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Development of a Minimum Performance Standard for Lavatory Trash Receptacle Automatic Fire Extinguishers

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16. Abstract

This report contains a summary of the work performed during the development of a minimum performance standard for lavatory trash receptacle automatic fire extinguishers. The developmental work was performed under the direction of the International Halon Replacement Working Group.

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PREFACE

At the second meeting of the International Halon Replacement Working Group (IHRWG) held in March 1994 at Moreton-in-Marsh, England, a seventh task group was formed. Task Group 7 was assigned the responsibility for developing and recommending a test protocol to establish a minimum performance standard for the automatic lavatory trash container fire extinguishers (hereafter referred to as Lavex). The minimum performance standard is to be used to evaluate the performance of alternative extinguishing agents which may be used to replace Halon 1301.

A working group meeting was hosted at the Walter Kidde Aerospace (WKA) facility in Wilson, North Carolina, in June 1994. A series of trash container fire tests were conducted during the meeting to facilitate the task group's understanding and the formulation of its recommendations. The resulting recommendations were reported at the July 26-27, 1994, IHRWG meeting in Seattle, Washington.

A draft procedure was prepared and circulated to the task group members. The draft was edited to include the comments of the task group members and forwarded to the Federal Aviation Administration (FAA) William J. Hughes Technical Center. The draft was reformatted by the FAA and circulated to the task group members.

The FAA conducted validation tests in 1995 and reported their findings at the IHRWG meeting at Hamburg, Germany, in March 1996. The FAA test results varied from the results found during the WKA tests by as much as 80 percent. The FAA and WKA then set up another meeting in Wilson, North Carolina, to determine the reason for the test discrepancies. As a result of the meeting, the test procedure was refined and a subsequent meeting was held at the William J. Hughes Technical Center to further discuss the revised test procedure and its results. During the subsequent July 1996 IHRWG meeting held at the Technical Center, the new test procedure and results were reported to the Group and a final call for comments was issued regarding the minimum performance standard.

This document was compiled to provide a chronological account of the evolution of the Lavex replacement agent minimum performance standard. It is intended to provide provisional guidance to Lavex equipment providers and users until the official minimum performance standard is released.

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ABBREVIATIONS

AC	Advisory Circular
BCAG	Boeing Commercial Airplane Group
FAA	Federal Aviation Administration
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
IHRWG	International Halon Replacement Working Group
Lavex	Automatic Lavatory Trash Receptacle Fire Extinguisher
NFPA	National Fire Protection Association
NIST	National Institute of Science and Technology
NOAEL	No Observed Adverse Effect Level
ODP	Ozone Depletion Potential
RTCA	Radio Technical Commission for Aeronautics
WKA	Walter Kidde Aerospace

EXECUTIVE SUMMARY

This report contains a summary of the activities conducted by Task Group 7 of the International Halon Replacement Working Group (IHRWG) to develop a minimum performance standard for the lavatory compartment trash receptacle automatic fire extinguisher. A draft minimum performance standard was developed using the Halon 1301 Lavex Bottle (manufactured in accordance with Boeing Commercial Airplane Group Specification Control Drawing 10-61909) as the performance reference standard. The draft was presented to the IHRWG at the July 1994 meeting in Seattle, Washington.

Originally, the group had secured an agreement that the minimum acceptable operating temperature for the Lavex would be 33°F. This permitted the use of some current zero ozone depletion potential (ODP) agents in the nonsuper-pressurized state, thereby permitting the potential use of a drop-in replacement with existing hardware. Upon conducting a limited survey of airline operators (end users of the Lavex device) worldwide, it became evident that a minimum operating temperature of 0°F was preferred by some operators since many aircraft are inoperative for several days in severe climates, often resulting in cabin temperatures approaching 0°F. However, further testing at the Federal Aviation Administration (FAA) William J. Hughes Technical Center revealed that the current Lavex device would not consistently function at temperatures near 0°F, so an alternate agreement was reached amongst the Task Group members. The premise of replacement agent performance is based on an equivalent level of safety with the current agents, and in this case, current system. It was therefore agreed that all replacement extinguishing agents/systems to be used in the lavatory trash receptacle must properly function at a minimum operating temperature of 30°F in order to demonstrate equivalency to the current Halon 1301 Lavex system.

1. INTRODUCTION.

The requirement for the provision of an automatic disposable fire extinguisher which discharges into a lavatory trash container was proposed in Federal Aviation Administration (FAA) notice 84-5 as a consequence of two accidents. The first involved an aircraft cabin fire (Air Canada, Cincinnati, 1983) in which 23 people perished. The second occurred at Tampa International Airport in Florida on June 25, 1983, which resulted in evacuation of the aircraft with no injuries or loss of life. Following these accidents, the FAA conducted an inspection survey of the fire containment capabilities in the U.S. carrier fleet. The survey revealed that the fire containment capabilities of trash containers may be compromised by the wear and tear typical of service. Considering the seriousness of in-flight cabin fires, an expanded approach to fire protection was considered necessary. Proposals were developed which would require that each lavatory trash container be equipped with a built-in automatic fire extinguisher which automatically discharges into the container upon the occurrence of a fire. The proposals were implemented in DOT 14 CFR Part 121.308.

Due to stratospheric ozone depletion concerns, Halon 1301 was included in a list of ozone depleting compounds whose production was to be controlled under the Montreal Protocol, a treaty signed by practically all industrialized nations worldwide. Legislation initially sought to control production of halons at 1986 levels and subsequently reduce them. These measures were further tightened at two subsequent Montreal Protocol review meetings and as a result, a total ban on the production of Halon 1301 was implemented in January 1994. Halons, and Halon 1301 in particular, are the mainstay of aircraft fire protection systems and thus environmentally acceptable replacements must be identified. The FAA established the International Halon Replacement Working Group (IHRWG) to address this issue. A key aspect of this work is to define minimum performance standards which can be used to assess the performance of candidate replacement agents. Task Group 7 was formed to develop a minimum performance standard for the lavatory trash receptacle fire extinguishing system.

2. DEVELOPMENT OF THE MINIMUM PERFORMANCE STANDARD.

2.1 INITIAL TEST DEVELOPMENT.

The minimum performance standard development process started with the test article (figure 1). With the advice of the Boeing Commercial Airplane Group (BCAG), the test article was defined as a rectangular box having dimensions of 18 inches wide by 8 inches deep by 16 inches high, giving an internal volume of 1.333 cubic feet. This container is considered to be representative of the largest trash receptacle in current service. In the top surface, a 6.2-inch square opening (38.44 in^2 area) was located at the left-hand side. A plate was mounted 0.5 inch above this opening leaving a ventilation area 12.4 in^2. Additionally, twelve 1-inch-diameter ventilation holes were provided at the bottom of the test article to provide sufficient ventilation for combustion to start and sustain until the Lavex discharged. The ventilation holes were provided with damper flaps which were closed upon discharge initiation to minimize leakage of the agent from the bottom of the test article. Note that an actual trash container does not (by design) provide ventilation at the bottom of the container. A Lexan viewing window was provided on the front of the test article. The Lavex was mounted such that the discharge tube and the temperature sensitive closure entered at a central location in the top of the test article. The discharge tube projected approximately 1 inch into the test article.

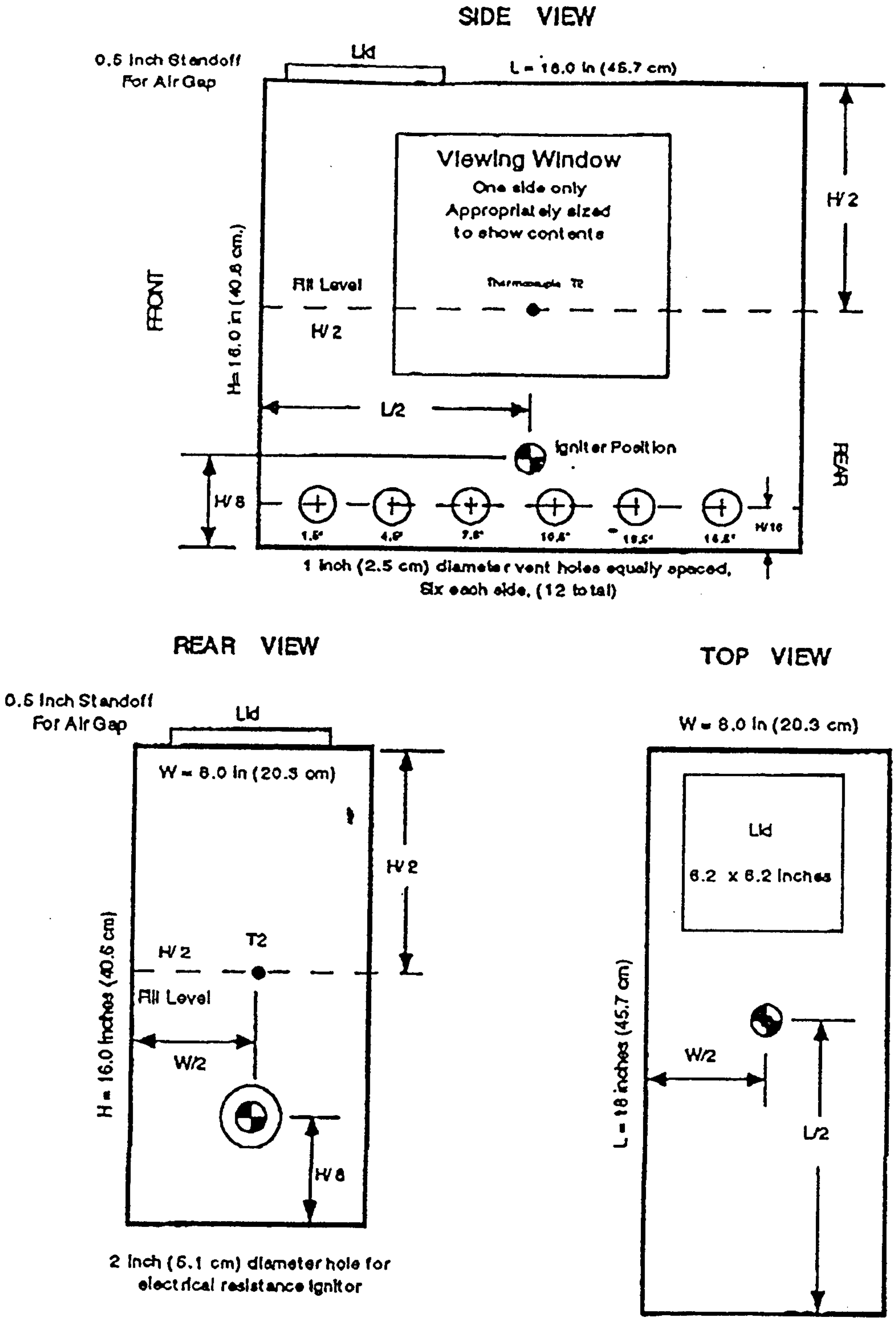

FIGURE 1. LAVEX TEST ARTICLE

The next consideration was in finding appropriate materials for a representative fire load. Initially, the fire test load was guided by FAA Advisory Circular (AC) 25-17 as

- 40 percent 2-ply paper towels, 10 by 11 inches
- 25 percent 2-ply paper towels, 16 by 16 inches
- 20 percent 8-ounce hot drink paper cups[1]
- 10 percent 3-ounce cold drink paper cups
- 5 percent empty cigarette packs

where the percentages refer to the number of items.

The ignition source was a pair of nichrome coils located close to the bottom of the trash receptacle. The intention was to simulate ignition from a glowing cigarette buried in the trash, resulting in smoldering combustion. The method described was used to evaluate various potential alternate agents for the Lavex prior to the Task Group meeting held at Walter Kidde Aerospace (WKA) in June 1994.

2.2 CHANGES TO FIRE LOAD.

During the June 1994 Task Group meeting, concern was expressed at the potential variability of the fire due to the complexity of the fire load recommended by AC 25-17. Initial tests using one pound of the fire load mixture specified in AC 25-17 were conducted using both the Halon 1301 bottle and an identical bottle containing FM-200. In both cases the fire was too easily extinguished.

The FAA William J. Hughes Technical Center representatives suggested a preference for shredded newspaper as used in cargo bay fire tests, which would represent a consistent fire load. As a result, the next three tests were conducted using one pound of shredded newsprint. First, a smoky, deep-seated fire was obtained that the FM-200 could not completely extinguish. The second fire quickly flashed into a flame apparently because the electric ignition coil had been displaced during loading, and the Halon 1301 easily gave complete extinguishment. The third test was a repeat with Halon 1301 with more careful placement of the ignition coil. The fire produced was very smoky and deep seated as in the first test and the Halon 1301 failed to achieve extinguishment. These tests confirmed WKA's expectation that the current Lavex could not suppress a fire of this nature due to the considerable compaction of the material.

After much discussion, it was suggested by Dr. George Harrison that the shredded newspaper be replaced with crumpled paper towels which would represent a more typical fire load. Tests were repeated using 8 by 13 inch 2-ply paper towels, (supplied by American Airlines). The volume of the fuel load was increased to a minimum of 50 percent of the receptacle volume to reduce the disturbance of the fuel load during the Lavex discharge. Five tests were run in this series, beginning with a fire load of 468 grams (equivalent to the weight of the AC 25-17 mixture

[1] Styrofoam cups were substituted as these were thought to provide a more severe fire challenge.

needed to fill the receptacle to about 75 percent by volume). The 468 grams of crumpled paper towels were fluffed to a 50 percent container volume. This fire was easily extinguished by the Halon 1301. Next, the mass of paper was increased to 702 grams compressed to fill a 50 percent container volume. The fire extinguishment by Halon 1301 was again successful, but more difficult. The third test in this series used 938 grams of the crumpled paper towels. This fire was very smoky and deep seated; the Halon 1301 bottle failed to achieve complete extinguishment. In the fourth test, the paper load was reduced to 814 grams again pressed to 50 percent container volume. The fire extinguishment with Halon 1301 was successful, even though the fire was again somewhat smoky and deep seated. Lastly, the 814 gram test was repeated with the Lavex loaded with FM-200. The fire was again successfully extinguished, demonstrating how an alternate agent could provide an equivalent level of safety when compared to halon. It was agreed by the Task Group members that this fire load represented the proper degree of difficulty, as the current Lavex could just extinguish this fire. The resulting procedure was written up, circulated to the Task Group members for comment and presented at the IHRWG meeting in July of 1994. (Appendix A shows the Lavex test article, initial test procedure, and the test results described above.)

2.3 DEVELOPMENTS SUBSEQUENT TO THE JULY 1994 SEATTLE IHRWG MEETING.

Three basic concerns were raised during the Seattle meeting:

Dr. Richard Gann National Institute of Science and Technology (NIST) felt that a controlled process to condition the paper towels prior to testing was necessary. Dr. Doug Dierdorf (Pacific Scientific) suggested that the condition process specified for fire testing of flame resistant textiles and films in National Fire Protection Association (NFPA) 701 would be suitable. The minimum performance standard proposed by the Task Group was amended to include this methodology.

Additionally, Dr. Gann raised concern regarding variations in flammability of the paper towels due to the wet strength treatments. It was suggested that pure cellulose paper (e.g., filter paper) be used. However, research suggested that this approach would make the test prohibitively expensive. It was concluded that unless someone specifically develops a flame retardant wet strength treatment, variations in the treatment is unlikely to affect the test substantively since the weight percentage of the doping agent is a maximum of 1.25 percent for towels specifically manufactured for high wet strength (e.g., Bounty household towels).

Robert Glaser (WKA) pointed out during his presentation that WKA had identified that one of the hydrofluorocarbon (HFC) agents was performing as a drop-in substitute against the draft minimum performance standard. However, this agent could not be used in a nonsuper-pressurized condition at temperatures lower than 33°F (nonsuper-pressurization is preferable since the status of the Lavex can be checked by weight or liquid level alone without recourse to a pressure gauge). WKA held the view that the Lavex function results from occupation of an airplane (use of trash receptacle, etc.) and since an airplane is not occupied until the internal temperature is comfortable for humans, that a minimum operating temperature of 40°F should be acceptable. No comment on this position was raised at the meeting.

2.4 MINIMUM OPERATIONAL TEMPERATURE.

The minimum operational temperature was left as a to be determined (TBD) by individual customers as a part of their operational requirements. A revised draft minimum performance standard was prepared and submitted to the FAA after the Seattle meeting (appendix B). The Technical Center indicated that the minimum operational temperature would likely be changed to 5°F, as this would concur with Radio Technical Commission for Aeronautics (RTCA) document number DO-160C for category A1 equipment which specifies a minimum operational temperature.

A presentation summarizing the work of the Task Group was given at the November 1994 IHRWG meeting in Atlantic City by Richard Sears, who pointed out the demerit of mandating a minimum operating temperature of 5°F. Briefly, since the vapor pressure of most of the potential replacement agents is too low to provide adequate discharge characteristics at 5°F, it would be necessary to superpressurize the agent. This presents a problem with Lavex condition monitoring since a simple weight check would not indicate whether the internal pressure is within acceptable limits, therefore a pressure gauge would have to be added to the Lavex which could present retrofit problems. No negative comments were received during questions. After the presentation however, Thomas Grabow of Deutsche Aerospace showed Richard Sears a facsimile which stated they do require a minimum operating temperature of 5°F.

2.5 AGENT ENVIRONMENTAL REQUIREMENTS.

At the April 1995 IHRWG meeting in Rome, Italy, a task group was formed to develop generic statements on environmental and toxicological concerns for the minimum performance standards being developed. The task group issued the following conclusions:

1. Environmental and toxicology concerns should not be part of the specific requirements of the minimum performance standards. They are essentially aims of and advisories to those developing halon replacements for use on board aircraft.

2. The minimum performance standards should have consistent formats which, as a minimum, should begin with the following sections:

   INTRODUCTION — a brief statement describing the reason for the standard.
   AIMS AND ADVISORY — environmental and toxicology statements.
   AGENT/SYSTEM REQUIREMENTS — specific, minimum performance requirements.

It was agreed that statements would be incorporated into the minimum agent performance specifications (appendix C).

2.6 AGENT PREFERENCE SURVEY.

Also at the April 1995 IHRWG meeting in Rome, a suggestion was made and accepted to query the airlines as to an acceptable/preferred firefighting agent for use in the lavatory trash receptacle. As a direct result of this suggestion, a task group was formed that prepared a package, including background information and a questionnaire for querying the airlines on their preference for a replacement agent for Halon 1301 in the lavatory trash receptacle automatic extinguishers [1].

2.7 INITIAL TESTING CONDUCTED AT THE FAA WILLIAM J. HUGHES TECHNICAL CENTER.

The Technical Center set up and began conducting initial tests on the Lavex testing device in May 1995. The purpose of this was to better familiarize Technical Center personnel (not previously associated with the Task Group) with the proposed Lavex test apparatus and to conduct validation tests. Tests were conducted using the standard Halon 1301 Lavex bottle along with a multitude of potential replacement agents, including water (table 1). During these initial tests, the agent temperature was maintained at 40°F. The results of these tests were presented at the March 1996 IHRWG meeting in Hamburg, Germany.

2.8 DEVELOPMENTS SUBSEQUENT TO THE MARCH 1996 IHRWG MEETING IN HAMBURG, GERMANY.

During this meeting, the Technical Center presented lavatory trash receptacle initial test results on four agents: Halon 1301, FM-200, HFC-125, and water. Upon presenting these results, it was determined that the FAA tests required as much as twice the amount of agent to consistently extinguish the fire compared to the WKA results when the proposed minimum performance standard was followed. There was no definitive explanation for the discrepancies, but it was suggested that the paper towels used in the FAA tests could differ slightly, along with the method of installing the fire load. It was agreed that representatives from the FAA would visit the WKA facility to determine the reason for the large discrepancies in the test results.

2.9 DEVELOPMENTS SUBSEQUENT TO THE MAY 1996 MEETING AT WALTER KIDDE AEROSPACE.

During the meeting held at Walter Kidde Aerospace, several points were discussed which could have the potential to impact the test results, including the type of paper towel used, the method of crumpling the towels and installing them into the test article, and the ignition source. As mentioned previously, the tests conducted at the Technical Center required nearly twice the agent than the WKA tests to extinguish the same fire. WKA agreed to conduct several tests during the meeting with all parties present to better understand the cause for the test differences.

TABLE 1. SUMMARY OF INITIAL TESTS CONDUCTED AT THE FAA TECHNICAL CENTER

Halon 1301		FM-200		HFC-125		Water	
Qty (g)	Test Result	Qty (g)	Test Result	Qty (g)	Test Result	Qty (g)	Test Result
125	not extinguished	150	not extinguished	270	not extinguished	1000	not extinguished
130	not extinguished	170	not extinguished	280	not extinguished	1000	not extinguished
135	not extinguished	180	not extinguished	290	extinguishment	1300	not extinguished
140	not extinguished	190	not extinguished	290	extinguishment	1300	not extinguished
150	not extinguished	200	not extinguished	290	extinguishment	1300	not extinguished
160	not extinguished	210	not extinguished	290	extinguishment	1500	extinguishment
170	not extinguished	220	not extinguished			1500	extinguishment
180	not extinguished	250	not extinguished			1500	extinguishment
190	not extinguished	260	not extinguished			1500	extinguishment
200	not extinguished	270	not extinguished				
210	not extinguished	280	not extinguished				
220	not extinguished	290	extinguishment				
230	not extinguished	290	extinguishment				
240	not extinguished	290	extinguishment				
250	extinguishment	290	extinguishment				
250	extinguishment						
250	extinguishment						
250	extinguishment						

Before any of the test apparatus particulars were discussed, the purpose of the test was re-iterated, namely, to provide a trash based fire challenge equal to the extinguishing performance capability of the BCA SCD 10-61909 eutectic Lavex. During a general discussion of the test setup and operation, the fire load conditioning was discussed. The moisture conditioning process for the towels was based on NFPA 701 which calls for baking at 145°F after conditioning for a minimum of 72 hours at 45 ± 15 percent relative humidity (RH). It was agreed that the baking process would be removed from the minimum performance standard since there is no humidity control specified during the process.

During a more in-depth review of the test setup and procedure, it was revealed that the FAA and WKA were indeed using a different type of paper towel. The WKA tests used a smaller, 2-ply towel compared to the type used during the FAA tests; differences in the size and density of the towel could lead to large differences in the mass fill density, compounding other problems. By specifying an actual towel, the potential for these types of problems could be minimized. It was agreed during this meeting that the standard towel (10.25 by 13.25 inches) would be used, and a specification would be developed based on this towel, which was used in the FAA tests.

After further discussion, some actual tests were performed. Representatives from WKA set up and conducted several tests, as witnessed by the FAA, and then the FAA set up and conducted a few tests. During these trials, the tests set up and conducted by WKA (using the standardized towels supplied by the FAA) were extinguished by the standard lavatory 1301 extinguisher, but the FAA tests were not. Since both the equipment and the fire load were identical during the trials, it was determined that the method of crumpling the paper and installing it into the test article could have a significant impact on the test outcome. During a direct comparison, it was revealed that the WKA tester would essentially crumple the towels tighter than the FAA tester. This being the case, once the respective towels were loaded into the receptacle, the WKA crumpled towels would occupy less volume than the FAA fire load (i.e., individually crumpled towels were more dense). When the crumpled towels were then compacted to half volume, as required in the test procedure, a different type of packing resulted. The more loosely crumpled FAA towels occupied a larger volume prior to compacting, resulting in less air space once they were compacted to half volume. With less air space, the FAA fire load required more time to develop and resulted in a smoldering type of fire that was not as easily extinguishable as the WKA fire load.

Another reason for the difference in the tightness of the fire load (and hence the fire growth) could have been with the towels used by WKA in the early development of the test procedure. Because these towels were a smaller, more dense 2-ply type, they occupied less volume than the type used in the early FAA tests which were much less dense. Less initial volume equated to less overall compaction needed to produce the required half volume, which meant that there was potentially more airspace between the towels, allowing the fire to grow more quickly.

Although the FAA and WKA Task Group members agreed that the difference in crumpling/ loading of the towels indeed influenced the test outcome, no decision was made as to how this could be controlled to yield repeatable results. In order to better understand problems with packing tightness, the FAA agreed to conduct several tests in which the mass of paper would remain constant, but the volume (i.e., packing) would be varied. Several trials would be conducted at half full, three-quarters full, seven-eighths full, and full. This would allow for a correct packing volume to be established that would allow for consistent extinguishment (table 2).

TABLE 2. SUMMARY OF TESTS AT THE FAA TECHNICAL CENTER FOLLOWING THE WKA MEETING

Paper Mass (g)	Paper Volume	Extinguisher Release Temp. (°F)	Agent Mass (g)	Time Until Visible Flames	Time Until Discharge	Maximum Temp. (°F)	Result
815	1/2 Full	62	125	did not occur	10 min 10 sec	1125	not extinguished
815	1/2 Full	63	130	did not occur	13 min 20 sec	1120	not extinguished
815	1/2 Full	66	140	did not occur	17 min 40 sec	1230	not extinguished
815	1/2 Full	65	125	did not occur	9 min 0 sec	580	not extinguished
815	3/4 Full	0	n/a	45 sec	OVERCOOLED	1588	ABORTED
815	3/4 Full	40 (at start)	137	50 sec	6 min	no data	extinguished
815	3/4 Full	-8	138	55 sec	8 min	1330	not extinguished
815	3/4 Full	0	n/a	50 sec	OVERCOOLED	1487	ABORTED
815	3/4 Full	-4	140	45 sec	5 min 49 sec	956	not extinguished
700	3/4 Full	0	n/a	45 sec	OVERCOOLED	1180	ABORTED
700	3/4 Full	-9	124	25 sec	3 min 59 sec	772	extinguished
700	3/4 Full	-7	126	40 sec	3 min 44 sec	1446	extinguished
815	7/8 Full	36 (at start)	142	20 sec	4 min 26 sec	no data	extinguished
815	7/8 Full	-1	139	60 sec	4 min 56 sec	721	extinguished
700	7/8 Full	1	n/a	40 sec	OVERCOOLED	815	ABORTED
700	7/8 Full	-6	124	50 sec	2 min 54 sec	697	extinguished
700	Full	2	126	60 sec	2 min 29 sec	no data	extinguished
815	Full	40 (at start)	136	1 min 20 sec	4 min 39 sec	no data	extinguished
815	Full	-2	129	35 sec	3 min 36 sec	577	extinguished
815	Full	-4	122	45 sec	4 min 5 sec	1100	not extinguished
815	Full	-3	n/a	50 sec	OVERCOOLED	898	ABORTED
815	Full	23	n/a	50 sec	OVERCOOLED	1180	ABORTED
815	Full	26	128	35 sec	4 min	777	extinguished
815	Full	16	122	45 sec	2 min 35 sec	1258	extinguished
815	Full	6	135	50 sec	2 min 40 sec	440	extinguished
815	Full	17	n/a	45 sec	OVERCOOLED	1361	ABORTED
815	Full	17	133	50 sec	3 min 10 sec	781	extinguished
815	Full	18	128	80 sec	4 min 15 sec	672	extinguished
815	Full	25	136	30 sec	4 min 50 sec	1279	extinguished
815	Full	13	132	55 sec	3 min 55 sec	670	extinguished
815	Full	3	n/a	45 sec	OVERCOOLED	1031	ABORTED
815	Full	10	n/a	37 sec	OVERCOOLED	1579	ABORTED

The topic of packing also became an issue when discussing the appropriate fire load. Realistically, paper towels are not jam packed into waste receptacles in service, since there is a bin flap that the towels must pass through. It would be unrealistic for passengers to forcibly pack the paper down into the receptacle by sticking their hand into the receptacle through the bin flap. This is the type of action that would be required by passengers in order to obtain the packing density that is currently specified in the test method.

An established time limit on the test itself was also discussed, as it was shown repeatedly that when the fire does not develop within approximately 2 minutes, the test is invariably a failure. Most of the Technical Center tests did not fully develop until approximately 8 minutes after initiation of the igniter. It may be necessary to specify that if the fire does not develop within several minutes, the test should be aborted and considered a nontest (this problem was directly related to the packing tightness and became less of a factor once the appropriate fill density issue had been resolved).

The issue of agent minimum operating temperature was again discussed, as this issue was left unresolved during previous IHRWG meetings. Several of the operators present expressed an interest in the requirement for 0°F agent temperature during discharge since many aircraft are left unoccupied for extended periods of time in severe climates, resulting in very low cabin temperatures. The Task Group members present at WKA reached an agreement to maintain 0°F or below at the time the agent is discharged into the test receptacle for all future tests.

Other minor issues relating to the test article were discussed and an agreement was reached to standardize the ignition source, the method for calibrating the temperature of the nichrome wire, the size of the sight glass window, and the amount of airflow near the test article. Individually, these items would not affect the test significantly, but collectively, they had the potential to impact the results. Although these issues were not resolved at this meeting, they would be discussed and standardized after further review. Additionally, all parties agreed that a follow-up meeting conducted at the Technical Center prior to the next IHRWG meeting would be helpful.

2.10 DEVELOPMENTS SUBSEQUENT TO THE JUNE 1996 FOLLOW-UP MEETING AT THE FAA TECHNICAL CENTER.

During an interim meeting held at the Technical Center, the Task Group reviewed test results on the effect of fire load compactness, the method of controlling the crumpling of the towels, and also discussed general refinement of the minimum performance standard.

As shown in table 2, consistent extinguishment could not be achieved when the fire load was compacted to either half full, or three-quarters full. This confirmed the results of earlier tests conducted at WKA which showed that when the standard 10.25- by 13.25-inch towels were crumpled and subsequently packed to achieve a half-volume fire load, the fire developed into a slow, smoldering type which was not easily extinguished. However, a high percentage of the tests could be extinguished when the fire load was compacted to seven-eighths full, or full, so it was agreed that the standardized load would be changed to full.

Task Group representatives from Pacific Scientific Corporation also developed a method of controlling the crumpling of the towels in an attempt to achieve more repeatable results. In order to accomplish this, a representative of each of the three testing facilities (the Technical Center, WKA, and Pacific Scientific) would crumple enough standard towels to freely fill an 18-inch-wide by 18-inch-deep by 18-inch-high container. These numbers would be averaged, and a final, standardized number of crumpled towels was agreed upon. This standardized number would dictate the degree by which the paper towels are crumpled prior to being loaded into the test article.

Additionally, measurements of airflow were taken in the immediate vicinity of the test article, and an agreement on the maximum amount was made. Previous tests conducted at the FAA Technical Center had shown a large difference in test results depending on chamber airflow, particularly when the fire load was removed for inspection. If there was substantial air movement in the inspection area, the paper had a greater tendency to rekindle and cause a test failure.

Another outgrowth of this meeting concerned the requirement that the agent temperature be 0°F at the time of discharge. As shown in table 3, a high percentage of the 32 tests conducted at the Technical Center resulted in incomplete discharge when the agent was cooled to temperatures near 0°F. In fact, several eutectic failures resulted even when the temperature of the agent was well above 0°F (10, 17, and 23°F). It was actually a failure of the bottle eutectic device rather than a failure of the agent to extinguish the fire. A tentative agreement was reached between WKA and the Technical Center that the agent discharge temperature should be modified to 25°F; WKA agreed to investigate this problem further by conducting tests at varying temperatures of 25 ± 10°F i.e., 15 to 35°F (see table 4).

2.11 DEVELOPMENTS SUBSEQUENT TO THE JULY 1996 IHRWG MEETING AT THE FAA TECHNICAL CENTER.

During the meeting, it was agreed that several procedures within the proposed minimum performance standard should be modified to produce a repeatable, realistic fire threat. The results of tables 3 and 4 were presented and discussed, which lead to several comments with respect to the effect of agent temperature on proper eutectic operation. Participants felt that the proposed agent discharge temperature of 25°F was too low in order to achieve consistent eutectic function. Participants suggested that the agent discharge temperature be changed to 30°F and several tests would be conducted to confirm proper operation.

TABLE 3. EFFECT OF TEMPERATURE ON EUTECTIC OPERATION
(FAA TECHNICAL CENTER TESTS)

Extinguisher Release Temp. (°F)	Time Until Visible Flames	Time Until Discharge	Maximum Temp. (°F)	Result
66	did not occur	17 min 40 sec	1230	not extinguished
65	did not occur	9 min 0 sec	580	not extinguished
63	did not occur	13 min 20 sec	1120	not extinguished
62	did not occur	10 min 10 sec	1125	not extinguished
40 (at test start)	50 sec	6 min	no data	extinguished
40 (at test start)	1 min 20 sec	4 min 39 sec	no data	extinguished
36 (at test start)	20 sec	4 min 26 sec	no data	extinguished
26	35 sec	4 min	777	extinguished
25	30 sec	4 min 50 sec	1279	extinguished
23	50 sec	OVERCOOLED	1180	ABORTED
18	80 sec	4 min 15 sec	672	extinguished
17	45 sec	OVERCOOLED	1361	ABORTED
17	50 sec	3 min 10 sec	781	extinguished
16	45 sec	2 min 35 sec	1258	extinguished
13	55 sec	3 min 55 sec	670	extinguished
10	37 sec	OVERCOOLED	1579	ABORTED
6	50 sec	2 min 40 sec	440	extinguished
3	45 sec	OVERCOOLED	1031	ABORTED
1	40 sec	OVERCOOLED	815	ABORTED
0	45 sec	OVERCOOLED	1588	ABORTED
0	50 sec	OVERCOOLED	1487	ABORTED
0	45 sec	OVERCOOLED	1180	ABORTED
-1	60 sec	4 min 56 sec	721	extinguished
-2	35 sec	3 min 36 sec	577	extinguished
-2	60 sec	2 min 29 sec	no data	extinguished
-3	50 sec	OVERCOOLED	898	ABORTED
-4	45 sec	5 min 49 sec	956	not extinguished
-4	45 sec	4 min 5 sec	1100	not extinguished
-6	50 sec	2 min 54 sec	697	extinguished
-7	40 sec	3 min 44 sec	1446	extinguished
-8	55 sec	8 min	1330	not extinguished
-9	25 sec	3 min 59 sec	772	extinguished

TABLE 4. LAVEX DISCHARGE TEMPERATURE TESTS CONDUCTED AT WKA

Start Temp. (°F)	Bottle Discharge Temp. (°F)	Time to Start Discharge	Discharge Time
10	n/a	Failed by eutectic leak cooling	n/a
15	24.2	1 min 59 sec	5.6 sec
15	n/a	Failed by eutectic leak cooling	n/a
15	n/a	Failed by eutectic leak cooling	n/a
20	25.8	1 min 19 sec	5.4 sec
20	28	1 min 37 sec	5.7 sec
20	29	2 min 46 sec	6.0 sec
20	n/a	Failed by eutectic leak cooling	n/a
25	28.2	46 sec	4.0 sec
25	n/a	Failed by eutectic leak cooling	n/a
25	27.6	37 sec	5.2 sec
30	32.2	49 sec	5.34 sec
30	32.3	43 sec	6.3 sec
30	34.2	47 sec	5.6 sec
70	70	1 min 2 sec	5.0 sec

Another issue which was opened for discussion was the minimum number of successful tests required for an agent to be considered acceptable. Early in the development phase, it was suggested that 4 successive tests be completed. This was modified in the later stages of development to any 4 out of 5 successful tests. However, this would be changed during final review of the data such that 5 successive tests must be completed in order for the agent to be accepted.

In addition, the Fort Howard company was contacted and a towel specification was developed based on the information supplied. This would aid in the consistency of fire growth in the event that the exact towels used in the Technical Center and WKA tests could not be obtained. Parameters such as weight, external dimensions, tensile strength, and absorption are specified.

Another test procedure refinement designed to achieve better consistency in the fire growth was the standardization of the ignition source. A hot wire ignition system was decided as the method of igniting the crumpled towels, and a specification for the igniter wire type, thickness, and configuration was finalized. The igniter consists of a nominal 0.025-inch-diameter nichrome wire looped 15 times over a length of 1.25 inches with a 0.25-inch loop diameter. Although the igniter specification clearly described the hardware required for initiating fires, the voltage passed through it would dictate the temperature and subsequent fire development, so a method for calibrating the igniter temperature was developed by WKA. As shown in figure 2, a 30 AWG type K thermocouple is placed within the confines of the looped nichrome wire, and the voltage of the variable output is adjusted to achieve the prescribed temperature (1650°F ± 50°F) at this location. Table 5 shows the results of five test trials conducted at the Technical Center to validate the temperature calibration method.

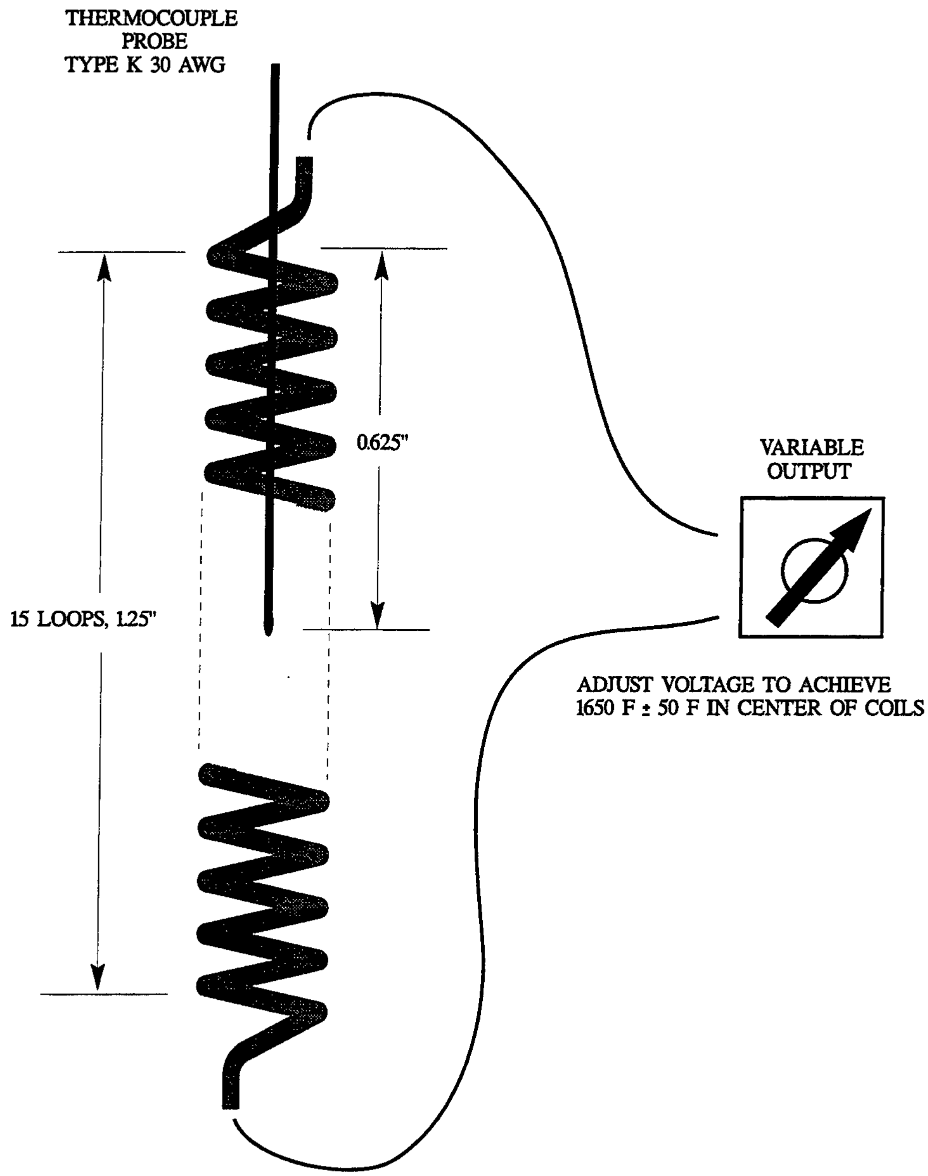

FIGURE 2. IGNITION SOURCE FOR STANDARD LAVATORY DISPOSAL RECEPTACLE

TABLE 5. IGNITER TEMPERATURE CALIBRATION TESTING

Igniter Temperature Test 1 Ambient Temperature = 84°F Ambient RH = 49%	
Time (sec)	Temperature (°F)
30	1624
60	1644
90	1640
Igniter Temperature Test 2 Ambient Temperature = 84°F Ambient RH = 48%	
Time (sec)	Temperature (°F)
30	1673
60	1666
90	1656
Igniter Temperature Test 3 Ambient Temperature = 84°F Ambient RH = 51%	
Time (sec)	Temperature (°F)
30	1670
60	1668
90	1666
Igniter Temperature Test 4 Ambient Temperature = 85°F Ambient RH = 46%	
Time (sec)	Temperature (°F)
30	1667
60	1664
90	1657
Igniter Temperature Test 5 Ambient Temperature = 86°F Ambient RH = 50%	
Time (sec)	Temperature (°F)
30	1684
60	1679
90	1669

Subsequent to the meeting, the Technical Center and WKA conducted numerous tests based on the latest version of the minimum performance standard, with very good results (see tables 6 and 7). The finalized minimum performance standard is shown in appendix D.

TABLE 6. SUMMARY OF THE FAA TECHNICAL CENTER TESTS BASED ON FINALIZED MINIMUM PERFORMANCE STANDARD

Paper Mass (g)	Agent Mass (g)	Agent Temp. At Discharge (°F)	Time Until Visible Flames	Time Until Discharge	Maximum Temp. at Center Line (°F)	Result
815	127	27.5	65 sec	4 min 30 sec	1153	extinguished
815	127	28.6	35 sec	4 min 40 sec	963	extinguished
815	136	25.2	55 sec	4 min 10 sec	1237	extinguished
815	123	28.6	55 sec	3 min 27 sec	NO DATA	extinguished
815	n/a	26.2	50 sec	OVERCOOLED	1489	ABORTED
815	144	28.6	50 sec	4 min 30 sec	861	not extinguished
815	137	27.5	55 sec	4 min 35 sec	540	extinguished
815	125	26.2	50 sec	4 min 0 sec	1277	extinguished
815	139	30.2	80 sec	4 min 5 sec	1250	extinguished
815	136	25.2	75 sec	3 min 10 sec	1143	extinguished
815	124	25.2	50 sec	2 min 47 sec	751	extinguished
815	125	30.2	40 sec	5 min 42 sec	1218	not extinguished
815	127	25.2	35 sec	3 min 25 sec	859	extinguished
815	141	26.8	45 sec	4 min 45 sec	1317	not extinguished
815	n/a	28.6	60 sec	OVERCOOLED	1366	ABORTED
815	140	18	35 sec	3 min 9 sec	NO DATA	extinguished
815	122	25.2	45 sec	3 min 45 sec	1167	extinguished
815	134	27.5	40 sec	4 min 10 sec	968	extinguished
815	118	24.6	40 sec	3 min 20 sec	875	extinguished
815	128	30.9	40 sec	4 min 58 sec	1211	not extinguished
815	126	29.1	50 sec	4 min 5 sec	733	extinguished
815	125	26.2	55 sec	2 min 20 sec	237	not extinguished
815	142	27.5	50 sec	3 min 5 sec	1157	extinguished
815	139	25.7	55 sec	3 min 10 sec	831	extinguished
815	114	28	45 sec	3 min 15 sec	1078	not extinguished

TABLE 7. SUMMARY OF WKA TESTS BASED ON FINALIZED MINIMUM PERFORMANCE STANDARD

WALTER KIDDE AEROSPACE LAVEX MINIMUM PERFORMANCE STANDARD—HALON 1301 RESULTS				
Agent Mass (g)	Agent Temperature at Discharge (°F)	Time Until Discharge	Maximum Temp. at Center Line (°F)	Result
138	41.2	2 min 20 sec	340	Agent temperature above test limit
139	29.5	3 min 45 sec	520	Fire extinguished
n/a	n/a	n/a	1010	Overcooled eutectic
127	29.3	1 min 22 sec	330	Fire extinguished
129	29.6	1 min 8 sec	600	Fire extinguished
n/a	n/a	n/a	600	Overcooled eutectic
n/a	n/a	n/a	1020	Overcooled eutectic
127	30.9	2 min 4 sec	630	Fire extinguished
123	32.2	3 min 3 sec	350	Agent temperature above test limit
132	27.7	35 sec	220	Fire extinguished
143	29.1	1 min 38 sec	580	Fire extinguished
143	29.3	1 min 3 sec	570	Fire extinguished
134	30.8	2 min 26 sec	270	Fire extinguished
117	28.6	51 sec	Thermocouple fail	Fire extinguished
131	30.8	1 min 32 sec	250	Fire extinguished

3. REFERENCES.

Grimstad, Greg, et al., "User Preferred Fire Suppression Agent for Lavatory Trash Container Fire Protection," DOT/FAA/AR-96/8, April 1996.

APPENDIX A—PROPOSED TEST ARTICLE AND INITIAL TEST RESULTS

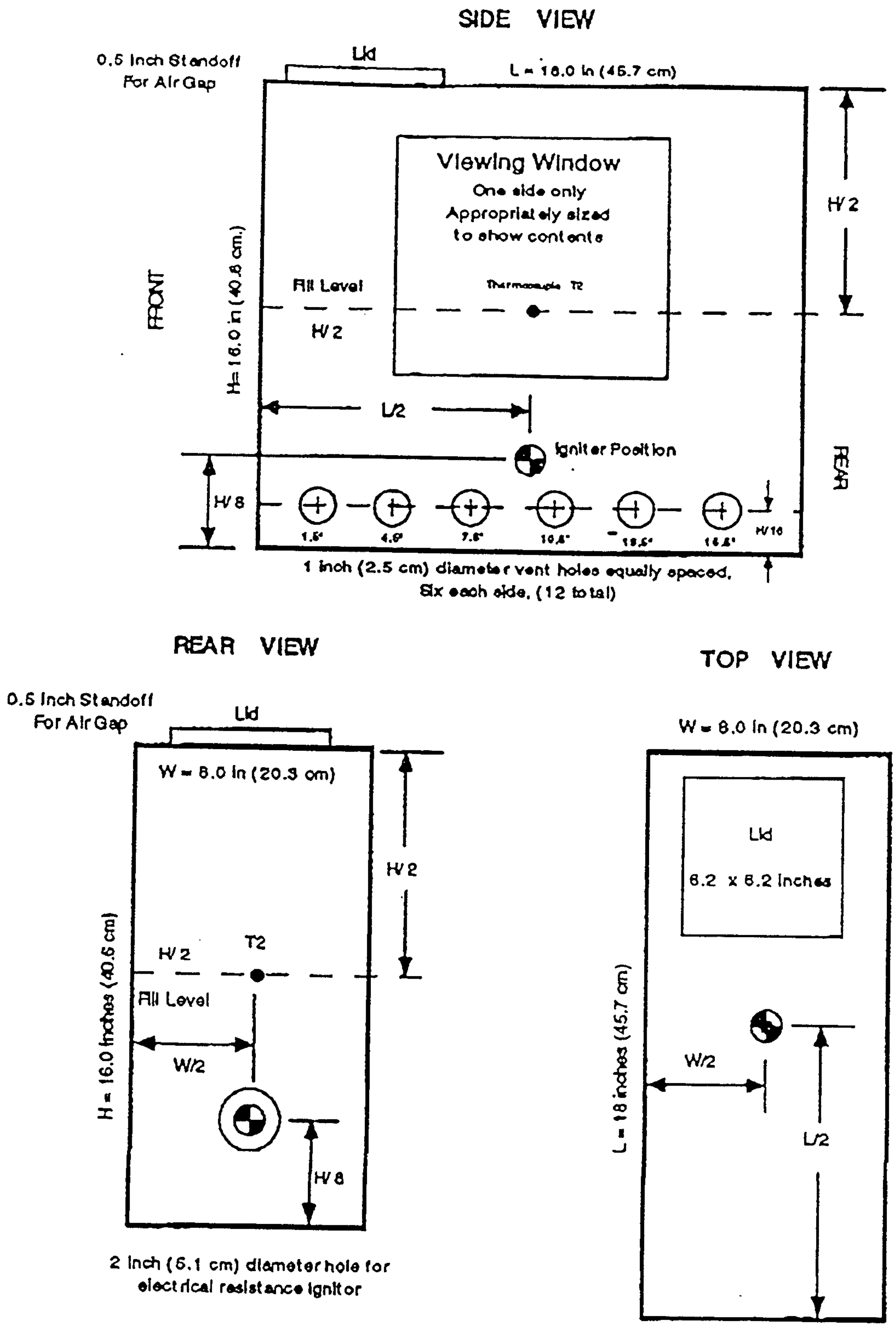

FIGURE A-1. STANDARD LAVATORY DISPOSAL RECEPTACLE FOR EVALUATING FIRE EXTINGUISHING AGENTS

WALTER KIDDE AEROSPACE
POTTY BOTTLE REPLACEMENT AGENT CONFERENCE
JUNE, 1994

SUMMARY OF FIRE TEST PROCEDURE.

- THERMOCOUPLES SHALL BE LOCATED ON THE EXTINGUISHER SKIN, AT THE CENTER LINE OF THE TEST ARTICLE AND WITHIN ONE INCH OF THE EXTINGUISHER NOZZLE. THE TEMPERATURES SHALL BE CONTINUOUSLY RECORDED USING DATA AQUISITION EQUIPMENT.

- WEIGH EXTINGUISHER, RECORD VALUE.

- RECORD THE AMBIENT TEMPERATURE, AMBIENT PRESSURE AND RELATIVE HUMIDITY.

- CONDITION EXTINGUISHER AT 30-35°F FOR A MINIMUM OF TWO HOURS.

- LOOSELY LOAD THE TEST ARTICLE ....

- INSTALL THE IGNITER AT THE APPROXIMATE CENTER OF THE RECEPTACLE BUT 1 INCH ABOVE THE VENTILATION HOLES.

- MOUNT THE CONDITIONED EXTINGUISHER TO THE TEST ARTICLE.

- TAKE STILL PHOTOGRAPH(S) OF THE TEST AREA TO SHOW TEST SET UP AND DATA EQUIPMENT.

- START THE DATA AQUISITION AND THE VIDEO CAMERA.

- WHEN THE EXTINGUISHER SURFACE REACHES 35-39°F, ENERGISE THE IGNITER.

- START THE STOP WATCH WHEN FLAMES ARE VISIBLE.

PBCONF-7

WALTER KIDDE AEROSPACE
POTTY BOTTLE REPLACEMENT AGENT CONFERENCE
JUNE, 1994

- AS THE EXTINGUISHER DISCHARGES, TAKE A STILL PHOTOGRAPH AND RECORD THE ELAPSED TIME.

- DE-ENERGISE THE IGNITER UPON EXTINGUISHER DISCHARGE.

- CLOSE ALL VENTILATION HOLES (EXCEPT TRASH ENTRY AND IGNITER ACCESS HOLES).

- NOTE THE ELAPSED TIME AT WHICH THE TEMPERATURE IN THE CENTER OF THE TEST ARTICLE DROPS TO WITHIN 100°F OF AMBIENT.

- AFTER A FURTHER 5 MINUTES HAS ELAPSED, OPEN THE FRONT PANEL AND TAKE A STILL PHOTOGRAPH.

- OBSERVE THE TEST ARTICLE CONTENTS FOR A FURTHER 2 MINUTES FOR RE-IGNITION.

- IF THE FIRE DOES NOT RE-IGNITE, EMPTY THE TEST ARTICLE AND SPREAD THE CONTENTS INTO A SINGLE LAYER. RECORD THE FOLLOWING OBSERVATIONS: EXTENT OF FIRE LOAD COMBUSTION, DEGREE OF SMOLDERING etc. TAKE STILL PHOTOGRAPHS SUCH THAT THE DEGREE OF COMBUSTION CAN BE ASSESSED. IF THE FIRE DOES RE-IGNITE, EXTINGUISH USING WATER.

- WEIGH THE DISCHARGED EXTINGUISHER, RECORD VALUE. CALCULATE AND RECORD THE WEIGHT OF AGENT.

PBCONF-7

POTTY BOTTLE REPLACEMENT CONFERENCE
WALTER KIDDE AEROSPACE
JUNE 28 & 29, 1994
DEMONSTRATION TEST DATA MATRIX

TEST # AND EXT. S/N	AGENT	TRASH CONTENT	AMB. TEMP.°F	AMBIENT PRESSURE IN HG	AMBIENT HUMDITY Rh %	EXTING. WT. BEFORE DISCHARGE (g)	ELAPSED TIME FLAME TO DISCHARGE (sec)	EXTING. WT. AFTER DISCHARGE	AGENT WT.	CONTENTS RE-IGNITE AFTER DISCHARGE	ESTIMATE CONTENTS BURNT	WIND CONDITION	OTHER COMMENTS	TEST CONTAINER VOLUME (FT³)
1 S/N 1	FM-200	A/C 25-17	80.2	30.01	61	382.34	15.53	261.10	121.24	NO	5%	CALM		1 1/3
2 S/N 2	FM-200	DOUBLE A/C 25-17	83.6	30.01	57	383.98	10.15	261.73	122.25	NO	10%	CALM		6
3 S/N 92	1301	A/C 25-17	86.2	30.01	55	405.70	11.12	285.39	120.31	NO	5%	CALM		1 1/3
4 S/N 17	1301	DOUBLE A/C 25-17	88.0	30.01	52	406.37	16.5	289.01	117.36	NO	10%	CALM		6
5 S/N 3	FM-200	465 g SHREDDED NEWSPAPER	71.4	29.84	89	393.98	4.50	261.97	132.01	YES	N/A	GUSTY		1 1/3
6 S/N 106	1301	465 g SHREDDED NEWSPAPER	76.0	29.84	89	417.72	6.30	276.92	140.80	NO	NOT OBSERVED	GUSTY		1 1/3
7 S/N 120	1301	465 g SHREDDED NEWSPAPER	77.0	29.84	85	414.78	4 MIN 36 SEC	280.55	134.23	YES	N/A	GUSTY		1 1/3
8 S/N 137	1301	468 g PAPER HAND TOWELS	80.0	29.84	68	415.38	3.09	277.38	138.00	NO	NOT OBSERVED	MOVED TO SHELTERED LOCATION	IGNITOR PORT COVERED, IGNITORS SUPPORTED	1 1/3
9 S/N 115	1301	702 g PAPER HAND TOWELS	83.0	29.84	65	410.68	1 MIN 19 SEC	277.84	132.84	NO	-	-	-	1 1/3
10 S/N 77	1301	938 g PAPER HAND TOWELS	84.0	29.84	60	407.96	6 MIN 46 SEC	282.49	125.47	YES	-	-	-	1 1/3
11 S/N 135	1301	814 g PAPER HAND TOWELS	86.0	29.84	58	408.88	1 MIN 23 SEC	283.18	125.70	NO	-	-	-	1 1/3
12 S/N 1 REFILLED	FM-200	814 g PAPER HAND TOWELS	88.4	29.84	52	388.75	1 MIN 30 SEC	260.09	128.66	NO	-	-	-	1 1/3

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 1⅓ ft^3 TRASH CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED.

WKA PN: G800100-1

TEST ARTICLE NO. 1

	CHARACTERISTICS / REQUIREMENTS	ACTUAL
1.	AMBIENT TEMPERATURE:	80 °F
2.	AMBIENT PRESSURE:	30.01 in Hg
3.	AMBIENT HUMIDITY: (Rh)	61 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	382.34 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	___ min 15.5 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	/ min ___ sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	261.10 grams
8.	AGENT WEIGHT:	121.24 grams

COMMENTS: • FIRE LOAD AC 25-17 • AGENT FM-200
FLAMES WERE COMPLETELY SUPPRESSED AS THE EXTINGUISHER DISCHARGED.
THE FIRE DID NOT RE-IGNITE
POST EXAMINATION SHOWED ~ 5% OF THE FIRE LOAD BURNT

VERY CALM AIR CONDITIONS

TESTER: [signature]

DATE: 6/28/94

TEST # 1

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 6 ft^3 UNDERSINK VOLUME CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED

WKA PN: G800100-1 TEST ARTICLE NO. 2

	CHARACTERISTICS / REQUIREMENTS	ACTUAL
1.	AMBIENT TEMPERATURE:	84 °F
2.	AMBIENT PRESSURE:	30.01 in Hg
3.	AMBIENT HUMIDITY: (Rh)	57 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	383.98 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	___min 10 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	___min ___sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	261.73 grams
8.	AGENT WEIGHT:	122.25 grams

COMMENTS: • FIRE LOAD DOUBLE AC 25-17 • AGENT FM-200
CENTER TEMP AT TIME OF DISCHARGE 342 °F
2 MINUTES AFTER DISCHARGE CENTER TEMP 133 °F
THE FIRE DID NOT RE-IGNITE
POST EXAMINATION SHOWED THAT ~10% OF THE FIRE LOAD BURNED

VERY CALM AIR CONDITIONS

TESTER: RF Gears DATE: 6/28/94

TEST # 2

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 1⅓ ft^3 TRASH CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED

WKA PN: G800100-1 TEST ARTICLE NO. 92

	CHARACTERISTICS / REQUIREMENTS	ACTUAL
1.	AMBIENT TEMPERATURE:	86 °F
2.	AMBIENT PRESSURE:	30.01 in Hg
3.	AMBIENT HUMIDITY: (RH)	55 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	405.70 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	___ min 11 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	— min 48 sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	285.39 grams
8.	AGENT WEIGHT:	120.31 grams

COMMENTS: • FIRE LOAD AC 25-17 • AGENT 1301
FIRE AND EXTINGUISHING BEHAVIOUR SIMILAR TO TEST #1
THE FIRE DID NOT RE-IGNITE
POST EXAMINATION SHOWED ~ 5% OF THE FIRE LOAD BURNT

VERY CALM AIR CONDITIONS

TESTER: RF [signature] DATE: 6/28/94

TEST # 3

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 6 ft^3 UNDERSINK VOLUME CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED

WKA PN: G800100-1 TEST ARTICLE NO. 17

CHARACTERISTICS / REQUIREMENTS		ACTUAL
1.	AMBIENT TEMPERATURE:	88 °F
2.	AMBIENT PRESSURE:	30.01 in Hg
3.	AMBIENT HUMIDITY: (Rh)	52 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	406.37 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	___ min 16.5 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	___ min 45 sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	___ grams
8.	AGENT WEIGHT:	___ grams

COMMENTS: • FIRE LOAD DOUBLE AC 25-17 • AGENT 1301
FIRE AND EXTINGUISHING BEHAVIOUR SIMILAR TO TEST #2
THE FIRE DID NOT RE-IGNITE
POST EXAMINATION SHOWED ~10% OF THE FIRE LOAD BURNT

VERY CALM AIR CONDITIONS

TESTER: RP Sears DATE: 6/28/99

TEST #4

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 1⅓ ft^3 TRASH CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED

WKA PN: G800100-1

TEST ARTICLE NO. 3

	CHARACTERISTICS / REQUIREMENTS	ACTUAL
1.	AMBIENT TEMPERATURE:	71 °F
2.	AMBIENT PRESSURE:	29.84 in Hg
3.	AMBIENT HUMIDITY: (Rh)	89 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	393.98 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	___ min 4.5 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	___ min ___ sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	261.97 grams
8.	AGENT WEIGHT:	132.01 grams

COMMENTS: • FIRE LOAD 465g SHREDDED N PAPER • AGENT FM-200
CONSIDERABLE SMOKE, FLAMES VISIBLE AT ~ 2 MINUTES.
EXTINGUISHER DISCHARGED 4.5 SEC. LATER. FLAMES WERE
SUPPRESSED BUT CONSIDERABLE SMOKE STILL GENERATED
2 MIN 18 SEC AFTER EXTINGUISHER DISCHARGE ~~THE~~ FLAMES
RE-APPEARED. FIRE WAS EXTINGUISHED USING WATER
WIND WAS GUSTY

TESTER: RF [signature]

DATE: 6/29/94

TEST # 5

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 1⅓ ft^3 TRASH CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED

WKA PN: G800100-1

TEST ARTICLE NO. 106

	CHARACTERISTICS / REQUIREMENTS	ACTUAL
1.	AMBIENT TEMPERATURE:	76 °F
2.	AMBIENT PRESSURE:	29.84 in Hg
3.	AMBIENT HUMIDITY: (Rh)	89 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	417.72 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	___ min 63 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	___ min ___ sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	276.92 grams
8.	AGENT WEIGHT:	140.80 grams

COMMENTS: • FIRE LOAD 465 g SHREDDED N PAPER • AGENT 1301
EXTINGUISHER DISCHARGED ~ 1 MIN AFTER IGNITION COIL TURNED ON.
2 MIN AFTER DISCHARGE MOST SMOKE HAD CLEARED.
FRONT PANEL REMOVED 5 MIN AFTER DISCHARGE.
2 MINUTES LATER NO SIGN OF RE-IGNITION ~ FIRE LOAD WAS SPREAD AND EXAMINED.

NOTE, WIND WAS GUSTY

TESTER: RF [signature]

DATE: 6/29/94

TEST #6

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 1⅓ ft^3 TRASH CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED

WKA PN: G800100-1 TEST ARTICLE NO. 120

	CHARACTERISTICS / REQUIREMENTS	ACTUAL
1.	AMBIENT TEMPERATURE:	77 °F
2.	AMBIENT PRESSURE:	29.84 in Hg
3.	AMBIENT HUMIDITY: (Rh)	85 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	414.78 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	4 min 36 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	___ min ___ sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	280.55 grams
8.	AGENT WEIGHT:	134.23 grams

COMMENTS: • FIRE LOAD 465g SHREDDED N PAPER • AGENT 1301
VERY SMOKY COMBUSTION FLAMES NOT PRESENT / OBSCURED
EXTINGUISHER DISCHARGED 4 MIN 36 SEC AFTER IGNITION
COIL ENERGISED. TEMPERATURE FELL THEN COMMENCED RISING
AGAIN AT 7 MIN. AT 11 MIN FLAMES WERE VISIBLE.
THE FIRE WAS EXTINGUISHED USING WATER

GUSTY WIND CONDITIONS

TESTER: RF [signature] DATE: 6/29/94

TEST #7

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 1⅓ ft^3 TRASH CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED

WKA PN: G800100-1 TEST ARTICLE NO. 137

	CHARACTERISTICS / REQUIREMENTS	ACTUAL
1.	AMBIENT TEMPERATURE:	80 °F
2.	AMBIENT PRESSURE:	29.84 in Hg
3.	AMBIENT HUMIDITY: (Rh)	68 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	415.38 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	3 min 9 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	___min ___sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	277.38 grams
8.	AGENT WEIGHT:	138.00 grams

COMMENTS: • FIRE LOAD 468g BALLED UP PAPER HAND TOWELS OCCUPYING 50% TEST ARTICLE VOLUME
• AGENT 1301
EXTINGUISHER DISCHARGED 3 M 9 SEC AFTER FLAMES VISIBLE
NO RE-LIGHT AFTER FIVE MIN
PANEL OPENED AT 5 MIN, NO RELIGHT AFTER A FURTHER 7 MIN

TEST SET UP MOVED TO SHELTERED LOCATION
2 IN IGNITOR PORT SEALED
IGNITORS SUPPORTED.

TESTER: RF Sears DATE: 6/29/94

TEST #8

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 1⅓ ft^3 TRASH CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED

WKA PN: G800100-1 TEST ARTICLE NO. 115

	CHARACTERISTICS / REQUIREMENTS	ACTUAL
1.	AMBIENT TEMPERATURE:	83 °F
2.	AMBIENT PRESSURE:	29.84 in Hg
3.	AMBIENT HUMIDITY: (RH)	65 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	410.68 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	1 min 19 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	9 min 00 sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	277.84 grams
8.	AGENT WEIGHT:	132.84 grams

COMMENTS: • FIRE LOAD 702 g BALLED UP PAPER HAND TOWELS OCCUPYING 50% TEST ARTICLE VOLUME.
• AGENT 1301
VERY SMOKY COMBUSTION - NO VISIBLE FLAMES. EXTINGUISHER DISCHARGE OCCURED 1 MIN 19 SEC AFTER IGNITION COIL ENERGISED
NO RE-LIGHT AFTER 5 MIN
PANEL OPENED AT 5 MIN, NO RE-LIGHT AFTER A FURTHER 2 MIN
TEMPERATURE AT CENTER OF TEST ARTICLE DECREASED AT A SLOWER RATE THAN TEST #8

TESTER: [signature] DATE: 6/29/94

TEST #9

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 1⅓ ft^3 TRASH CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED

WKA PN: G800100-1

TEST ARTICLE NO. 77

	CHARACTERISTICS / REQUIREMENTS	ACTUAL
1.	AMBIENT TEMPERATURE:	84 °F
2.	AMBIENT PRESSURE:	29.84 in Hg
3.	AMBIENT HUMIDITY: (Rh)	60 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	407.96 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	6 min 46 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	___min ___sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	282.49 grams
8.	AGENT WEIGHT:	125.47 grams

COMMENTS: • FIRE LOAD 938g BALLED UP PAPER HAND TOWELS
COMPRESSED TO 50% TEST ARTICLE VOLUME AND ALLOWED
TO SPRING BACK TO "NATURAL" LEVEL.
SMOKE VISIBLE 14 SEC AFTER ENERGISING IGNITION COIL
FLAMES " 2MIN 46SEC " " " "
EXTINGUISHER DISCHARGED MIN 46 SEC AFTER VISIBLE FLAMES
AT 7 MIN 34 SEC FLAMES RE-ERUPTED
FIRE EXTINGUISHED USING WATER

TESTER: [signature]

DATE: 6/29/94

TEST # 10

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 1⅓ ft^3 TRASH CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED

WKA PN: G800100-1

TEST ARTICLE NO. 135

CHARACTERISTICS / REQUIREMENTS		ACTUAL
1.	AMBIENT TEMPERATURE:	86 °F
2.	AMBIENT PRESSURE:	29.84 in Hg
3.	AMBIENT HUMIDITY: (RH)	58 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	408.88 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	1 min 23 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	___min ___sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	283.18 grams
8.	AGENT WEIGHT:	125.70 grams

COMMENTS: • FIRE LOAD 814 g BALLED UP PAPER HAND TOWELS COMPRESSED TO 50% TEST ARTICLE VOLUME AND ALLOWED TO SPRING BACK TO "NATURAL" LEVEL
• AGENT 1301
· FLAMES VISIBLE 33 SEC AFTER IGNITION COIL ENERGISED.
DISCHARGE 1 MIN 23 SEC AFTER FLAMES VISIBLE

FIRE DID NOT RE-IGNITE AFTER 5 MIN
PANEL OPENED AT 5 MIN, OBSERVED FOR A FURTHER 2 MIN, NO RE-IGNITION

TESTER: R P [signature]

DATE: 6/29/94

TEST # 11

WALTER KIDDE AEROSPACE

POTTY BOTTLE EXTINGUISHING TEST

DESCRIPTION: 1⅓ ft^3 TRASH CONTAINER TEST

TEST PER: OUTLINE TEST PROCEDURE ATTACHED

WKA PN: G800100-1 TEST ARTICLE NO. 1

	CHARACTERISTICS / REQUIREMENTS	ACTUAL
1.	AMBIENT TEMPERATURE:	8 °F
2.	AMBIENT PRESSURE:	29.84 in Hg
3.	AMBIENT HUMIDITY: (RH)	52 %
4.	EXTINGUISHER WEIGHT BEFORE DISCHARGE:	388.75 grams
5.	ELAPSED TIME, FLAME TO EXT DISCHARGE:	1 min 30 sec
6.	ELAPSED TIME, FLAME TO CHAMBER TEMP 100°F:	___min ___sec
7.	EXTINGUISHER WEIGHT AFTER DISCHARGE:	260.09 grams
8.	AGENT WEIGHT:	128.66 grams

COMMENTS: • FIRE LOAD 814 g BALLED UP PAPER HAND TOWELS COMPRESSED TO 50% TEST ARTICLE VOLUME AND ALLOWED TO SPRING BACK TO "NATURAL" LEVEL
• AGENT FM-200
FLAMES VISIBLE 37 SEC AFTER IGNITION COIL ENERGISED.
DISCHARGE 1 MIN 30 SEC AFTER FLAMES VISIBLE

FIRE DID NOT RE-IGNITE AFTER 5 MIN
PANEL OPENED AT 5 MIN, OBSERVED FOR A FURTHER 2 MIN — NO RE IGNITION

TESTER: RF [signature]

DATE: 6/29/94

TEST # 12

APPENDIX B—PROPOSED METHODOLOGY FOR LAVATORY DISPOSAL RECEPTACLE BUILT-IN FIRE EXTINGUISHER AGENT EVALUATION

1. GENERAL INFORMATION.

The U.S. Department of Transportation, Federal Aviation Administration (FAA) Regulation DOT 14 CFR 121.308(b) requires that "After April 29, 1987, no person may operate a passenger carrying transport category airplane unless each lavatory in the airplane is equipped with a built-in fire extinguisher for each disposal receptacle for towels, paper, or waste located within the lavatory. The fire extinguisher must be designed to discharge automatically into each disposal receptacle upon occurrence of a fire in the receptacle."

The disposal receptacles are designed to comply with the requirements contained in FAR Part 25.853(f) which states, "Each receptacle used for the disposal of flammable waste material must be fully enclosed, constructed of at least fire resistance materials, and must contain fires likely to occur in it under normal use. The ability of the receptacle to contain those fires under all probable conditions of wear, misalignment, and ventilation expected in service must be demonstrated by test." FAA Advisory Circular 25-17 provides an acceptable method to show compliance with this rule.

Currently, all aircraft lavatory disposal receptacle fire extinguishers use halon as the fire extinguishing agent. The production of halons has ceased as of 1 January 1994 due to their identification as ozone destroying compounds. As a result, a search for an alternative agent is being conducted. To evaluate the performance of potential agents, the definition of a standard test method, receptacle, and fire fuel load is necessary. It is the intent of this document to provide such definition.

This proposed evaluation method was developed by Task Group 7 of the International Halon Working Group. It has been prepared for the guidance and use of those charged with designing, installing, testing, purchasing, or approving an agent for the use in aircraft lavatory disposal receptacle built-in fire extinguishers.

This evaluation is not a qualification or certification method for lavatory disposal receptacle built-in fire extinguisher systems. Rather, it is a means by which to evaluate the agents which provide an equivalent level of safety. Qualification shall be according to the requirements defined in procurement specifications, while certification will be according to methods acceptable to those authorities having jurisdiction.

The fire suppression capability of an agent depends on several variables: discharge method, fuel density and type, ignition source and location, ventilation, etc. A fire extinguishing agent which quickly knocks out flames, prevents high temperatures, and minimizes smoldering has the characteristics recognized as being required of a replacement agent.

In addition to the agents fire suppression capability, other issues which must be considered but are beyond the scope of this task group are

- Ozone Depletion Potential—ODP should be as low as practical and in accordance with currently accepted values.

- Global Warming Potential—GWP should be as low as practical and in accordance with currently acceptable values.

- Toxicity—Agents utilized should be listed in the Significant New Alternatives Policy (SNAP) for occupied spaces.

- Stability—Long-term stability of at least 20 years within the storage vessel is recommended.

- Compatibility—Agent compatibility with the extinguishing system and surrounding aircraft structure and systems must be considered.

2. PURPOSE.

Provide test procedures for the evaluation of fire suppression agents that will ensure an equivalent level of fire suppression capability for use in aircraft lavatory disposal receptacles.

2.1 APPARATUS.

- Standard lavatory disposal receptacle, see section 6, Disposal Receptacle and Chute
- Fire extinguisher and installation hardware
- Cold chamber
- Fire load, see section 7, Fire Load
- Electrical resistance igniter

2.2 INSTRUMENTATION.

- A thermocouple shall be installed on the fire extinguisher surface (Tl)
- A thermocouple shall be installed at the center line of the disposal receptacle (T2)
- A thermocouple shall be placed to measure ambient temperature (T3)
- Data recorder: strip chart or plotter for recording thermocouple data
- Stop watch
- Both still and video cameras
- Scale

2.3 AMBIENT CONDITIONS.

The test will be performed in a chamber whose ambient is defined by

- Temperature — 75 ± 25°F
- Relative humidity — As low as possible, to be recorded
- Ambient pressure — 11.0 to 15.0 psia

Comparative tests of different agents shall be performed at essentially the same ambient conditions (±5%).

3. TEST PROCEDURES.

STEP	PROCEDURE
1	Weigh extinguisher, record the value.
2	Condition the fire extinguisher in the cold chamber to a temperature of -20°F for a minimum of 4 hours to cold soak the agent. The minimum lavatory fire extinguisher operating temperature is dependent upon the application and thus shall be specified by the aircraft manufacturer. While the extinguisher is conditioning, do steps 3 and 4.
3	a Check out the data acquisition system. b Set up the video camera.
4	a Load the test disposal receptacle as described in section 6, Disposal Receptacle and Chute with the fuel described in section 7, Fire Load. **Ensure that all other preparations are complete before carrying out this task to minimize the fuel load moisture uptake.** b Install igniter and secure approximately 1 inch above the ventilation holes of the disposal receptacle and approximately at the receptacle's center line.
5	a Mount the conditioned extinguisher on the test chamber. The extinguisher should be installed immediately upon removal from the cold chamber to prevent agent temperature increase. b Photograph the complete installation.
6	a Record the ambient temperature, relative humidity, and pressure. b Record and monitor the extinguisher surface temperature, thermocouple T1. c When the extinguisher surface temperature, T1, reaches the minimum lavatory operating temperature as per the application and as established by the aircraft manufacturer:

STEP	PROCEDURE
	(1) Start the video camera. (2) Energize the igniter. d Begin recording of receptacle temperature, thermocouple T2.
7	Upon agent discharge the following must be performed: a De-energize the igniter. b Close all ventilation holes. c Five minutes after discharge, open the viewing window (assuming there is no fire or evidence of combustion after checking both visual and thermal measurements). d Observe disposal receptacle contents for an additional 2 minutes for reignition. (1) If the fire does **not** reignite, empty the compartment and spread the waste material into a single layer. Record observations: extent of fire load consumption by fire, presence or lack of smoldering, etc. Take a still photograph(s) in such a way that the degree of combustion can be assessed. Go to step 8. (2) If the fire reignites, extinguish fire by means of choice. Test was a failure. e Continue recording data until contents are removed in step 7d.
8	a Weigh discharged extinguisher. b Calculate the weight of discharged agent from the data recorded in steps 1 and 8a. Record the weight.
9	Repeat steps 1 through 7 three additional times, for a total of four complete tests. (Note: A single failure of any configuration is considered a failure of that configuration. The only way to continue testing is to change the configuration by (1) adding extinguishing agent to the bottle, (2) change the extinguishing agent, or (3) change the mechanical configuration of the system.)

4. EVALUATION CRITERIA.

For the agent to be acceptable the following two criteria **must** be met:

- The extinguishing agent must extinguish the test fire.

- Successful extinguishment requires that the receptacle thermocouple temperature, after agent discharge, shows a decreasing trend with no significant sustained high temperature excursions. Further, successful extinguishment requires that the fire does not reignite on any of the four tests. This requires that the fire not flareup after the viewing window has been opened.

5. TEST REPORT.

The report should contain the data required in section 3, Test Procedure and be of sufficient detail to enable a technical person, unfamiliar with the subject, to understand. Photographs and video should be included where required or if otherwise appropriate. The report should bear the signatures of the test engineer.

6. DISPOSAL RECEPTACLE AND CHUTE.

Figure B-1 shows a receptacle acceptable for testing fire extinguishers for use in disposal receptacles up to 1.333 ft^3 (0.0377 m^3) volume. The test receptacle has a viewing window (fire resistant polycarbonate or glass) to facilitate visual observations. A 2-inch (5.1-cm)-diameter hole is provided to facilitate insertion of the igniter and shall be sealed after insertion of the igniter. On each side panel there are six 1-inch (2.54-cm)-diameter holes (12 holes total) to facilitate air infiltration, these are the holes identified in step 7b that need to be closed upon discharge of agent.

The waste flap opening will measure 6.2 inch (15.7 cm) x 6.2 inch (15.7 cm) for a total area of 38.44 in^2 (248 cm^2). A plate mounted 0.5 inch (1.27 cm) above this opening will provide 12.4 in^2 for air infiltration.

Maximum open area for air infiltration is 16.4 square inches per cubic foot of receptacle volume. For the test receptacle shown in figure B-1 the maximum infiltration area is 21.8 square inches.

The extinguisher (not shown) shall be installed according to a typical installation drawing.

For comparative evaluation of different systems and/or agents, identical receptacles and fire load shall be used. The maximum variation in ambient parameters shall not exceed ±5% of the nominal value.

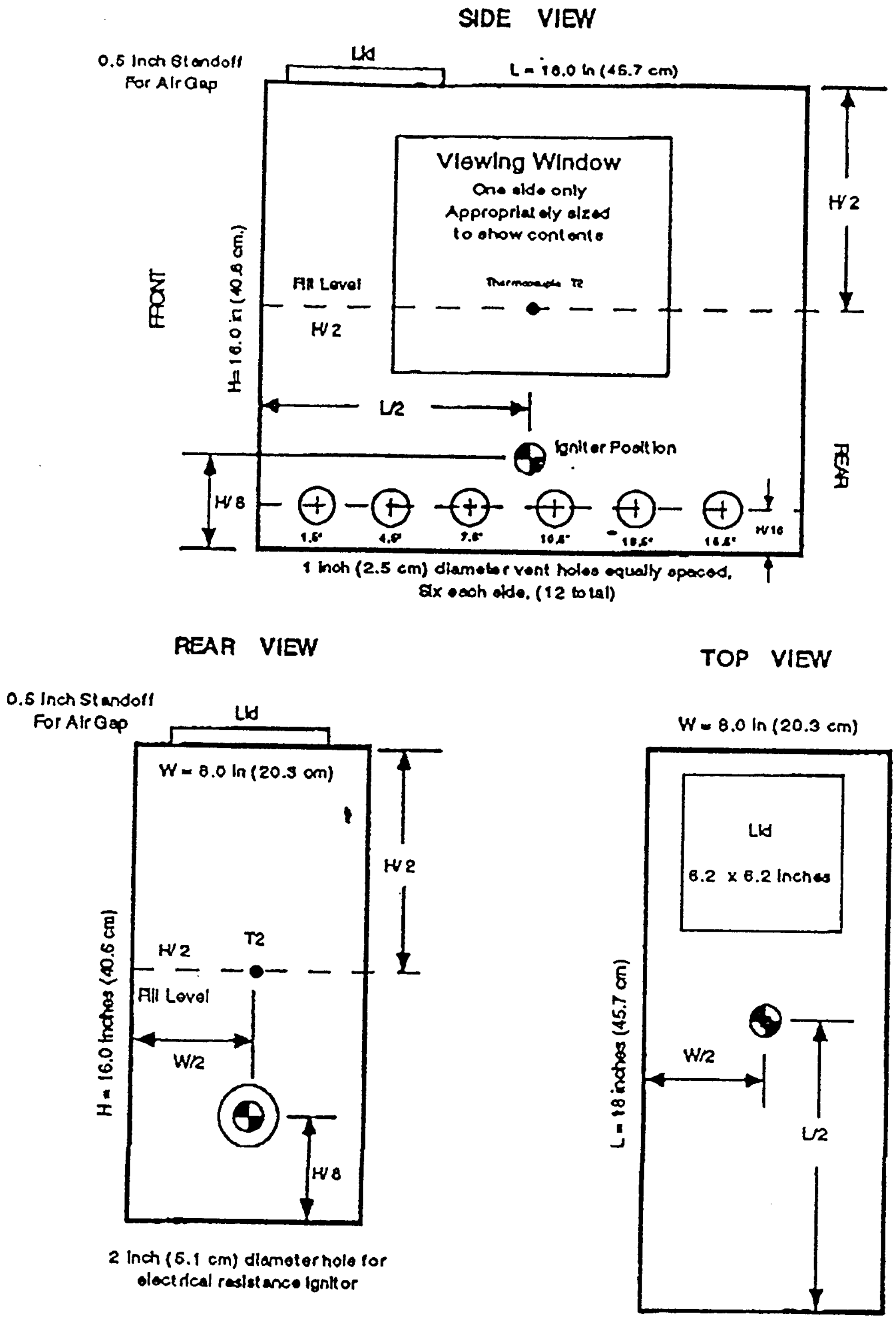

FIGURE B-1. STANDARD LAVATORY DISPOSAL RECEPTACLE FOR EVALUATING FIRE EXTINGUISHING AGENTS

7. FIRE LOAD.

The fire load shall consist of the following materials and shall be loaded into the test receptacle (see appendix A) as follows:

7.1 FIRE LOAD COMPOSITION.

Two-ply paper hand towels, approximately 10 x 11 inches (25 x 28 cm.) having a total weight of 815 ± 5g. These shall be opened and crumpled to simulate used hand towels.

7.2 FIRE LOAD CONDITIONING.

- Fuel load material shall be stored in a space which maintains a relative humidity of 45 ± 15% for a minimum of 72 hours prior to the test to avoid excess moisture content.

- The fuel load shall be conditioned in a forced draft oven at a temperature of 140-145°F for a duration of not less than 1 hour and not more than 1 1/2 half hours before testing. The fuel load shall be removed from the oven and immediately subjected to the fire test procedure.*

7.3 LOADING SEQUENCE.

- Pack several crumpled hand towels under the igniter to prevent damage to the igniter during subsequent loading.

- Load remaining hand towels and compress to 50 percent fill level. Allow hand towels to spring back to natural level.

* Conditioning process taken from NFPA 701, Standard Methods of Fire Tests for Flame Resistant Textiles and Films.

APPENDIX C—PROPOSED AGENT ENVIRONMENTAL AND TOXICOLOGICAL STATEMENTS

1. INTRODUCTION.

A brief statement describing the reason for the standard.

2. AIMS AND ADVISORY.

2.1 ENVIRONMENTAL.

Existing fire protection measures, required by Airworthiness Regulations, are largely based on the use of halons. For all practical purposes, production of halons has ceased under the provisions of the Montreal Protocol. The primary environmental characteristics to be considered in assessing a new agent are ozone depletion potential (ODP), global warming potential (GWP), and Atmospheric Lifetime. The agent selected should have environmental characteristics in harmony with international laws and agreements, as well as applicable local laws. This minimum performance specification sets out means of assessing the technical performance of potential alternatives, but in selecting a new agent, it should be borne in mind that an agent which does not have a zero or near-zero ODP and the lowest practical GWP and Atmospheric Lifetime may have problems of international availability and commercial longevity.

2.2 TOXICOLOGY.

The toxicological acceptability of an agent is dependent on its use pattern. As a general rule, the agent must not pose an unacceptable health hazard for workers during installation and maintenance of the extinguishing system. In areas where passengers or workers are present or where leakage could cause the agent to enter the passenger compartment, at no time should the agent concentration present an unacceptable health hazard. Following release in fire extinguishment, the cumulative toxicological effect of the agent, its pyrolytic breakdown products and the by-products of combustion must not pose an unacceptable health hazard.

3. AGENT/SYSTEM REQUIREMENTS.

Specific, minimum performance requirements.

APPENDIX D—LAVATORY DISPOSAL RECEPTACLE BUILT-IN EXTINGUISHER MINIMUM PERFORMANCE STANDARD

1. INTRODUCTION.

The U.S. Department of Transportation, Federal Aviation Regulations (FAR) 14 CFR 121.308(b) requires that, "After April 29, 1987, no person may operate a passenger carrying transport category airplane unless each lavatory in the airplane is equipped with a built-in fire extinguisher for each disposal receptacle for towels, paper, or waste located within the lavatory. The fire extinguisher must be designed to discharge automatically into each disposal receptacle upon occurrence of a fire in the receptacle."

The disposal receptacles are designed to comply with the requirements contained in FAR 14 CFR 25.853(f) which states, "Each receptacle used for the disposal of flammable waste material must be fully enclosed, constructed of at least fire resistance materials, and must contain fires likely to occur in it under normal use. The ability of the receptacle to contain those fires under all probable conditions of wear, misalignment, and ventilation expected in service must be demonstrated by test." FAA Advisory Circular 25-17, "Transport Airplane Cabin Interiors Crashworthiness Handbook," provides an acceptable method to show compliance with this rule.

Currently, although not required by airworthiness regulations, the typical aircraft lavatory disposal receptacle fire extinguisher uses Halon 1301. For all practical purposes, the production of halons ceased, as of 1 January 1994, under the provisions of the Montreal Protocol due to their identification as an ozone destroying compound. As a result, a search for alternative agents was conducted.

2. SCOPE.

To establish the minimum performance standards (MPS) that an agent must meet and which provides an equivalent level of safety to that of halon, the performance of an agent is measured against a standard test method. This document establishes the fire load, trash disposal receptacle test article, test procedures, and pass/fail criteria for built-in extinguishers for lavatory disposal receptacles.

3. AGENT SELECTION GUIDANCE.

3.1 ENVIRONMENTAL.

The primary environmental characteristics to be considered in assessing a new agent are ozone depletion potential (ODP), global warming potential (GWP), and Atmospheric Lifetime. The agent selected should have environmental characteristics in harmony with international laws and agreements, as well as applicable local laws. This MPS sets out the means of assessing the technical performance of potential alternatives, but in selecting a new agent it should be borne in mind that an agent which does not have a zero or near-zero ODP and the lowest practical GWP and Atmospheric Lifetime may have problems of international availability and commercial longevity.

3.2 TOXICOLOGY.

The toxicological acceptability of an agent is dependent on its use pattern. As a general rule, the agent must not pose an unacceptable health hazard for workers during installation and maintenance of the extinguishing system. In areas where passengers or workers are present or where leakage could cause the agent to enter the passenger compartment, at no time should the agent concentration present an unacceptable health hazard. Following release during fire extinguishment, the cumulative toxicological effect of the agent, its pyrolytic breakdown products, and the by-products of combustion must not pose an unacceptable health hazard.

4. REQUIREMENTS.

4.1 ENVIRONMENT.

The replacement agent must be approved under the Environmental Protection Agency (EPA) Clean Air Act, Significant New Alternatives Policy (SNAP) program, or other international governmental approving programs. Approved agents on the SNAP or other international list must not exceed the established criteria for ozone depletion potential (ODP) and toxicity.

4.2 TOXICOLOGY.

The quantity of agent, when discharged into the protected trash receptacle volume, shall not exceed the NOAEL in the occupiable space within the lavatory. (See appendix A.)

4.3 FIRE PROTECTION.

The fire extinguisher must successfully extinguish a test fire contained in the test receptacle after automatically discharging into the trash receptacle test article.

Additional testing may be required to substantiate agent/system effectiveness in trash receptacles larger than the 1.333 cu ft volume test article. If an extinguishing system is to be used on receptacles with internal volume larger than 1.333 cu ft, it is the responsibility of the manufacturer to demonstrate the effectiveness of a particular agent amount.

4.4 FIRE THREAT.

The fire threat that must be extinguished is a trash receptacle test article (see section 5.2) filled with crumpled paper towels. The specific requirements for the fire load are contained in section 5.3.

4.5 ACCEPTANCE CRITERIA.

Each lavatory trash receptacle automatic discharge extinguisher must meet the following criteria:

- Five separate extinguisher tests must be performed and each must extinguish the test fire.
- Extinguisher discharge performance must meet the following criteria:
  - The nozzle must activate when the temperature in the test receptacle reaches 175°F ± 5°F.
  - The extinguisher must activate within 60 seconds of reaching the above activation temperature.
  - The discharge duration must not exceed 15 seconds.
- The test fire must be extinguished and must not reignite or flareup after the access panel to the test receptacle has been opened.
- An extinguisher that meets the requirements for use in trash receptacles up to 1.333 cu ft is acceptable for use in a smaller receptacle, with a similar installation, without additional testing.

5. TEST REQUIREMENTS.

5.1 TEST CONDITIONS.

Each test must be performed under the following conditions:

- The ambient temperature must be 80°F ± 20°F.
- The fire load materials, described in section 5.3, must be conditioned to 70 ± 5°F and a maximum of 55 percent relative humidity until moisture equilibrium is reached for 24 hours. The test must be initiated within 30 minutes of removal of fire load materials from the conditioning chamber if the atmospheric conditions within the test area are different.
- Agent Temperature. Extinguishing systems in which the agent bottle is typically mounted externally to the trash receptacle with a protruding discharge tube must maintain an agent temperature of 30°F or less at the time the agent is discharged (i.e., time of eutectic release). Extinguishing systems which are typically mounted within the trash receptacle must maintain a 30°F agent temperature at the start of the test (i.e., ignition of fire load).

Examples of maintaining proper agent discharge temperature:

- Example 1. The agent may be kept in a separate cold chamber during the test, ensuring that the temperature will be at or below 30°F. The cold chamber should be as close to the discharge point of the test article as possible, to allow for the shortest possible transfer plumbing.

- Example 2. Overcooling of the agent may be used when an accurate estimate of the elapsed time can be determined for the eutectic device to open (i.e., the temperature at the top of the test article will reach 175°F) after initiation of the igniter. This would allow the tester to back calculate the maximum amount of time available to ensure that the agent is at or below 30°F once it is removed from the cold chamber.

5.2 TEST APPARATUS.

The test standard trash receptacle and extinguisher bottle installation is described below.

5.2.1 Trash Receptacle Test Article.

The test receptacle must be constructed of either aluminum or steel 0.125 inch thick (nominal). The test receptacle for trash containers up to 1.333 cubic feet (0.038 m^3) volume is shown in figure D-1. All receptacle dimensions are internal measurements.

The front of the test receptacle must contain a clear access panel constructed of fire resistant polycarbonate or glass for visual observation. The access panel must be 9.5 ± 0.5 inch (24.13 cm) wide by 8.5 ± 0.5 inch (21.59 cm) high with the lower edge of the panel positioned 6 ± 0.5 inch (15.24 cm) from the bottom surface.

A 2-inch (5.08-cm)-diameter hole must be centered 2 inches up the side of the test receptacle for igniter insertion and must be sealed after insertion of the igniter.

The front and back face of the test receptacle must have six 1-inch (2.54-cm)-diameter holes (12 holes total) equally spaced for ventilation which are equipped with a mechanism for quick opening or closing.

A waste flap opening must be provided at the top of the test receptacle. The opening must be 6.2 inches (15.75 cm) by 6.2 inches (15.75 cm). A plate which is no more than 0.5 inch (1.27 cm) larger than the opening must be mounted 0.5 inch (1.27 cm) above the opening.

The agent discharge tube must be centered in the top of the test receptacle, pointing straight down and must protrude into the cabinet 1 inch from the upper surface. A hole in the cabinet shall be provided to allow insertion of the discharge tube, which must fit snugly, in the hole. Heat resistant tape can be used on the outer surface of the cabinet to facilitate an airtight seal.

5.2.2 Ignition Source.

A standard electrical resistance igniter must be used. The igniter shall consist of a nichrome wire (nominal 0.025 inch diameter) with 15 loops of 0.25 inch diameter. The length of the igniter (loop section) must be 1.25 ± 0.125 inch. To ensure consistent test commencement, the voltage through the igniter shall be adjusted to provide 1650 ± 50°F at the center point. The temperature at the center point should be calibrated as follows:

- Mount a thermocouple, as described in section 5.2.3, in the center of a vertically positioned igniter device, making certain that the wires do not come in contact with the igniter, as shown in figure D-2. Ensure that the thermocouple reading device is functioning properly and protected from drafts.

- Energize igniter and simultaneously start the timing device. Measure the temperature at 30, 60, and 90 seconds.

- Repeat four times for a total of five tests, using a new igniter each time.

5.2.3 Thermocouples.

Three thermocouples are to be used for testing and must be type K grounded with a nominal 30 American Wire Gauge (AWG) size conductor.

- One thermocouple must be installed on the fire extinguisher to measure surface temperature. To obtain the most accurate reading of the agent temperature, it is recommended that the thermocouple be placed over a nonpainted area on the agent vessel and covered using adhesive tape. Lightly sand the painted exterior of the agent vessel if necessary.

- One thermocouple must be installed at the center line of the test receptacle, as defined in figure D-1.

- One thermocouple must be placed to measure ambient temperature.

5.2.4 Instrumentation.

A data acquisition system or other suitable instrument with an appropriate range must be used to measure and record the output of the thermocouples.

5.2.5 Timing Device.

A stopwatch or other device must be used to measure the time of ignition energizing, smoke generation, open flaming, agent discharge, and extinguishment.

5.3 TEST FIRE LOAD.

The fire load shall consist of crumpled two-ply paper hand towels having a total weight of 815 ± 5g.

5.3.1 Paper Towel Specification.

Type: Bleached, C-fold deep embossed handifold towels
External dimensions: 10.25 by 13.25 inches
Weight: 4.5 ± 0.1g per towel
Tensile strength dry (grams/inch): 707
Tensile strength dry (kg/15 mm): 0.42
Tensile strength wet (grams/inch): 189
Tensile strength wet (kg/15 mm): 0.11
Note: All tensile strength test results are derived from the average of both directions.
Absorbency (sec/0.1 ml): 30

Towels manufactured by:
Fort Howard Corporation
1919 South Broadway (54304)
P.O. Box 19130
Green Bay, WI 54307
Telephone: 1-800-558-7325
Fax: 1-800-635-6906
part number 244-00

Towels distributed by:
W.W. Grainger Inc.
(713) 748-8280
part number 2U215

5.3.2 Paper Crumpling Specification.

Prior to loading the paper towels into the test receptacle, they must be opened and crumpled to simulate used hand towels. This can be accomplished by performing a free fill density procedure in which 340 ± 10 paper towels, are crumpled to fill an 18- x 18- x 18-inch container to the top level to ensure similarity of crumpling between the various testing facilities. This procedure may require several attempts in order to achieve the proper crumpling tightness.

5.4 TEST BOOTH OR CHAMBER.

The trash receptacle test article should be located in a booth or room containing adequate ventilation capabilities. The maximum air velocity directly adjacent to the test receptacle should not exceed 50 feet per minute.

5.5 TEST PROCEDURE.

- Condition the fire load.
- Weigh the extinguisher and record the value.
- Set up data acquisition system.
- In the test receptacle, install and clamp the igniter 1 inch above the ventilation holes at the approximate center line of the receptacle, as shown in figure D-1. A clipping device or other nonintrusive means may be used to prevent the ignition source from skewing left or right when the paper is being loaded into the receptacle.
- Installation of the fire load. Remove the observation window and begin loading the crumpled hand towels. Ensure that the entire bottom of the test receptacle is fully covered with a layer of precrumpled towels (also pack one or two precrumpled hand towels under the igniter to prevent damage during subsequent loading). When approximately one-half of the paper is loaded, reinstall the observation window and finish loading the remainder of 815 ± 5g of crumpled towels into the receptacle through the bin flap. If there is difficulty in fitting the entire 815g of crumpled towels into the test receptacle, it can be shaken lightly to provide adequate space. When all materials are loaded, the edges of the observation window can be sealed with duct tape to prevent air infiltration or agent release. The test must be initiated within 30 minutes of removal of the fire load materials from the conditioning chamber if the atmospheric conditions within the test area or booth are different.
- Mount the conditioned fire extinguisher to the test receptacle per the manufacturer's installation drawing, ensuring that the agent temperature will be at or below 30°F at the time of discharge (externally mounted type), as described in section 5.1.
- Record initial ambient, extinguisher surface, and test receptacle temperatures.
- Start the data acquisition system.
- Energize the igniter (time = 0) and begin to record the times to relevant events as described below.
- Upon extinguisher discharge, remove power from the igniter, immediately close all ventilation holes in the test receptacle, and record the time of discharge. (It is critical that the ventilation holes be closed immediately upon agent discharge to prevent the agent from escaping.) If the extinguisher does not discharge within 5 minutes of the igniter energizing, the test should be aborted and considered a nontest.

- If after 5 minutes from the conclusion of the agent discharge, the temperature and visual observations indicate that combustion has ceased, open and secure the access panel.

- If after a further 2 minutes reignition does not occur, empty the compartment and spread the waste into a single layer, observe and note any residual smoldering. Record the extent of fire load consumption, presence or lack of smoldering, etc. If residual smoldering is present, the test is a failure.

- If reignition does occur, the test is a failure. Extinguish the fire using water or other environmentally friendly method.

- Weigh the discharged extinguisher to determine and record weight of agent discharged.

5.6 TEST REPORT.

The test report must include the following:

- A complete description of the test receptacle and the fire extinguisher, including photographs, if appropriate.

- Details of the test results should include the temperature of the extinguisher surface, temperature of the receptacle, and the times from ignition energizing to the generation of smoke, open flaming, agent discharge, and end of test.

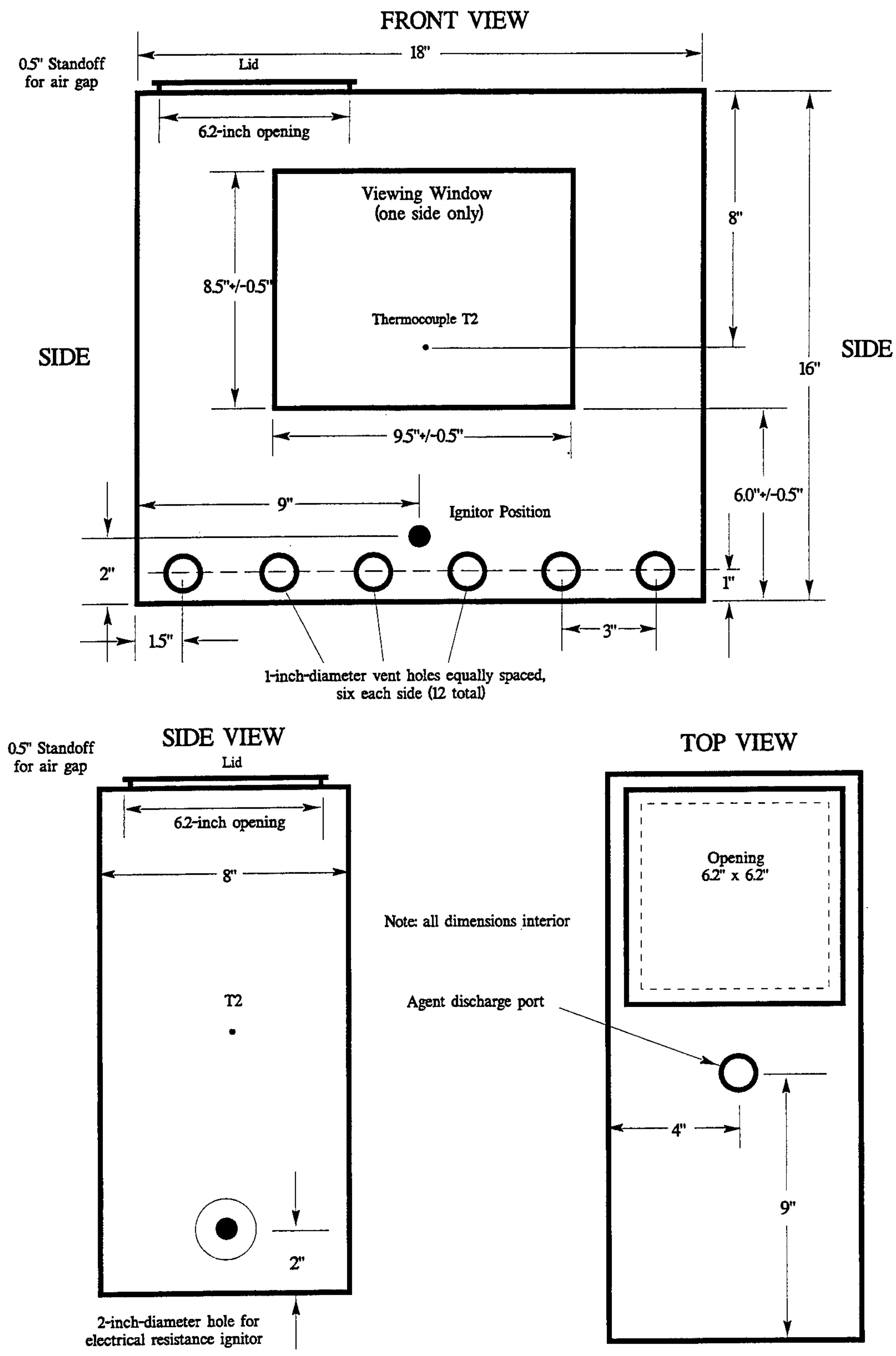

FIGURE D-1. STANDARD LAVATORY DISPOSAL RECEPTACLE FOR EVALUATING FIRE EXTINGUISHING AGENTS

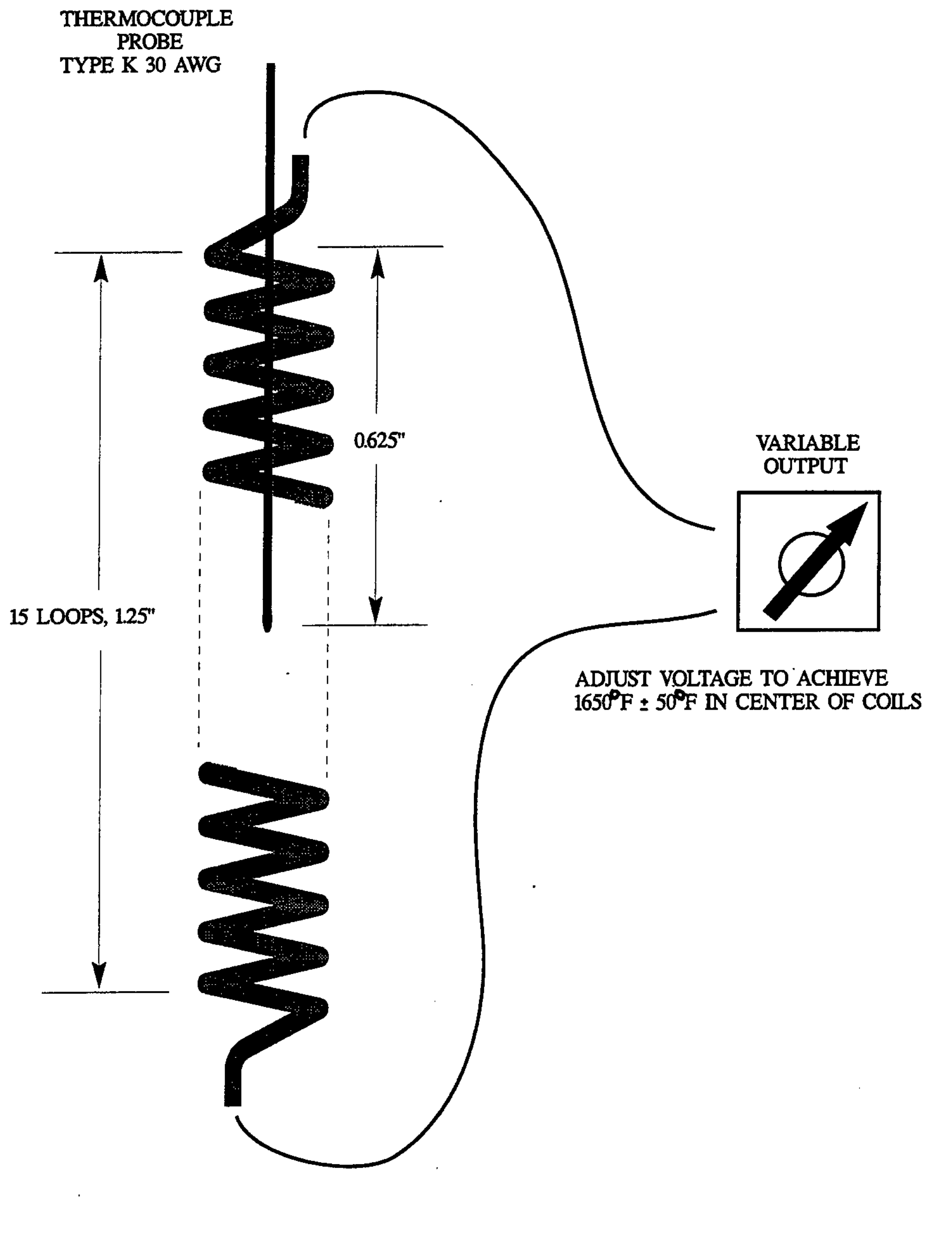

FIGURE D-2. IGNITION SOURCE FOR STANDARD LAVATORY DISPOSAL RECEPTACLE