

MAINE YANKEE EOC-4
SUMMARY OF FUEL INSPECTION RESULTS

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SUMMARY OF FUEL INSPECTION RESULTS

Fuel Assembly Sipping Campaign

The fuel assembly leak test program (sipping) was completed on the entire Maine Yankee core during the outage at the end of Cycle 4. Nine (9) fuel assemblies have been identified as containing leaking rods. These assemblies include 3 H Batch, 2 G Batch, 3 E Batch and 1 F Batch assemblies. The G and E Batch assemblies had completed their second operating cycle; the F assembly completed its third and the H Batch assemblies their first cycle. The assemblies containing perforated rods and their associated measured isotopic activities are presented in Table 1. The location of each of the nine assemblies in Cycle 4 is given in Figure 1.

Visual Inspection of Fuel Assemblies

A total of [] fuel assemblies were visually inspected following Cycle 4 including [] assemblies examined to determine the number of rods containing one or more elliptical surface anomalies* as a function of [] (Figure 2). [] of the Batch H assemblies inspected contained burnable poison rods with [] in place of the conventional $Al_2O_3-B_4C$ shim material. The visual examination confirmed satisfactory performance of the [] bearing rods after one irradiation cycle in that no [] were observed. [] of the nine assemblies identified by sipping as containing leaking fuel rods were also visually inspected. The inspection revealed a total of [] perforated fuel rods in the [] assemblies (Figure 1). [] of the perforated rods were observed in [] Batch H assemblies. The approximate axial position of each of the perforations is given in Figure 3.

The core loading pattern devised by Yankee Atomic for Cycle 4 included the use of E batch assemblies in positions containing CEA's. For these E assemblies water rods were substituted for the burnable poison rods. All []

[]

assemblies containing leaking fuel rods were [] to a Batch E assembly, at least on [] The location of the perforated rods appears to be [] Additionally, these peripheral E batch assemblies contain the group #5 CEAs, which are used as a regulating bank. This regulating control rod bank was utilized during power changes just prior to primary coolant activity increases in February and March 1979.



Visual fuel inspections of the [] batch assemblies appear to show relatively [] between grids [] (near the top of the assembly) compared to other regions of the assembly. This is consistent with general observations which show increasing [] with increasing [] Visual observations in this region also showed [] which varied from one assembly to another and tended to increase with the [] rods. In an effort to determine the distribution of discolored elliptical surface anomalies throughout the core, [] fuel assemblies were visually examined to locate and count the number of [] fuel rods in each that contained one or more of the anomalies. Figure 4 shows the number of []

[] The incidence of these discolored elliptical surface anomalies for each fuel batch is shown below:

No. of Assemblies
Examined

Fuel Batch

Total Number of Rods with
Surface Anomalies

[

]

The most affected rods [] were located in assemblies near [

]

(see Appendix A for a summary of the assemblies observed with surface anomalies).

As would be expected, the discolored elliptical surface anomalies were observed in [] from assembly to assembly. However, several conclusions about the [] of the discolored elliptical surface anomalies and/or generalizations can be made concerning these observations:

[

Assembly and Single Rod Inspections

A total of five fuel assemblies (H208, H214, H218, G123 and G132) determined by sipping to contain perforated fuel rods were disassembled for single rod eddy current testing. Subject to reactor critical path scheduling requirements, the basic purpose of this campaign was to purge the leaking fuel rods from each of the five assemblies prior to reactor insertion for Cycle 5. Due to the uncertainties associated with the removal of []

Fuel bundle H208 was chosen as the first candidate for disassembly because it contained the most observable []

The first [] fuel rods removed from [] (Table 2) were selectively chosen as a sample for additional testing to further evaluate the surface anomalies observed during the fuel assembly visual examination program. The [] rods represented a []

[] The types of inspections that each of these [] rods were subjected to are summarized in Table 2.

Visual examination of the fuel rods removed from [] showed the [] to contain the discolored elliptical surface anomalies. Furthermore, these surface anomalies were always []

[] [] rods did not contain the elliptical surface anomalies even though they appeared to be as uniformly crudded as the [] rods. Physics calculations also showed that the []

]

As indicated in Table 2, each of the [] fuel rods pulled from [] were eddy current tested in the [] condition. Rods [] were among those eddy current tested. (These [] rods contained perforations that were observed during visual examination of the fuel assembly). The eddy current tests revealed []

]

In an effort to further clarify the eddy current results previously obtained, [] were retested at [] The results of these tests verified that []

]

A detailed visual examination of the regions giving the [] indications revealed that the []

]

FUEL ROD PROFILOMETRY

Profilometry was performed on [] fuel rods that were removed from assembly [] for the detailed inspection program (Table 2). The purpose of this additional testing was to: []

The modes of profilometer testing included:]

- 1) Spiral scans (0.25 inch pitch) of each fuel rod from the rod bottom into the plenum region.
- 2) Linear scans []
- 3) Scans around the rod circumference at []

The types of scans performed on each of the [] rods that were examined by profilometry are listed in Table 2. Figure 5 summarizes the ovalities and average diametral strain as determined from the spiral profilometer scans for the [] rods tested. [

]

This information shows:

Ovality



Diametra. Strain



Summary of Profilometry Observations

The key observations made during review of the profilometry data include:

[Empty space for key observations]

Additional Fuel Rod Eddy Current Testing

[Empty space for additional fuel rod eddy current testing]

[]

A total of [] fuel rods were eddy current tested from the five assemblies that were reconstituted. Based on the results of the eddy current and visual examinations, a total of 44 fuel rods were discharged and replaced with either solid Zircaloy dummy rods for the Batch G's and 1.96 w/o U_{235} fuel rods for the Batch H assemblies. Appendix B summarizes the rods tested and replaced for each of the five reconstituted assemblies. []

[]

FIGURE 1
CORE MAP SHOWING THE LOCATION
OF FUEL ASSEMBLIES DETERMINED
TO CONTAIN LEAKING RODS BY
WET SIPPING

Building
North

NORTH →

□ Assemblies that were visually examined

● indicates approximate location of fuel rods observed to contain perforations

Figure

Figure 2

MAINE YANKEE CYCLE 4
CORE MAP SHOWING THE
FUEL ASSEMBLIES THAT
WERE VISUALLY INSPECTED.

-1-

FIGURE 3

MAINE YANKEE EOC-4: AXIAL POSITION OF FUEL ROD PERFORATIONS BY
VISUAL EXAMINATION AND [] BY EDDY CURRENT INSPECTION

FIGURE 4
MAINE YANKEE CYCLE 4
CORE MAP SHOWING THE DISTRIBUTION
OF FUEL RODS CONTAINING ELLIPTICAL
SURFACE ANOMALIES ON ASSEMBLIES
THAT WERE VISUALLY INSPECTED

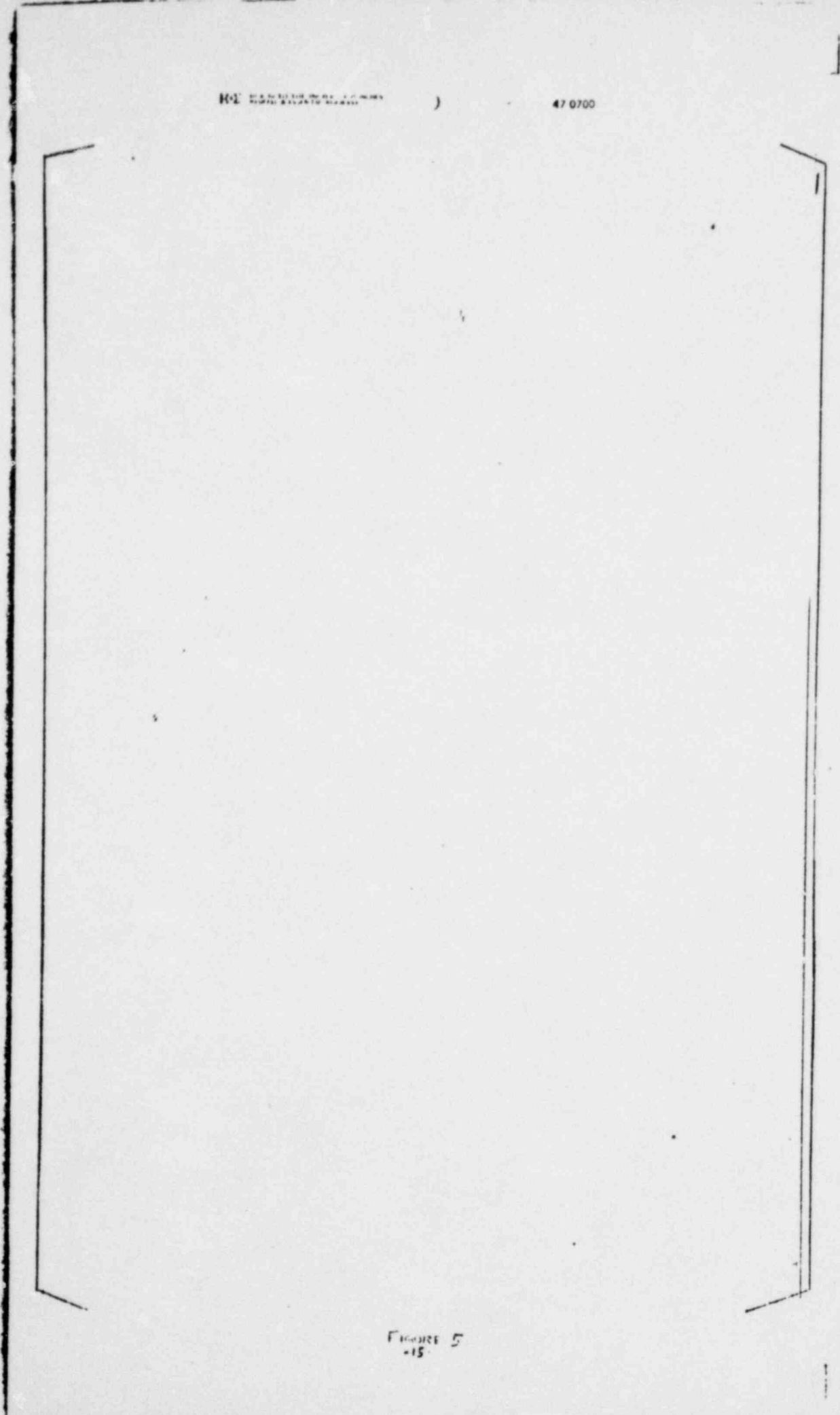
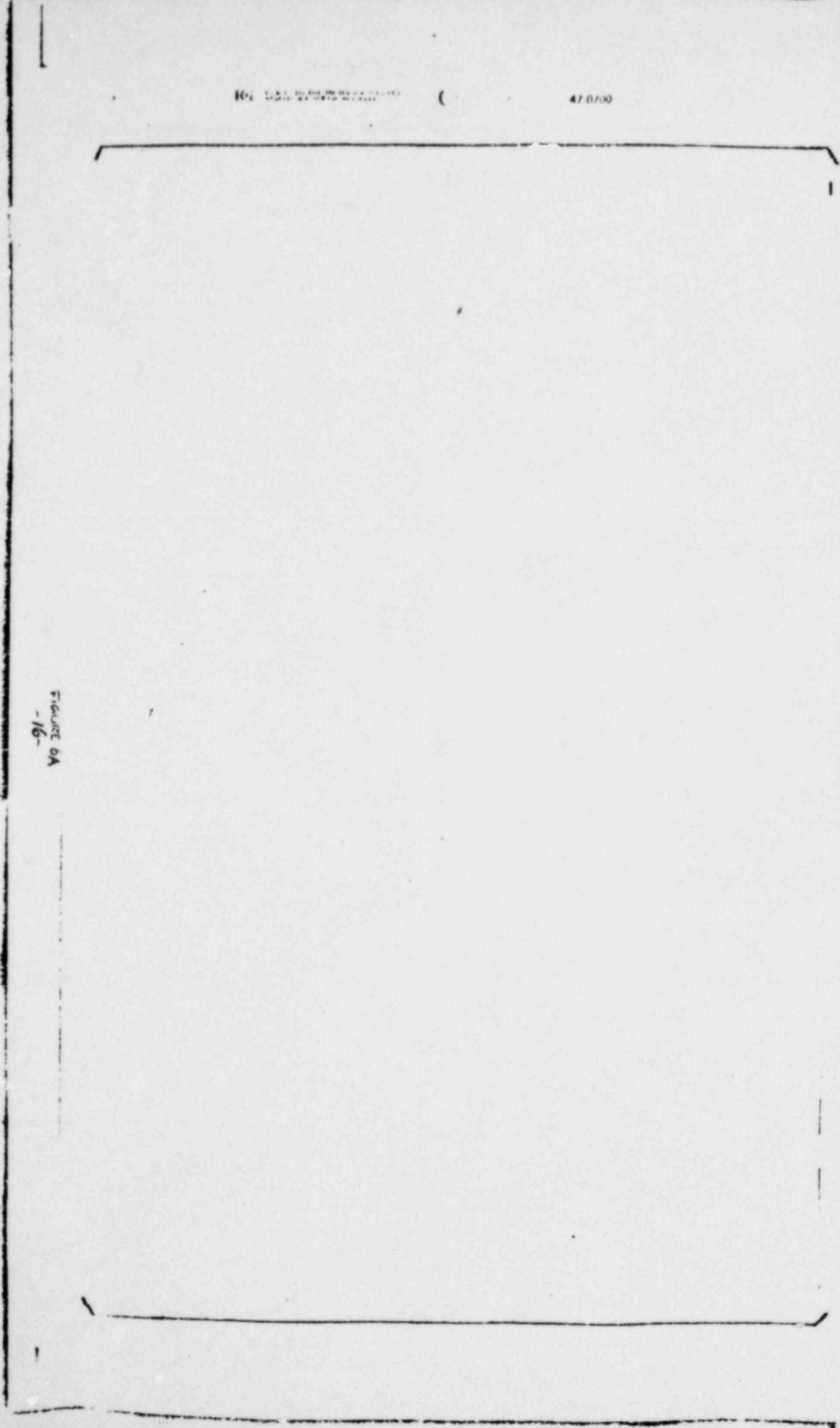
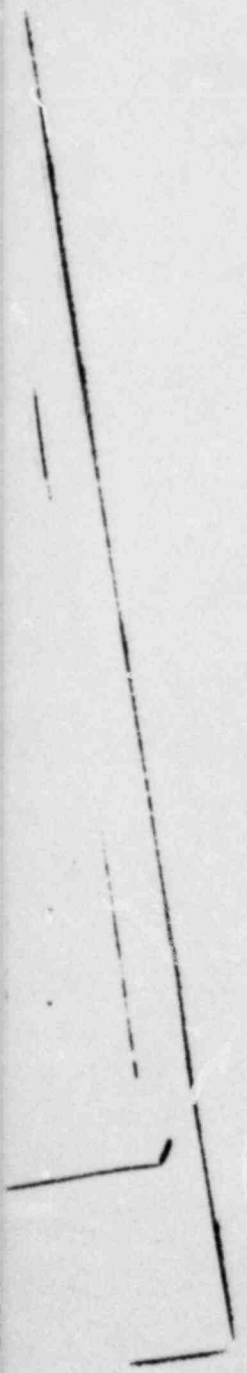


FIGURE 5
-15-

FIGURE 6A
-16-



11-11-78

TABLE 1

ISOTOPIC ACTIVITIES FOR FUEL ASSEMBLIES
CONTAINING LEAKING FUEL RODS

(ACTIVITIES ARE IN MICROCURIES/ML WITH BASELINE SUBTRACTED)

<u>ASSEMBLY NUMER</u>	<u>FUEL BATCH</u>	<u>EOC 4 ASSY. AVG. BURNUP (MWD/MTU)</u>
H208	H	13323
H214	H	13415
H218	H	12193
G132	G	22285
G123	G	19704
72	E	29411
6G	E	30200
7W	E	30391
9E	F	32764

NE - NOT EXAMINED

TABLE 2
[] SINGLE ROD INSPECTION SUMMARY

TABLE 3
Eddy Current Test Data on [

]



TABLE 4

APPENDIX A

ASSEMBLIES CONTAINING
ELLIPTICAL SURFACE ANOMALIES

ASSEMBLIES CONTAINING
ELLIPTICAL SURFACE ANOMALIES

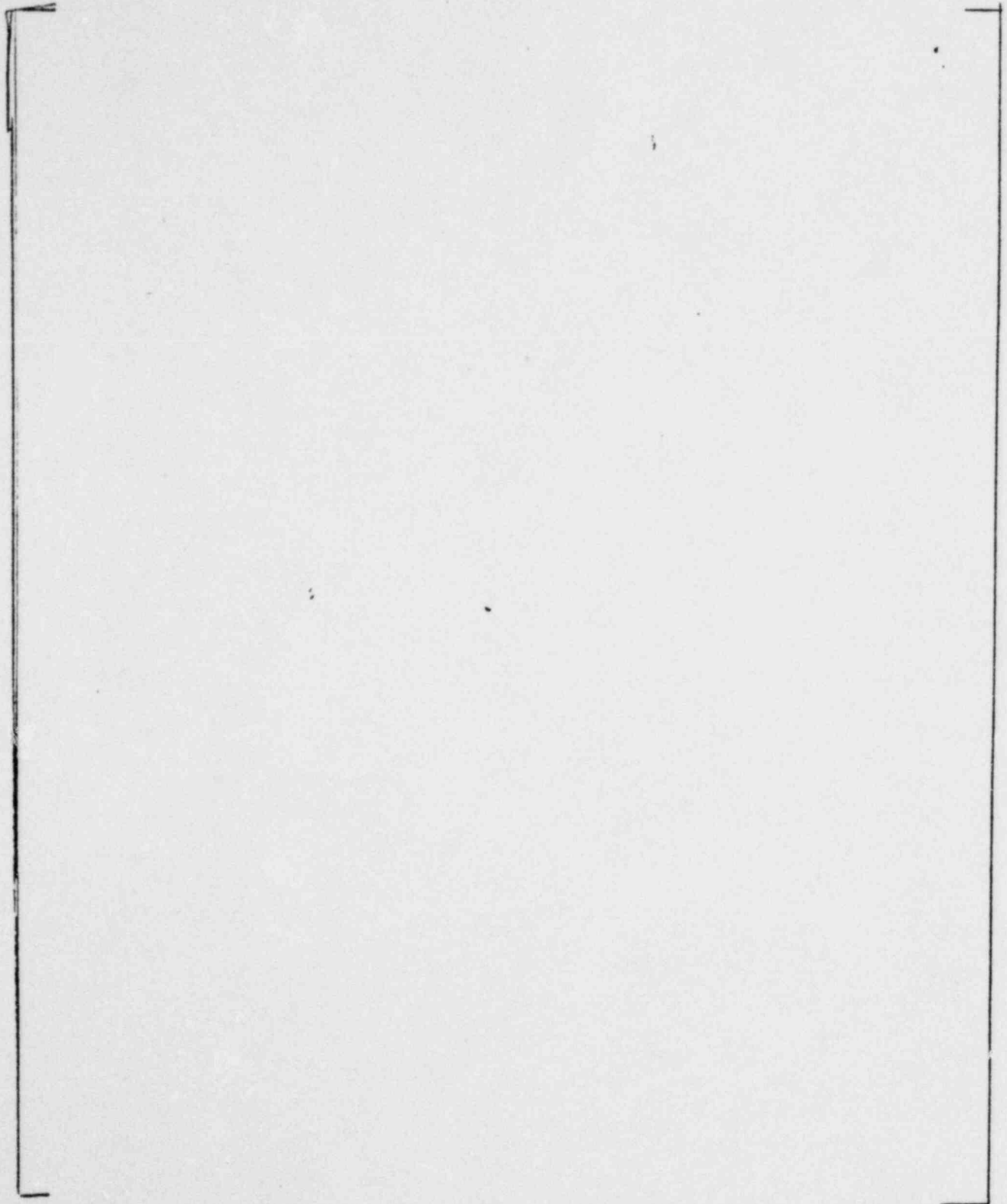
ASSEMBLIES CONTAINING
ELLIPTICAL SURFACE ANOMALIES



APPENDIX B

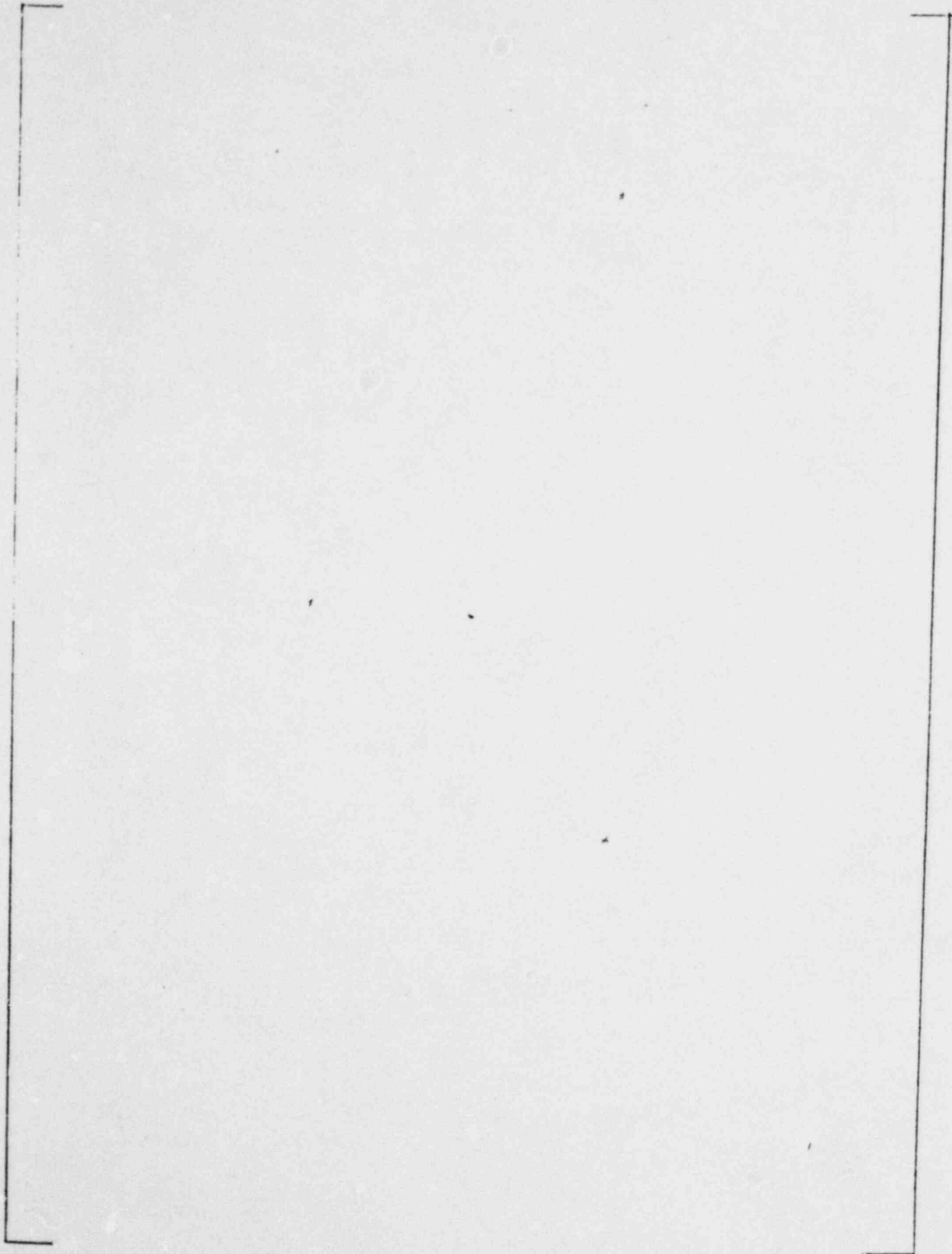
SUMMARY OF RODS
EDDY CURRENT TESTED AND
DISCHARGED FROM THE FIVE
RECONSTITUTED ASSEMBLIES

FUEL ASSEMBLY MYH208



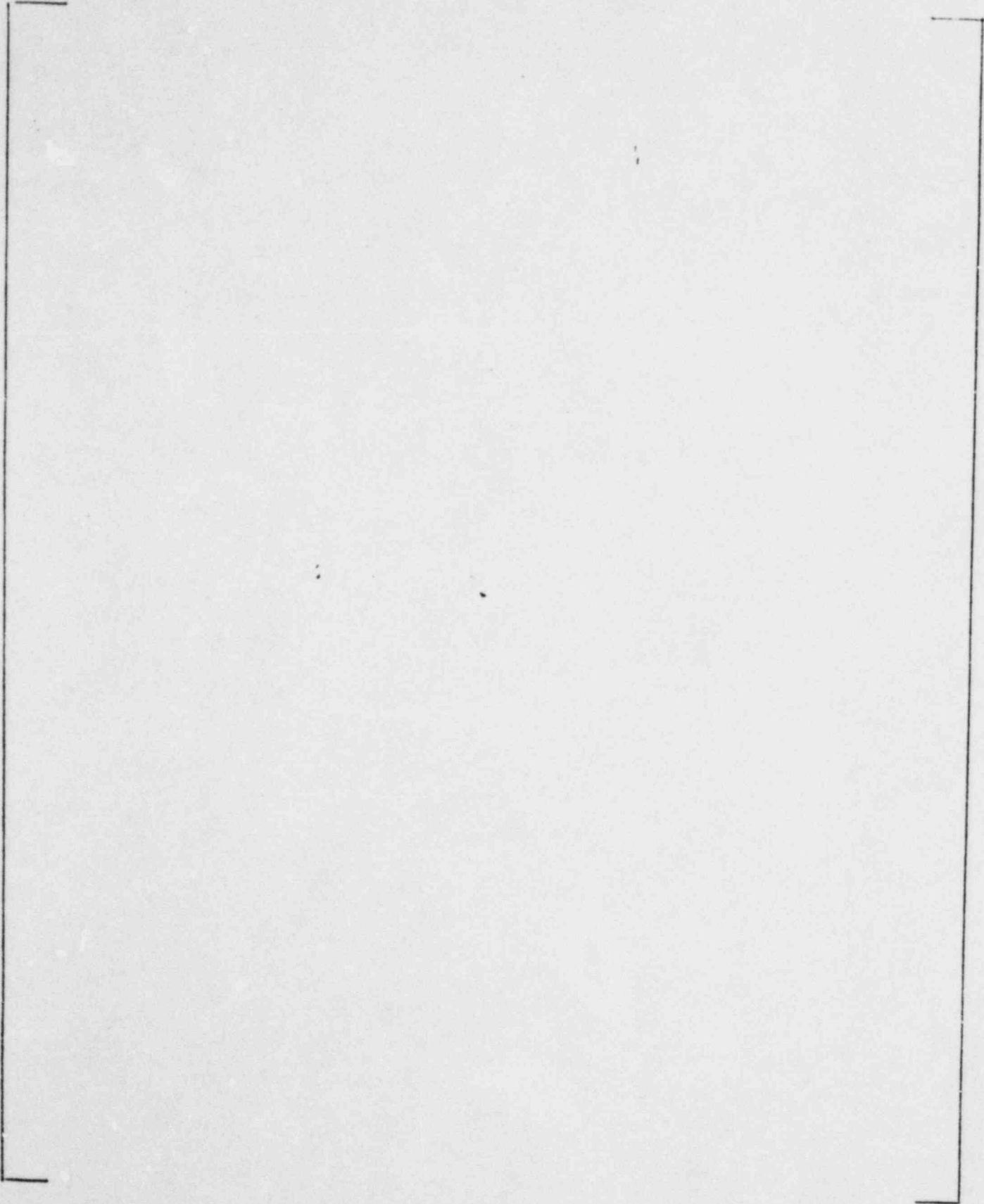
SUMMARY OF RODS
DISCHARGED FROM
ASSEMBLY H208

FUEL ASSEMBLY MYH214



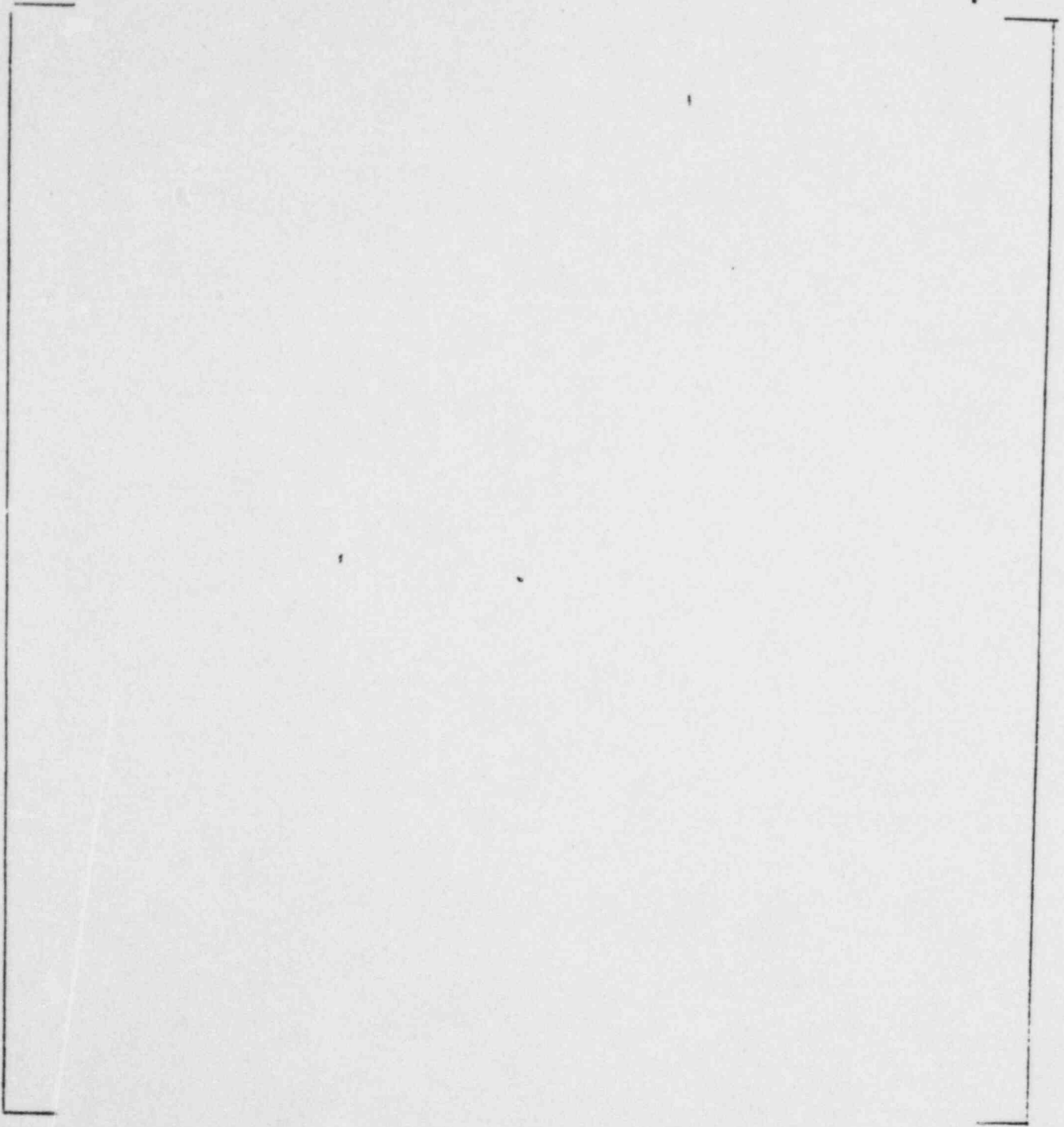
SUMMARY OF RODS
DISCHARGED FROM ASSEMBLY H214

FUEL ASSEMBLY MYH218

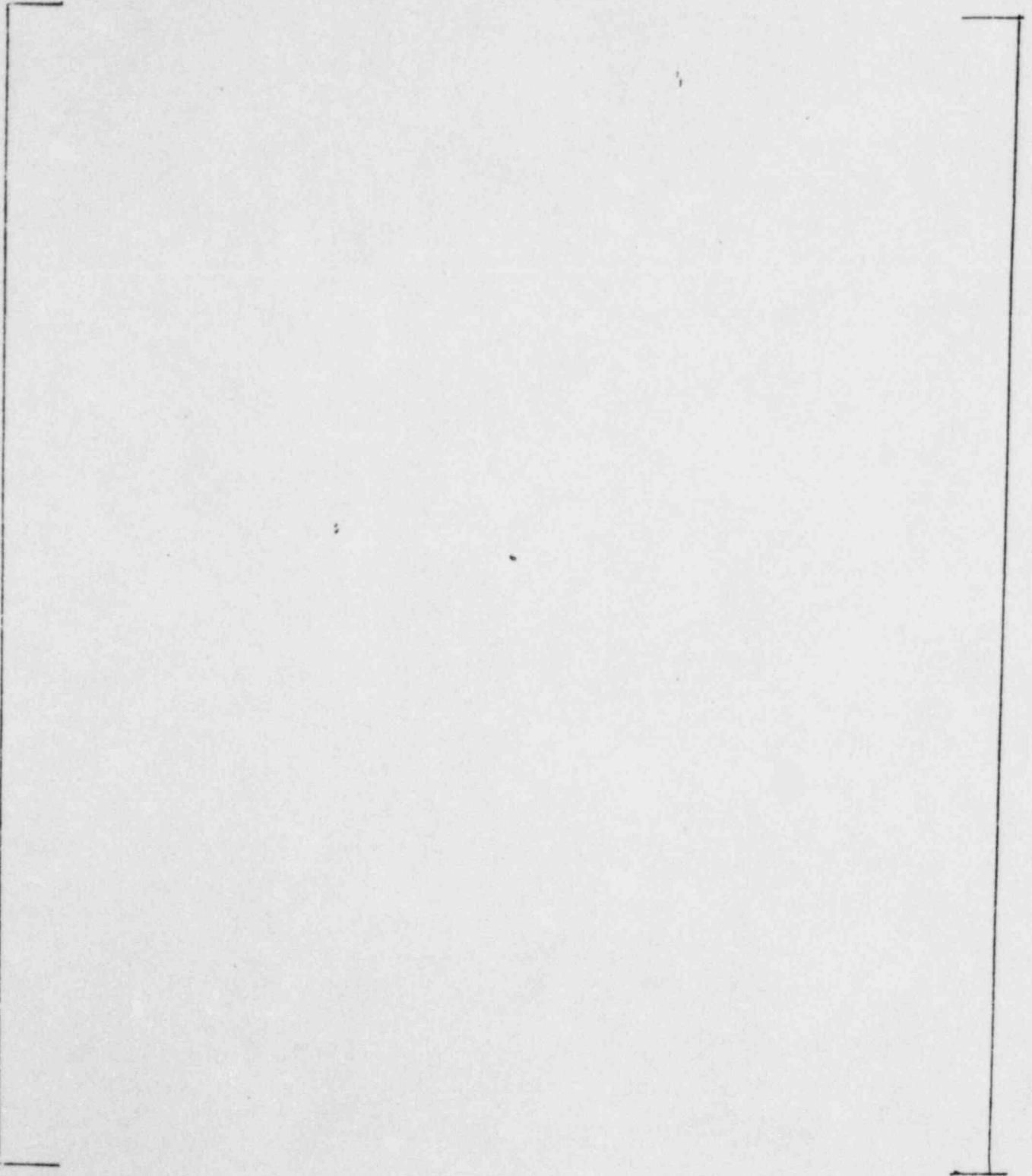


SUMMARY OF RODS DISCHARGED
FROM ASSEMBLY H218

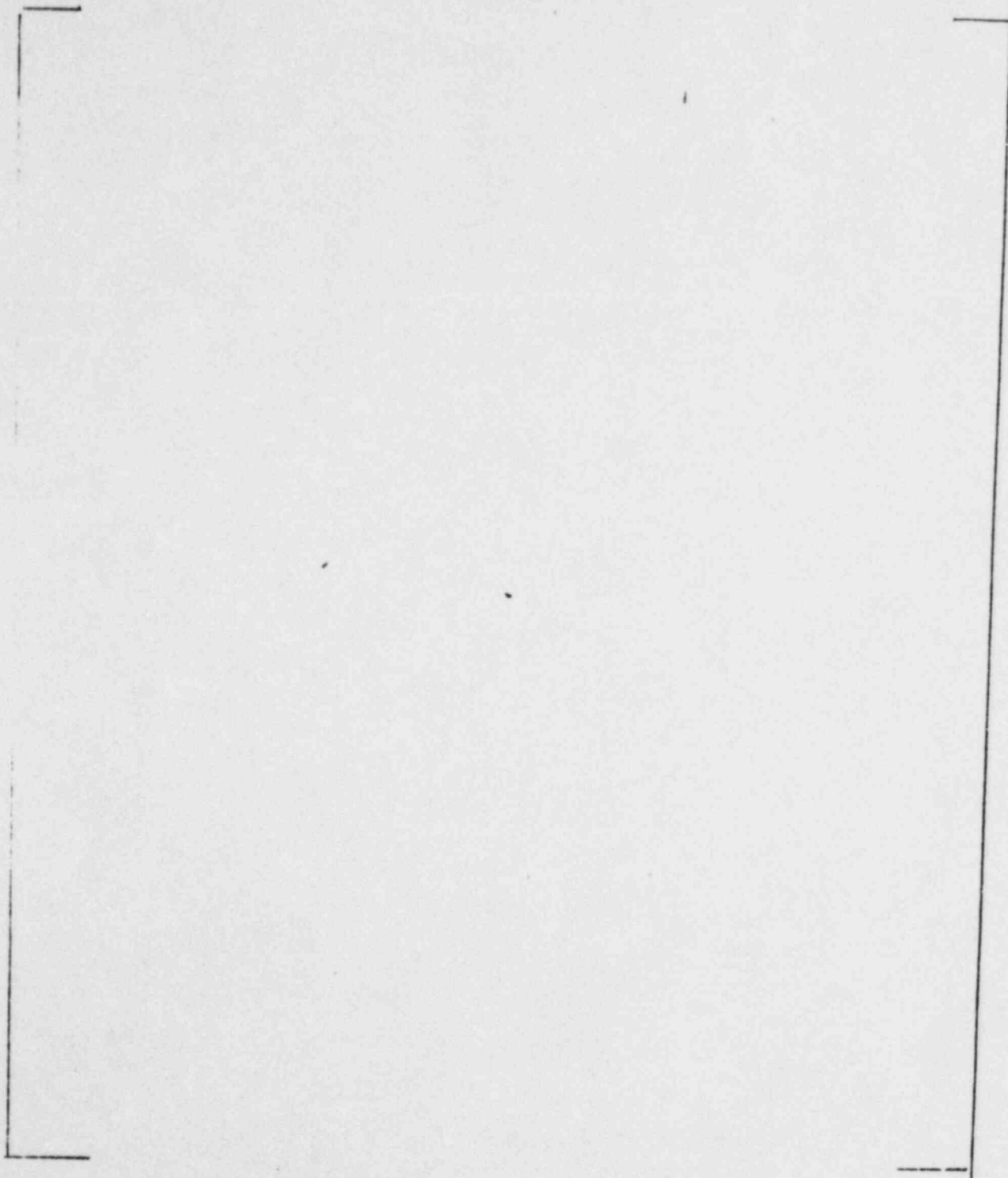
FUEL ASSEMBLY MYG132



SUMMARY OF RODS DISCHARGED
FROM ASSEMBLY G132

A large empty rectangular frame with a thin black border, intended for a table or data. The frame is centered on the page and occupies most of the lower two-thirds of the document. It consists of four solid black lines forming a rectangle.

FUEL ASSEMBLY MYG123



SUMMARY OF RODS DISCHARGED
FROM ASSEMBLY G123

