Gamma Scan Measurements at Edwin I. Hatch Nuclear Plant Unit 1 Following Cycle 1

NP-511
Research Project 130-3

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Prepared by

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FOREWORD

This report is the third compilation of reactor power distribution data coming from measurement campaigns at operating power reactors. The principal purpose of this research project has been to provide reference quality power distribution information for use in the qualification of reactor core analysis methods.

The measurements described in this report were performed during the spring of 1977 at Unit 1 of the Edwin I. Hatch Nuclear Plant, a boiling water reactor operated by the Georgia Power Company. Similar measurements (EPRI NP-214) were performed in January of 1976 at the Quad Cities Unit 1 BWR and at the Zion Unit 2 PWR (EPRI NP-509) in January of 1977. Both of these units are owned and operated by the Commonwealth Edison Company.

Although the same gamma scanning techniques were employed in all three experimental programs, the measurement campaign carried out at the Hatch 1 Reactor differed significantly from the prior work. As the Hatch 1 Reactor approached the end of its first fuel cycle, it was operated with a substantial inventory of control blades inserted in the core. Thus, much of the data reported in this document shows the end of cycle power distribution in fuel bundles adjacent to inserted control blades. (Immediately prior to the gamma scan campaign at Quad Cities 1, the reactor was operated in an all-blades-out configuration.) Such data will provide a more stringent test for nuclear fuel calculational methods. Furthermore, the research program at the Hatch 1 Reactor also included measurements with three different types of traversing in-core probes (TIPs). The purpose of this part of the program was to obtain information on the relative merits of in-core detectors which are sensitive to different types of radiation for determining power distributions in the reactor. The gamma scan data reported herein serve as a reference against which calculations using data from these types of detectors can be compared.

Four reports have been prepared to document the research effort at the Hatch Unit 1 BWR. This document contains the gamma scan data obtained from measurements with the gamma scanning apparatus in the spent fuel pool after reactor shutdown. A companion report, EPRI NP-540, "Special TIP Detector Measurements at Edwin I. Hatch Nuclear Plant Unit 1 Prior to End of Cycle 1", documents the result of the TIP measurement program conducted just prior to reactor shutdown. The core operating history for Cycle 1 is contained in EPRI NP-562, "Core Design and Operating Data for Cycle 1 of Hatch 1". Finally, the comparisons of process computer calculations for power distribution with the results of the gamma scanning experiment are contained in EPRI NP-561, "Comparisons of Process Computer Thermal TIP and Special Gamma TIP Calculations with Gamma Scan Measurements at Edwin I. Hatch Nuclear Plant Unit 1 at End of Cycle 1".

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ABSTRACT

A measurement program to obtain relative La-140 gamma ray intensities from irradiated fuel bundles and rods was conducted at the Hatch 1 Reactor during the refueling and maintenance outage at the end of the first fuel cycle. Of 106 bundles measured, 75 comprised a complete octant of the core and 35 were adjacent to partially inserted control blades.

This report describes the measurement program and contains the gamma scan measurement data. The data are reported as relative La-140 intensities for discrete locations along the fuel axis. The data are further formatted into various displays to accentuate particular features of the core, such as controlled bundle shapes, core radial shapes, and bundle power asymmetries. Evaluation of the measurement uncertainties yields values of ±1.7% (1σ) for bundle nodal intensities and ±2.0% (1σ) for most of the single fuel rod intensities.

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1. INTRODUCTION

1.1 GENERAL

An extensive gamma scan measurement program of irradiated fuel was undertaken at the Hatch 1 Reactor following the end of cycle 1. One hundred six bundles were axially scanned, and four of these were disassembled for rod-by-rod scanning. The program was a joint effort of the General Electric Company, the Georgia Power Company, and the Electric Power Research Institute (as part of Contract RP 130-3, "Nuclear Reactor Core Benchmark Data").

As the Hatch 1 Reactor approached shutdown for refueling and maintenance at the end of cycle 1, the core was operated with a substantial number of control rods partially inserted. Hence, the opportunity arose to obtain gamma scan data for a BWR core with a normal control rod inventory for verification of both process computer and off-line predictive calculations of core power distribution. The 106 bundles scanned included an octant of the core which, by symmetry, is representative of the entire core. This particular octant also contained the traveling in-core probes (TIP's) which had indicated the largest bundle power asymmetries. A measurement program using gamma, fast neutron, and thermal neutron sensitive TIP detectors was executed during the last 60 days of operation to evaluate alternate TIP detector types. That program included the gathering of process computer calculations of bundle power, based on the various TIPs, for comparisons with gamma scan data.

This report describes only the gamma scan measurements and results. Results of the TIP detector measurements are contained in Reference 1. Reference 2 contains comparisons of process computer calculations with the gamma scan. Reference 3 contains a summary of the core design and operating history of Hatch 1 in order that meaningful comparisons can be made with the data reported herein.

In this report, the measurements are discussed in seven sections, and the data are presented in nine appendices in various formats for ease in making comparisons. The measurement description is contained in Section 2, while the measurement technique is described in Section 3. Section 4 is a discussion of the accuracy of the measurements and the inherent biases in inferring relative Ba-140 intensities from the gamma scan data. Section 5 contains descriptions of the various data display formats of the nine appendices. Asymmetries in La-140 intensities are also discussed. Section 6 is a description of how Ba-140 relates to power, and Section 7 concludes the report.

1.2 SUMMARY

The reactor was shut down on March 12, 1977. Prior to that date, the gamma scan in-pool hardware, electronics, and data acquisition system had been installed and functionally checked. Equipment calibration prior to production gamma scanning occurred on March 27 when the bundle chosen as the measurement standard was unloaded from the core and became available for scanning. Scanning of 106 bundles commenced in earnest on March 30 and ended April 15. Disassembly and rod-by-rod scanning of four bundles began April 24 and ended May 4.

A total of 9500 gamma spectra were recorded during the measurement program. Subsequent analysis indicates that measurement uncertainty for bundles is ±1.7% (1σ). Uncertainty for rods is ±2.0% (1σ) for most of the data, and ±3.4% (1σ) for measurements at 111 inches above the active fuel column.

In summary, relative La-140 intensities, characteristic of the axial power shapes of 106 bundles in the core, were measured to provide the power distribution data base. These bundles included an entire octant of the core, 20 additional TIP symmetric bundles, and four additional Process Computer rotationally symmetric bundles. Of the 106 bundles scanned, 71 were uncontrolled at end of cycle and 35 were partially controlled to notch positions ranging from 34 to 14. In addition, La-140 intensities at 10 or 12 axial positions of 160 fuel rods removed from four bundles were also measured to obtain a local peaking factor data base for typical controlled and uncontrolled bundles. The gamma scans also provide data on core power symmetry and the effects of asymmetric B sequence control blade patterns.

2. MEASUREMENT DESCRIPTION

2.1 PROGRAM OBJECTIVES

The objective of the gamma scan portion of the project was to obtain reference quality core power distribution data for a high power density BWR-4 with a typical control rod inventory. Specifically, gamma scan measurements were to be made for the following:

a. Bundle axial and radial La-140 distributions over an octant of the core which, by symmetry, would characterize the entire core.

b. Bundle axial La-140 distributions on four pairs of four-bundle clusters surrounding some of the largest TIP asymmetry locations, and one four-bundle cluster to test TIP/Process Computer rotational methods.

c. Local (rod-by-rod) La-140 distributions of four bundles surrounding a TIP and adjacent to two partially inserted control rods.

2.2 BUNDLE SELECTIONS

Figure 2-1 is a map of the core showing the specific bundles selected for gamma scanning. Figure 2-2 shows the control rod withdrawn notch positions just prior to shutdown. The octant selected contained three of four of the most asymmetric indicating TIP sets. The bundles surrounding location 24-17 were for testing Process Computer rotational methods. The bundles surrounding location 28-37 were disassembled and scanned rod-by-rod at specified elevations. Forty of the forty-nine rods in each bundle were scanned; the eight tie rods and one spacer positioning rod were not removed for gamma scanning. In all, 106 bundles from the core were measured.

2.3 MEASUREMENT LOCATIONS

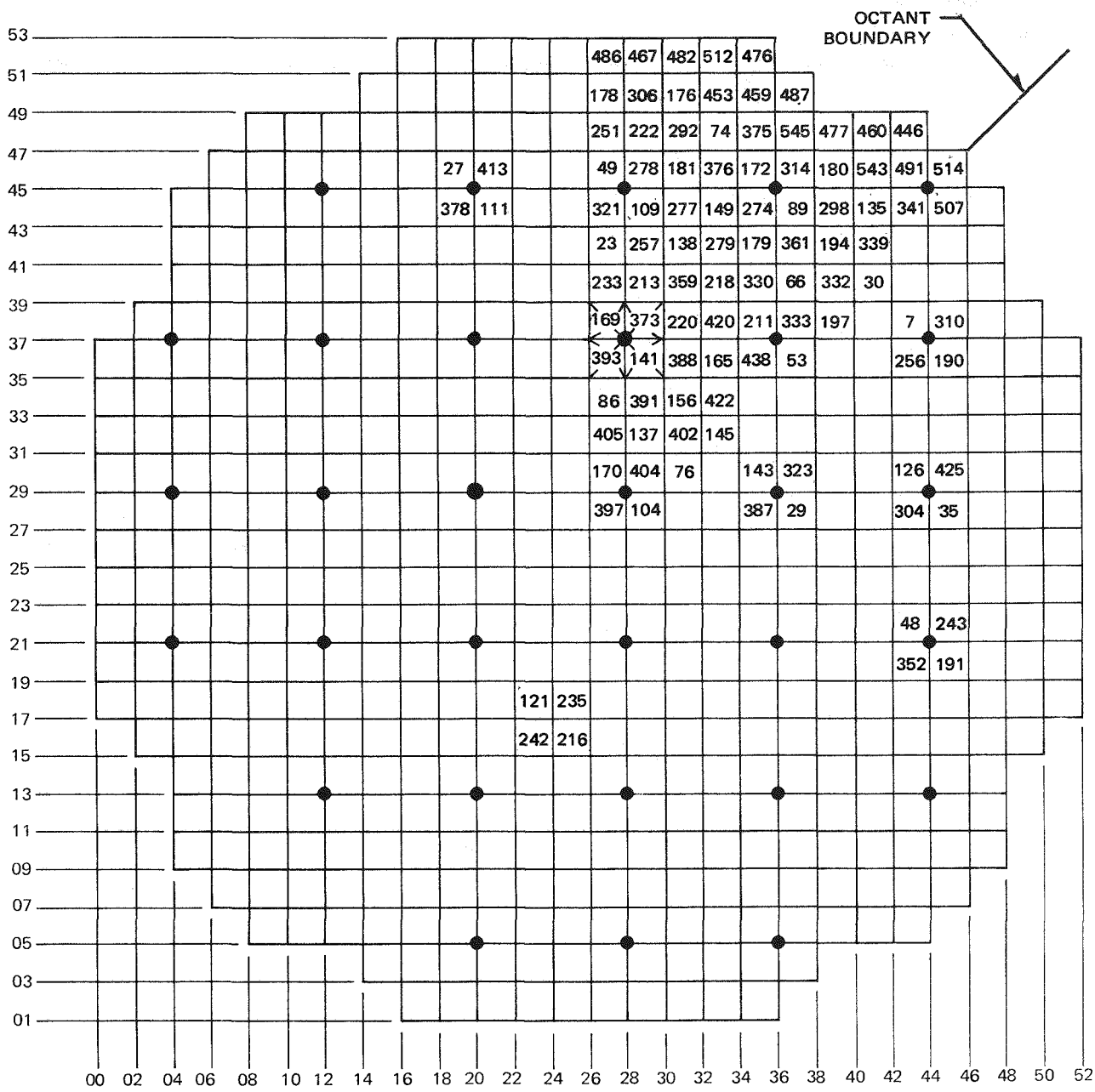
The choices of measurement locations and the total number of axial points scanned for each bundle were based upon the insertion depth of the control rod adjacent to that bundle. Of the 106 bundles scanned, 71 were uncontrolled. Sixty-nine of these were gamma scanned at twelve evenly spaced points, except near spacers. Thirty-one of the thirty-five bundles which were adjacent to control rods were scanned with an additional two data points added to the basic set of twelve to define more clearly the power shape near the tip of the control blade. Six bundles which were representative of the various bundle power shapes were scanned with a higher density of axial positions: twenty-four for the uncontrolled and twenty-seven for the controlled bundles. Four of these six bundles were disassembled and gamma scanned rod-by-rod.

Local power shapes were obtained from single rod scans at 10 or 12 elevations. Rods from bundles HX393 and HX373 (controlled) were scanned at 12 elevations while those from bundles HX169 and HX141 (uncontrolled) were scanned at 10 elevations. In addition, the rods in the wide-wide and the narrow-narrow corners of bundles HX393 and HX373 were scanned near the blade tip at one or two inch intervals to obtain detailed information of the axial power shape in those rods. Table 2-1 lists the measurement locations for bundles and rods.

A special measurement was made to determine correction factors for the gamma ray attenuation about the positions at 111, 108 and 106 inches from the bottom of active fuel. These corrections were required because the fuel preparation machine (FPM) upper carriage rotating fixture was located at those elevations, thus putting more material in the gamma beam than elsewhere. Further discussion of the measurement is contained in Section 3.5.3.

2.4 SYSTEM PERFORMANCE

Overall performance of the gamma scan system was monitored periodically by rescanning one bundle or rod chosen as the measurement standard. The degree of reproducibility of these measurements was one of the major factors in determining overall measurement uncertainty. By means of these repetitive measurements such diverse factors as geometrical constancy of fuel source-to-collimator, gain drift of detector electronics, or malfunctions of mechanical or electrical hardware were readily monitored and corrective action taken when needed. In addition, measurement of the attenuation coefficient of lead was made prior to production gamma scanning to verify the correct measurement of relative 1596 keV La-140 activity.



NOTE: BUNDLES DISASSEMBLED FOR ROD SCANNING

● TIP LOCATIONS

HXnnn BUNDLE IDENTIFICATION

Figure 2-1. Gamma Scanned Bundles

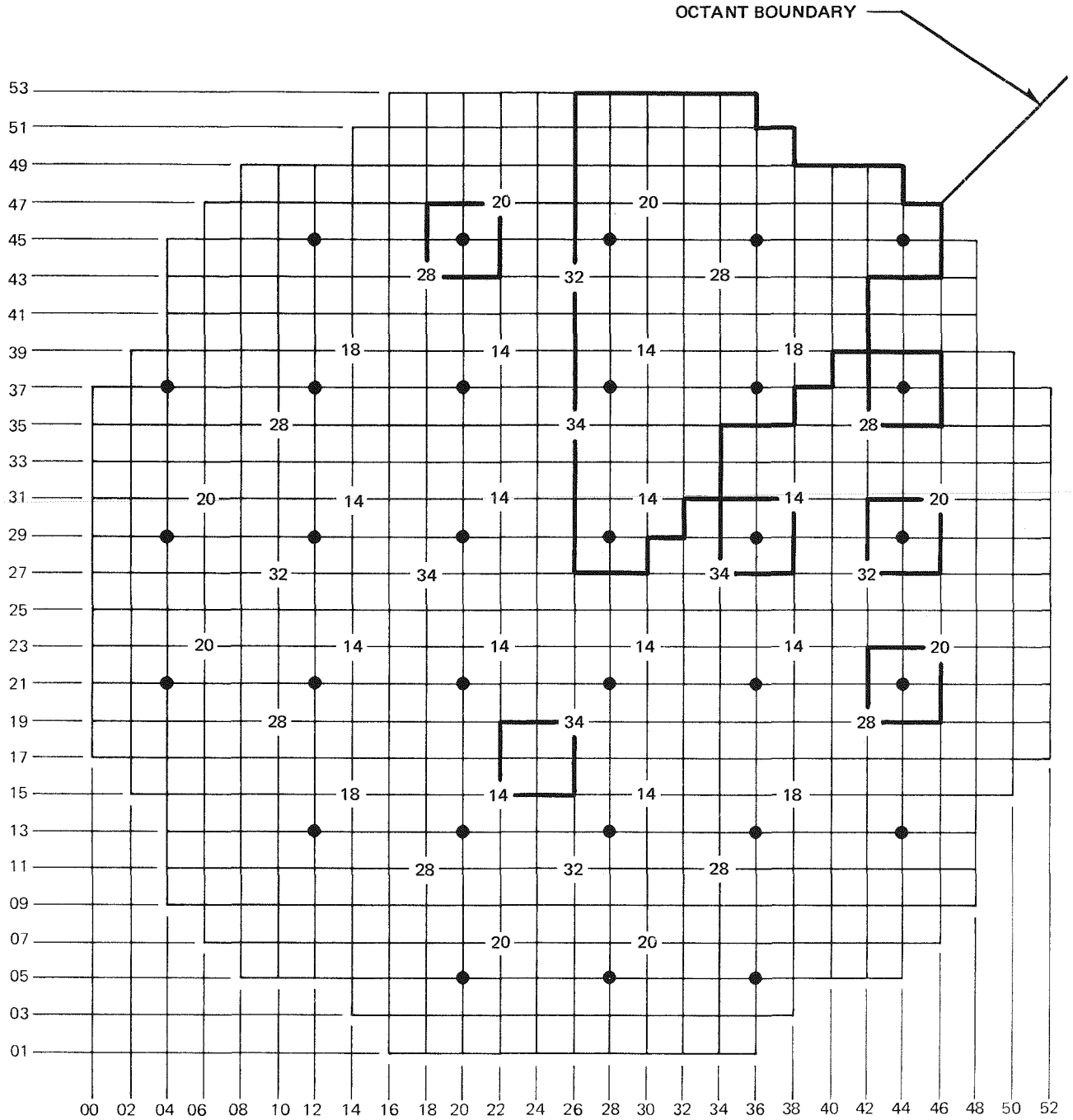


Figure 2-2. Control Rod Notch Positions at End of Cycle 1

TABLE 2-1

MEASUREMENT LOCATIONS
(Inches Above Bottom of Active Fuel)

Bundles		Rods
24-Point Scan[a]	12-Point Scan[b]	10-Point Scan[b]
141		
135	135	
129		129
123	123	123
117		
111*	111*	111
106†**		
97**	97**	
93		93
87	87	87
82**		
75	75	
69		
63	63	63
57		57
51	51	51
45		
37**	37**	
33		
27	27	
21		21
15	15	15
9		
3	3	

[a]Controlled bundles add 3 points in vicinity of blade tip (See Section 5.1.1).

[b]Controlled bundles add 2 points in vicinity of blade tip (See Appendices A and E).

*1.222 correction applied for upper carriage attenuation (See Section 3.5.3).

**Moved from even mesh location to avoid spacers.

†1.113 correction applied for upper carriage attenuation.

3. MEASUREMENT TECHNIQUE

3.1 DETECTION SYSTEM

The gamma ray detector was a thallium-activated sodium iodide [NaI(Tl)] crystal with associated electronics. NaI(Tl) was chosen because of its high efficiency and count rate capability and to simplify the design of the in-pool hardware. The energy resolution of this detector is adequate for this application since only the energetically well-isolated 1596 keV gamma ray from La-140 was measured.

Figure 3-1 is an exploded view of the detector assembly. It is a cylindrically shaped NaI(Tl) crystal of density 3.67, mounted to a 0.25 in-thick lucite disc in which two Monsanto MV-5253 light-emitting diodes (LED's) are embedded. Electrical leads to the LED's are routed through the detector base. The crystal and lucite disc are optically coupled to an RCA 8575 photomultiplier tube which is connected to a voltage divider network and tube base.

The electronic configuration is shown in Figure 3-2. The anode signal from the detector goes to a fast discriminator which is set to trigger on input pulses whose amplitudes are greater than a predetermined voltage level. The discriminator provides an external trigger to the linear gate. The dynode signal from the detector is amplified and differentiated in the fast side of the linear amplifier, then routed to the linear gate where the pulses of amplitude greater than the discriminator setting are selected. These pulses are then routed to the slow side of the linear amplifier where they are further shaped for presentation to a spectrum stabilizer and the analog-to-digital converter (ADC) of a 1024-channel multichannel analyzer (MCA). The memory of the MCA is read out to the HP2100 computer after each accumulation period, and the data stored on magnetic tape and disc.

The fast discriminator and linear gate eliminate the low energy component of the fission product spectrum (energy cutoff approximately 900 keV) leaving only the 1596 keV and higher energy gammas. Thus a lower pulse rate is presented to the linear amplifier, reducing the pileup.

A pulse generator which is triggered randomly provides the drive pulse for the LED. The LED/pulser provides a standard energy peak by which the total system gain can be stabilized against changing conditions of count rate, temperature, or high voltage. It also provides a peak of known input count rate from which pile-up losses in the system can be determined.

Counting losses occur because of the need to operate the system at high rates to maximize fuel measurement throughput. The losses which occur in the linear amplifier, the ADC, and the memory of the MCA are a result of electronic dead times which prohibit the analysis of more than one event at a time. In the memory of the MCA, the losses are due to the fixed time required to fetch a particular channel from memory, increment it, then return the value to memory. The MCA live-time clock automatically compensates for this loss due to processing time.

Losses in the ADC arise from the timing circuitry necessary to detect (time-to-peak) and to digitize (digitizing time) the incoming pulse peak height. As with the memory processing time, these time losses are automatically accounted for by the MCA live-time clock. Additional "losses" can occur in the time-to-peak circuitry because of a spectral biasing toward higher energy pulses. If, during the time-to-peak period after the input discriminator is triggered, a second pulse appears at the ADC input, the larger pulse will be digitized and the smaller one will be "lost."

Losses in the linear amplifier are governed by Poisson statistics, and occur when two or more pulses arrive during the amplifier resolving time. The amplifier integrates the charge in all of the pulses and produces a single output pulse of larger amplitude and width than any of the individual input pulses. A correction for these electronic losses is made by comparing the integrated LED pulser peak intensity in the gamma spectrum to the average rate of the pulse generator.

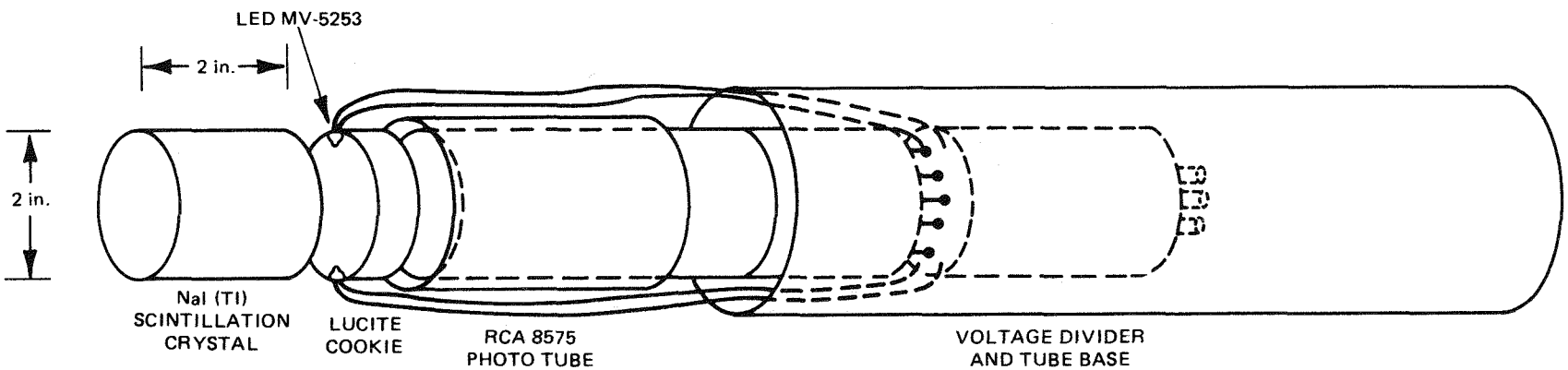
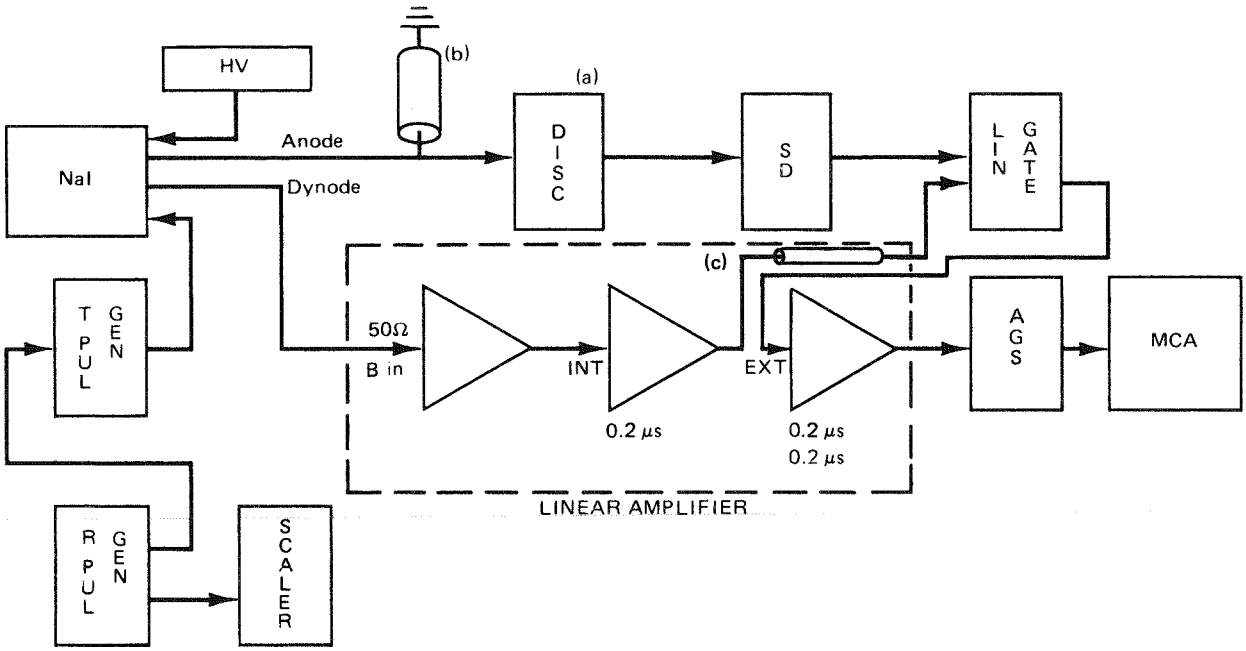


Figure 3-1. Exploded View of NaI (Tl) Detector Assembly



EQUIPMENT LIST

1. 2.0 in X 2.0 in NaI(Tl) DETECTOR ASSEMBLY, NUCLEAR ENTERPRISES, INC. (NaI)
2. HIGH VOLTAGE POWER SUPPLY, AEC315, POWER DESIGNS, INC. (HV)
3. TAIL PULSE GENERATOR, BH-1, BERKELEY NUCLEONICS CORPORATION (T PUL GEN)
4. RANDOM PULSE GENERATOR, DB-2, BERKELEY NUCLEONICS CORPORATION (R PUL GEN)
5. FAST DISCRIMINATOR, NO. 4680, NUCLEAR ENTERPRISES, INC (DISC)
6. SCALER DRIVER, DS104/N, E.G.& G. (SD)
7. LINEAR GATE, TC304, TENNELEC, INC.
8. LINEAR AMPLIFIER, TC220BLR, TENNELEC, INC.
9. AUTOMATIC GAIN STABILIZER, M1720 CANBERRA INDUSTRIES (AGS)
10. MULTI-CHANNEL ANALYZER, HP5401B, HEWLETT PACKARD (MCA)
11. SCALER/PRINTER, MODEL 4660, KINETIC SYSTEMS, INC.

NOTES

a) DISCRIMINATOR LEVEL SET AT ~ 900 keV
b) CLIPPING LENGTH IS 48 in
c) DELAY LENGTH IS ∿ 50 ns

Figure 3-2. NaI Detection System

3.2 IN-POOL HARDWARE

3.2.1 Collimator

The collimator was originally designed for and used at the Zion Nuclear Generating Station to scan Pressurized Water Reactor assemblies [4]. For use in this application, changes were made in the amount and placement of shielding near the collimator front aperture, and in the method of suspending the collimator in the spent fuel pool.

Figure 3-3 shows the collimator with the changes near the end closest to the fuel. The effect of these changes was to eliminate the streaming of low energy scattered gamma rays from non-beam regions of the fuel, thus improving the ratio of 1596 keV photopeak gamma rays to low energy background. A lead filter which consisted of 0.25 inch plates was used to adjust the intensity of gamma rays on the detector by preferentially absorbing low energy fission product gammas. For bundles this filter thickness was 1.75 inches, while for rods it was 1.0 inch. The height of the aperture formed by the tungsten slits, which for bundles was 0.200 inch and for rods was 0.900 inch, defined the amount of fuel seen by the detector. In addition the angular tilt of the tungsten slit pieces was remotely adjustable in order to optimize the ratio of uncollided gamma rays to gamma rays which scattered from the slit surfaces. The beam non-limiting aperture which followed the tungsten slit was narrowed from an "as-built" height of 1.5 inches to 1.0 inch using two 0.25 inch-thick lead plates spaced apart by styrofoam pieces. The styrofoam, which was in the beam line, introduced no significant degradation of spectral quality.

The collimator provided a water- and light-tight environment for the NaI(Tl) detector assembly. It also shielded the detector from ambient gamma ray background which existed as pool water contamination or came from nearby spent fuel bundles. To insure that water did not leak into the collimator, it was pressurized to approximately 20 psig with dry nitrogen gas. A tapered hole formed by high density concrete provided a path for the gamma beam from the slit aperture to the detector. Further definition of the beam was provided by a lead/tungsten assembly which was placed directly in front of the detector and narrowed the beam to an areal size of 0.500 x 0.200 in^2. A copper-cadmium-aluminum sleeve surrounding the NaI (Tl) crystal provided additional shielding from low energy X-rays. Signal cables from the detector were carried to the water surface inside a water-tight metallic flex-hose.

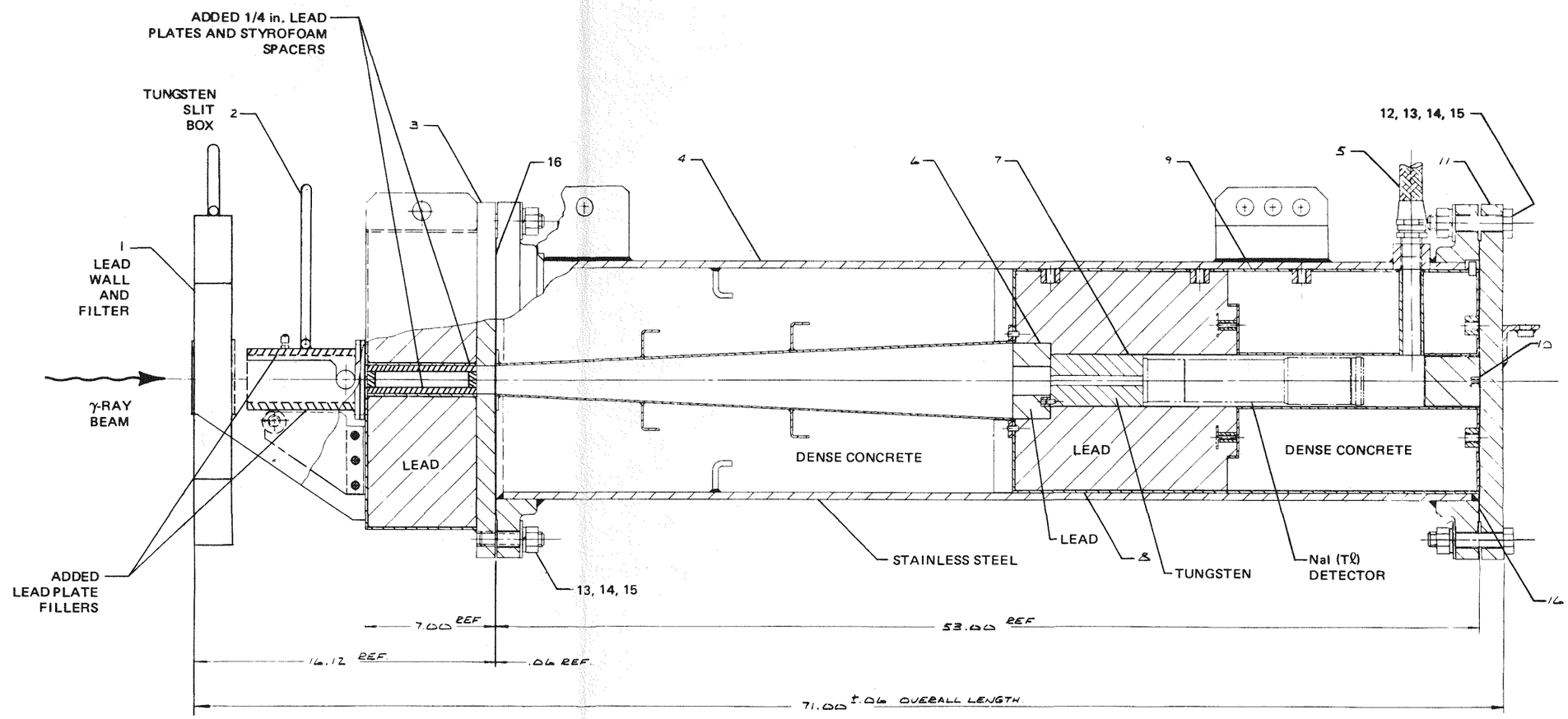
Emplacement of the collimator-detector assembly was accomplished by suspending it over and attaching it to the 4 inch wide curb which surrounds the spent fuel pool. For this purpose, two lengths of 3/8 in x 20 ft stainless steel wire rope were used to attach the collimator to special brackets mounted on the curb. A third cable restrained the collimator from movement toward the FPM. The collimator was spaced away from the pool wall by adjustable stand-offs which contacted the wall at three points. The weight of the collimator against the pool wall was sufficient to prevent it from moving laterally, and thus maintain constant geometry between it and the FPM.

Figure 3-4 is a photograph of a fuel bundle being scanned by the system. The collimator is suspended to the left of the bundle and over empty fuel storage racks.

3.2.2 Fuel Bundle/Rod Positioning Assembly

Positioning of the fuel bundle or rod to particular axial elevations was accomplished by automatically starting and stopping the FPM under computer control. Typically, a bundle or rod could be positioned within ±0.2 inch of a pre-selected elevation. The positioning device consisted of a low pressure pneumatic cylinder with adjustable stroke, which was secured at one end to the railing of the fuel preparation machine platform and attached at the other end to the FPM foot pedal. Air supplied to the cylinder was controlled by two three-way electrically operated solenoidal air valves which, when triggered by the computer, caused the FPM to move in the appropriate direction or to stop. Mechanical chain stops prevented the FPM from over-traveling.

A position transducer determined the axial elevation of the fuel. The transducer consisted of a variable resistance potentiometer attached to a 1/16 inch stainless steel cable which was wound around a spring retractable spool. The transducer assembly was anchored to the fuel pool wall adjacent to the FPM and the cable was attached to the FPM upper carriage. A 24 volt dc power supply powered the transducer, and the resulting changing voltage caused by movement of the FPM was digitized by digital voltmeters (DVM's) located at poolside and in the counting area. The computer recorded the DVM signal in the counting area, while the other was used for visual verification of the position of the FPM from poolside.



PT NO.	NAME
1	FILTER BOX
2	SLIT BOX
3	NOSE ASS'Y
4	COLLIMATOR PIPE
5	FLEX HOSE
6	SHIELD
7	PLUG
8	SHIELD

PT NO.	NAME
9	SHIELD
10	PLUG
11	BLIND FLANGE
12	BOLT
13	NUT
14	LOCK WASHER
15	PLAIN WASHER
16	GASKET

Figure 3-3. Collimator

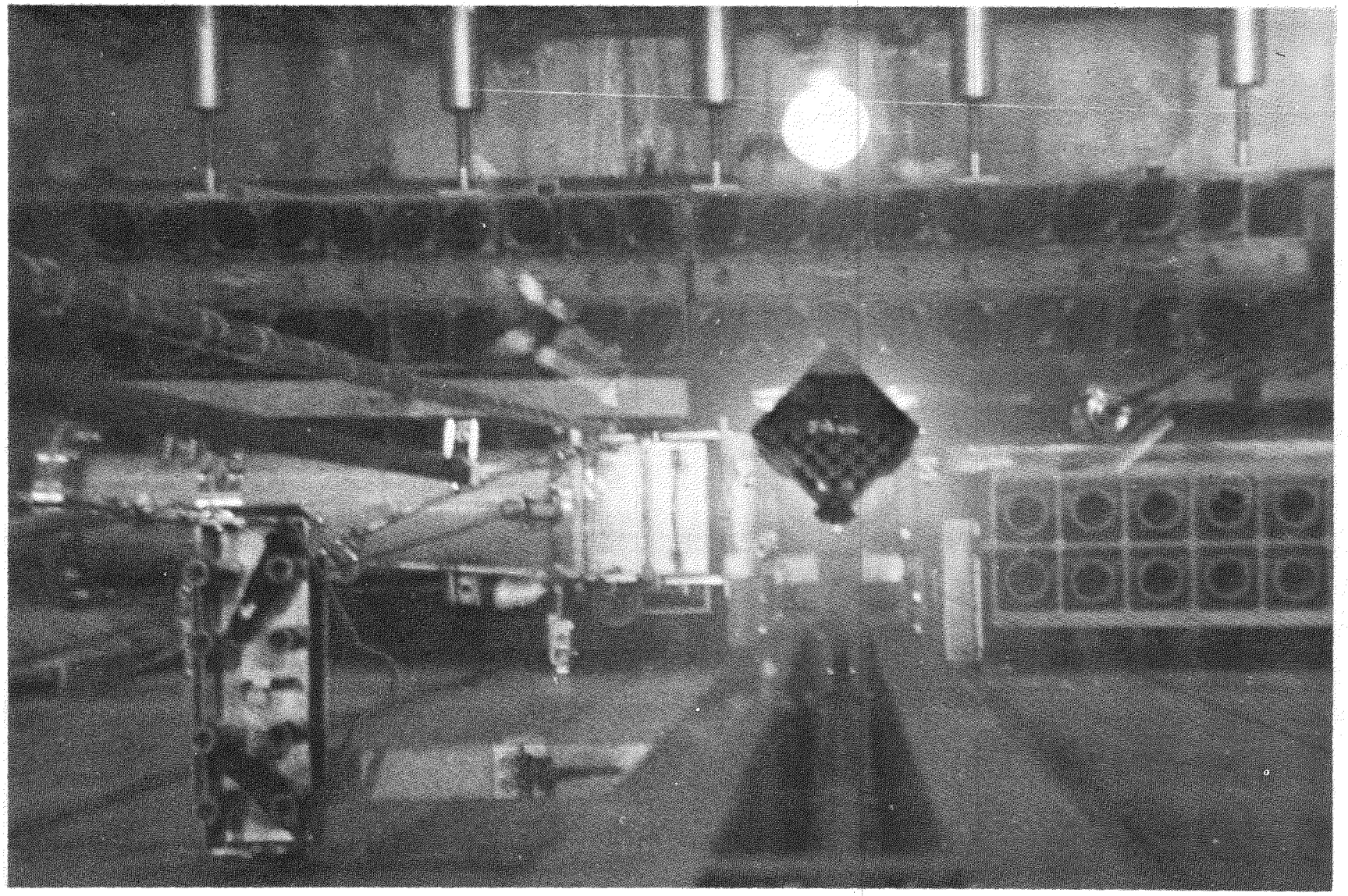


Figure 3-4. Photograph of Bundle Being Scanned

Rotation of the bundle to each of the four corners was done manually. To accomplish this, a standard fuel inspection rotating bearing and a fuel inspection upper carriage rotating fixture were installed on the FPM. The upper fixture was designed with close tolerances to reduce geometrical mispositioning, and to accurately rotate the bundle to a corner by means of pre-positioned stops on the rotator.

For measurement of a fuel rod, a special single rod holder was attached to the outboard side of the upper and lower carriages of the FPM. The rod could then be scanned in a manner similar to the bundles.

3.3 DATA ACQUISITION

The data acquisition system was located on the 204 foot level of the reactor building in a radioactively clean area, and was housed in an electrically grounded metallic building. The system consisted of Nuclear Instrument Module (NIM) electronics, a 1024-channel multichannel analyzer and a digital computer (HP2100S). Automatic bundle positioning was accomplished by computer controlled relays and digital voltmeter. Input-output devices peripheral to the computer included a CRT terminal, moving head disc drive, magnetic tape unit, teletype, paper tape reader, high speed punch, and electrostatic printer/plotter. The HP2100S has a 16-bit word, 1.6 microsecond memory cycle time and 32K memory size. Figure 3-5 shows a diagram of the system.

After a bundle or rod was placed in the FPM and rotated to point the desired bundle corner at the collimation system, the computer positioned the bundle or rod axially and started the MCA data collection cycle. After the accumulation time (30 seconds for bundles, 1 minute for rods), the spectrum was transferred to both disc and magnetic tape. Each spectrum was stored with a 128 word identification block. This sequence was repeated for a predetermined set of axial measurement positions. Operator control was necessary only when the bundle was rotated to the next corner or a new bundle or rod was inserted in the FPM.

System software permitted fast on-line evaluation of the data stored on disc. Preliminary spectrum analysis results were output to the printer/plotter for immediate use and stored on a disc file for future detailed analyses. Highly automated on-line data handling procedures were essential due to the large volume of data accumulated (9500 gamma ray energy spectra).

Figure 3-6 shows a typical NaI spectrum from the measurements. The La-140 photopeak is located at channel 271 and the LED peak at channel 728. No La-140 activity was observed except when fuel was placed in front of the collimator, indicating the absence of pool background that might distort the measured intensities from fuel sources.

3.4 DATA REDUCTION

The process of converting gamma energy spectra to relative La-140 distributions involved several stages of data reduction which are described below.

3.4.1 Calculation of Peak Intensity

Gross photopeak areas were found by summing the counts in each channel of the peak region. Net peak areas were calculated by subtracting a background determined from a linear least-squares fit through two regions of data points, one on each side of the photopeak, which best represented the background under the photopeak. Peak and background regions for the La-140 and the pulser peaks were chosen after examining several spectra spanning the intensity range encountered in the measurement. The regions used were automatically shifted by any small amount that the peak drifted.

3.4.2 Correction for Counting Losses

Photopeak intensities were corrected for counting losses by monitoring losses of a pulser peak introduced at a known rate. The magnitude of this factor ranged from 1.03 for the least intense points to 1.31 for the most intense points. This technique is standard to high count rate gamma ray spectroscopy.

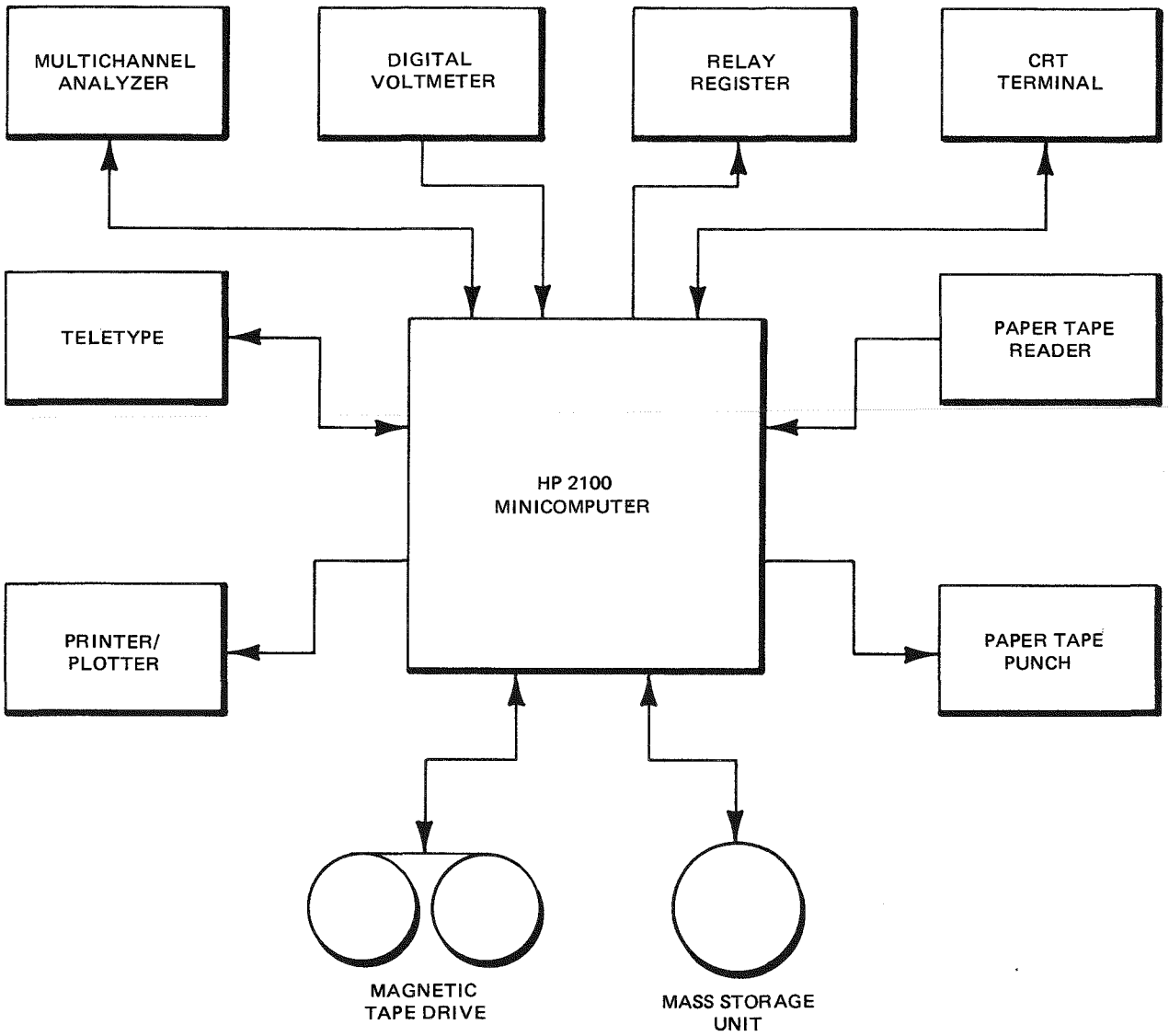


Figure 3-5. Gamma Scan Data Acquisition System

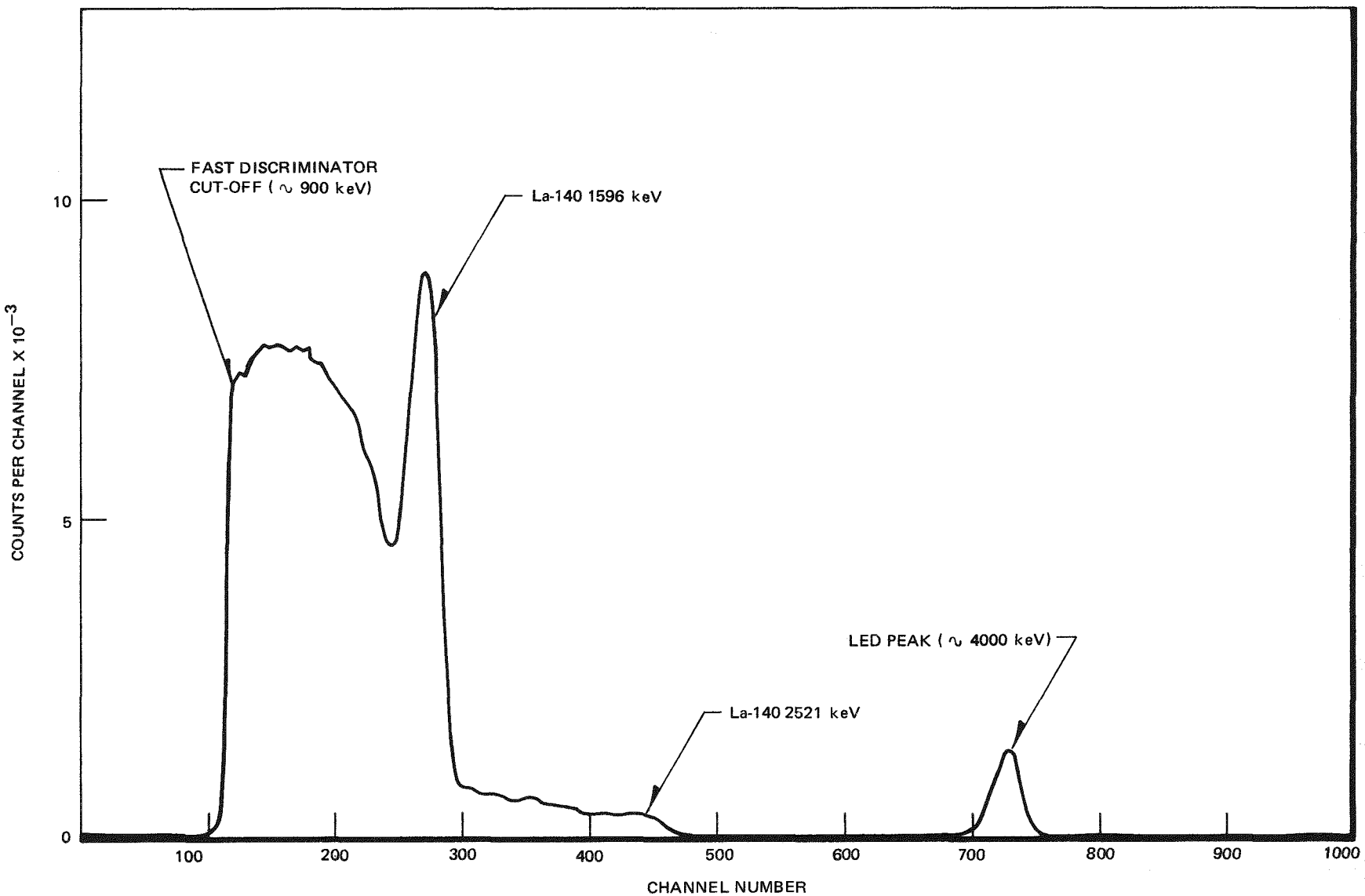


Figure 3-6. Typical Gamma Ray Energy Spectrum Chosen from Bundle Measurements

3.4.3 Counting Time and Decay Time Corrections

A counting time correction was made to standardize all data to the same time interval by dividing the La-140 intensity by the MCA live time in minutes. A correction for the decay of the La-140 activity was made by multiplying measured intensities by the factor exp (λ T) where $\lambda = 0.05419\ day^{-1}$ (corresponding to a 12.79-day half-life) and T is the time interval between 0000 hr, March 12, 1977, and the time of measurement.

3.4.4 Averaging

The corrected La-140 intensities were averaged over the four corners measured at each elevation for each bundle. Further averaging and normalization are discussed in Section 5.

3.5 CALIBRATION PROCEDURES AND SPECIAL MEASUREMENTS

Prior to the start of actual data-taking and throughout the program for both bundle and rod phases, certain activities were carried out to qualify the gamma scanning system for recording data. These activities are discussed below.

3.5.1 Calibration of Automatic Positioning System

Calibration of the automatic positioning system required establishing the relationship of DVM output to the vertical position of the FPM. This relationship was determined relative to a 24-foot long aluminum pole which had fiducial markings at 10 inch intervals, and was placed on the upper carriage of the FPM during the calibration. The index was taken to be the top of a 4 inch high curb which surrounded the base plate of the FPM platform. By this method, distance calibrations relative to the physical FPM chain stops could be made at frequent intervals throughout the measurement program.

Operating parameters of the system, such as distance of travel of FPM foot pedal, air pressure of actuating air cylinder, and rate of travel of FPM, were also established to insure reliable positioning of fuel to within ±0.5 inch of desired elevation under computer control. In fact, positioning was good to about ±0.2 inch except during a period of bundle measurements when the air hoist driving the FPM began to fail. It then became necessary to replace the hoist, a task which was expeditiously carried out by plant personnel.

3.5.2 Location of Bottom and Top of Active Fuel

The index for all measurements was the bottom of the fuel column as established during this calibration procedure for the standard bundle and rod. This value was obtained by stepping the FPM in approximate 0.1-inch intervals around the region of the bottom of active fuel and measuring the intensity of La-140. Thus, a curve showing an abrupt change in intensity from non-fuel to fuel regions was obtained with a resolution of about half a slit height (0.05 inch for bundles, 0.5 inch for rods).

The same technique was used to determine the top of active fuel to confirm that the entire column of fuel could be seen by the gamma scanning system. The change in intensity at the top for bundles was less abrupt, however, consistent with variations in the length of individual fuel columns due to manufacturing.

3.5.3 Attenuation through FPM Upper Carriage

At an elevation of approximately 111 inches above the bottom of active fuel there exists the upper carriage and fuel inspection rotating fixture to hold the bundle in the FPM. This structure covers enough of the bundle so that some representative measurement of the gamma intensity is desirable. The measurement must then be corrected to account for attenuation through the material in the beam.

The procedure to experimentally determine the attenuation required grappling the fuel in the FPM with the refueling bridge, and holding the fuel stationary while the FPM was lowered. Measurements of the gamma intensity were then recorded as a function of elevation of the FPM through the region of the upper carriage.

Figure 3-7 shows the plot of relative intensity versus elevation. Included in the plot are other data recorded during previous programs using a generic inspection fixture and FPM upper carriage. Normalization is to the region around 108 inches. The additional data show details of the FPM which are not included in the current data. From the current data, corrections were deduced for elevations 111, 108 and 106 inches above the bottom of active fuel.

3.5.4 Lead Attenuation Test

Verification that the gamma scanning system was accurately recording the intensity of 1596 keV gammas was accomplished by measuring the gamma attenuation through lead at typical counting intensities. With the system oriented on a particular side and elevation of the standard bundle, data were recorded for three thicknesses of lead (1.25, 1.50 and 1.75 inches) in the gamma beam. Three measurements were deemed sufficient because changing the lead thickness required removal of the 200 lb lead wall just forward of the collimation slit, a time and energy consuming procedure.

The three gamma intensities obtained from this test were corrected to a common thickness of lead using known values for the thickness and the 1596 keV mass attenuation coefficients of lead and water [5]. The agreement of the three values was within 0.3%, with an individual measurement having a counting statistic of ±0.3% (1σ).

3.5.5 Background Measurements

Periodically throughout the program, data were recorded with no fuel directly in front of the collimator and the spectra inspected for the presence of interfering gamma background in the region of the 1596 keV line. No interference of this type was found.

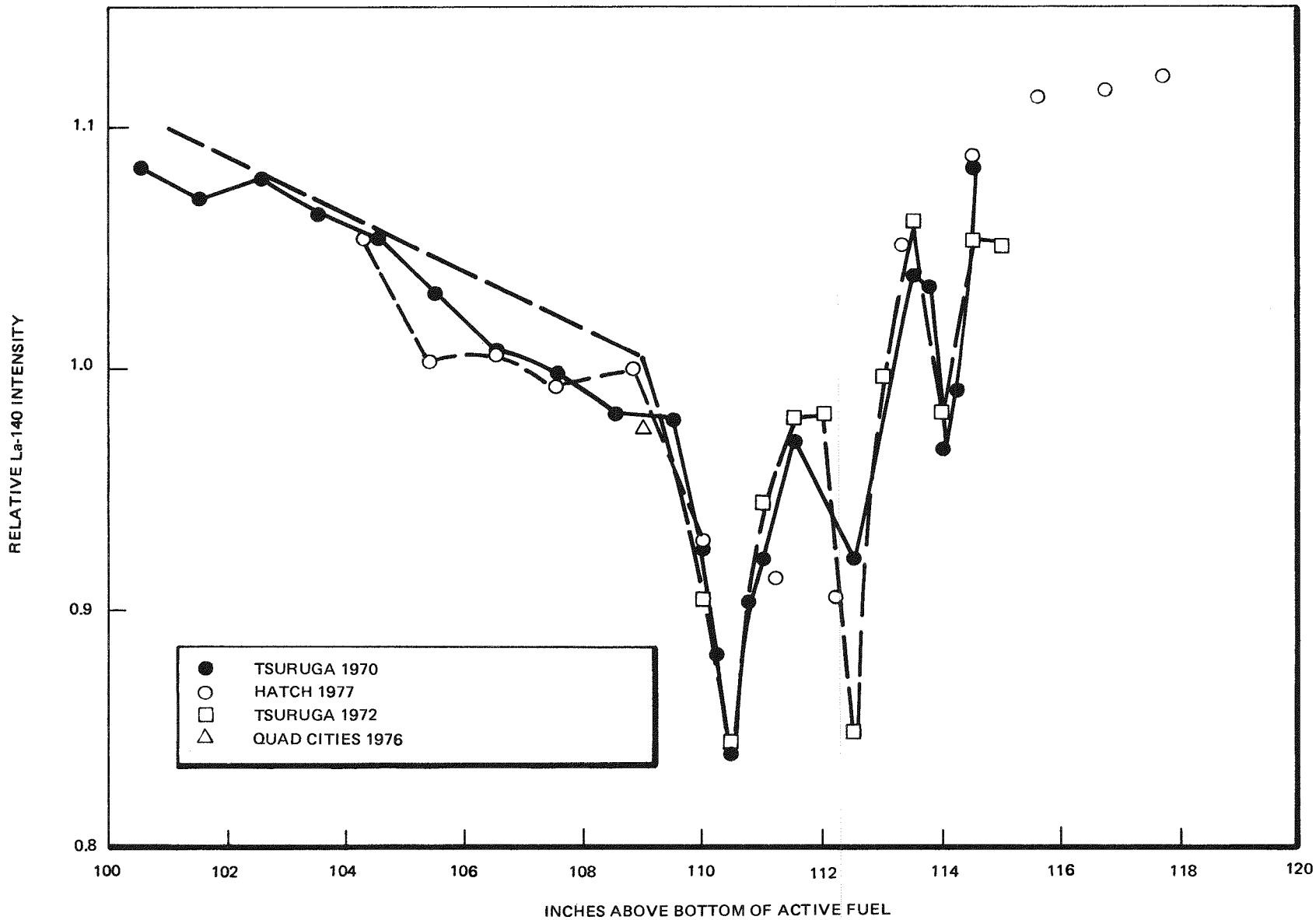


Figure 3-7. Measurements of Attenuation through Upper Carriage of FPM

4. ACCURACY

4.1 MEASUREMENT UNCERTAINTY

Measurement uncertainties for bundles and rods were estimated from periodic rescanning of one corner of the standard bundle and the standard rod. This rescanning served as the primary means of monitoring the overall performance of the system for possible biases or bad measurements which might arise, for instance, from changes in the collimator-bundle (rod) geometry, malfunctions in the detector or electronics, or imprecise axial or azimuthal positioning of the fuel. It confirmed, in fact, that the half-life of Ba-140 is 12.79 days [6]. Since this measurement and the measurement of gamma attenuation in lead spanned the range of intensities encountered during the program, it is concluded that the relative intensities of 1596 keV La-140 gamma rays were measured consistently well by the gamma scan system.

4.1.1 Standard Bundle Reproducibility

The standard bundle replication measurements occurred over an 18-day span during which the same corner (corner 1) of bundle HX393 was scanned periodically at 12 elevations. The results are tabulated in Table 4-1. Excluding momentarily the results at 111 inches, the reproducibilities of 20 replicate measurements range from 1.7% (1σ) to 1.1% (1σ). By quadratically unfolding the counting statistics from the reproducibilities, the residual random uncertainties are obtained. The mean of the residual uncertainties is 0.7% which, when averaged over four corners, yields $0.7\% \div \sqrt{4} = 0.4\%$. This residual would represent random errors in the data due, for example, to uncontrollable perturbations of collimator-bundle geometry.

TABLE 4-1

STANDARD BUNDLE REPRODUCIBILITY

Inches Above BAF*	Measurement Reproducibility (%1σ)	Mean Statistical Uncertainty (%1σ)	Residual Uncertainty (%1σ)
3	1.7	1.8	0
15	1.6	1.4	0.9
27	1.2	1.3	0
37	1.1	1.2	0
51	1.5	1.0	1.1
63	1.4	1.0	1.0
75	1.2	1.0	0.7
87	1.7	1.0	1.4
97	1.3	1.0	0.8
111	2.5	1.0	2.3
123	1.4	1.0	1.0
135	1.2	1.1	0.6
		Mean (excluding 111 inches) =	0.7

*Bottom of Active fuel

Note:

Mean Statistical Uncertainty = Uncertainty Based on Counting Statistics Alone

Residual Uncertainty $\equiv \sqrt{MR^2 - MSU^2}$

Quadratic combining of this residual random uncertainty with the statistical uncertainty for each measurement would yield a total random uncertainty for that measurement. It is more useful, however, to consider an overall measurement accuracy by considering the range of statistical uncertainties encountered throughout the program. The worst four-corner-averaged counting statistic occurs at 3 inches above active fuel on a controlled bundle measured about 2 weeks after start of the program and is equal to 1.6% (1σ). The best statistic of 0.5% (1σ) occurs for all bundles at other elevations for a majority of the measurements. Combining these statistical uncertainties with the 0.4% residual uncertainty yields a range of measurement accuracies between 1.7% and 0.6% (1σ). An overall value of 1.7% (1σ) is therefore recommended for the total measurement uncertainty of each reported bundle nodal intensity.

The replication measurements at 111 inches show greater scatter due to the fact that this datum point occurs in a region where the upper rotating guide fixture and the upper carriage of the FPM attenuate the gamma beam coming from the bundle. Because special measurements at this elevation (see Figure 3-7) indicated strong dependence of the intensities to precise axial positioning, those replication measurements were reanalyzed excluding 5 of 20 measurements taken outside of the region 111 ± 0.05 inches. The reproducibility changed from 2.5% to 1.9% (1σ). The larger number is used, however, since repeatability of axial positioning was more like ±0.2 inch, yielding a four-corner-averaged residual uncertainty of ±1.2% (1σ). Thus, the total measurement uncertainty at this elevation is 2.0%; this is also a reasonable estimate for the measurements made at 108 and 106 inches.

4.1.2 Standard Rod Reproducibility

The same analysis described for the standard bundle is applied to the standard rod (A1, bundle HX393) except that no reduction of uncertainty due to four-corner averaging exists. Again excluding the results at 111 inches, the mean of the residual random uncertainties is found to be 0.9% (1σ) as shown in Table 4-2.

For the measurements at 111 inches, the reproducibility is considerably worse yielding a random uncertainty of 3.3% (1σ). This spread is not explained by the presence of the upper carriage fixture, as in the case of bundle measurements, nor to any known structure of the fuel holder at that elevation. However, the detailed scans of rods A1 and G7 in HX373 (see Figure 5-6) about this elevation indicate a non-uniform intensity attenuation, leading to the belief that the anomaly is specific to the rod holder rather than to a particular rod or bundle. In any event, the data suggest that a larger random uncertainty of 3.3% should be assigned to measurements at 111 inches.

TABLE 4-2

STANDARD ROD REPRODUCIBILITY

Inches Above BAF	Measurement Reproducibility (%1σ)	Mean Statistical Uncertainty (%1σ)	Residual Uncertainty (%1σ)
15	3.2	2.8	1.7
21	2.7	2.6	0.8
51	1.1	1.0	0.4
57	1.1	1.0	0.5
63	1.2	1.0	0.7
87	1.1	0.9	0.6
93	1.4	0.9	1.1
111	3.4	0.9	3.3
123	1.4	0.9	1.1
129	1.8	1.0	1.5
		Mean (excluding 111 inches) =	0.9

An overall measurement uncertainty for all rod measurements is not definable because of a relatively greater variation in counting statistics for rods versus bundles. By the time rod measurements commenced, the La-140 intensity had decayed two half-lives from the start of bundle measurements. Also, the source intensity of a single rod is much lower (~1/15) than that of bundles; steps were taken to improve counting statistics by increasing the slit height, decreasing lead filter and increasing count time. A few rod measurements, particularly those on rods near an inserted control blade, have counting statistics much worse than the majority of the others, and are not indicative of overall measurement accuracy. In addition, measurements at elevation 111 inches were substantially worse in reproducibility as noted above.

At all elevations except 111 inches, the overall measurement uncertainty is 2.0% of which 1.8% is attributed to counting statistics. Thirty-six measurements (out of 1598) had greater than 1.8% counting statistics; the worst case statistic was 2.7% yielding an overall uncertainty of 2.8%. These measurements are indicated with an asterisk (*) in the Appendix E displays. The overall uncertainty for all measurements at 111 inches is 3.4%.

4.2 METHOD BIASES AND LIMITATIONS

Although the La-140 gamma scan technique is the most accurate method for independent verification of power distribution, there are some small inherent biases which must be recognized in evaluating the accuracy and usefulness of the data.

4.2.1 Gamma Ray Attenuation in Bundle Measurements

The gamma scan system does not measure all rods in a bundle with equal efficiency because of attenuation due to the fuel, cladding and water. Edge rods have a substantially higher contribution to the total observed intensity than interior rods; the effect increases with decreasing γ-ray energy. Even for the relatively high energy (1596 keV) gamma ray of La-140, the intensity of the center rod in a 7x7 bundle is attenuated by about a factor of 4.5 compared to the corner rods. Insofar as the local (rod-to-rod) power distribution may vary due to design, control state, voids or exposure, small biases in the bundle nodal La-140 intensities reported here are inherent.

The procedure of averaging the four corner measurements to determine the relative total La-140 intensity at a given axial location can be shown to be an accurate method, not sensitive to the differences in the rod-to-rod distribution. Using a two-dimensional gamma ray transport code to simulate the detector-bundle geometry of the scan, several calculated and measured rod-to-rod distributions have been considered spanning fuel type (geometry and materials), control state, void condition, and exposure. It can be shown that no biases greater than 2.5% are introduced in determining relative bundle La-140 intensities. An evident trend within the 2.5% maximum bias mentioned above is with void content. In general, increasing void content shifts power to the exterior of the bundle, enhancing the measured La-140 intensity by 0.5% to 1.8%, depending on fuel type.

Experimental confirmation of the validity of the four-corner average method comes from comparing single rod and bundle measurements for those bundles which were disassembled and rod scanned in addition to being scanned as bundles. The relative bundle La-140 intensities of those bundles can be determined by summation of the single rod intensities and by averaging of the four-corner measurements. The comparison procedure is imperfect in that tie rods, which contribute significantly to the bundle measurements, being on the edge, are not removed and measured as single rods. Relative bundle-to-bundle La-140 intensities at ten planes were determined in these two ways for the four bundles disassembled and the results are given in Table 4-3. The 1σ rms deviation from an expected value of unity is $\pm 1.3\%$.

Similar calculations are reported in references 7 and 8. Combining these data sets with that reported herein, a deviation of 1.3% (1σ) is calculated. The combined data sets represent a total of 10 different 7x7 and 8x8 bundle types exposed in two different cores in a variety of core power environments. Two of these data sets come from remeasurements of two particular bundles after a second cycle of exposure.

TABLE 4-3

RATIO OF BUNDLE NODAL INTENSITIES DETERMINED BY TWO METHODS: FOUR CORNER AVERAGE AND SUMMATION OF SINGLE ROD MEASUREMENTS AT TEN SEPARATE ELEVATIONS

Elevation (Inches)	HX169	HX141	HX393	HX373
15	1.011	1.012	0.973	0.997
21	1.004	1.013	0.981	0.995
51	1.012	1.017	0.984	0.983
57	1.012	1.011	0.983	0.994
63	1.008	1.009	0.990	0.991
87	1.014	1.006	0.989	0.988
93	1.004	1.013	0.992	0.987
111	0.999	1.006	0.985	1.009
123	1.006	1.004	0.973	1.016
129	1.011	1.002	0.982	1.005

1σ rms deviation = 1.3%

In summary, variations in bundle neutron flux distribution and fuel design can introduce biases in the measured La-140 bundle intensities of up to 2.5%. Without knowledge of the rod-to-rod distributions for each bundle measured, it is not possible to completely remove this small but inherent bias in the gamma scan bundle measurements.

4.2.2 Gamma Ray Attenuation in Single Rod Measurements

In a similar vein, but to a lesser extent, variations in source radial distribution within single rods cause variations in the gamma escape probability. The smaller amount of attenuating material for rods than bundles, however, reduces the dependence on rod internal La-140 distributions. A limited number of measurements of this effect were made by recording data for the standard rod at fixed elevation and four azimuthal orientations, obtained by grappling the rod and manually turning it in the rod holder. Figure 4-1 shows the results. After quadratically unfolding the counting statistics, the residual effect due to a possible rod internal distribution was 1.0%. No corrections, however, have been applied to the data since the observation was limited to an isolated case, and the effect appears relatively small.

4.3 SUMMARY OF LIMITATIONS

The combined considerations of measurement uncertainty and method biases imply a practical accuracy of approximately 3% in the reported relative La-140 intensities for bundles and rod-to-rod distributions. It should be noted that no single value applies to all possible specific comparisons of the data, and that the appropriate accuracy to apply in specific comparisons might be slightly higher or lower. The basis for estimating the 3% was quadratic combination of uncertainties and biases, treating them as random sources.

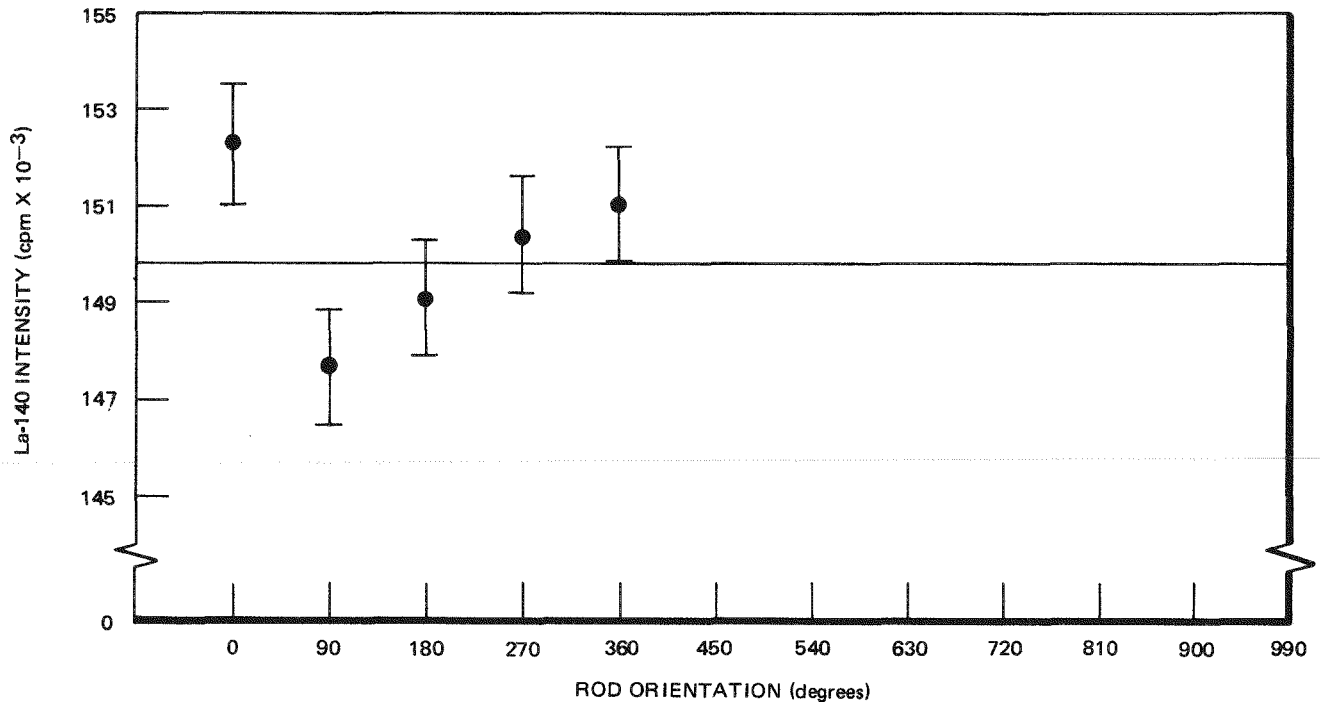


Figure 4-1. La-140 Intensity versus Azimuthal Orientation of Rod A1, Bundle HX393

5. Results

5.1 BUNDLE MEASUREMENTS

The four-corner-averaged La-140 intensities of 106 bundles are displayed in several different formats to facilitate review and evaluation. Seventy-five of these bundles define the benchmark octant; the remaining thirty-one are required to evaluate the TIP/Process Computer system.

5.1.1 Data Listing by Bundles (Appendix A)

The four-corner-averaged La-140 intensities of 106 bundles are listed for 12, 14, or 24 elevations. Sixteen individual corner measurements affecting ten of the reported 1344 four-corner averages were obtained by linear interpolation of measured data at adjacent elevations and the other corner measurements on the same bundle. The interpolations were required because of missing data points which were caused by intermittent equipment failures. The missing points were not discovered until after completion of data-taking when detailed analyses of the data were undertaken. Judging from the data, the interpolation methods used do not cause the respective four-corner averages to be less certain than normal points by more than about 0.3%. In Appendix A these 10 affected data points are noted by an asterisk (*).

Four bundles were scanned at more than 24 elevations. The extra data points were near control blade tips and are listed below in order of bundle identification, core elevations in inches, and respective La-140 intensities:

a.	HX393	42, 48, 54	1038570, 1359121, 1481540,
b.	HX373	102, 108	1606618, 1991388,
c.	HX279	60, 66, 72	1264861, 1674740, 1798593,
d.	HX278	84, 90, 96	1607354, 1983881, 2032868.

The measurement at 108 inches is corrected by a factor of 1.123 for attenuation through the upper carriage of the FPM (see Section 3.5.3).

5.1.2 Planar Display of the Bundles Defining the La-140 Intensities in the Benchmark Octant (Appendix B)

The 75 bundles defining the benchmark octant are listed by planes; twelve others required for TIP/Process Computer evaluation are also displayed. Normalization at each plane is to the average of the 75 benchmark bundles, with half-weighting assigned to bundles straddling the diagonal octant boundary.

5.1.3 Planar Display of Eight Bundles Symmetric across the TIP Line of Symmetry (Appendix C)

Eight bundles symmetric across the TIP line of symmetry are displayed by planes. These bundles surround the LPRM's at core locations 20-45 and 44-21. Normalization in the plane is to the average of the eight bundles. Note that three other such eight-bundle groups are included in the Appendix B display.

5.1.4 Planar Display of Eight Bundles Rotationally Symmetric about Core Center (Appendix D).

Eight bundles rotationally symmetric about the center of the core are displayed by planes. The four bundles surrounding LPRM location 28-37 are in the benchmark octant and are repeated from Appendix B. The other four bundles surround core location 24-17. Normalization at each plane is to the average of the eight bundles.

5.2 ROD MEASUREMENTS

Single rods were scanned in the four bundles surrounding the LPRM at core location 28-37. Bundles HX169 and 141, which were uncontrolled, were scanned at 10 elevations. Bundles HX393 and 373, which were adjacent to inserted control blades, were scanned at two additional elevations near the tip of the respective blade position. Of the 1760 measurements, two were missed because of a malfunction in the multichannel analyzer which was not discovered before the rod was reinserted in the bundle. No effort has been made to obtain interpolated values for these points since the rods were not scanned in sufficient axial detail to allow interpolation.

5.2.1 Rod-to-Rod Planar Displays by Bundles (Appendix E)

The rod-to-rod measurements are displayed in 10 or 12 planes for each bundle. The normalization in each plane is to the average of the measured rods.

5.2.2 Normalized Rod-to-Rod Planar Displays for the Four Bundle Group (Appendix F)

For the ten elevations common to all four bundles, the rod-to-rod planar measurements are displayed in normalized format. Normalization is to the average of the measured rods in the plane. The relative La-140 bundle powers determined from the rods are also given.

5.3 DETAILED AXIAL MEASUREMENTS

Detailed axial shapes were obtained for four controlled bundles and two uncontrolled ones as a demonstration of typical bundle power shapes existing in the core. Figures 5-1, 2, 3 and 4 show the four controlled bundles (HX278, 279, 373, 393) with the positions of their adjacent blades. Figure 5-5 shows the two uncontrolled bundles (HX141 and 169) plotted together, which were also two of the four bundles disassembled for rod-by-rod scanning.

The other two disassembled bundles (HX393 and 373), which were controlled, had two rods each (A1 and G7) which were measured in one- or two-inch intervals about the tip of the respective control blade position. These rods, at the wide-wide and narrow-narrow corners, represent extremes in axial shape for rods in those bundles. Figures 5-6 and 5-7 are the axial plots of the La-140 distributions. Note the depressions in the shapes at elevations 52, 106, and 116 inches which were caused by support structure on the single rod holding device.

5.4 BUNDLE AXIAL SHAPES

A few bundle axial shapes are plotted together because they illustrate interesting characteristics of the core.

5.4.1 Axial Plots of Bundles Symmetric within the Core (Appendix G)

Figure 5-8 shows groupings of gamma scanned four bundle clusters which are symmetrically located within the core. Each grouping also has four bundle clusters surrounding LPRM positions which are reflectively symmetric across the diagonal benchmark octant boundary (TIP Line of Symmetry). Within these groupings, individual symmetrically located bundles have been plotted together and are shown in Appendix G. (The numbers "2" or "3" appear on the plots where 2 or 3 nodal intensities had the same value.) Asymmetries in La-140 distributions have been calculated and are summarized in Section 5.5.

5.4.2 Axial Plots of Bundles Symmetric along the Diagonal Octant Boundary (Appendix H)

Bundle pairs symmetrically located across the diagonal octant boundary are plotted together in Appendix H to illustrate their symmetry and trends in axial shapes with increasing radius. These bundle pairs are:

Bundle ID's	Core Locations
170/104	27-30/29-28
137/76	29-32/31-30
156/145	31-34/33-32
211/53	35-38/37-36
66/197	37-40/39-38
194/30	39-42/41-40
491/507	43-46/45-44

5.4.3 Core Radial Shape at Different Elevations

Bundle La-140 intensities normalized to the core average are plotted in Figures 5-9, 5-10, 5-11, and 5-12 along two different radial axes as shown in the figures. The various radial shapes are shown by elevation.

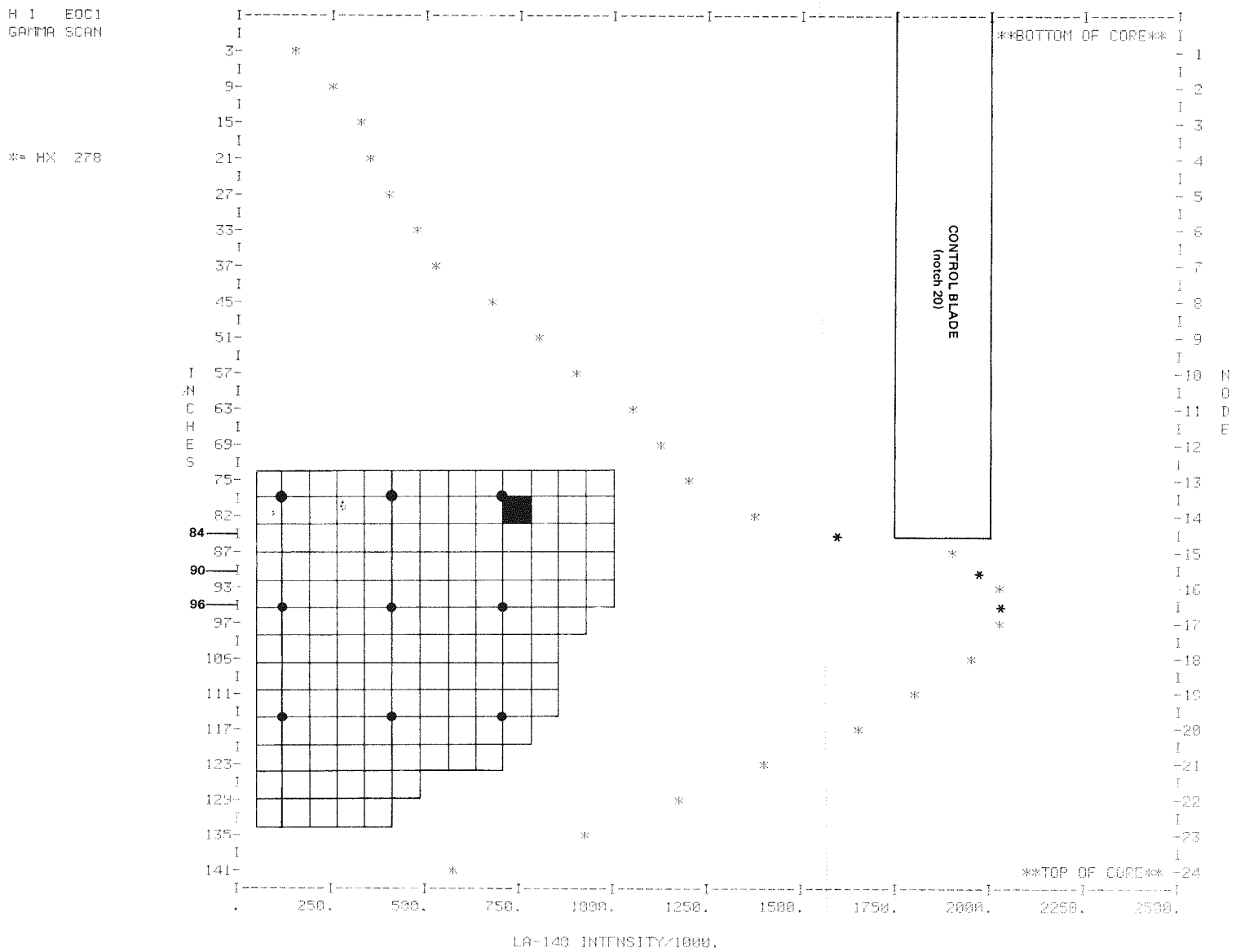


Figure 5-1. Detailed Axial Plot of HX278

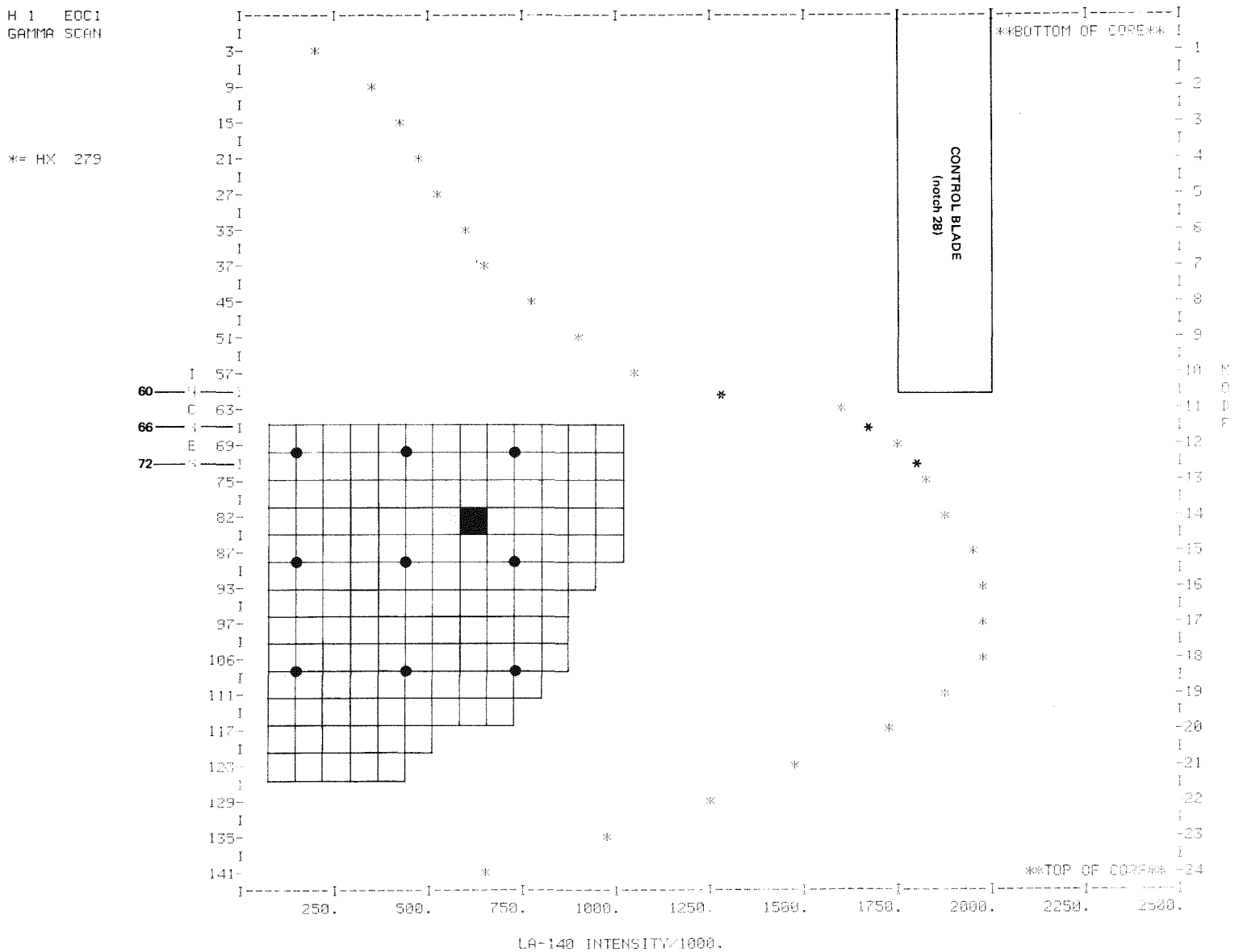


Figure 5-2. Detailed Axial Plot of HX279

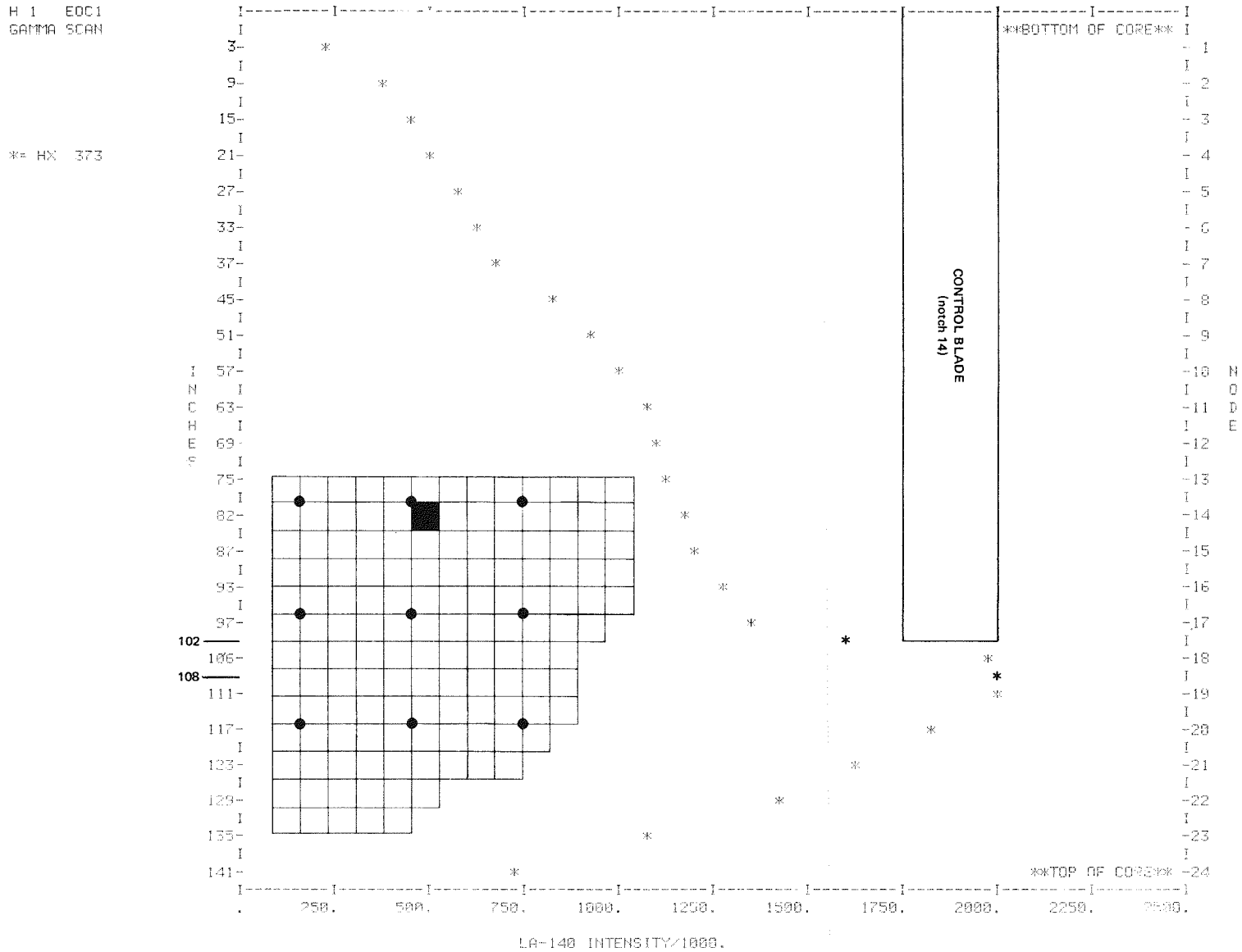


Figure 5-3. Detailed Axial Plot of HX373

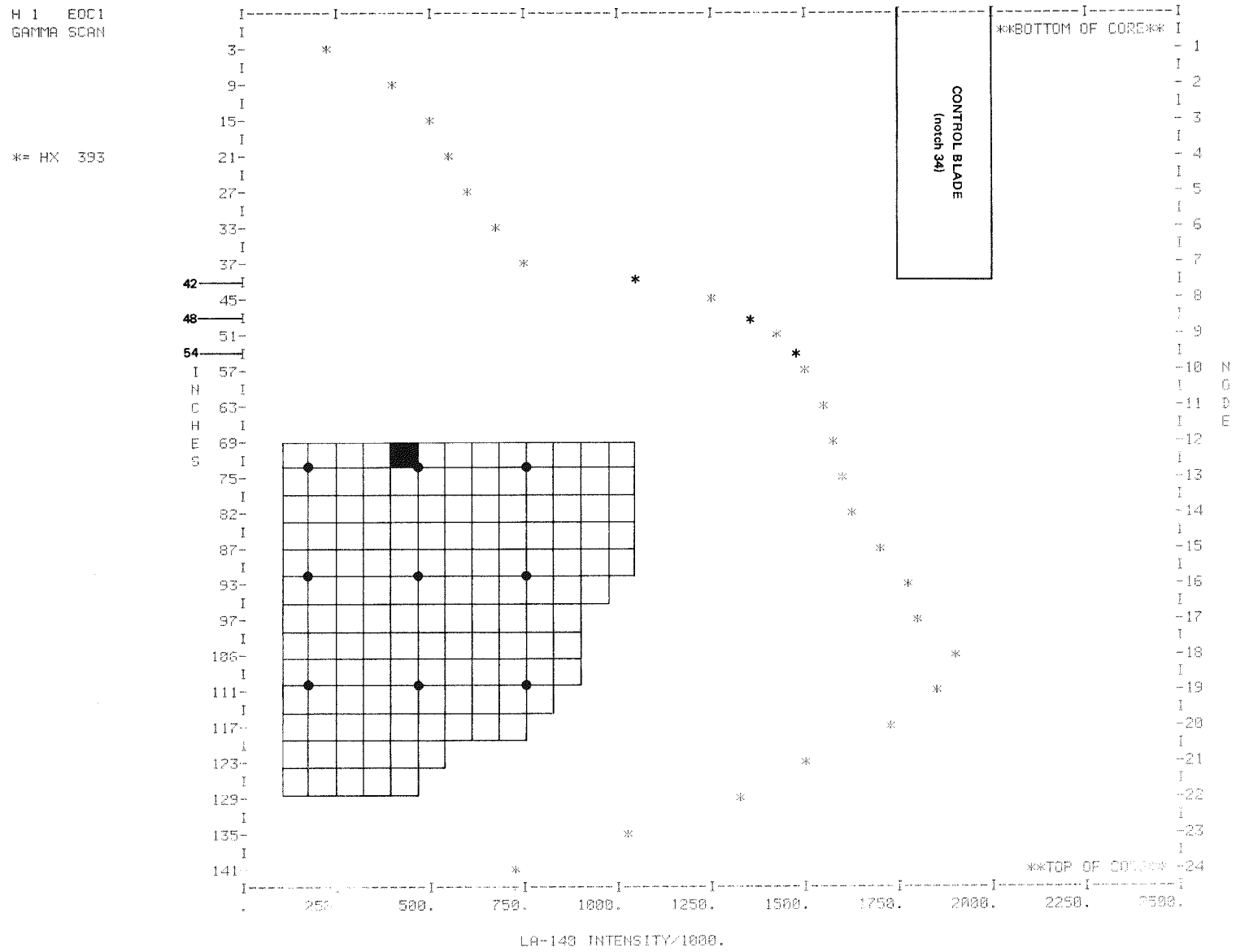


Figure 5-4. Detailed Axial Plot of HX393

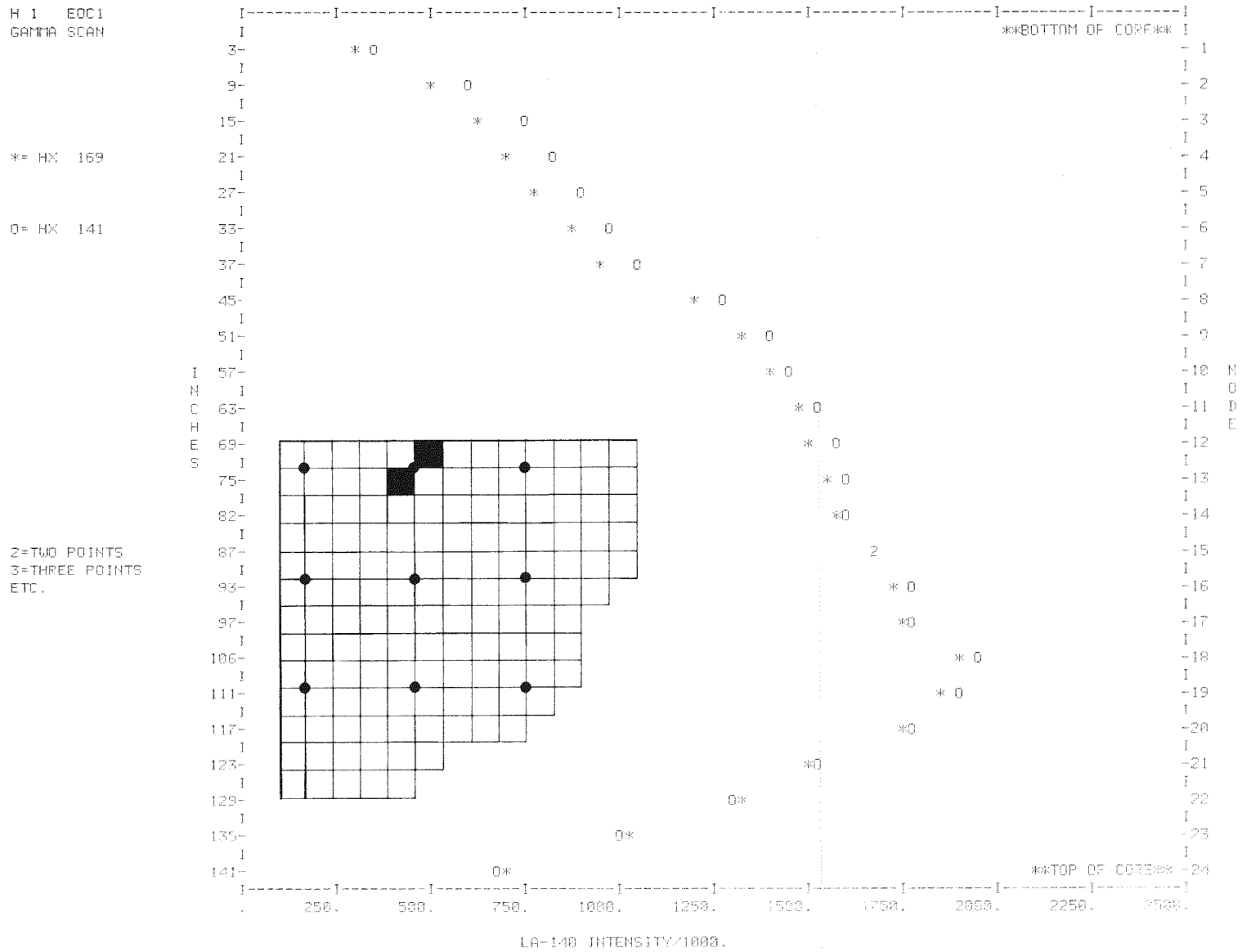


Figure 5-5. Detailed Axial Plots of HX141 and HX169

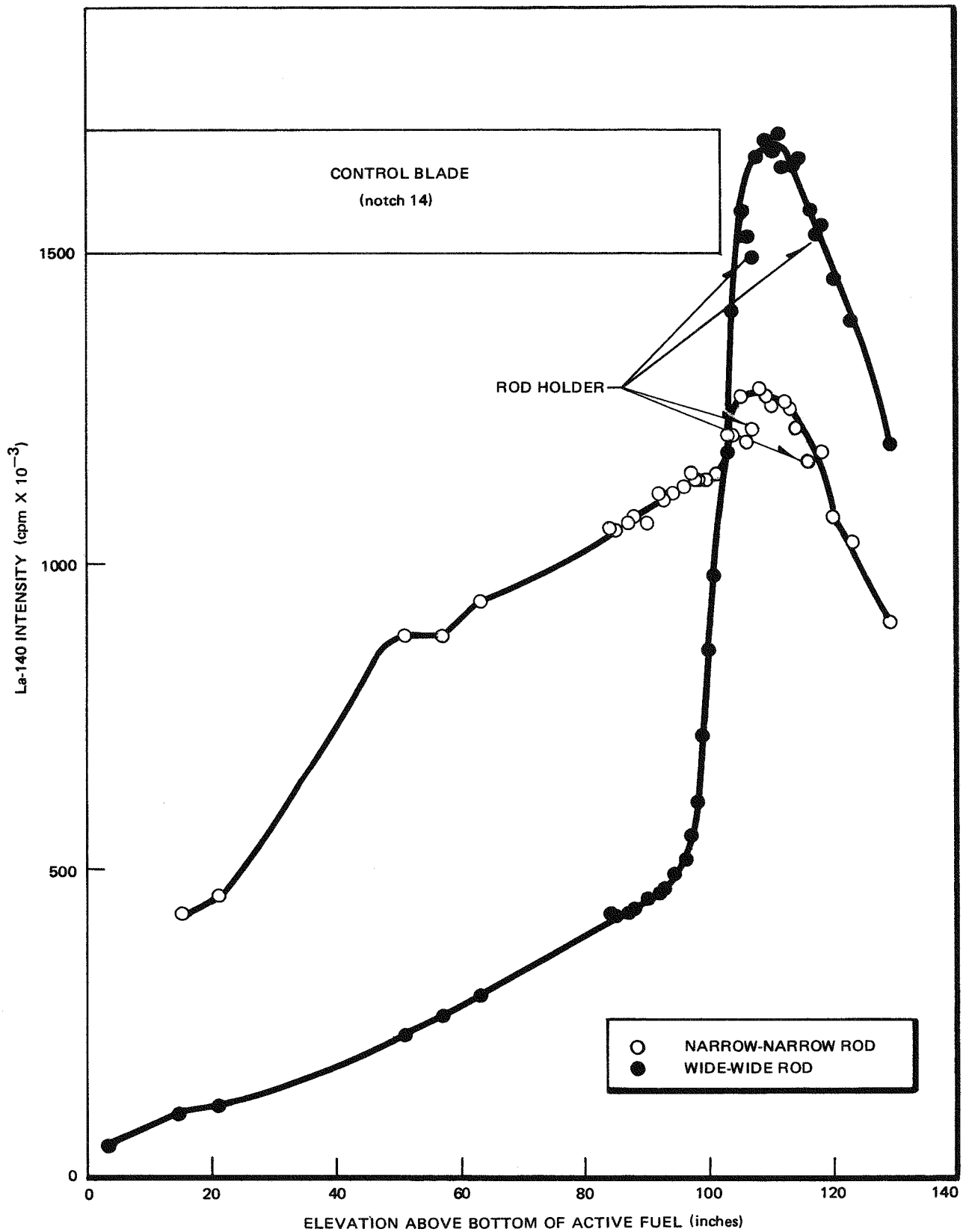


Figure 5-6. Detailed Axial Plots of Two Rods in HX373

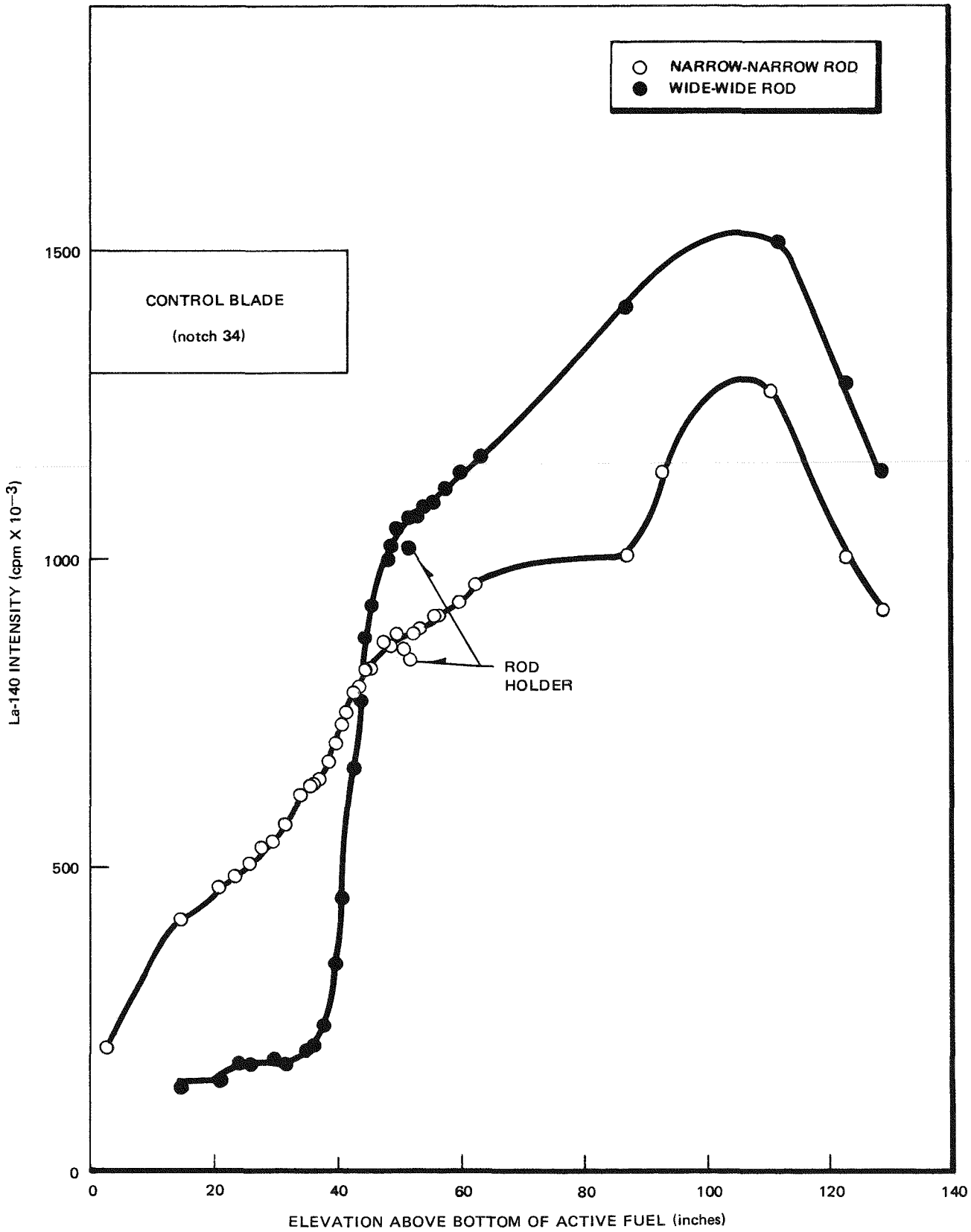
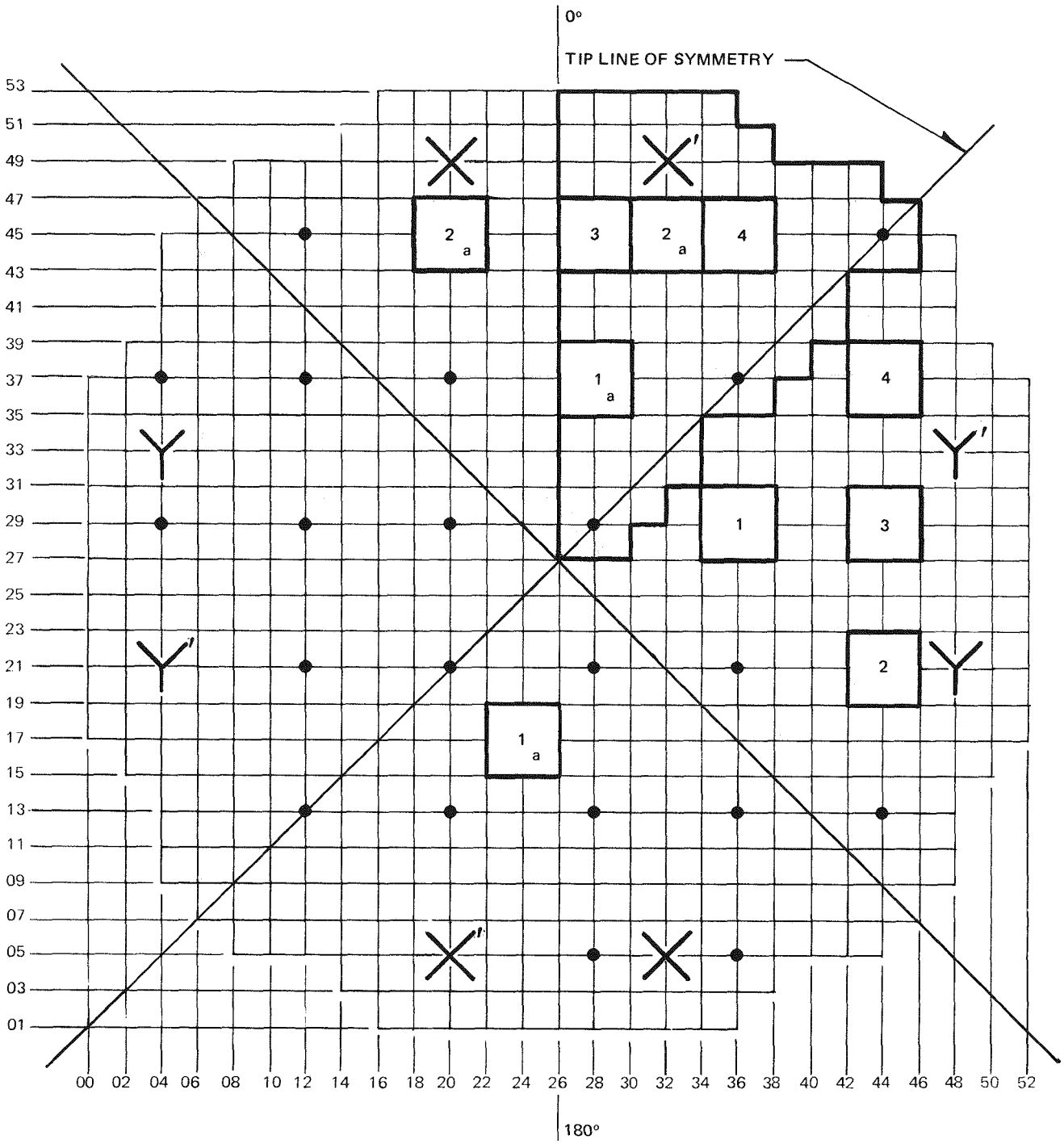


Figure 5-7. Detailed Axial Plots of Two Rods in HX393



NOTE: LETTERS X AND Y IDENTIFY OCTANTS IN WHICH BUNDLES ARE SYMMETRIC WITH RESPECT TO CONTROL IN THE A AND B PATTERNS, AND TO FLOW. X' AND Y' INDICATE FURTHER SYMMETRY RELATIVE TO BUNDLE TYPE LOADING.

Figure 5-8. Symmetric Groupings of Bundles

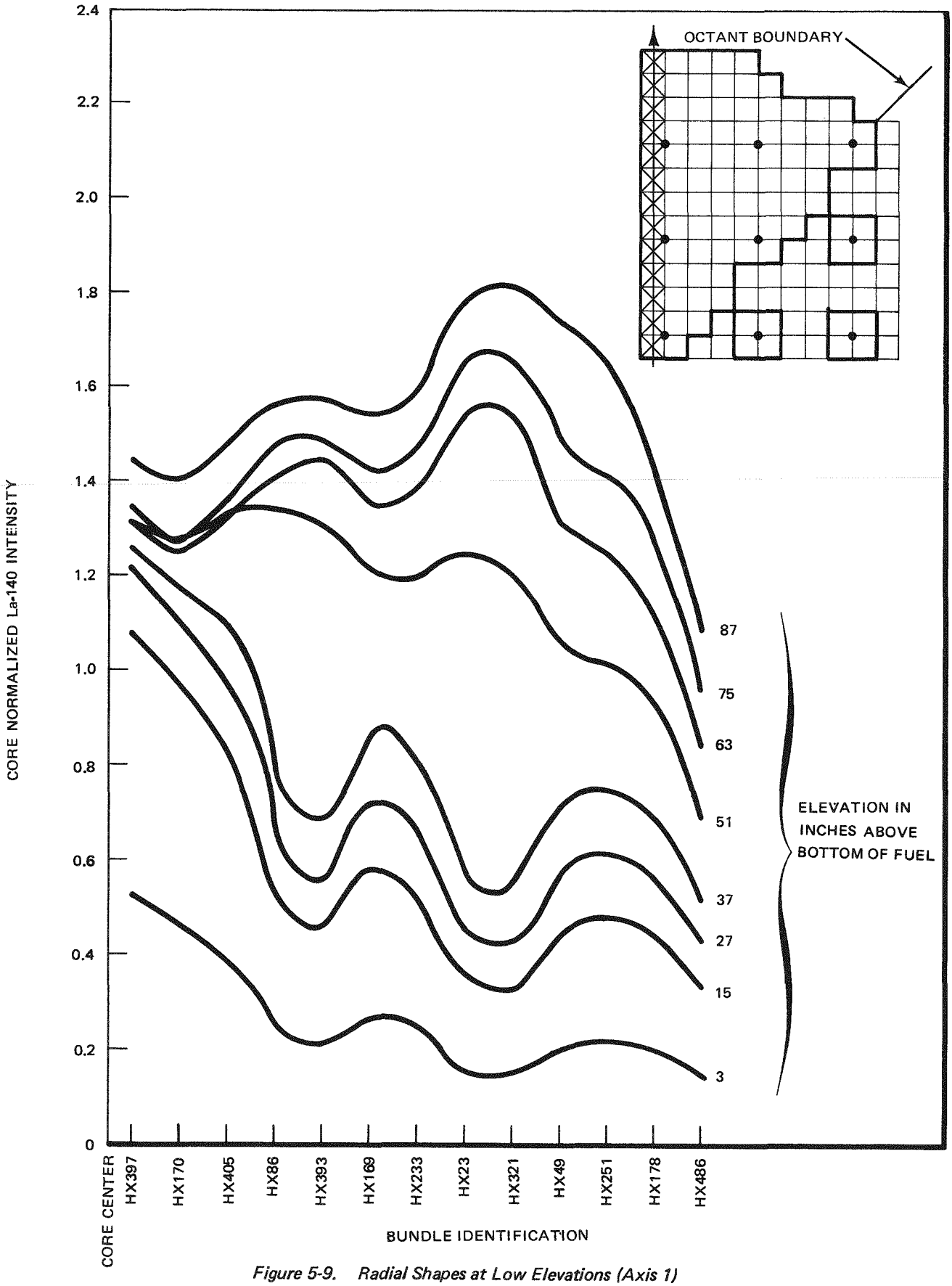


Figure 5-9. Radial Shapes at Low Elevations (Axis 1)

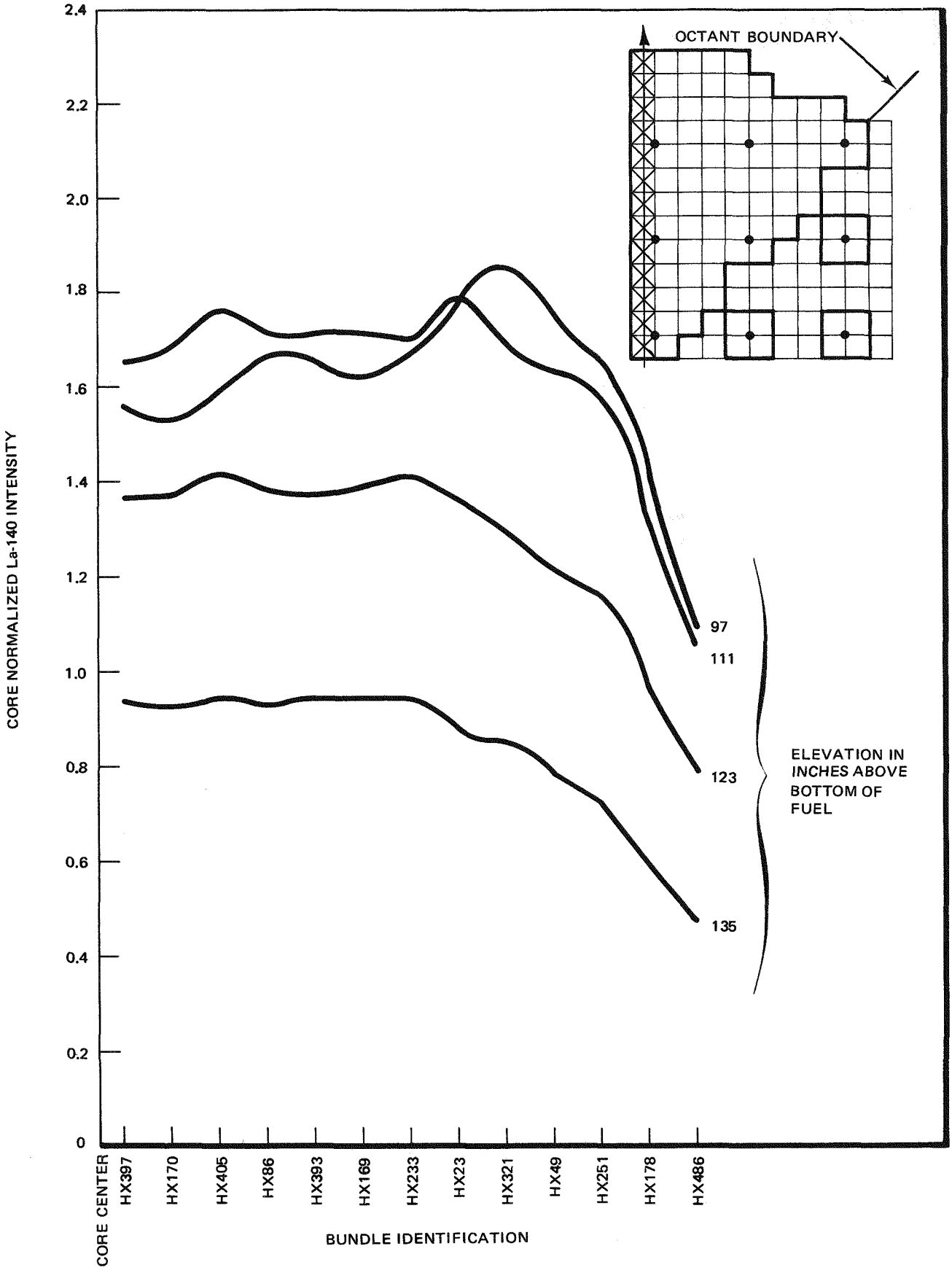


Figure 5-10. Radial Shapes at High Elevations (Axis 1)

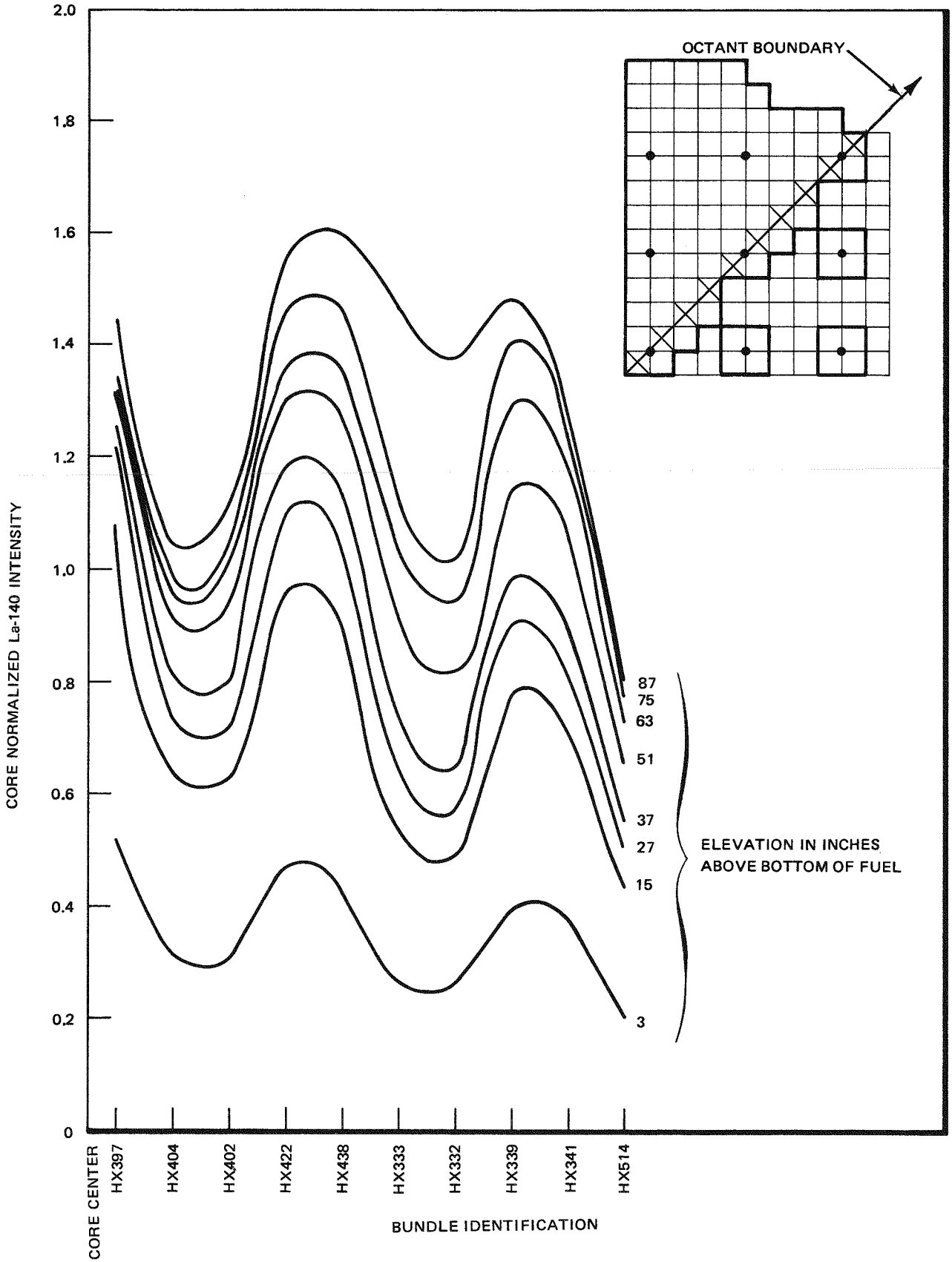


Figure 5-11. Radial Shapes at Low Elevations (Axis 2)

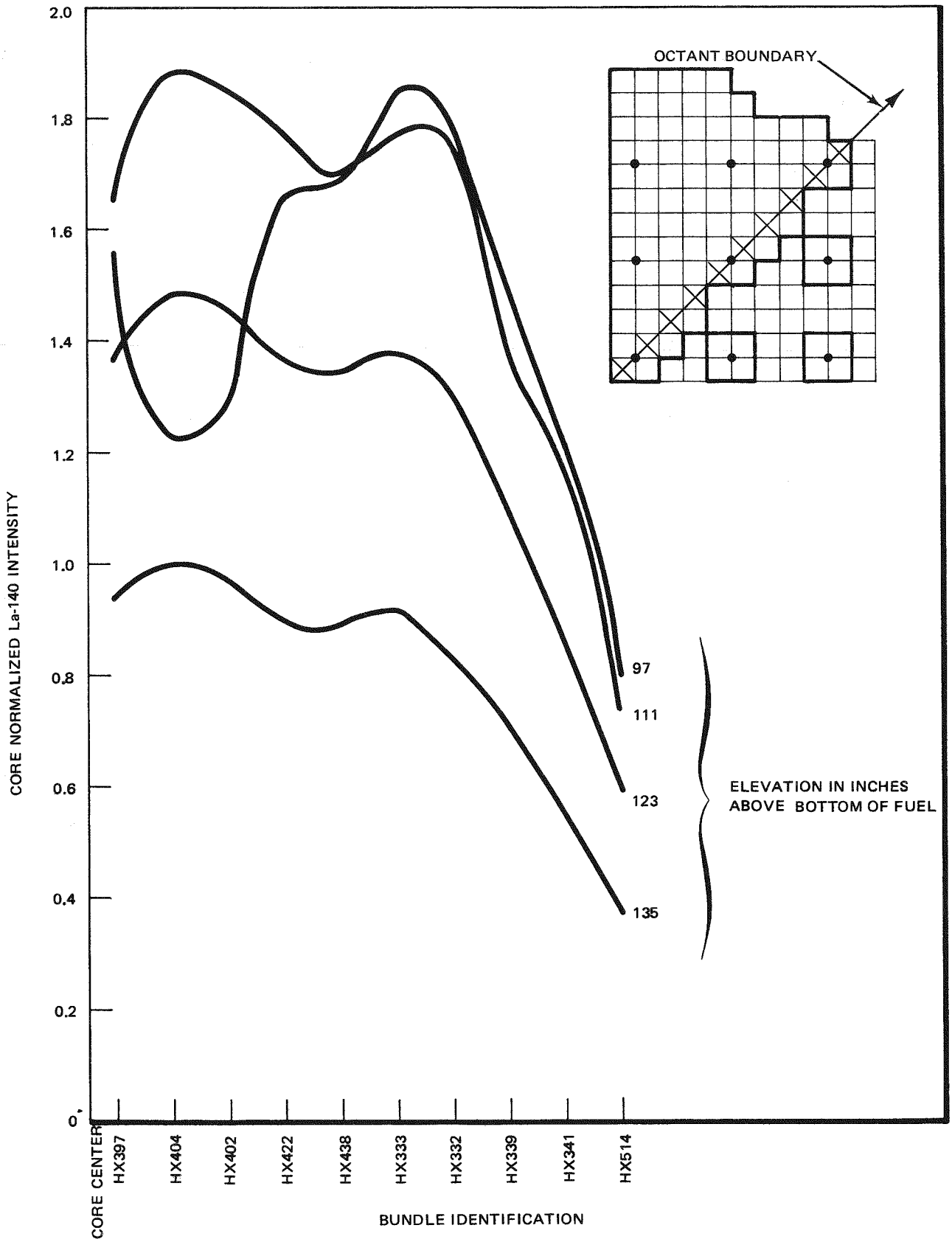


Figure 5-12. Radial Shapes at High Elevations (Axis 2)

5.5 ASYMMETRIES IN LA-140 INTENSITY IN PAIRS OF SYMMETRIC BUNDLES

One of the goals of this measurement program was to investigate power symmetry between symmetric TIP locations. In this section asymmetries using the gamma scan data are calculated. The comparisons must be viewed, however, with the knowledge that real power asymmetries can exist due, for example, to previous asymmetric exposure caused by asymmetric control blade patterns or asymmetric core loading.

The Hatch core coasted down in the A sequence which is symmetric with respect to the major 45° and 90° core axes (and thus the TIP line of symmetry). Previous operation in the B sequences, however, is symmetric only with respect to the major 90° axis, as is moderator flow. Fuel loading of the core was checkerboard in the interior with the two types of fuel differing only in the amount of gadolinia in one of the fuel rods. Near the periphery, bundles were of a third type. At the end of cycle 1, gadolinia should have burned out so that core loading at this point in time is octant symmetric.

Eight clusters of four bundles each were gamma scanned (Groups 1-4, see Figure 5-8) to measure these asymmetries. These are reflectively symmetric across the TIP line of symmetry. Bundle pairs which are symmetrically located from these clusters are not controlled symmetrically in B sequences. The group 1a cluster around location 28-37 is reflectively symmetric across the center of the core with the cluster around location 24-17; control of symmetrically located bundles from these two clusters is symmetric in both A and B control patterns. In addition, the fuel loading is symmetric. The four-bundle cluster around location 20-45 is symmetric to the cluster at location 32-45 with respect to both A and B-sequence symmetry axes, but is not symmetric with respect to bundle types due to the checkerboard loading pattern. Thus, comparisons of these bundles are best made on a four-bundle averaged basis. This group is designated 2a.

For each symmetrically located pair of bundles, we define the ratio:

$$\alpha = \frac{C}{D}$$

where C is the La-140 intensity of bundle C (located below the TIP line of symmetry; see Figure 5-8), and D the intensity of bundle D (located above the TIP line of symmetry). Thus, α can be calculated in the following ways:

a. Nodally, where C and D are the La-140 intensities at each elevation (α_{nodal}),

b. Integrally, where C and D are the sums of the La-140 intensities for each respective bundle ($\alpha_{integral}$).

Either nodally or integrally, α is then a measure of the power asymmetry existing in the core near the end of cycle. If the core loading and operation were symmetric, we would expect α to be normally distributed about unity with an rms dispersion approximately equal to the measurement uncertainty of the ratio. Since we know that operation is rarely perfectly symmetric, we expect the dispersion to be somewhat greater than the measurement uncertainty of the ratio.

Table 5-1 summarizes the results of calculating α in various ways for the TIP symmetric groups. Point-by-point nodal ratios for bundle pairs are given in Appendix I. On the basis of measurement uncertainty also, the individual nodal asymmetry ratios are expected to have a worst case of ± 0.023 (1σ); the bundle integral ratios would have a dispersion of ± 0.007 (1σ) (see Section 4.1). It is seen from Table 5-1 that on a bundle integral basis, the La-140 intensities are nearly symmetric. On a nodal basis, however, the dispersion is consistently much larger than can be explained simply by measurement uncertainty. Figure 5-13 is an axial plot of the asymmetry ratio for group 2 bundles, taken from Appendix I. The plot shows an axial variation of the asymmetry ratio; the other three groups show the same general trend. Note that although the integral treatment shows an average asymmetry of only 2.6% for group 2 (see Table 5-1), asymmetries for individual nodes of up to 17% were measured. This axial variation in the asymmetry ratio can be shown to be due to exposure accumulation in the B rod sequences.

TABLE 5-1

SUMMARY OF ASYMMETRY RATIOS FOR BUNDLES SYMMETRIC ACROSS THE TIP LINE OF SYMMETRY

Group	Bundle Identification	Bundle Integral Ratios ($\alpha_{integral}$)	Bundle Nodal Ratios (α_{nodal}) 12-Node Mean	RMS Dispersion About Mean
1	29/169	1.010	1.014	0.031
	323/373	1.014	1.033	0.044
	143/141	0.985	1.003	0.057
	387/393	1.002	1.018	0.047
2	191/27	0.985	1.022	0.084
	243/413	0.967	1.010	0.082
	48/111	0.972	1.010	0.086
	352/378	0.971	1.009	0.076
3	35/49	1.017	1.028	0.055
	425/278	0.994	1.026	0.058
	126/109	0.985	1.020	0.084
	304/321	0.986	1.004	0.044
4	190/172	0.986	1.020	0.093
	310/314	0.992	1.017	0.081
	256/274	0.995	1.027	0.073
	7/89	0.989	1.008	0.068
Averages		0.991 ± 0.015	1.017	0.066

Table 5-2 summarizes the results for group 1a. These bundles are expected to show a high degree of symmetry, and indeed, the data demonstrates this on both an integral and a nodal basis when compared with groups 1-4. Further, the plot of nodal asymmetry ratios in Figure 5-14 shows none of the axial variation seen in Figure 5-13 for group 2 bundles.

The group 2a bundles are compared as a four bundle cluster because of the asymmetry in bundle types. It is interesting to make the comparison in the following ways:

a. Location irrespective of bundle type within the group (HX 376, 181, 277, 149 vs. HX 27, 413, 111, 378).

b. Bundle type irrespective of location within the group (HX 376, 413, 277, 378 vs. HX 27, 181, 111, 149).

The results are summarized in Table 5-3 together with the data from group 1a also collapsed to four bundle clusters. The integral ratios show symmetry for both ways of comparing bundles. The nodal symmetry ratios are consistent with the ratios for group 1a, i.e., the mean ratio is consistent with symmetry with slightly worse dispersions occurring for group 2a. In comparing the four bundle clusters by bundle type irrespective of location, however, it is noted that the ratios at 3, 111, and 135 inches are more than 2σ greater than the mean (see Appendix I). The large ratio at 111 inches can be explained by the greater measurement uncertainty for that elevation. The other two ratios are at relatively low exposure (~5 GWd/t) nodes where there is less gadolinia in one bundle type than the other.

The results of this analysis indicate that on a bundle integral basis only small end-of-cycle asymmetries across the TIP line of symmetry exist irrespective of previous asymmetric control. On a nodal basis, however, asymmetries exist which can be explained by the actual previous B sequence control history. For groups 1a and 2a where power symmetries are expected due to control and flow symmetry, a high degree of symmetry is demonstrated by the data.

TABLE 5-2

BUNDLE ASYMMETRY RATIOS FOR BUNDLES SYMMETRIC TO A AND B SEQUENCE CONTROL LINES OF SYMMETRY AND CORE LOADING

Group	Bundle Identification	Bundle Integral Ratios ($\alpha_{integral}$)	Bundle Nodal Ratios (α_{nodal}) 12-Mode Mean	RMS Dispersion About Mean
1a	216/169	1.008	1.007	0.014
	242/373	0.985	0.992	0.022
	121/141	0.988	0.989	0.013
	235/393	1.019	1.018	0.011
Averages		1.002 ± 0.015	1.000	0.015

TABLE 5-3

FOUR BUNDLE ASYMMETRY RATIOS FOR BUNDLES SYMMETRIC TO A AND B SEQUENCE CONTROL LINES OF SYMMETRY

Group	Symmetry	Four Bundle Integral Ratio	Four Bundle Nodal Ratio 12-Node Mean	RMS Dispersion About Mean
1a	Core Location	1.001	1.001	0.009
2a	Core Location	0.996	1.002	0.018
	Bundle Types	1.008	1.007	0.011

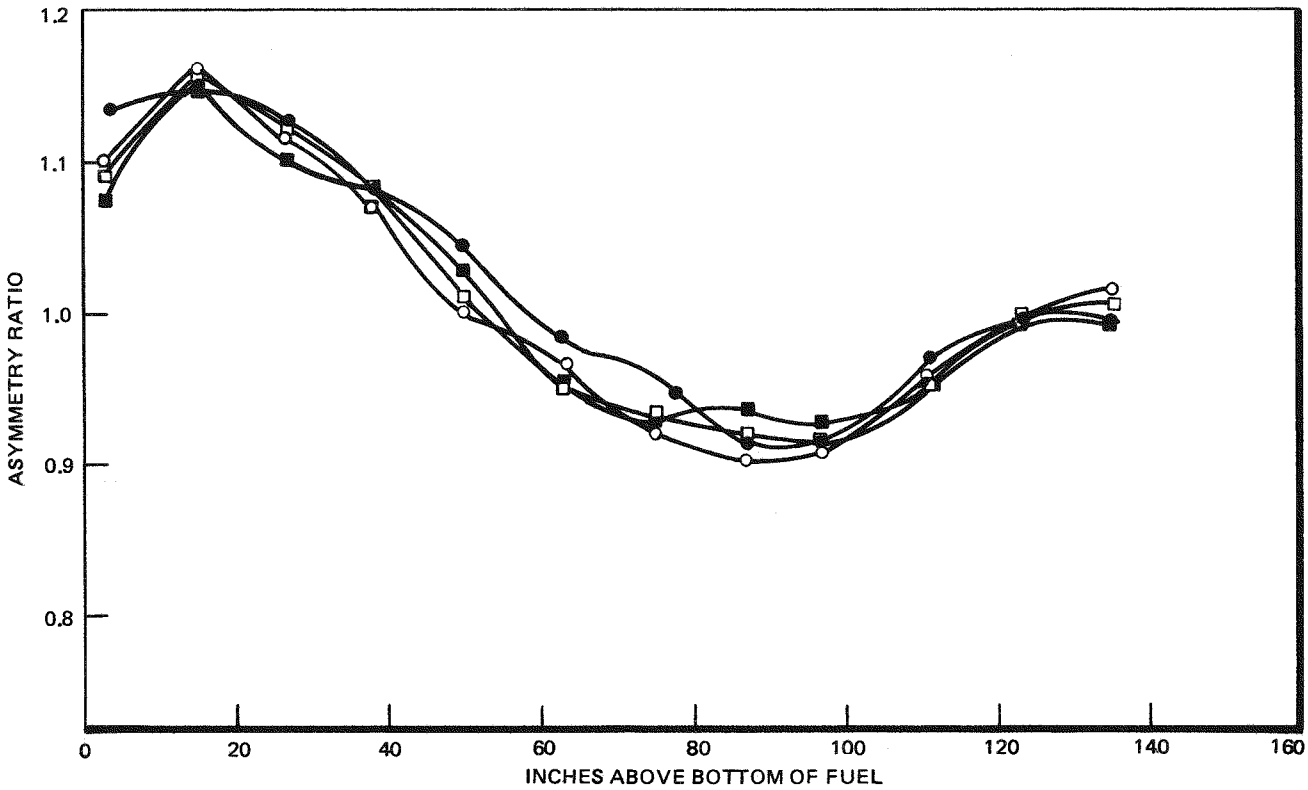


Figure 5-13. Symmetry Group 2 Nodal Ratios

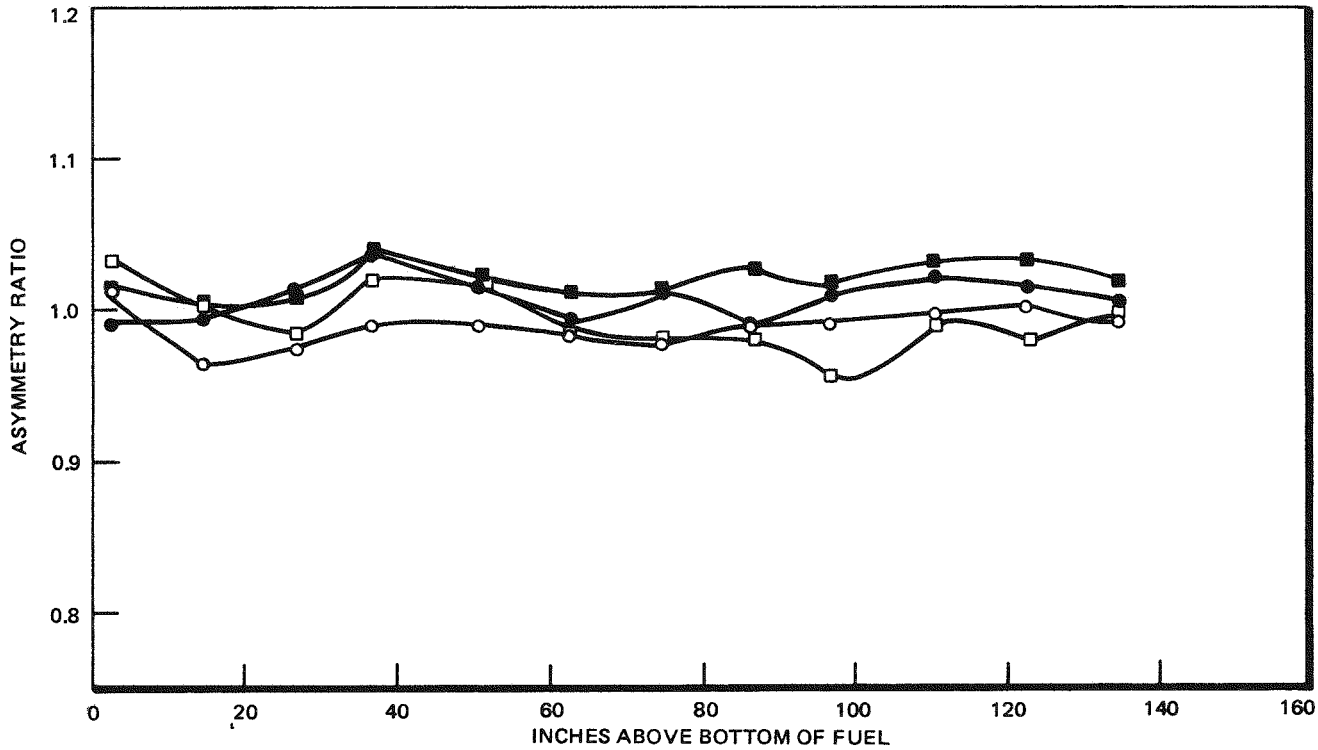


Figure 5-14. Symmetry Group 1a Nodal Ratios

6. UTILIZATION OF THE DATA FOR POWER DISTRIBUTION BENCHMARK

The gamma scanning technique described in this report measures the 1596 keV gamma which accompanies the beta decay of La-140. The half-life of La-140 is 40.23 hours. Accumulation of La-140 in exposed fuel is governed by the beta decay of the fission product Ba-140, which has a half-life of 12.79 days [6]. Thus, the Ba-140 distribution is characteristic of the integrated power history of the core during the last 2 to 3 months before a shutdown. Following a period of approximately 10 days after the reactor shutdown, the La-140 activity is decaying at a rate determined by the half-life of Ba-140 and is proportional to the Ba-140 atom density (see Figure 6-1).

In general, proper utilization of the measured La-140 intensities for benchmarking power distribution methods requires the predicted end-of-cycle Ba-140 distribution to be calculated. By far the most sensitive input to this calculation is the power distribution history, so that a valid benchmark results. Figure 6-2 gives a flow chart of the process.

The relationship between the fission rate (F) at time t, at a point $\vec{r}$, and the power (P) at that point, is given by

$$F = \frac{KP}{\langle E \rangle} \text{ fissions/sec-cm}^3,$$

where K is a proportionality constant with the value

$$K = 6.2383 \times 10^{18} \frac{\text{MeV/sec}}{\text{MW}},$$

$$P = \text{power density at } \vec{r}, \text{ MW/cm}^3,$$

and

$$\langle E \rangle = \frac{\sum_k (\Sigma_{fk}\phi)E_k}{\sum_k (\Sigma_{fk}\phi)} \equiv \sum_k f_k E_k = \text{the average energy per fission,}$$

ϕ = neutron flux at position $\vec{r}$,

Σ_{fk} = macroscopic fission cross-section for fissile nuclide k at position $\vec{r}$, cm^{-1},

E_k = energy per fission of the kth fission cross-section, MeV,

f_k = fission fraction of nuclide k at $\vec{r}$.

Then the relationship between the production rate of Ba-140 (S_B) and power, at a time t, is given as

$$S_B = \left\{ \sum_k X_{Bk} f_k \right\} F = \left\{ \sum_k X_{Bk} f_k \right\} \frac{KP}{\langle E \rangle} \frac{\text{Barium atoms}}{\text{cm}^3 \text{ sec}}$$

where

X_{Bk} = cumulative fission yield of Ba-140 from fissile nuclide k.

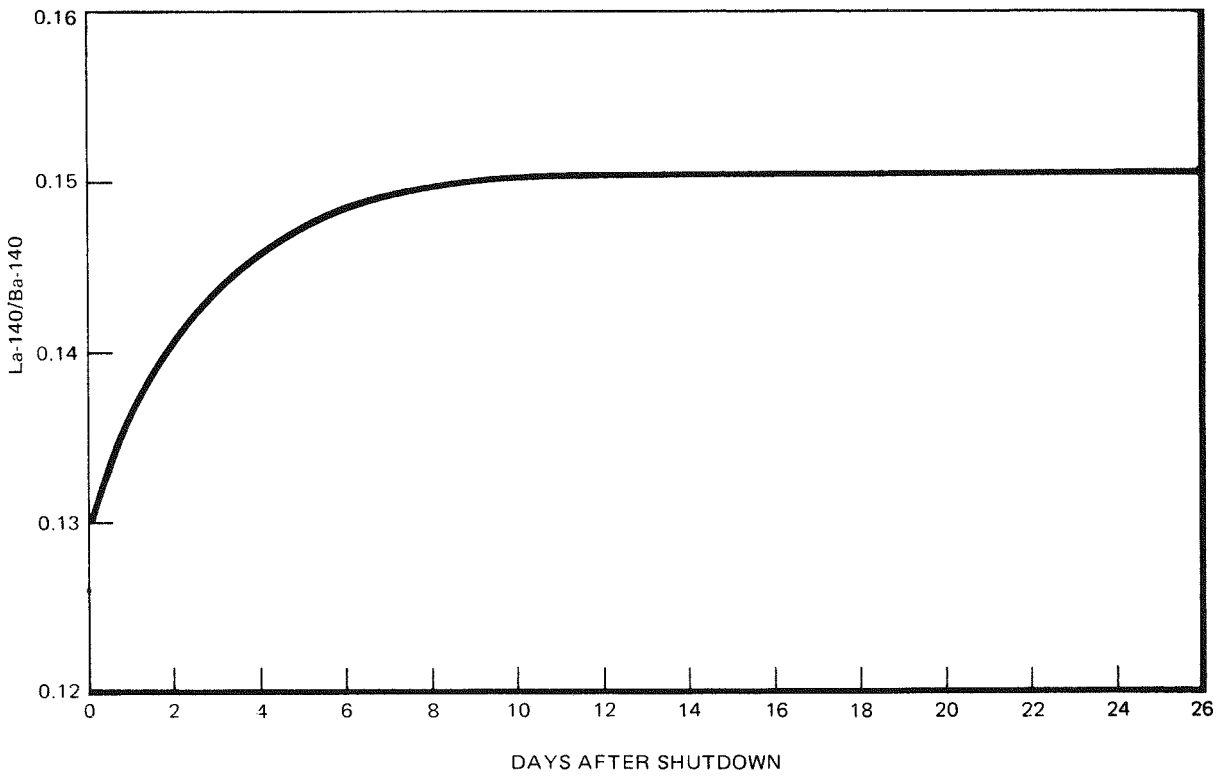


Figure 6-1. Ratio of La-140 Atom Density to Ba-140 Atom Density After Shutdown, Following Long Irradiation

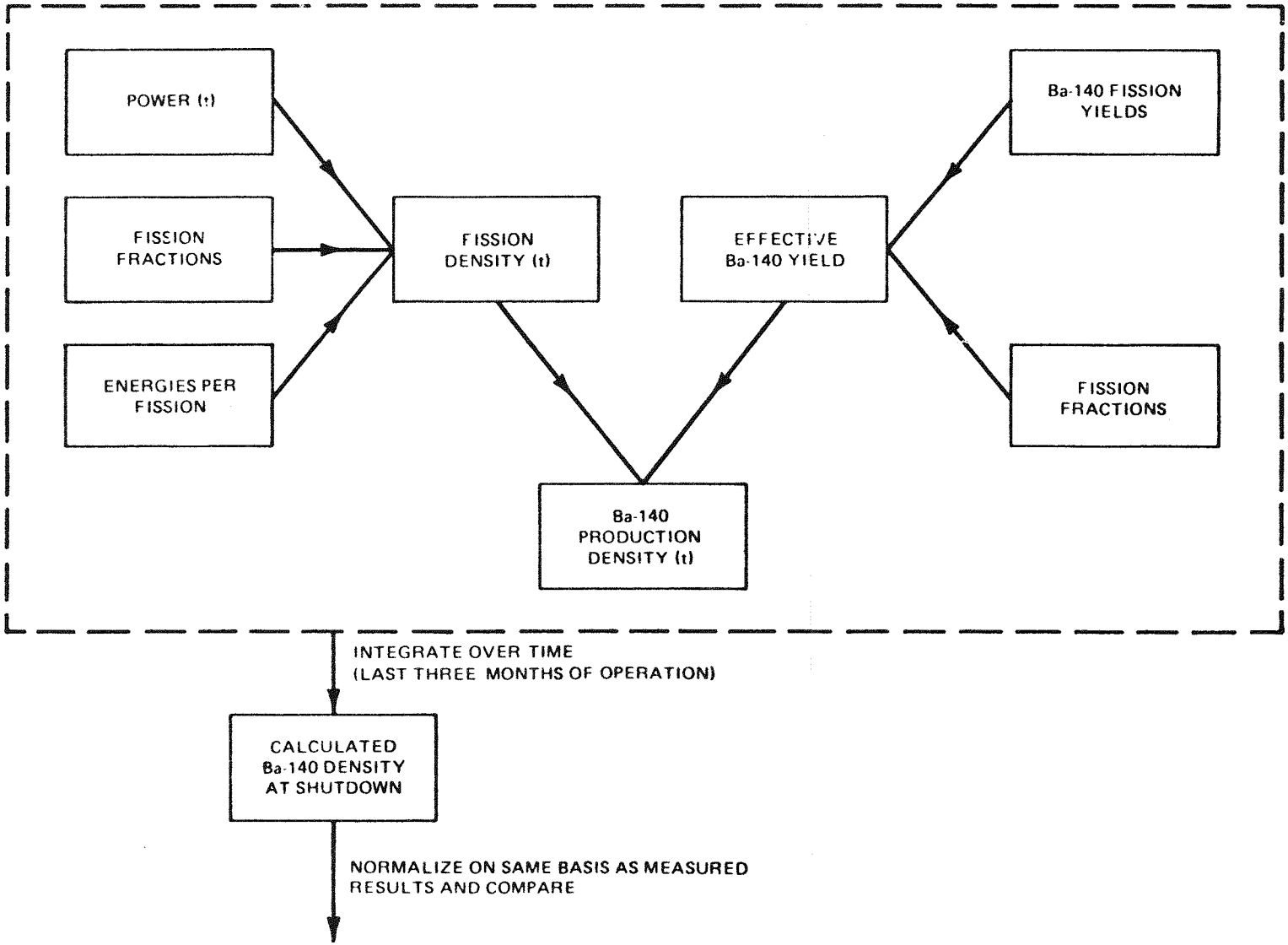


Figure 6-2. Flow Chart of Ba-140 Calculation

To determine the total accumulation of Ba-140, then, requires solving the equation

$$N_B(t) = \int_{t_0}^{t_f} [S_B(t) - \lambda N_B(t)]\, dt ,$$

where

N_B = Ba-140 atom density, atoms/cm^3,

λ = Ba-140 decay constant = 0.05419 day^{-1} ,

and the interval of integration is the entire irradiation period. Neutron absorption by Ba-140 is negligible relative to decay. Since Ba-140 may not be one of the fission products normally followed by the core simulator it may be necessary to determine it by independent calculation. Some simplifying assumptions can generally be made to assist in the solution of this problem. In the case of most fuel under consideration, the number of fissile nuclides, k, which contribute significantly to the fission rate, is small. Table 6-1 shows the 4 largest contributors and their respective yields for a 2.34% enriched UO_2 bundle at a 40% voided condition. Similar calculations of effective yields at 0% and 70% voids and for MO_2 bundles show less than 1% difference from the above case. An additional assumption that can be made is to assume that P and ⟨E⟩ are stepwise constant over the interval $\Delta t = t_n - t_{n-1}$, therefore replacing the time integral with successive substitution, as;

$$N_B(t_n) = \frac{S_B(t_n)}{\lambda} + \left[N_B(t_{n-1}) - \frac{S_B(t_n)}{\lambda} \right] e^{-\lambda \Delta T} ,$$

where

$n = 1, 2, \ldots m,$

$N_B(t_m)$ = end of cycle Ba-140 atom density.

The production term, S_B, can be further simplified. ⟨E⟩ can be approximated as constant. To determine the *relative* distribution of Ba-140 rather than absolute atom densities, power and effective yield are the only inputs, K and ⟨E⟩ being eliminated by normalization. This consideration is very useful in gamma scan and power comparisons, since only relative Ba-140 distributions are measured. The resulting formulation, using $S_B(t_n) = Y_e P(t_n)$, is

$$N_B(t_n) = \frac{Y_e P(t_n)}{\lambda} + \left[N_B(t_{n-1}) - \frac{Y_e P(t_n)}{\lambda} \right] e^{-\lambda \Delta T} ,$$

where

Y_e = effective yield = $\sum_{i=1}^{4} Y_i F_i$, i = U-235, U-238, Pu-239, and Pu-241,

Y_i = cumulative yield for fissile nuclide i,

F_i = fraction of fissions for fissile nuclide i.

TABLE 6-1

EFFECTIVE YIELD (Y_e) %

2.34% Enriched UO_2, 40% Voids

Fission Fractions

Exposure (GWd/t)	F(U-235)	F(Pu-239)	F(Pu-241)	F(U-238)	Total	Y_e †
0.0	0.92349	0.0	0.0	0.07651	1.0000	6.25
1.0	0.85374	0.06863	0.00019	0.07740	0.99996	6.20
5.0	0.67514	0.23457	0.01024	0.07974	0.99969	6.08
10.0	0.53431	0.34639	0.03708	0.08155	0.99933	5.99
20.0	0.34626	0.46581	0.09992	0.08655	0.99854	5.90
40.0	0.10734	0.58688	0.19996	0.10290	0.99708	5.80

Individual Ba-140 Yields*

Y(U-235) = 6.28
Y(Pu-239) = 5.55
Y(Pu-241) = 6.27
Y(U-238) = 5.94

†Calculated from $Y_e = \sum_{i=1}^{4} F_i Y_i$ = effective yield, i = U-235, U-238, PU-239, Pu-241

*Reference 6.

The term $P(t_n)$ is the power distribution (one, two, or three dimensional), taken from the core simulator or process computer. Thus, in this mode of calculation, the gamma scan can serve as a benchmark for computer programs which calculate power distributions. The power distribution should be calculated for as many power levels and control configurations as is necessary to adequately represent the operating history of the reactor. Each distribution is then input in turn as $P(t_n)$. Minor control rod changes late in the cycle, which have little effect on the total power history of the core, can significantly affect the Ba-140 distribution for specific bundles. Therefore, it is desirable that the power level and control configuration remain constant near shutdown, such that the Ba-140 distribution of every bundle is allowed to equilibrate with a single power distribution.

The uncertainty in determining the barium distribution from the bundle powers, assuming the powers to be correct, is dependent upon the power and $\langle E \rangle$ remaining constant over the period ΔT, and the accuracy of determining Y_e, the effective yield for Ba-140 for that period. Naturally, finer ΔT steps will improve the accuracy of the calculation. The minor uncertainties in the calculation of Ba-140 from process computer power calculations or core simulators, combined with the consideration of Section 4 indicate that benchmarking of power distribution methods within 4% is reasonably achievable from the data resulting from this program. In specific comparisons, even more accurate benchmarking is possible, or the calculation necessary can be simplified, or both.

In particular cases where the power distributions have not appreciably changed over the equilibrium period, such as rod-to-rod distributions in UO_2 bundles, or UO_2 bundle power sharing around an incore at one elevation, it is generally adequate to only apply the consideration of differing fission yields, and not to calculate Ba-140 using time steps in operating history. In these cases, knowing an effective yield allows the calculation of an *approximate* power distribution from the La-140 distribution without following detailed operation history. This is only accurate in cases where the power distribution is stable. As the total core power drops during a coastdown, for instance, void distributions shift causing axial power shapes to change.

In a few instances the La-140 distribution can be used directly for power distribution questions. For instance, core power *symmetry* in symmetrically loaded and operated cores can be examined without direct application of either the time integral or differing fission yield considerations.

7. CONCLUSIONS

The set of gamma scan La-140 intensities reported herein constitutes an accurate data base against which power distribution calculations and on-line power measurement systems can be compared. By virtue of their extensiveness and by symmetry considerations, these data characterize the entire core during the last several weeks of operation. It is the hope of the participants that these data will be useful in reducing uncertainties in the design and operation of nuclear power plants, resulting in improved performance and increased operating margins.

8. REFERENCES

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2. J. L. Goudey, and J. J. Chromik, *Comparisons of Process Computer Thermal TIP and Special Gamma TIP Calculations with Gamma Scan Measurements at Edwin I. Hatch Nuclear Plant Unit 1 at End of Cycle 1,* NP-561, Electric Power Research Institute, Palo Alto, California.

3. N. H. Larsen and J. L. Goudey, *Core Design and Operating Data for Cycle 1 of Hatch 1,* NP-562, Electric Power Research Institute, Palo Alto, California.

4. G. R. Parkos and G. F. Valby, *Gamma Scan Measurements at Zion Station Unit 2 Following Cycle 1,* NP-509, Electric Power Research Institute, Palo Alto, California, September, 1977.

5. Values were interpolated from tables in *Engineering Compendium on Radiation Shielding, Vol. 1,* edited by R. G. Jaeger, Springer-Verlag, New York, 1968.

6. B. F. Rider and M. E. Meek, *Compilation of Fission Product Yields, Vallecitos Nuclear Center — 1977,* July 1977, (NEDO-12154-2), General Electric Company, Pleasanton, California.

7. M. B. Cutrone and G. F. Valby, *Gamma Scan Measurements at Quad Cities Nuclear Power Station Unit 1 Following Cycle 2,* NP-214, Electric Power Research Institute, Palo Alto, California, July, 1976.

8. D. W. Merth, *Gamma Scan Measurements at Quad Cities Nuclear Power Station Unit 1 Following Cycle 3,* NP-512, Electric Power Research Institute, Palo Alto, California.

9. DATA INDEX

INDEX TO THE DATA BY BUNDLES

Bundle Identification	Core Location	Notch Position of Adjacent Control Blade	Core* Symmetry Group	Number of Nodes Measured	Appendix Reference
7	43-38	48	4	12	A-10, B, G-16
23	27-42	32	BO**	14	A-6, B
27	19-46	48	2	12	A-10, C, G-8
29	37-28	48	1	12	A-2, B, G-4
30	41-40	48		12	A-9, B, H-6
35	45-28	48	3	12	A-2, B, G-12
48	43-22	48	2	12	A-3, C, G-7
49	27-46	48	3, BO	12	A-3, B, G-12
53	37-36	48		12	A-1, B, H-4
66	37-40	18	BO	14	A-4, B, H-5
74	33-48	48	BO	12	A-7, B
76	31-30	14		14	A-4, B, H-2
86	27-34	34	BO	14	A-5, B
89	37-44	48	4, BO	12	A-10, B, G-16
104	29-28	48		12	A-4, B, H-1
109	29-44	48	3, BO	12	A-3, B, G-11
111	21-44	48	2	12	A-3, C, G-7,
121	23-18	48	1	12	A-2, D, G-3
126	43-30	48	3	12	A-3, B, G-11
135	41-44	48	BO	12	A-8, B
137	29-32	14	BO	14	A-4, B, H-2
138	31-42	48	BO	12	A-6, B
141	29-36	48	1, BO	24	A-9, B, D, E, F, G-3
143	35-30	48	1	12	A-2, B, G-3
145	33-32	48		12	A-9, B, H-3
149	33-48	28	2, BO	14	A-11, B, G-5
156	31-34	48	BO	12	A-5, B, H-3
165	33-36	48	BO	12	A-5, B
169	27-38	48	1, BO	24	A-9, B, D, E, F, G-4
170	27-30	48	BO	12	A-3, B, H-1
172	35-46	48	4, BO	12	A-9, B, G-15
176	31-50	48	BO	12	A-7, B
178	27-50	48	BO	12	A-6, B
179	35-42	28	BO	14	A-11, B
180	39-46	48	BO	12	A-8, B
181	31-46	20	2, BO	14	A-10, B, G-6
190	45-36	48	4	12	A-1, B, G-15
191	45-20	48	2	12	A-3, C, G-8
194	39-42	48	BO	12	A-11, B, H-6
197	39-38	18		14	A-4, B, H-5
211	35-38	48	BO	12	A-1, B, H-4
213	29-40	14	BO	14	A-1, B
216	25-16	48	1	12	A-9, D, G-4
218	33-40	48	BO	12	A-5, B
220	31-38	14	BO	14	A-6, B

INDEX TO THE DATA BY BUNDLES (Continued)

Bundle Identification	Core Location	Notch Position of Adjacent Control Blade	Core Symmetry Group	Number of Nodes Measured	Appendix Reference
222	29-48	20	BO	14	A-6, B
233	27-40	48	BO	12	A-10, B
235	25-18	34	1	14	A-2, D, G-1
242	23-16	14	1	14	A-2, D, G-2
243	45-22	20	2	14	A-9, C, G-6
251	27-48	48	BO	12	A-6, B
256	43-36	28	4	14	A-10, B, G-13
257	29-42	48	BO	12	A-2, B
274	35-44	28	4, BO	14	A-9, B, G-13
277	31-44	48	2, BO	12	A-7, B, G-7
278	29-46	20	3, BO	27	A-9, B, G-10
279	33-42	28	BO	27	A-11, B
292	31-48	20	BO	14	A-6, B
298	39-44	48	BO	12	A-8, B
304	43-28	32	3	14	A-2, B, G-9
306	29-50	48	BO	12	A-6, B
310	45-38	48	4	12	A-3, B, G-14
314	37-46	48	4, BO	12	A-9, B, G-14
321	27-44	32	3, BO	14	A-3, B, G-9
323	37-30	14	1	14	A-2, B, G-2
330	35-40	48	BO	12	A-7, B
332	39-40	18	BO	14	A-4, B
333	37-38	18	BO	14	A-1, B
339	41-42	48	BO	12	A-10, B
341	43-44	48	2	12	A-4, B
352	43-20	28	BO	14	A-10, C, G-5
359	31-40	14	BO	14	A-5, B
361	37-42	48	BO	12	A-11, B
373	29-38	14	1, BO	27	A-8, B, D, E, F, G-2
375	35-48	48	BO	12	A7, B
376	33-46	48	2, BO	12	A-11, B, G-8
378	19-44	28	2	14	A-10, C, G-5
387	35-28	34	1	14	A-2, B, G-1
388	31-36	48	BO	12	A-5, B
391	29-34	48	BO	12	A-5, B
393	27-36	34	1, BO	27	A-1, B, D, E, F, G-1
397	27-28	48	BO	14	A-3, B
402	31-32	14	BO	14	A-4, B
404	29-30	14	BO	14	A-4, B
405	27-32	48	BO	12	A-5, B
413	21-46	20	2	14	A-10, C, G-6
420	33-38	48	BO	12	A-5, B
422	33-34	48	BO	12	A-4, B
425	45-30	20	3	14	A-1, B, G-10
438	35-36	48	BO	12	A-1, B
446	43-48	48	BO	12	A-8, B

INDEX TO THE DATA BY BUNDLES (Continued)

Bundle Identification	Core Location	Notch Position of Adjacent Control Blade	Core Symmetry Group	Number of Nodes Measured	Appendix Reference
453	33-50	48	BO	12	A-7, B
459	35-50	48	BO	12	A-8, B
460	41-48	48	BO	12	A-8, B
467	29-52	48	BO	12	A-6, B
476	35-52	48	BO	12	A-8, B
477	39-48	48	BO	12	A-8, B
482	31-52	48	BO	12	A-7, B
486	27-52	48	BO	12	A-6, B
487	37-50	48	BO	12	A-7, B
491	43-46	48	BO	12	A-5, B, H-7
507	45-44	48		12	A-1, B, H-7
512	33-52	48	BO	12	A-7, B
514	45-46	48	BO	12	A-1, B
543	41-46	48	BO	12	A-8, B
545	37-48	48	BO	12	A-7, B

*Refer to Figure 5-8
**Benchmark Octant

APPENDIX A

La-140 INTENSITIES BY BUNDLES

INCHES	BUNDLE HX 333	BUNDLE HX 213	BUNDLE HX 393	BUNDLE HX 190	BUNDLE HX 53	BUNDLE HX 438	BUNDLE HX 211	BUNDLE HX 514	BUNDLE HX 507	BUNDLE HX 425	NODE
3	288992.94	185039.94	231812.78	321541.75	410321.19	471361.75	416408.62	221000.41	310860.06	165805.37	1
9	.00	.00	399770.19	.00	.00	.00	.00	.00	.00	.00	2
15	582485.50	395615.50	492366.75	637866.12	835700.50	974301.00	866657.50	468820.81	605160.62	346377.06	3
21	.00	.00	560483.50	.00	.00	.00	.00	.00	.00	.00	4
27	706226.12	499029.50	603476.50	760138.25	992273.62	1124986.50	1023513.25	546869.37	714479.12	444627.06	5
33	.00	.00	669252.00	.00	.00	.00	.00	.00	.00	.00	6
37	802835.62	624020.25	742059.50	906948.75	1091200.75	1222543.25	1133273.75	596959.00	781435.87	557835.37	7
45	.00	.00	1256097.25	.00	.00	.00	.00	.00	.00	.00	8
51	979681.87	918476.50	1414599.50	1186406.00	1299805.25	1366921.75	1290260.50	709530.25	935431.12	850775.00	9
57	.00	.00	1490982.50	.00	.00	.00	.00	.00	.00	.00	10
63	1116099.00	1113315.75	1561031.75	1467115.75	1445080.50	1461282.75	1399952.50	790973.62	1068996.25	1086856.25	11
69	.00	.00	1580288.50	.00	.00	.00	.00	.00	.00	.00	12
75	1204099.50	1106106.75	1610416.25	1595310.00	1596485.50	1587461.25	1521888.25	842622.87	1096543.25	1168160.75	13
82	.00	.00	1618675.50	.00	.00	.00	.00	.00	.00	1436753.25	14
87	1589637.50	1278990.25	1702820.25	1573240.00	1758527.25	1732682.25	1735994.25	871558.12	1130176.50	1810410.50	15
93	1926529.50	.00	1782971.50	.00	.00	.00	.00	.00	.00	1936667.75	16
97	1993524.00	1423401.75	1790954.00	1560173.00	1878062.75	1825331.25	1861983.25	863918.87	1088946.75	1917980.25	17
106	2001481.00	1956195.50	1893835.00	.00	.00	.00	.00	.00	.00	.00	18
111	1917771.50	1942984.00	1855544.50	1465410.25	1854039.00	1838747.50	1827384.50	797587.87	1021170.50	1757870.50	19
117	.00	1789144.50	1724832.00	.00	.00	.00	.00	.00	.00	.00	20
123	1490111.00	1563248.00	1494910.00	1144466.50	1434305.75	1456505.25	1449107.75	640897.75	781754.12	1376636.50	21
129	.00	.00	1319644.00	.00	.00	.00	.00	.00	.00	.00	22
135	992037.62	1032142.12	1023650.00	752902.87	942274.75	967708.37	951500.75	400366.69	503110.19	925574.75	23
141	.00	.00	721872.87	.00	.00	.00	.00	.00	.00	.00	24

INCHES	BUNDLE HX 35	BUNDLE HX 257	BUNDLE HX 387	BUNDLE HX 143	BUNDLE HX 29	BUNDLE HX 242	BUNDLE HX 323	BUNDLE HX 235	BUNDLE HX 121	BUNDLE HX 304	NODE
3	227598.62	232995.34	248361.03	374161.81	299163.06	221123.06	239936.78	234842.59	346920.00	172951.03	1
9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2
15	488611.75	495282.75	518711.31	797968.25	648920.25	456827.19	494811.31	492133.06	713439.75	371807.56	3
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4
27	635936.87	640605.00	627168.12	947526.25	766103.00	556023.87	594205.87	607339.50	868533.00	477136.00	5
33	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	6
37	819661.87	811773.37	835220.37	1123129.50	986499.37	690482.75	724347.62	769933.12	1044697.87	619861.50	7
45	.00	.00	1293590.50	.00	.00	.00	.00	1288266.75	.00	922313.37	8
51	1296828.25	1242606.00	1448400.25	1398571.00	1390507.50	930358.12	963028.25	1445343.00	1380730.00	1369421.75	9
57	.00	.00	1486955.50	.00	.00	.00	.00	1516470.75	.00	1582034.25	10
63	1570968.00	1559389.25	1555912.50	1442712.75	1547236.00	1068501.00	1110172.75	1575826.75	1487080.25	1711015.50	11
69	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	12
75	1692270.75	1694080.25	1594827.75	1504904.75	1600520.00	1098389.00	1151102.50	1627488.75	1551773.00	1767839.25	13
82	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	14
87	1837352.00	1848572.00	1666031.75	1613454.25	1654265.50	1185128.00	1230124.50	1745465.00	1666701.75	1866699.50	15
93	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	16
97	1797850.25	1869576.50	1749141.75	1709303.75	1745034.25	1272956.50	1337677.25	1817105.75	1766620.00	1854070.50	17
106	.00	.00	.00	.00	.00	1931267.00	1944049.50	.00	.00	.00	18
111	1679249.00	1878697.25	1908657.00	1801544.50	1825937.75	1970408.50	1955908.00	1906565.00	* 1898148.00	1751543.00	19
117	.00	.00	.00	.00	.00	1829795.75	1798010.50	.00	.00	.00	20
123	1313306.50	1436288.00	1465660.25	1474921.25	1467312.50	1582692.50	1575899.00	1541311.50	1516675.25	1378170.25	21
129	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	22
135	866319.25	960357.50	1027895.00	1003950.75	1009429.75	1067686.75	1079266.00	1040526.75	1003267.00	928792.00	23
141	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	24

INCHES	BUNDLE HX 126	BUNDLE HX 321	BUNDLE HX 49	BUNDLE HX 109	BUNDLE HX 310	BUNDLE HX 191	BUNDLE HX 48	BUNDLE HX 111	BUNDLE HX 170	BUNDLE HX 397	NODE
3	241506.25	165607.31	216911.56	221035.03	374777.62	265617.37	253166.41	230626.81	496397.37	564838.75	1
9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2
15	534391.87	353091.94	477721.19	461111.31	713307.62	532334.50	532475.12	458652.62	1045238.62	1169932.25	3
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4
27	681691.75	462241.87	616071.75	588900.12	828764.12	654632.37	662443.12	590204.00	1186907.25	1318433.00	5
33	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	6
37	835498.75	594546.87	768846.37	776578.00	950058.12	811287.25	812093.12	758495.62	1269238.75	1361843.00	7
45	.00	839524.12	.00	.00	.00	.00	.00	.00	.00	.00	8
51	1276545.75	1306305.00	1150324.00	1227489.75	1186294.75	1140447.25	1157808.00	1157668.75	1384856.25	1427067.25	9
57	.00	1518603.75	.00	.00	.00	.00	.00	.00	.00	.00	10
63	1552842.00	1663539.50	1429329.25	1566866.50	1420133.00	1463588.00	1513060.25	1567496.75	1356930.25	1422813.25	11
69	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	12
75	1641679.50	1788800.25	1613797.00	1714864.75	1503822.25	1601658.25	1616159.75	1753436.25	1381788.50	1456514.25	13
82	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	14
87	1807177.25	1961697.50	1882066.25	1964027.75	1513616.25	1702908.75	1784216.25	1975880.50	1523486.75	1564726.75	15
93	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	16
97	1844897.00	2009575.50	1895733.50	1977072.75	1477040.25	1718220.50	1794248.50	1977162.25	1659842.00	1691018.00	17
106	.00	.00	.00	.00	.00	.00	.00	.00	.00	1805626.00	18
111	1746256.25	1830343.75	1772505.00	1841582.25	1403979.25	1618073.75	1734397.75	1811433.75	1825169.25	1792517.75	19
117	.00	.00	.00	.00	.00	.00	.00	.00	.00	1717438.00	20
123	1379594.25	1407381.75	1313675.00	1392567.00	1075700.00	1269302.50	1394178.00	1398005.50	1485457.75	1478175.00	21
129	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	22
135	895661.37	931250.62	849025.12	924268.50	698834.37	828920.62	911138.12	897407.62	1004596.12	1017756.75	23
141	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	24

INCHES	BUNDLE HX 104	BUNDLE HX 404	BUNDLE HX 137	BUNDLE HX 76	BUNDLE HX 402	BUNDLE HX 422	BUNDLE HX 66	BUNDLE HX 332	BUNDLE HX 197	BUNDLE HX 341	NODE
3	487223.25	336944.31	289041.00	318665.25	331235.87	511628.87	253501.75	285781.06	264619.25	403992.81	1
9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2
15	1019376.25	686977.37	604080.00	638421.50	675672.62	1040168.50	496348.31	536183.50	527308.37	773862.75	3
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4
27	1174603.00	789509.25	710101.50	747620.00	780746.12	1201407.25	589273.62	624722.25	606312.37	877473.00	5
33	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	6
37	1245114.75	872271.37	812443.75	860727.75	873158.75	1283755.25	695904.25	711587.50	695437.75	965892.25	7
45	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	8
51	1373241.75	985436.12	1002408.50	1012295.00	1017377.62	1413139.50	883557.62	887985.75	889370.75	1145663.75	9
57	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	10
63	1404584.50	1040096.37	1076877.50	1071195.75	1092478.75	1474520.50	1067847.50	1024591.50	1070794.00	1267953.00	11
69	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	12
75	1441866.00	1053729.75	1109182.25	1104213.00	1143407.50	1583987.00	1180359.25	1106705.50	1194321.50	1337365.50	13
82	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	14
87	1546833.75	1130062.25	1190772.00	1176333.25	1217333.75	1684826.50	1584499.00	1494967.00	1564058.25	1348381.75	15
93	.00	.00	.00	.00	.00	.00	1937059.25	1877204.75	1942231.50	.00	16
97	1679319.50	1331232.75	1316955.00	1393541.50	1401705.00	1794256.25	1982471.75	1936213.00	1971508.25	1311069.50	17
106	.00	1953765.75	1904180.25	1939265.25	1906021.50	.00	1963948.25	1896083.75	1981715.50	.00	18
111	1791878.00	2039372.25	1996327.50	2052762.75	2001901.25	1927332.75	1950966.00	1904758.00	1974444.25	1274974.25	19
117	.00	1848196.25	1791699.50	1828370.25	1805364.25	.00	.00	.00	.00	.00	20
123	1485639.50	1604672.75	1570647.75	1592314.25	1579582.00	1482723.50	1427591.25	1412284.50	1447114.50	936212.25	21
129	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	22
135	1005157.75	1081019.25	1038813.50	1082076.75	1048577.25	973258.37	921024.87	986653.62	919353.12	598994.12	23
141	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	24

INCHES	BUNDLE HX 491	BUNDLE HX 86	BUNDLE HX 405	BUNDLE HX 156	BUNDLE HX 391	BUNDLE HX 388	BUNDLE HX 165	BUNDLE HX 420	BUNDLE HX 218	BUNDLE HX 359	NODE
3	315519.81	273655.37	417741.37	*442454.12	391267.37	415993.12	476434.25	430635.50	340528.19	224075.53	1
9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2
15	597402.00	587549.00	911960.62	935697.37	810870.25	868735.62	1006909.37	901150.62	712100.87	457547.62	3
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4
27	705149.12	712383.62	1062236.75	1096230.25	971862.50	1037752.25	1168635.75	1068235.50	856684.50	557822.37	5
33	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	6
37	781776.50	850284.00	1188513.50	1208432.25	1122812.25	1160188.25	1249236.25	1172499.50	1001707.25	679181.87	7
45	.00	1343799.50	.00	.00	.00	.00	.00	.00	.00	.00	8
51	952611.12	1451664.00	1436814.25	1410291.25	1405599.75	1358691.50	1387068.25	1328677.50	1238931.50	919757.75	9
57	.00	1500241.75	.00	.00	.00	.00	.00	.00	.00	.00	10
63	1080291.75	1525321.00	1436679.50	1495474.25	1497894.50	1473854.50	1469878.25	1452752.25	1474620.75	1123239.50	11
69	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	12
75	1129161.25	1598718.00	1472503.50	1568071.25	1542073.25	1525874.25	1566455.00	1566329.00	1647107.25	1259376.00	13
82	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	14
87	1138047.50	1688150.50	1603643.50	1668112.50	1646352.75	1651200.75	1738867.75	1715019.75	1802068.75	1351545.75	15
93	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	16
97	1107800.00	1806076.50	1730293.50	1794866.75	1760269.00	1775039.75	1804601.50	1829003.50	1905308.00	1438516.75	17
106	.00	.00	.00	.00	.00	.00	.00	.00	.00	2005257.00	18
111	1017933.00	1855208.75	1904256.00	1899134.25	1884171.25	1906930.00	1855770.75	1929058.50	1949698.50	2036321.75	19
117	.00	.00	.00	.00	.00	.00	.00	.00	.00	1831159.50	20
123	793385.25	1498507.75	1535212.00	1532555.50	1512280.25	1492607.50	1465727.75	1527536.75	1527200.25	1585592.25	21
129	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	22
135	498096.25	1008764.87	1026838.37	1012411.62	1019996.50	1009797.75	962829.37	1008890.25	992146.00	1044019.37	23
141	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	24

INCHES	BUNDLE HX 220	BUNDLE HX 23	BUNDLE HX 251	BUNDLE HX 178	BUNDLE HX 486	BUNDLE HX 467	BUNDLE HX 306	BUNDLE HX 222	BUNDLE HX 292	BUNDLE HX 138	NODE
3	279186.25	171322.53	232424.97	212444.41	155449.62	154347.25	203632.69	161143.69	161634.37	264520.81	1
9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2
15	567355.50	383245.69	516187.94	473060.06	357298.50	336031.62	428132.69	325679.56	311725.62	535885.12	3
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4
27	675333.62	492288.87	660251.00	605100.12	461889.12	444589.56	547334.12	417989.62	406530.69	679508.87	5
33	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	6
37	775748.87	623159.50	809328.75	748708.62	560007.00	544577.12	687404.62	527073.50	512563.37	851896.87	7
45	.00	877988.87	.00	.00	.00	.00	.00	.00	.00	.00	8
51	962507.37	1347639.50	1094688.00	1005618.00	745573.25	730018.62	948462.62	757128.87	754758.87	1203798.50	9
57	.00	1546252.75	.00	.00	.00	.00	.00	.00	.00	.00	10
63	1062462.00	1669735.25	1348833.75	1211747.25	910616.87	895521.75	1189805.25	965142.50	990259.75	1570684.75	11
69	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	12
75	1121542.50	1793135.50	1529529.25	1374699.50	1037127.87	1012147.00	1309954.25	1125361.75	1128902.25	1736425.75	13
82	.00	.00	.00	.00	.00	.00	.00	1384384.00	*1364173.25	.00	14
87	1228973.00	1921869.75	1789730.75	1537360.50	1172260.00	1150003.25	1534001.75	1844159.50	1764650.50	1873579.75	15
93	.00	.00	.00	.00	.00	.00	.00	1927342.00	1875753.50	.00	16
97	1314281.75	1936955.50	1795055.75	1526974.25	1187967.25	1159786.50	1521752.00	1922481.00	1832749.25	1928924.25	17
106	1964479.50	.00	.00	.00	.00	.00	.00	.00	.00	.00	18
111	2038192.50	1942383.50	1717665.75	1421485.75	1151899.00	1132679.50	1439735.50	1784623.00	*1751885.00	*1960145.75	19
117	1830079.25	.00	.00	.00	.00	.00	.00	.00	.00	.00	20
123	1591018.25	1475592.00	1259630.50	1040201.25	858380.87	827721.12	1036180.37	1282719.75	1251997.50	1452400.75	21
129	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	22
135	1034369.12	954329.00	788686.87	640249.50	519556.75	507888.07	641345.62	806708.12	777467.50	922641.75	23
141	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	24

INCHES	BUNDLE HX 277	BUNDLE HX 482	BUNDLE HX 176	BUNDLE HX 512	BUNDLE HX 453	BUNDLE HX 74	BUNDLE HX 330	BUNDLE HX 545	BUNDLE HX 487	BUNDLE HX 375	NODE
3	239824.59	150164.62	186675.50	138547.69	210532.62	233393.09	343346.44	273810.31	*192073.50	*275250.00	1
9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2
15	474182.81	323300.56	394158.62	301035.37	419646.37	464278.56	720786.12	511346.50	376144.31	524801.37	3
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4
27	600748.62	409870.62	510476.69	388518.94	533313.75	584996.50	867004.37	636023.62	467633.94	640165.12	5
33	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	6
37	767521.37	508664.62	642283.75	486440.81	667045.87	727544.87	1000843.87	780205.75	574818.37	789903.87	7
45	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	8
51	1159605.50	714535.37	905603.25	680152.87	944950.12	1066710.75	1207228.50	1064918.25	775332.00	1107614.50	9
57	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	10
63	1536428.50	886731.37	1153305.25	828885.25	1187089.00	1340439.75	1441117.25	1277778.00	924276.12	1386278.50	11
69	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	12
75	1724705.00	979117.00	1300042.25	946278.25	1316650.75	1490647.00	1610224.75	1373847.75	1032144.87	1503846.75	13
82	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	14
87	1956463.50	1119529.50	1466128.75	1046693.87	1422905.50	1678454.25	1807742.50	1454108.50	1092336.50	1575349.75	15
93	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	16
97	1965647.00	1127476.50	1484338.75	1033675.25	1440166.00	1661446.00	1908308.00	1407587.75	1108562.25	1560855.75	17
106	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	18
111	1921511.75	*1130459.50	1341518.25	975426.00	1296954.75	1535767.00	1881089.25	1313801.75	1046273.62	1442816.50	19
117	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	20
123	1390219.75	812551.87	993034.37	754364.62	994316.00	1157474.50	1466060.50	1011539.25	831931.75	1089519.75	21
129	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	22
135	894572.87	482772.25	619239.87	454786.62	607269.25	719576.62	963567.25	626663.50	516628.87	698710.50	23
141	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	24

INCHES	BUNDLE HX 459	BUNDLE HX 476	BUNDLE HX 298	BUNDLE HX 180	BUNDLE HX 477	BUNDLE HX 135	BUNDLE HX 543	BUNDLE HX 460	BUNDLE HX 446	BUNDLE HX 373	NODE
3	211449.00	123894.41	396086.25	338306.81	265899.62	411832.75	356764.00	234094.72	188481.56	214023.50	1
9	.00	.00	.00	.00	.00	.00	.00	.00	.00	368174.19	2
15	417548.75	272937.25	766311.62	665433.25	509000.31	802354.75	680710.37	474631.12	402388.75	456493.12	3
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	511738.25	4
27	519540.19	350058.19	913589.75	803553.25	618838.00	953959.87	804793.12	576112.37	487672.06	565128.37	5
33	.00	.00	.00	.00	.00	.00	.00	.00	.00	630353.37	6
37	646331.37	438363.19	1055598.75	940632.50	720943.37	1054282.75	919590.00	660753.12	548522.37	678408.12	7
45	.00	.00	.00	.00	.00	.00	.00	.00	.00	832828.75	8
51	891346.62	612473.37	1295016.25	1182716.75	923683.00	1229958.25	1115361.50	830876.62	688088.37	918766.37	9
57	.00	.00	.00	.00	.00	.00	.00	.00	.00	1002194.00	10
63	1129337.00	771640.87	1463075.00	1350091.75	1080375.00	1378889.50	1264476.50	934617.00	782560.25	1083172.50	11
69	.00	.00	.00	.00	.00	.00	.00	.00	.00	1103710.50	12
75	1244560.50	881610.37	1525582.00	1426451.25	1167518.50	1446372.25	1309934.50	1004164.50	861685.25	1119454.00	13
82	.00	.00	.00	.00	.00	.00	.00	.00	.00	1181566.25	14
87	1309897.75	961771.87	1586314.00	1435072.75	1229388.00	1481062.25	1334117.25	1046120.87	905111.87	1211608.25	15
93	.00	.00	.00	.00	.00	.00	.00	.00	.00	1270720.25	16
97	1291193.25	971099.75	1576521.50	1418200.25	1210580.75	1452295.75	1301139.50	1019856.75	901778.75	1340939.50	17
106	.00	.00	.00	.00	.00	.00	.00	.00	.00	1983523.75	18
111	1195040.25	925687.00	1484882.75	* 1297534.50	1153527.25	1364060.75	1194632.00	* 978298.50	846405.12	1995117.25	19
117	.00	.00	.00	.00	.00	.00	.00	.00	.00	1835879.75	20
123	901417.62	722877.12	1146262.25	1010048.87	915110.12	1045750.75	933261.12	768152.37	672344.37	1625558.75	21
129	.00	.00	.00	.00	.00	.00	.00	.00	.00	1412587.00	22
135	547290.37	438093.69	741706.00	638726.12	574437.12	666742.25	576084.50	480128.00	415382.00	1070927.00	23
141	.00	.00	.00	.00	.00	.00	.00	.00	.00	723764.62	24

INCHES	BUNDLE HX 169	BUNDLE HX 141	BUNDLE HX 216	BUNDLE HX 243	BUNDLE HX 145	BUNDLE HX 30	BUNDLE HX 278	BUNDLE HX 274	BUNDLE HX 172	BUNDLE HX 314	NODE
3	288616.06	341813.62	285640.75	171187.09	444905.06	404209.56	151073.78	214003.66	280955.75	322898.69	1
9	500283.62	602055.62	.00	.00	.00	.00	252453.87	.00	.00	.00	2
15	628108.62	740136.37	623988.25	347956.25	986606.25	835287.00	313894.81	413739.62	550563.00	613202.62	3
21	702296.87	819141.37	.00	.00	.00	.00	358639.25	.00	.00	.00	4
27	779867.87	891098.75	789295.12	439653.81	1150205.00	924716.62	403187.00	501486.44	667752.75	757852.75	5
33	872368.00	971613.62	.00	.00	.00	.00	464012.37	.00	.00	.00	6
37	940171.62	1055539.50	975067.37	556954.87	1259446.00	1023264.00	526178.62	635014.25	816332.00	899676.75	7
45	1192876.00	1283963.25	.00	.00	.00	.00	664555.12	.00	.00	.00	8
51	1323822.50	1392473.50	1343611.25	791130.87	1398980.50	1207796.25	806996.37	864459.50	1143350.25	1196622.75	9
57	1409134.75	1458646.25	.00	.00	.00	.00	912374.87	1050869.25	.00	.00	10
63	1469062.25	1517730.75	1459519.50	1034707.62	1405653.50	1381990.25	1055457.75	1562912.50	1493404.75	1441569.25	11
69	1500340.25	1572649.50	.00	.00	.00	.00	1114614.00	1751719.25	.00	.00	12
75	1544720.75	1588710.25	1556802.00	1153509.50	1509565.50	1489479.75	1189967.50	1779131.00	1658425.25	1552941.75	13
82	1578798.50	1604359.00	.00	1361725.00	.00	.00	1384303.50	.00	.00	.00	14
87	1671197.50	1684733.00	1653547.25	1799258.00	1609256.50	1670082.75	1904507.25	1858864.00	1710979.75	1593506.75	15
93	1719057.50	1763047.00	.00	1881321.00	.00	.00	2015633.50	.00	.00	.00	16
97	1753688.50	1784015.00	1773139.00	1892719.00	1739854.00	1736938.50	2020918.00	1849783.75	1706752.50	1583910.75	17
106	1894663.25	1948947.75	.00	.00	.00	.00	1948095.50	.00	.00	.00	18
111	1853536.25	1906524.25	1890337.50	1745738.50	1819316.50	1611141.50	1793488.25	1695476.50	1569700.75	1449816.00	19
117	1742131.50	1778562.75	.00	.00	.00	.00	1658054.50	.00	.00	.00	20
123	1509176.25	1513348.25	1528376.50	1389523.00	1512510.75	1268093.00	1399385.00	1324487.25	1197733.00	1123415.25	21
129	1318790.25	1304579.25	.00	.00	.00	.00	1182670.00	.00	.00	.00	22
135	1024012.87	1011606.75	1026637.37	916772.62	1005549.50	820039.12	914593.87	872025.12	762684.87	712358.62	23
141	705493.12	686477.00	.00	.00	.00	.00	569752.00	.00	.00	.00	24

INCHES	BUNDLE HX 89	BUNDLE HX 256	BUNDLE HX 7	BUNDLE HX 352	BUNDLE HX 27	BUNDLE HX 378	BUNDLE HX 413	BUNDLE HX 339	BUNDLE HX 233	BUNDLE HX 181	NODE
3	330218.25	243559.16	375245.94	192395.50	234179.62	179092.03	156784.37	430833.87	262903.87	154993.72	1
9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2
15	664033.00	484575.69	759988.37	399197.50	463820.87	345881.50	302815.06	849840.87	557041.12	320706.81	3
21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4
27	807885.75	559550.25	846469.12	486777.25	581407.75	443138.37	393083.75	976535.00	716533.12	399151.37	5
33	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	6
37	959393.12	663451.25	955082.50	609560.37	747957.62	569119.75	514664.12	1065931.50	875829.87	517204.56	7
45	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	8
51	1262218.75	870441.00	1172693.75	869878.12	1090813.50	845815.87	782224.87	1238313.50	1293288.75	789148.37	9
57	.00	1045293.25	.00	1134889.75	.00	1127475.50	.00	.00	.00	.00	10
63	1547327.50	1541076.00	1458791.75	1549976.25	1489751.75	1629302.25	1091650.75	1403417.00	1497051.50	1065879.25	11
69	.00	1691725.50	.00	1700551.25	.00	1793865.00	.00	.00	.00	.00	12
75	1651935.50	1747989.00	1632844.25	1745037.00	1672149.25	1884765.50	1239729.00	1520388.00	1595103.00	1222588.00	13
82	.00	.00	.00	.00	.00	.00	1552192.25	.00	.00	1432011.00	14
87	1699267.75	1790302.75	1660445.75	1852189.00	1865372.75	1980184.75	1957297.25	1605703.75	1721265.00	1941810.00	15
93	.00	.00	.00	.00	.00	.00	2084390.75	.00	.00	2001467.00	16
97	1717939.25	1776742.75	1685153.75	1841100.50	1873346.25	1984087.25	2073664.75	1607031.75	1815852.25	2063511.00	17
106	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	18
111	1586884.75	1666850.75	1546064.00	1726846.75	1670188.75	1814371.25	1834490.50	1481208.00	1843991.00	1814770.25	19
117	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	20
123	1231356.75	1300749.75	1205519.75	1398868.00	1283358.25	1407980.25	1393075.75	1177130.75	1530611.00	1390827.25	21
129	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	22
135	802975.50	862695.12	800155.50	924461.62	835055.00	932191.75	911920.37	756953.62	1026683.12	885126.37	23
141	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	24

INCHES	BUNDLE HX 376	BUNDLE HX 149	BUNDLE HX 279	BUNDLE HX 179	BUNDLE HX 361	BUNDLE HX 194	BUNDLE HX 0	BUNDLE HX 0	BUNDLE HX 0	BUNDLE HX 0	NODE
3	240403.62	179844.09	205049.97	215172.34	332319.81	381755.50	.00	.00	.00	.00	1
9	.00	.00	340400.69	.00	.00	.00	.00	.00	.00	.00	2
15	472327.56	364831.87	416493.12	427136.19	654384.87	757253.25	.00	.00	.00	.00	3
21	.00	.00	473877.94	.00	.00	.00	.00	.00	.00	.00	4
27	590616.12	459618.75	521546.31	523834.12	810086.00	889266.00	.00	.00	.00	.00	5
33	.00	.00	596185.25	.00	.00	.00	.00	.00	.00	.00	6
37	739831.37	576963.00	650252.50	643867.50	936181.62	1016325.37	.00	.00	.00	.00	7
45	.00	.00	774027.87	.00	.00	.00	.00	.00	.00	.00	8
51	1073091.25	849328.87	891837.75	853463.37	1209297.25	1246432.75	.00	.00	.00	.00	9
57	.00	1052974.50	1048212.50	977006.87	.00	.00	.00	.00	.00	.00	10
63	1481952.50	1577055.75	1591920.75	1569531.00	1468554.50	1427054.00	.00	.00	.00	.00	11
69	.00	1750036.75	1760351.75	1722983.50	.00	.00	.00	.00	.00	.00	12
75	1669546.25	1805532.50	1826110.50	1800497.00	1593330.25	1508294.50	.00	.00	.00	.00	13
82	.00	.00	1882032.75	.00	.00	.00	.00	.00	.00	.00	14
87	1876171.25	1942849.25	1943046.00	1917577.75	1775227.75	1645420.00	.00	.00	.00	.00	15
93	.00	.00	1982953.50	.00	.00	.00	.00	.00	.00	.00	16
97	1879644.25	1938741.00	1977725.50	1942351.75	1828053.25	1743143.25	.00	.00	.00	.00	17
106	.00	.00	1965916.50	.00	.00	.00	.00	.00	.00	.00	18
111	1695224.75	1786915.75	1867201.50	1810953.00	1729892.25	1604534.25	.00	.00	.00	.00	19
117	.00	.00	1721159.50	.00	.00	.00	.00	.00	.00	.00	20
123	1297198.00	1378229.00	1476711.25	1402628.25	1356965.25	1256362.00	.00	.00	.00	.00	21
129	.00	.00	1261393.50	.00	.00	.00	.00	.00	.00	.00	22
135	848867.37	892863.00	976947.62	920899.37	883862.87	820688.62	.00	.00	.00	.00	23
141	.00	.00	640330.25	.00	.00	.00	.00	.00	.00	.00	24

APPENDIX B

PLANAR DISPLAYS OF THE BUNDLES DEFINING THE La-140 INTENSITIES IN THE BENCHMARK OCTANT

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   !--------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 ! 155.4  154.3  150.2  138.5  123.9!
   ! .565   .561   .546   .504   .451 !
   !                              !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !          OCTANT BOUNDARY
50 ! 212.4  203.6  186.7  210.5  211.4  192.1!
   ! .773   .741   .679   .766   .769   .699 !
   !                                !--------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 ! 232.4  161.1  161.6  233.4  275.2  273.8  265.9  234.1  188.5!
   ! .845   .586   .588   .849  1.001   .996   .967   .852   .686 !
   !                                                        !------!
   !HX 49  HX278  HX181  HX376  HX172  HX314  HX180  HX543  HX491  HX514 !
46 ! 216.9  151.1  155.0  240.4  281.0  322.9  338.3  356.8  315.5  221.0!
   ! .789   .550   .564   .875  1.022  1.175  1.231  1.298  1.148   .804 !
   !      L                          L                          L       !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !
44 ! 165.6  221.0  239.8  179.8  214.0  330.2  396.1  411.8  404.0  310.9!
   ! .602   .804   .872   .654   .778  1.201  1.441  1.498  1.470  1.131 !
   !                                                  !--------------!
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !
42 ! 171.3  233.0  264.5  205.0  215.2  332.3  381.8  430.8!
   ! .623   .848   .962   .746   .783  1.209  1.389  1.567 !
   !                                                  !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !
40 ! 262.9  185.0  224.1  340.5  343.3  253.5  285.8  404.2!
   ! .956   .673   .815  1.239  1.249   .922  1.040  1.470 !
   !                                          !------!-------------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !       !HX  7  HX310 !
38 ! 288.6  214.0  279.2  430.6  416.4  289.0  264.6!       ! 375.2  374.8!
   !1.050   .779  1.016  1.567  1.515  1.051   .963 !       !1.365  1.363 !
   !      L                          L       !------!       !      L      !
   !HX393  HX141  HX388  HX165  HX438  HX 53 !              !HX256  HX190 !
36 ! 231.8  341.8  416.0  476.4  471.4  418.3!              ! 243.6  321.5!
   ! .843  1.243  1.513  1.733  1.715  1.493 !              ! .886  1.170 !
   !                        !-------------!                 !-------------!
   !HX 86  HX391  HX156  HX422 !
34 ! 273.7  391.3  442.5  511.6!
   ! .995  1.423  1.610  1.861 !
   !                        !
   !HX405  HX137  HX402  HX145 !
32 ! 417.7  289.0  331.2  444.9!
   !1.520  1.051  1.205  1.618 !
   !                    !------!-------------!              !-------------!
   !HX170  HX404  HX 76 !       !HX143  HX323 !              !HX126  HX425 !
30 ! 496.4  336.9  318.7!       ! 374.2  239.9!              ! 241.5  165.8!
   !1.806  1.226  1.159 !       !1.361   .873 !              ! .879   .603 !
   !      L       !------!      !      L      !              !      L      !
   !HX397  HX104 !              !HX387  HX 29 !              !HX304  HX 35 !
28 ! 564.8  487.2!              ! 248.4  299.2!              ! 173.0  227.6!
   !2.055  1.772 !              ! .903  1.088 !              ! .629   .828 !
   C-------------!-------------!-------------!-------------!-------------!--------------------!
      27      29      31      33      35      37      39      41      43      45      47      49      51
```

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 3 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

```
!------!
!ABC123!
! 274.9!
!1.000 !
!------!
```

BUNDLE SERIAL #
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

```
   !--------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 ! 357.3  336.0  323.3  301.0  272.9!
   ! .634   .596   .574   .534   .484 !
   !                                  !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !
50 ! 473.1  428.1  394.2  419.6  417.5  376.1!
   ! .840   .760   .700   .745   .741   .668 !
   !                                         !--------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 ! 516.2  325.7  311.7  464.3  524.8  511.3  509.0  474.6  402.4!
   ! .916   .578   .553   .824   .931   .907   .903   .842   .714 !
   !                                                              !------!
   !HX 49  HX278  HX181  HX376  HX172  HX314  HX180  HX543  HX491  HX514 !
46 ! 477.7  313.9  320.7  472.3  550.6  613.2  665.4  680.7  597.4  468.8!
   ! .848   .557   .569   .838   .977  1.088  1.181  1.208  1.060   .832 !
   !      L                        L                        L       !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !
44 ! 353.1  461.1  474.2  364.8  413.7  664.0  766.3  802.4  773.9  605.2!
   ! .627   .818   .842   .647   .734  1.178  1.360  1.424  1.373  1.074 !
   !                                                 !-------------!
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !
42 ! 383.2  495.3  535.9  416.5  427.1  654.4  757.3  849.8!
   ! .680   .879   .951   .739   .758  1.161  1.344  1.508 !
   !                                                       !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !
40 ! 557.0  395.6  457.5  712.1  720.8  496.3  536.2  835.3!
   ! .989   .702   .812  1.264  1.279   .881   .952  1.482 !
   !                                          !------!-------------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !      !HX  7  HX310 !
38 ! 628.1  456.5  567.4  901.2  866.7  582.5  527.3!      ! 760.0  713.3!
   !1.115   .810  1.007  1.599  1.538  1.034   .936 !      !1.349  1.266 !
   !      L                        L      !------!      !      L      !
   !HX393  HX141  HX388  HX165  HX438  HX 53 !             !HX256  HX190 !
36 ! 492.4  740.1  868.7 1006.9  974.3  835.7!             ! 484.6  637.9!
   ! .874  1.314  1.542  1.787  1.729  1.483 !             ! .860  1.132 !
   !                           !-------------!             !-------------!
   !HX 86  HX391  HX156  HX422 !
34 ! 587.5  810.9  935.7 1040.2!
   !1.043  1.439  1.661  1.846 !
   !                           !
   !HX405  HX137  HX402  HX145 !
32 ! 912.0  605.0  675.7  986.6!
   !1.618  1.074  1.199  1.751 !
   !                   !------!-------------!             !-------------!
   !HX170  HX404  HX 76 !      !HX143  HX323 !             !HX126  HX425 !
30 !1045.2  687.0  638.4!      ! 798.0  494.8!             ! 534.4  346.4!
   !1.855  1.219  1.133 !      !1.416   .878 !             ! .948   .615 !
   !      L      !------!      !      L      !             !      L      !
   !HX397  HX104 !             !HX387  HX 29 !             !HX304  HX 35 !
28 !1169.9 1019.4!             ! 518.7  648.9!             ! 371.8  488.6!
   !2.076  1.809 !             ! .921  1.152 !             ! .660   .867 !
   C-------------!-------------!-------------!-------------!-------------!--------------------!
      27      29      31      33      35      37      39      41      43      45      47      49      51
```

OCTANT BOUNDARY

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 15 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

```
BUNDLE SERIAL #      !------!
                     !ABC123!
LA140 COUNTS/1000.   ! 563.5!
NORMALIZED LA140     !1.000 !
                     !------!
```

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

```
   !--------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 ! 461.9  444.6  409.9  388.5  350.1!
   ! .674   .649   .598   .567   .511 !
   !                              !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !
50 ! 605.1  547.3  510.5  533.3  519.5  467.6!
   ! .883   .799   .745   .778   .758   .682 !
   !                                !--------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 ! 660.3  418.0  406.5  585.0  640.2  636.0  618.8  576.1  487.7!
   ! .963   .610   .593   .854   .934   .928   .903   .841   .712 !
   !                                                        !------!
   !HX 49  HX278  HX181  HX376  HX172  HX314  HX180  HX543  HX491  HX514 !
46 ! 616.1  403.2  399.2  590.6  667.8  757.9  803.6  804.8  705.1  546.9!
   ! .899   .588   .582   .862   .974  1.106  1.173  1.174  1.029   .798 !
   !      L                          L                          L      !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !
44 ! 462.2  588.9  600.7  459.6  501.5  807.9  913.6  954.0  877.5  714.5!
   ! .674   .859   .877   .671   .732  1.179  1.333  1.392  1.280  1.043 !
   !                                                  !-------------!
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !
42 ! 492.3  640.6  679.5  521.5  523.8  810.1  889.3  976.5!
   ! .718   .935   .992   .761   .764  1.182  1.298  1.425 !
   !                                                  !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !
40 ! 716.5  499.0  557.8  856.7  867.0  589.3  624.7  924.7!
   !1.046   .728   .814  1.250  1.265   .860   .912  1.349 !
   !                                        !------!-------------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !      !HX  7  HX310 !
38 ! 779.9  565.1  675.3 1068.2 1023.5  706.2  606.3!      ! 846.5  828.8!
   !1.138   .825   .985  1.559  1.493  1.030   .885 !      !1.235  1.209 !
   !      L                          L      !------!      !      L      !
   !HX393  HX141  HX388  HX165  HX438  HX 53 !             !HX256  HX190 !
36 ! 603.5  891.1 1037.8 1168.6 1125.0  992.3!             ! 559.6  760.1!
   ! .881  1.300  1.514  1.705  1.642  1.448 !             ! .816  1.109 !
   !                             !-------------!             !-------------!
   !HX 86  HX391  HX156  HX422 !
34 ! 712.4  971.9 1096.2 1201.4!
   !1.039  1.418  1.600  1.753 !
   !                           !
   !HX405  HX137  HX402  HX145 !
32 !1062.2  710.1  780.7 1150.2!
   !1.550  1.036  1.139  1.678 !
   !                    !------!-------------!             !-------------!
   !HX170  HX404  HX 76 !      !HX143  HX323 !             !HX126  HX425 !
30 !1186.9  789.5  747.6!      ! 947.5  594.2!             ! 681.7  444.6!
   !1.732  1.152  1.091 !      !1.383   .867 !             ! .995   .649 !
   !      L      !------!      !      L      !             !      L      !
   !HX397  HX104 !             !HX387  HX 29 !             !HX304  HX 35 !
28 !1318.4 1174.6!             ! 627.2  766.1!             ! 477.1  635.9!
   !1.924  1.714 !             ! .915  1.118 !             ! .696   .928 !
   C-------------!-------------!-------------!-------------!-------------!--------------------!
      27      29      31      33      35      37      39      41      43      45      47      49      51
```

OCTANT BOUNDARY

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 27 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

```
!------!
!ABC123!
! 685.3!
!1.000 !
!------!
```

BUNDLE SERIAL #
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

```
   !--------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 ! 560.0  544.6  508.7  486.4  438.4!
   ! .693   .674   .630   .602   .543 !
   !                                  !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !
50 ! 748.7  687.4  642.3  667.0  646.3  574.8!
   ! .927   .851   .795   .826   .800   .711 !
   !                                  !--------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 ! 809.3  527.1  512.6  727.5  789.9  780.2  720.9  660.8  548.5!
   !1.002   .652   .634   .900   .978   .966   .892   .818   .679 !
   !                                                             !------!
   !HX 49  HX278  HX181  HX376  HX172  HX314  HX180  HX543  HX491  HX514 !
46 ! 768.8  526.2  517.2  739.8  816.3  899.7  940.6  919.6  781.8  597.0!
   ! .952   .651   .640   .916  1.010  1.113  1.164  1.138   .968   .739 !
   !      L                          L                       L      !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !
44 ! 594.5  776.6  767.5  577.0  635.0  959.4 1055.6 1054.3  965.9  781.4!
   ! .736   .961   .950   .714   .786  1.187  1.306  1.305  1.195   .967 !
   !                                                   !-------------!
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !
42 ! 623.2  811.8  851.9  650.3  643.9  936.2 1016.3 1065.9!
   ! .771  1.005  1.054   .805   .797  1.159  1.258  1.319 !
   !                                                       !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !
40 ! 875.8  624.0  679.2 1001.7 1000.8  695.9  711.6 1023.3!
   !1.084   .772   .841  1.240  1.239   .861   .881  1.266 !
   !                                          !------!-------------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !      !HX  7  HX310 !
38 ! 940.2  678.4  775.7 1172.5 1133.3  802.8  695.4!      ! 955.1  950.1!
   !1.164   .840   .960  1.451  1.403   .994   .861 !      !1.182  1.176 !
   !      L                          L      !------!      !      L      !
   !HX393  HX141  HX388  HX165  HX438  HX 53 !             !HX256  HX190 !
36 ! 742.1 1055.5 1160.2 1249.2 1222.5 1091.2!             ! 663.5  906.9!
   ! .918  1.306  1.436  1.546  1.513  1.351 !             ! .821  1.122 !
   !                          !-------------!             !-------------!
   !HX 86  HX391  HX156  HX422 !
34 ! 850.3 1122.8 1208.4 1283.8!
   !1.052  1.390  1.496  1.589 !
   !                          !
   !HX405  HX137  HX402  HX145 !
32 !1188.5  812.4  873.2 1259.4!
   !1.471  1.006  1.081  1.559 !
   !                   !------!-------------!             !-------------!
   !HX170  HX404  HX 76 !      !HX143  HX323 !             !HX126  HX425 !
30 !1269.2  872.3  860.7!      !1123.1  724.3!             ! 835.5  557.8!
   !1.571  1.080  1.065 !      !1.390   .896 !             !1.034   .690 !
   !      L      !------!      !      L      !             !      L      !
   !HX397  HX104 !             !HX307  HX 29 !             !HX304  HX 35 !
28 !1361.8 1245.1!             ! 835.2  986.5!             ! 619.9  019.7!
   !1.685  1.541 !             !1.034  1.221 !             ! .767  1.014 !
   C-------------!-------------!-------------!-------------!-------------!-------------!
      27      29      31      33      35      37      39      41      43      45      47      49      51
```

OCTANT BOUNDARY

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 37 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

```
!------!
!ABC123!
! 808.0!
!1.000 !
!------!
```

BUNDLE SERIAL #
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

```
   !-----------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 ! 745.6  730.0  714.5  680.2  612.5!
   ! .693   .678   .664   .632   .569 !
   !                                  !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !
50 !1005.6  948.5  905.6  945.0  891.3  775.3!
   ! .934   .881   .841   .878   .828   .720 !
   !                                          !--------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 !1094.7  757.1  754.8 1066.7 1107.6 1064.9  923.7  830.9  688.1!
   !1.017   .703   .701   .991  1.029   .989   .858   .772   .639 !
   !                                                             !------!
   !HX 49  HX278  HX181  HX376  HX172  HX314  HX180  HX543  HX491  HX514 !
46 !1150.3  807.0  789.1 1073.1 1143.4 1196.6 1182.7 1115.4  952.6  709.5!
   !1.069   .750   .733   .997  1.062  1.112  1.039  1.036   .885   .659 !
   !      L                           L                           L      !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !
44 !1306.3 1227.5 1159.6  849.3  864.5 1262.2 1295.0 1230.0 1145.7  935.4!
   !1.213  1.140  1.077   .789   .803  1.172  1.203  1.143  1.064   .869 !
   !                                                   !-------------!
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !
42 !1347.6 1242.6 1203.8  891.8  853.5 1209.3 1246.4 1238.3!
   !1.252  1.154  1.118   .828   .793  1.123  1.158  1.150 !
   !                                                       !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !
40 !1293.3  918.5  919.8 1238.9 1207.2  883.6  888.0 1207.8!
   !1.201   .853   .854  1.151  1.121   .821   .825  1.122 !
   !                                                       !------!-------------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !      !HX  7  HX310 !
38 !1323.8  918.8  962.5 1328.7 1290.3  979.7  889.4!      !1172.7 1186.3!
   !1.230   .853   .894  1.234  1.199   .910   .826 !      !1.089  1.102 !
   !      L                           L      !------!      !      L      !
   !HX393  HX141  HX388  HX165  HX438  HX 53 !             !HX256  HX190 !
36 !1414.6 1392.5 1358.7 1387.1 1366.9 1299.8!             ! 870.4 1186.4!
   !1.314  1.293  1.262  1.288  1.270  1.207 !             ! .809  1.102 !
   !                             !-------------!             !-------------!
   !HX 86  HX391  HX156  HX422 !
34 !1451.7 1405.6 1410.3 1413.1!
   !1.348  1.306  1.310  1.313 !
   !                           !
   !HX405  HX137  HX402  HX145 !
32 !1436.8 1002.4 1017.4 1399.0!
   !1.335   .931   .945  1.300 !
   !                    !------!-------------!             !-------------!
   !HX170  HX404  HX 76 !      !HX143  HX323 !             !HX126  HX425 !
30 !1384.9  985.4 1012.3!      !1398.6  963.0!             !1276.5  850.8!
   !1.286   .915   .940 !      !1.299   .895 !             !1.186   .790 !
   !      L      !------!      !      L      !             !      L      !
   !HX397  HX104 !             !HX387  HX 29 !             !HX304  HX 35 !
28 !1427.1 1373.2!             !1448.4 1390.5!             !1369.4 1296.8!
   !1.326  1.276 !             !1.345  1.292 !             !1.272  1.205 !
   C-------------!-------------!-------------!-------------!-------------!-------------!
      27      29      31      33      35      37      39      41      43      45      47      49      51
```

OCTANT BOUNDARY

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 51 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

```
!------!
!ABC123!
!1076.5!
!1.000 !
!------!
```

BUNDLE SERIAL #
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

```
   !-----------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 ! 910.6  895.5  886.7  828.9  771.6!
   ! .703   .691   .685   .640   .596 !
   !                                   !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !          OCTANT BOUNDARY
50 !1211.7 1189.8 1153.3 1187.1 1129.3  924.3!
   ! .936   .919   .891   .917   .872   .714 !
   !                                         !--------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 !1348.8  965.1  990.3 1340.4 1386.3 1277.8 1080.4  934.6  782.6!
   !1.042   .745   .765  1.035  1.070   .987   .834   .722   .604 !
   !                                                             !------!
   !HX 49  HX278  HX181  HX376  HX172  HX314  HX180  HX543  HX491  HX514 !
46 !1429.3 1055.5 1065.9 1482.0 1493.4 1441.6 1350.1 1264.5 1080.3  791.0!
   !1.104   .815   .823  1.144  1.153  1.113  1.042   .976   .834   .611 !
   !      L                        L                        L      !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !      !
44 !1663.5 1566.9 1536.4 1577.1 1562.9 1547.3 1463.1 1378.9 1268.0 1069.0!      !
   !1.285  1.210  1.186  1.218  1.207  1.195  1.130  1.065   .979   .825 !      !
   !                                                   !-------------!      !
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !                    !
42 !1669.7 1559.4 1570.7 1591.9 1569.5 1468.6 1427.1 1403.4!                    !
   !1.289  1.204  1.213  1.229  1.212  1.134  1.102  1.084 !                    !
   !                                                       !                    !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !                    !
40 !1497.1 1113.3 1123.2 1474.6 1441.1 1067.8 1024.6 1382.0!                    !
   !1.156   .860   .867  1.139  1.113   .825   .791  1.067 !                    !
   !                                                 !------!-------------!      !------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !      !HX  7  HX310 !             !
38 !1469.1 1083.2 1062.5 1452.8 1400.0 1116.1 1070.8!      !1458.8 1420.1!             !
   !1.134   .836   .820  1.122  1.081   .862   .827 !      !1.126  1.097 !             !
   !      L                        L      !------!      !      L      !             !------!
   !HX393  HX141  HX388  HX165  HX438  HX 53 !             !HX256  HX190 !                    !
36 !1561.0 1517.7 1473.9 1469.9 1461.3 1445.1!             !1541.1 1467.1!                    !
   !1.205  1.172  1.138  1.135  1.128  1.116 !             !1.190  1.133 !                    !
   !                        !-------------!             !-------------!                    !
   !HX 86  HX391  HX156  HX422 !                                                             !
34 !1525.3 1497.9 1495.5 1474.5!                                                             !
   !1.178  1.157  1.155  1.139 !                                                             !
   !                        !                                                                !
   !HX405  HX137  HX402  HX145 !                                                             !
32 !1436.7 1076.9 1092.5 1405.7!                                                             !
   !1.109   .832   .844  1.085 !                                                             !
   !                !------!-------------!             !-------------!                    !
   !HX170  HX404  HX 76 !      !HX143  HX323 !             !HX126  HX425 !                    !
30 !1356.9 1040.1 1071.2!      !1442.7 1110.2!             !1552.8 1086.9!                    !
   !1.048   .803   .827 !      !1.114   .857 !             !1.199   .839 !                    !
   !      L      !------!      !      L      !             !      L      !                    !
   !!HX397  HX104 !             !HX387  HX 29 !             !HX304  HX 35 !                    !
28 !1422.8 1404.6!             !1555.9 1547.2!             !1711.0 1571.0!                    !
   !1.099  1.085 !             !1.201  1.195 !             !1.321  1.213 !                    !
   C-------------!-------------!-------------!-------------!-------------!--------------------!
      27      29      31      33      35      37      39      41      43      45      47      49      51
```

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 63 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

```
BUNDLE SERIAL #      !------!
                     !ABC123!
LA140 COUNTS/1000.   !1295.1!
NORMALIZED LA140     !1.000 !
                     !------!
```

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

```
   !--------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 !1037.1 1012.1  979.1  946.3  881.6!
   ! .737   .719   .696   .672   .626 !
   !                              !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !
50 !1374.7 1310.0 1300.0 1316.7 1244.6 1032.1!
   ! .977   .931   .924   .936   .884   .733 !
   !                                !-------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 !1529.5 1125.4 1128.9 1490.6 1503.8 1373.8 1167.5 1004.2  861.7!
   !1.087   .800   .802  1.059  1.069   .976   .830   .714   .612 !
   !                                                        !------!
   !HX 49  HX278  HX181  HX376  HX172  HX314  HX180  HX543  HX491  HX514 !
46 !1613.8 1190.0 1222.6 1669.5 1658.4 1552.9 1426.5 1309.9 1129.2  842.6!
   !1.147   .846   .869  1.186  1.178  1.103  1.014   .931   .802   .599 !
   !      L                        L                        L      !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !
44 !1788.8 1714.9 1724.7 1805.5 1779.1 1651.9 1525.6 1446.4 1337.4 1096.5!
   !1.271  1.218  1.225  1.283  1.264  1.174  1.084  1.028   .950   .779 !
   !                                                !-------------!
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !
42 !1793.1 1694.1 1736.4 1826.1 1800.5 1593.3 1508.3 1520.4!
   !1.274  1.204  1.234  1.298  1.279  1.132  1.072  1.080 !
   !                                                !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !
40 !1595.1 1186.1 1259.4 1647.1 1610.2 1180.4 1106.7 1489.5!
   !1.133   .843   .895  1.170  1.144   .839   .786  1.058 !
   !                                        !------!-------------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !      !HX  7  HX310 !
38 !1544.7 1119.5 1121.5 1566.3 1521.9 1204.1 1194.3!      !1632.8 1503.8!
   !1.098   .795   .797  1.113  1.081   .856   .849 !      !1.160  1.069 !
   !      L                        L      !------!      !      L      !
   !HX393  HX141  HX388  HX165  HX438  HX 53 !             !HX256  HX190 !
36 !1610.4 1588.7 1525.9 1566.5 1587.5 1596.5!             !1748.0 1595.3!
   !1.144  1.129  1.084  1.113  1.128  1.134 !             !1.242  1.134 !
   !                     !-------------!                   !-------------!
   !HX 86  HX391  HX156  HX422 !
34 !1598.7 1542.1 1568.1 1583.9!
   !1.136  1.096  1.114  1.125 !
   !                     !
   !HX405  HX137  HX402  HX145 !
32 !1472.5 1109.2 1143.4 1509.6!
   !1.046   .788   .812  1.073 !
   !                !------!-------------!             !-------------!
   !HX170  HX404  HX 76 !      !HX143  HX323 !             !HX126  HX425 !
30 !1381.8 1053.7 1104.2!      !1504.9 1151.1!             !1641.7 1168.2!
   ! .982   .749   .785 !      !1.069   .818 !             !1.166   .830 !
   !      L       !------!      !      L      !             !      L      !
   !HX397  HX104 !             !HX387  HX 29 !             !HX304  HX 35 !
28 !1456.5 1441.9!             !1594.8 1600.5!             !1767.8 1692.3!
   !1.035  1.025 !             !1.133  1.137 !             !1.256  1.202 !
   C-------------!-------------!-------------!-------------!-------------!-------------------!
      27      29      31      33      35      37      39      41      43      45      47      49      51
```

OCTANT BOUNDARY

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 75 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

```
BUNDLE SERIAL #      !------!
                     !ABC123!
LA140 COUNTS/1000.   !1407.4!
NORMALIZED LA140     !1.000 !
                     !------!
```

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

```
   !-----------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 !1172.3 1150.1 1119.5 1046.7  961.8!
   ! .749   .734   .715   .668   .614 !
   !                                 !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !
50 !1537.4 1534.0 1466.1 1422.9 1309.9 1092.3!
   ! .982   .980   .936   .909   .837   .698 !
   !                                         !-------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 !1789.7 1844.2 1764.7 1678.5 1575.3 1454.1 1229.4 1046.1  905.1!
   !1.143  1.178  1.127  1.072  1.006   .929   .785   .668   .578 !
   !                                                             !------!
   !HX 49  HX278  HX18!  HX376  HX172  HX314  HX180  HX543  HX491!  HX514 !
46 !1882.1 1904.5 1941.0 1876.2 1711.0 1593.5 1435.1 1334.1 1138.0  871.6!
   !1.202  1.216  1.240  1.198  1.093  1.018   .916   .852   .727   .557 !
   !      L                         L                         L      !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !
44 !1961.7 1964.0 1956.5 1942.8 1858.9 1699.3 1586.3 1481.1 1348.4 1130.2!
   !1.253  1.254  1.249  1.241  1.187  1.085  1.013   .946   .861   .722 !
   !                                                   !-------------!
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !
42 !1921.9 1848.6 1873.6 1943.0 1917.6 1775.2 1645.4 1605.7!
   !1.227  1.181  1.197  1.241  1.225  1.134  1.051  1.025 !
   !                                                      !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !
40 !1721.3 1279.0 1351.5 1802.1 1807.7 1584.5 1495.0 1670.1!
   !1.099   .817   .863  1.151  1.154  1.012   .955  1.067 !
   !                                          !------!-------------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !      !HX  7  HX310 !
38 !1671.2 1211.6 1229.0 1715.0 1736.0 1589.6 1564.1!      !1660.4 1513.6!
   !1.067   .774   .785  1.095  1.109  1.015   .999 !      !1.060   .967 !
   !      L                         L      !------!      !      L      !
   !HX393  HX141  HX388  HX165  HX438  HX 53 !             !HX256  HX190 !
36 !1702.8 1684.7 1651.2 1730.9 1732.7 1758.5!             !1790.3 1573.2!
   !1.087  1.076  1.054  1.105  1.107  1.123 !             !1.143  1.005 !
   !                           !-------------!             !-------------!
   !HX 86  HX391  HX156  HX422 !
34 !1688.2 1646.4 1668.1 1684.8!
   !1.078  1.051  1.065  1.076 !
   !                           !
   !HX405  HX137  HX402  HX145 !
32 !1603.6 1190.8 1217.3 1609.3!
   !1.024   .760   .777  1.028 !
   !                    !------!-------------!             !-------------!
   !HX170  HX404  HX 76 !      !HX143  HX323 !             !HX126  HX425 !
30 !1523.5 1130.9 1176.3!      !1613.5 1230.1!             !1807.2 1810.4!
   ! .973   .722   .751 !      !1.030   .786 !             !1.154  1.156 !
   !      L      !------!      !      L      !             !      L      !
   !HX397  HX104 !             !HX387  HX 29 !             !HX304  HX 35 !
28 !1564.7 1546.8!             !1666.0 1654.3!             !1866.7 1837.4!
   ! .999   .988 !             !1.064  1.056 !             !1.192  1.173 !
   C-------------!-------------!-------------!-------------!-------------!
      27      29      31      33      35      37      39      41      43      45      47      49      51
```

OCTANT BOUNDARY

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 87 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

```
BUNDLE SERIAL #      !------!
                     !ABC123!
LA140 COUNTS/1000.   !1565.9!
NORMALIZED LA140     !1.000 !
                     !------!
```

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

```
   !--------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 !1188.0 1159.8 1127.5 1033.7  971.1!
   ! .732   .715   .695   .637   .599 !
   !                                  !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !          OCTANT BOUNDARY
50 !1527.0 1521.8 1484.3 1440.2 1291.2 1108.6!
   ! .941   .938   .915   .888   .796   .683 !
   !                                         !--------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 !1795.1 1922.5 1832.7 1661.4 1560.9 1407.6 1210.6 1019.9  901.8!
   !1.107  1.185  1.130  1.024   .962   .868   .746   .629   .556 !
   !                                                             !------!
   !HX 49  HX278  HX181  HX376  HX172  HX314  HX180  HX543  HX491  HX514 !
46 !1895.7 2020.9 2063.5 1879.6 1706.8 1583.9 1418.2 1301.1 1107.8  863.9!
   !1.169  1.246  1.272  1.159  1.052   .977   .874   .802   .683   .533 !
   !      L                L                L                     !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !
44 !2009.6 1977.1 1965.6 1938.7 1849.8 1717.9 1576.5 1452.3 1311.1 1088.9!
   !1.239  1.219  1.212  1.195  1.140  1.059   .972   .895   .808   .671 !
   !                                                   !-------------!
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !
42 !1937.0 1869.6 1928.9 1977.7 1942.4 1828.1 1743.1 1607.0!
   !1.194  1.153  1.189  1.219  1.198  1.127  1.075   .991 !
   !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !
40 !1815.9 1423.4 1438.5 1905.3 1908.3 1982.5 1936.2 1736.9!
   !1.120   .878   .887  1.175  1.177  1.222  1.194  1.071 !
   !                                                !------!-------------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !      !HX  7  HX310 !
38 !1759.7 1340.9 1314.3 1829.0 1862.0 1993.5 1971.5!      !1685.2 1477.0!
   !1.085   .827   .810  1.128  1.148  1.229  1.215 !      !1.039   .911 !
   !      L                L       !------!            !      L      !
   !HX393  HX141  HX388  HX165  HX438  HX 53 !             !HX256  HX190 !
36 !1791.0 1784.8 1775.0 1804.6 1825.3 1878.1!             !1776.7 1560.2!
   !1.104  1.100  1.094  1.113  1.125  1.158 !             !1.095   .962 !
   !                           !-------------!             !-------------!
   !HX 86  HX391  HX156  HX422 !
34 !1806.1 1760.3 1794.9 1794.3!
   !1.114  1.085  1.107  1.106 !
   !                           !
   !HX405  HX137  HX402  HX145 !
32 !1730.3 1317.0 1401.7 1739.9!
   !1.067   .812   .864  1.073 !
   !                    !------!-------------!             !-------------!
   !HX170  HX404  HX 76 !      !HX143  HX323 !             !HX126  HX425 !
30 !1659.8 1331.2 1393.5!      !1709.3 1337.7!             !1844.9 1918.0!
   !1.023   .821   .859 !      !1.054   .825 !             !1.137  1.182 !
   !      L      !------!      !      L      !             !      L      !
   !HX397  HX104 !             !HX387  HX 29 !             !HX304  HX 35 !
28 !1691.0 1679.3!             !1749.1 1745.0!             !1854.1 1797.9!
   !1.043  1.035 !             !1.078  1.076 !             !1.143  1.108 !
   C-------------!-------------!-------------!-------------!-------------!
      27      29      31      33      35      37      39      41      43      45      47      49      51
```

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 97 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

BUNDLE SERIAL #	ABC123
LA140 COUNTS/1000.	1622.0
NORMALIZED LA140	1.000

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

```
   !--------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 !1151.9 1132.7 1130.5  975.4  925.7!
   ! .707   .695   .693   .598   .568 !
   !                                  !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !          OCTANT BOUNDARY
50 !1421.5 1439.7 1341.5 1297.0 1195.0 1046.3!
   ! .872   .883   .823   .796   .733   .642 !
   !                                          !-------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 !1717.7 1784.6 1751.9 1535.8 1442.8 1313.8 1153.5  978.3  846.4!
   !1.054  1.095  1.075   .942   .885   .806   .708   .600   .519 !
   !                                                             !------!
   !HX 49  HX278  HX181  HX376  HX172  HX314  HX180  HX543  HX491  HX514 !
46 !1772.5 1793.5 1814.8 1695.2 1569.7 1449.8 1297.5 1194.6 1017.9  797.6!
   !1.087  1.100  1.113  1.040   .963   .889   .796   .733   .624   .489 !
   !      L                       L                       L      !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !
44 !1830.3 1841.6 1921.5 1786.9 1695.5 1586.9 1484.9 1364.1 1275.0 1021.2!
   !1.123  1.130  1.179  1.096  1.040   .973   .911   .837   .782   .626 !
   !                                                   !-------------!
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !
42 !1942.4 1878.7 1960.1 1867.2 1811.0 1729.9 1604.5 1481.2!
   !1.191  1.152  1.202  1.145  1.111  1.061   .984   .909 !
   !                                                       !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !
40 !1844.0 1943.0 2036.3 1949.7 1881.1 1951.0 1904.8 1611.1!
   !1.131  1.192  1.249  1.196  1.154  1.197  1.168   .988 !
   !                                          !------!-------------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !      !HX  7  HX310 !
38 !1853.5 1995.1 2038.2 1929.1 1827.4 1917.8 1974.4!      !1546.1 1404.0!
   !1.137  1.224  1.250  1.183  1.121  1.176  1.211 !      ! .948   .861 !
   !      L                       L      !------!      !      L      !
   !HX393  HX141  HX388  HX165  HX438  HX 53 !             !HX256  HX190 !
36 !1855.5 1906.5 1906.9 1855.8 1838.7 1854.0!             !1666.9 1465.4!
   !1.138  1.169  1.170  1.138  1.128  1.137 !             !1.022   .899 !
   !                     !-------------!                   !-------------!
   !HX 86  HX391  HX156  HX422 !
34 !1855.2 1884.2 1899.1 1927.3!
   !1.138  1.156  1.165  1.182 !
   !                     !
   !HX405  HX137  HX402  HX145 !
32 !1904.3 1996.3 2001.9 1819.3!
   !1.168  1.225  1.228  1.116 !
   !                     !------!-------------!             !-------------!
   !HX170  HX404  HX 76 !      !HX143  HX323 !             !HX126  HX425 !
30 !1825.2 2039.4 2052.8!      !1801.5 1955.9!             !1746.3 1757.9!
   !1.120  1.251  1.259 !      !1.105  1.200 !             !1.071  1.078 !
   !      L      !------!      !      L      !             !      L      !
   !HX397  HX104 !             !HX387  HX 29 !             !HX304  HX 35 !
28 !1792.5 1791.9!             !1808.7 1825.9!             !1751.5 1679.2!
   !1.100  1.099 !             !1.109  1.120 !             !1.074  1.030 !
   C-------------!-------------!-------------!-------------!-------------!-------------------!
      27      29      31      33      35      37      39      41      43      45      47      49      51
```

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 111 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

```
   !------!
   !ABC123!
   !1630.3!
   !1.000 !
   !------!
```

BUNDLE SERIAL #
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

```
   !-------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 ! 858.4  827.7  812.6  754.4  722.9!
   ! .680   .656   .644   .598   .573 !
   !                              !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !          OCTANT BOUNDARY
50 !1040.2 1036.2  993.0  994.3  901.4  831.9!
   ! .824   .821   .787   .788   .714   .659 !
   !                            !-------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 !1259.6 1282.7 1252.0 1157.5 1089.5 1011.5  915.1  768.2  672.3!
   ! .998  1.016   .992   .917   .863   .801   .725   .609   .533 !
   !                                                     !------!
   !HX 49  HX278  HX181  HX376  HX172  HX314  HX180  HX543  HX491  HX514 !
46 !1313.7 1399.4 1390.8 1297.2 1197.7 1123.4 1010.0  933.3  793.4  640.9!
   !1.041  1.109  1.102  1.028   .949   .890   .800   .739   .629   .508 !
   !      L                       L                       L      !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !      !
44 !1407.4 1392.6 1390.2 1378.2 1324.5 1231.4 1146.3 1045.8  936.2  781.8!      !
   !1.115  1.103  1.102  1.092  1.049   .976   .908   .829   .742   .619 !      !
   !                                          !-------------!                   !
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !                    !
42 !1475.6 1436.3 1452.4 1476.7 1402.6 1357.0 1256.4 1177.1!                    !
   !1.169  1.138  1.151  1.170  1.111  1.075   .995   .933 !                    !
   !                                                      !                    !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !                    !
40 !1530.6 1563.2 1585.6 1527.2 1466.1 1427.6 1412.3 1268.1!                    !
   !1.213  1.239  1.256  1.210  1.162  1.131  1.119  1.005 !                    !
   !                                          !------!-------------!      !------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !      !HX  7  HX310 !
38 !1509.2 1625.6 1591.0 1527.5 1449.1 1490.1 1447.1!      !1205.5 1075.7!
   !1.196  1.288  1.261  1.210  1.148  1.181  1.147 !      ! .955   .852 !
   !      L                       L      !------!      !      L      !
   !HX393  HX141  HX388  HX165  HX438  HX 53 !             !HX256  HX190 !
36 !1494.9 1513.3 1492.6 1465.7 1456.5 1434.3!             !1300.7 1144.5!
   !1.184  1.199  1.183  1.161  1.154  1.136 !             !1.031   .907 !
   !                     !-------------!                   !-------------!
   !HX 86  HX391  HX156  HX422 !
34 !1498.5 1512.3 1532.6 1482.7!
   !1.187  1.198  1.214  1.175 !
   !                     !
   !HX405  HX137  HX402  HX145 !
32 !1535.2 1570.6 1579.6 1512.5!
   !1.216  1.244  1.252  1.198 !
   !                    !------!-------------!             !-------------!
   !HX170  HX404  HX 76 !      !HX143  HX323 !             !HX126  HX425 !
30 !1485.5 1604.7 1592.3!      !1474.9 1575.9!             !1379.6 1376.6!
   !1.177  1.271  1.262 !      !1.169  1.249 !             !1.093  1.091 !
   !      L      !------!      !      L      !             !      L      !
   !HX397  HX104 !             !HX387  HX 29 !             !HX304  HX 35 !
28 !1478.2 1485.6!             !1465.7 1467.3!             !1378.2 1313.3!
   !1.171  1.177 !             !1.161  1.163 !             !1.092  1.041 !
   C-------------!-------------!-------------!-------------!-------------!-------------!
      27      29      31      33      35      37      39      41      43      45      47      49      51
```

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 123 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

BUNDLE SERIAL #	ABC123
LA140 COUNTS/1000.	1262.1
NORMALIZED LA140	1.000

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

```
   !--------------------------------!
   !HX486  HX467  HX482  HX512  HX476 !
52 ! 519.6  507.9  482.8  454.8  438.1!
   ! .635   .621   .590   .556   .535 !
   !                                  !------!
   !HX178  HX306  HX176  HX453  HX459  HX487 !          OCTANT BOUNDARY
50 ! 640.2  641.3  619.2  607.3  547.3  516.6!
   ! .782   .784   .757   .742   .669   .631 !
   !                                         !--------------------!
   !HX251  HX222  HX292  HX 74  HX375  HX545  HX477  HX460  HX446 !
48 ! 788.7  806.7  777.5  719.6  698.7  626.7  574.4  480.1  415.4!
   ! .964   .986   .950   .879   .854   .766   .702   .587   .508 !
   !                                                              !------!
   !HX 49  HX278  HX181  HX376  HX172  HX314  HX180  HX543  HX491  HX514 !
46 ! 849.0  914.6  885.1  848.9  762.7  712.4  638.7  576.1  498.1  400.4!
   !1.038  1.118  1.082  1.037   .932   .871   .781   .704   .609   .489 !
   !      L                      L                                L      !------!
   !HX321  HX109  HX277  HX149  HX274  HX 89  HX298  HX135  HX341  HX507 !      !
44 ! 931.3  924.3  894.6  892.9  872.0  803.0  741.7  666.7  599.0  503.1!      !
   !1.138  1.130  1.093  1.091  1.066   .981   .906   .815   .732   .615 !      !
   !                                                 !-------------!      !
   !HX 23  HX257  HX138  HX279  HX179  HX361  HX194  HX339 !              !
42 ! 954.3  960.4  922.6  976.9  920.9  883.9  820.7  757.0!              !
   !1.166  1.174  1.128  1.194  1.126  1.080  1.003   .925 !              !
   !                                                 !                    !
   !HX233  HX213  HX359  HX218  HX330  HX 66  HX332  HX 30 !              !
40 !1026.7 1032.1 1044.0  992.1  963.6  921.0  906.7  820.0!              !
   !1.255  1.261  1.276  1.213  1.178  1.126  1.108  1.002 !              !
   !                                           !------!-------------!      !------!
   !HX169  HX373  HX220  HX420  HX211  HX333  HX197 !      !HX  7  HX310 !
38 !1024.0 1070.9 1034.4 1008.9  951.5  992.0  919.4!      ! 800.2  698.8!
   !1.252  1.309  1.264  1.233  1.163  1.212  1.124 !      ! .978   .854 !
   !      L                        L      !------!      !      L      !
   !HX393  HX141  HX388  HX165  HX438  HX 53 !             !HX256  HX190 !
36 !1023.7 1011.6 1009.8  962.8  967.7  942.3!             ! 862.7  752.9!
   !1.251  1.236  1.234  1.177  1.183  1.152 !             !1.054   .920 !
   !                        !-------------!             !-------------!
   !HX 86  HX391  HX156  HX422 !
34 !1008.8 1020.0 1012.4  973.3!
   !1.233  1.247  1.237  1.189 !
   !                          !
   !HX405  HX137  HX402  HX145 !
32 !1026.8 1038.8 1048.6 1005.5!
   !1.255  1.270  1.282  1.229 !
   !                    !------!-------------!             !-------------!
   !HX170  HX404  HX 76 !      !HX143  HX323 !             !HX126  HX425 !
30 !1004.6 1081.0 1082.1!      !1004.0 1079.3!             ! 895.7  925.6!
   !1.228  1.321  1.322 !      !1.227  1.319 !             !1.095  1.131 !
   !      L      !------!      !      L      !             !      L      !
   !HX397  HX104 !             !HX387  HX 29 !             !HX304  HX 35 !
28 !1017.8 1005.2!             !1027.9 1009.4!             ! 928.8  866.3!
   !1.244  1.228 !             !1.256  1.234 !             !1.135  1.059 !
   C-------------!-------------!-------------!-------------!-------------!--------------------!
     27      29      31      33      35      37      39      41      43      45      47      49      51
```

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL 1977

PLANAR LA140 DISTRIBUTION AT 135 INCHES
ABOVE BOTTOM OF ACTIVE FUEL

LEGEND: C=CENTER OF CORE
L=LPRM LOCATION

BUNDLE SERIAL #	ABC123
LA140 COUNTS/1000.	818.2
NORMALIZED LA140	1.000

NORMALIZATION: AVERAGE OF OCTANT
AT THIS ELEVATION SET EQUAL TO ONE

APPENDIX C

PLANAR DISPLAYS OF EIGHT BUNDLES SYMMETRIC ACROSS THE TIP LINE OF SYMMETRY

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 3 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 27 234.2 1.113	HX 413 156.8 .745
HX 378 179.1 .851		HX 243 171.2 .814
HX 111 230.6 1.096		HX 191 265.6 1.263
	HX 48 253.2 1.203	HX 352 192.4 .915

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 15 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 27 463.8 1.097	HX 413 302.8 .716
HX 378 345.9 .818		HX 243 348.0 .823
HX 111 458.7 1.085		HX 191 532.3 1.259
	HX 48 532.5 1.259	HX 352 399.2 .944

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 27 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 27 581.4 1.094	
	HX 413 393.1 .740	
HX 378 443.1 .834		HX 243 439.7 .827
HX 111 590.2 1.111		HX 191 654.6 1.232
	HX 48 662.4 1.247	
	HX 352 486.8 .916	

LEGEND:

BUNDLE SERIAL NUMBER

LA140 COUNTS/1000.

NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 37 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 27 748.0 1.112	HX 413 514.7 .765
HX 378 569.1 .846		HX 243 557.0 .828
HX 111 758.5 1.128		HX 191 811.3 1.206
	HX 48 812.1 1.208	HX 352 609.6 .906

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 51 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 27 1090.8 1.114	HX 413 782.2 .799
HX 378 845.8 .864		HX 243 791.1 .808
HX 111 1157.7 1.182		HX 191 1140.4 1.164
	HX 48 1157.8 1.182	HX 352 869.9 .888

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/100A.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 63 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 27 1489.8 1.051	HX 413 1091.7 .770
HX 378 1629.3 1.149		HX 243 1034.7 .730
HX 111 1567.5 1.106		HX 191 1463.6 1.033
	HX 48 1513.1 1.067	HX 352 1550.0 1.094

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 75 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 27 1672.1 1.056	HX 413 1239.7 .783
HX 378 1884.8 1.190		HX 243 1153.5 .729
HX 111 1753.4 1.107		HX 191 1601.7 1.012
	HX 48 1616.2 1.021	HX 352 1745.0 1.102

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 87 INCHES ABOVE BOTTOM OF ACTIVE FUEL

HX 27	1865.4
	1.000

HX 413	1957.3
	1.050

HX 378	1980.2
	1.062

HX 243	1799.3
	.965

HX 111	1975.9
	1.060

HX 191	1702.9
	.913

HX 48	1784.2
	.957

HX 352	1852.2
	.993

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 97 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 27 1873.3 .989	HX 413 2073.7 1.095
HX 378 1984.1 1.047		HX 243 1892.7 .999
HX 111 1977.2 1.044		HX 191 1718.2 .907
	HX 48 1794.2 .947	HX 352 1841.1 .972

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 111 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 27 1670.2 .957	HX 413 1834.5 1.052
HX 378 1814.4 1.040		HX 243 1745.7 1.001
HX 111 1811.4 1.038		HX 191 1618.1 .928
	HX 48 1734.4 .994	HX 352 1726.8 .990

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 123 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 27 1283.4 .939	
HX 378 1408.0 1.030		HX 413 1393.1 1.019
		HX 243 1389.5 1.017
HX 111 1398.0 1.023		HX 191 1269.3 .929
	HX 48 1394.2 1.020	HX 352 1398.9 1.023

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 135 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 27 835.1 .933	HX 413 911.9 1.019
HX 378 932.2 1.042		HX 243 916.8 1.025
HX 111 897.4 1.003		HX 191 828.9 .926
	HX 48 911.1 1.018	HX 352 924.5 1.033

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

APPENDIX D

PLANAR DISPLAYS OF EIGHT BUNDLES ROTATIONALLY SYMMETRIC ABOUT CORE CENTER

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 3 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 169 288.6 1.067	HX 373 214.0 .791
HX 393 231.8 .857		HX 141 341.8 1.263
HX 121 346.9 1.282		HX 235 234.8 .868
	HX 242 221.1 .817	HX 216 285.6 1.056

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 15 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 169 628.1 1.092	HX 373 456.5 .793
HX 393 492.4 .856		HX 141 740.1 1.286
HX 121 713.4 1.240		HX 235 492.1 .855
	HX 242 456.8 .794	HX 216 624.0 1.084

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A
PLANE 27 INCHES ABOVE
BOTTOM OF ACTIVE FUEL

HX 169	
779.9	
1.102	

HX 373	
565.1	
.799	

HX 393	
603.5	
.853	

HX 141	
891.1	
1.259	

HX 121	
868.5	
1.227	

HX 235	
607.3	
.858	

HX 242	
556.0	
.786	

HX 216	
789.3	
1.115	

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE
OF 8 BUNDLES AT
THIS ELEVATION SET
EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 37 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 169 940.2 1.091	HX 373 678.4 .787
HX 393 742.1 .861		HX 141 1055.5 1.224
HX 121 1044.7 1.212		HX 235 769.9 .893
	HX 242 690.5 .801	HX 216 975.1 1.131

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 51 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 169 1323.8 1.043	HX 373 918.8 .724
HX 393 1414.6 1.115		HX 141 1392.5 1.098
HX 121 1380.7 1.088		HX 235 1445.3 1.139
	HX 242 930.4 .733	HX 216 1343.6 1.059

LEGEND:

BUNDLE SERIAL NUMBER

LA140 COUNTS/1000.

NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 63 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 169 1469.1 1.047	HX 373 1083.2 .772
HX 393 1561.0 1.113		HX 141 1517.7 1.082
HX 121 1487.1 1.060		HX 235 1575.8 1.123
	HX 242 1068.5 .762	HX 216 1459.5 1.040

LEGEND:

BUNDLE SERIAL NUMBER

LA140 COUNTS/1000.

NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 75 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 169 1544.7 1.056	HX 373 1119.5 .766
HX 393 1610.4 1.101		HX 141 1588.7 1.087
HX 121 1551.8 1.061		HX 235 1627.5 1.113
	HX 242 1090.4 .751	HX 216 1556.8 1.065

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 87 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 169 1671.2 1.068	HX 373 1211.6 .774
HX 393 1702.8 1.088		HX 141 1684.7 1.076
HX 121 1666.7 1.065		HX 235 1745.5 1.115
	HX 242 1185.1 .757	HX 216 1653.5 1.056

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 97 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 169 1759.7 1.058	HX 373 1340.9 .806
HX 393 1791.0 1.077		HX 141 1784.8 1.073
HX 121 1766.6 1.062		HX 235 1817.1 1.092
	HX 242 1273.0 .765	HX 216 1773.1 1.066

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 111 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 169 1853.5 .971	HX 373 1995.1 1.045
HX 393 1855.5 .972		HX 141 1906.5 .998
HX 121 1898.1 .994		HX 235 1906.6 .998
	HX 242 1970.4 1.032	HX 216 1890.3 .990

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 123 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 169 1509.2 .981	HX 373 1625.6 1.056
HX 393 1494.9 .971		HX 141 1513.3 .983
HX 121 1516.7 .985		HX 235 1541.3 1.001
	HX 242 1582.7 1.028	HX 216 1528.4 .993

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

HATCH 1 EOC1
BENCHMARK GAMMA SCAN
APRIL 1977

LA140 INTENSITY ON A PLANE 135 INCHES ABOVE BOTTOM OF ACTIVE FUEL

	HX 169 1024.0 .991	HX 373 1070.9 1.036
HX 393 1023.7 .990		HX 141 1011.6 .979
HX 121 1003.3 .971		HX 235 1040.5 1.007
	HX 242 1067.7 1.033	HX 216 1026.6 .993

LEGEND:

BUNDLE SERIAL NUMBER
LA140 COUNTS/1000.
NORMALIZED LA140

NORMALIZATION: AVERAGE OF 8 BUNDLES AT THIS ELEVATION SET EQUAL TO ONE

APPENDIX E

ROD-TO-ROD PLANAR DISPLAYS BY BUNDLES

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 141
ROD BY ROD PLANAR LA140 DISTRIBUTION
15 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

WIDE WIDE GAP	A	B	C	D	E	F	G
1	592297. 1.176	524148. 1.041	X X X X X X X X	511133. 1.015	X X X X X X X X	542414. 1.077	503798. 1.000
2	518919. 1.030	543766. 1.080	499536. .992	569140. 1.130	553061. 1.098	544799. 1.082	471871. .937
3	X X X X X X X X X	503228. .999	575785. 1.143	531102. 1.055	500007. .993	506081. 1.005	X X X X X X X X X
4	526171. 1.045	573952. 1.140	506547. 1.006	X X X X X X X X X	459553. .913	473832. .941	509157. 1.011
5	X X X X X X X X X	548891. 1.090	478088. .949	466674. .927	460165. .914	469101. .932	X X X X X X X X X
6	522954. 1.038	544591. 1.081	513006. 1.019	468725. .931	450300. .894	473698. .941	416652. .827
7	478911. .951	450728. .895	X X X X X X X X X	501932. .997	X X X X X X X X X	411014. .816	447020. .888

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 141
ROD BY ROD PLANAR LA140 DISTRIBUTION
21 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP 1	627332. 1.129	577350. 1.039	X X X X X X X X	598851. 1.078	X X X X X X X X	577703. 1.040	544374. .980
2	576704. 1.038	610632. 1.099	556696. 1.002	641104. 1.154	624411. 1.124	619252. 1.114	497582. .895
3	X X X X X X X X X	557840. 1.004	617013. 1.110	570152. 1.026	545680. .982	572909. 1.031	X X X X X X X X X
4	587215. 1.057	639483. 1.151	583733. 1.051	X X X X X X X X X	511852. .921	536476. .965	551293. .992
5	X X X X X X X X X	605874. 1.090	543620. .978	517684. .932	512404. .922	511333. .920	X X X X X X X X X
6	573861. 1.033	521781. .939	562845. 1.013	538180. .969	521540. .939	530096. .954	465267. .837
7	529461. .953	483234. .870	X X X X X X X X X	541536. .975	X X X X X X X X X	454119. .817	488050. .878

HATCH 1 EOCI BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 141
ROD BY ROD PLANAR LA140 DISTRIBUTION
51 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE GAP			X X		X X		
1	1042244.	964927.	X X	1003340.	X X	1111122.	1060600.
			X		X		
	1.100	1.018	X X	1.059	X X	1.173	1.119
			X X		X X		
2	943715.	968561.	912502.	1052525.	1053411.	1106163.	1001893.
	.996	1.022	.963	1.111	1.112	1.167	1.057
3	X X	891288.	993893.	953456.	944078.	982660.	X X
	X X						X X
	X						X
	X X	.941	1.049	1.006	.996	1.037	X X
	X X						X X
4	931491.	1004789.	904733.	X X	903670.	936237.	1031750.
				X X			
				X			
	.983	1.060	.955	X X	.954	.988	1.089
				X X			
5	X X	945541.	873157.	857369.	894987.	917188.	X X
	X X						X X
	X						X
	X X	.998	.921	.905	.945	.968	X X
	X X						X X
6	944069.	960565.	908538.	883373.	895357.	926855.	856392.
	.996	1.014	.959	.932	.945	.978	.904
7	871799.	820123.	X X	920414.	X X	828168.	899464.
			X X		X X		
			X		X		
	.920	.866	X X	.971	X X	.874	.949
			X X		X X		

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 141
ROD BY ROD PLANAR LA140 DISTRIBUTION
57 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE GAP							
1	1070482. 1.103	978219. 1.008	X X X X X X X X	1064461. 1.097	X X X X X X X X	1114815. 1.149	1099863. 1.134
2	966799. .996	977315. 1.007	920919. .949	1092536. 1.126	1060661. 1.093	1128816. 1.163	1015689. 1.047
3	X X X X X X X X X	890236. .918	1044451. 1.077	980435. 1.011	950100. .979	1015765. 1.047	X X X X X X X X X
4	971896. 1.002	1025206. 1.057	937331. .966	X X X X X X X X X	893857. .921	966687. .996	1066658. 1.099
5	X X X X X X X X X	993699. 1.024	912324. .940	870368. .897	902985. .931	933858. .963	X X X X X X X X X
6	946319. .975	988395. 1.019	938401. .967	889167. .916	907156. .935	937759. .967	882044. .909
7	900863. .929	833694. .859	X X X X X X X X X X	961948. .991	X X X X X X X X X X	841714. .868	934612. .963

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL. 1977

BUNDLE SERIAL NUMBER HX 141
ROD BY ROD PLANAR LA140 DISTRIBUTION
63 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP 1	1164851. 1.157	1024285. 1.018	X X X X X X X X	1085818. 1.079	X X X X X X X X	1177781. 1.170	1148282. 1.141
2	1007552. 1.001	1056688. 1.050	970924. .965	1136820. 1.130	1111561. 1.104	1152021. 1.145	1036537. 1.030
3	X X X X X X X X	936450. .930	1037599. 1.031	992153. .986	1008442. 1.002	1053263. 1.047	X X X X X X X X
4	1012641. 1.006	1048107. 1.041	956403. .950	X X X X X X X X	935334. .929	974436. .968	1098182. 1.091
5	X X X X X X X X	1009523. 1.003	945349. .939	902166. .896	927344. .921	953532. .947	X X X X X X X X
6	1001588. .995	1015433. 1.009	950787. .945	917917. .912	932062. .926	973722. .968	919648. .914
7	964487. .958	897166. .891	X X X X X X X X	1003199. .997	X X X X X X X X	873764. .868	943050. .937

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 141
ROD BY ROD PLANAR LA140 DISTRIBUTION
87 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP							
1	1421297. 1.232	1220292. 1.058	X X X X X X X	1266817. 1.099	X X X X X X X	1365879. 1.184	1366227. 1.185
2	1180533. 1.024	1234653. 1.071	1101506. .955	1269251. 1.101	1248269. 1.082	1301478. 1.129	1218155. 1.056
3	X X X X X X X	1079768. .936	1187614. 1.030	1124137. .975	1128122. .978	1217229. 1.056	X X X X X X X
4	1212821. 1.052	1235497. 1.071	1089784. .945	X X X X X X X	1015320. .880	1094392. .949	1256001. 1.089
5	X X X X X X X	1170161. 1.015	1068937. .927	1024589. .888	1021037. .885	1059223. .919	X X X X X X X
6	1159131. 1.005	1188840. 1.031	1061483. .920	1053743. .914	1033550. .896	1080379. .937	1043323. .905
7	1127359. .978	1045277. .906	X X X X X X X	1107244. .960	X X X X X X X	987226. .856	1060747. .920

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL. 1977

BUNDLE SERIAL NUMBER HX 141
ROD BY ROD PLANAR LA140 DISTRIBUTION
93 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP			X X X X X X X X X		X X X X X X X X X		
1	1441982. 1.193	1268237. 1.049		1323711. 1.095		1400631. 1.159	1410901. 1.167
2	1237467. 1.024	1291294. 1.068	1173200. .971	1359919. 1.125	1321114. 1.093	1409637. 1.166	1285435. 1.063
3	X X X X X X X X X	1144602. .947	1224272. 1.013	1205379. .997	1181580. .977	1266449. 1.048	X X X X X X X X X
4	1236833. 1.023	1290875. 1.068	1161660. .961	X X X X X X X X X	1078184. .892	1180208. .976	1306457. 1.081
5	X X X X X X X X X	1253124. 1.037	1122037. .928	1058072. .875	1038332. .859	1109546. .918	X X X X X X X X X
6	1214772. 1.005	1233478. 1.020	1103788. .913	1081070. .894	1083978. .897	1137127. .941	1090783. .902
7	1191261. .985	1067782. .883	X X X X X X X X X	1199397. .992	X X X X X X X X X	1016489. .841	1152431. .953

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 141
ROD BY ROD PLANAR LA140 DISTRIBUTION
111 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 3.4%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE GAP							
1	1559098. 1.186	1364446. 1.038	X X X X X X X X	1417079. 1.078	X X X X X X X X	1501983. 1.142	1478950. 1.125
2	1320275. 1.004	1370588. 1.042	1265491. .962	1422757. 1.082	1396691. 1.062	1455646. 1.107	1330606. 1.012
3	X X X X X X X X X	1217152. .926	1339505. 1.019	1243760. .946	1248966. .950	1284931. .977	X X X X X X X X X
4	1377519. 1.048	1402314. 1.066	1224193. .931	X X X X X X X X X	1172280. .892	1232278. .937	1403240. 1.067
5	X X X X X X X X X	1363316. 1.037	1248088. .949	1169164. .889	1116056. .849	1205312. .917	X X X X X X X X X
6	1429596. 1.087	1477764. 1.124	1264800. .962	1213631. .923	1174191. .893	1221023. .929	1188929. .904
7	1448049. 1.101	1304661. .992	X X X X X X X X	1344854. 1.023	X X X X X X X X	1125501. .856	1271344. .967

HATCH 1 EOCI BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 141
ROD BY ROD PLANAR LA140 DISTRIBUTION
123 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP			X X X X X X X X X		X X X X X X X X X		
1	1211541. 1.141	1063663. 1.002		1124849. 1.059		1190637. 1.121	1210809. 1.140
2	1060468. .999	1091958. 1.028	992113. .934	1141847. 1.075	1147816. 1.081	1177255. 1.109	1084047. 1.021
3	X X X X X X X X X	1001208. .943	1092198. 1.029	1011418. .953	1008662. .950	1054569. .993	X X X X X X X X X
4	1089905. 1.027	1123967. 1.059	1016172. .957	X X X X X X X X X	942602. .888	1011038. .952	1131822. 1.066
5	X X X X X X X X X	1110811. 1.046	998635. .941	949537. .894	849214. .800	966884. .911	X X X X X X X X X
6	1141022. 1.075	1191238. 1.122	1025613. .966	981959. .925	962620. .907	995342. .937	961449. .906
7	1186479. 1.117	1074540. 1.012	X X X X X X X X X	1106489. 1.042	X X X X X X X X X	936585. .882	1050297. .989

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 141
ROD BY ROD PLANAR LA140 DISTRIBUTION
129 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP			X X		X X		
1	1042582.	896129.	X X	931155.	X X	1016268.	1039401.
			X		X		
	1.137	.978	X X	1.016	X X	1.109	1.134
			X X		X X		
2	898788.	926418.	880516.	1013782.	988763.	1051107.	963050.
	.980	1.011	.960	1.106	1.079	1.147	1.051
3	X X	841013.	952934.	879581.	856148.	897606.	X X
	X X						X X
	X						X
	X X	.917	1.039	.959	.934	.979	X X
	X X						X X
4	953522.	962270.	885563.	X X	816298.	835204.	996916.
				X X			
				X			
	1.040	1.050	.966	X X	.890	.911	1.087
				X X			
5	X X	958719.	865073.	805308.	706140.	836533.	X X
	X X						X X
	X						X
	X X	1.046	.944	.878	.770	.913	X X
	X X						X X
6	995224.	1032405.	869286.	860857.	851710.	869655.	837756.
	1.086	1.126	.948	.939	.929	.949	.914
7	1016612.	925569.	X X	968190.	X X	822715.	923109.
			X X		X X		
			X		X		
	1.109	1.010	X X	1.056	X X	.897	1.007
			X X		X X		

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 169
ROD BY ROD PLANAR LA140 DISTRIBUTION
15 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP			X X		X X		
1	466533. 1.091	412848. .965	X X X X	431886. 1.010	X X X X	427832. 1.001	382117. .894
2	423715. .991	446216. 1.044	397886. .931	470121. 1.099	456392. 1.067	453223. 1.060	377776. .883
3	X X X X X X	403204. .943	463324. 1.084	421630. .986	415914. .973	417097. .975	X X X X X X
4	424995. .994	487030. 1.139	425781. .996	X X X X X X	389768. .912	419495. .981	432715. 1.012
5	X X X X X X	471327. 1.102	414315. .969	392607. .918	407920. .954	415755. .972	X X X X X X
6	457835. 1.071	480577. 1.124	447546. 1.047	413821. .968	404794. .947	441858. 1.033	397136. .929
7	424760. .993	392619. .918	X X X X X X	458430. 1.072	X X X X X X	408998. .956	426238. .997

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 169
ROD BY ROD PLANAR LA140 DISTRIBUTION
21 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP			X X X X X X X X X		X X X X X X X X X		
1	529963. 1.102	471744. .981		489257. 1.018		473223. .984	429477. .893
2	469693. .977	488455. 1.016	469603. .977	528110. 1.098	507397. 1.055	498165. 1.036	424198. .882
3	X X X X X X X X X	462871. .963	525119. 1.092	488558. 1.016	465791. .969	479640. .998	X X X X X X X X X
4	495049. 1.030	530567. 1.104	482951. 1.004	X X X X X X X X X	439569. .914	460863. .959	492467. 1.024
5	X X X X X X X X X	534392. 1.111	475617. .989	457368. .951	461774. .960	463043. .963	X X X X X X X X X
6	516226. 1.074	535925. 1.115	493528. 1.026	473437. .985	463311. .964	486598. 1.012	451690. .939
7	472553. .983	449012. .934	X X X X X X X X X	505187. 1.051	X X X X X X X X X	422769. .879	466791. .971

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL. 1977

BUNDLE SERIAL NUMBER HX 169
ROD BY ROD PLANAR LA140 DISTRIBUTION
51 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE GAP			X X X X X X		X X X X X X		
1	978288. 1.080	886638. .978		882976. .974		917710. 1.013	836073. .923
2	895463. .988	938111. 1.035	839482. .926	977710. 1.079	934670. 1.031	941436. 1.039	796879. .879
3	X X X X X X X X X	870915. .961	939289. 1.037	871337. .962	842049. .929	871191. .961	X X X X X X X X X
4	936799. 1.034	992673. 1.095	922406. 1.018	X X X X X X X X X	838121. .925	865554. .955	868303. .958
5	X X X X X X X X X	1002048. 1.106	910506. 1.005	844639. .932	862798. .952	884488. .976	X X X X X X X X X
6	1003185. 1.107	1033923. 1.141	942876. 1.040	925390. 1.021	874965. .966	914562. 1.009	803823. .887
7	958540. 1.058	938751. 1.036	X X X X X X X X X	1002851. 1.107	X X X X X X X X X	824838. .910	875885. .967

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 169
ROD BY ROD PLANAR LA140 DISTRIBUTION
57 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP			X X		X X		
1	1018962. 1.088	923446. .986	X X X X	932701. .996	X X X X	966175. 1.032	916395. .979
2	897965. .959	955541. 1.020	878096. .938	1018360. 1.088	951903. 1.017	991392. 1.059	829991. .886
3	X X X X X X X X X	898624. .960	999617. 1.068	928381. .991	880102. .940	885956. .946	X X X X X X X X X
4	959923. 1.025	1044912. 1.116	925820. .989	X X X X X X X X X	868013. .927	895461. .956	935123. .999
5	X X X X X X X X X	1024183. 1.094	931536. .995	887937. .948	861730. .920	872377. .932	X X X X X X X X X
6	1038921. 1.109	1073217. 1.146	1003250. 1.071	905512. .967	888951. .949	915105. .977	815021. .870
7	1017472. 1.087	943434. 1.008	X X X X X X X X X	1019853. 1.089	X X X X X X X X X	860674. .919	893497. .954

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 169
ROD BY ROD PLANAR LA140 DISTRIBUTION
63 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP			X X		X X		
1	1009513. 1.036	906459. .930	X X X X	990118. 1.016	X X X X	997137. 1.023	953157. .978
2	944545. .969	993367. 1.019	900686. .924	1060276. 1.088	1023941. 1.051	1029543. 1.056	894430. .918
3	X X X X X X	952172. .977	1029002. 1.056	977571. 1.003	941741. .966	942539. .967	X X X X X X
4	987728. 1.013	1084236. 1.112	984664. 1.010	X X X X X X	907003. .931	934837. .959	970950. .996
5	X X X X X X	1058812. 1.086	965362. .990	908797. .932	902885. .926	934527. .959	X X X X X X
6	1062985. 1.091	1090429. 1.119	1021927. 1.048	947811. .972	925645. .950	980437. 1.006	871734. .894
7	1060323. 1.088	978872. 1.004	X X X X X X	1037803. 1.065	X X X X X X	885885. .909	937904. .962

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 169
ROD BY ROD PLANAR LA140 DISTRIBUTION
87 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP 1	1276895. 1.125	1168172. 1.029	X X X X X X X	1203056. 1.060	X X X X X X X	1224827. 1.079	1152331. 1.015
2	1165977. 1.027	1192941. 1.051	1098574. .968	1253214. 1.104	1213928. 1.070	1232278. 1.086	1065356. .939
3	X X X X X X X	1128715. .995	1196370. 1.054	1120865. .988	1100097. .969	1101726. .971	X X X X X X X
4	1179345. 1.039	1274490. 1.123	1104466. .973	X X X X X X X	1003872. .885	1043327. .919	1144248. 1.008
5	X X X X X X X	1231156. 1.085	1116988. .984	1015038. .894	988756. .871	1018865. .898	X X X X X X X
6	1242408. 1.095	1270177. 1.119	1142081. 1.006	1073681. .946	1032035. .909	1061106. .935	975147. .859
7	1215458. 1.071	1134642. 1.000	X X X X X X X	1159582. 1.022	X X X X X X X	990454. .873	1083484. .955

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL. 1977

BUNDLE SERIAL NUMBER HX 169
ROD BY ROD PLANAR LA140 DISTRIBUTION
93 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP			X X X X X		X X X X X		
1	1347347. 1.133	1246312. 1.048	1.048	1246268. 1.048	1294291. 1.088	1219507. 1.025	
2	1224353. 1.029	1250827. 1.052	1171938. .985	1323834. 1.113	1272769. 1.070	1276824. 1.073	1142933. .961
3	X X X X X X X X	1165208. .980	1258616. 1.058	1166040. .980	1109233. .933	1164432. .979	X X X X X X X X
4	1216060. 1.022	1292814. 1.087	1186736. .998	X X X X X X X X	1087106. .914	1104702. .929	1212112. 1.019
5	X X X X X X X X	1280705. 1.077	1160239. .975	1064186. .895	1042143. .876	1086254. .913	X X X X X X X X
6	1271227. 1.069	1310113. 1.101	1191825. 1.002	1121022. .942	1052316. .885	1121832. .943	1042267. .876
7	1270893. 1.068	1185456. .997	X X X X X X X X	1233298. 1.037	X X X X X X X X	1008501. .848	1154999. .971

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 169
ROD BY ROD PLANAR LA140 DISTRIBUTION
111 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 3.4%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE			X X		X X		
GAP	1399780.	1335181.	X X	1334925.	X X	1472867.	1500843.
1			X		X		
	1.088	1.038	X X	1.038	X X	1.145	1.167
			X X		X X		
	1312344.	1330232.	966027.	1406406.	1405217.	1456343.	1306092.
2							
	1.020	1.034	.751	1.093	1.092	1.132	1.015
	X X						X X
	X X	1231416.	1327435.	1278442.	1272483.	1287701.	X X
3	X						X
	X X	.957	1.032	.994	.989	1.001	X X
	X X						X X
				X X			
	1317329.	1418362.	1238177.	X X	1156981.	1241754.	1362178.
4				X			
	1.024	1.103	.963	X X	.899	.965	1.059
				X X			
	X X						X X
	X X	1345272.	1234355.	1155971.	1093136.	1197613.	X X
5	X						X
	X X	1.046	.960	.899	.850	.931	X X
	X X						X X
	1394155.	1405094.	1251092.	1195258.	1173891.	1217882.	1149708.
6							
	1.084	1.092	.973	.929	.913	.947	.894
			X X		X X		
	1365640.	1245518.	X X	1328879.	X X	1121749.	1218345.
7			X		X		
	1.062	.968	X X	1.033	X X	.872	.947
			X X		X X		

HATCH 1 EOCI BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 169
ROD BY ROD PLANAR LA140 DISTRIBUTION
123 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

WIDE WIDE GAP	A	B	C	D	E	F	G
1	1217620. 1.151	1107584. 1.047	X X X X X X X X	1128076. 1.067	X X X X X X X X	1218386. 1.152	1211763. 1.146
2	1092495. 1.033	1101228. 1.041	1009252. .954	1166313. 1.103	1144812. 1.082	1187733. 1.123	1081336. 1.022
3	X X X X X X X X X	1004596. .950	1100290. 1.040	1019001. .963	1007031. .952	1053305. .996	X X X X X X X X X
4	1090583. 1.031	1148556. 1.086	1011445. .956	X X X X X X X X X	942154. .891	989781. .936	1122449. 1.061
5	X X X X X X X X X	1139069. 1.077	1026400. .970	936115. .885	856516. .810	978113. .925	X X X X X X X X X
6	1138386. 1.076	1145842. 1.083	1006244. .951	971885. .919	947900. .896	969013. .916	895404. .847
7	1144268. 1.082	1037929. .981	X X X X X X X X	1056263. .999	X X X X X X X X	888198. .840	1014836. .959

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 169
ROD BY ROD PLANAR LA140 DISTRIBUTION
129 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE			X X		X X		
GAP 1	1082852.	933012.	X X	978622.	X X	1060437.	1058746.
	1.179	1.016	X X	1.065	X X	1.154	1.152
2	950232.	965161.	893009.	1010024.	974469.	1049246.	951392.
	1.034	1.051	.972	1.099	1.061	1.142	1.036
3	X X X X X X	874589. .952	982799. 1.070	868000. .945	868322. .945	863528. .940	X X X X X X
4	946692. 1.030	1007903. 1.097	886860. .965	X X X X	815509. .888	835636. .910	970622. 1.057
5	X X X X X X	993123. 1.081	856536. .932	808796. .880	708853. .772	837829. .912	X X X X X X
6	999757. 1.088	1020451. 1.111	851671. .927	829934. .903	820311. .893	849200. .924	818056. .890
7	989609. 1.077	905712. .986	X X X X	949632. 1.034	X X X X	795318. .866	885075. .963

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
15 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

* EXPT UNCERTAINTY = 2.8%

	A	B	C	D	E	F	G
WIDE WIDE GAP							
1	* 109794. .349	* 123687. .393	X X X X X X .592	186502.	X X X X X X .924	290890.	387327. 1.230
2	* 114552. .364	* 173812. .552	201797. .641	* 282155. .896	* 330589. 1.050	382995. 1.216	384865. 1.222
3	X X X X X X	* 198946. .632	270200. .858	308517. .980	341945. 1.086	406879. 1.292	X X X X X X
4	* 155069. .492	* 252663. .802	297945. .946	X X X X X X	350731. 1.114	396152. 1.258	465913. 1.479
5	X X X X X X	* 295839. .939	325996. 1.035	349431. 1.110	376750. 1.196	408304. 1.297	X X X X X X
6	241130. .766	* 321322. 1.020	363549. 1.154	372835. 1.184	402893. 1.279	436933. 1.387	401869. 1.276
7	* 311168. .988	334680. 1.063	X X X X X X	425804. 1.352	X X X X X X	383358. 1.217	430813. 1.368

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
21 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

* EXPT UNCERTAINTY = 2.8%

WIDE GAP	A	B	C	D	E	F	G
1	* 118577. .335	* 139294. .394	X X X X X X X X	206651. .585	X X X X X X X X	333203. .943	419990. 1.188
2	* 132717. .375	209214. .592	* 237581. .672	* 314229. .889	361266. 1.022	437457. 1.238	433262. 1.226
3	X X X X X X X X X	* 219991. .622	321269. .909	343308. .971	389157. 1.101	459082. 1.299	X X X X X X X X X
4	* 180211. .510	* 284915. .806	346605. .981	X X X X X X X X X	386564. 1.094	461436. 1.305	497316. 1.407
5	X X X X X X X X X	* 322091. .911	366880. 1.038	388482. 1.099	440104. 1.245	458221. 1.296	X X X X X X X X X
6	265806. .752	368549. 1.043	406101. 1.149	423695. 1.199	458758. 1.298	478657. 1.354	452249. 1.279
7	356814. 1.009	370389. 1.048	X X X X X X X X X	467188. 1.322	X X X X X X X X X	422085. 1.194	459733. 1.301

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL. 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
51 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

* EXPT UNCERTAINTY = 2.8%

	A	B	C	D	E	F	G
WIDE WIDE GAP			X X X X X X X X X		X X X X X X X X X		
1	240190. .371	277672. .429		393018. .607		574843. .888	733659. 1.134
2	263723. .408	388262. .600	453678. .701	570171. .881	641390. .991	735083. 1.136	744097. 1.150
3	X X X X X X X X X	413939. .640	585743. .905	637001. .984	682186. 1.054	761988. 1.178	X X X X X X X X X
4	* 328805. .508	544975. .842	618440. .956	X X X X X X X X X	725566. 1.121	803198. 1.241	895375. 1.384
5	X X X X X X X X X	606441. .937	670007. 1.035	724006. 1.119	772325. 1.193	827998. 1.280	X X X X X X X X X
6	542704. .839	706783. 1.092	745651. 1.152	777905. 1.202	824920. 1.275	884535. 1.367	813399. 1.257
7	707482. 1.093	716143. 1.107	X X X X X X X X X	861587. 1.331	X X X X X X X X X	806836. 1.247	883146. 1.365

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
57 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE GAP			X X		X X		
1	266000.	311958.	X X	414864.	X X	597671.	783048.
			X		X		
	.393	.460	X X	.612	X X	.882	1.156
			X X		X X		
2	283292.	429789.	482120.	605525.	672457.	768086.	774168.
	.418	.634	.712	.894	.992	1.134	1.143
3	X X	452853.	621403.	667717.	719138.	790442.	X X
	X X						X X
	X						X
	X X	.668	.917	.985	1.061	1.167	X X
	X X						X X
4	374670.	585318.	646548.	X X	758351.	812191.	909005.
				X			
	.553	.864	.954	X X	1.119	1.199	1.342
				X X			
5	X X	657769.	700122.	758936.	812584.	843104.	X X
	X X						X X
	X						X
	X X	.971	1.033	1.120	1.199	1.244	X X
	X X						X X
6	571692.	750598.	774169.	806557.	857095.	901848.	832751.
	.844	1.108	1.143	1.190	1.265	1.331	1.229
7	729576.	745851.	X X	914443.	X X	837976.	882350.
			X X		X X		
			X		X		
	1.077	1.101	X X	1.350	X X	1.237	1.302
			X X		X X		

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
63 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

WIDE WIDE GAP	A	B	C	D	E	F	G
1	300363. .411	353517. .484	X X X X X X X	454145. .622	X X X X X X X	647059. .886	832223. 1.140
2	332433. .455	471943. .646	520683. .713	650100. .890	709773. .972	802177. 1.098	813230. 1.114
3	X X X X X X X X X	510791. .699	668830. .916	719642. .985	767305. 1.051	840415. 1.151	X X X X X X X X X
4	436169. .597	671625. .920	712074. .975	X X X X X X X X X	815347. 1.116	853729. 1.169	976008. 1.336
5	X X X X X X X X X	730905. 1.001	751481. 1.029	795387. 1.089	849817. 1.164	894649. 1.225	X X X X X X X X X
6	641886. .879	804294. 1.101	862662. 1.181	877963. 1.202	895856. 1.227	945590. 1.295	876085. 1.200
7	801194. 1.097	808419. 1.107	X X X X X X X	987828. 1.353	X X X X X X X	889037. 1.217	939325. 1.286

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
87 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE GAP			X X		X X		
1	437715.	487498.	X X X	566946.	X X X	805671.	1005440.
	.517	.576	X X X	.670	X X X	.952	1.189
2	444352.	593157.	648775.	772068.	830498.	950616.	938757.
	.525	.701	.767	.913	.982	1.124	1.110
3	X X X X X	627809.	801212.	811185.	859491.	930671.	X X X X X
	X X X X X	.742	.947	.959	1.016	1.100	X X X X X
4	543581.	767430.	817842.	X X X X X	898762.	985038.	1093021.
	.643	.907	.967	X X X X X	1.062	1.164	1.292
5	X X X X X	832782.	858263.	895542.	911346.	990070.	X X X X X
	X X X X X	.984	1.015	1.059	1.077	1.170	X X X X X
6	797973.	924791.	950296.	961056.	994621.	1026082.	971636.
	.943	1.093	1.123	1.136	1.176	1.213	1.149
7	987116.	955311.	X X X X X	1108606.	X X X X X	988590.	1067099.
	1.167	1.129	X X X X X	1.310	X X X X X	1.169	1.261

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
93 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 39 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

WIDE GAP	A	B	C	D	E	F	G
1	471631. .528	520069. .583	X X X X X X X	612054. .686	X X X X X X X	859244. .962	1054891. 1.182
2	482161. .540	650452. .729	689402. .772	822974. .922	873617. .979	967014. 1.083	1013074. 1.135
3	X X X X X X X X X	663662. .743	826113. .925	864247. .968	906749. 1.016	938707. 1.051	X X X X X X X X X
4	572686. .641		861596. .965	X X X X X X X	942498. 1.056	1010994. 1.132	1144954. 1.282
5	X X X X X X X X X	878056. .984	902313. 1.011	916826. 1.027	975353. 1.092	1051635. 1.178	X X X X X X X X X
6	836167. .937	988874. 1.108	999371. 1.119	1013858. 1.136	1039109. 1.164	1079970. 1.210	1017134. 1.139
7	1043649. 1.169	1024241. 1.147	X X X X X X X	1167473. 1.308	X X X X X X X	1033255. 1.157	1102275. 1.235

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
105 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

| EXPT | LA140 INTENSITY
| NORM | NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE GAP 1	1569306. 1.200	1284862. .983	X X X X X X X	1355904. 1.037	X X X X X X X	1448871. 1.108	1456604. 1.114
2	1387605. 1.061	1361423. 1.041	1268535. .970	1433977. 1.097	1403150. 1.073	1409777. 1.078	1311161. 1.003
3	X X X X X X X	1279043. .978	1363589. 1.043	1210925. .926	1247745. .954	1292169. .988	X X X X X X X
4	1249841. .956	1489265. 1.139	1186428. .907	X X X X X X X	1192990. .912	1209308. .925	1337144. 1.023
5	X X X X X X X	1432161. 1.095	1217095. .931	1165098. .891	1126790. .862	1122469. .858	X X X X X X X
6	1507110. 1.152	1455900. 1.113	1304601. .998	1200446. .918	1156963. .885	1158891. .886	1142196. .873
7	1434573. 1.097	1338775. 1.024	X X X X X X X	1361658. 1.041	X X X X X X X	1162557. .889	1271143. .972

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL. 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
108 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

| EXPT | LA140 INTENSITY
| NORM | NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP 1	1653748. 1.204	1452801. 1.057	X X X X X X X	1460031. 1.063	X X X X X X X	1518820. 1.105	1469036. 1.069
2	1432178. 1.042	1441678. 1.049	1337931. .974	1516871. 1.104	1460167. 1.063	1496802. 1.089	1353059. .985
3	X X X X X X X X X	1365043. .994	1455273. 1.059	1315981. .958	1298516. .945	1331488. .969	X X X X X X X X X
4	1455747. 1.060	1535576. 1.118	1338840. .974	X X X X X X X X X	1222172. .890	1245338. .906	1376009. 1.002
5	X X X X X X X X X	1492609. 1.086	1294106. .942	1221854. .889	1162069. .846	1234842. .899	X X X X X X X X X
6	1572713. 1.145	1507416. 1.097	1340216. .975	1252392. .912	1192595. .868	1260582. .918	1168343. .850
7	1503888. 1.095	1370092. .997	X X X X X X X	1398480. 1.018	X X X X X X X	1169210. .851	1282181. .933

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
111 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 3.4%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP 1	1697090. 1.237	1470463. 1.072	X X X X X X X X	1465194. 1.068	X X X X X X X X	1522797. 1.110	1488438. 1.085
2	1481693. 1.080	1495674. 1.090	1354218. .987	1527266. 1.113	1467318. 1.069	1471201. 1.072	1340720. .977
3	X X X X X X X	1387731. 1.011	1457385. 1.062	1337137. .975	1282342. .935	1336487. .974	X X X X X X X X X
4	1522557. 1.110	1541994. 1.124	1356584. .989	X X X X X X X X X	1230804. .897	1228956. .896	1347406. .982
5	X X X X X X X X X	1490735. 1.087	1252580. .913	1219955. .889	1157866. .844	1221728. .890	X X X X X X X X X
6	1536854. 1.120	1508682. 1.100	1331565. .971	1240389. .904	1037794. .756	1251330. .912	1158994. .845
7	1506489. 1.098	1374758. 1.002	X X X X X X X X X	1370330. .999	X X X X X X X X X	1144249. .834	1263256. .921

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL. 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
123 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE			X X		X X		
GAP	1392703.	1210570.	X X	1188508.	X X	1241846.	1247809.
1	1.235	1.073	X X	1.054	X X	1.101	1.106
			X X		X X		
	1257514.	1232496.	1108045.	1221035.	1216078.	1211848.	1106395.
2	1.115	1.093	.982	1.083	1.078	1.074	.981
	X X						X X
	X X	1117261.	1197295.	1092868.	1054102.	1078915.	X X
3	X						X
	X X	.991	1.061	.969	.935	.957	X X
	X X						X X
				X X			
	1237586.	1277811.	1097953.	X X	995632.	1027997.	1130585.
4	1.097	1.133	.973	X	.883	.911	1.002
				X X			
	X X						X X
	X X	1220717.	1076580.	972852.	948423.	1001643.	X X
5	X						X
	X X	1.082	.954	.862	.841	.888	X X
	X X						X X
	1274084.	1205935.	1082292.	1024609.	1012852.	1020229.	948002.
6	1.130	1.069	.960	.908	.898	.904	.840
			X X		X X		
	1244208.	1089126.	X X	1111686.	X X	910468.	1031656.
7	1.103	.966	X	.986	X	.807	.915
			X X		X X		

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 373
ROD BY ROD PLANAR LA140 DISTRIBUTION
129 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP							
1	1190058. 1.202	1039584. 1.050	X X X X X X	1056570. 1.067	X X X X X X	1106617. 1.117	1079651. 1.090
2	1065568. 1.076	1095126. 1.106	963494. .973	1101265. 1.112	1051376. 1.062	1065652. 1.076	966733. .976
3	X X X X X X	976585. .986	1037450. 1.048	930936. .940	922294. .931	930968. .940	X X X X X X
4	1072398. 1.083	1102022. 1.113	976812. .986	X X X X X X	873283. .882	908474. .917	1000824. 1.011
5	X X X X X X	1098080. 1.109	940747. .950	868018. .877	826109. .834	892928. .902	X X X X X X
6	1098109. 1.109	1094936. 1.106	925475. .935	894031. .903	886967. .896	917266. .926	851415. .860
7	1100585. 1.111	970254. .980	X X X X X X	1006670. 1.017	X X X X X X	821695. .830	903634. .913

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
15 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

* EXPT UNCERTAINTY = 2.8%

WIDE WIDE GAP	A	B	C	D	E	F	G
1	* 153892. .442	* 159140. .457	X X X X X X	* 209953. .602	X X X X X X	303433. .871	359841. 1.032
2	* 154519. .443	* 229436. .658	* 243147. .698	319643. .917	348724. 1.001	380604. 1.092	373675. 1.072
3	X X X X X X X X	* 231436. .664	318595. .914	338606. .972	352442. 1.011	405977. 1.165	X X X X X X X X
4	* 200511. .575	316994. .909	325755. .935	X X X X X X X X	372982. 1.070	415242. 1.191	452030. 1.297
5	X X X X X X X X	360600. 1.035	372686. 1.069	387473. 1.112	395799. 1.136	412288. 1.183	X X X X X X X X
6	336419. .965	417677. 1.198	429444. 1.232	422175. 1.211	423062. 1.214	455414. 1.307	403810. 1.159
7	438648. 1.259	423922. 1.216	X X X X X X X X	470754. 1.351	X X X X X X X X	407596. 1.169	417126. 1.197

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
21 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

* EXPT UNCERTAINTY = 2.8%

WIDE GAP	A	B	C	D	E	F	G
WIDE							
1	* 167809. .428	* 185363. .472	X X X X X X	* 234315. .597	X X X X X X	340814. .868	407773. 1.039
2	* 183875. .468	* 251473. .641	280152. .714	358471. .913	371014. .945	443489. 1.130	418605. 1.066
3	X X X X X X X X	279188. .711	376232. .958	385215. .981	388841. .991	445546. 1.135	X X X X X X X X
4	* 233614. .595	375883. .958	393234. 1.002	X X X X X X	430027. 1.096	461161. 1.175	488095. 1.243
5	X X X X X X X X	417081. 1.063	420005. 1.070	442013. 1.126	442529. 1.127	464480. 1.183	X X X X X X X X
6	381710. .972	474835. 1.210	491719. 1.253	467634. 1.191	476702. 1.214	486859. 1.240	438284. 1.117
7	477439. 1.216	464420. 1.183	X X X X X X	544092. 1.386	X X X X X X	444709. 1.133	466494. 1.188

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
45 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP 1	877299. 1.004	793868. .908	X X X X X X X	811931. .929	X X X X X X X	917364. 1.050	889802. 1.018
2	814159. .932	857443. .981	800531. .916	935494. 1.070	927521. 1.061	952023. 1.089	857059. .981
3	X X X X X X X	810899. .928	925472. 1.059	855377. .979	844610. .966	864096. .989	X X X X X X X
4	892614. 1.021	945683. 1.082	849418. .972	X X X X X X X	832055. .952	849142. .972	925387. 1.059
5	X X X X X X X	955213. 1.093	857546. .981	833933. .954	842439. .964	827308. .947	X X X X X X X
6	985320. 1.127	991532. 1.134	911295. 1.043	863316. .988	828719. .948	852304. .975	763908. .874
7	943100. 1.079	890781. 1.019	X X X X X X X	965817. 1.105	X X X X X X X	791108. .905	826375. .946

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
48 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

WIDE WIDE GAP	A	B	C	D	E	F	G
1	973951. 1.023	906524. .953	X X X X X X	941413. .989	X X X X X X	999757. 1.051	977422. 1.027
2	911626. .958	974129. 1.024	912709. .959	1044981. 1.098	1006868. 1.058	1030427. 1.083	889053. .934
3	X X X X X X X X	876040. .921	1030031. 1.082	934050. .981	909132. .955	963512. 1.012	X X X X X X X X
4	958373. 1.007	1055200. 1.109	935373. .983	X X X X X X	894763. .940	916273. .963	951041. .999
5	X X X X X X X X	1058751. 1.113	939600. .987	907539. .954	890472. .936	890344. .936	X X X X X X X X
6	1061528. 1.115	1092969. 1.148	990151. 1.040	909407. .956	883949. .929	927450. .975	824749. .867
7	1031138. 1.084	962953. 1.012	X X X X X X	1005140. 1.056	X X X X X X	833951. .876	863491. .907

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
51 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE GAP 1	1067855. 1.072	987474. .991	X X X X X X X X	990972. .995	X X X X X X X X	1030821. 1.035	1026550. 1.030
2	994452. .998	1030884. 1.035	957370. .961	1086914. 1.091	1047639. 1.052	1095916. 1.100	935657. .939
3	X X X X X X X X	959106. .963	1077157. 1.081	985976. .990	938925. .943	1002234. 1.006	X X X X X X X X
4	1030869. 1.035	1094095. 1.098	988075. .992	X X X X X X X X	931131. .935	939693. .943	1008734. 1.013
5	X X X X X X X X	1087868. 1.092	967846. .972	932067. .936	921434. .925	929860. .933	X X X X X X X X
6	1093020. 1.097	1134471. 1.139	1036916. 1.041	979862. .984	927105. .931	971154. .975	848110. .851
7	1048897. 1.053	1006598. 1.010	X X X X X X X X	1037074. 1.041	X X X X X X X X	860326. .864	856055. .859

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
57 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 39 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE GAP			X X		X X		
1	1124363. 1.103	1010753. .991	X X X X	1043075. 1.023	X X X X	1087866. 1.067	1049609. 1.029
2		1067909. 1.047	976002. .957	1121026. 1.099	1101485. 1.080	1121813. 1.100	968825. .950
3	X X X X X X X X X	998980. .980	1080085. 1.059	989198. .970	969751. .951	986022. .967	X X X X X X X X X
4	1054004. 1.034	1136930. 1.115	1003394. .984	X X X X X X X X X	925823. .908	961521. .943	1029742. 1.010
5	X X X X X X X X X	1087975. 1.067	994870. .976	939913. .922	938198. .920	937787. .920	X X X X X X X X X
6	1113468. 1.092	1160511. 1.138	1042154. 1.022	961745. .943	940931. .923	958292. .940	872521. .856
7	1092827. 1.072	1022892. 1.003	X X X X X X X X X	1091815. 1.071	X X X X X X X X X	899108. .882	907180. .890

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
63 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE			X X		X X		
GAP	1204109.	1071427.	X X	1078638.	X X	1110107.	1083093.
1			X		X		
	1.142	1.016	X X	1.023	X X	1.052	1.027
			X X		X X		
	1057865.	1084531.	1037732.	1172326.	1132916.	1146235.	993765.
2	1.003	1.028	.984	1.111	1.074	1.087	.942
	X X						X X
	X X	1041288.	1109270.	1050803.	1003876.	1026561.	X X
3	X						X
	X X	.987	1.052	.996	.952	.973	X X
	X X						X X
				X X			
	1045134.	1191079.	1059109.	X X	958273.	934726.	1094880.
4				X			
	.991	1.129	1.004	X X	.909	.886	1.038
				X X			
	X X						X X
	X X	1136799.	1023903.	973934.	948489.	964185.	X X
5	X						X
	X X	1.078	.971	.923	.899	.914	X X
	X X						X X
	1153399.	1161639.	1062458.	1000926.	977570.	1012941.	900917.
6	1.094	1.101	1.007	.949	.927	.960	.854
			X X		X X		
	1149221.	1051707.	X X	1102922.	X X	922289.	959514.
7			X		X		
	1.090	.997	X X	1.046	X X	.874	.910
			X X		X X		

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
87 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE GAP							
1	1383468. 1.167	1237841. 1.044	X X X X X X X X	1222184. 1.031	X X X X X X X X	1280447. 1.080	1266503. 1.068
2	1242237. 1.047	1270908. 1.072	1175177. .991	1303150. 1.099	1232525. 1.039	1271233. 1.072	1140880. .962
3	X X X X X X X X X	1154904. .974	1255064. 1.058	1131153. .954	1115827. .941	1136431. .958	X X X X X X X X X
4	1243309. 1.048	1316407. 1.110	1173782. .990	X X X X X X X X X	1040927. .878	1093194. .922	1200951. 1.013
5	X X X X X X X X X	1274014. 1.074	1120508. .945	1077189. .908	1018329. .859	1058578. .893	X X X X X X X X X
6	1331882. 1.123	1310715. 1.105	1182270. .997	1091543. .920	1065192. .898	1098492. .926	999928. .843
7	1348253. 1.137	1195083. 1.008	X X X X X X X X	1256737. 1.060	X X X X X X X X	1056229. .891	1063928. .897

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
93 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE GAP			X X		X X		
1	1450086.	1316283.	X X	1255492.	X X	1345552.	1349703.
	1.161	1.054	X X	1.005	X X	1.078	1.081
			X X		X X		
	1330945.	1347126.	1208046.	1360758.	1294491.	1336537.	1214808.
2	1.066	1.079	.967	1.090	1.037	1.070	.973
	X X						X X
	X X	1222256.	1307557.	1198118.	1173929.	1197419.	X X
3	X						X
	X X	.979	1.047	.960	.940	.959	X X
	X X						X X
				X X			
	1322566.	1392213.	1214244.	X X	1101514.	1147968.	1222727.
4				X			
	1.059	1.115	.972	X X	.882	.919	.979
				X X			
	X X						X X
	X X	1359471.	1198982.	1115296.	1068771.	1116074.	X X
5	X						X
	X X	1.089	.960	.893	.856	.894	X X
	X X						X X
	1423063.	1370943.	1267057.	1146685.	1131393.	1148015.	1067522.
6	1.140	1.098	1.015	.918	.906	.919	.855
			X X		X X		
	1411070.	1278420.	X X	1302571.	X X	1086501.	1143547.
7			X		X		
	1.130	1.024	X X	1.043	X X	.870	.916
			X X		X X		

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
111 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 3.4%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE							
WIDE GAP							
1	1508057. 1.154	1359157. 1.040	X X X X X X X X	1357281. 1.039	X X X X X X X X	1427736. 1.093	1433303. 1.097
2	1344388. 1.029	1341187. 1.027	1265713. .969	1386001. 1.061	1388984. 1.063	1428043. 1.093	1268406. .971
3	X X X X X X X X X	1266748. .970	1344831. 1.029	1236416. .946	1170032. .896	1247297. .955	X X X X X X X X X
4	1388210. 1.063	1421626. 1.088	1174455. .899	X X X X X X X X X	1178544. .902	1226472. .939	1310758. 1.003
5	X X X X X X X X X	1405651. 1.076	1237334. .947	1187665. .909	1127077. .863	1172855. .898	X X X X X X X X X
6	1465501. 1.122	1432644. 1.097	1294983. .991	1213735. .929	1191322. .912	1265723. .969	1145389. .877
7	1472003. 1.127	1334703. 1.022	X X X X X X X X X	1384435. 1.060	X X X X X X X X X	1175199. .900	1276950. .977

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
123 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

EXPT	LA140 INTENSITY
NORM	NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP 1	1286231. 1.188	1145367. 1.058	X X X X X X	1132186. 1.045	X X X X X X	1186468. 1.095	1204277. 1.112
2	1129943. 1.043	1132755. 1.046	1039039. .959	1175058. 1.085	1143743. 1.056	1150833. 1.063	1068837. .987
3	X X X X X X	1057442. .976	1131251. 1.044	992799. .917	1006208. .929	1031520. .952	X X X X X X
4	1144745. 1.057	1177752. 1.087	1040211. .960	X X X X X X	947792. .875	993920. .918	1110486. 1.025
5	X X X X X X	1163007. 1.074	1029133. .950	953649. .881	932251. .861	978097. .903	X X X X X X
6	1208502. 1.116	1195528. 1.104	1070151. .988	1011684. .934	969643. .895	1021771. .943	902281. .833
7	1219043. 1.126	1121378. 1.035	X X X X X X	1121566. 1.036	X X X X X X	952226. .879	1043893. .964

HATCH 1 EOC1 BENCHMARK GAMMA SCAN
APRIL, 1977

BUNDLE SERIAL NUMBER HX 393
ROD BY ROD PLANAR LA140 DISTRIBUTION
129 INCHES ABOVE BOTTOM OF ACTIVE FUEL
EXPT UNCERTAINTY = 2.0%

LEGEND:

| EXPT | LA140 INTENSITY
| NORM | NORMALIZED LA140 INTENSITY (AVERAGE OF 40 RODS = 1.0)

X = TIE RODS AND SPACER CAPTURE ROD

	A	B	C	D	E	F	G
WIDE WIDE GAP			X X X X X X X X X		X X X X X X X X X		
1	1141258. 1.206	985463. 1.041		971203. 1.026		1027297. 1.086	1057742. 1.118
2	963583. 1.018	1002988. 1.060	905298. .957	1020023. 1.078	1011463. 1.069	1025151. 1.083	919071. .971
3	X X X X X X X X X	887392. .938	974286. 1.030	897152. .948	889607. .940	876259. .926	X X X X X X X X X
4	990063. 1.046	1033549. 1.092	919315. .972	X X X X X X X X X	832110. .879	895266. .946	988753. 1.045
5	X X X X X X X X X	1016850. 1.075	885398. .936	857058. .906	821561. .868	855435. .904	X X X X X X X X X
6	1022331. 1.080	1038788. 1.098	898763. .950	889518. .940	848643. .897	912044. .964	798239. .844
7	1069194. 1.130	949730. 1.004	X X X X X X X X X	1022842. 1.081	X X X X X X X X X	832022. .879	917082. .969

APPENDIX F

NORMALIZED ROD-TO-ROD PLANAR DISPLAYS FOR THE FOUR BUNDLE GROUP

	A	B	C	D	E	F	G	7	6	5	4	3	2	1	
1	1.170	1.036		1.083		1.073	.959	.781	.605		.389		.287	.275	A
2	1.063	1.119	.998	1.179	1.145	1.137	.948	.840	.806	.742	.634	.499	.436	.310	B
3		1.011	1.162	1.058	1.043	1.046			.912	.818	.747	.678	.506		C
4	1.066	1.222	1.068		.978	1.052	1.085	1.068	.935	.877		.774	.708	.468	D
5		1.182	1.039	.985	1.023	1.043			1.011	.945	.880	.858	.829		E
6	1.148	1.205	1.123	1.038	1.015	1.108	.996	.962	1.096	1.024	.994	1.021	.961	.730	F
7	1.065	.985		1.150		1.026	1.069	1.081	1.008		1.169		.965	.972	G
G	.903	.937		1.134		1.013	1.046	1.121	1.031		1.259		1.131	1.201	7
F	.761	.955	1.018	1.042	1.034	1.142	1.022	1.045	1.188	1.130	1.176	1.287	1.366	1.312	6
E		.875	.884	.936	.993	1.061			1.177	1.154	1.171	1.199	1.377		5
D	.527	.802	.849		.972	1.059	1.181	1.277	1.189	1.153		1.271	1.440	1.320	4
C		.610	.799	.817	.935	1.077			1.269	1.254	1.332	1.444	1.262		3
B	.399	.576	.581	.795	.905	1.048	1.063	1.184	1.367	1.387	1.428	1.253	1.364	1.302	2
A	.386	.388		.503		.844	1.100	1.264	1.361		1.282		1.315	1.486	1
	1	2	3	4	5	6	7	G	F	E	D	C	B	A	

BND ID		BND PWR	
169	373	1.073	.790
393	141	.874	1.263

15 INCHES ABOVE BOTTOM OF ACTIVE FUEL

FOUR-BUNDLE ROD-ROD PLANAR LA-140 DISTRIBUTION NORMALIZED TO MEASURED RODS IN THE PLANE

	A	B	C	D	E	F	G	7	6	5	4	3	2	1	
1	1.189	1.059		1.098		1.062	.964	.801	.596		.404		.298	.266	A
2	1.054	1.096	1.054	1.185	1.139	1.118	.952	.831	.827	.723	.639	.494	.469	.313	B
3		1.039	1.178	1.096	1.045	1.076			.911	.823	.778	.721	.533		C
4	1.111	1.191	1.084		.986	1.034	1.105	1.048	.951	.872		.770	.705	.464	D
5		1.199	1.067	1.026	1.036	1.039			1.029	.988	.867	.873	.811		E
6	1.158	1.203	1.108	1.062	1.040	1.092	1.014	.947	1.074	1.028	1.035	1.030	.982	.748	F
7	1.060	1.008		1.134		.949	1.048	1.032	1.015		1.116		.972	.942	G
G	.915	.939		1.095		.984	1.047	1.095	1.019		1.215		1.084	1.188	7
F	.765	.995	1.000	1.035	1.042	1.093	.998	1.044	1.190	1.170	1.208	1.263	1.171	1.288	6
E		.833	.873	.965	.993	1.070			1.147	1.150	1.162	1.220	1.360		5
D	.526	.804	.864		.992	1.049	1.221	1.237	1.204	1.149		1.310	1.435	1.318	4
C		.629	.844	.882	.943	1.103			1.286	1.225	1.279	1.385	1.252		3
B	.416	.564	.627	.844	.936	1.066	1.042	1.117	1.390	1.401	1.439	1.249	1.370	1.294	2
A	.377	.413		.524		.857	1.071	1.222	1.296		1.344		1.296	1.408	1
	1	2	3	4	5	6	7	G	F	E	D	C	B	A	

BND ID		BND PWR	
169	373	1.079	.793
393	141	.881	1.247

21 INCHES ABOVE BOTTOM OF ACTIVE FUEL

FOUR-BUNDLE ROD-ROD PLANAR LA-140 DISTRIBUTION NORMALIZED TO MEASURED RODS IN THE PLANE

	A	B	C	D	E	F	G	7	6	5	4	3	2	1	
1	1.119	1.014		1.010		1.050	.956	.809	.621		.376		.302	.275	A
2	1.024	1.073	.960	1.118	1.069	1.077	.911	.819	.808	.694	.623	.473	.444	.318	B
3		.996	1.074	.997	.963	.996			.853	.766	.707	.670	.519		C
4	1.072	1.135	1.055		.959	.990	.993	.985	.890	.828		.729	.652	.450	D
5		1.146	1.041	.966	.987	1.012			.944	.883	.830	.780	.734		E
6	1.147	1.183	1.078	1.058	1.001	1.046	.919	.923	1.012	.947	.919	.872	.841	.658	F
7	1.096	1.074		1.147		.943	1.002	1.010	.930		1.024		.851	.839	G
G	1.174	1.070		1.154		.970	.979	1.029	.947		1.053		.938	.997	7
F	1.179	1.254	1.146	1.075	1.064	1.111	.984	.980	1.060	1.024	1.010	1.039	1.099	1.080	6
E		1.198	1.074	1.065	1.054	1.060			1.049	1.024	.981	.999	1.082		5
D	1.133	1.243	1.128		1.066	1.121	1.186	1.180	1.071	1.034		1.035	1.149	1.065	4
C		1.095	1.232	1.130	1.107	1.186			1.124	1.080	1.091	1.137	1.019		3
B	1.129	1.179	1.097	1.251	1.244	1.298	1.151	1.146	1.265	1.205	1.204	1.044	1.108	1.079	2
A	1.221	1.137		1.179		1.250	1.200	1.213	1.271		1.148		1.104	1.192	1
	1	2	3	4	5	6	7	G	F	E	D	C	B	A	

BND ID	BND PWR
169 ! 373	1.037! .740
393 ! 141	1.139!1.084

51 INCHES ABOVE BOTTOM OF ACTIVE FUEL

FOUR-BUNDLE ROD-ROD PLANAR LA-140 DISTRIBUTION NORMALIZED TO MEASURED RODS IN THE PLANE

	A	B	C	D	E	F	G	7	6	5	4	3	2	1	
1	1.132	1.026		1.036		1.073	1.018	.810	.635		.416		.315	.295	A
2	.997	1.061	.975	1.131	1.057	1.101	.922	.829	.834	.731	.650	.503	.477	.347	B
3		.998	1.110	1.031	.978	.984			.860	.778	.718	.690	.536		C
4	1.066	1.161	1.028		.964	.995	1.039	1.016	.896	.843		.742	.673	.461	D
5		1.138	1.035	.986	.957	.969	.000		.952	.903	.842	.799	.747		E
6	1.154	1.192	1.114	1.006	.987	1.017	.905	.931	1.002	.937	.902	.878	.853	.664	F
7	1.130	1.048		1.133		.956	.993	.980	.925		1.010		.860	.870	G
G	1.166	1.076		1.144		.969	1.008	1.038	.935		1.069		.926	1.001	7
F	1.208	1.246	1.095	1.068	1.042	1.064	.999	.980	1.042	1.008	.988	1.042	1.098	1.051	6
E		1.224	1.077	1.028	1.042	1.045			1.037	1.003	.967	1.013	1.104		5
D	1.159	1.245	1.099		1.044	1.068	1.213	1.185	1.074	.993		1.041	1.139	1.080	4
C		1.084	1.200	1.115	1.105	1.158			1.128	1.055	1.089	1.160	.989		3
B	1.123	1.186	1.110	1.263	1.209	1.289	1.136	1.128	1.254	1.178	1.214	1.023	1.086	1.074	2
A	1.249			1.171		1.237	1.214	1.222	1.238		1.182		1.087	1.189	1
	1	2	3	4	5	6	7	G	F	E	D	C	B	A	

BND ID	BND PWR
169 ! 373	1.039! .752
393 ! 141	1.132!1.077

57 INCHES ABOVE BOTTOM OF ACTIVE FUEL

FOUR-BUNDLE ROD-ROD PLANAR LA-140 DISTRIBUTION NORMALIZED TO MEASURED RODS IN THE PLANE

	A	B	C	D	E	F	G	7	6	5	4	3	2	1	
1	1.072	.963		1.052		1.059	1.012	.851	.682	.000	.463	.000	.353	.319	A
2	1.003	1.055	.957	1.126	1.088	1.093	.950	.859	.854	.776	.713	.543	.501	.375	B
3		1.011	1.093	1.038	1.000	1.001		.000	.916	.798	.756	.710	.553	.000	C
4	1.049	1.152	1.046		.963	.993	1.031	1.049	.932	.845	.000	.764	.690	.482	D
5		1.125	1.025	.965	.959	.993		.000	.951	.903	.866	.815	.754	.000	E
6	1.129	1.158	1.085	1.007	.983	1.041	.926	.944	1.004	.950	.907	.893	.852	.687	F
7	1.126	1.040		1.102		.941	.996	.998	.930	.000	1.037	.000	.864	.884	G
G	1.150	1.055		1.163		.957	1.019	1.002	.928		1.065		.953	1.024	7
F	1.179	1.217	1.090	.993	1.024	1.076	.980	.977	1.034	.990	.975	1.010	1.078	1.064	6
E		1.203	1.066	1.018	1.007	1.038			1.013	.985	.958	1.004	1.072		5
D	1.146	1.245	1.116		1.034	1.063	1.171	1.166	1.035	.993		1.016	1.113	1.076	4
C		1.102	1.178	1.125	1.087	1.128			1.119	1.071	1.054	1.102	.995		3
B	1.138	1.152	1.106	1.265	1.207	1.234	1.117	1.101	1.224	1.181	1.207	1.031	1.122	1.070	2
A	1.279	1.124		1.110		1.225	1.221	1.220	1.251		1.153		1.088	1.237	1
	1	2	3	4	5	6	7	G	F	E	D	C	B	A	

BND ID		BND PWR	
169	373	1.035	.776
393	141	1.120	1.069

63 INCHES ABOVE BOTTOM OF ACTIVE FUEL

FOUR-BUNDLE ROD-ROD PLANAR LA-140 DISTRIBUTION NORMALIZED TO MEASURED RODS IN THE PLANE

	A	B	C	D	E	F	G	7	6	5	4	3	2	1	
1	1.182	1.082		1.114		1.134	1.067	.914	.739		.503		.411	.405	A
2	1.080	1.105	1.017	1.160	1.124	1.141	.986	.885	.856	.771	.711	.581	.549	.451	B
3		1.045	1.108	1.038	1.019	1.020			.880	.795	.757	.742	.601		C
4	1.092	1.180	1.023		.930	.966	1.059	1.026	.890	.829		.751	.715	.525	D
5		1.140	1.034	.940	.916	.943			.921	.844	.832	.796	.769		E
6	1.150	1.176	1.057	.994	.956	.983	.903	.915	.950	.917	.912	.862	.880	.746	F
7	1.125	1.051		1.074		.917	1.003	.988	.900		1.012		.869	.931	G
G	1.173	1.056		1.112		.926	.985	.982	.914		1.025		.968	1.044	7
F	1.186	1.177	1.052	1.012	.980	1.017	.978	.966	1.000	.957	.976	.983	1.101	1.073	6
E		1.141	1.033	.964	.943	.986			.981	.945	.949	.990	1.083		5
D	1.132	1.207	1.047		.997	1.011	1.164	1.163	1.013	.940		1.009	1.144	1.123	4
C		1.088	1.162	1.087	1.038	1.095			1.127	1.045	1.041	1.100	1.000		3
B	1.146	1.177	1.069	1.219	1.180	1.214	1.107	1.128	1.205	1.156	1.175	1.020	1.143	1.093	2
A	1.281	1.150		1.151		1.233	1.248	1.265	1.265		1.173		1.130	1.316	1
	1	2	3	4	5	6	7	G	F	E	D	C	B	A	

BND ID	BND PWR
169 ! 373	1.051! .783
393 ! 141	1.098!1.068

87 INCHES ABOVE BOTTOM OF ACTIVE FUEL

FOUR-BUNDLE ROD-ROD PLANAR LA-140 DISTRIBUTION NORMALIZED TO MEASURED RODS IN THE PLANE

	A	B	C	D	E	F	G	7	6	5	4	3	2	1	
1	1.186	1.097		1.097		1.139	1.073	.918	.736		.504		.424	.415	A
2	1.077	1.101	1.031	1.165	1.120	1.124	1.006	.901	.870	.773		.584	.572	.458	B
3		1.025	1.108	1.026	.976	1.025			.879	.794	.758	.727	.607		C
4	1.070	1.138	1.044		.957	.972	1.067	1.027	.892	.807		.760	.724	.539	D
5		1.127	1.021	.936	.917	.956			.914	.858	.829	.798	.769		E
6	1.119	1.153	1.049	.986	.926	.987	.917	.909	.950	.925	.890	.826	.851	.756	F
7	1.118	1.043		1.085		.887	1.016	.970	.895		1.007		.891	.928	G
G	1.188	1.069		1.076		.939	1.006	1.014	.894		1.055		.940	1.048	7
F	1.184	1.176	1.054	1.010	.982	1.010	.956	.960	1.001	.954	.951	.971	1.085	1.069	6
E		1.139	1.033	.969	.940	.996			.976	.914	.931	.987	1.103		5
D	1.105	1.197	1.054		.981	1.009	1.146	1.150	1.039	.949		1.022	1.136	1.088	4
C		1.063	1.151	1.068	1.055	1.115			1.114	1.040	1.061	1.077	1.007		3
B	1.158	1.185	1.076	1.225	1.196	1.206	1.125	1.131	1.240	1.162	1.197	1.032	1.136	1.089	2
A	1.276	1.171		1.164		1.252	1.242	1.242	1.232		1.165		1.116	1.269	1
	1	2	3	4	5	6	7	G	F	E	D	C	B	A	

BND ID		BND PWR	
169	373	1.048	.787
393	141	1.100	1.065

93 INCHES ABOVE BOTTOM OF ACTIVE FUEL

FOUR-BUNDLE ROD-ROD PLANAR LA-140 DISTRIBUTION NORMALIZED TO MEASURED RODS IN THE PLANE

	A	B	C	D	E	F	G	7	6	5	4	3	2	1	
1	1.061	1.012		1.011		1.116	1.137	1.141	1.164		1.154		1.123	1.286	A
2	.994	1.008	.732	1.066	1.065	1.103	.990	1.042	1.143	1.129	1.168	1.051	1.133	1.114	B
3		.933	1.006	.969	.964	.976			1.009	.949	1.028	1.104	1.026		C
4	.998	1.075	.938		.877	.941	1.032	1.038	.940	.924		1.013	1.157	1.110	D
5		1.019	.935	.876	.828	.907			.786	.877	.932	.972	1.112		E
6	1.056	1.065	.948	.906	.889	.923	.871	.867	.948	.926	.931	1.013	1.115	1.154	F
7	1.035	.944		1.007		.850	.923	.957	.878		1.021		1.016	1.128	G
G	1.086	.961		.993		.868	.967	.963	.853		1.019		.988	1.097	7
F	1.082	1.082	.945	.929	.889	.959	.890	.901	.925	.890	.919	.958	1.120	1.083	6
E		1.052	.886	.893	.854	.903			.913	.846	.886	.946	1.033		5
D	1.028	1.050	.937		.900	.920	1.049	1.063	.934	.888		.927	1.062	1.044	4
C		.959	1.019	.890	.937	.981			.974	.946	.942	1.015	.922		3
B	1.030	1.016	.960	1.077	1.065	1.085	1.011	1.008	1.103	1.058	1.078	.959	1.038	1.000	2
A	1.143	1.019		1.052		1.110	1.115	1.121	1.138		1.074		1.034	1.181	1
	1	2	3	4	5	6	7	G	F	E	D	C	B	A	

BND ID		BND PWR	
169	373	.975	1.039
393	141	.990	.996

111 INCHES ABOVE BOTTOM OF ACTIVE FUEL

FOUR-BUNDLE ROD-ROD PLANAR LA-140 DISTRIBUTION NORMALIZED TO MEASURED RODS IN THE PLANE

	A	B	C	D	E	F	G	7	6	5	4	3	2	1	
1	1.125	1.023		1.042		1.125	1.119	1.149	1.177		1.143		1.162	1.286	A
2	1.009	1.017	.932	1.077	1.057	1.097	.999	1.006	1.114	1.128	1.180	1.032	1.138	1.118	B
3		.928	1.016	.941	.930	.973			1.000	.994	1.014	1.106	1.023		C
4	1.007	1.061	.934		.870	.914	1.037	1.027	.946	.899		1.009	1.128	1.098	D
5		1.052	.948	.865	.791	.903			.936	.876	.920	.974	1.123		E
6	1.052	1.058	.929	.898	.876	.895	.827	.841	.942	.925	.950	.997	1.119	1.147	F
7	1.057	.959		.976		.820	.937	.953	.876		1.044		1.022	1.153	G
G	1.112	.987		1.026		.833	.964	.970	.865		1.022		.993	1.096	7
F	1.096	1.063	.953	.918	.903	.944	.880	.888	.919	.889	.907	.947	1.100	1.054	6
E		1.056	.929	.875	.861	.896			.893	.784	.877	.922	1.026		5
D	1.046	1.085	.917		.881	.934	1.036	1.045	.934	.871		.939	1.038	1.007	4
C		.960	1.045	.961	.951	.988			.974	.932	.934	1.009	.925		3
B	1.058	1.046	.977	1.088	1.074	1.104	1.036	1.001	1.087	1.060	1.055	.916	1.009	.980	2
A	1.188	1.044		1.057		1.116	1.126	1.118	1.100		1.039		.982	1.119	1
	1	2	3	4	5	6	7	G	F	E	D	C	B	A	

BND ID		BND PWR	
169	373	.977	1.042
393	141	1.000	.981

123 INCHES ABOVE BOTTOM OF ACTIVE FUEL

FOUR-BUNDLE ROD-ROD PLANAR LA-140 DISTRIBUTION NORMALIZED TO MEASURED RODS IN THE PLANE

	A	B	C	D	E	F	G	7	6	5	4	3	2	1	
1	1.148	.989		1.038		1.125	1.123	1.167	1.165		1.137		1.130	1.262	A
2	1.008	1.024	.947	1.071	1.033	1.113	1.009	1.029	1.161	1.164	1.169	1.036	1.161	1.102	B
3		.927	1.042	.920	.921	.916			.981	.998	1.036	1.100	1.022		C
4	1.004	1.069	.940		.865	.886	1.029	1.068	.948	.920		.987	1.168	1.120	D
5		1.053	.908	.858	.752	.888			.941	.876	.926	.978	1.115		E
6	1.060	1.082	.903	.880	.870	.901	.868	.871	.973	.947	.963	.987	1.130	1.174	F
7	1.049	.960		1.007		.843	.939	.958	.903		1.061		1.025	1.145	G
G	1.122	.975		1.049		.847	.973	.979	.872		1.027		.982	1.078	7
F	1.089	1.087	.929	.949	.907	.967	.882	.888	.922	.903	.913	.922	1.095	1.055	6
E		1.073	.943	.882	.871	.900			.887	.749	.854	.917	1.017		5
D	1.030	1.082	.951		.909	.943	1.085	1.057	.886	.866		.939	1.020	1.011	4
C		.960	1.033	.975	.939	.953			.952	.908	.933	1.011	.892		3
B	1.045	1.064	.941	1.096	1.078	1.102	1.007	1.021	1.115	1.049	1.075	.934	.982	.953	2
A	1.210	1.022		1.050		1.084	1.134	1.102	1.078		.987		.950	1.106	1
	1	2	3	4	5	6	7	G	F	E	D	C	B	A	

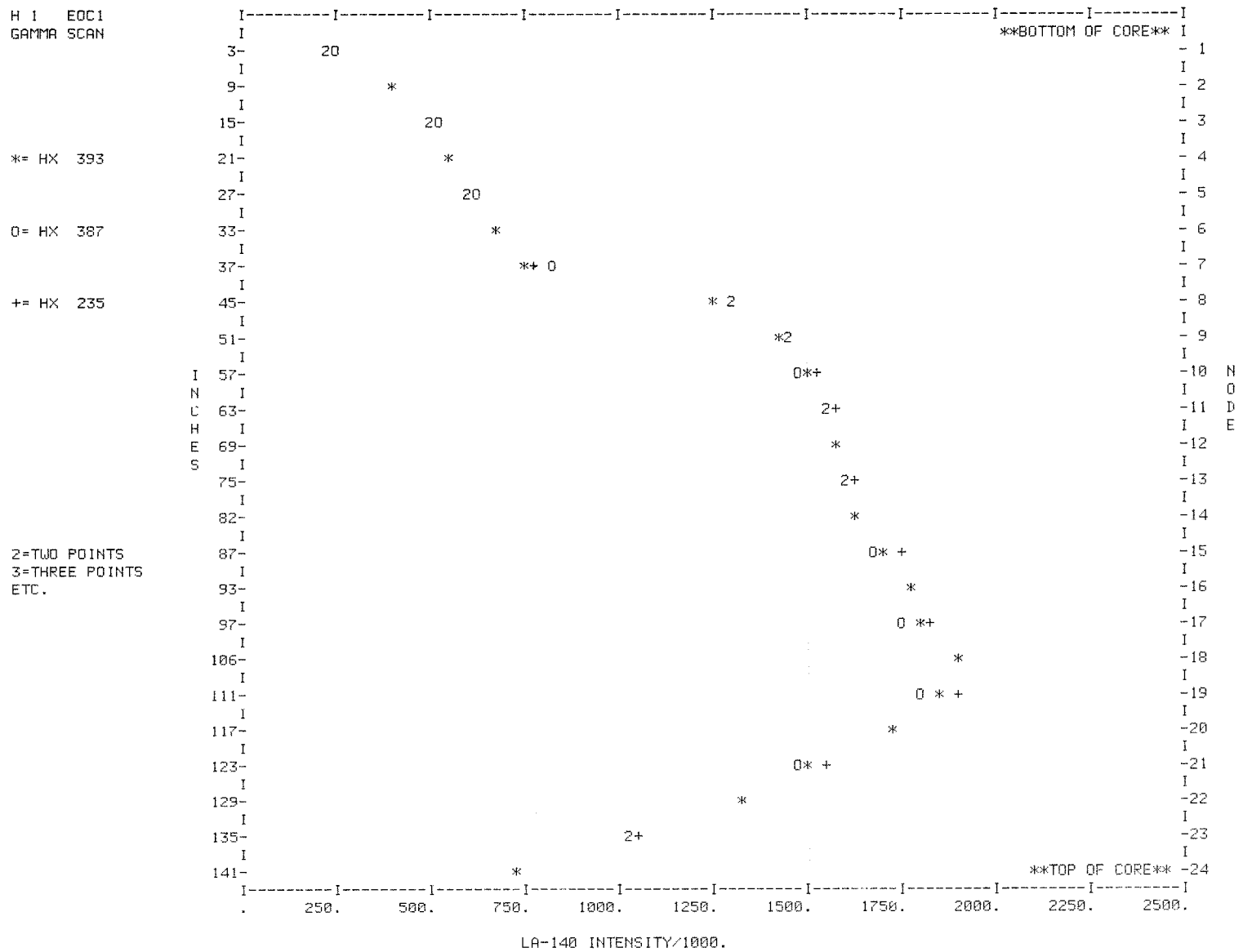
BND ID		BND PWR	
169	373	.974	1.050
393	141	1.003	.972

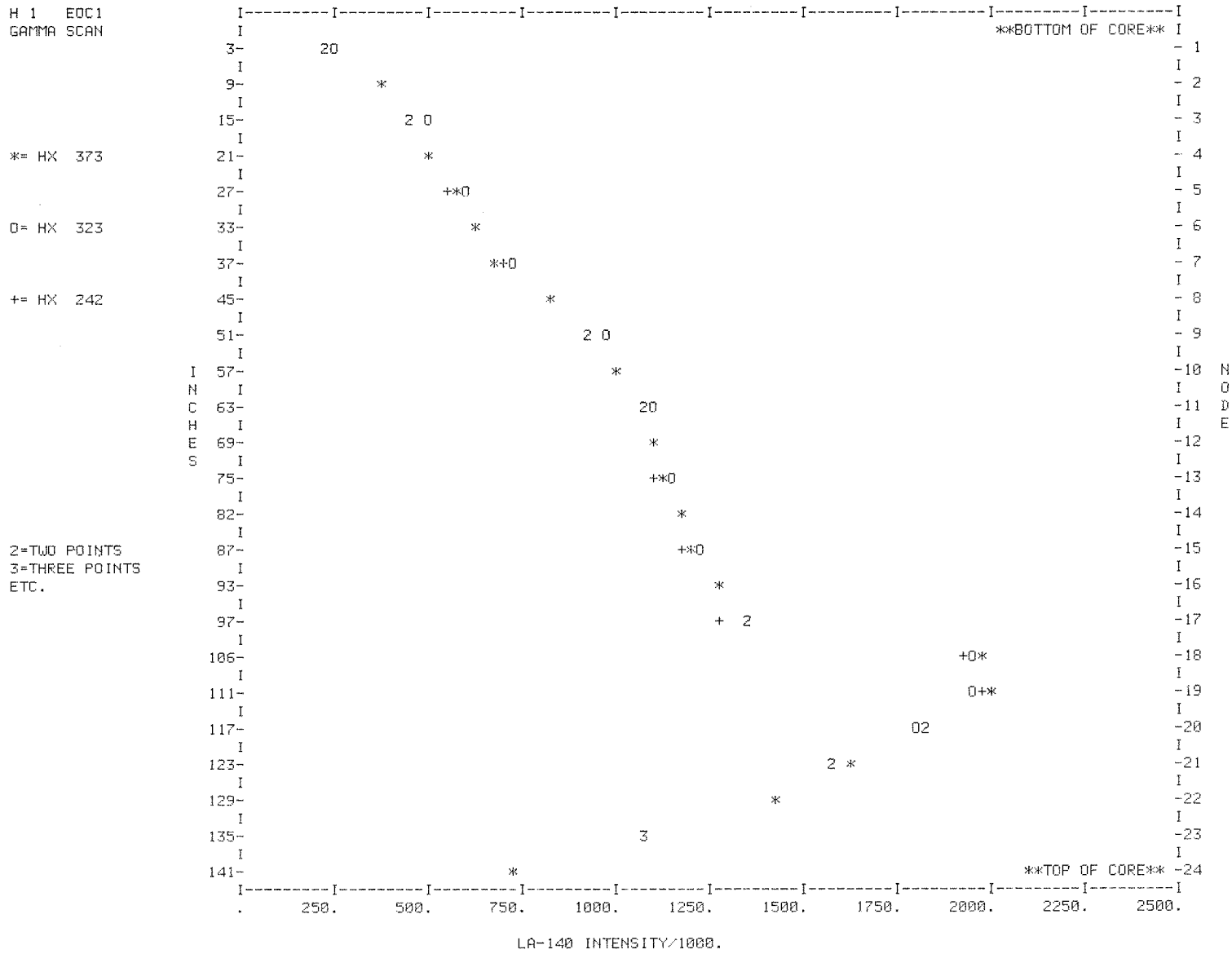
129 INCHES ABOVE BOTTOM OF ACTIVE FUEL

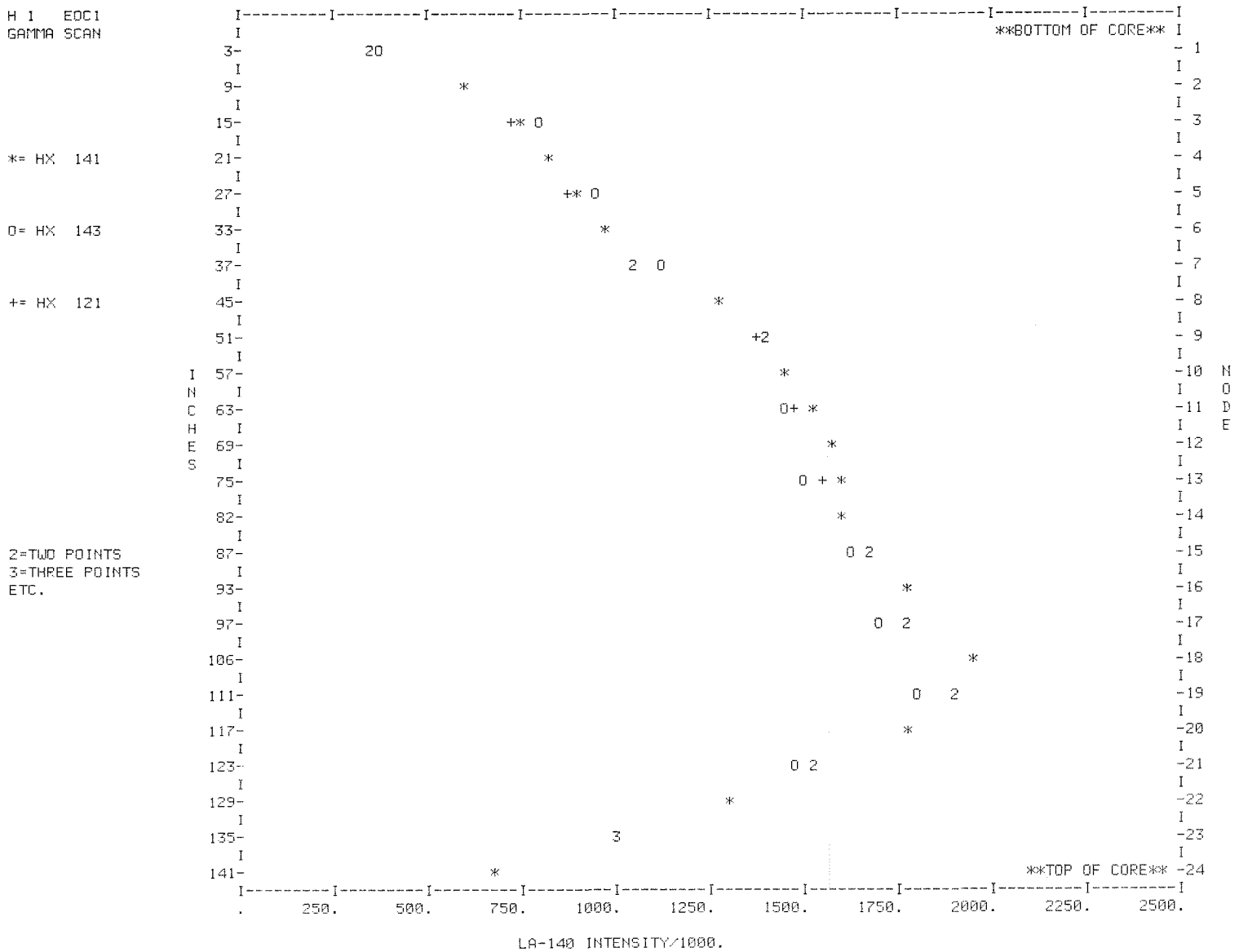
FOUR-BUNDLE ROD-ROD PLANAR LA-140 DISTRIBUTION NORMALIZED TO MEASURED RODS IN THE PLANE

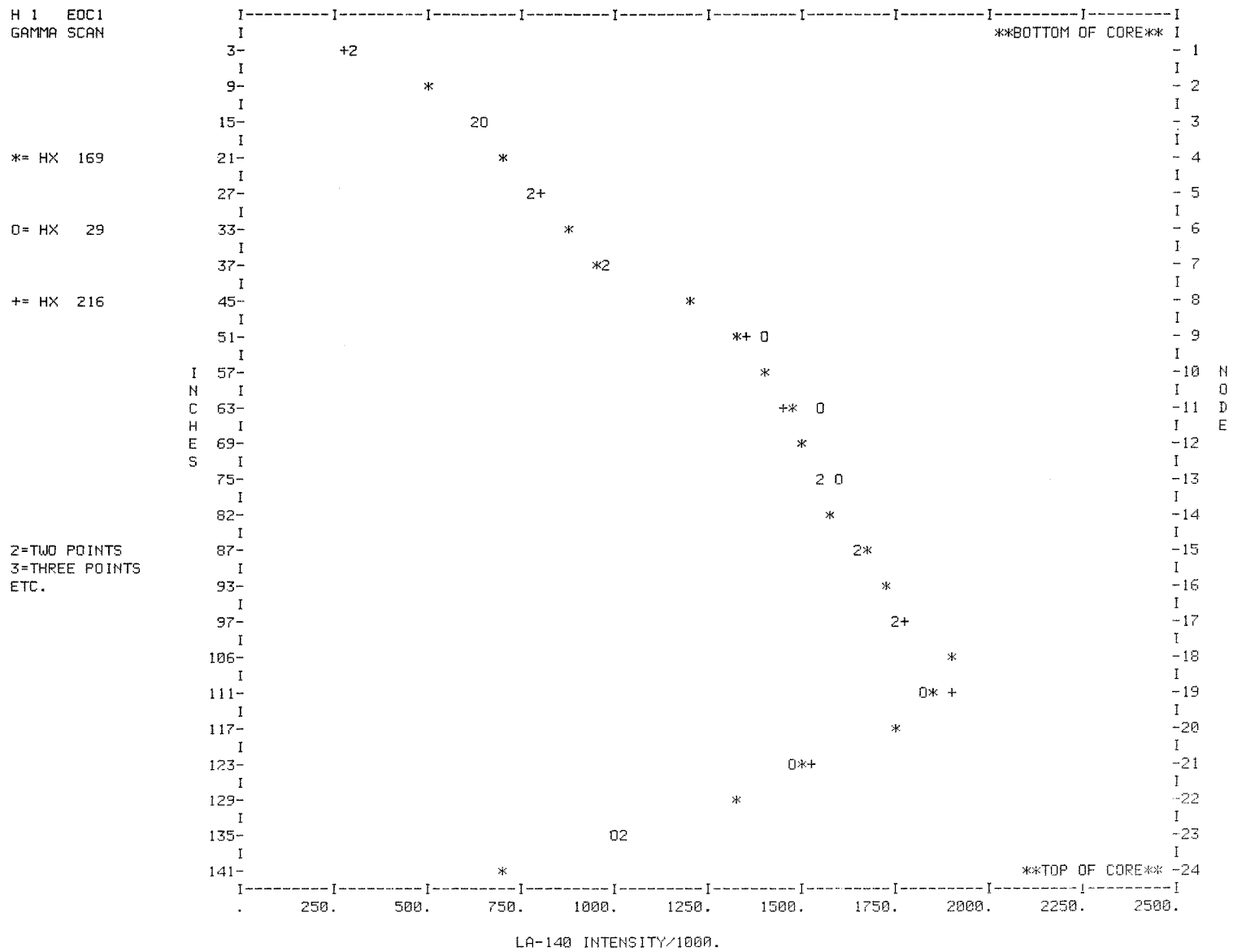
APPENDIX G

AXIAL PLOTS OF BUNDLES SYMMETRIC WITHIN THE CORE


H 1 EOC1
GAMMA SCAN
*= HX 393
O= HX 387
+= HX 235
2=TWO POINTS
3=THREE POINTS
ETC.
INCHES
NODE
BOTTOM OF CORE
TOP OF CORE
3- 9- 15- 21- 27- 33- 37- 45- 51- 57- 63- 69- 75- 82- 87- 93- 97- 106- 111- 117- 123- 129- 135- 141-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
. 250. 500. 750. 1000. 1250. 1500. 1750. 2000. 2250. 2500.
LA-140 INTENSITY/1000.


H 1 EOC1
GAMMA SCAN
*= HX 373
O= HX 323
+= HX 242
2=TWO POINTS
3=THREE POINTS
ETC.
INCHES
NODE
BOTTOM OF CORE
TOP OF CORE
3- 9- 15- 21- 27- 33- 37- 45- 51- 57- 63- 69- 75- 82- 87- 93- 97- 106- 111- 117- 123- 129- 135- 141-
- 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 -10 -11 -12 -13 -14 -15 -16 -17 -18 -19 -20 -21 -22 -23 -24
. 250. 500. 750. 1000. 1250. 1500. 1750. 2000. 2250. 2500.
LA-140 INTENSITY/1000.


H 1 EOC1
GAMMA SCAN
*= HX 141
O= HX 143
+= HX 121
2=TWO POINTS
3=THREE POINTS
ETC.
BOTTOM OF CORE
TOP OF CORE
INCHES
NODE
LA-140 INTENSITY/1000.
250. 500. 750. 1000. 1250. 1500. 1750. 2000. 2250. 2500.


H 1 EOC1
GAMMA SCAN
*= HX 169
O= HX 29
+= HX 216
2=TWO POINTS
3=THREE POINTS
ETC.
INCHES
NODE
BOTTOM OF CORE
TOP OF CORE
3- 9- 15- 21- 27- 33- 37- 45- 51- 57- 63- 69- 75- 82- 87- 93- 97- 106- 111- 117- 123- 129- 135- 141-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
. 250. 500. 750. 1000. 1250. 1500. 1750. 2000. 2250. 2500.
LA-140 INTENSITY/1000.

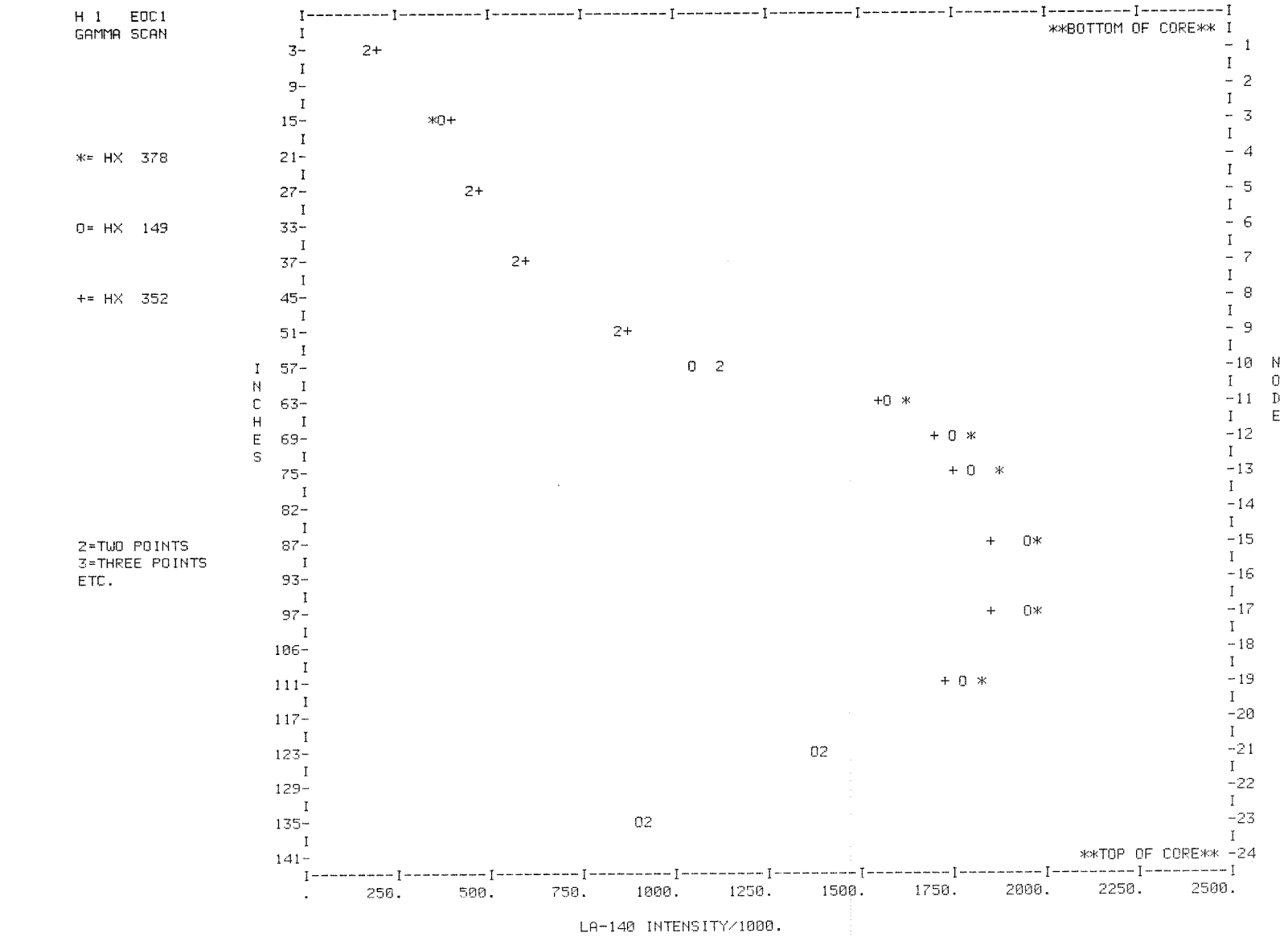
H 1 EOC1
GAMMA SCAN

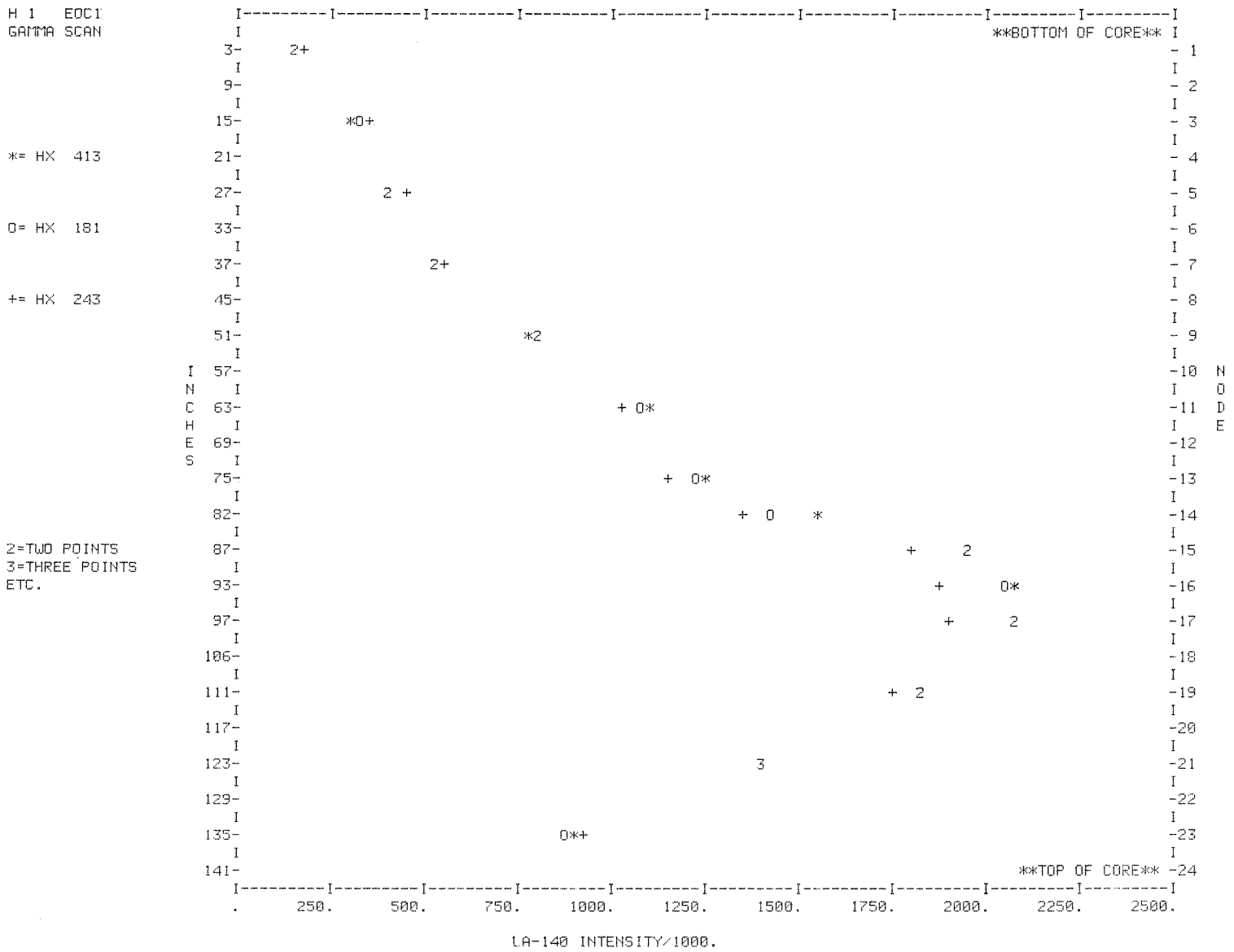
*= HX 378

O= HX 149

+= HX 352

2=TWO POINTS
3=THREE POINTS
ETC.




H 1 EOC1
GAMMA SCAN
*= HX 413
O= HX 181
+= HX 243
2=TWO POINTS
3=THREE POINTS
ETC.
BOTTOM OF CORE
TOP OF CORE
INCHES
NODE
LA-140 INTENSITY/1000.

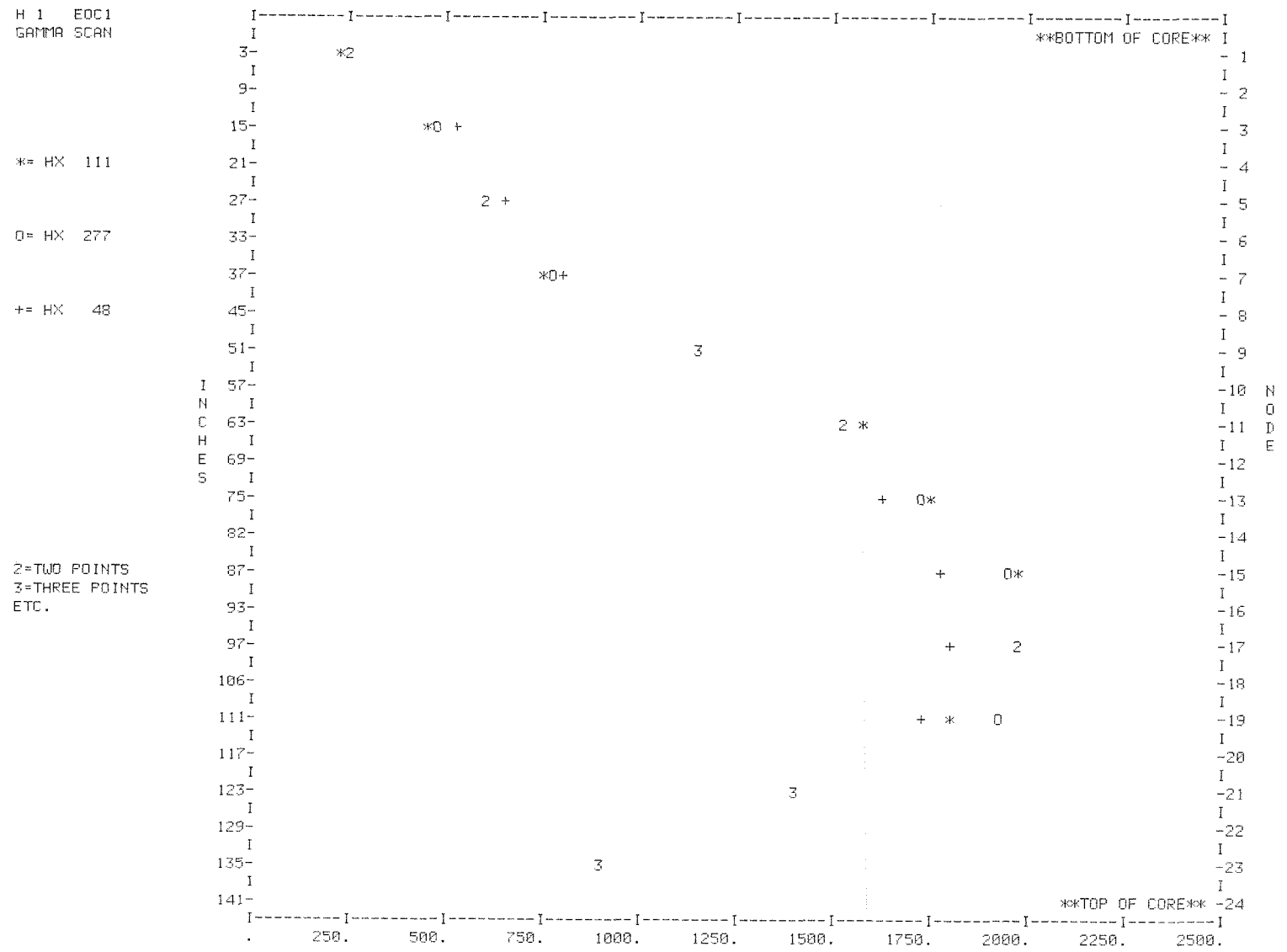
H 1 EOC1
GAMMA SCAN

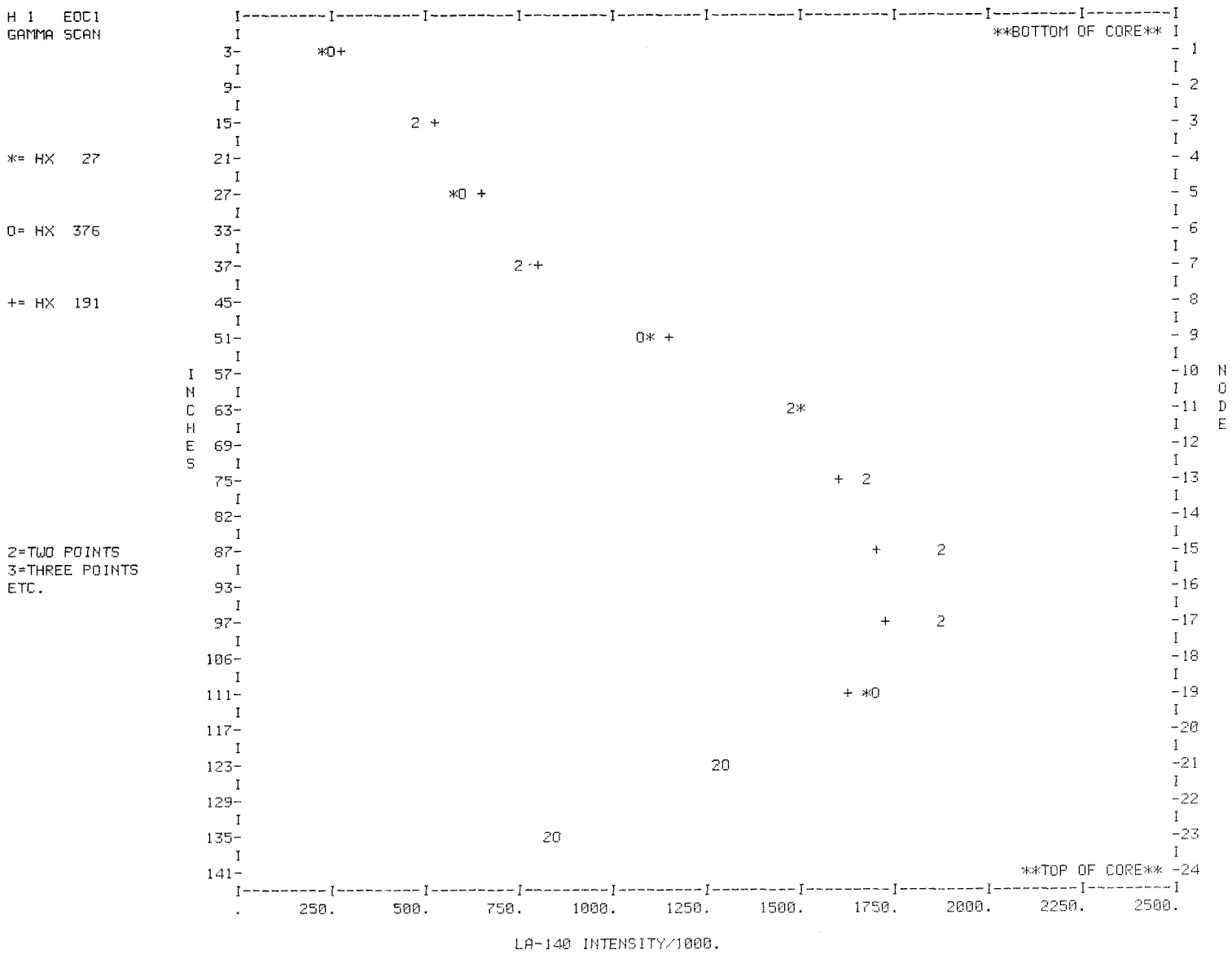
*= HX 111

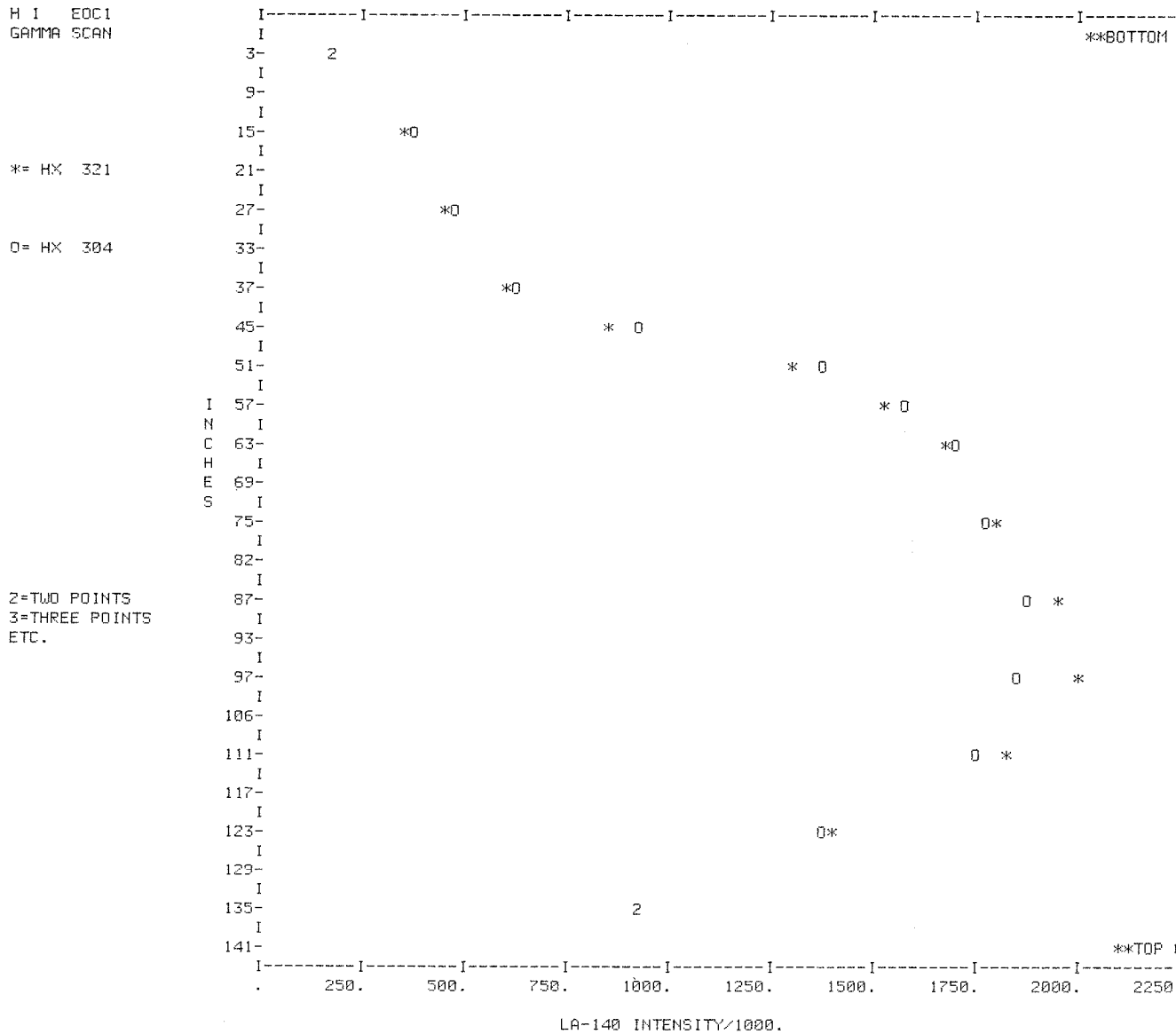
O= HX 277

+= HX 48

2=TWO POINTS
3=THREE POINTS
ETC.




H 1 EOC1
GAMMA SCAN
*= HX 27
O= HX 376
+= HX 191
2=TWO POINTS
3=THREE POINTS
ETC.
INCHES
NODE
BOTTOM OF CORE
TOP OF CORE
3
9
15
21
27
33
37
45
51
57
63
69
75
82
87
93
97
106
111
117
123
129
135
141
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
250.
500.
750.
1000.
1250.
1500.
1750.
2000.
2250.
2500.
LA-140 INTENSITY/1000.

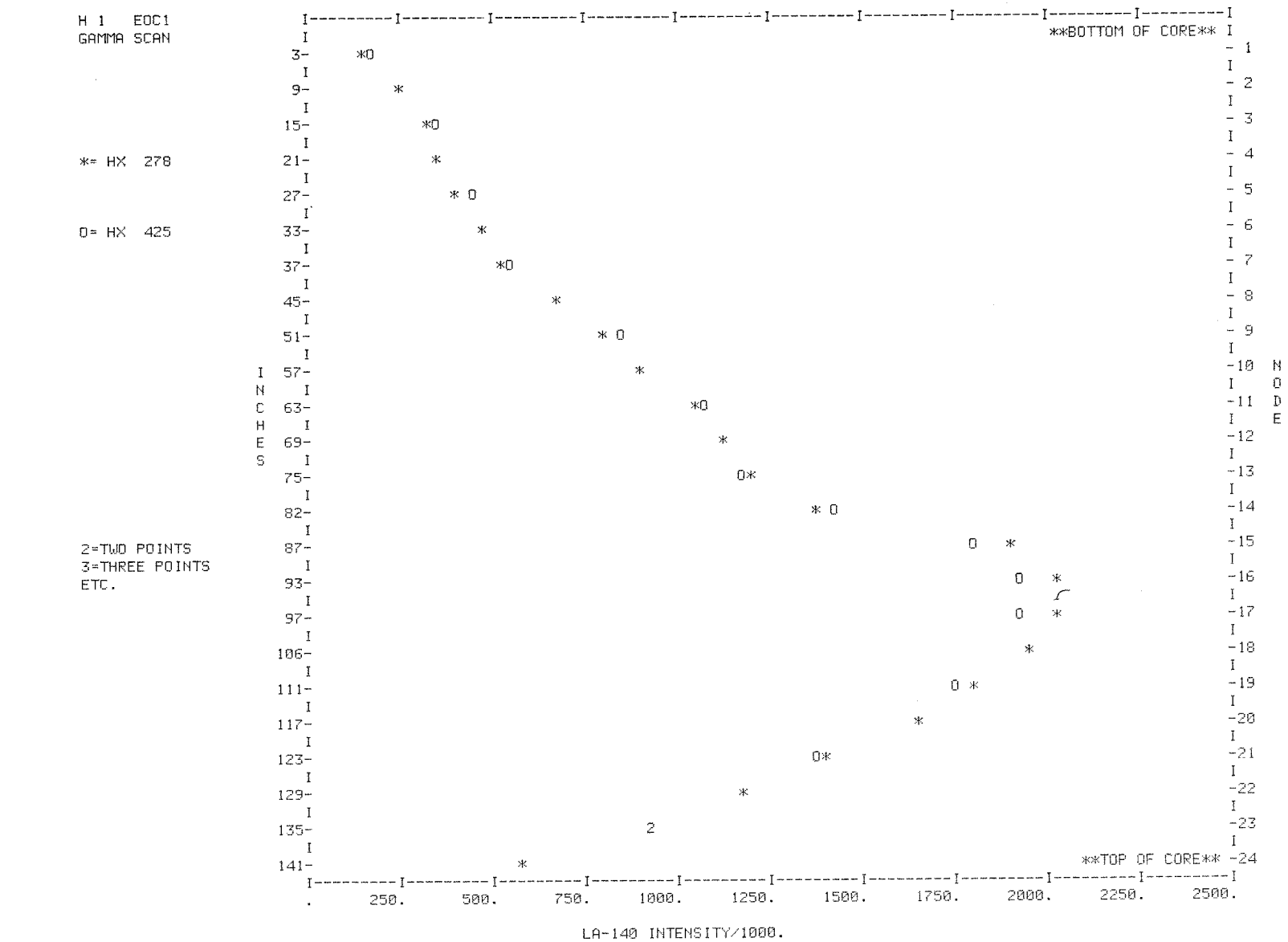

H I EOC1
GAMMA SCAN
*= HX 321
O= HX 304
2=TWO POINTS
3=THREE POINTS
ETC.
INCHES
NODE
BOTTOM OF CORE
TOP OF CORE
3- 9- 15- 21- 27- 33- 37- 45- 51- 57- 63- 69- 75- 82- 87- 93- 97- 106- 111- 117- 123- 129- 135- 141-
- 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 -10 -11 -12 -13 -14 -15 -16 -17 -18 -19 -20 -21 -22 -23 -24
. 250. 500. 750. 1000. 1250. 1500. 1750. 2000. 2250. 2500.
LA-140 INTENSITY/1000.

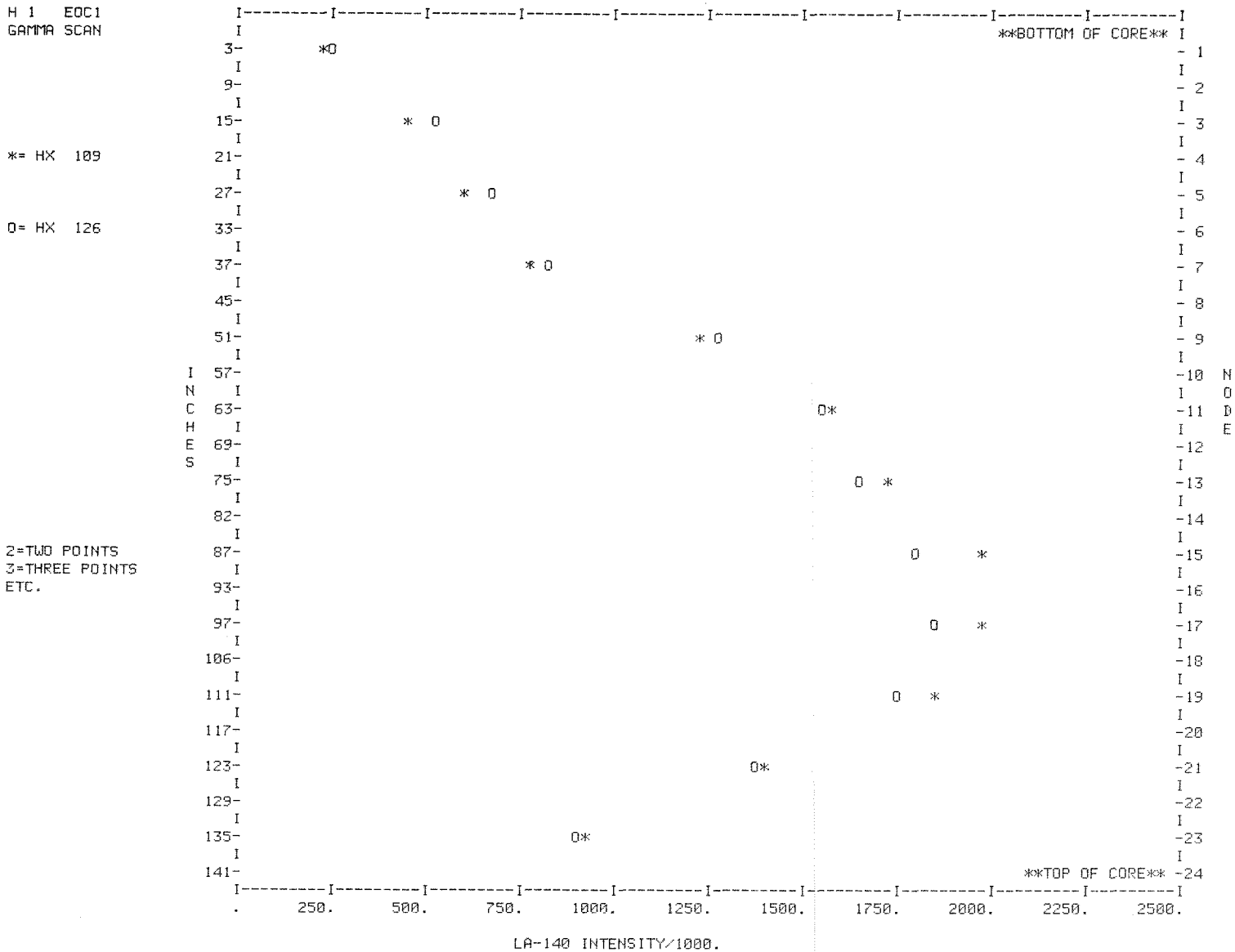
H 1 EOC1
GAMMA SCAN

*= HX 278

O= HX 425

2=TWO POINTS
3=THREE POINTS
ETC.



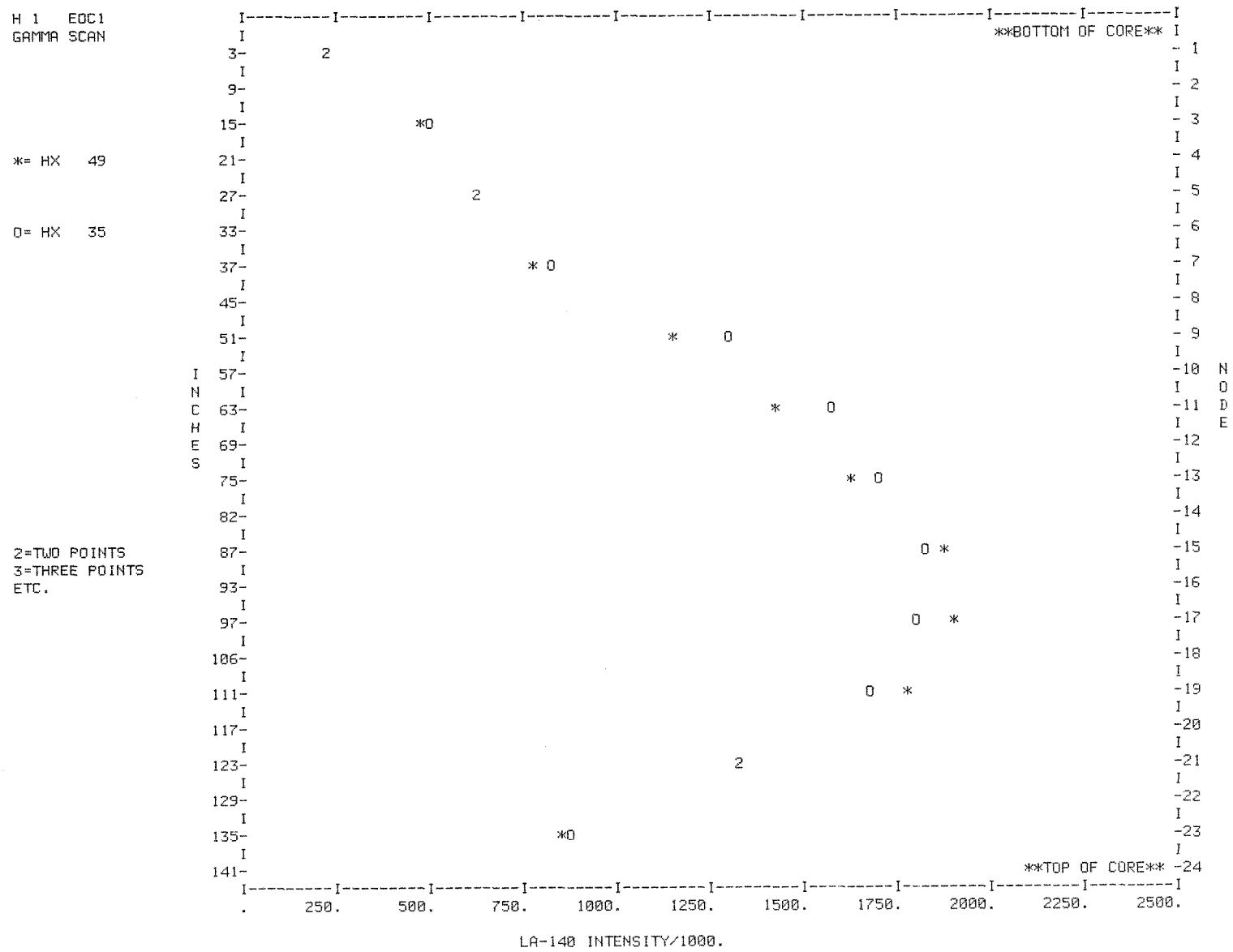

H 1 EOC1
GAMMA SCAN
*= HX 109
O= HX 126
2=TWO POINTS
3=THREE POINTS
ETC.
INCHES
BOTTOM OF CORE
TOP OF CORE
NODE
LA-140 INTENSITY/1000.

H 1 EOC1
GAMMA SCAN

*= HX 49

O= HX 35

2=TWO POINTS
3=THREE POINTS
ETC.

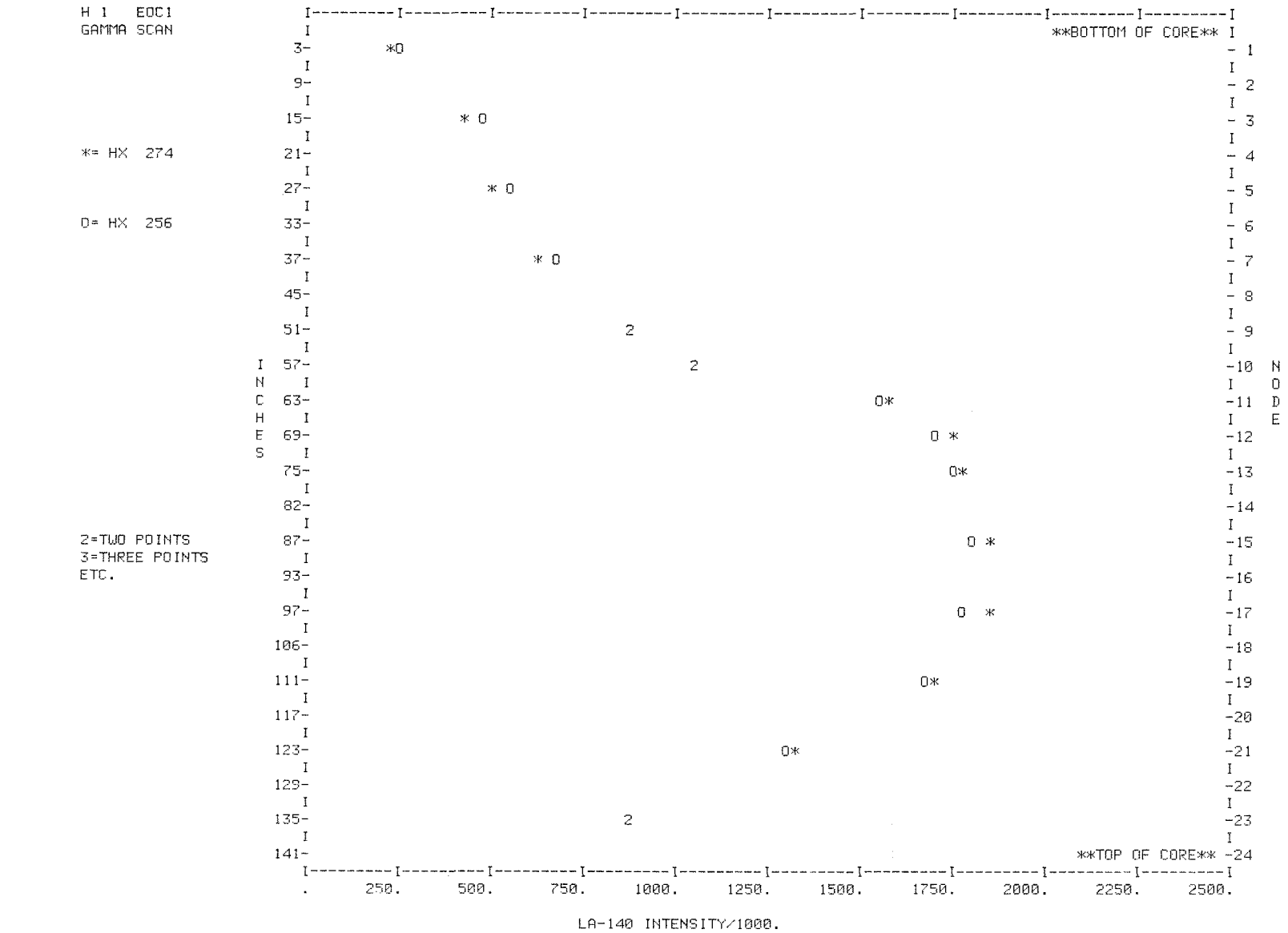


H 1 EOC1
GAMMA SCAN

*= HX 274

O= HX 256

2=TWO POINTS
3=THREE POINTS
ETC.

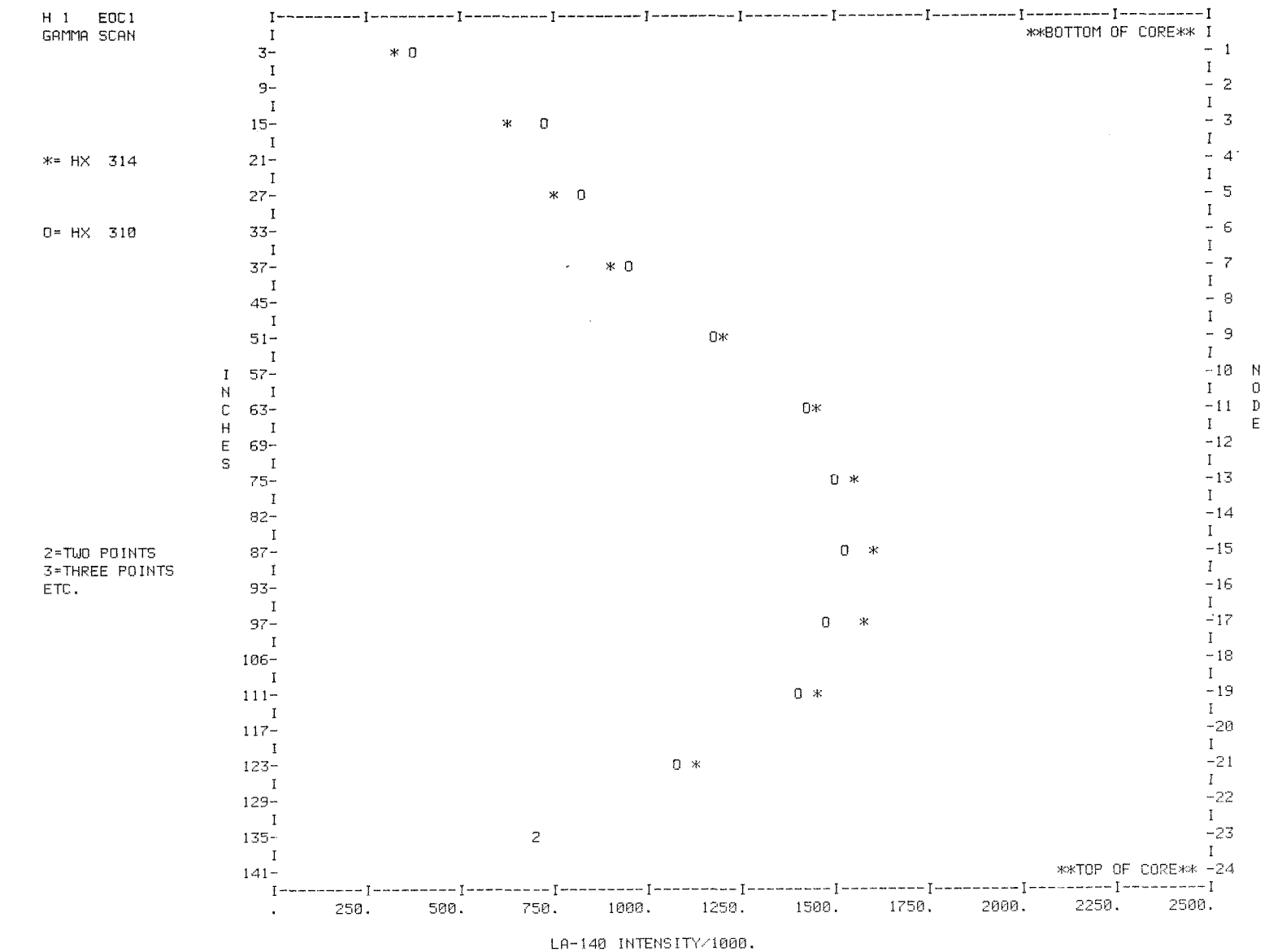


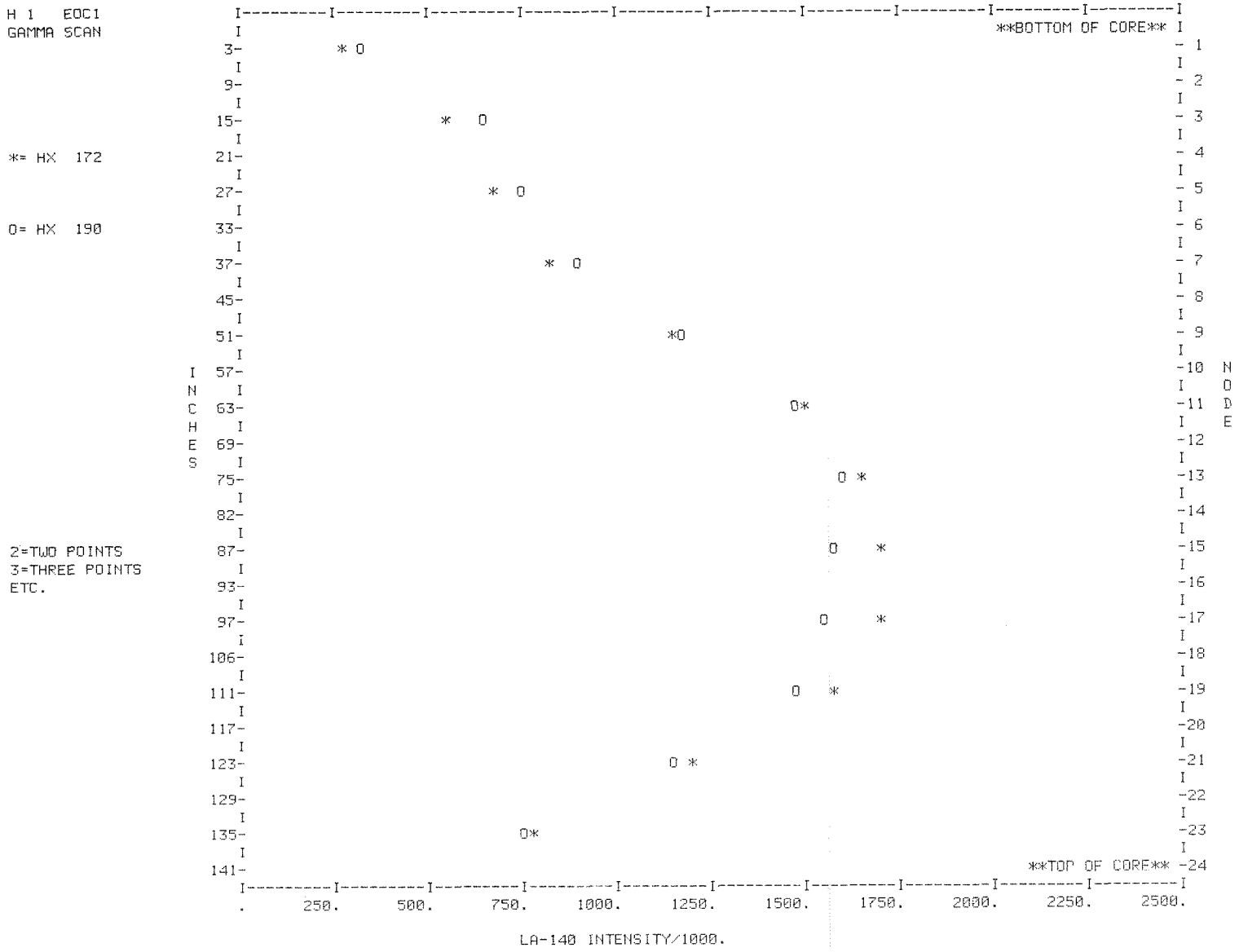
H 1 EOC1
GAMMA SCAN

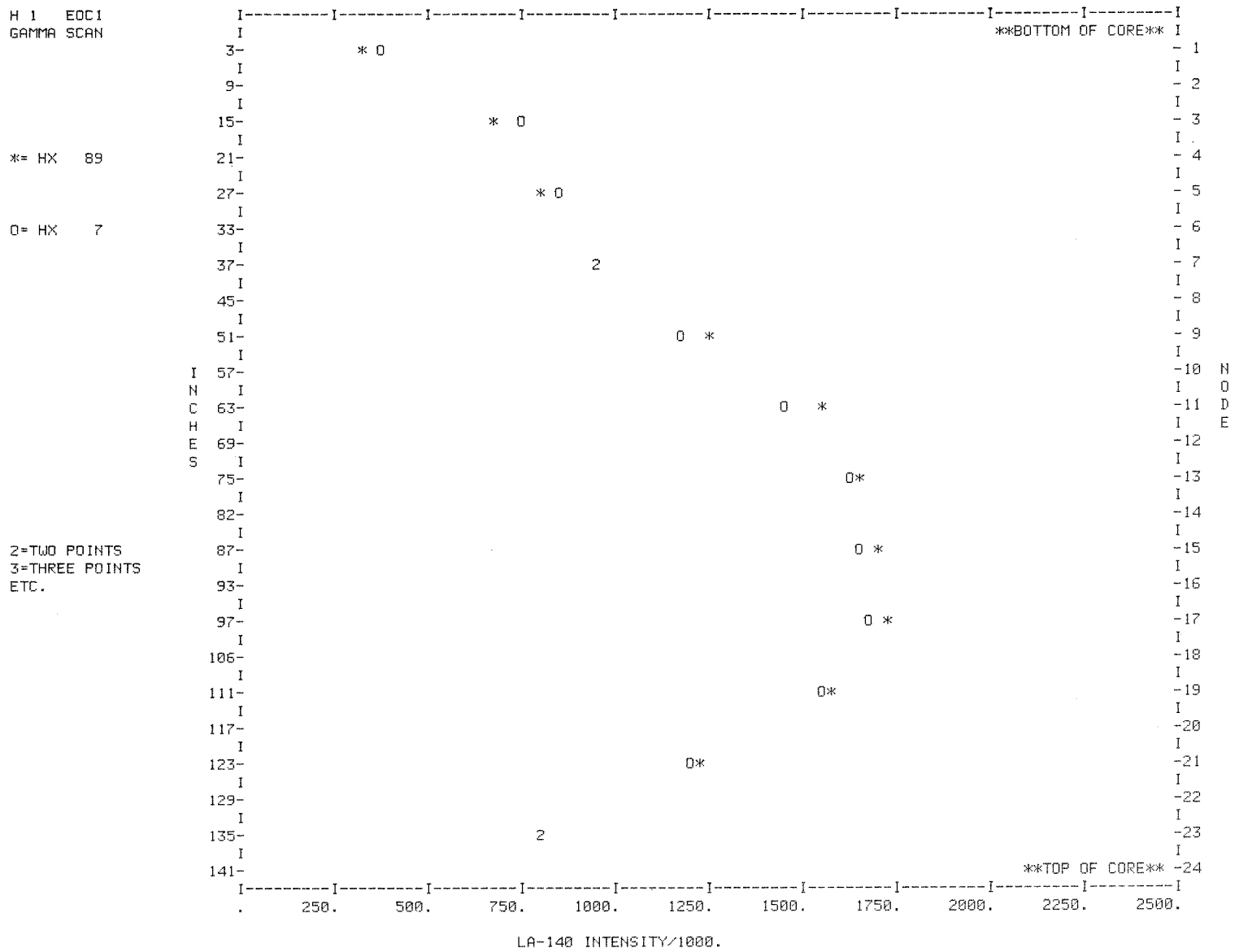
*= HX 314

O= HX 310

2=TWO POINTS
3=THREE POINTS
ETC.

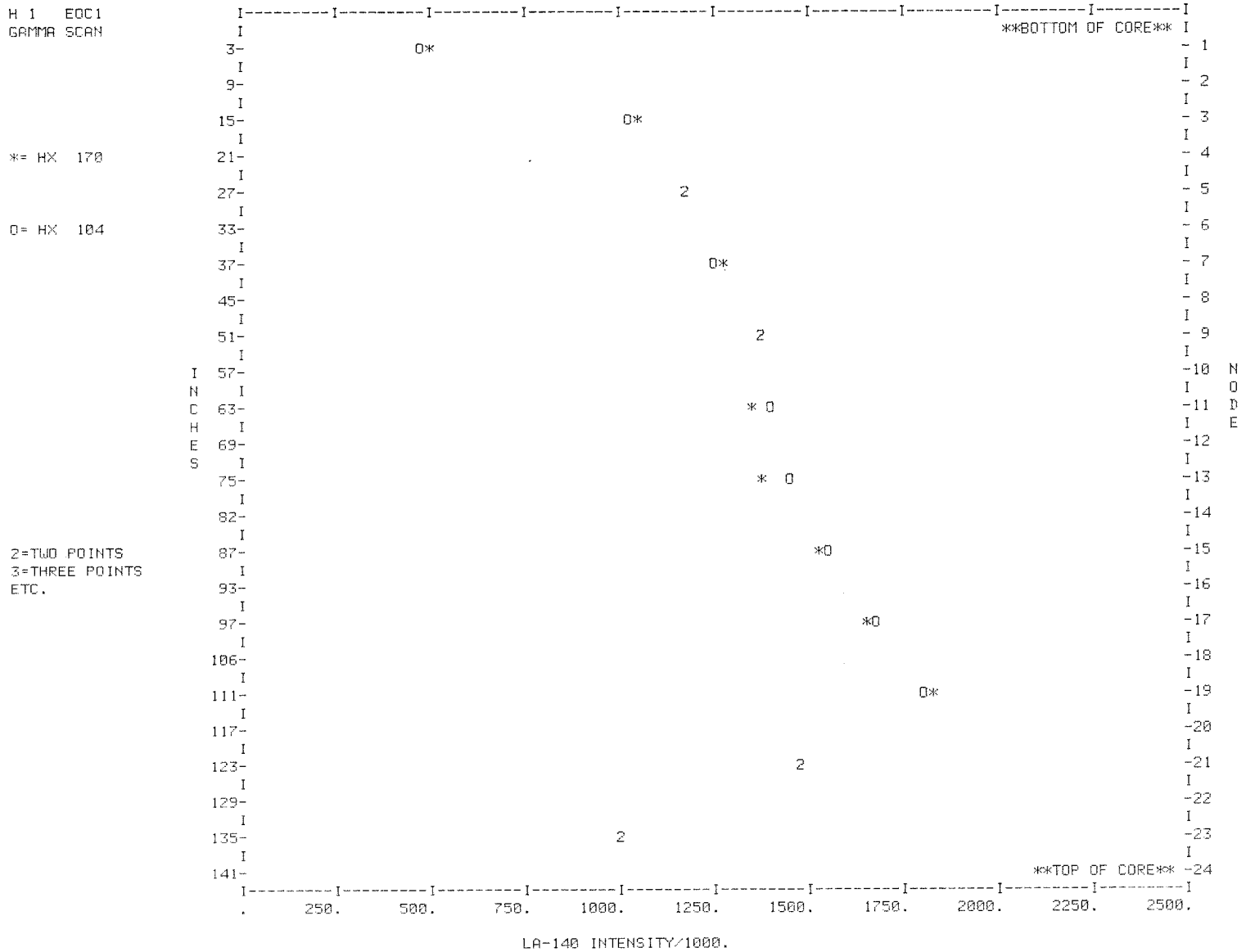


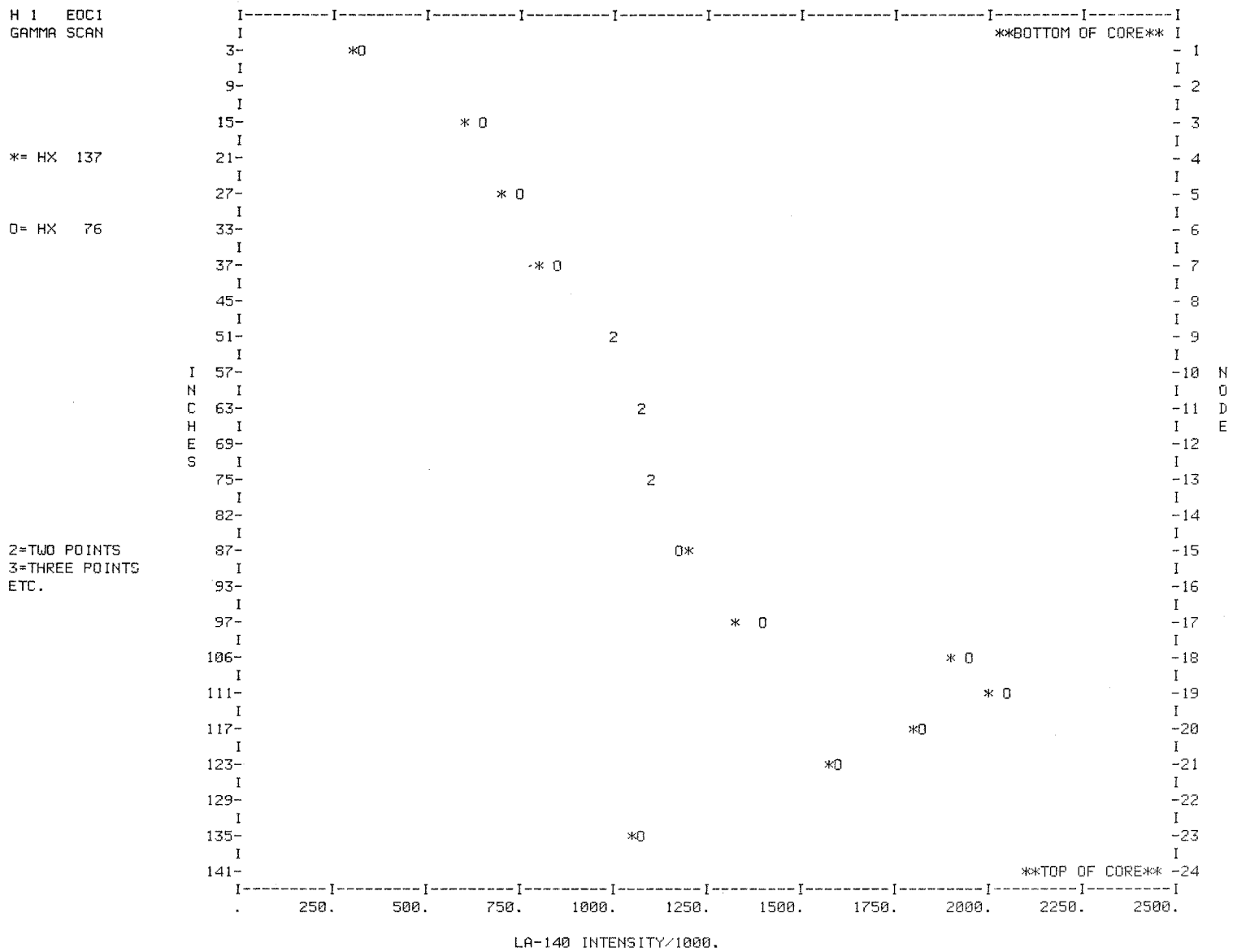

H 1 EOC1
GAMMA SCAN
*= HX 172
O= HX 190
2=TWO POINTS
3=THREE POINTS
ETC.
INCHES
BOTTOM OF CORE
TOP OF CORE
NODE
LA-140 INTENSITY/1000.

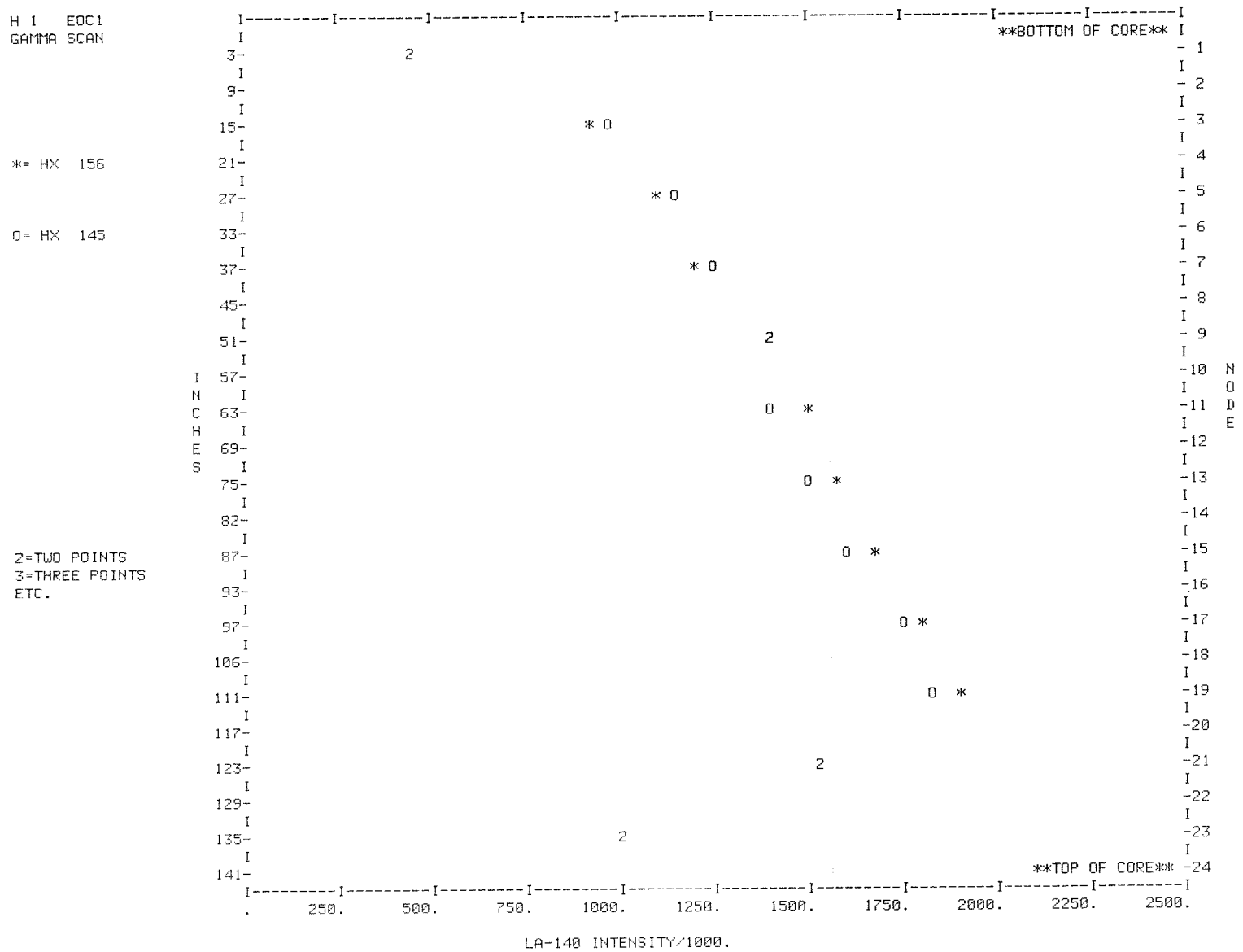

H 1 EOC1
GAMMA SCAN
*= HX 89
O= HX 7
2=TWO POINTS
3=THREE POINTS
ETC.
INCHES
NODE
BOTTOM OF CORE
TOP OF CORE
LA-140 INTENSITY/1000.

APPENDIX H

AXIAL PLOTS OF BUNDLES SYMMETRIC ALONG THE DIAGONAL OCTANT BOUNDARY


H 1 EOC1
GAMMA SCAN
*= HX 170
O= HX 104
2=TWO POINTS
3=THREE POINTS
ETC.
INCHES
NODE
BOTTOM OF CORE
TOP OF CORE
250. 500. 750. 1000. 1250. 1500. 1750. 2000. 2250. 2500.
LA-140 INTENSITY/1000.


H 1 EOC1
GAMMA SCAN
*= HX 137
O= HX 76
2=TWO POINTS
3=THREE POINTS
ETC.
BOTTOM OF CORE
TOP OF CORE
INCHES
NODE
LA-140 INTENSITY/1000.

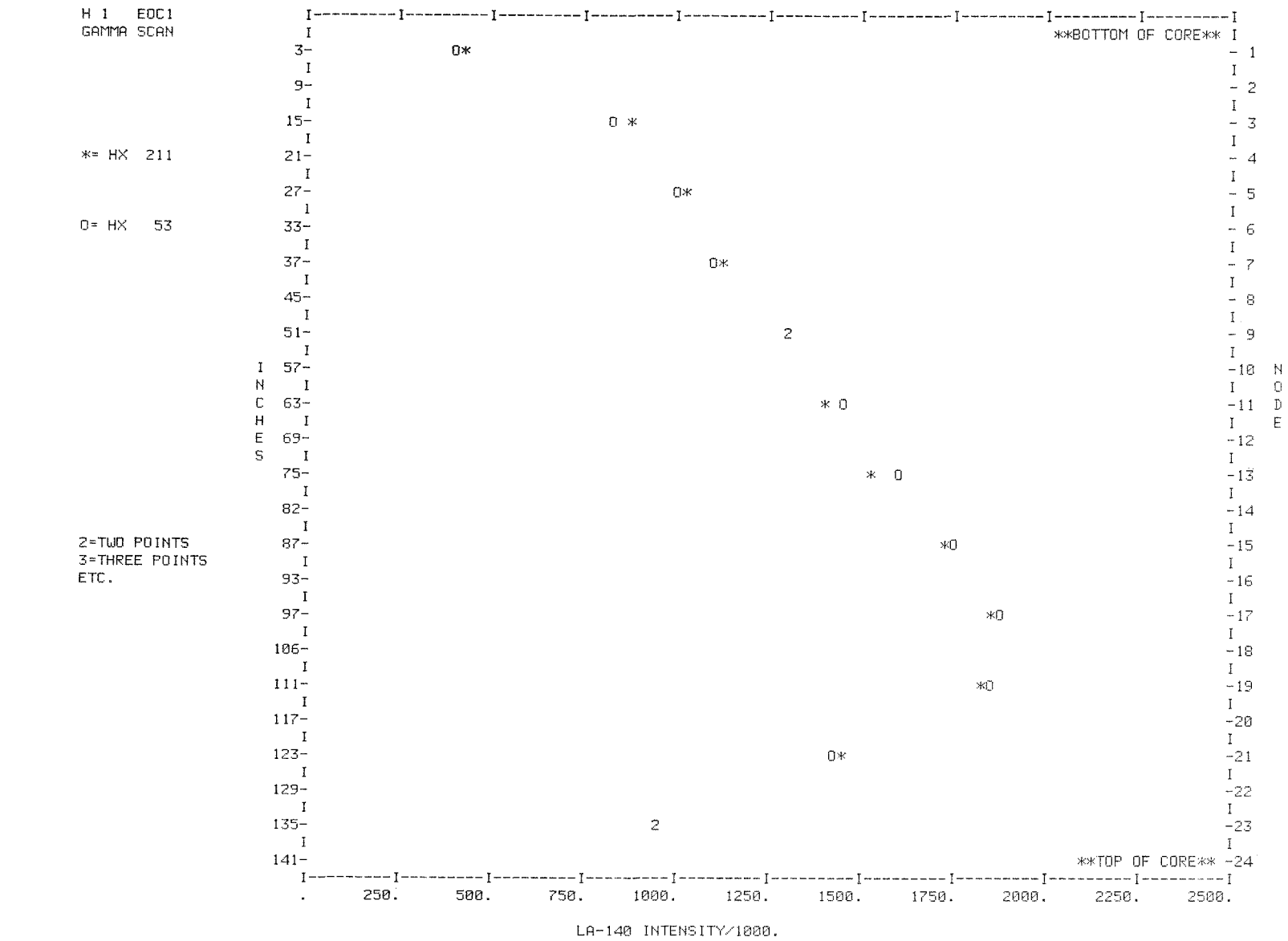

H 1 EOC1
GAMMA SCAN
*= HX 156
O= HX 145
2=TWO POINTS
3=THREE POINTS
ETC.
INCHES
BOTTOM OF CORE
TOP OF CORE
NODE
LA-140 INTENSITY/1000.

H 1 EOC1
GAMMA SCAN

*= HX 211

O= HX 53

2=TWO POINTS
3=THREE POINTS
ETC.

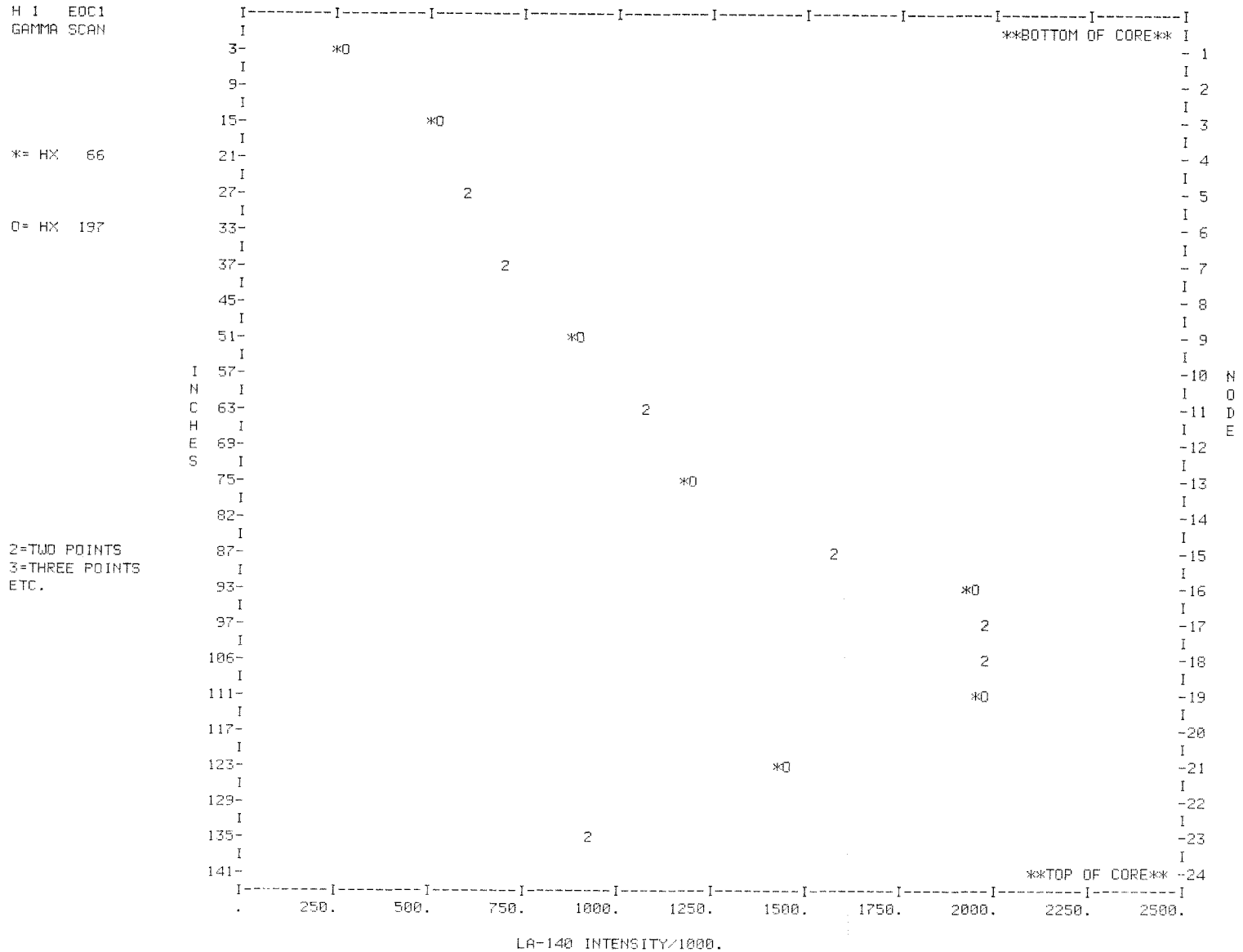


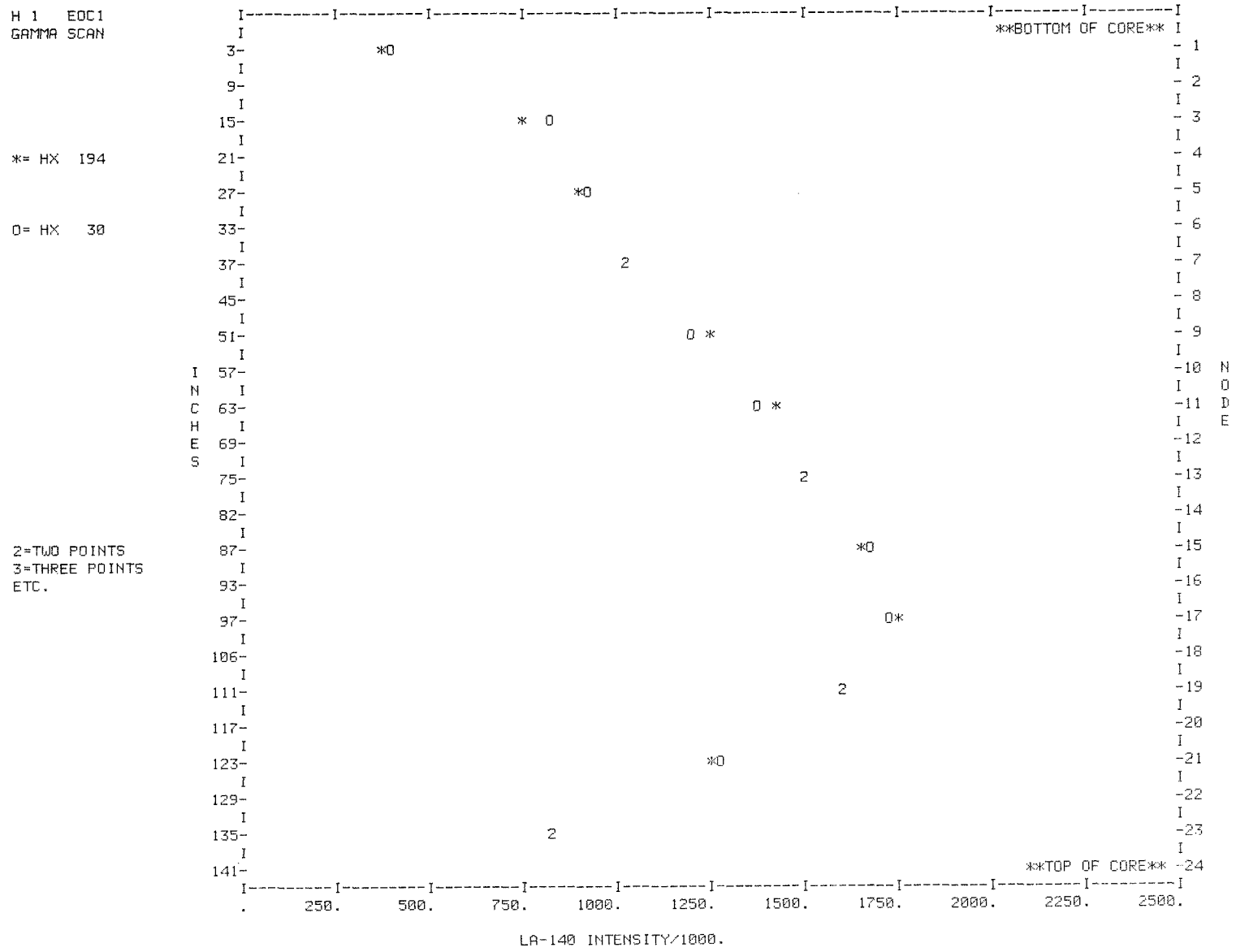
H 1 EOC1
GAMMA SCAN

*= HX 66

O= HX 197

2=TWO POINTS
3=THREE POINTS
ETC.




H 1 EOC1
GAMMA SCAN
*= HX 194
O= HX 30
2=TWO POINTS
3=THREE POINTS
ETC.
INCHES
BOTTOM OF CORE
TOP OF CORE
NODE
LA-140 INTENSITY/1000.

```
H 1   EOC1                I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
GAMMA SCAN                I                                                                                 **BOTTOM OF CORE** I
                         3-          0*                                                                                        - 1
                          I                                                                                                    I
                         9-                                                                                                    - 2
                          I                                                                                                    I
                        15-                     2                                                                               - 3
                          I                                                                                                    I
*= HX  491              21-                                                                                                     - 4
                          I                                                                                                    I
                        27-                         *0                                                                          - 5
                          I                                                                                                    I
0= HX  507              33-                                                                                                     - 6
                          I                                                                                                    I
                        37-                             2                                                                       - 7
                          I                                                                                                    I
                        45-                                                                                                     - 8
                          I                                                                                                    I
                        51-                                 0*                                                                  - 9
                          I                                                                                                    I
                    I   57-                                                                                                     -10  N
                    N     I                                                                                                    I    O
                    C   63-                                         2                                                           -11  D
                    H     I                                                                                                    I    E
                    E   69-                                                                                                     -12
                    S     I                                                                                                    I
                        75-                                         0*                                                          -13
                          I                                                                                                    I
                        82-                                                                                                     -14
                          I                                                                                                    I
2=TWO POINTS            87-                                          0*                                                         -15
3=THREE POINTS            I                                                                                                    I
ETC.                    93-                                                                                                     -16
                          I                                                                                                    I
                        97-                                         2                                                           -17
                          I                                                                                                    I
                       106-                                                                                                     -18
                          I                                                                                                    I
                       111-                                     2                                                               -19
                          I                                                                                                    I
                       117-                                                                                                     -20
                          I                                                                                                    I
                       123-                             0*                                                                      -21
                          I                                                                                                    I
                       129-                                                                                                     -22
                          I                                                                                                    I
                       135-                 2                                                                                   -23
                          I                                                                                                    I
                       141-                                                                                 **TOP OF CORE** -24
                          I---------I---------I---------I---------I---------I---------I---------I---------I---------I---------I
                          .      250.      500.      750.     1000.     1250.     1500.     1750.     2000.     2250.     2500.

                                                   LA-140 INTENSITY/1000.
```

APPENDIX I

ASYMMETRY RATIOS FOR SYMMETRICALLY PAIRED BUNDLE SETS

Group 1 Symmetric Ratios

Elevation (In Inches)	Ratios for Bundle Pairs			
	29/169	323/373	143/141	387/393
3	1.037	1.121	1.095	1.072
15	1.033	1.084	1.078	1.053
27	0.982	1.051	1.063	1.039
37	1.049	1.068	1.064	1.125
51	1.050	1.048	1.004	1.024
63	1.053	1.025	0.951	0.997
75	1.036	1.028	0.947	0.990
87	0.990	1.015	0.958	0.978
97	0.992	0.998	0.958	0.977
111	0.985	0.980	0.945	0.975
123	0.972	0.969	0.975	0.980
135	0.986	1.008	0.992	1.004
Integral	1.010	1.014	0.985	1.002

Group 2 Symmetric Ratios

Elevation (In Inches)	Ratios for Bundle Pairs			
	191/27	243/413	48/111	352/378
3	1.134	1.092	1.098	1.074
15	1.148	1.149	1.161	1.154
27	1.126	1.119	1.122	1.099
37	1.085	1.082	1.071	1.071
51	1.045	1.011	1.000	1.028
63	0.982	0.948	0.965	0.951
75	0.958	0.930	0.922	0.926
87	0.913	0.919	0.903	0.935
97	0.917	0.913	0.907	0.928
111	0.969	0.952	0.957	0.952
123	0.989	0.997	0.997	0.994
135	0.993	1.005	1.015	0.992
Integral	0.985	0.967	0.972	0.971

Group 3 Symmetric Ratios

Elevation (In Inches)	Ratios for Bundle Pairs			
	35/49	425/278	126/109	304/321
3	1.049	1.097	1.093	1.045
15	1.023	1.104	1.159	1.053
27	1.031	1.103	1.158	1.032
37	1.066	1.060	1.076	1.043
51	1.127	1.054	1.040	1.048
63	1.099	1.030	0.991	1.029
75	1.049	0.982	0.957	0.988
87	0.976	0.951	0.920	0.952
97	0.948	0.949	0.933	0.923
111	0.947	0.980	0.948	0.957
123	1.000	0.984	0.991	0.979
135	1.020	1.012	0.969	0.997
Integral	1.017	0.994	0.985	0.986

Group 4 Symmetric Ratios

Elevation (In Inches)	Ratios for Bundle Pairs			
	190/172	310/314	256/274	7/89
3	1.144	1.161	1.138	1.136
15	1.159	1.163	1.171	1.145
27	1.138	1.094	1.116	1.048
37	1.111	1.056	1.045	0.996
51	1.038	0.991	1.007	0.929
63	0.982	0.985	0.986	0.943
75	0.962	0.968	0.983	0.988
87	0.919	0.950	0.963	0.977
97	0.914	0.933	0.960	0.981
111	0.934	0.968	0.983	0.974
123	0.956	0.958	0.982	0.979
135	0.987	0.981	0.989	0.997
Integral	0.986	0.992	0.995	0.989

Group 1a Symmetric Ratios

Elevation (In Inches)	Ratios for Bundle Pairs 216/169	242/373	121/141	235/393	Ratio of 4-Bundle Nodal Sums
3	0.990	1.033	1.015	1.013	1.011
15	0.993	1.001	0.964	0.999	0.987
27	1.012	0.984	0.975	1.006	0.993
37	1.037	1.018	0.990	1.037	1.019
51	1.015	1.013	0.992	1.022	1.010
63	0.993	0.986	0.980	1.009	0.993
75	1.008	0.981	0.977	1.011	0.995
87	0.989	0.978	0.989	1.025	0.997
97	1.008	0.949	0.990	1.015	0.993
111	1.020	0.988	0.996	1.028	1.007
123	1.013	0.974	1.002	1.031	1.004
135	1.003	0.997	0.992	1.016	1.002
Integral	1.008	0.985	0.988	1.019	
4-Bundle Integral		1.001			

Group 2a Ratios for Four Bundle Nodal Sums

Elevation (In Inches)	Core Location Symmetric	Bundle Type Symmetric
3	1.018	1.021
15	1.039	0.992
27	1.021	0.999
37	1.004	0.996
51	0.999	0.993
63	0.980	1.007
75	0.981	1.010
87	0.992	1.006
97	0.992	1.006
111	1.012	1.026
123	0.995	1.007
135	0.985	1.022
4 Bundle Integral	0.996	1.008