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ILLINOIS POWER COMPANY

CLINTON POWER STATION, P.O. BOX 678, CLINTON, ILLINOIS 61727

Docket No. 50-461

January 8, 1985

Mr. B. L. Siegel
Clinton Licensing Project Manager
Licensing Branch No. 2
U.S. Nuclear Regulatory Commission
Phillips Building - Room 136
Bethesda, MD 20814

Subject: General Electric's Power Generation Control Complex Floor System Halon Fire Protection

Dear Mr. Siegel:

A position paper (attachment I) was developed by Niagara Mohawk, Gulf States Utilities, Pennsylvania Power & Light, and Illinois Power Company as a means to encourage the revision of the Halon concentration criterion for the Power Generation Control Complex (PGCC) floor system. The proposal for a different Halon limit is based upon Halon suppression test results (attachment II) sponsored by the NRC in 1981 which show a criterion of 6% Halon with a 10 minute duration is adequate.

A meeting in your offices during January, 1985 is requested so we can discuss the details and merits of this proposal.

Sincerely yours,

T.L. Gubelfor

F. A. Spangenberg
Director - Nuclear Licensing
and Configuration
Nuclear Station Engineering

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Attachments

cc: Regional Administrator Region III, USNRC
NRC Resident Office
Illinois Department of Nuclear Safety

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Alternative Approach to NEDO 10466-A

The goal of this presentation is to show that a Halon (1301) concentration level of 6% and a holding time of 10 minutes is sufficient to extinguish a deep seated fire.

The PGCC floor modules are separated into distinct fire protection zones having individual Halon (1301) distribution systems. The installation of the floor modules is concluded by sealing the zones from each other. Physical constraints in some cases result in less than perfect sealing of these zones; hence the zone leak tightness and the Halon equipment capacity must be correlated. The Halon injection equipment must be able to achieve a given Halon concentration within 10 seconds and then sustain that concentration for a given holding time. The 20% concentration with a holding time of 20 minutes (20/20) is contained on page 4-25 of NEDO Document 10466-A (February, 1979) but no reference was given so that the basis or circumstance could be studied in detail.

In 1981, Sandia National Laboratories conducted a series of Halon (1301) suppression tests on cable tray configurations per an NRC contract (SAND 81-1785). The test results established that a Halon concentration of 6% with a holding time of 10 minutes (6/10) was sufficient for obtaining fire extinguishment and preventing subsequent reignition. This particular report was not released but the test summary was published in NUREG/CR-2607. The particular tests (SAND 81-1785) were conducted in an open room tray design and the 6/10 was successful. We have reasoned that closed trays would be equally successful at 6/10 due to the confinement and metal mass of the floor trays (zones). We understand that NUREG CR-3656, "Evaluation of Suppression Methods for Electrical Cable Fire" will be published soon, perhaps during the first quarter of 1985, and that it supports the criterion for a 6% Halon concentration sustained for a 10 minute period.

The halon (1301) fire suppression systems for the PGCC floor modules were designed for total flooding of the protected volumes. The physical conditions or constraints of a PGCC floor module (zone) are more conducive to Halon extinguishment than the open room tray arrangement used in the Sandia tests. Oxygen input is substantially reduced and the combustion product efflux (reduction) is inhibited within the PGCC floor modules when compared with the open room tray tests. The enclosed tray (PGCC) is more effective in dissipating heat through the metal mass of the attached floor modules than the open room tray dispersion of heat into the air volume.

In summary, our analysis supports the acceptability of a lower Halon concentration (6%) and a reduced holding time. It seems prudent based on our analysis that a practical concentration value of 6% Halon (1301) be utilized (10 minute duration) to first ensure that adequate fire inhibition is present and secondly that human occupation of the control room can occur as long as possible under extreme conditions.

II.5.2 Halon Suppression Tests

A series of nine tests we. conducted at Sandia National Laboratories to determine the effectiveness of Halon 1301 in suppressing flaming and deep-seated cable tray fires.[34] This halogen compound is produced by E.I. DuPont de Nemours and Company, Incorporated and has the chemical formula $CBrF_3$. Halon 1301 has been extensively tested as a fire suppressant.[35] In addition to the retardant action on fires, it is believed that Halon 1301 presents less of a personnel hazard than carbon dioxide or nitrogen inerting systems. Accordin; to human effects experiments conducted by Haskell Laboratories[36] the health hazard threshold for Halon 1301 is 7 percent by volume. The room volumetric concentration of Halon did not exceed 6 percent for this series of cable fire suppression tests.

The experimental facility used in all earlier tests had to be modified in order to install the various suppression systems to be tested. One new feature of the facility was a ventilation system, installed to allow simulation of normal air ventilation and circulation in a room of a nuclear power plant. The flow rate of the ventilation system, when used, was set to approximately 2100 ft^3 per minute which provided an air turnover rate in the room of about once every 4.6 minutes.

Tests were conducted in both the horizontal and vertical configuration of cable trays, and both IEEE-383 qualified (cross-linked polyethylene, 3 conductor) and unqualified (PE/PVC, 3 conductor) cables were used as in previous tests. Trays were separated by 10.5 in. (27.6 cm). "Dummy" trays consisting of an insulating barrier were placed adjacent to the two trays (vertical tests) or above the top tray (horizontal tests) to provide reradiation of heat. In these tests, the ignition tray was designated the donor tray, while the second tray was designated the acceptor tray. Five-minute on-and-off burn cycles using a total of 140,000 BTU/HR (41-kW) propane burners were used until a "well-developed" fire was started. At this point, an insulating barrier separating the two cable trays was removed and 1 minute later the Halon discharged. The discharge rates complied with NFPA 12A-1980.[37] The room was also sealed at the time of discharge as required.

Table VII summarizes the tests conducted as well as the results. Tests 58 and 59 used no Halon but instead allowed the fire to proceed until the ventilation system was

TABLE VII

Halon Suppression Tests Summary

Test Number	Configuration	Cable Type	Suppression Method	Results
56	Horizontal	IEEE-383 Qualified	45-minute soak using Halon	No reignition after admission of fresh air
57	Horizontal	Qualified	10-minute Halon soak	No reignition
58	Horizontal	Qualified	No Halon; 45 minutes without ventilation	Self-quenched after 30 minutes
59	Horizontal	Qualified	No Halon; 10 minutes without ventilation	Burning after 10 minutes
60	Horizontal	Qualified	4-minute Halon soak	Reignited when ventilated
61	Horizontal	Unqualified	16-minute Halon soak	No reignition
62	Vertical	Unqualified	5-minute Halon	No reignition
63	Vertical	Qualified	4-minute Halon soak	No reignition
64	Vertical	Qualified	Halon discharged but room continuously vented	No reignition

turned on later. In only one instance using Halon, Test 60, did the cable insulation reignite after readmission of fresh air. The soak time represents the amount of time the room was sealed, i.e., time between discharge of Halon and readmission of fresh air using the ventilation system.

Halon 1301 was very effective in suppressing flames. Figure 15 shows that 5 seconds after discharge the flames have been extinguished and all that remains is smoke and condensed water vapor. Figure 16 taken from Test 61 shows the dramatic temperature drop in the flaming region as Halon is discharged.

Halon 1301 was not as rapid in suppressing deep-seated cable tray fires. Figure 17 indicates that even after the Halon has been discharged the interior cable bundle temperature continues to rise, probably resulting from continued combustion of cable insulation. The second increase in temperature occurs after the readmission of air and reignition of the cable insulation.

Finally, Figures 18 and 19 show the dynamic mass loss of cable insulation in the donor trays for Tests 57 and 59. These two tests were identical in every respect except that in Test 57 a 10-minute Halon soak was provided whereas no Halon was used in Test 59. However, only 3.7 kg of insulation was lost when Halon was used (most of it before Halon discharge) compared to a loss of 6 kg when the fire was allowed to self-extinguish. Clearly, Halon is an effective fire suppressant agent even for deep-seated cable fires.

Major Findings

Six very obvious but important items stand out among all conceivable findings from the Halon suppression systems tests. They number as follows:

1. No damage to, or reduction in, the acceptor tray cables' current-carrying capacity as a result of Halon was observed in any of the tests.

2. In all of the tests in which it was used, the Halon effectively extinguished fires in both the acceptor and donor trays. In only one test (60) was a flame rekindled in either tray after the room was ventilated.

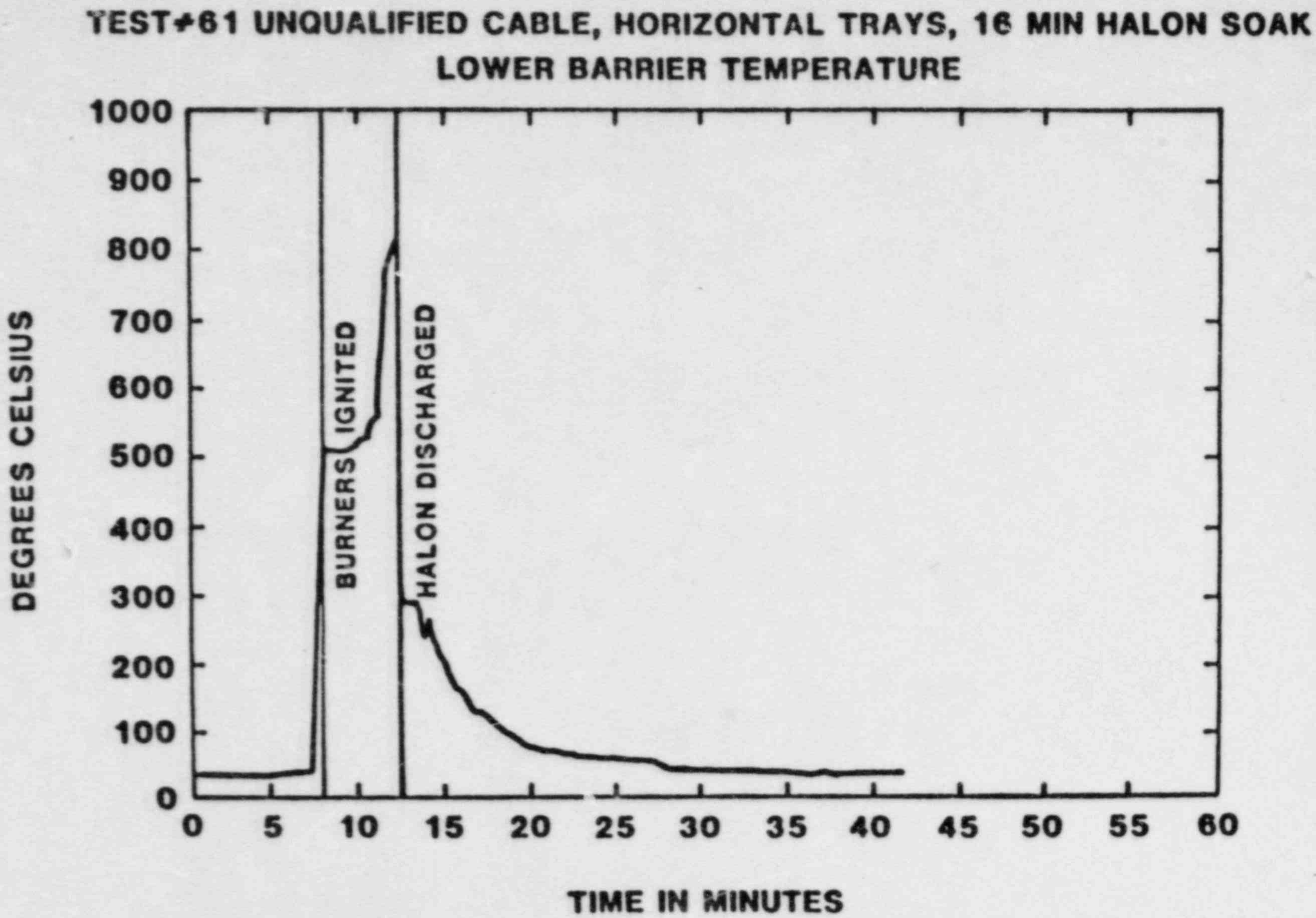

Figure 16

Temperature Drop in Flaming Region

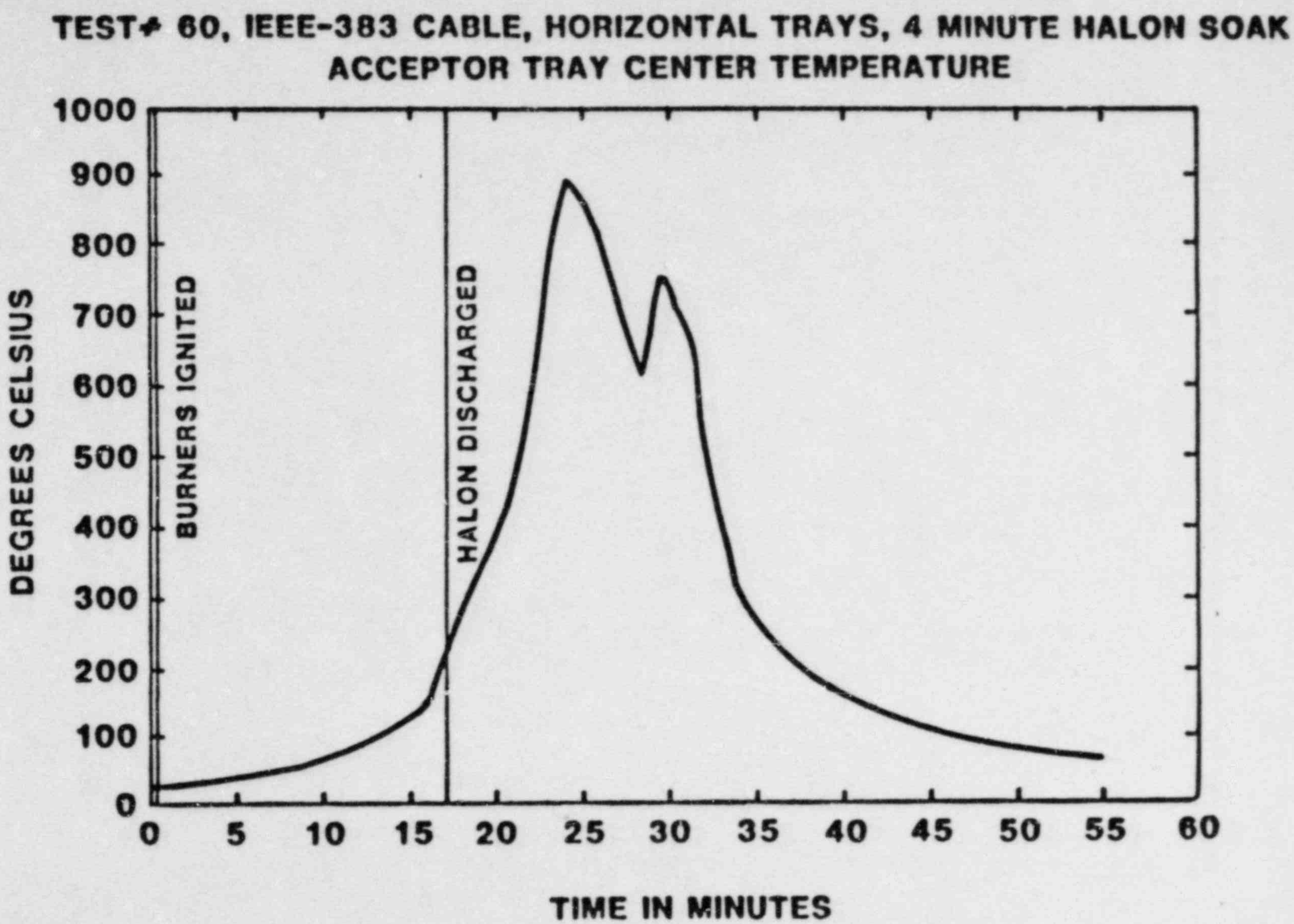

Figure 17

Indication of Deep-Seated Fire and Reignition of Cables

TEST #57, IEEE-383 CABLE, HORIZONTAL TRAYS, 10 MINUTE HALON SOAK, TOTAL MASS OF DONOR TRAY

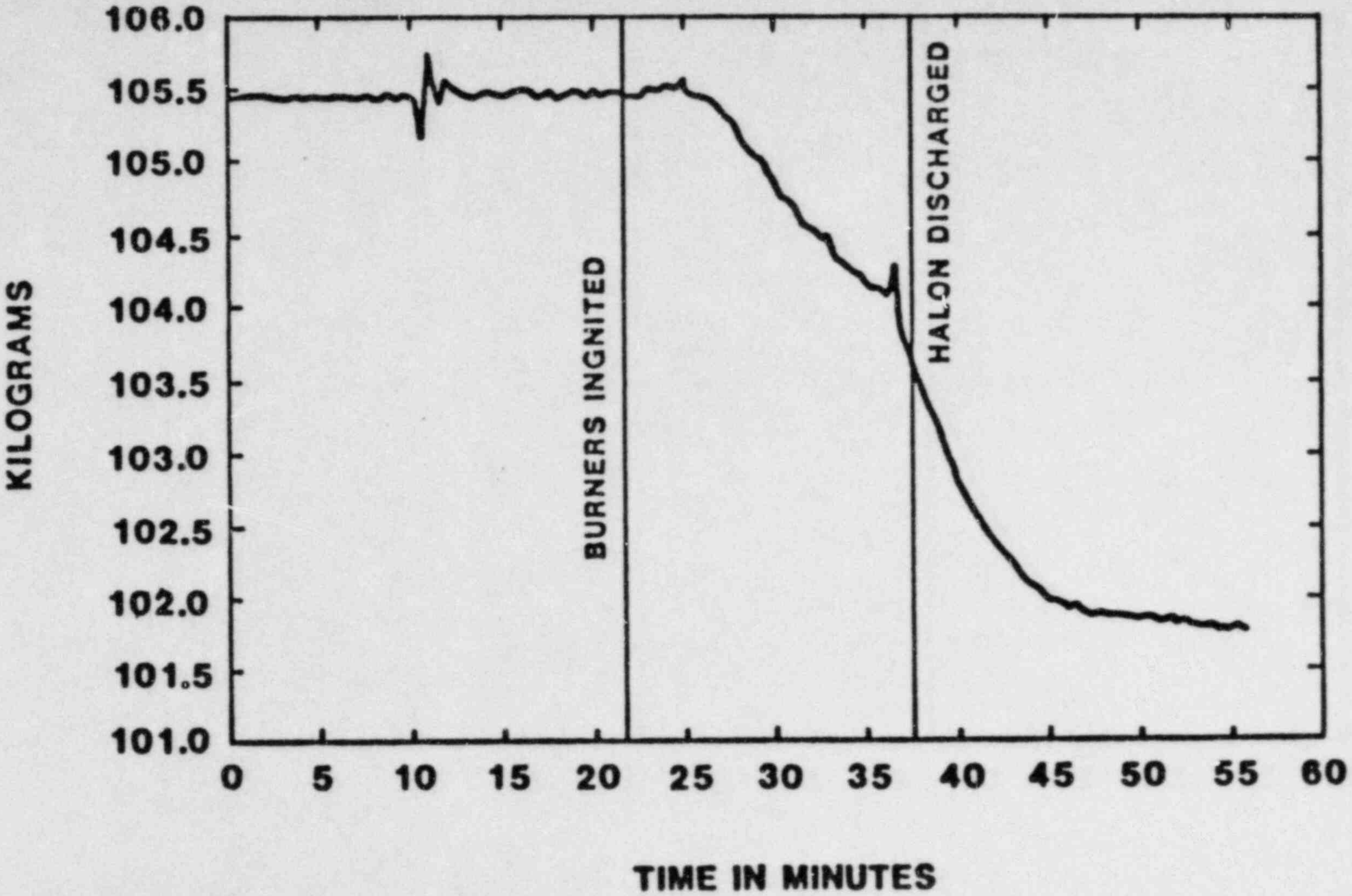

Figure 18
Mass Loss in Presence of Halon

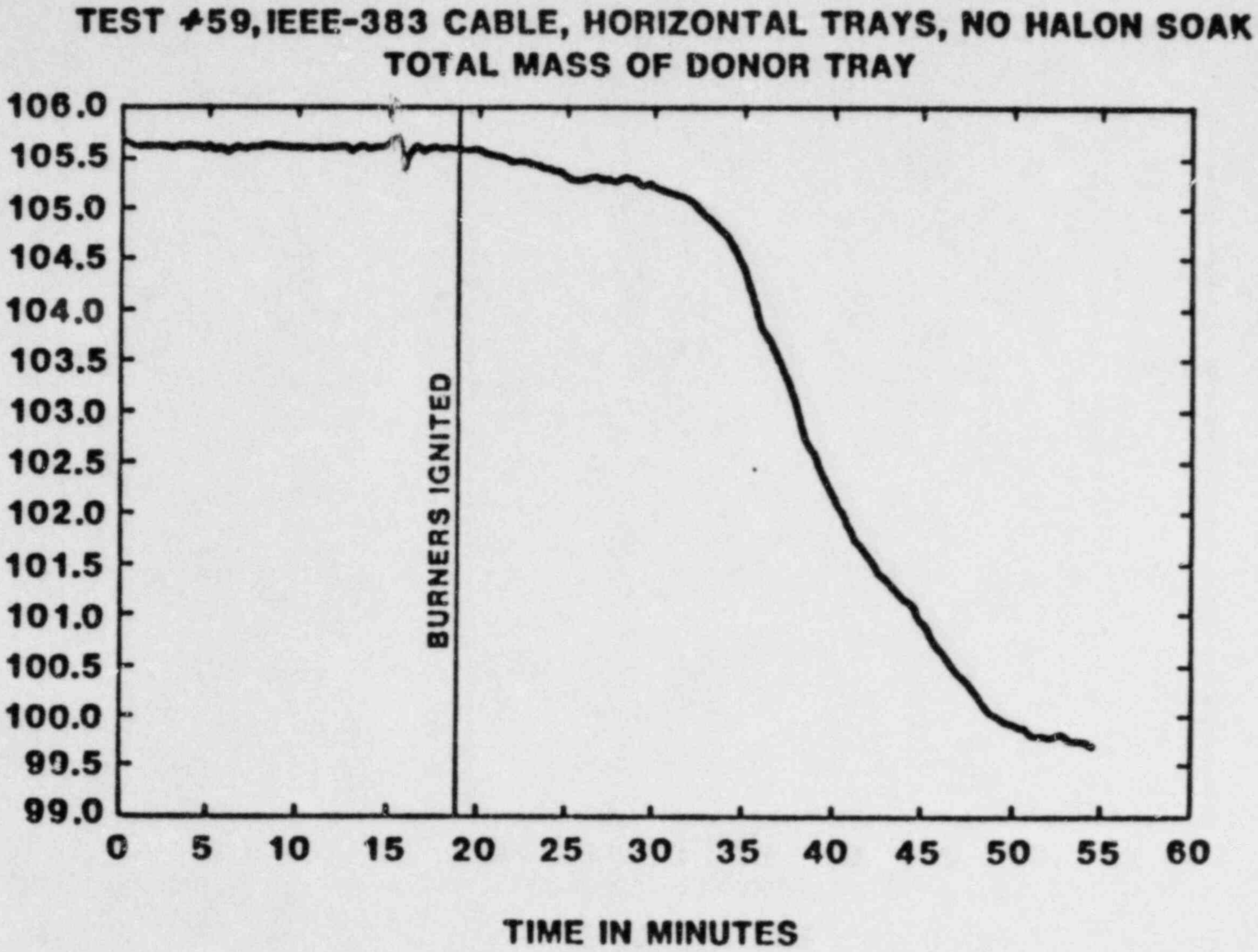

Figure 19

Mass Loss Without Halon Suppression

3. No flammable concentrations of unburned hydrocarbons were pyrolyzed during the Halon soak time in any of the tests.

4. A time limit on the Halon's ability to permanently extinguish a cable tray fire may have emerged. While a 10-minute interval of Halon soak was enough to extinguish a fire in a horizontally oriented tray filled with qualified cable, a 4-minute interval was inadequate for this task.

5. As mentioned above, the Halon permanently extinguished a fire after only a 10-minute soak time, whereas the same time limit on simple oxygen deprivation was insufficient to keep the flame from returning upon ventilation.

6. While a 4-minute soak time was not enough to prevent a rekindling in a horizontally oriented tray filled with qualified cable, it was enough to prevent reignition in a vertically oriented tray filled with the same cable. From this, the conclusion is that Halon more effectively quenches fires in vertically oriented trays than in those horizontally oriented.

II.5.3 Water Sprinkler Tests (NFPA 13)

A series of tests was conducted to determine the effectiveness of overhead sprinklers in suppressing cable tray fires. The original intention was to duplicate the Halon test series in order to get a direct comparison between Halon suppression and water sprinkler suppression. Although no final report on the water tests has been issued as yet, the results are briefly summarized here. Table VIII lists the tests performed and the results.

Two pendent-type, open-head sprinklers with standard orifices of 1/2 in. (1.3 cm) diameter were used. The sprinklers were 12.5 ft high (3.8 m), were offset from the cable trays and were separated by 12 ft (3.7 m). The water system was designed to produce a pressure of 35 psig (2.4×10^5 Pa) at each open head. A total flow rate of 71 gal per minute (4.5 ℓ per second) was obtained. The system was activated manually. The