEPA, Safety Analysis and Permits Checklist, 8/29/86.
- 6 J. S. Murdock, "NEPA Environmental Evaluation, Stack Plume Marking Tests - 105 Buildings, Test Authorization 1-2253", October 3, 1986.
- 7 J. D. Menna, "Stack Plume Marking Tests - 105 Buildings", TA 1-2253, December 2, 1986.
- 8 J. D. Menna, "Stack Plume Marking Tests - 105-K Building", SP-2408 (TA 1-2253), Approved January 26, 1987.
- 9 P. H. Clark, "Stack Plume Marking Tests - 105 Building", TA 1-2253A, October 14, 1987.
- 10 P. H. Clark, "Stack Plume Marking Tests - 105-K Building", SP-2408, Rev. 1, 1/11/88.
- 11 P. H. Clark, "Stack Plume Marking Tests - 105-K Building", SP-2408, Rev. 2, 3/31/88.
- 12 A. H. Weber, "Wind Tunnel Modeling of SRP Reactor Stacks", DPST-88-895, October 13, 1988.
- 13 William H. Snyder, US EPA, Letter to Mr. Lewis C. Goldell, SR DOE, March 19, 1990 (see Appendix, Item 3).

FIGURE 1
MILITARY-TYPE CANISTER AT ATTA RANGE

SMOKE CANISTER HOLDER NO. 1 FOR
REACTOR STACK PLUME MARKING TESTS

FIGURE 2

S.F. Pety
9/12/66

FIGURE 3
SMOKE CANISTER HOLDER NO. 1
IN STACK BREECH OF 105-K.

FIGURE 4
3/11/87 TEST WITH
THEATRIC-TYPE CANISTER BURNING

FIGURE 5
3/11/87 TEST WITH
MILITARY-TYPE CANISTER

FIGURE 6
3/11/87 SMOKE AT GROUND LEVEL
FROM ATMOSPHERIC CONVECTION

FIGURE 7
3/11/87 TIME-EXPOSED PHOTOGRAPH
OF NIGHT TEST

FIGURE 8
9/7/87 BURNING SMOKE CANISTER
AT FORD BUILDING

FIGURE 9
POURING WATER OVER CANISTER
TO BE TESTED

FIGURE 10
11/6/87 TEST OF WATERPROOF
SMOKE CANISTER AT FORD BUILDING

FIGURE 11
TEST CANISTER REMOVED FROM
METAL CAN

FIGURE 12
SPECIAL CUNO FILTER
FOR KANNE INSTRUMENTATION

FIGURE 13
CUNO FILTER HOUSING IN
105-K FAR SAMPLE ROOM

Note: Studs in Makeup Ring 1/2" Longer Than studs in Basket ring

NOTE: NEED 2 CUSTOM GASKETS

- 1 BETWEEN MAKEUP RING AND BASKET
- 1 BETWEEN BASKET AND COVER

5.3
F. H. 100
12/10/88

FIGURE 14
SMOKE CANISTER HOLDER NO. 2

FIGURE 15
PREFABRICATED SMOKE CANISTER
HOLDER NO. 2

FIGURE 16
4/6/88 (YELLOW) SMOKE TEST WITH
CANISTER FROM MP ASSOCIATES

=====

SECTION 1: PRODUCT IDENTIFICATION

Company Address: P. O. Box 96, Spotswood, NJ 08884
Telephone Number: (201) 251-0800
Chemical Family: Screening Smoke
Trade Name: Superior Smoke for air flow studies

Read the entire MSDS for a thorough evaluation of hazards.

=====

SECTION 2: PRODUCT INGREDIENTS (SMOKE)

	TLV	PEL	8-hour time weighed average
Hydrated Zinc Chloride	1 mg/m ³	1 mg/m ³	
Water Condensate	-	-	
Carbon Monoxide	55 mg/m ³	55 mg/m ³	

All other ingredients are present in negligible amounts and/or non-hazardous.

Superior Smoke products are available in various sizes that provide sufficient materials capable of occupying the following volumes with an undiluted concentration of 90 mg per cubic meter. Superior Smoke is easily visible at the zinc chloride concentration of 10 mg per cubic meter.

Superior #1A	-	4,000 cu. ft.:	113 m ³
Superior #2B	-	8,000 cu. ft.:	227 m ³
Superior #3C	-	35,000 cu. ft.:	1133 m ³
Superior #5D	-	100,000 cu. ft.:	2832 m ³

=====

SECTION 3: PHYSICAL DATA (SMOKE)

Boiling Point: Not Applicable
Vapor Pressure: Not Applicable
Vapor Density: Not Applicable
Solubility in Water: Soluble
pH: No Data
Appearance and Odor: Gray to white with an odor of burning paper.

=====

SECTION 4: FIRE & EXPLOSION HAZARD DATA

(SMOKE): Flash Point (method used): None
Autoignition: Not Applicable
Flammable limits in air: Not Applicable

(SOLID PRODUCT): Extinguishing Media: Not applicable. Use media suitable for surrounding fire.

(SMOKE/SOLID PRODUCT): Special fire fighting protective equipment: self-contained breathing apparatus and full protective clothing.

(SMOKE/SOLID PRODUCT): Unusual fire and explosion hazards: None Known

MATERIAL SAFETY DATA SHEET (continued)

=====

SECTION 5: REACTIVITY DATA (SOLID PRODUCT)

Stability: Stable under normal conditions

Hazardous decomposition products: See Section 2

Hazardous polymerization: None known

=====

SECTION 6: HEALTH HAZARD ASSESSMENT (SMOKE)

General: Superior Smoke can be used without hazard if applied as directed. The main effects of the smoke are some minimal irritation of the throat, an awareness of an odd odor, and the appearance of smoke. These effects act as a warning and are desirable to prevent voluntary overexposure. Individuals should be urged not to accept exposures that cause minor irritation, but to leave the area and ventilate well to dissipate the smoke.

Ingestion: Not a significant route of exposure.

Eye Contact: Acute exposure is not likely to induce eye irritation.

Skin Absorption: Not a significant route of exposure.

Inhalation: Acute exposure can cause irritation of the respiratory tract and mucous membranes. Irritation is a warning property of smoke materials; in itself irritation is not usually regarded as a toxic effect unless it is sufficient to cause inflammation and then inflammation, not irritation, is the toxic effect.

Emergency and First Aid Procedures: Remove victim to fresh air. If breathing is difficult, get medical attention.

=====

SECTION 7: DISPOSAL METHOD

(SMOKE): Ventilate area: Use local exhaust to keep exposure to a minimum. The duration of smoke would be short and the length of exposure could be reduced further by opening doors and windows for a few minutes, if and when the smoke appears.

(SOLID PRODUCT): Disposal Method: Dispose in chemical disposal area or in a manner that complies with local, state and federal regulations.

=====

The information herein is given in good faith, but no warranty, expressed or implied, is made.

=====

MP Associates, Inc.

APPENDIX

E. VERNON HILL INC.

ITEM 2

P. O. Box 7053
CORTE MADERA, CA 94925
(415) 924-8837

MATERIAL SAFETY DATA SHEET

SECTION I

MANUFACTURER'S NAME MP ASSOCIATES, INC.		EMERGENCY TELEPHONE NO. (415) 465-0782
ADDRESS (Number, Street, City, State, and ZIP Code) 484 Lake Park Avenue Oakland, California 94610		
CHEMICAL NAME AND SYNONYMS Smoke Pot	TRADE NAME AND SYNONYMS Smoke Candle	
CHEMICAL FAMILY	FORMULA KClO₃ - C₆H₁₀O₅ - Na HCO₃-Vat Dye	

SECTION II HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS	--		BASE METAL		
CATALYST	--		ALLOYS		
VEHICLE	--		METALLIC COATINGS		
SOLVENTS	--		FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES	--		OTHERS		
OTHERS	--				
HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES				%	TLV (Units)
Device is composed of an oxidizer - fuel - dye composition producing a Class C Explosive					

SECTION III PHYSICAL DATA

BOILING POINT (°F.)	--	SPECIFIC GRAVITY (H ₂ O=1)	--
VAPOR PRESSURE (mm Hg.)	--	PERCENT VOLATILE BY VOLUME (%)	--
VAPOR DENSITY (AIR=1)	--	EVAPORATION RATE (_____/hr)	--
SOLUBILITY IN WATER	--		
APPEARANCE AND ODOR When ignited produces a volume of smoke.			

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED)	168° C /Brass Block Test	FLAMMABLE LIMITS	LFL	UFL
EXTINGUISHING MEDIA	Water or CO ₂			
SPECIAL FIRE FIGHTING PROCEDURES	Extinguish fire with water.			
UNUSUAL FIRE AND EXPLOSION HAZARDS				
This device is classified as a Class C Explosive - "Smoke Pot"				

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE

Not Available

EFFECTS OF OVEREXPOSURE

EMERGENCY AND FIRST AID PROCEDURES

SECTION VI - REACTIVITY DATA

STABILITY

UNSTABLE

CONDITIONS TO AVOID

Heat and Fire

STABLE

XX

INCOMPATIBILITY (Materials to avoid)

NONE

HAZARDOUS DECOMPOSITION PRODUCTS

NONE

HAZARDOUS
POLYMERIZATION

MAY OCCUR

--

CONDITIONS TO AVOID

WILL NOT OCCUR

--

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

WASTE DISPOSAL METHOD

Dispose of used device by saturating in
water before throwing away.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)

Particle Mask

VENTILATION

LOCAL EXHAUST

SPECIAL

MECHANICAL (General)

OTHER

PROTECTIVE GLOVES

EYE PROTECTION

OTHER PROTECTIVE EQUIPMENT

Do not hold in hand when using - device becomes hot.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Store in Cool Dry Place

OTHER PRECAUTIONS

Device should be burned outside, or if burned
inside, use in well ventilated area - ALL SMOKE IS AN IRRITANT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY^{Goldell.ltr}
ATMOSPHERIC RESEARCH AND EXPOSURE ASSESSMENT LABORATORY
RESEARCH TRIANGLE PARK
NORTH CAROLINA 27711

March 19, 1990

**APPENDIX
ITEM 3**

Mr. Lewis C. Goldell
Department of Energy
Building 703-41A
Savannah River Operations
Aiken, SC 29808

Dear Mr. Goldell:

We have recently been doing some wind-tunnel measurements of stack-tip downwash with the goal of establishing the conditions under which downwash occurs and, given such, to determine the concentration distributions that result downstream. Our preliminary results suggest that the downwash is not nearly so severe as that predicted by Briggs downwash formula. This seems to be due to the fact that Briggs formula was based upon previous wind-tunnel measurements where the Reynolds number was subcritical. Our Reynolds number, as well as that of virtually all full-scale stacks, is supercritical, and the suction-pressures developed on the lee sides of the stacks are much smaller than those at subcritical Reynolds numbers.

Dr. Allen Weber has told me of some smoke tests he and Dr. Petry have been doing at Savannah River Laboratory on a stack which should occasionally experience rather severe downwash, at least according to Briggs formula. We would be highly interested in this work being pursued in order to verify the wind-tunnel results and to establish a more correct downwash formula. Since this effort might involve interagency cooperation, I felt it appropriate to write to you. In many ways, the situation at Savannah River seems ideally suited for such a study. The stack has a relatively low and steady volume efflux rate, so that downwash may be expected, according to Briggs formula, whenever the wind speed exceeds about 4 miles per hour. The site is well instrumented with anemometers at stack-top elevation and not too far distant from the stack. A smoke source and video recording equipment are readily available to document the extent of downwash at the stack top. And the effluent is neutrally buoyant, so that the data are not complicated by buoyancy effects. Ideally, we would like to obtain some flow-visualization data showing the effluent conditions at the stack top, with accompanying data on the wind speed and average effluent speed for a range of effluent-to-wind-speed ratios of, say, 0.3 to 1.5.

We would be most grateful if Savannah River Laboratory would undertake such a measurement program.

Sincerely yours,

William H. Snyder
Chief, Fluid Modeling Branch, MD-81
Atmospheric Sciences Modeling Division

WHS/ac

✓ bcc: Allen H. Weber

DATE

FILMED

7/26/94

END