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WCAP-13961

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PCS WATER DISTRIBUTION PHASE 3 TEST DATA REPORT

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Westinghouse Electric Corporation
Energy Systems Business Unit
Advance Technology Business Area
P.O. Box 355
Pittsburgh, Pennsylvania 15230

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1.0 SCOPE

This data report was prepared as a record of tests performed in response to Test Specification AP600 Phase 3 Passive Containment Cooling System Water Distribution Test (REFERENCE 1). The report provides test facility photographs, test model photographs, a discussion of test operations, copies of all raw test data, and copies of the log book entries for the Phase 3 test program.

2.0 TEST OBJECTIVES

The objectives of this program were to:

o Assess the effectiveness of the weir design to distribute water over the containment dome and top of the sidewall for the entire range of expected water flow rates.

o Provide a large scale visual demonstration of the water distribution over the containment dome.

o Determine the flow off the sides and bottom of the model with weirs over the range of expected flow rates.

o Determine film thickness and volumetric flow rate at the springline of the model to adequately characterize the thin film flow for use in safety analysis.

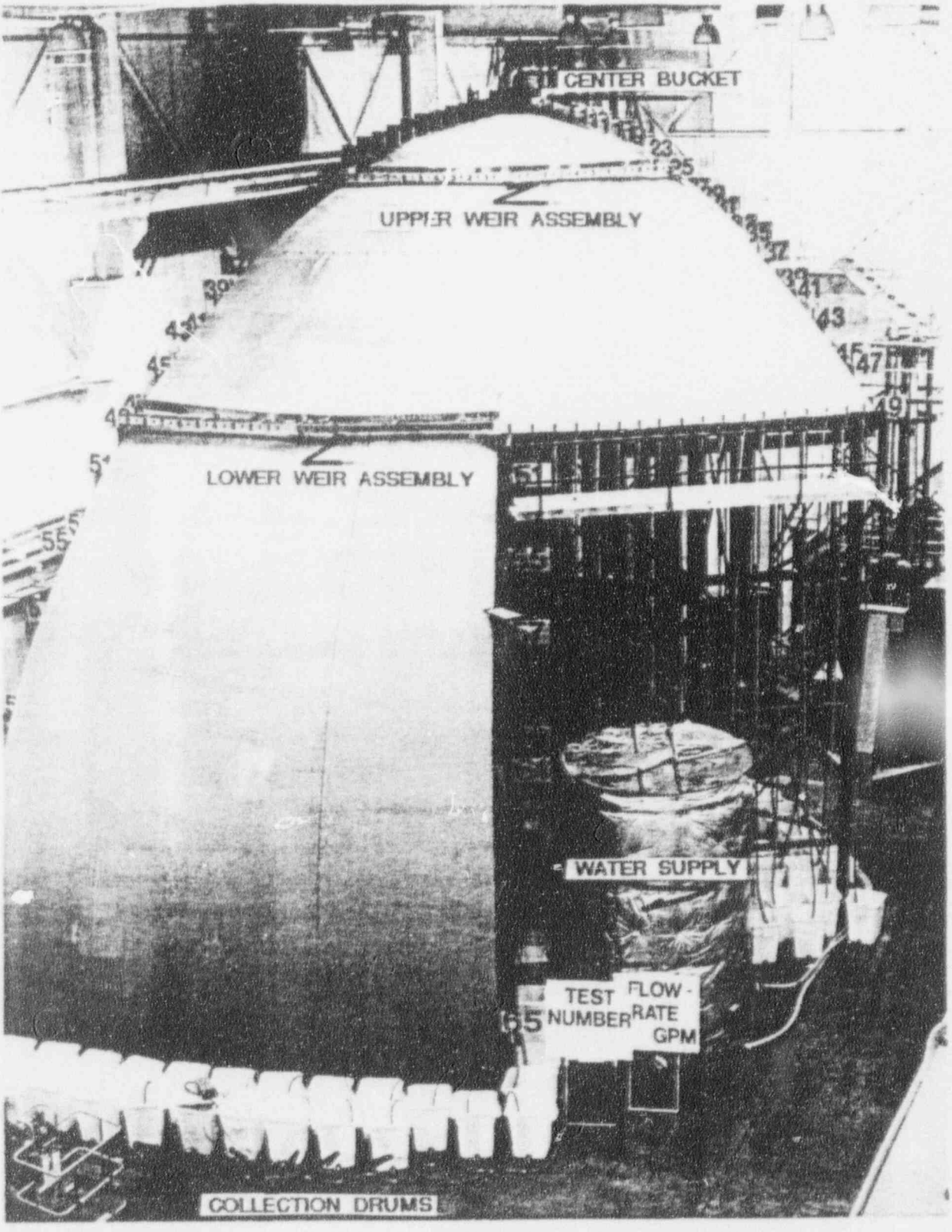
3.0 TEST FACILITY, MODEL, AND WEIR DESCRIPTION

The Passive Containment Cooling System - Water Distribution Tests for Phase 3 were conducted using the existing full scale 1/8th (45^{o}) sector model of the AP600 containment dome. The model was designed and constructed to represent the major design features, dimensional characteristics, including allowable weld and surface variations, and surface treatments which could influence the effective, reproducible distribution of cooling water over the surface of the Containment dome. Measurements of the water distribution were obtained by collecting and measuring the flow over defined areas and by selective measurement of the film thickness using a capacitance probe. Tests were conducted over a range of water flow rates which bracketed the flows anticipated.

The test facility is shown in Figure Number 1. The facility consists of a full scale 1/8th sector model of the containment dome, a water supply system to deliver water to the supply bucket at the top center of the containment dome, a water collection and measurement system, and a Weir distribution system. Detailed descriptions and figures of the test model construction and facility construction are presented in PCS Water Distribution Test Phase II Test Data Report AP600 (REFERENCE 2) and the Construction/Test plan for the Passive Containment Cooling System Test Articles (REFERENCE 3).

The fabrication drawings for the upper and lower weir assemblies

FIGURE NUMBER 1



OVERALL VIEW OF THE TEST FACILITY

and the weir support detail drawings are listed in ATTACHMENT I. Figures Number 2 and 3 show the Upper and Lower Weir Assemblies looking down from the top of the containment dome respectively. The distribution box, collection tube, and back stiffener are shown in Figure Number 4. Figure Number 5 shows the [ ] distribution box drain hole located in the bottom plate. The channel [ ] drain back holes and outlet side plate of the distribution box are shown in Figure Number 6. Typical weir channel divider plates with 1" cross over holes are shown in Figure Number 7. The upper weir assemblies had [ ] notch plates for each left and right channel assembly, where as the lower assemblies had [ ] notch plates for each left and right channel. Figure Number 8 shows the upper assembly notch plate spacing and stop plate. The lower assembly notch plate spacing and stop plate is shown in Figures Number 9 and 10. The weir channel end support is shown in Figure Number 11. The relationship of the lower weir assembly to the upper weir assembly is shown in Figure Number 12 along with the distribution box mounting plate and weir channel end support. Figure Number 13 shows the relative position of the upper weir assembly to the center bucket and the center of the containment dome. The upper weir assembly "V" notches were [ ] of total angle opening as shown in Figure Number 14. Figure Number 14 shows also the lower weir assembly "V" notches which were [ ] of total angle opening.

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4.0 TEST OPERATIONS

The weir assemblies were attached to the model in the locations defined in REFERENCE 4 AP600 Plant Engineering, PCS Water Distribution Weirs.

During the initial check-out of the model it was observed that the lower weir assembly was inadequately distributing the water over the desired surface area. The decision was made to double the number of "V" notches for that assembly, along with the increased number the notch angle was changed from [ ] total angle opening. The testing was conducted with no other changes to the weir assembly notch spacings and opening angles.

a,c

The defined tests were conducted in accordance with an approved test procedure titled AP600 Phase 3 Passive Containment Cooling System Water Distribution Test (REFERENCE 5).

There were a total of sixteen test runs conducted on the model. All test runs were conducted at ambient water temperature. The first four tests (Test Numbers 1 through 4) were conducted with weir channel assemblies in the level condition. The test flow rates were [ ] gallons per minute. The [ ] gpm test was conducted with the model surface allowed to dry overnight. The water collection drum measurements were taken for these tests. The next two tests (Test Numbers 5 and 6) were conducted with the weir channel assemblies tilted at the far ends. The tilt was achieved by placing a [ ] square bar under the channels at the support. Tests were run at [ ] gallons per minute. The water collection drum measurements were taken for these tests. The next two tests

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FIGURE NUMBER 2

UPPER WEIR ASSEMBLY

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FIGURE NUMBER 3

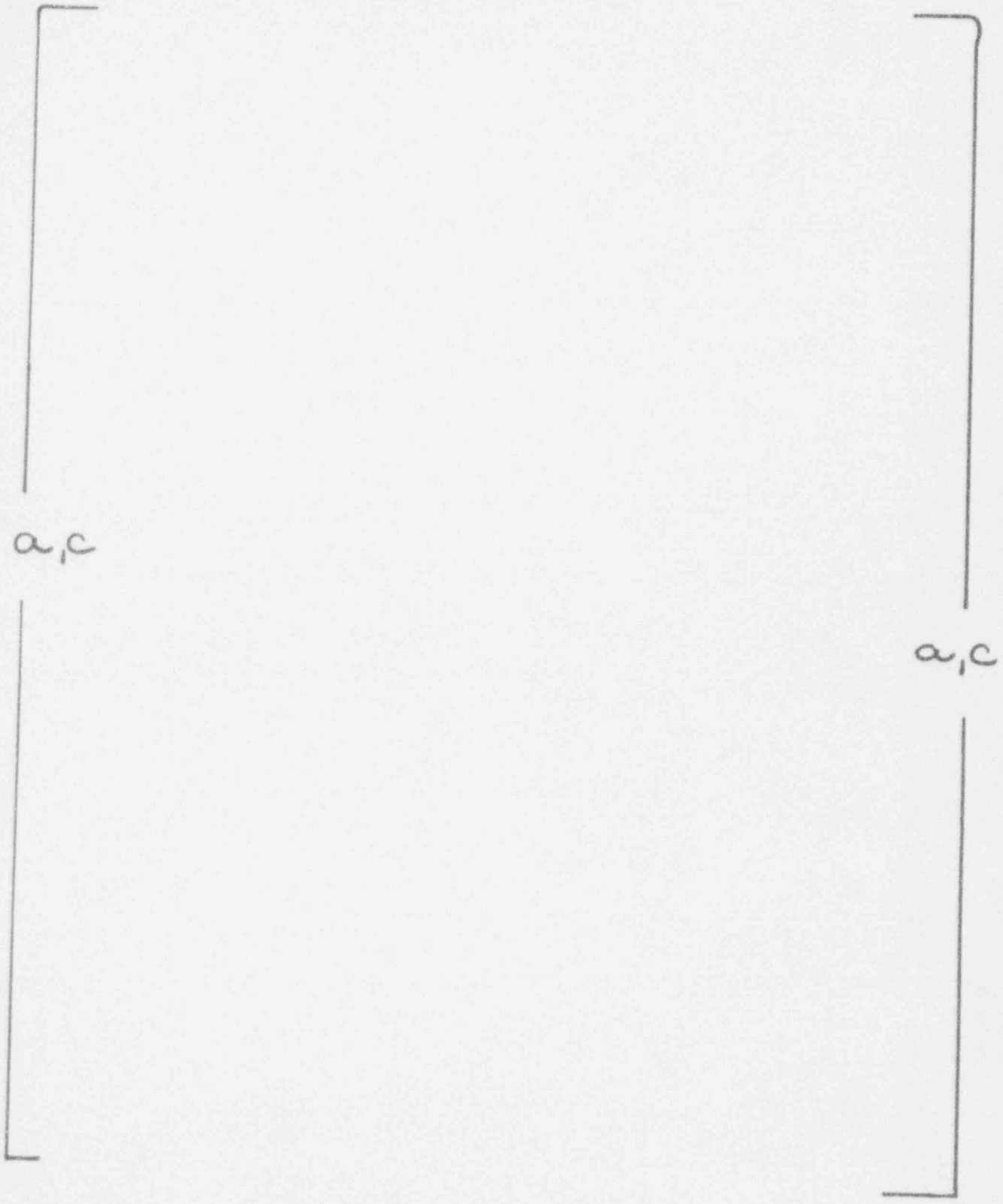
LOWER WEIR ASSEMBLY

FIGURE NUMBER 4

VIEW OF THE DISTRIBUTION BOX, COLLECTION TUBE, AND BACK STIFFENER

FIGURE NUMBER 5

FIGURE NUMBER 6



CHANNEL DRAIN BACK HOLES AND OUTLET SIDE PLATE

FIGURE NUMBER 7

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CHANNEL DIVIDER PLATES WITH CROSS OVER HOLES

FIGURE NUMBER 8

UPPER ASSEMBLY NOTCH PLATE SPACING AND STOP PLATE

FIGURE NUMBER 9

LOWER ASSEMBLY NOTCH PLATE SPACING AND STOP PLATE

FIGURE NUMBER 10

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a,c

LOWER ASSEMBLY NOTCH PLATE SPACING AND STOP PLATE

FIGURE NUMBER 11

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WEIR CHANNEL END SUPPORT

FIGURE NUMBER 12

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DISTRIBUTION BOX MOUNTING PLATE AND CHANNEL END SUPPORT

FIGURE NUMBER 13

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POSITION OF UPPER WEIR ASSEMBLY

FIGURE NUMBER 14

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UPPER & LOWER "V" NOTCH PLATE

(Test Numbers 7 and 8) had the weir channel assemblies put back to the level condition by removing the [ ] square bars. The distribution box drain holes were plugged with [ ] nuts and bolts with rubber washers. Tests were conducted at [ ] and [ ] gallons per minute. The water collection drum measurements were taken for these tests. The drain holes were then unplugged for the next series of tests. As part of the next six tests (Test Numbers 9 through 14) a [ ] volumetric collection gutter was installed on the straight wall section of the model near the center of that portion of the model (the sixteenth segment that reaches to the floor). The gutter is shown in Figure Number 15. The gutter was [ ] inches high and was divided into [ ] compartments. Each compartment drained through a three way ball valve to the drain or to the graduated cylinder designated for that compartment. With the gutter installed volumetric flows over time were collected. Also, during these six tests film thickness measurements were taken using capacitance probes. The probes with mounting fixture, signal conditioners, station switching panel, and digital voltmeters are shown in Figure Number 16. The film thickness readings were taken at the [ ] and the [ ] foot radius of the model for all flow paths that developed for each of these six tests. The film thickness measurements were conducted in accordance with an approved procedure (REFERENCE 6). The first four of these tests were conducted with the weir channel assemblies in the level condition at the following flow rates: [ ] and [ ] gallons per minute. Film thickness measurements and volumetric data were taken for these tests. The next two tests were conducted with the weir channel assemblies tilted with the [ ] square bars installed. The test flow rates were [ ] gallons per minute. Film thickness measurements and volumetric data were taken for these tests. The weir channel assemblies were returned to the level condition by removing the [ ] square bars. The last two tests (Test Numbers 15 and 16) were conducted with simulated baffle plate supports attached to the model surface. Four inch diameter tubing two inches long was attached to the model surface at twelve locations. The simulated supports are shown in Figure Number 17. The tests were conducted at [ ] gallons per minute. The water collection drum measurements were taken for these tests.

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All test series runs were video taped with copies of the tapes being maintained at the Waltz Mill Site Photography Lab.

The collection drum data sheets for Test Numbers 1 through 8, 15 and 16 are contained in ATTACHMENT II.

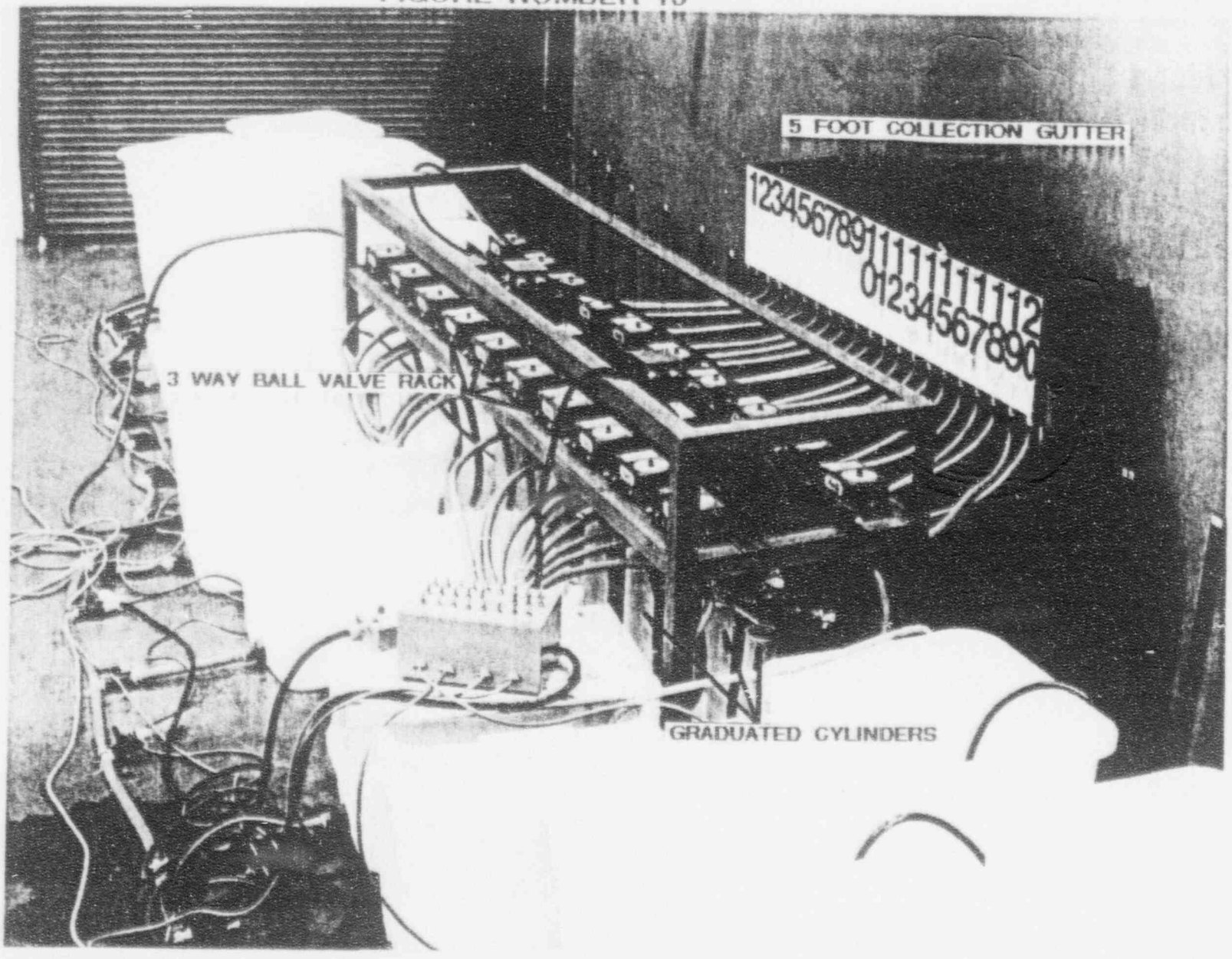
The volumetric collection data sheets for Test Numbers 9 through 14 are contained in ATTACHMENT III.

The film thickness data sheets for Test Numbers 9 through 14 are contained in ATTACHMENT IV.

The daily test log book entries are presented as ATTACHMENT V.

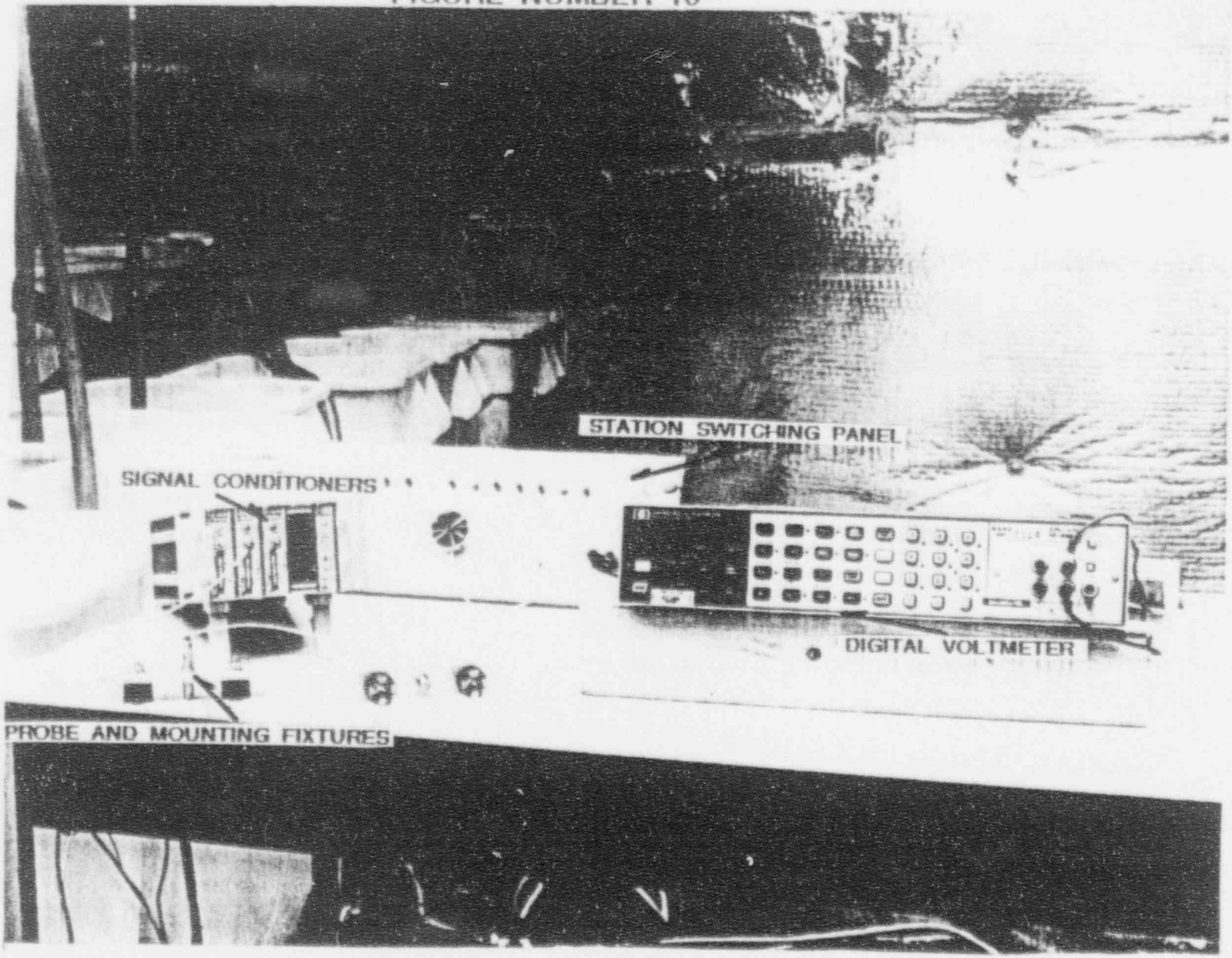
Documentation of the as built/installed positions of the weir

FIGURE NUMBER 15



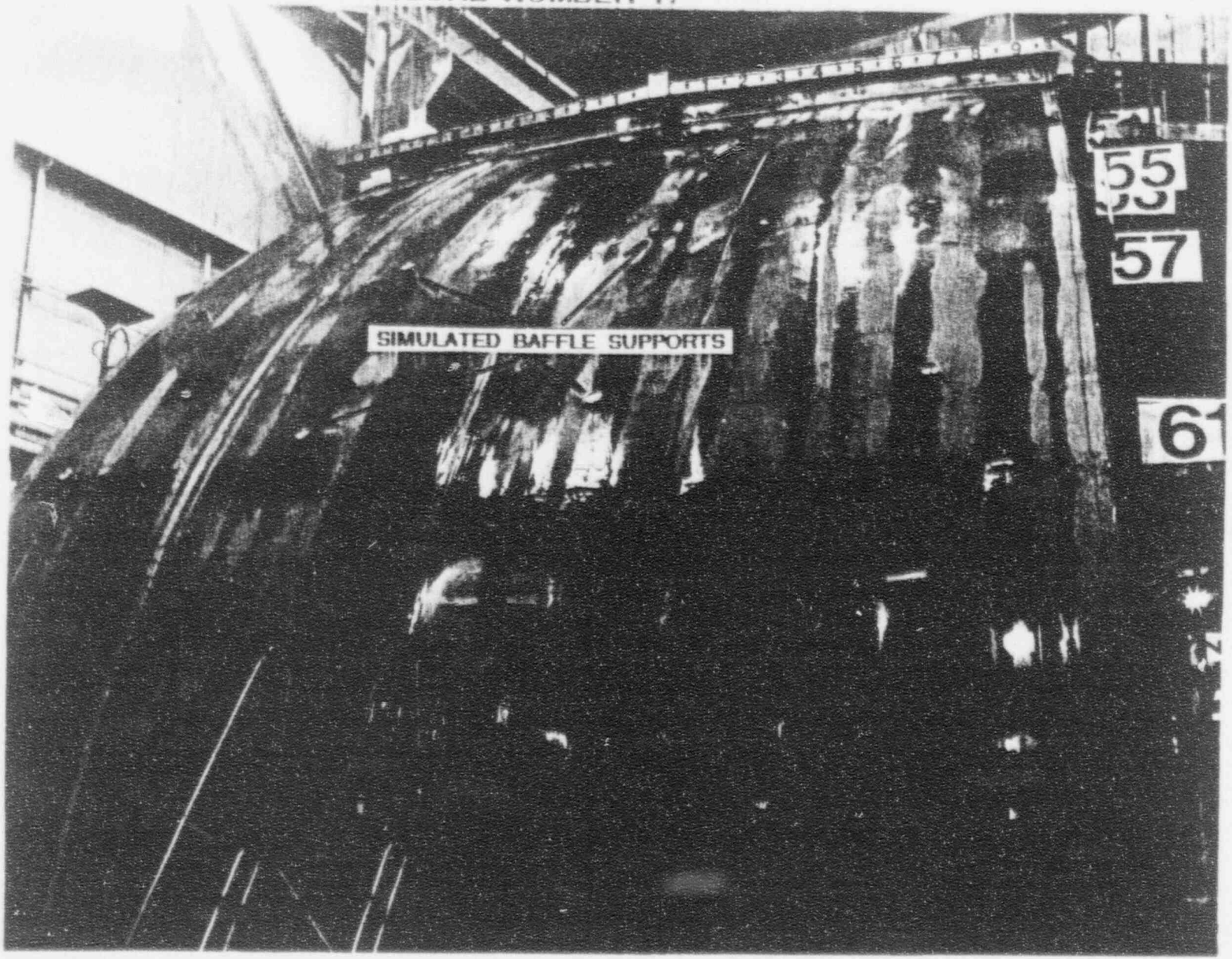
FIVE FOOT VOLUMETRIC COLLECTION GUTTER

FIGURE NUMBER 16



CAPACITANCE PROBE FIXTURE, CONDITIONERS, AND INSTRUMENTATION

FIGURE NUMBER 17



SIMULATED BAFFLE PLATE SUPPORTS

channels and supports on the AP600 model for Phase 3 testing are contained in ATTACHMENT VI.

REFERENCES

1.0 Phase 3 Passive Containment Cooling System Water Distribution Test, AP600 #PCS-T1P-006, WCAP-13816.

2.0 PCS Water Distribution Test Phase II Test Data Report AP600 Document No. PCS-T2R-007, Rev.0.

3.0 Construction/Test Plan For The Passive Containment Cooling System Test Articles, OI-TEAL-0002, Rev.0.

4.0 AP600 Plant Engineering, PCS Water Distribution Weirs, PEG/WMS0930.

5.0 AP600 Phase 3 Passive Containment Cooling System Water Distribution Test, AP600 Document No. MT01-T1P-014, Rev.0.

6.0 AP600 Phase 3 Passive Containment Cooling System Water Distribution Test Film Thickness Measurement Procedure, AP600 Document No. MT01-T1P-015, Rev.0.

ATTACHMENT I

UPPER WEIR, LOWER WEIR & SUPPORT DETAIL DRAWINGS

WEIR DRAWINGS

DRAWING NO.	REVISION	TITLE
6437E16	1	CONTAINMENT COOLING SYSTEM TEST, FIXTURE DETAILS
6437E27	1	CONTAINMENT COOLING SYSTEM TEST, LOWER WEIR CHANNEL ASSEMBLY
6437E28	1	CONTAINMENT COOLING SYSTEM TEST, LOWER WEIR CHANNEL DETAIL
6437E29	1	CONTAINMENT COOLING SYSTEM TEST, LOWER WEIR DETAILS
6437E22	1	CONTAINMENT COOLING SYSTEM TEST, WEIR CHANNEL ASSEMBLY
6437E21	1	CONTAINMENT COOLING SYSTEM TEST, WEIR CHANNEL DETAIL
6437E17	1	CONTAINMENT COOLING SYSTEM TEST, WEIR DETAILS
6437E23	1	CONTAINMENT COOLING SYSTEM TEST, WEIR SUPPORT DETAILS

ATTACHMENT II

CONTAIN COLLECTION DRUM DATA SHEETS INFORMATION

PAGES 25 THRU 34 HAVE BEEN OMITTED AS THIS

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ATTACHMENT III

CONTAIN VOLUMETRIC COLLECTION DATA SHEETS INFORMATION

PAGES 36 THRU 41 HAVE BEEN OMITTED AS THIS

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ATTACHMENT IV

CONTAIN FILM THICKNESS DATA SHEETS INFORMATION

PAGES 43 THRU 55 HAVE BEEN OMITTED AS THIS

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ATTACHMENT V

CONTAIN DAILY TEST LOG BOOK ENTRIES INFORMATION

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