PDR

CONFIRMATORY SURVEY OF THE TURBINE INTERNAL COMPONENTS SHOREHAM NUCLEAR POWER STATION BROOKHAVEN, NEW YORK

T. J. VITKUS

Prepared for the
Division of Low-Level Waste Management and Decommissioning
Headquarters Office
U. S. Nuclear Regulatory Commission

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
Environmental Survey and Site Assessment Program
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NOTICES

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Prepared by

T. J. Vitkus

Environmental Survey and Site Assessment Program
Energy/Environment System Division
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

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Division of Low-Level Waste Management
and Decommissioning Headquarters Office

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FINAL REPORT

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CONFIRMATORY SURVEY
OF THE TURBINE INTERNAL COMPONENTS
SHOREHAM NUCLEAR POWER STATION
BROOKHAVEN, NEW YORK

Prepared by: ______________________ Date: 7/16/93
T. J. Vitkus, Project Leader
Environmental Survey and Site Assessment Program

Reviewed by: ______________________ Date: 7/20/93
W. L. Beck, Acting Laboratory Manager
Environmental Survey and Site Assessment Program

Reviewed by: ______________________ Date: 7/20/93
M. R. Landis, Project Manager
Environmental Survey and Site Assessment Program

Reviewed by: ______________________ Date: 7/20/93
A. T. Payne, Quality Assurance Officer
Environmental Survey and Site Assessment Program

Reviewed by: ______________________ Date: 7/21/93
J. D. Berger, Program Director
Environmental Survey and Site Assessment Program

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FIELD STAFF

D. A. Gibson

LABORATORY STAFF

R. D. Condra
J. S. Cox
M. J. Laudeman

CLERICAL STAFF

T. T. Claiborne
D. A. Cox
M. A. Perry
K. E. Waters

ILLUSTRATOR

E. A. Powell

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ABBREVIATIONS AND ACRONYMS

ac	acre
ASME	American Society of Mechanical Engineers
cm^2	square centimeter
cpm	counts per minute
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
ha	hectare
GM	Geiger-Mueller
km	kilometer
LILCO	Long Island Lighting Company
LIPA	Long Island Power Authority
m^2	square meter
MDA	Minimum Detectable Activity
mi	mile
NaI	Sodium Iodide
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
QA	Quality Assurance
SU	Survey Unit
SNPS	Shoreham Nuclear Power Station

CONFIRMATORY SURVEY
OF THE TURBINE INTERNAL COMPONENTS
SHOREHAM NUCLEAR POWER STATION
BROOKHAVEN, NEW YORK

INTRODUCTION AND SITE HISTORY

Shoreham Nuclear Power Station (SNPS), constructed by Long Island Lighting Company (LILCO) was a boiling water reactor, designed to provide a gross electrical output of 849 Megawatts. The plant achieved initial criticality in February 1985; the U.S. Nuclear Regulatory Commission (NRC) license (NRC Docket File No. 50-322) allowed reactor operations at power levels not to exceed 5% of full power. Low-power testing in accordance with the license commenced in July 1985 and continued intermittently until January 1989, at which time power generating operations were terminated. The total reactor operating history was equivalent to 2.03 effective full-power days of fuel exposure. Before reaching design power levels, a decision was made to decommission the facility, and the irradiated fuel was subsequently removed from the reactor vessel and placed into the spent fuel pool in August 1989.

Various reactor components, piping systems, and other equipment became radiologically contaminated as a result of the reactor low-power testing operations. The primary contaminants which have been identified during characterization studies include iron-55 (Fe-55), cobalt-60 (Co-60), which constituted 97% of the contamination present and smaller quantities of nickel-63, tritium, carbon-14, nickel-59, manganese-54, zinc-65, and europium-152.[1]

The Long Island Power Authority (LIPA) was established to decommission the facility and plans to release the site for unrestricted use. The LIPA decommissioning plan was approved for implementation by the NRC in June 1992 and will include decontamination or removal of contaminated portions of the reactor and other plant systems and equipment.[2] One of the objectives of the decommissioning is to maintain the integrity and salability of structures and process systems, to the extent possible, to enable the future use of the facility in other capacities, such as conventional power generation. The decommissioning will be conducted in several

phases, terminating in the removal of the irradiated fuel. Phase I involved radiological surveys of the interior components of the main steam turbine's high pressure stage.

At the request of the NRC Headquarter's Division of Low-Level Waste Management and Decommissioning, the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) performed a confirmatory radiological survey of the SNPS main steam turbine components. This report describes the procedures and results of that survey.

SITE DESCRIPTION

The SNPS is located in the Town of Brookhaven, New York, on the north shore of Long Island, approximately 80 km (50 mi) east of the confluence of the East River and Long Island Sound (Figure 1). The SNPS site is a 32.4 ha (80 ac) portion of a larger [202 ha (499 ac)] parcel of land owned by LILCO. The site is bounded on the north by Long Island Sound, on the east by the Wading River Marshland, on the west by other LILCO property, and on the south by Route 25A. A fence encloses the site secured areas. Within this boundary are the buildings and grounds, classified as the Restricted Area (also known as the power block) where radiological controls were necessary (Figure 2). The turbine is located at elevation 63 feet of the Turbine Building.

LIPA has approached termination surveys in accordance with draft NUREG-5849.[3] The portions of the facility which will be addressed during the decommissioning have been designated as either affected or unaffected survey units. Survey units have been further categorized as either structures, systems, or embedded piping. The internal components of the main steam turbine have been designated as an affected system with the LIPA Survey Unit (SU) identifier of SU029. The turbine is a General Electric 1800 tandem compound turbine with one high pressure and two low pressure sections. Only the high pressure section was addressed by the licensee based on contamination potential and NRC concurrence.

At the time of this survey, the high pressure side of the turbine had been partially disassembled to facilitate the survey. The upper half of the turbine cover had been removed and staged

separately, as had the upper diaphragms, which when assembled fit into recesses that are found in the turbine cover, and the diffusers. The remainder of the turbine remained assembled, with the primary components being the east and west stage wheels, the rotor, labrynth seals, steam exhaust ports, and steam inlet piping (Figure 3).

OBJECTIVES

The objectives of the confirmatory survey were to provide independent document reviews and comparative radiological data for use by the NRC in evaluating the adequacy and accuracy of the licensee's termination survey report, relative to the established guidelines.

DOCUMENT REVIEW

ESSAP reviewed the licensee's facility termination survey plan and termination final survey report prepared for the steam turbine system, for adequacy, appropriateness, and consistency between the documents.[4,5] The termination survey data were also reviewed for accuracy, completeness, and compliance with the guidelines.

PROCEDURES

ESSAP conducted a confirmatory survey of the internal components of the main turbine on February 23 and 24, 1993. The survey was in accordance with a February 8, 1993 site-specific survey plan which was submitted to and approved by the NRC.[6] Additional information regarding instrumentation and procedures may be found in Appendices A and B.

REFERENCE SYSTEM

LIPA-prepared field drawings were used by ESSAP for referencing measurement and sampling locations on individual turbine components. The turbine stages, shown on Figure 3, were referenced as the upper 180° and lower 180°, according to their orientation within the casing.

The main shaft had been rotated prior to this survey where the lower 180° portion was accessible during ESSAP's survey.

SURFACE SCANS

Surface scans for gamma and beta activity were performed on representative and accessible portions of the various turbine components. Scans were performed using NaI and GM detectors, coupled to ratemeters or ratemeter-scalers with audible indicators.

SURFACE ACTIVITY MEASUREMENTS

ESSAP performed direct measurements to determine total beta surface activity levels at 55 of the 1091 LIPA direct measurement locations. Measurements were performed using GM detectors coupled to ratemeter-scalers. The survey unit was not classified as an alpha-affected area; therefore, direct measurements for total alpha activity were not performed. A smear sample was collected from each direct measurement location to determine removable activity levels. Figures 4 through 54 indicate measurement locations.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ESSAP's Oak Ridge laboratory for analysis and interpretation. Smears were analyzed for gross alpha and gross beta activity using a low background proportional counter. Analytical data and direct measurement data were converted to units of disintegrations per minute per 100 cm^2 (dpm/100 cm^2). The results were compared to the NRC guidelines, which are provided in Appendix C.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP's review of the termination survey plan indicated that the document provided an adequate description of survey methodologies and general approaches. Comments identified were provided to the NRC in a January 12, 1993 correspondence.[7] ESSAP's review of the termination survey final report, which was conducted concurrent with the confirmatory survey, identified several additional issues which were discussed during a February 23, 1993 site meeting.

SURFACE SCANS

Surface scans did not identify any areas of elevated direct radiation on the turbine components.

SURFACE ACTIVITY LEVELS

The results of total and removable activity are summarized in Table 1. All total beta activity levels were below the minimum detectable activity of 990 dpm/100 cm^2. Removable activity was less than 12 dpm/100 cm^2 and less than 17 dpm/100 cm^2 for gross alpha and gross beta, respectively.

COMPARISON OF RESULTS WITH GUIDELINES

Regulatory Guide 1.86 provides the guidelines for acceptable surface contamination levels which are used by the NRC to determine whether a licensed facility may be released to unrestricted use. These guidelines are presented in Appendix C. The applicable guidelines are those for beta-gamma emitters, of which Co-60 and Fe-55 are the primary contaminants at SNPS. The residual surface activity guidelines are:

Total Activity

$5{,}000\ \beta\text{-}\gamma\ \text{dpm}/100\ \text{cm}^2$, averaged over $1\ \text{m}^2$

$15{,}000\ \beta\text{-}\gamma\ \text{dpm}/100\ \text{cm}^2$, maximum in $100\ \text{cm}^2$

Removable Activity

$1{,}000\ \beta\text{-}\gamma\ \text{dpm}/100\ \text{cm}^2$

All total and removable activity levels were well within these guidelines. Because Fe-55 cannot be measured at the guideline levels by direct measurement techniques, using commercially available field instrumentation, surface activity measurements, which exceed the minimum detectable activity level (MDA), require a correction factor that will account for the Co-60 to Fe-55 activity ratio. Surface activity measurements, which exceed the MDA of the instrumentation, are therefore adjusted by a factor of 1.2 to account for the Fe-55 contribution. This correction factor was derived from the Co-60 to Fe-55 activity ratio identified in characterization samples. There were no surface activity levels exceeding MDA identified on the turbine components and therefore, the data provided in this report has not been adjusted. All total and removable activity levels are well within the guidelines.

SUMMARY

In February 1993 ESSAP performed a confirmatory survey of the main turbine components at the Shoreham Nuclear Power Station in Brookhaven, New York. Confirmatory activities included document reviews, surface scans, direct surface activity measurements, and removable activity sampling.

The ESSAP survey results indicate that surface activity levels were within the NRC surface contamination guidelines. These findings support the results of the termination survey which LIPA performed.

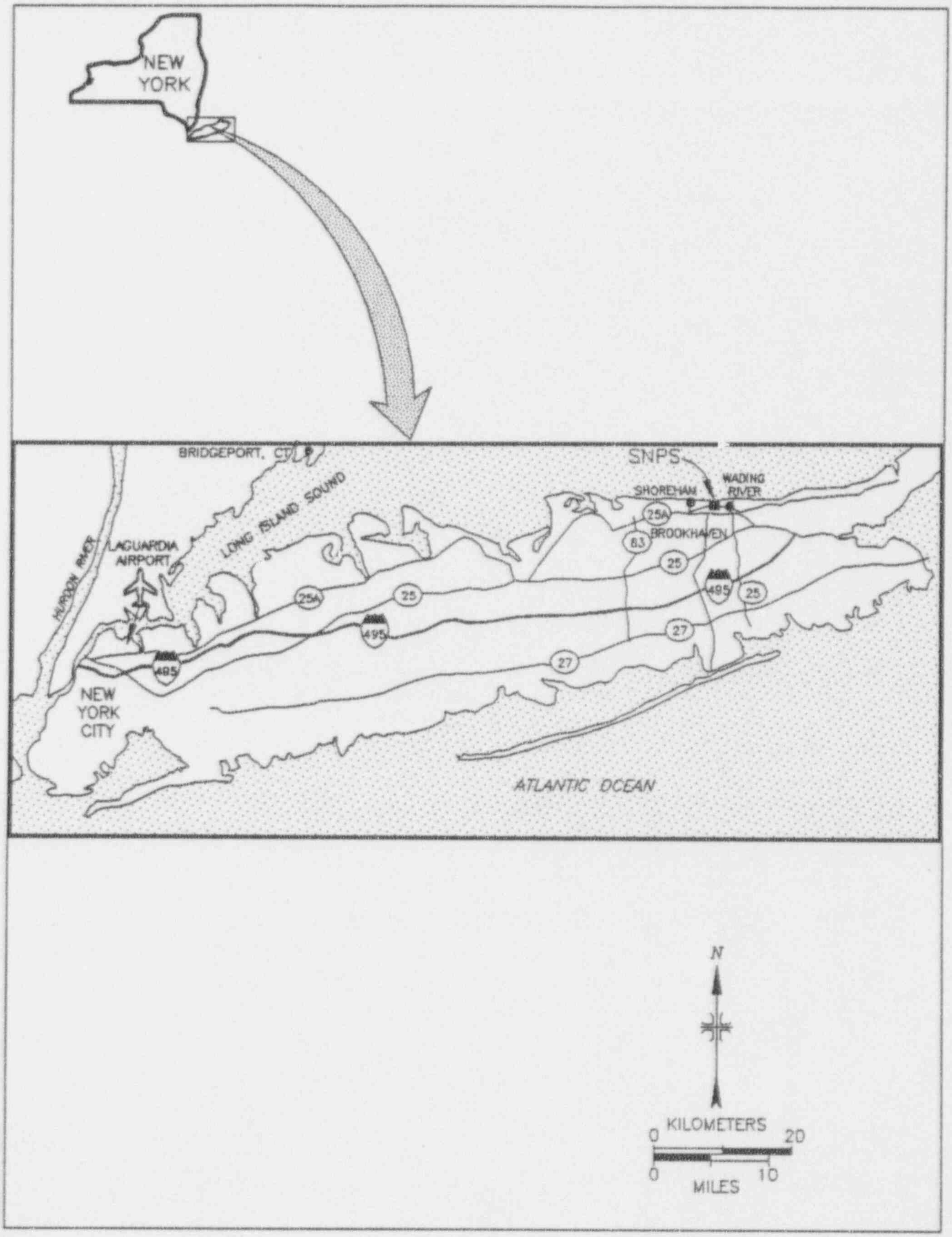


FIGURE 1: Location of the Shoreham Nuclear Power Station

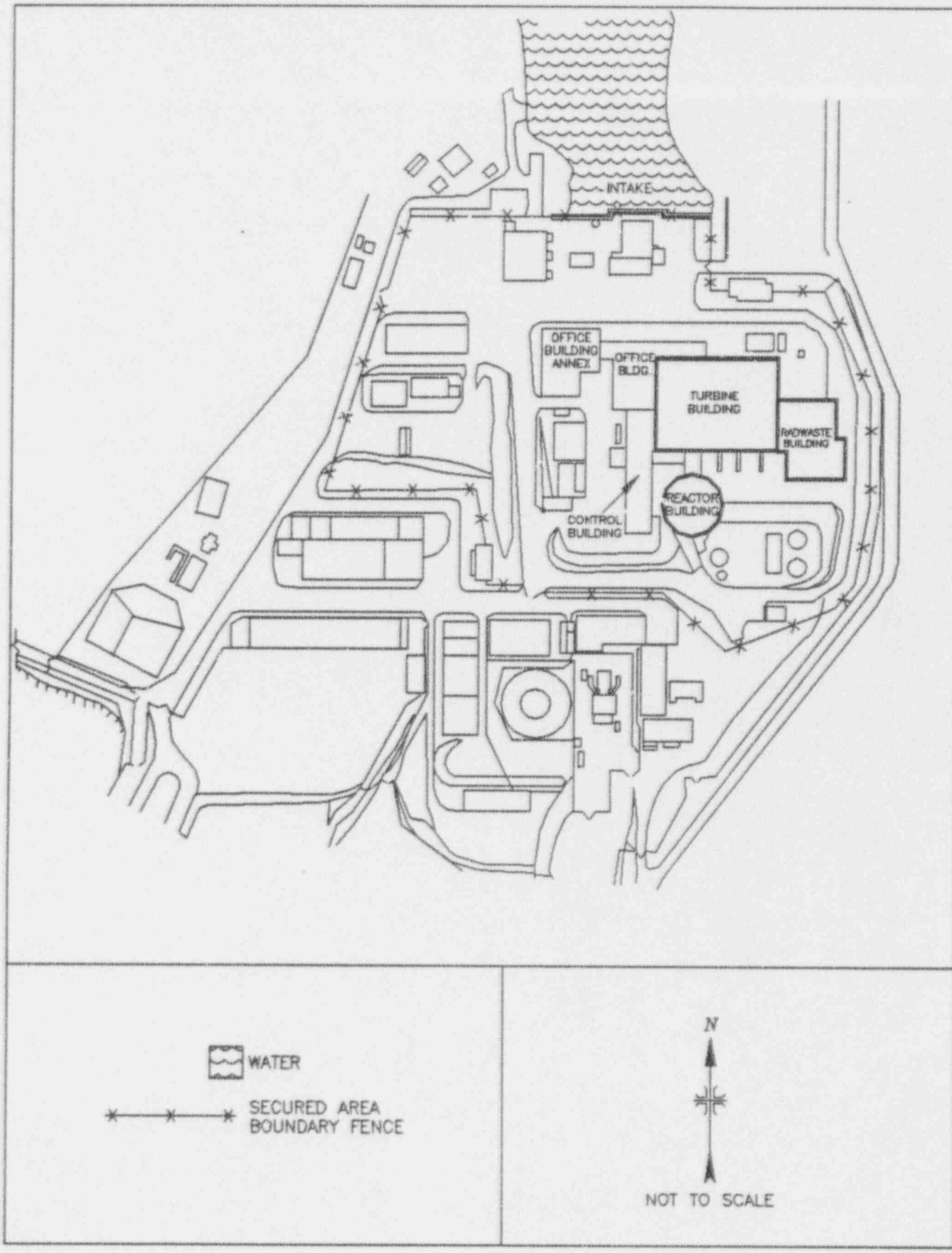


FIGURE 2: Plot Plan of the Shoreham Nuclear Power Station

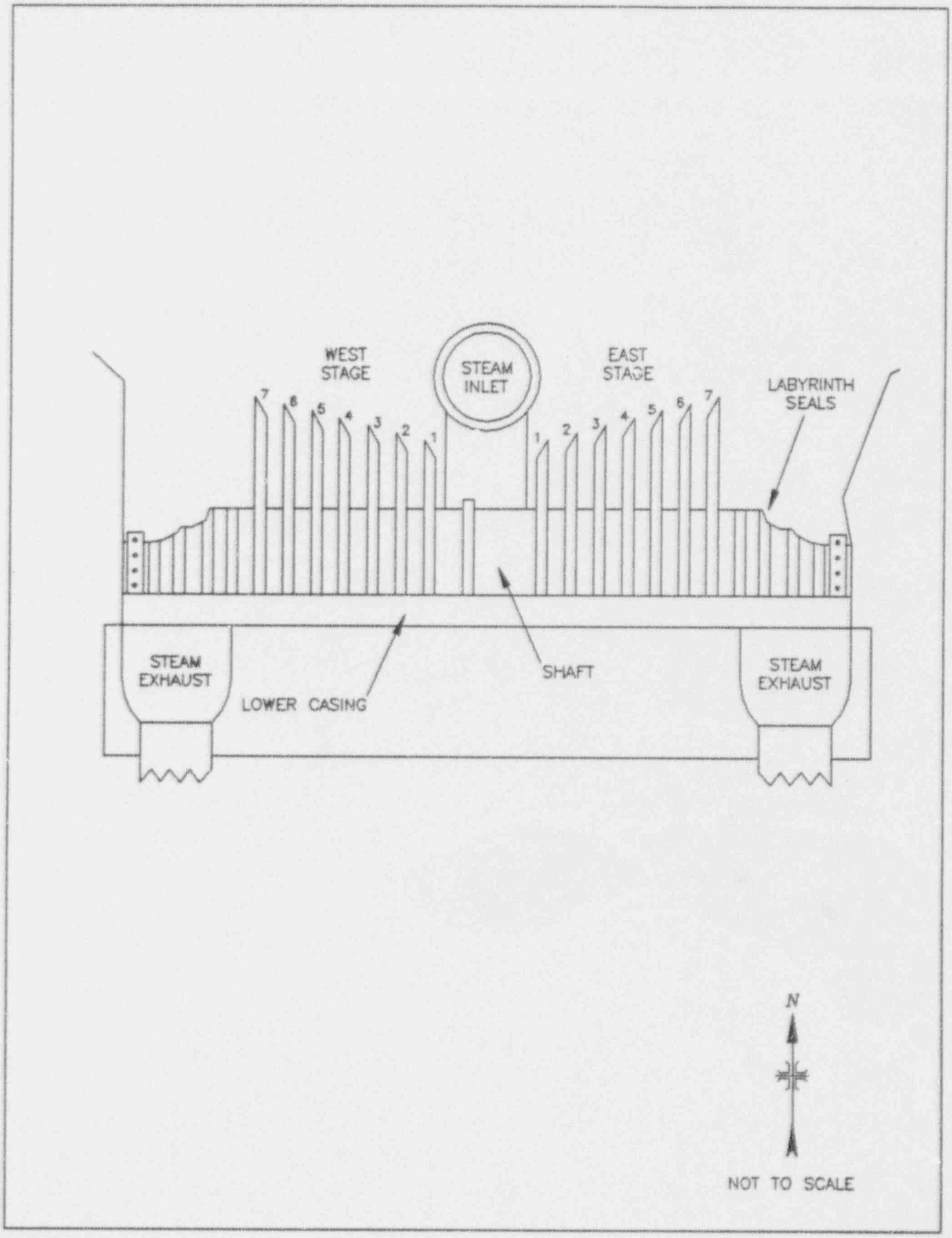


FIGURE 3: Main Turbine – High Pressure Section with Upper Casing Removed

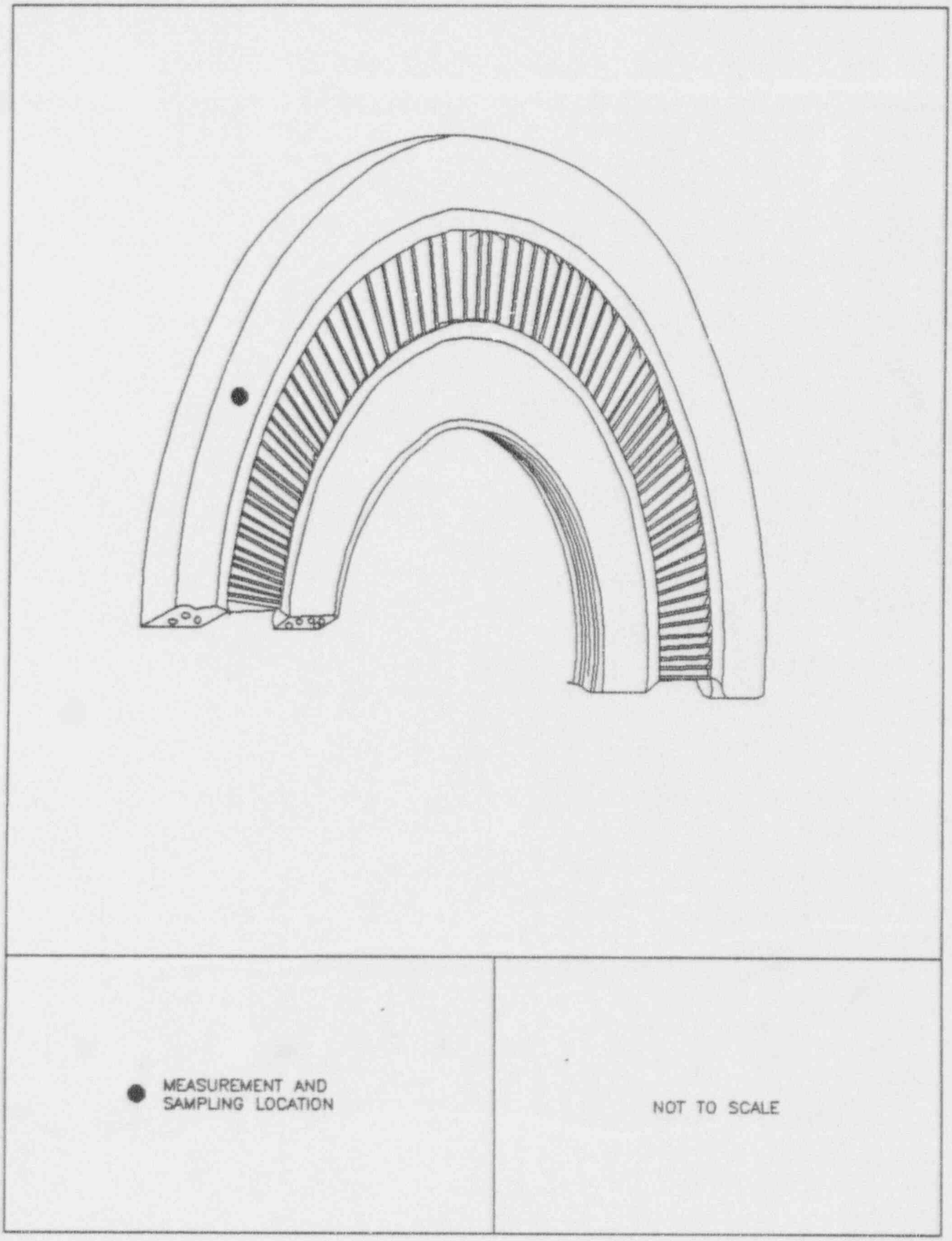


FIGURE 4: Main Turbine, Diaphragm #2G – Measurement and Sampling Location

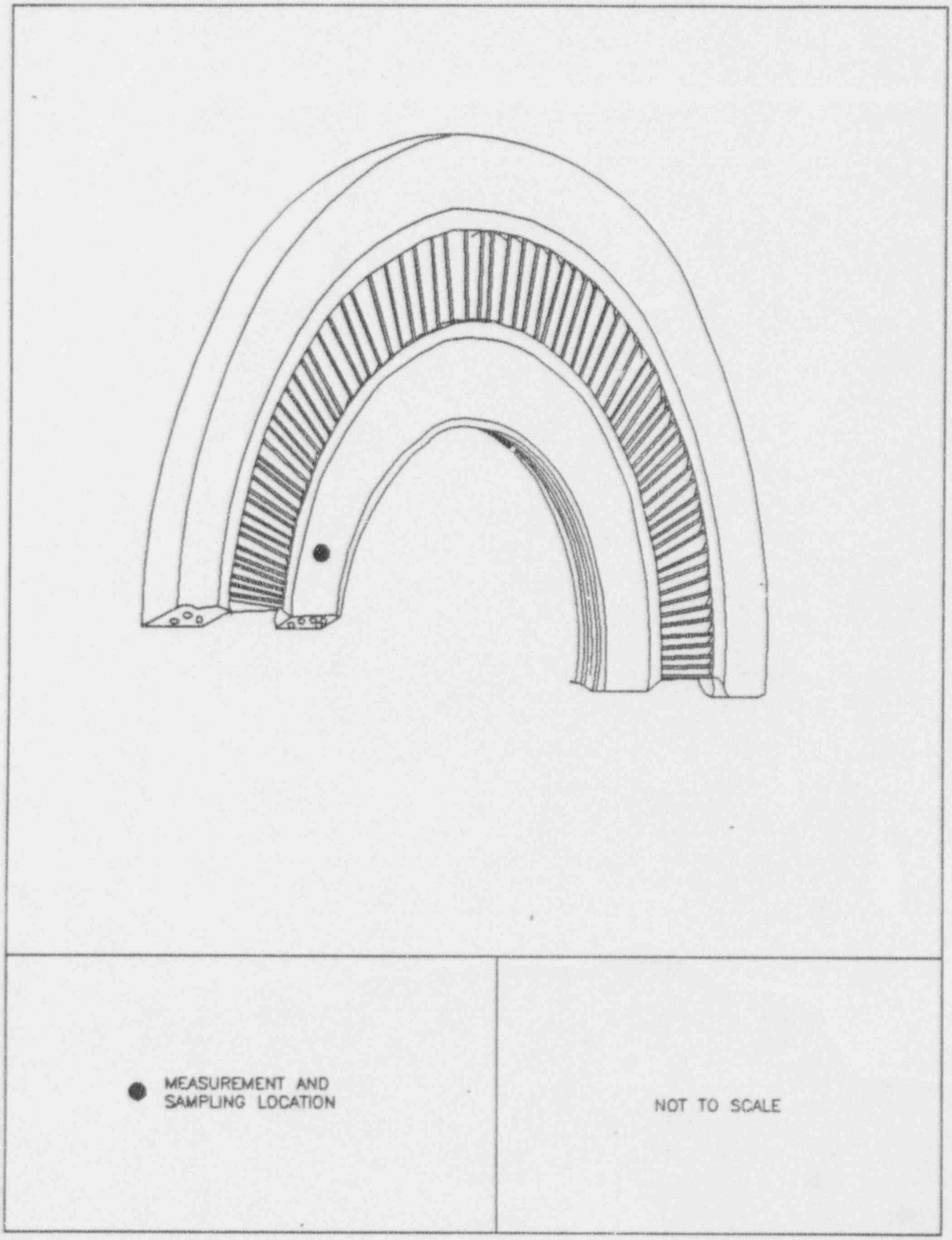


FIGURE 5: Main Turbine, Diaphragm #2T – Measurement and Sampling Location

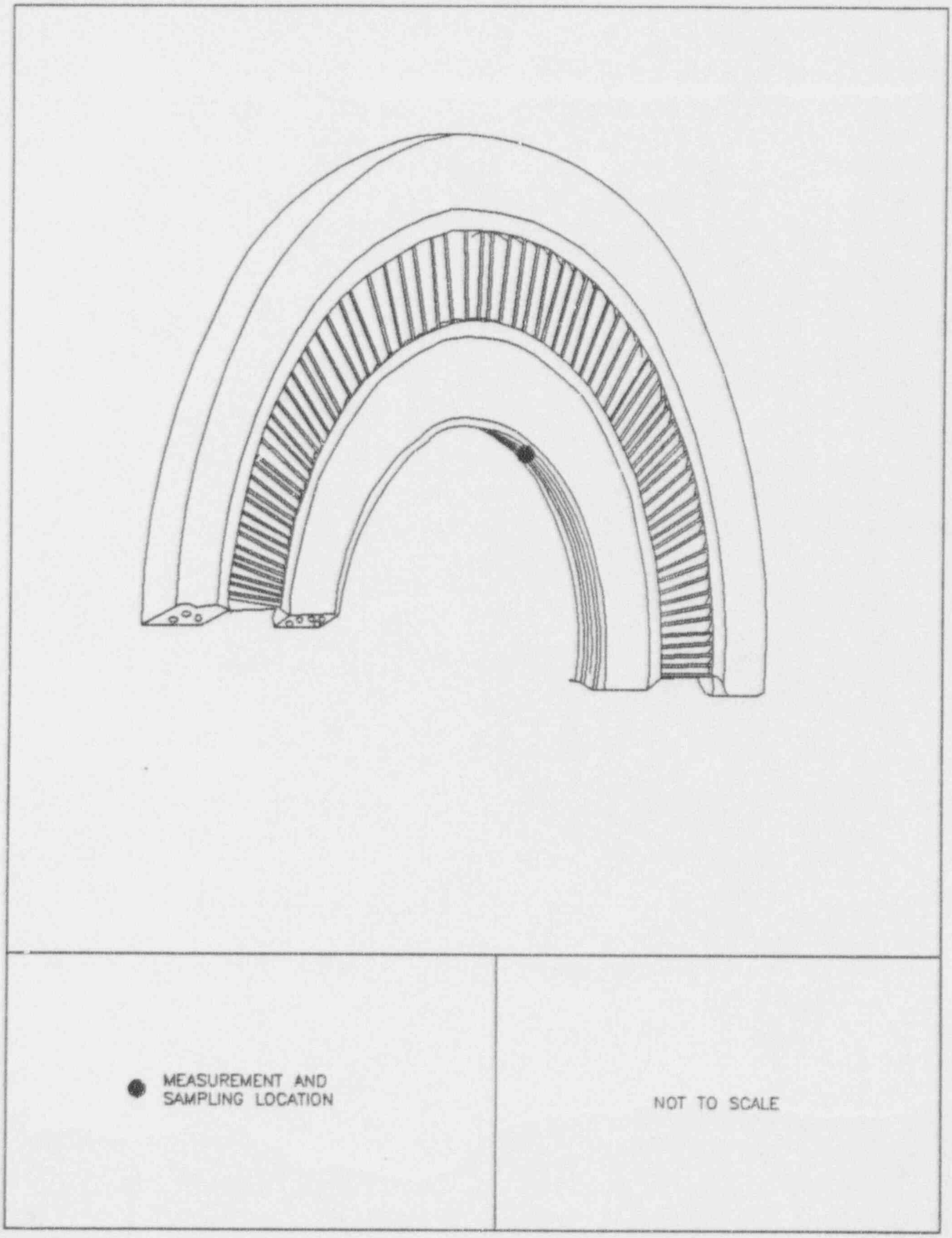


FIGURE 6: Main Turbine, Diaphragm #4G – Measurement and Sampling Location

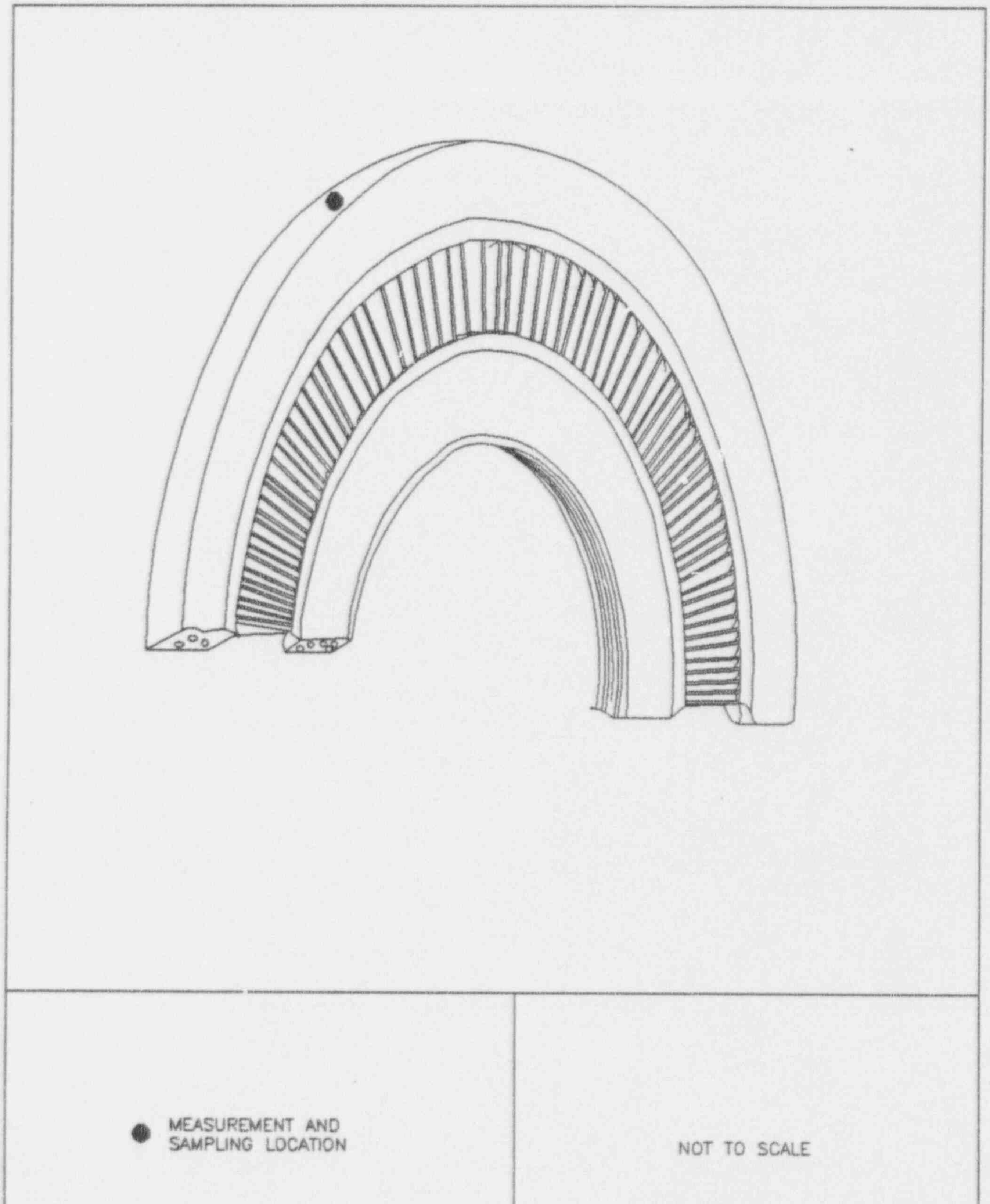


FIGURE 7: Main Turbine, Diaphragm #4T – Measurement and Sampling Location

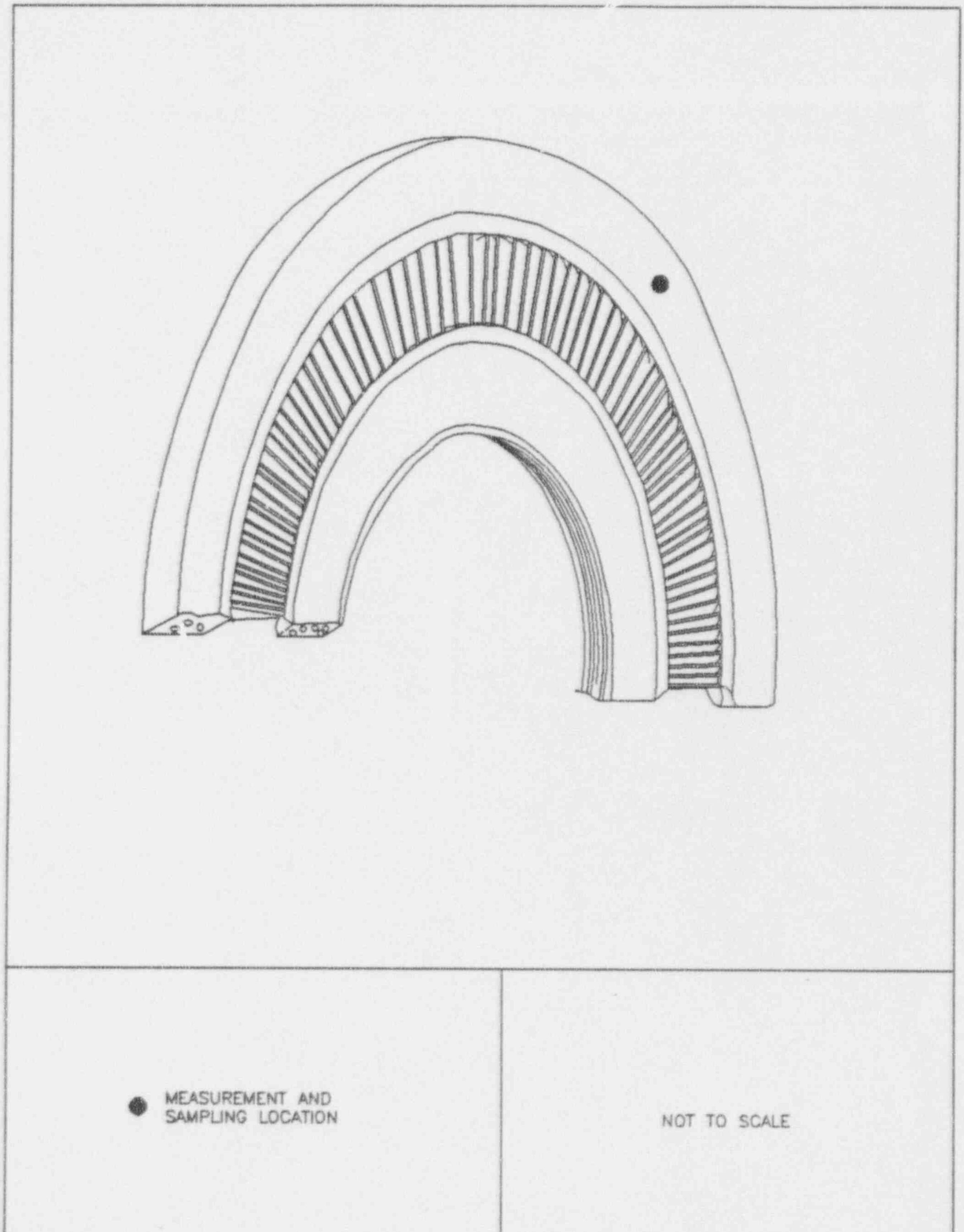


FIGURE 8: Main Turbine, Diaphragm #6G – Measurement and Sampling Location

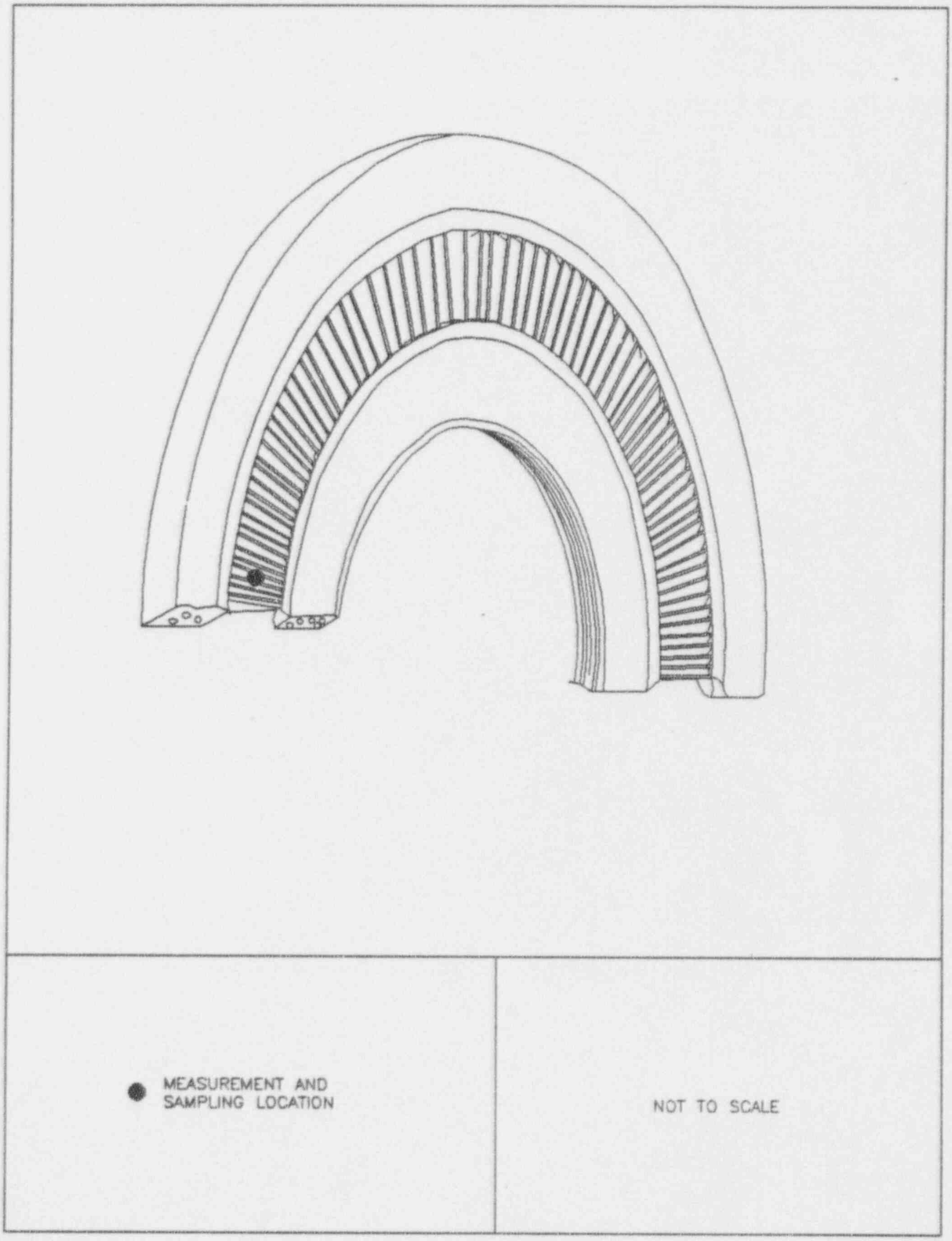


FIGURE 9: Main Turbine, Diaphragm #6T – Measurement and Sampling Location

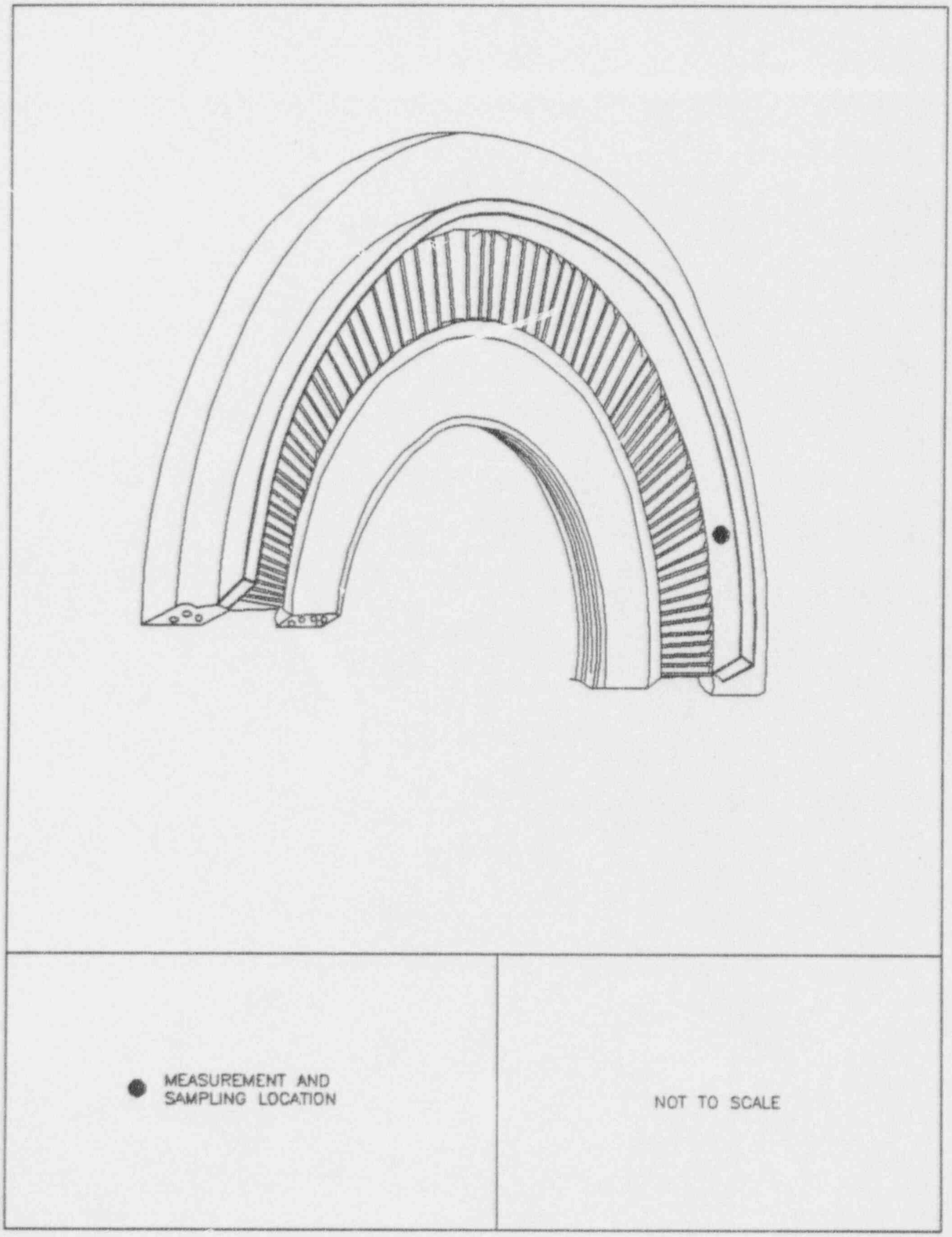
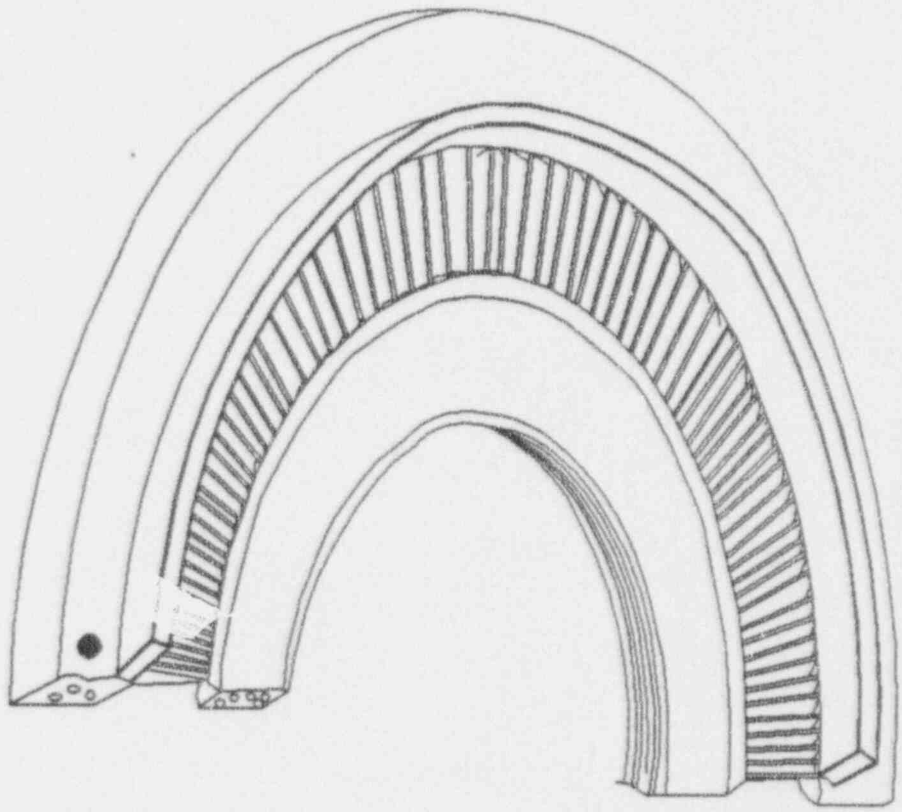


FIGURE 10: Main Turbine, Diaphragm #7G – Measurement and Sampling Location



● MEASUREMENT AND SAMPLING LOCATION

NOT TO SCALE

FIGURE 11: Main Turbine, Diaphragm #7T – Measurement and Sampling Location

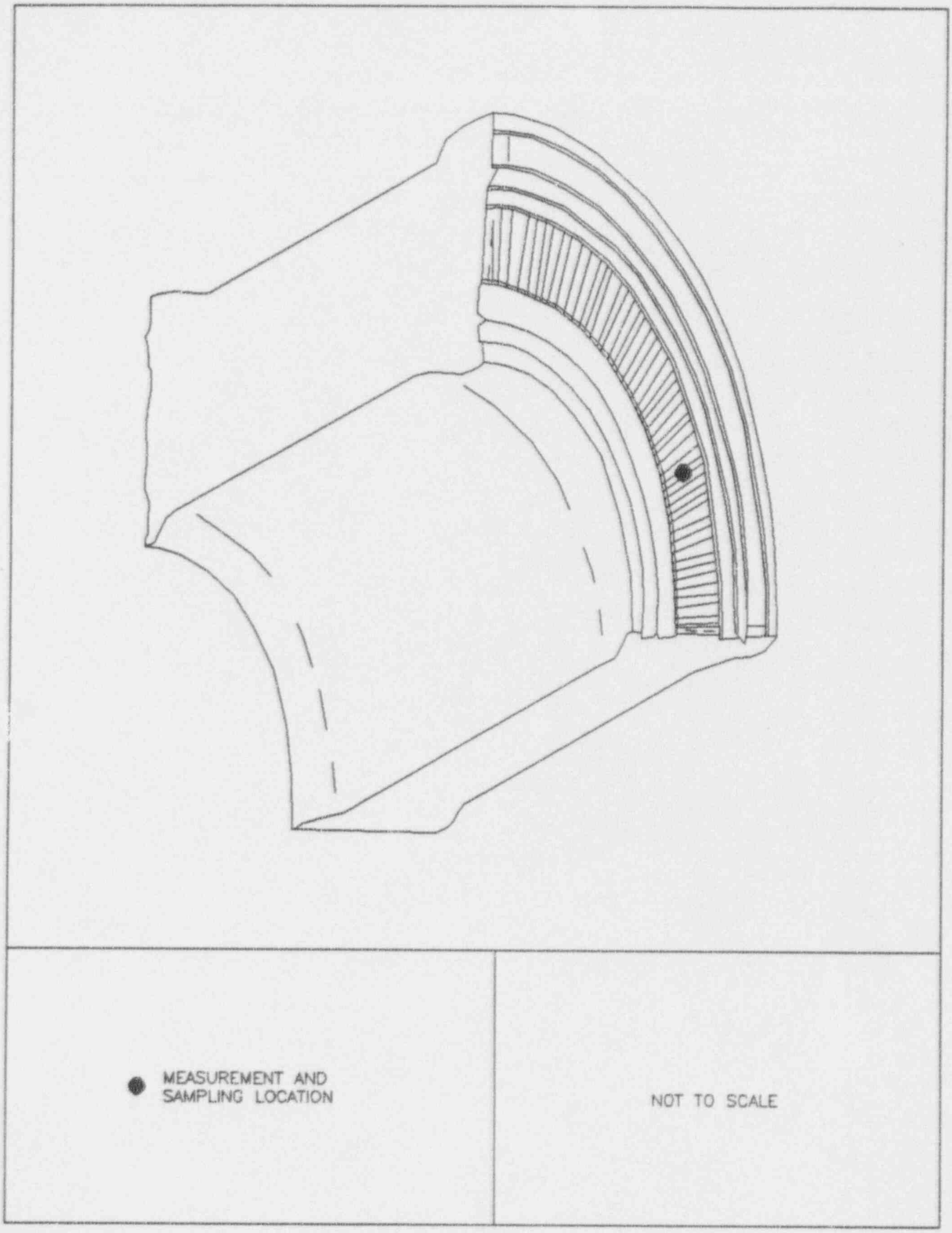


FIGURE 12: Main Turbine, Northeast Diffuser – Measurement and Sampling Location

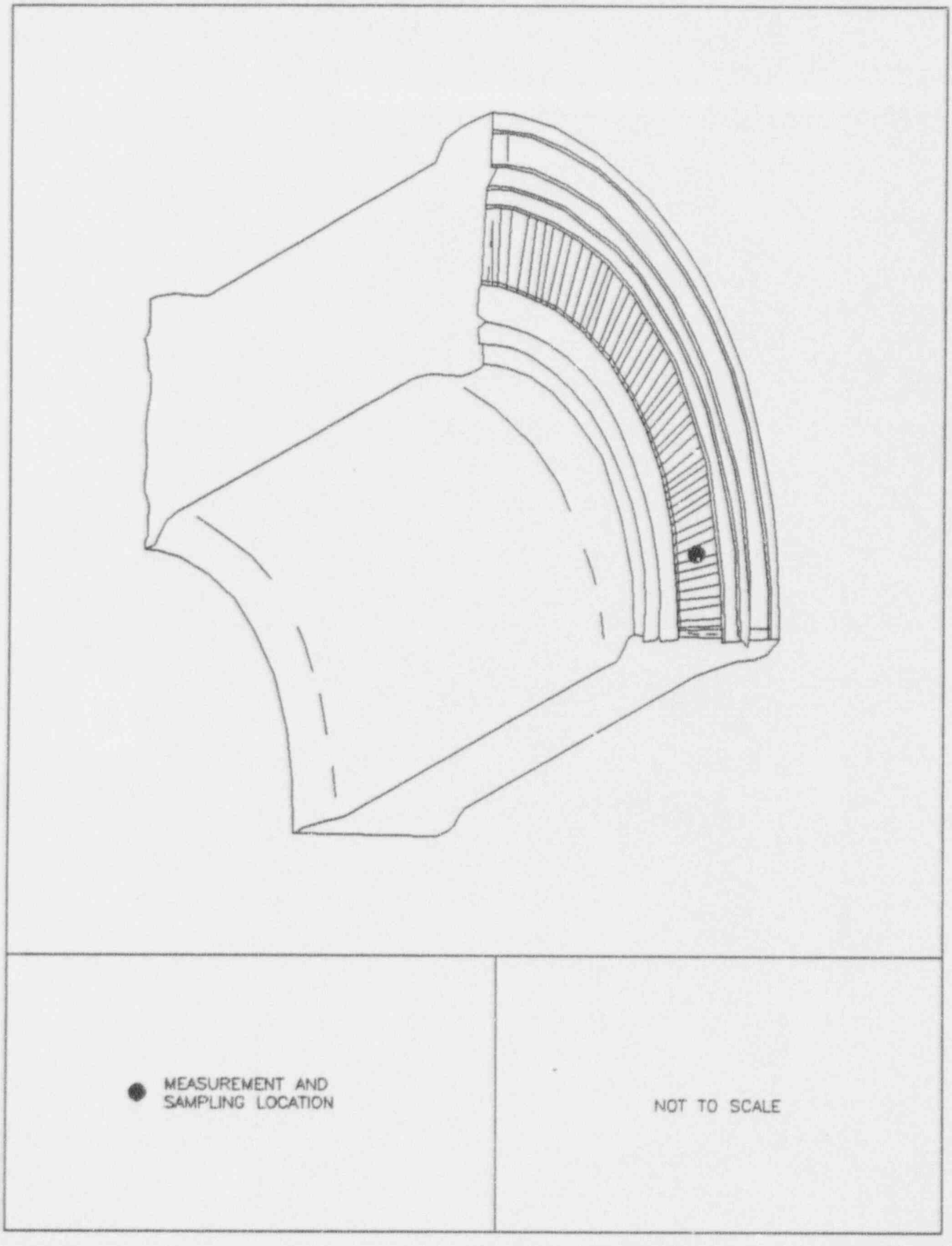


FIGURE 13: Main Turbine, Southwest Diffuser – Measurement and Sampling Location

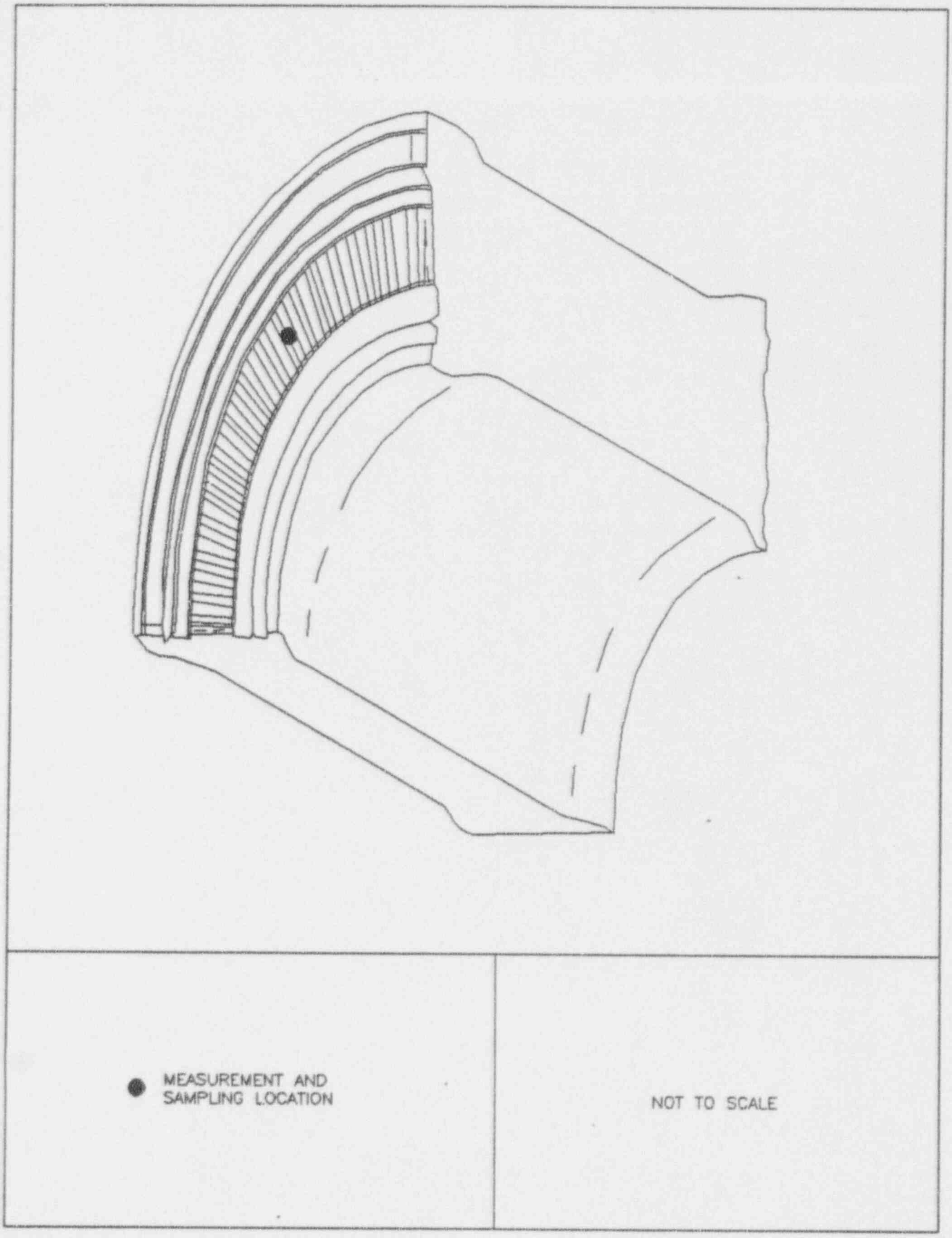


FIGURE 14: Main Turbine, Northwest Diffuser – Measurement and Sampling Location

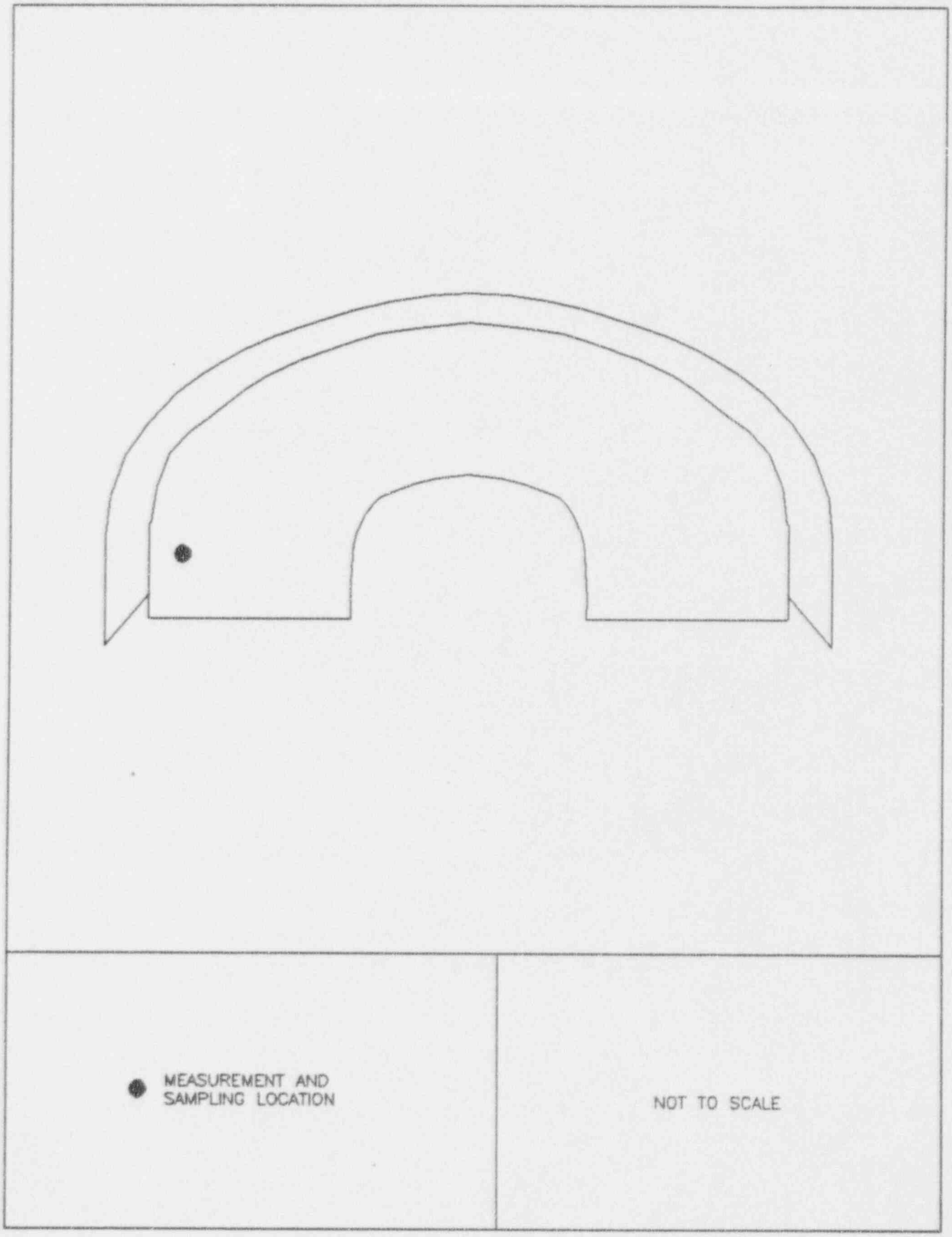


FIGURE 15: Main Turbine, Upper Casing Interior, First Inset (East) – Measurement and Sampling Location

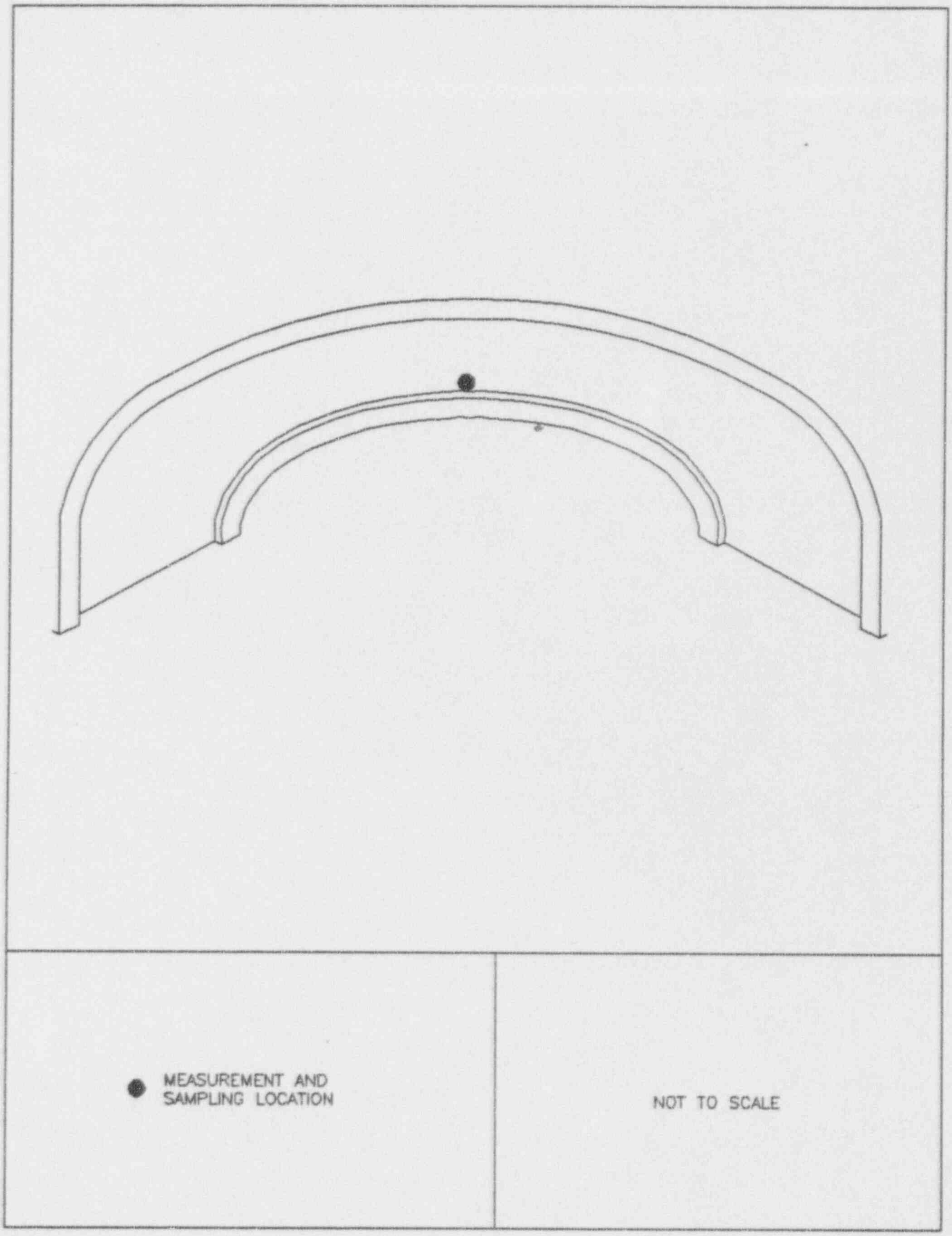


FIGURE 16: Main Turbine, Upper Casing Interior, Second Inset (East) – Measurement and Sampling Location

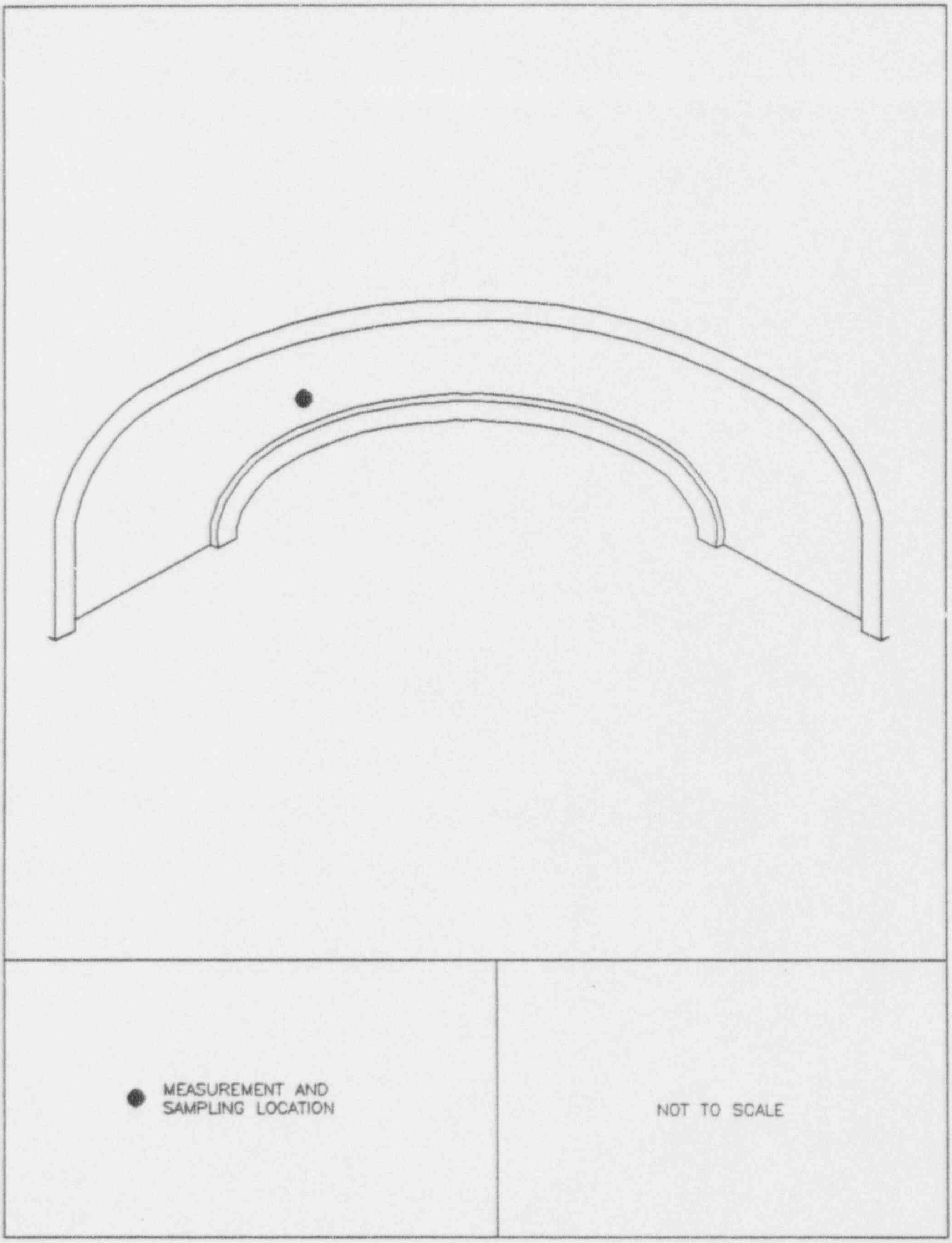


FIGURE 17: Main Turbine, Upper Casing Interior, Third Inset (East) – Measurement and Sampling Location

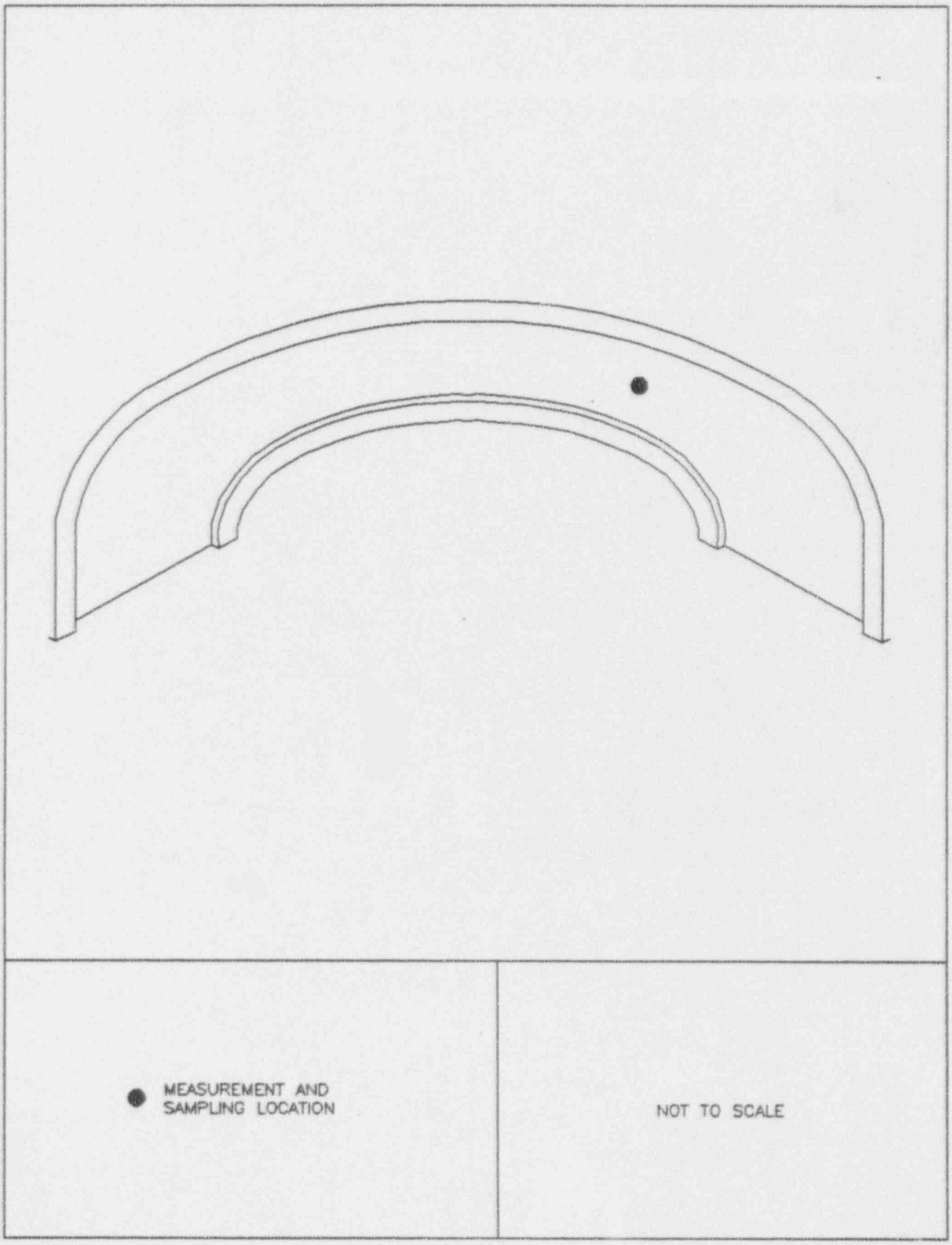


FIGURE 18: Main Turbine, Upper Casing Interior, Fourth Inset (East) – Measurement and Sampling Location

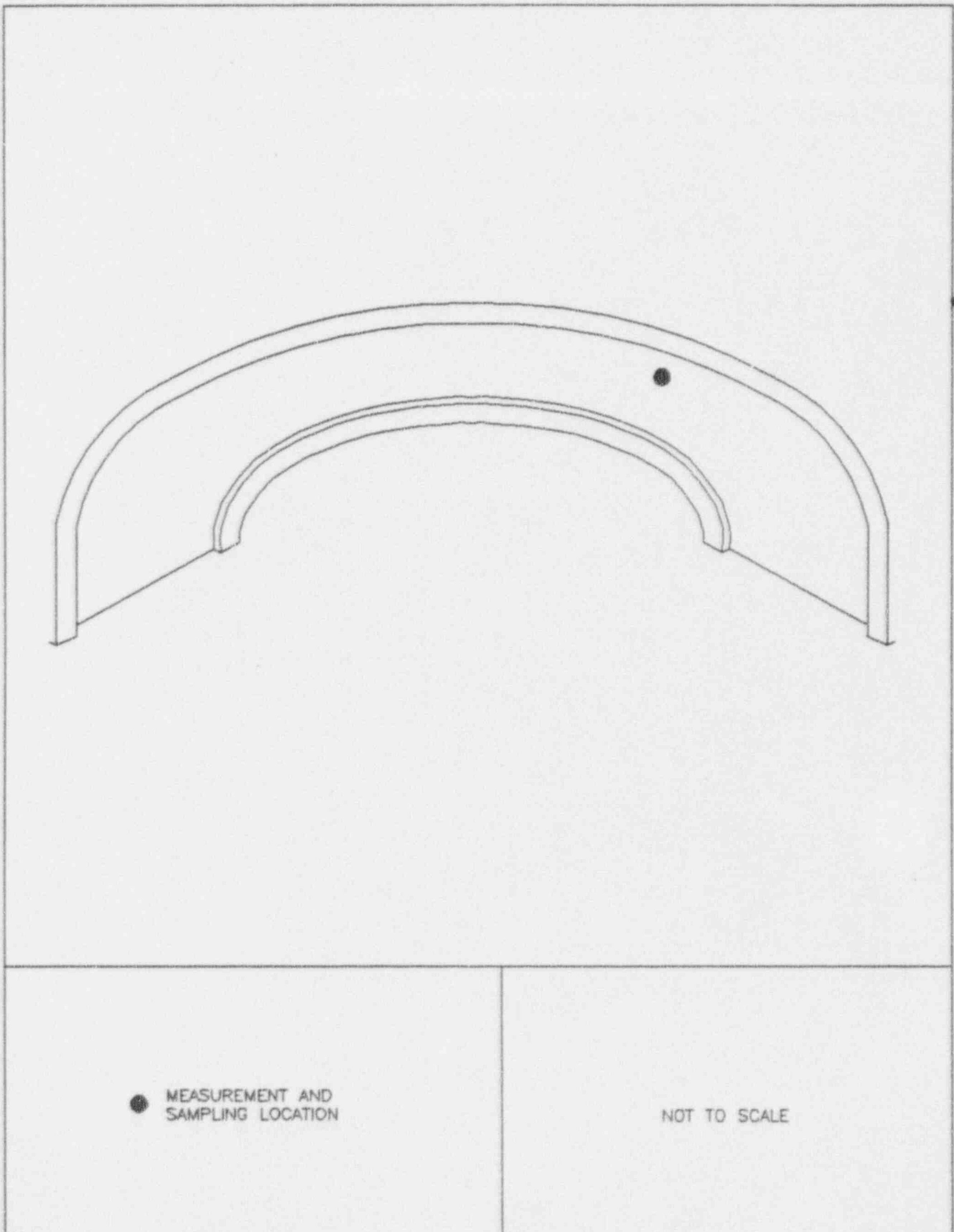


FIGURE 19: Main Turbine, Upper Casing Interior, Fifth Inset (East) – Measurement and Sampling Location

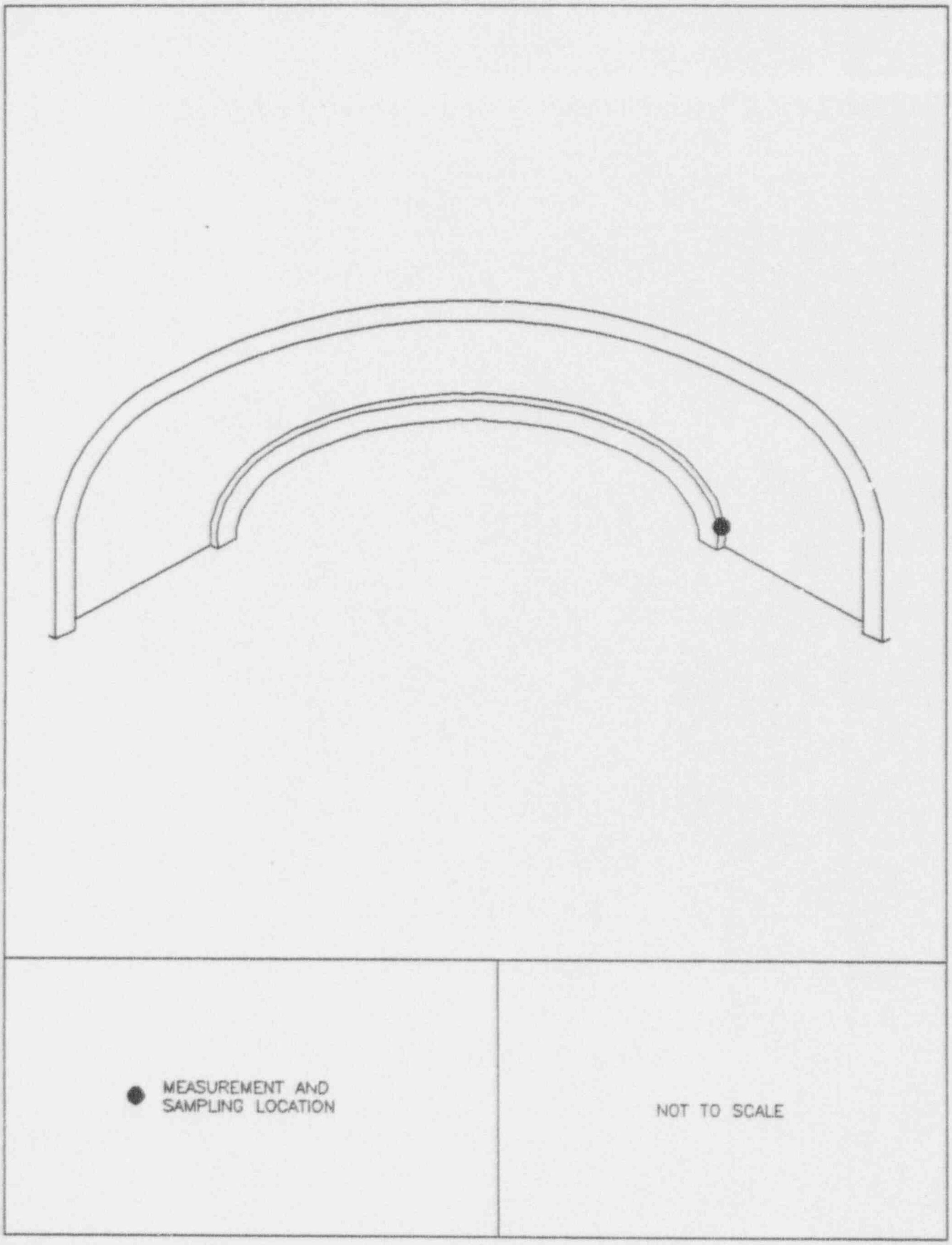


FIGURE 20: Main Turbine, Upper Casing Interior, Sixth Inset (East) – Measurement and Sampling Location

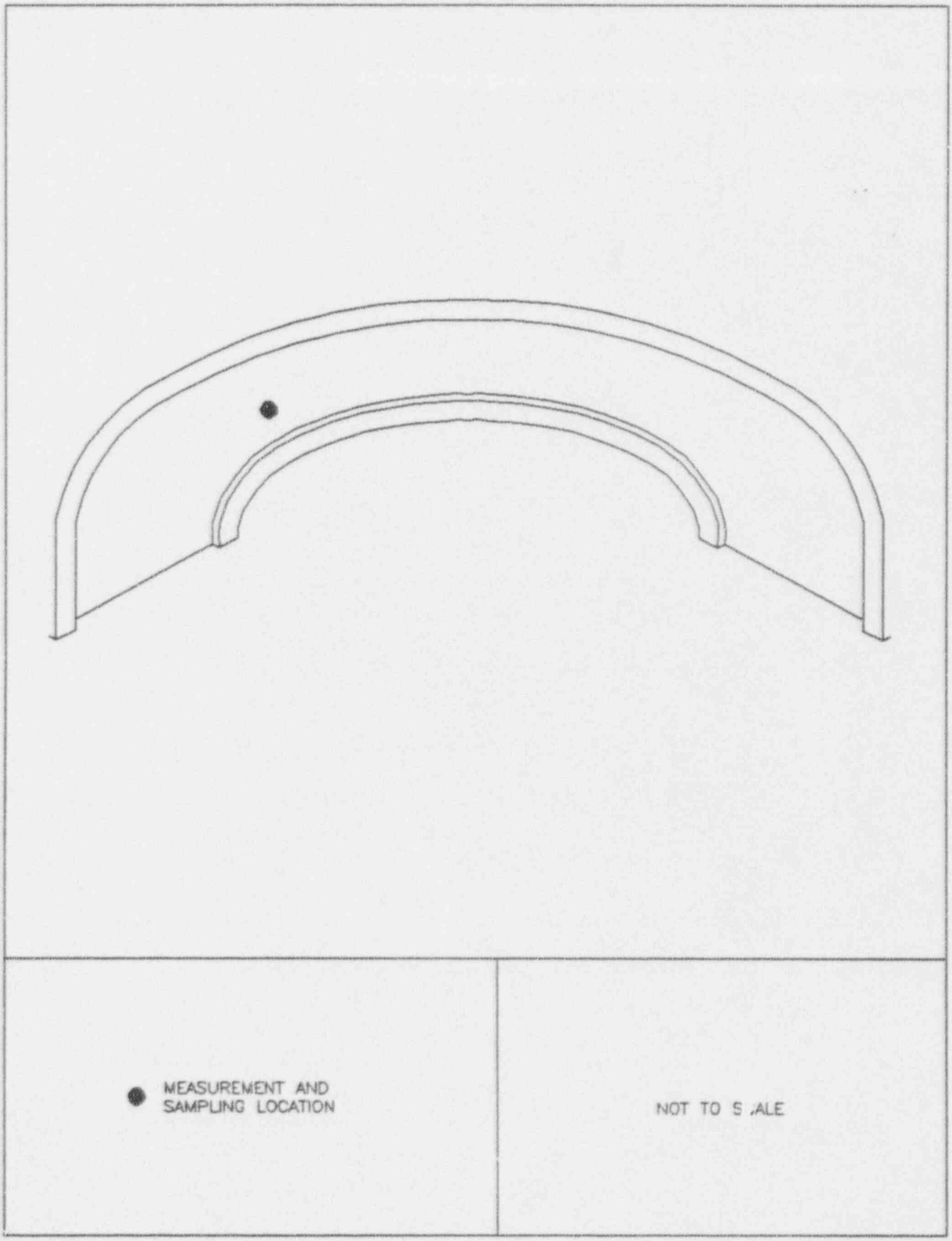


FIGURE 21: Main Turbine, Upper Casing Interior, Seventh Inset (East) – Measurement and Sampling Location

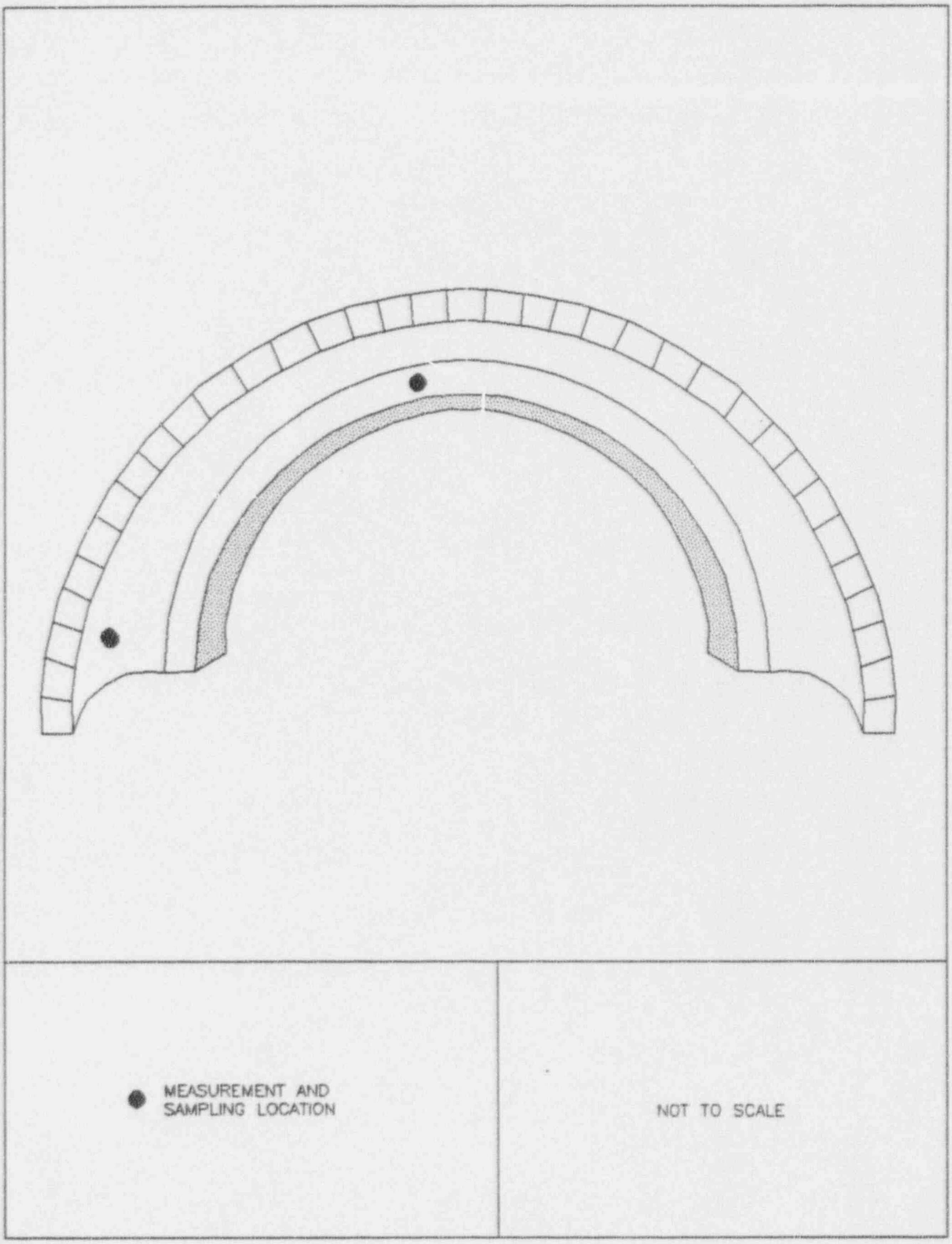


FIGURE 22: Main Turbine, Upper Casing Interior, Eighth Inset (East) – Measurement and Sampling Location

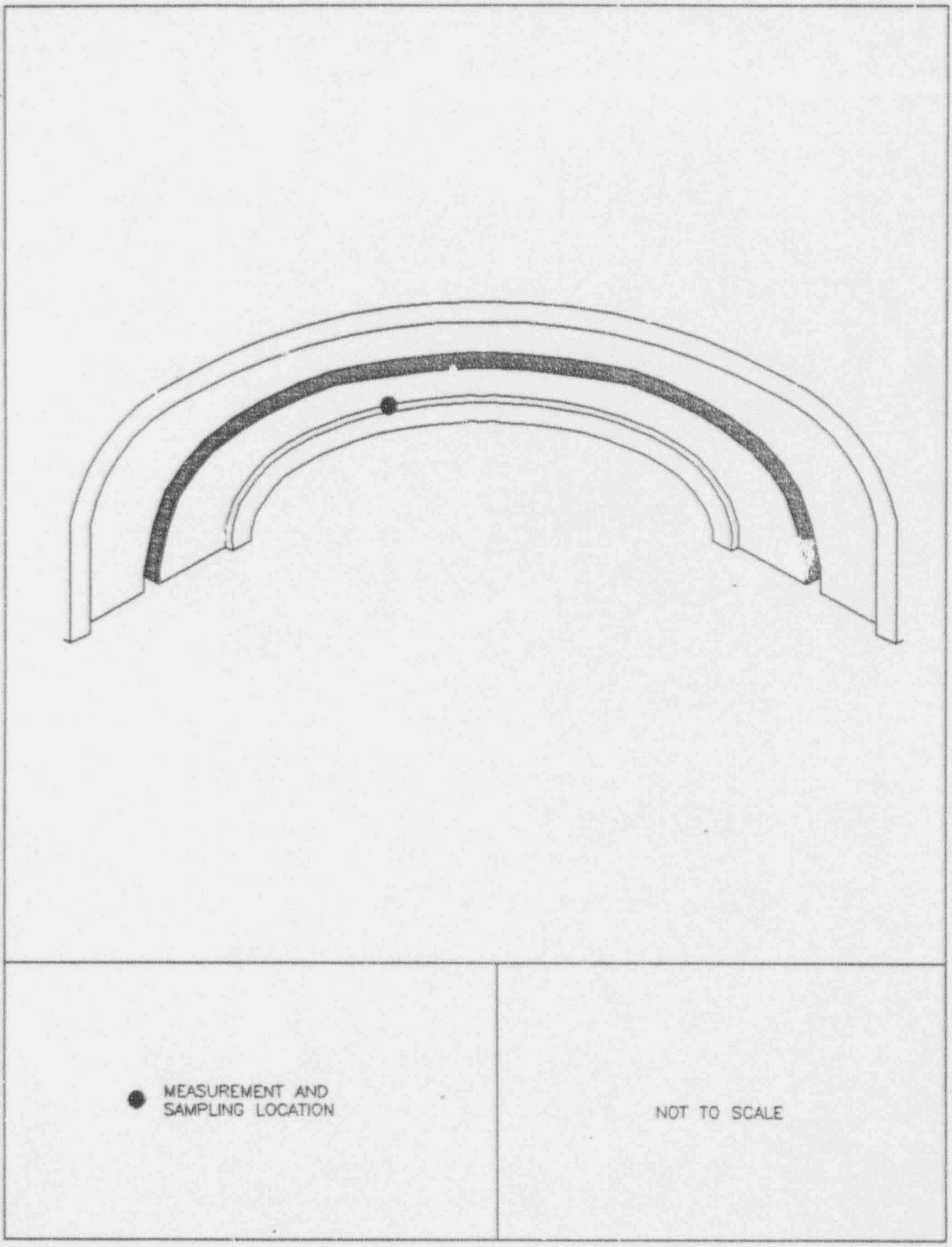
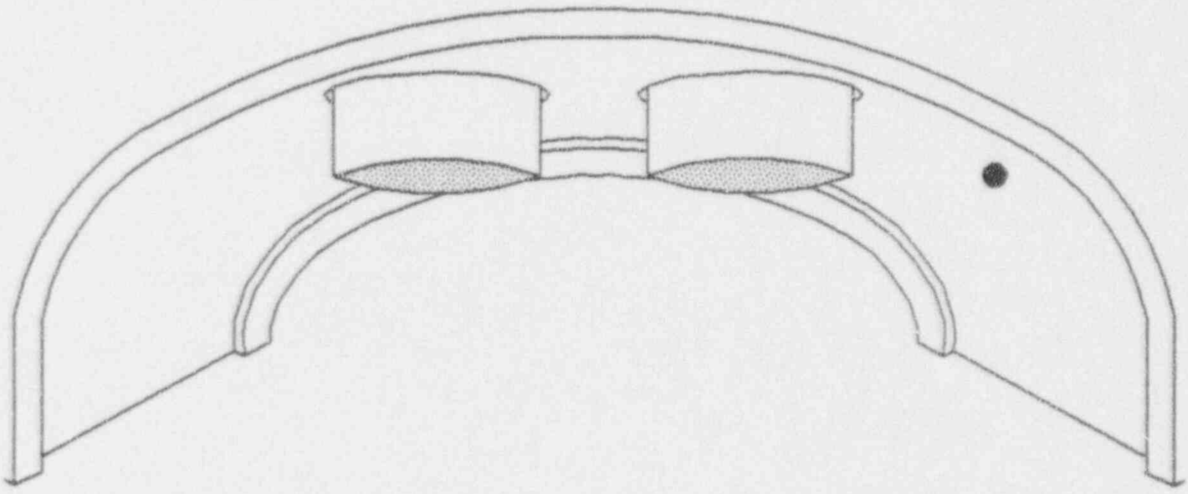


FIGURE 23: Main Turbine, Upper Casing Interior, Tenth Inset (East) – Measurement and Sampling Location



MEASUREMENT AND SAMPLING LOCATION

NOT TO SCALE

FIGURE 24: Main Turbine, Upper Casing Interior, First Inset (West) – Measurement and Sampling Location

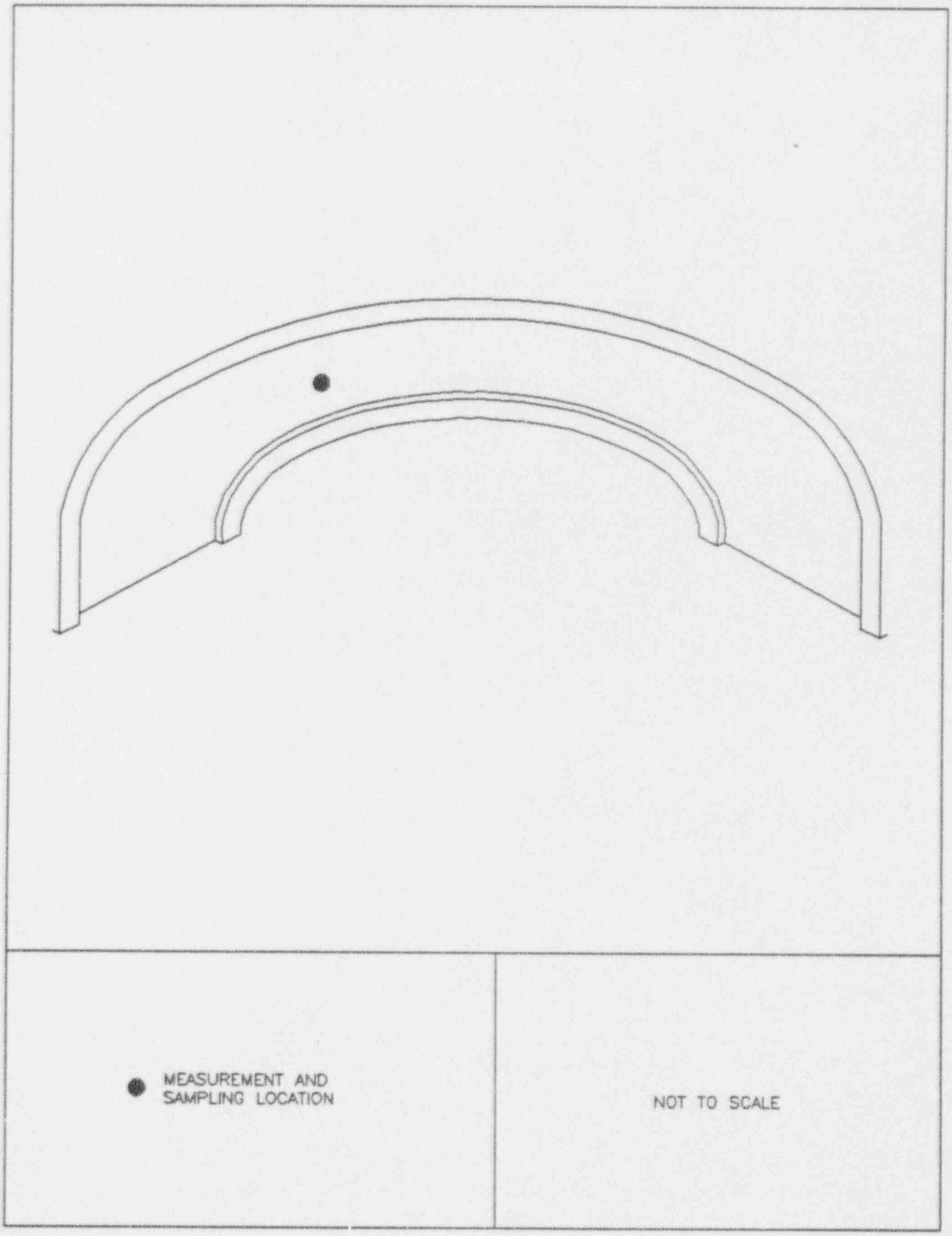


FIGURE 25: Main Turbine, Upper Casing Interior, Second Inset (West) – Measurement and Sampling Location

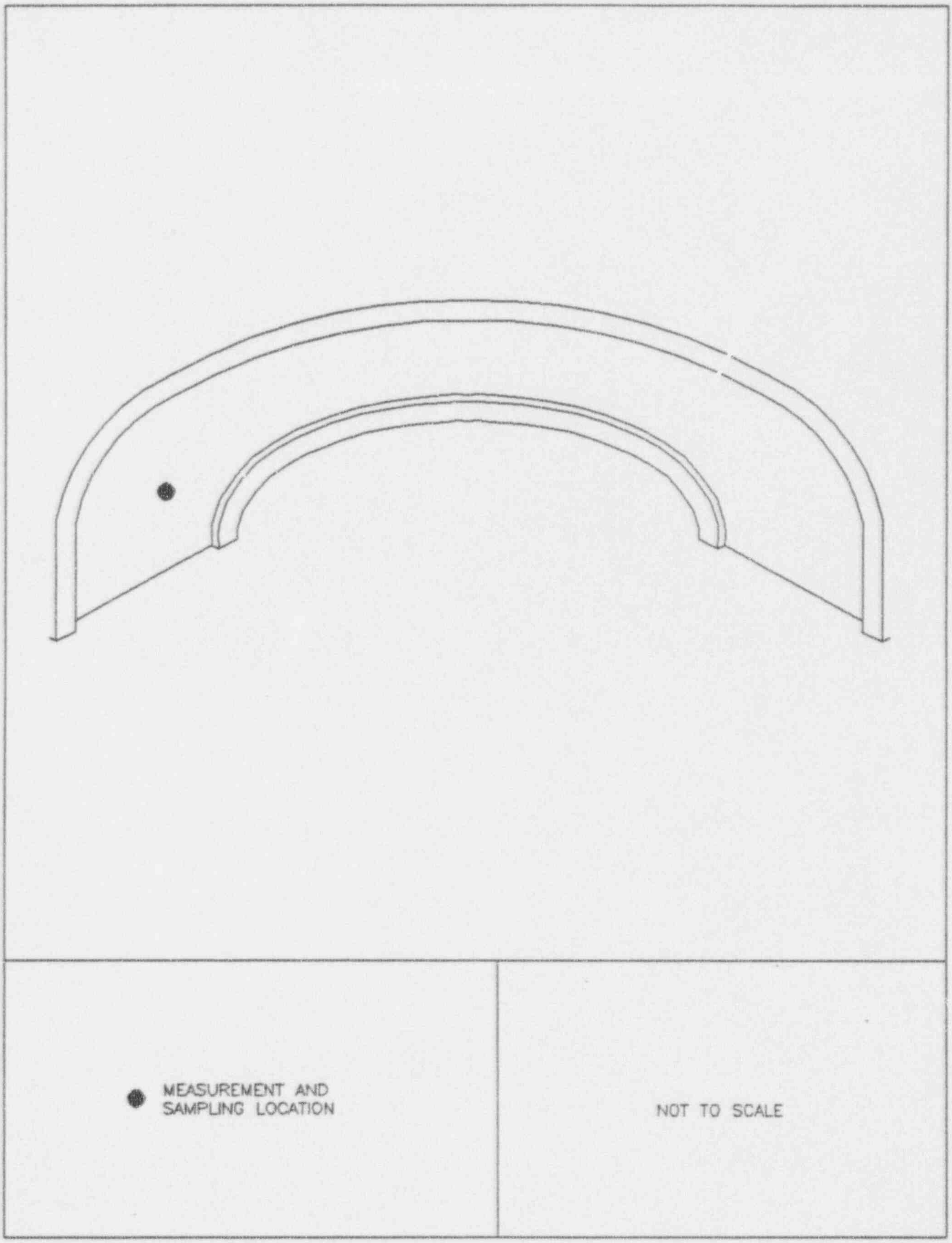


FIGURE 26: Main Turbine, Upper Casing Interior, Third Inset (West) – Measurement and Sampling Location

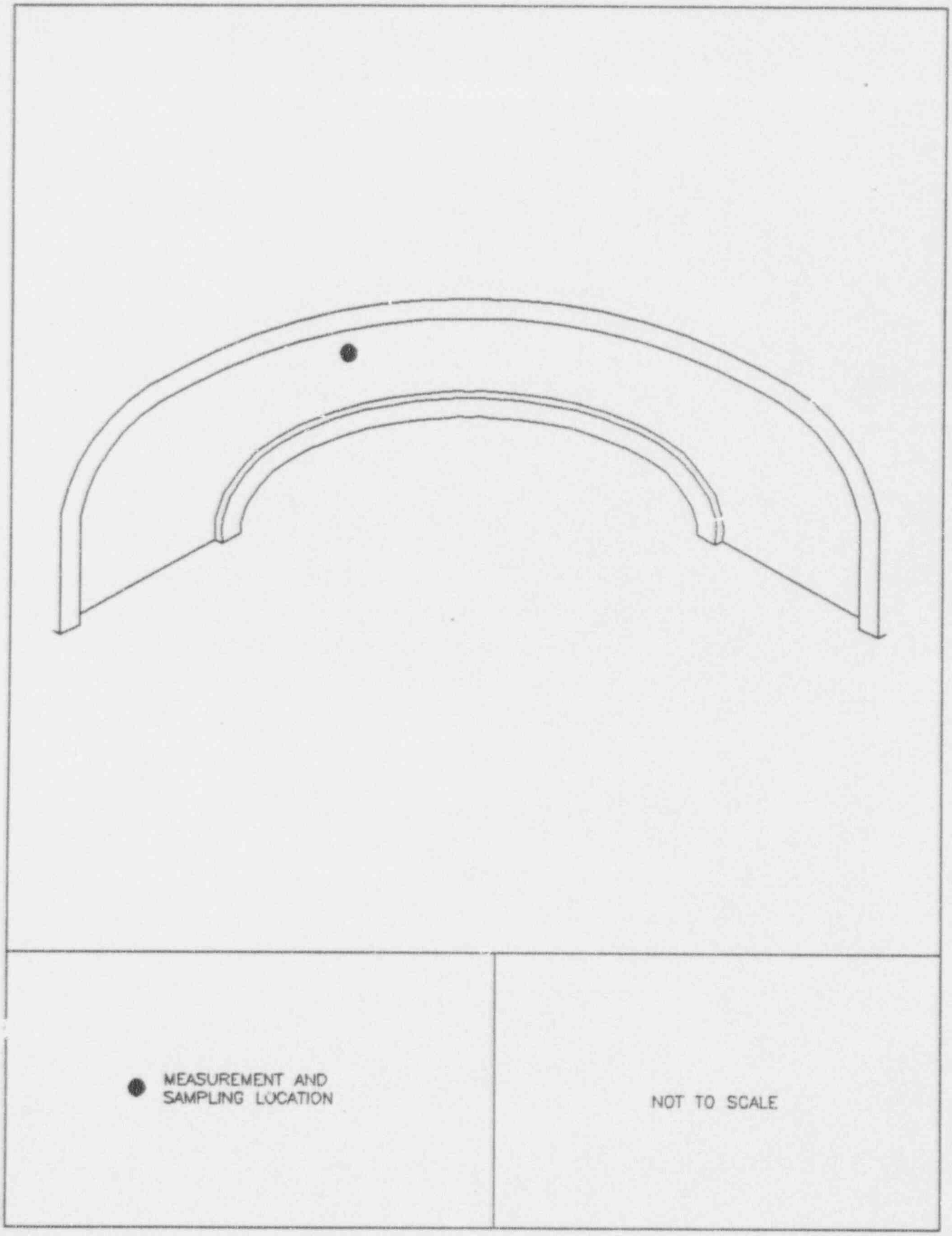


FIGURE 27: Main Turbine, Upper Casing Interior, Fourth Inset (West) – Measurement and Sampling Location

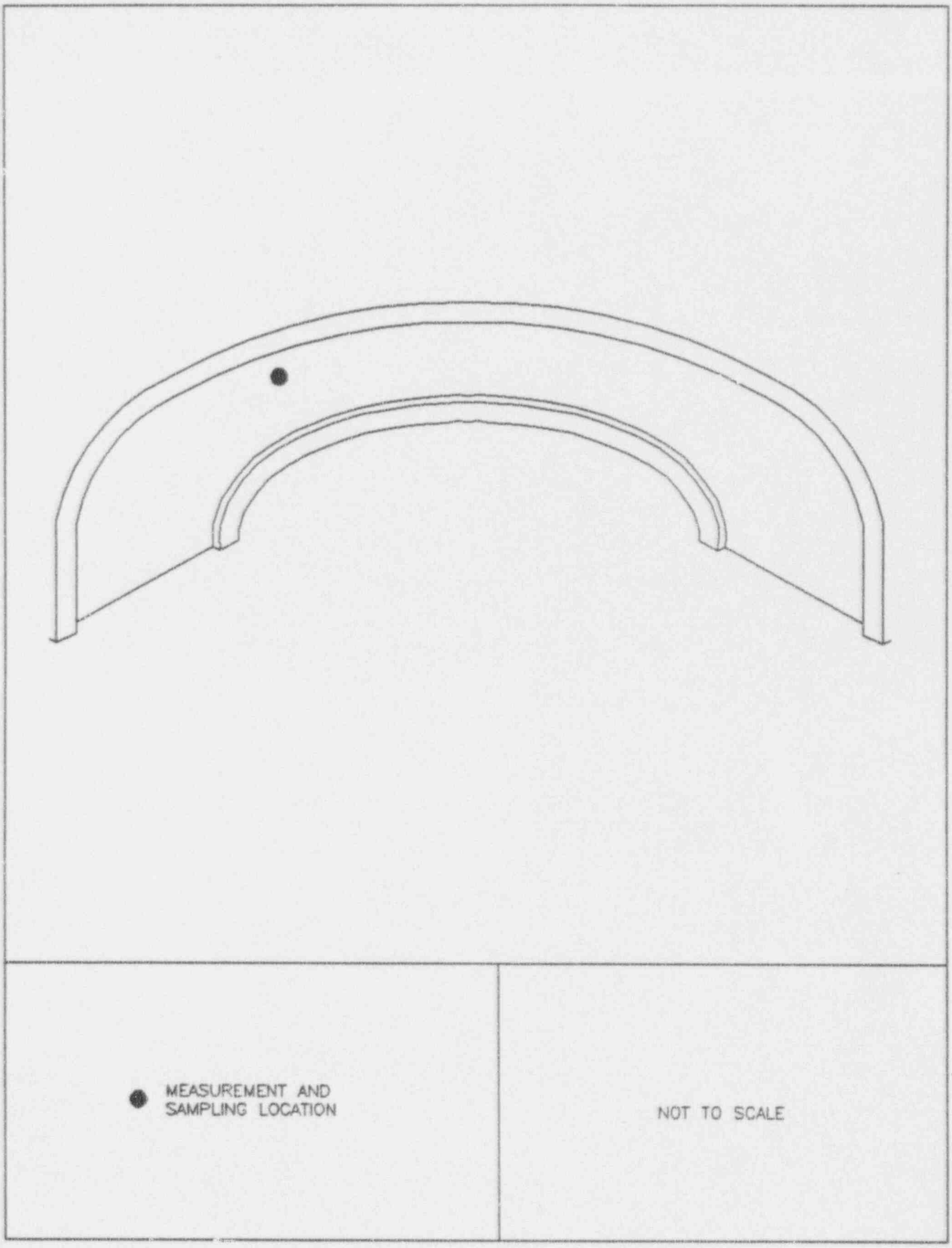


FIGURE 28: Main Turbine, Upper Casing Interior, Fifth Inset (West) – Measurement and Sampling Location

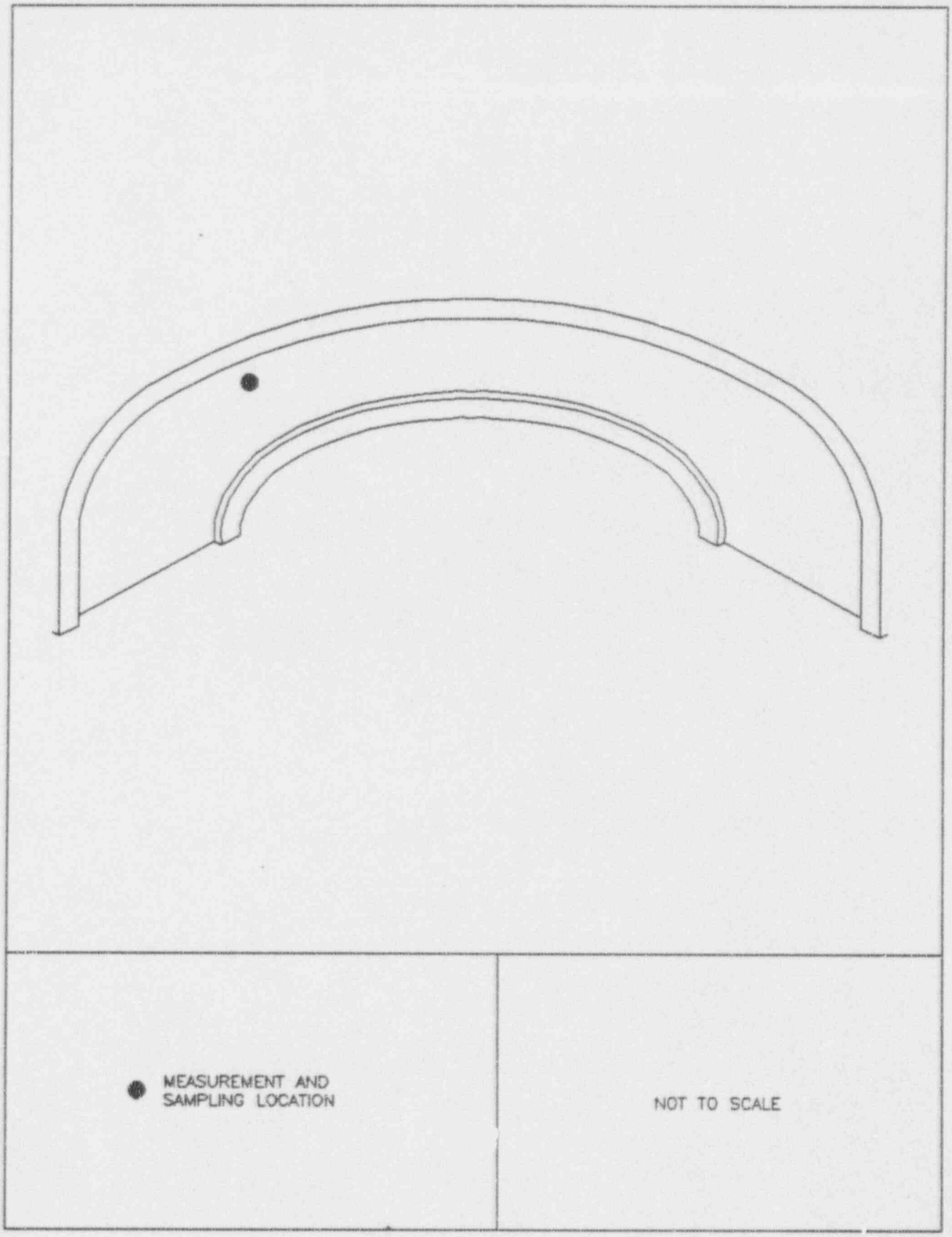


FIGURE 29: Main Turbine, Upper Casing Interior, Sixth Inset (West) – Measurement and Sampling Location

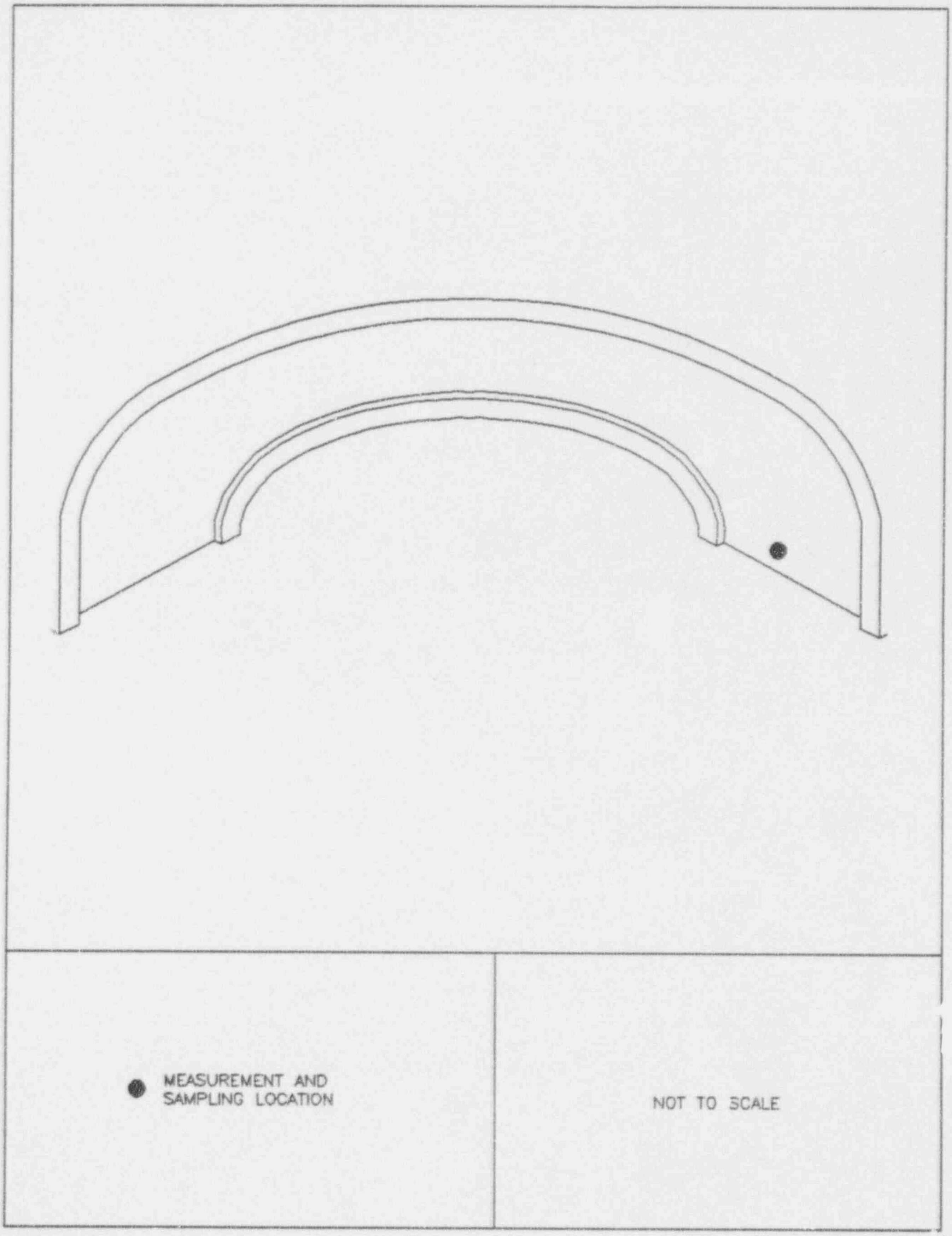


FIGURE 30: Main Turbine, Upper Casing Interior, Seventh Inset (West) – Measurement and Sampling Location

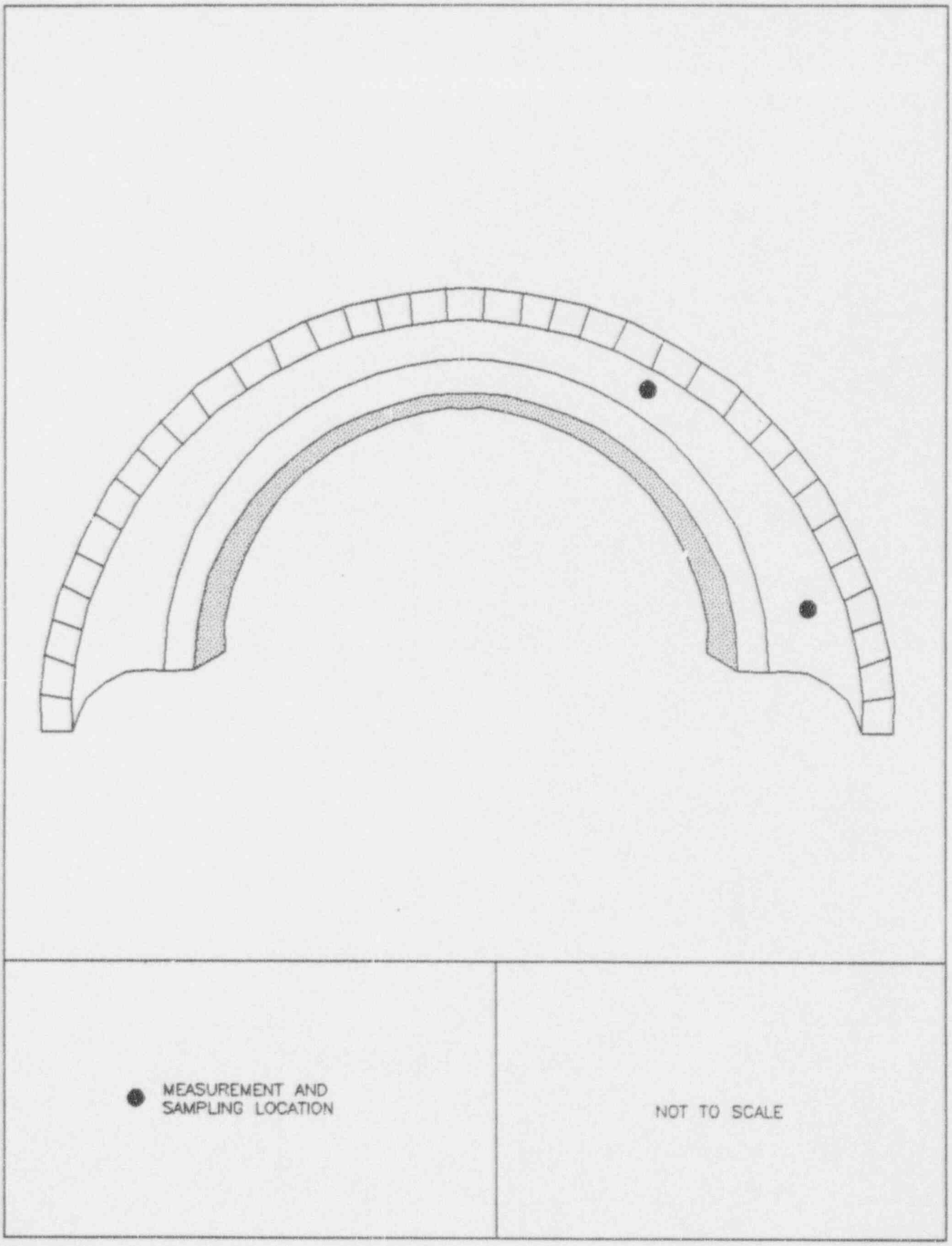
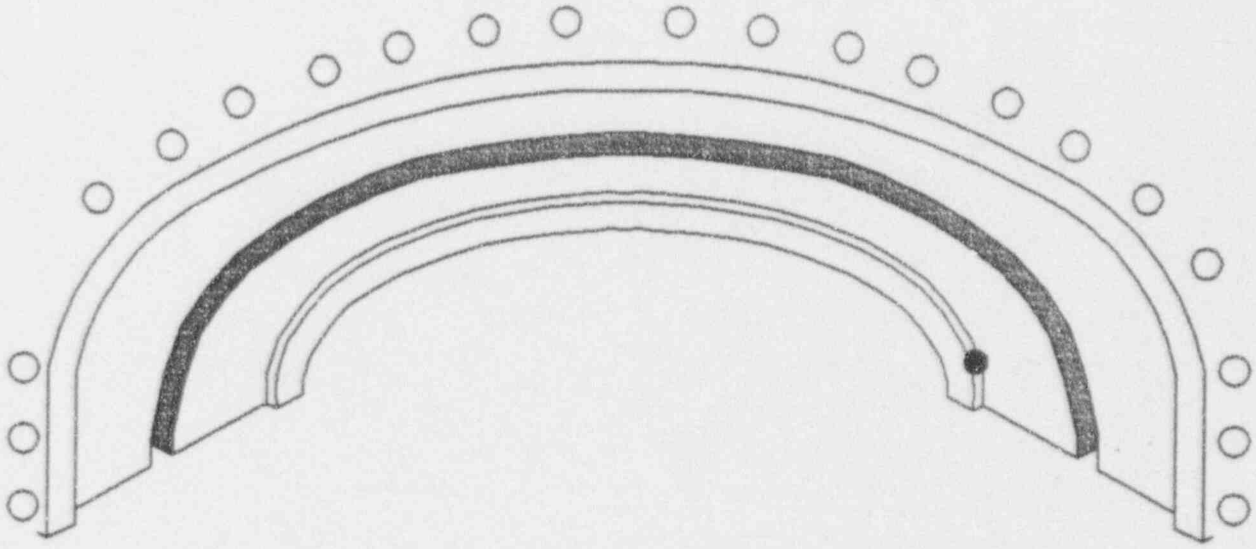


FIGURE 31: Main Turbine, Upper Casing Interior, Eighth Inset (West) – Measurement and Sampling Locations



● MEASUREMENT AND SAMPLING LOCATION

NOT TO SCALE

FIGURE 32: Main Turbine, Upper Casing Interior, Tenth Inset (West) – Measurement and Sampling Location

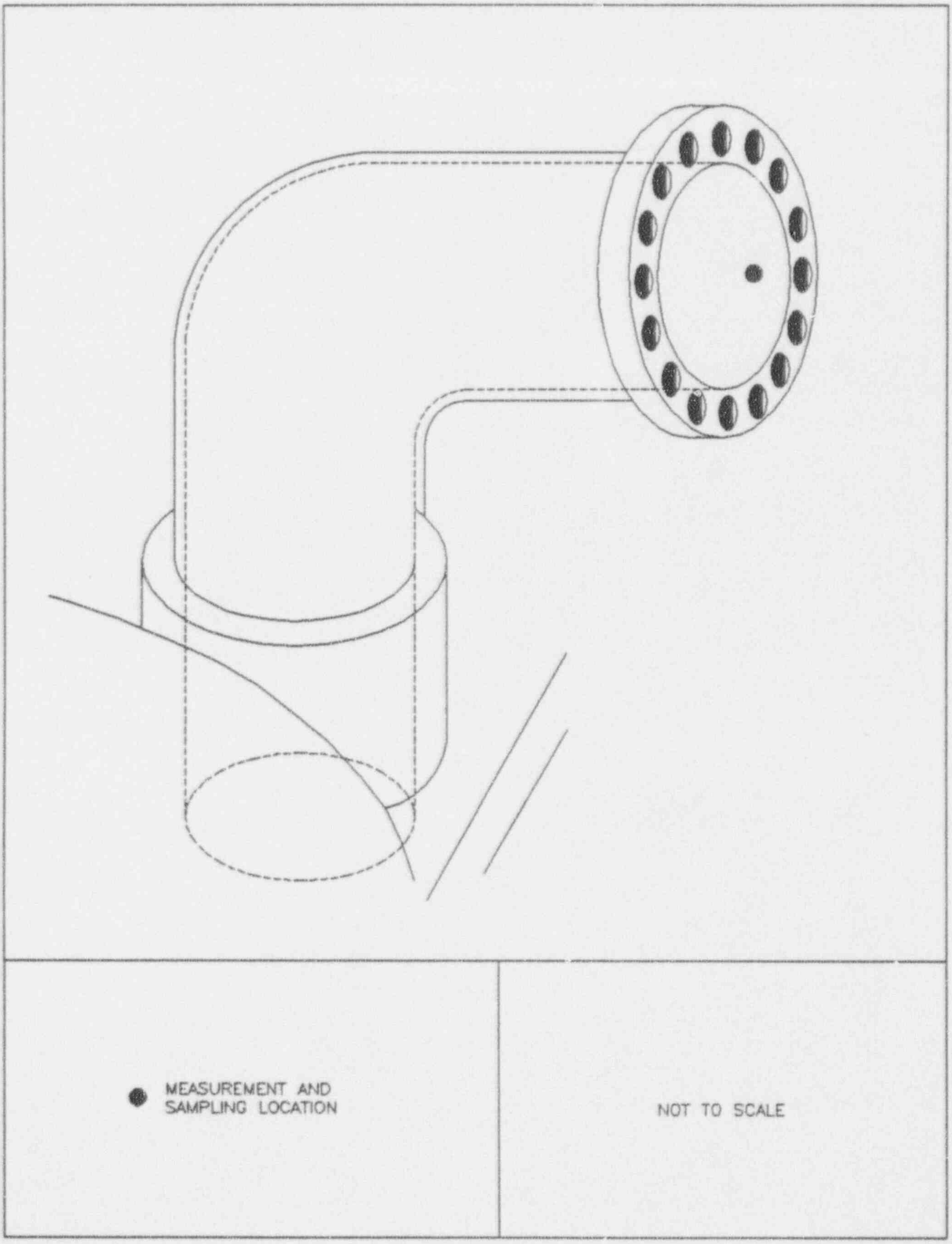


FIGURE 33: Main Turbine, Upper Casing, Steam inlet – Measurement and Sampling Location

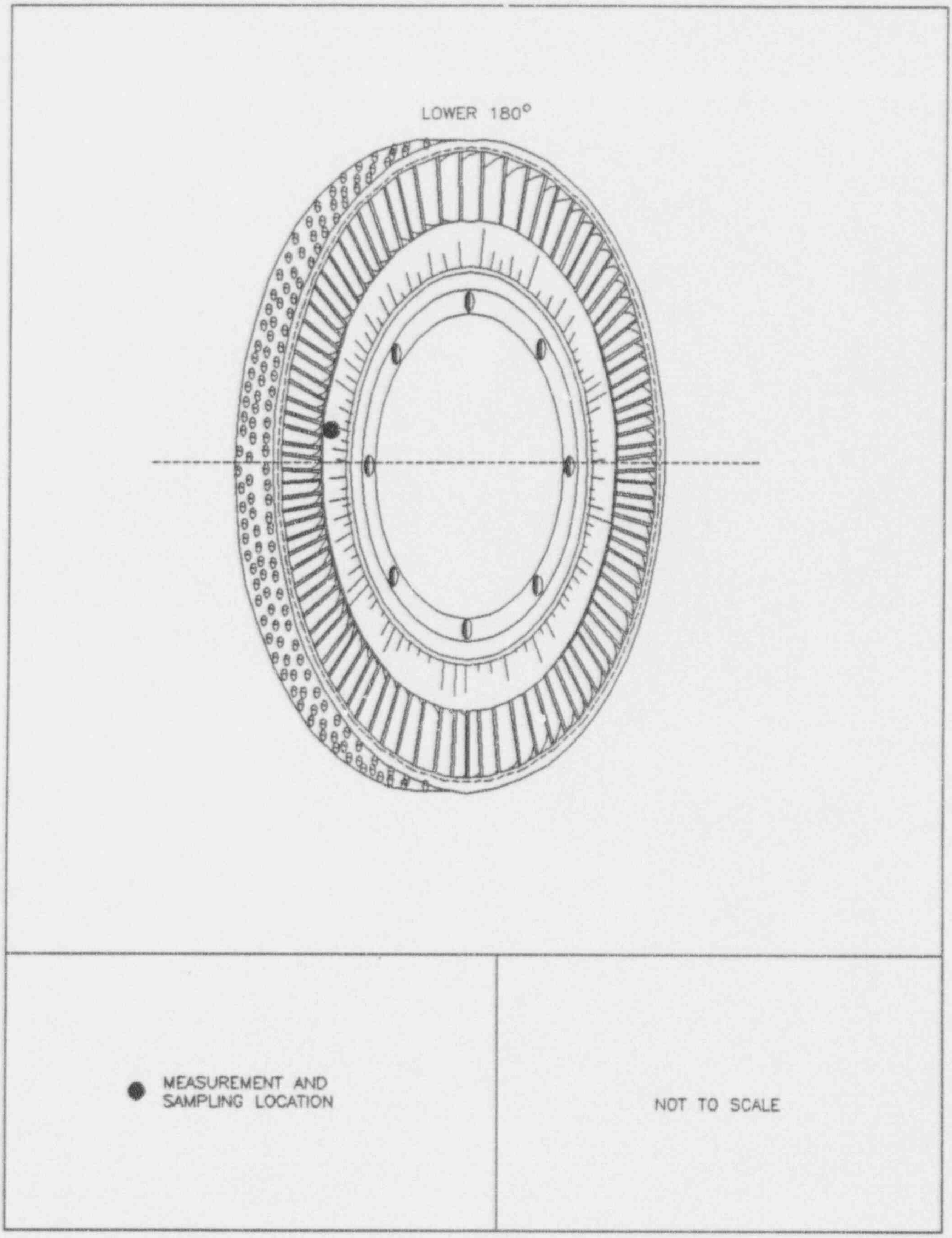


FIGURE 34: Main Turbine, First Stage East (East Face) – Measurement and Sampling Location

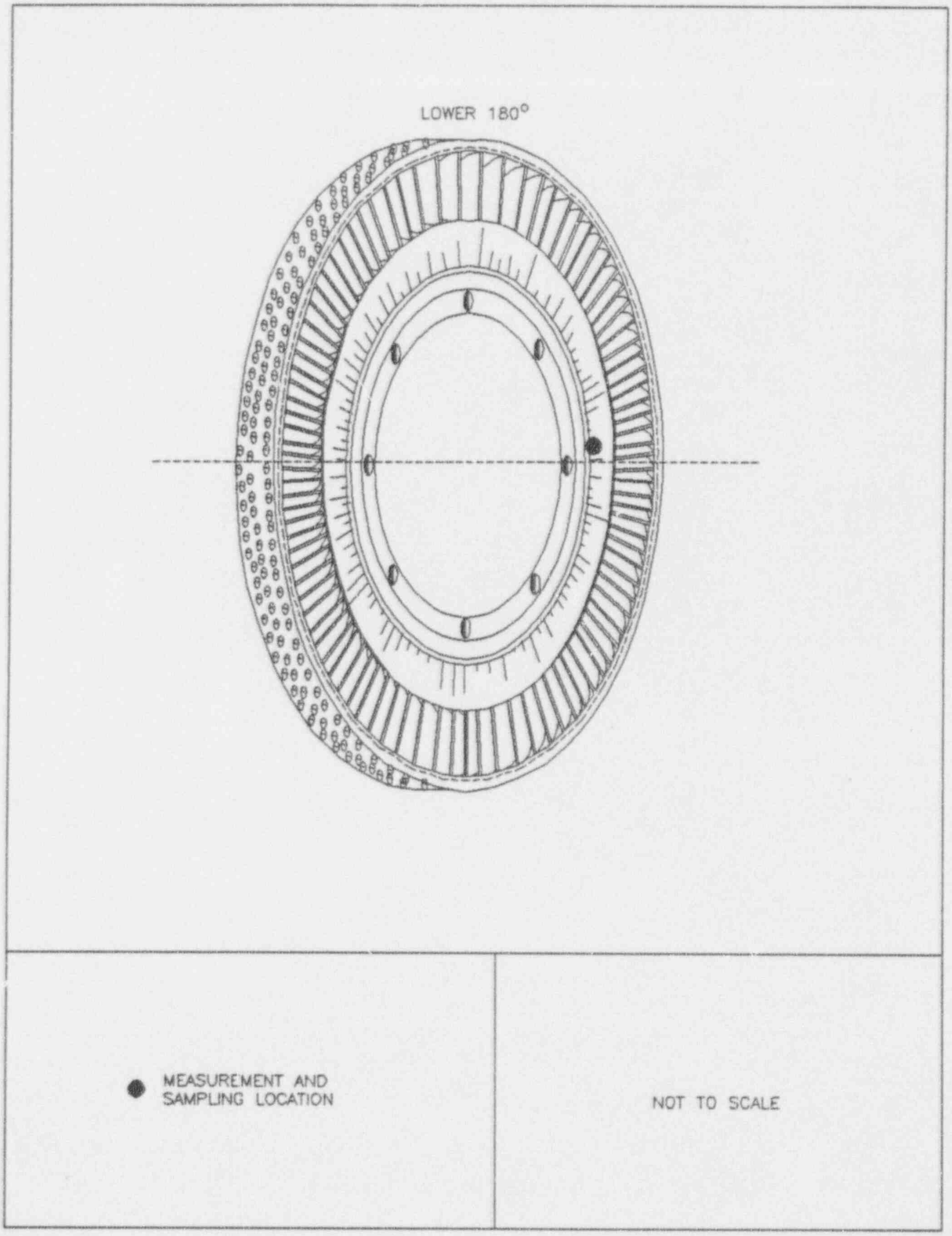


FIGURE 35: Main Turbine, First Stage East (West Face) – Measurement and Sampling Location

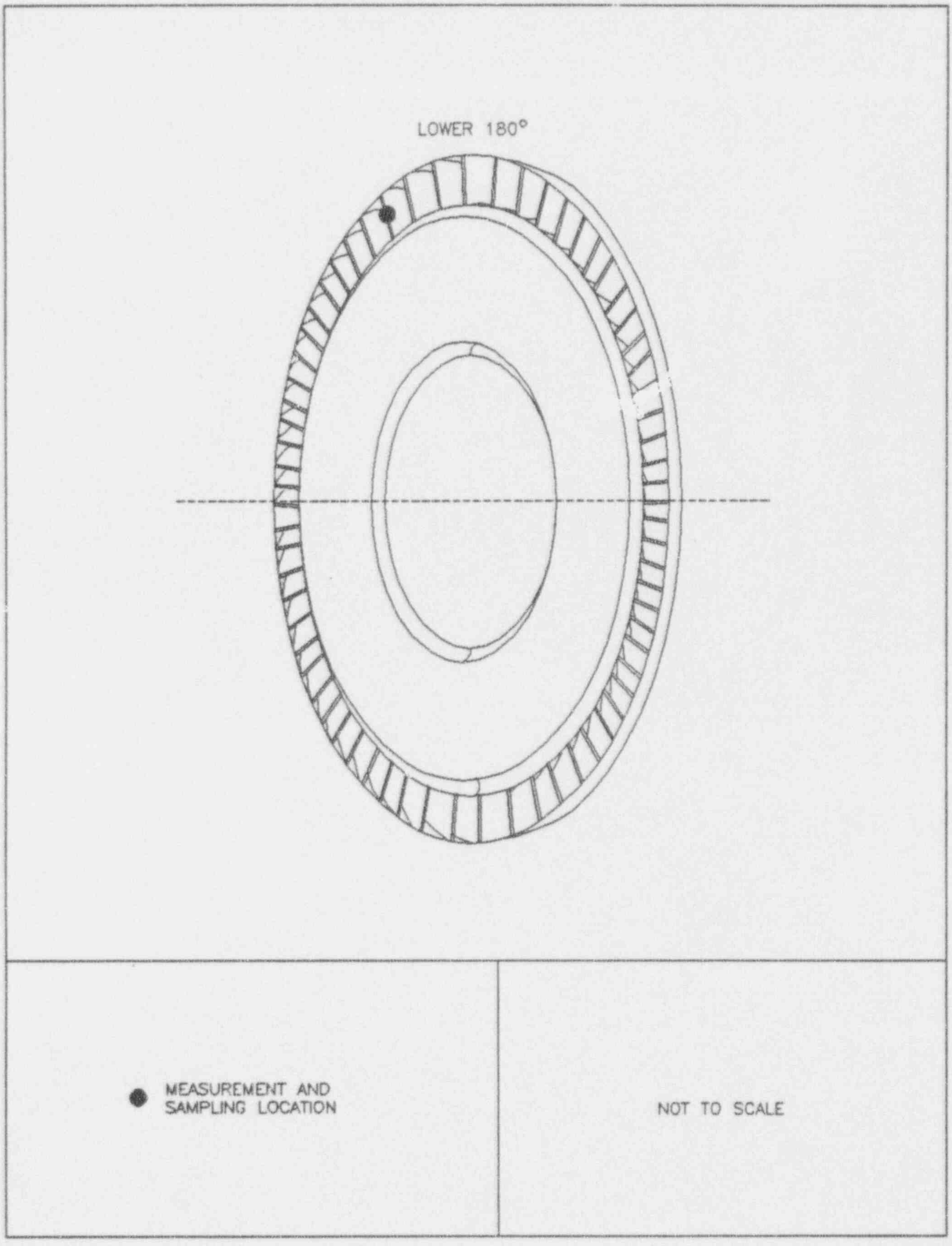


FIGURE 36: Main Turbine, Fourth Stage East (East Face) – Measurement and Sampling Location

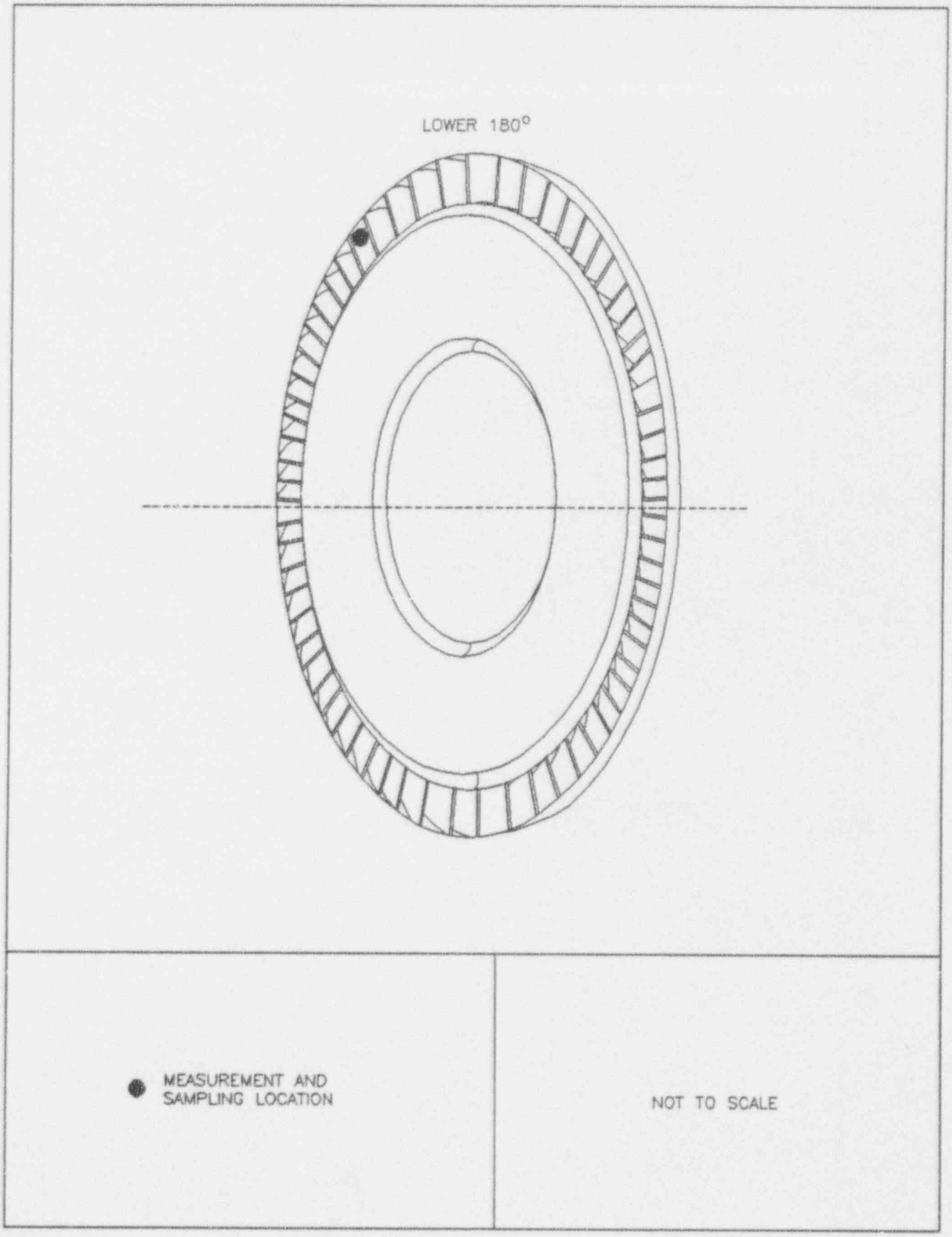
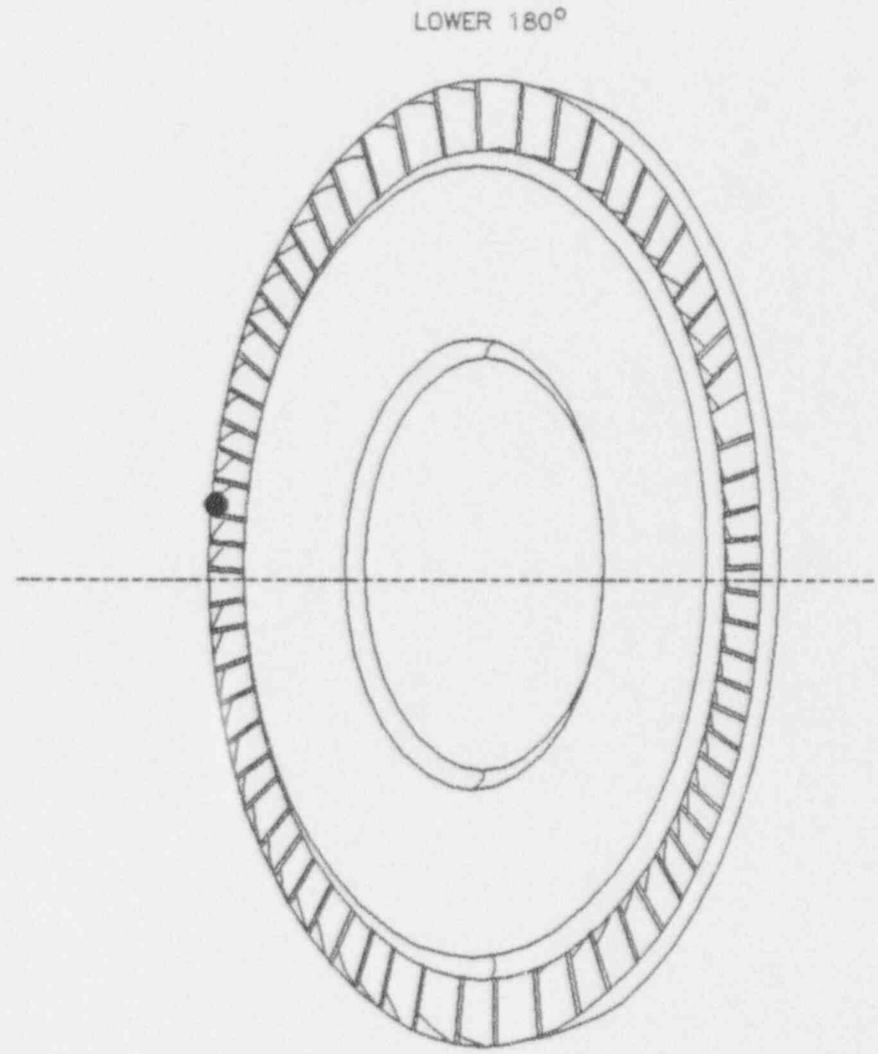


FIGURE 37: Main Turbine, Fourth Stage East (West Face) – Measurement and Sampling Location



● MEASUREMENT AND SAMPLING LOCATION

NOT TO SCALE

FIGURE 38: Main Turbine, Fifth Stage East (East Face) – Measurement and Sampling Location

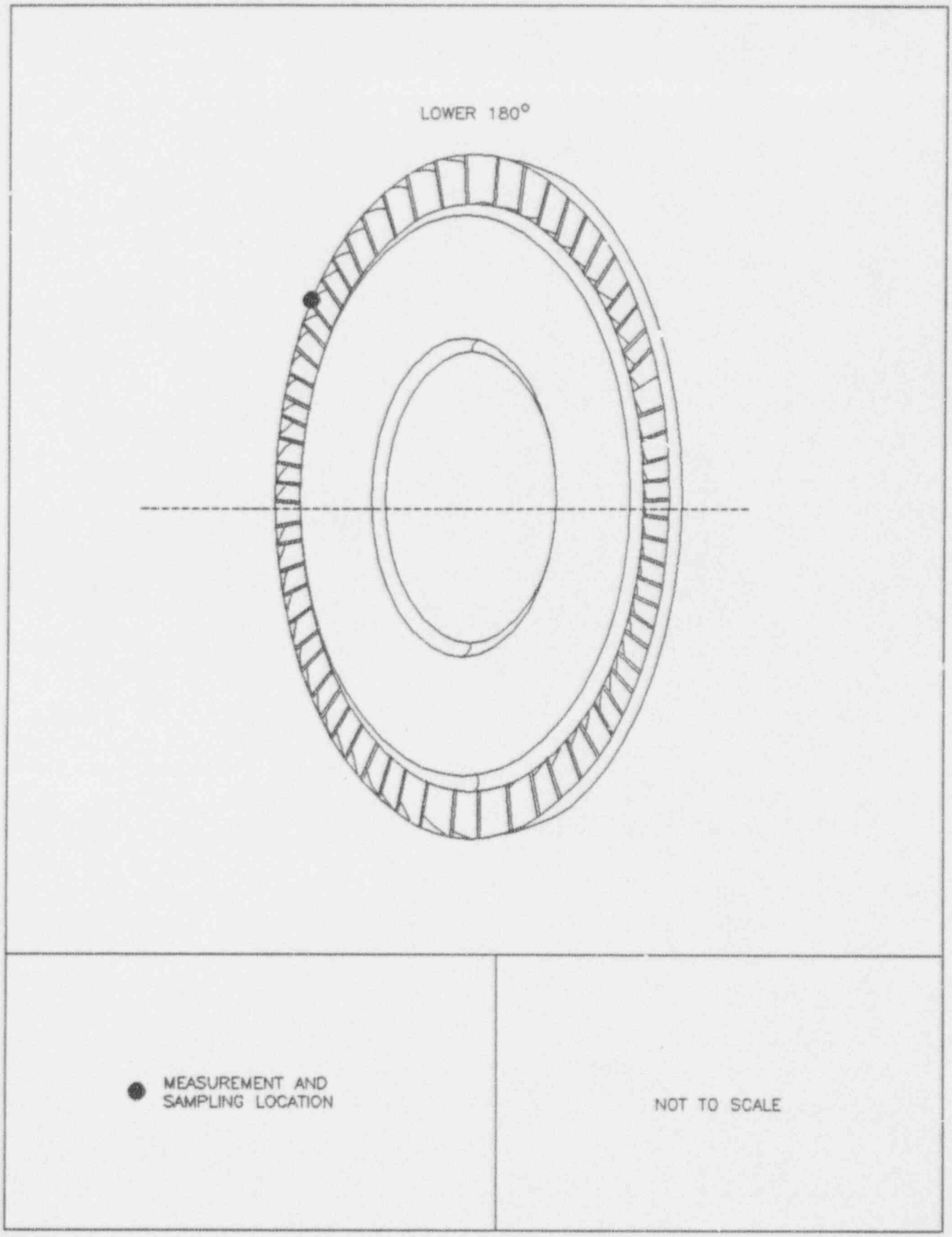
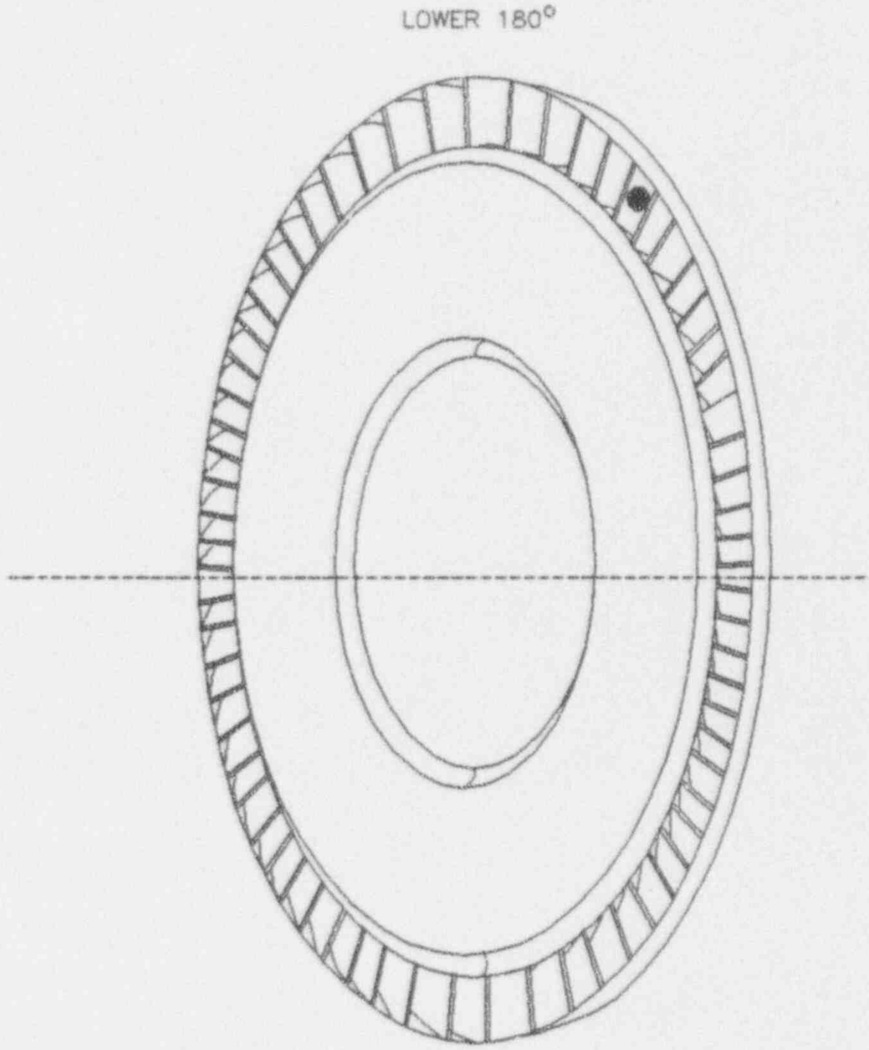


FIGURE 39: Main Turbine, Fifth Stage East (West Face) — Measurement and Sampling Location



● MEASUREMENT AND SAMPLING LOCATION

NOT TO SCALE

FIGURE 40: Main Turbine, Sixth Stage East (East Face) – Measurement and Sampling Location

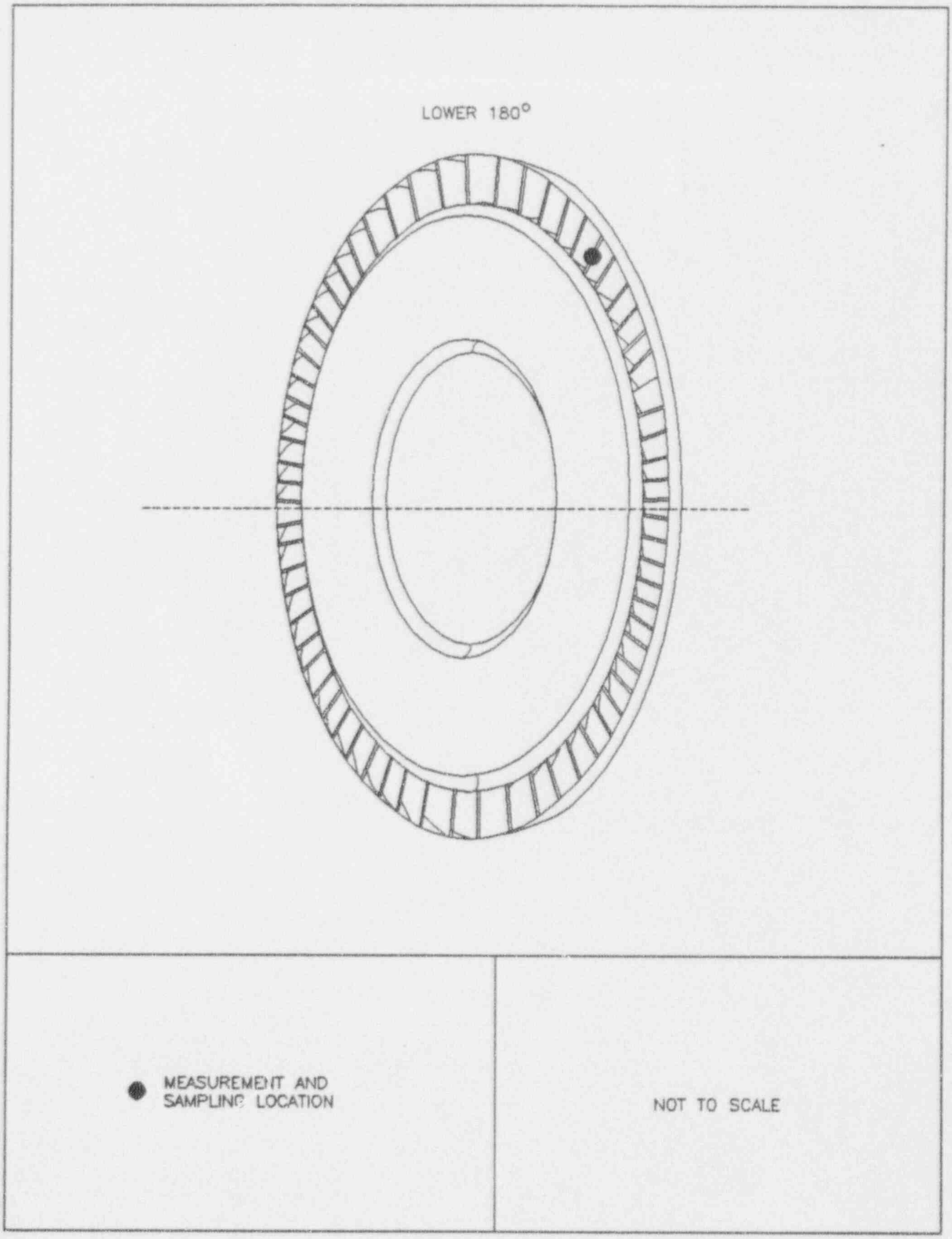


FIGURE 41: Main Turbine, Sixth Stage East (West Face) – Measurement and Sampling Location

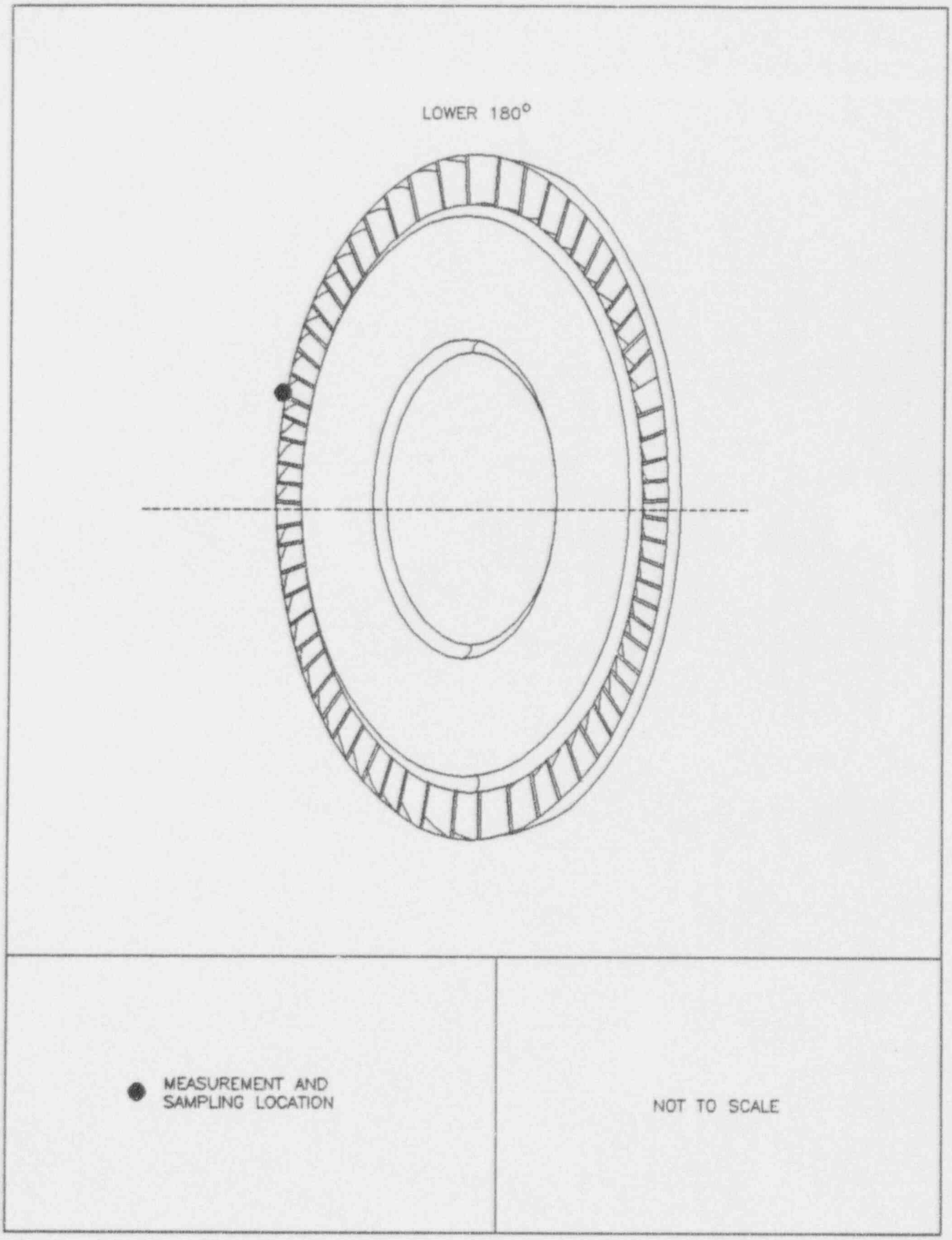


FIGURE 42: Main Turbine, Seventh Stage East (East Face) – Measurement and Sampling Location

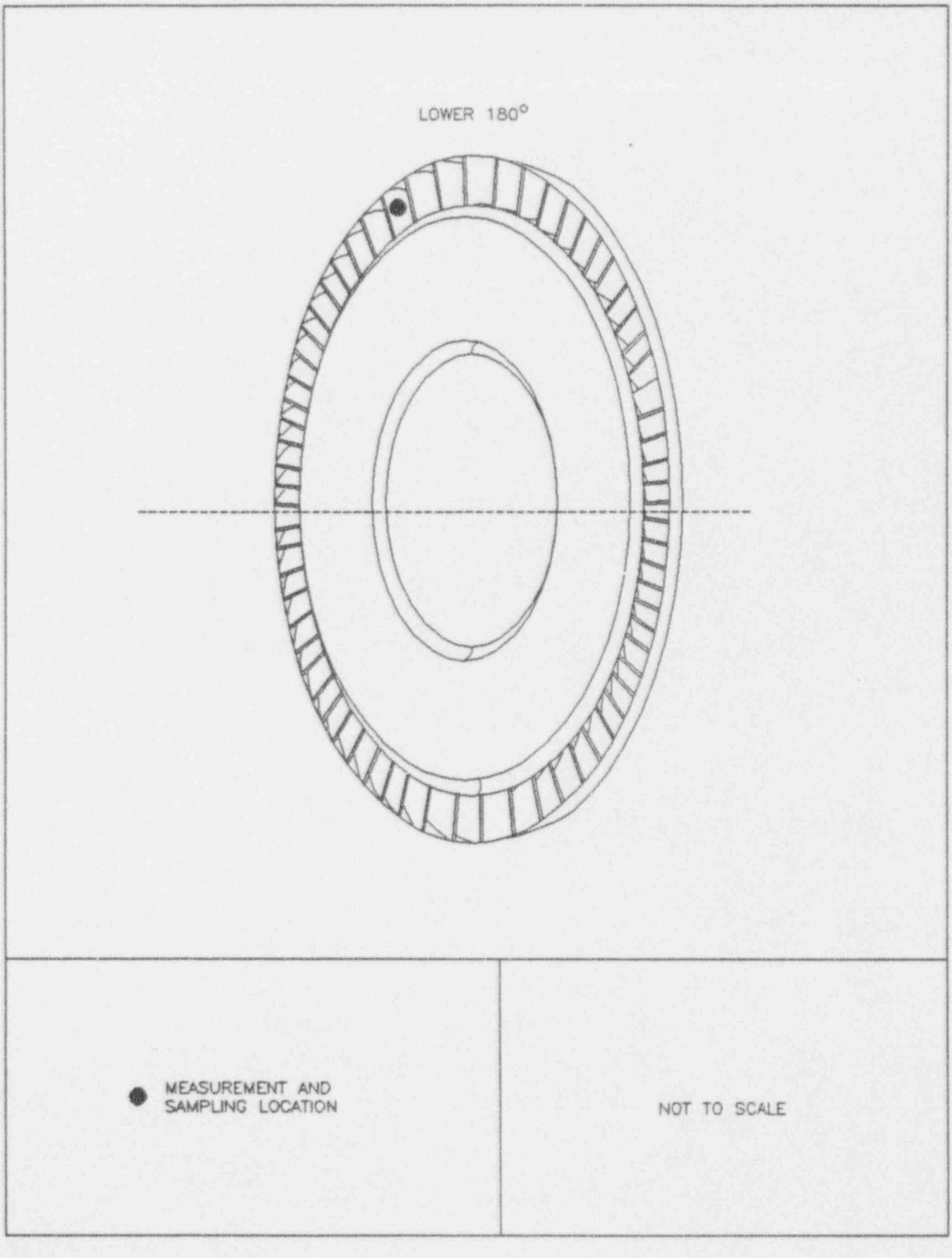


FIGURE 43: Main Turbine, Seventh Stage East (West Face) – Measurement and Sampling Location

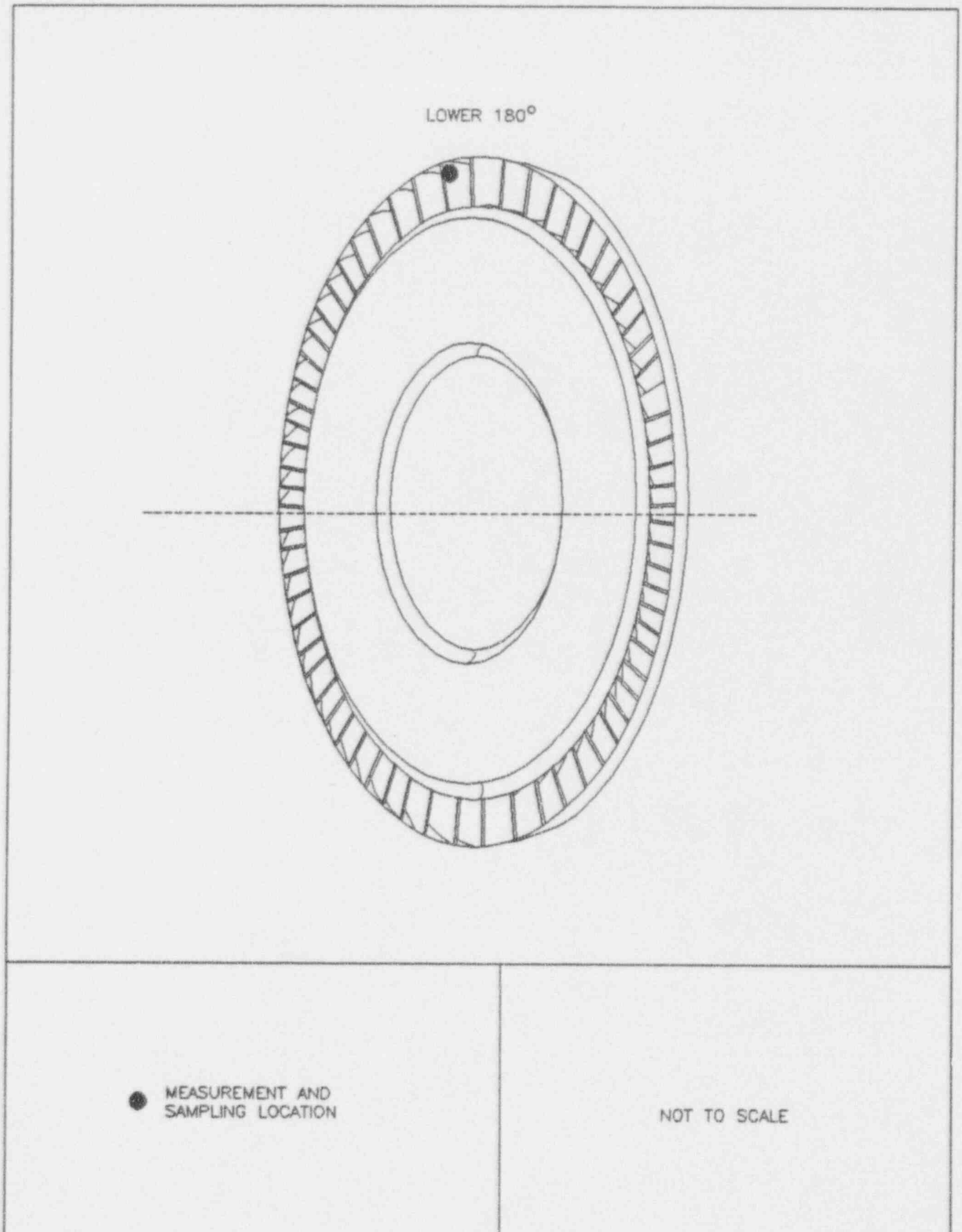


FIGURE 44: Main Turbine, Second Stage West (East Face) – Measurement and Sampling Location

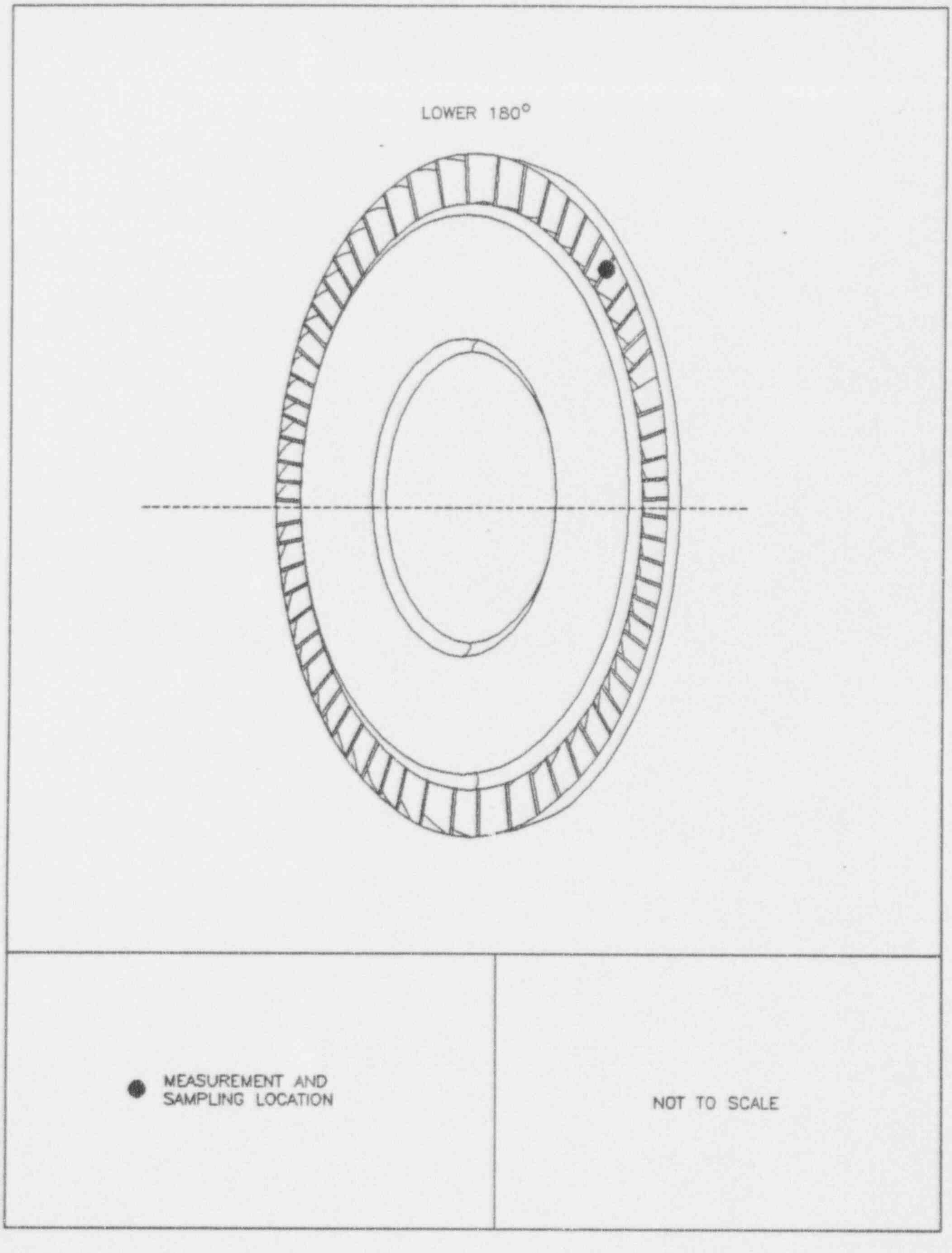


FIGURE 45: Main Turbine, Second Stage West (West Face) – Measurement and Sampling Location

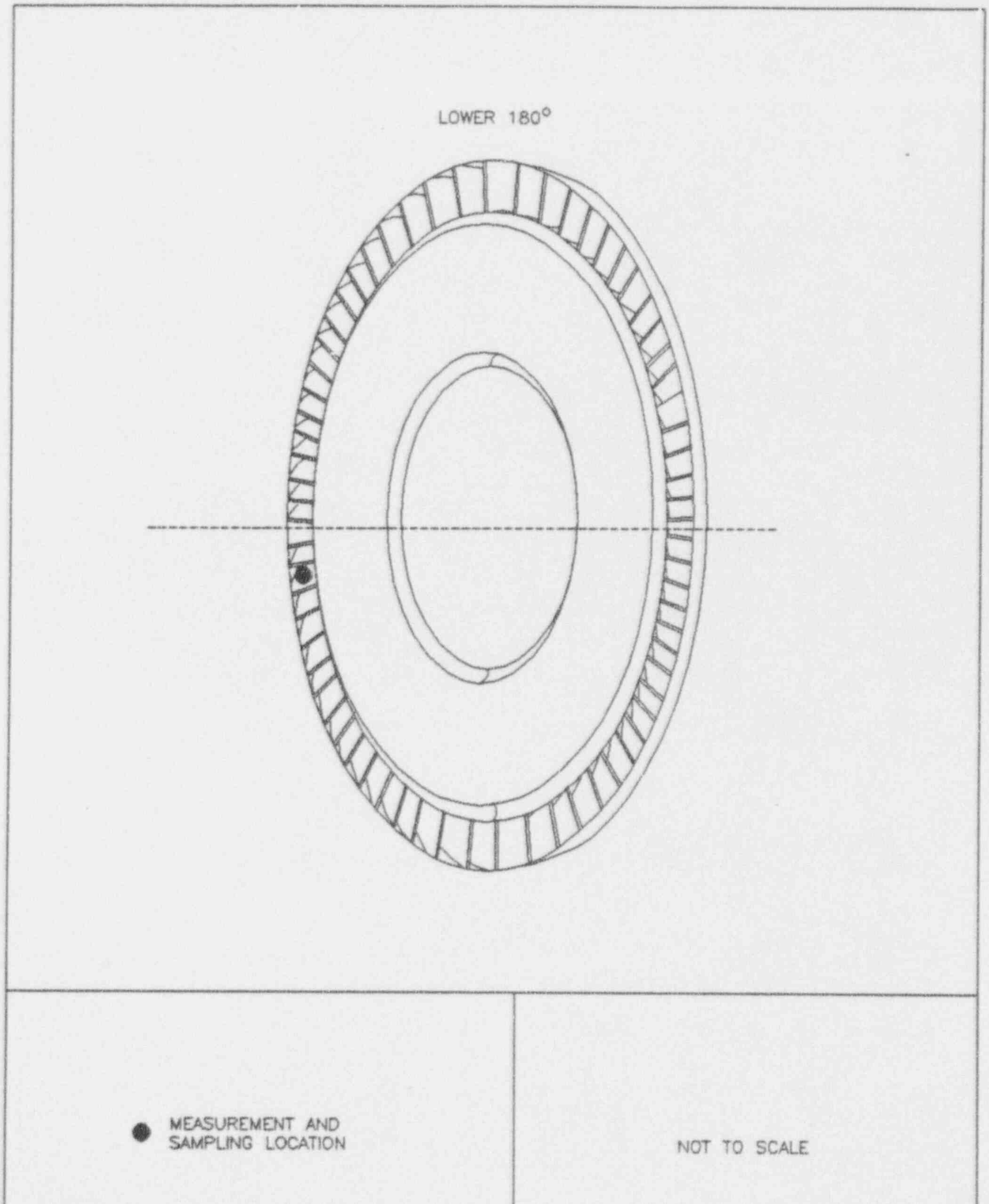


FIGURE 46: Main Turbine, Third Stage West (East Face) -- Measurement and Sampling Location

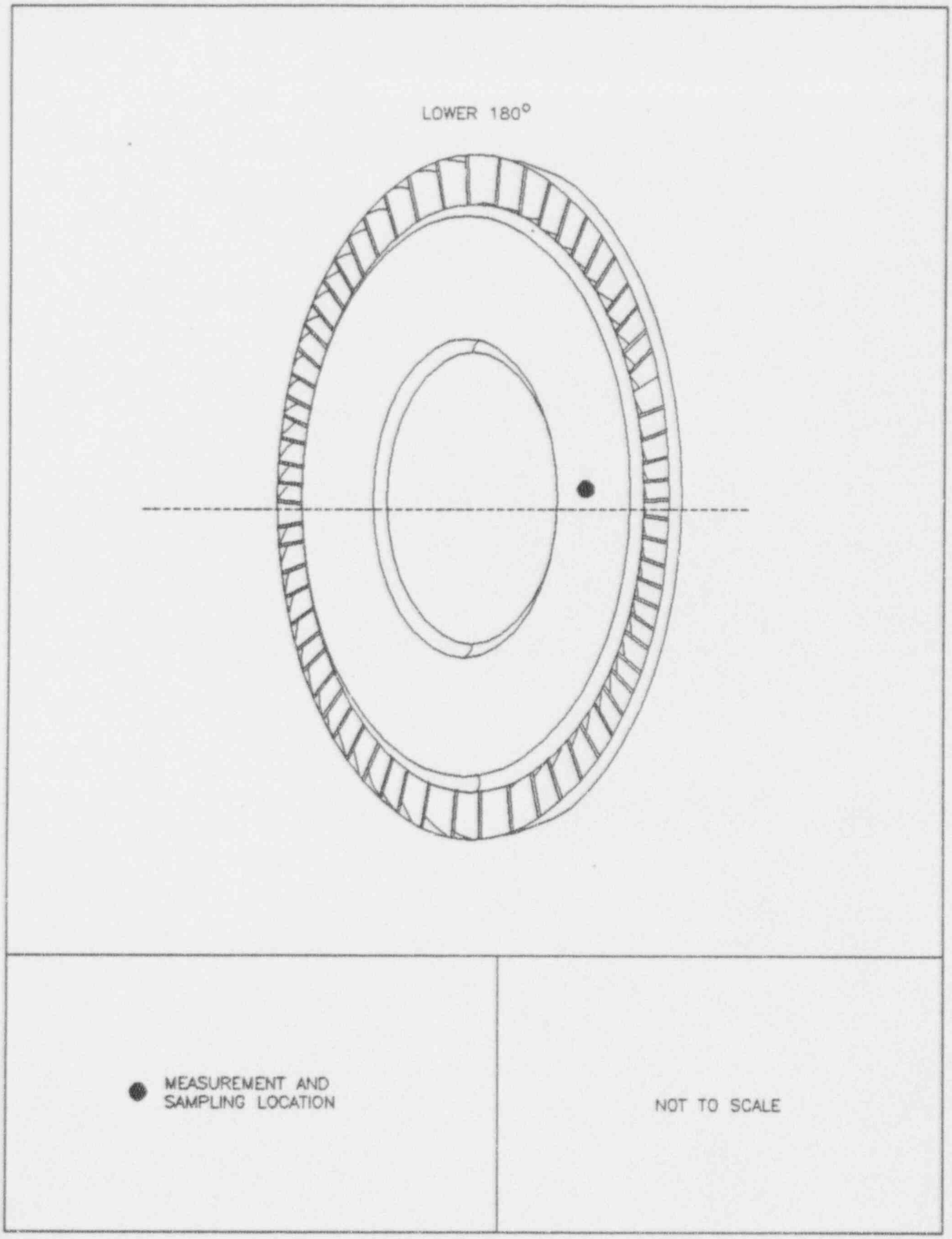


FIGURE 47: Main Turbine, Third Stage West (West Face) – Measurement and Sampling Location

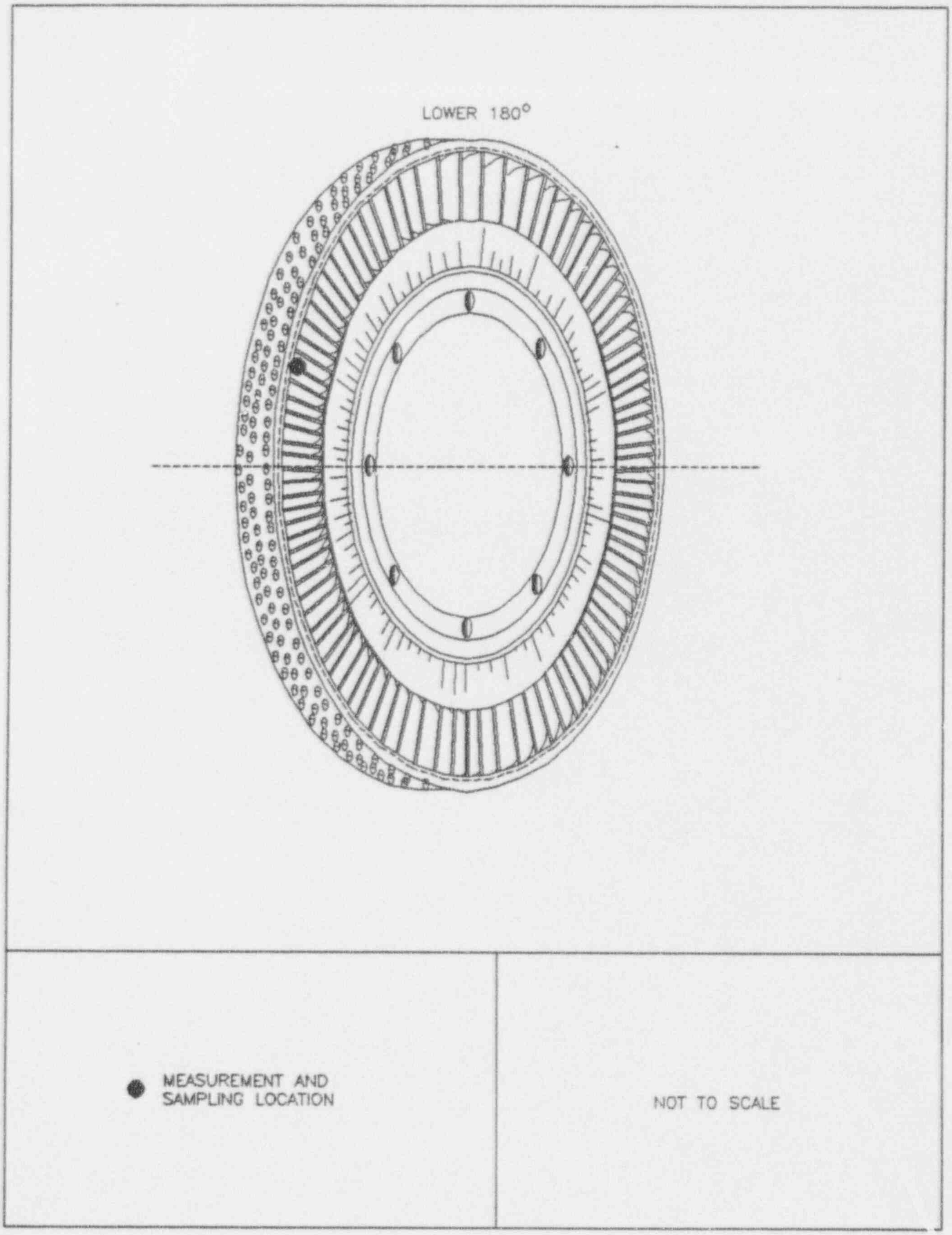


FIGURE 48: Main Turbine, Fifth Stage West (West Face) – Measurement and Sampling Location

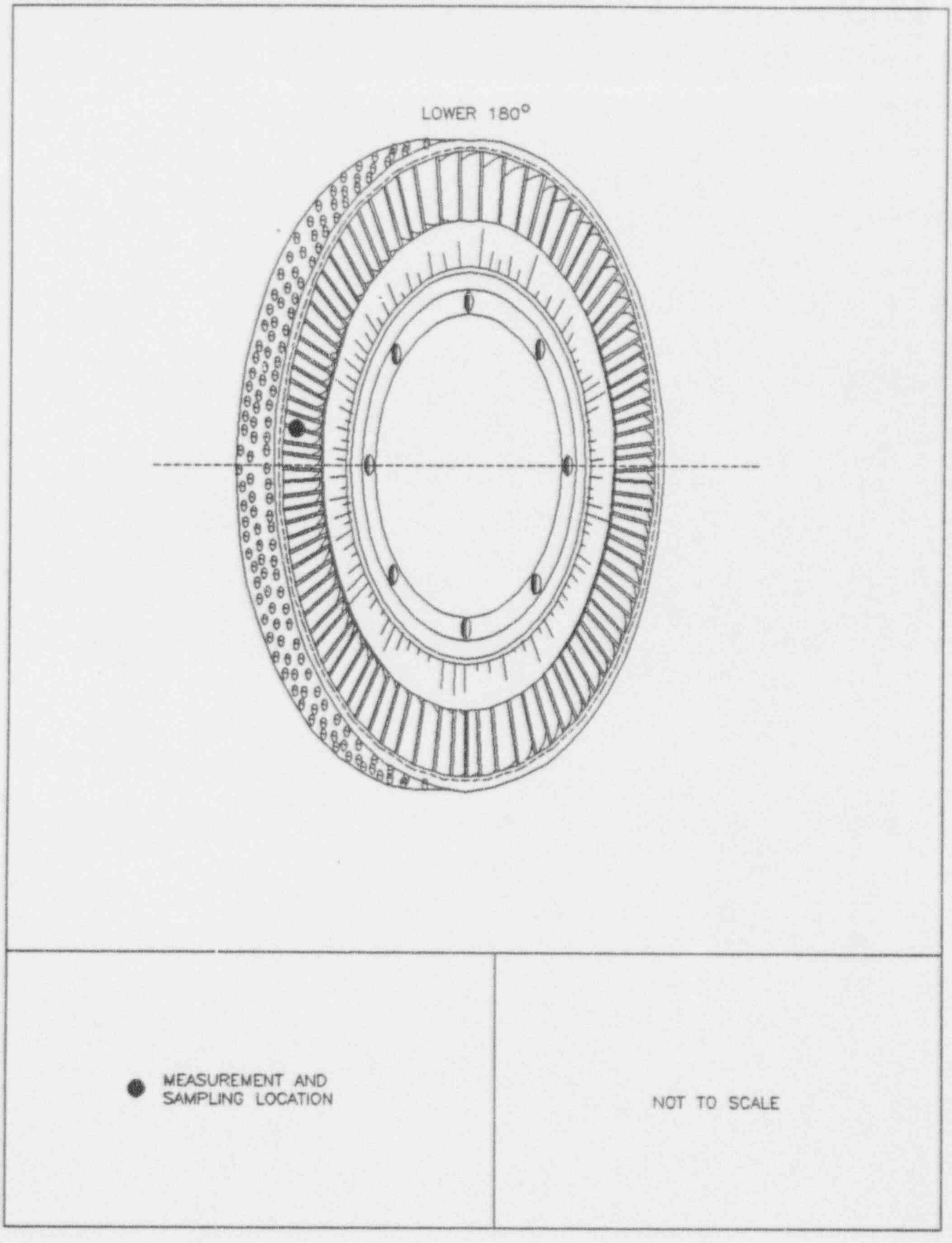


FIGURE 49: Main Turbine, Sixth Stage West (East Face) – Measurement and Sampling Location .

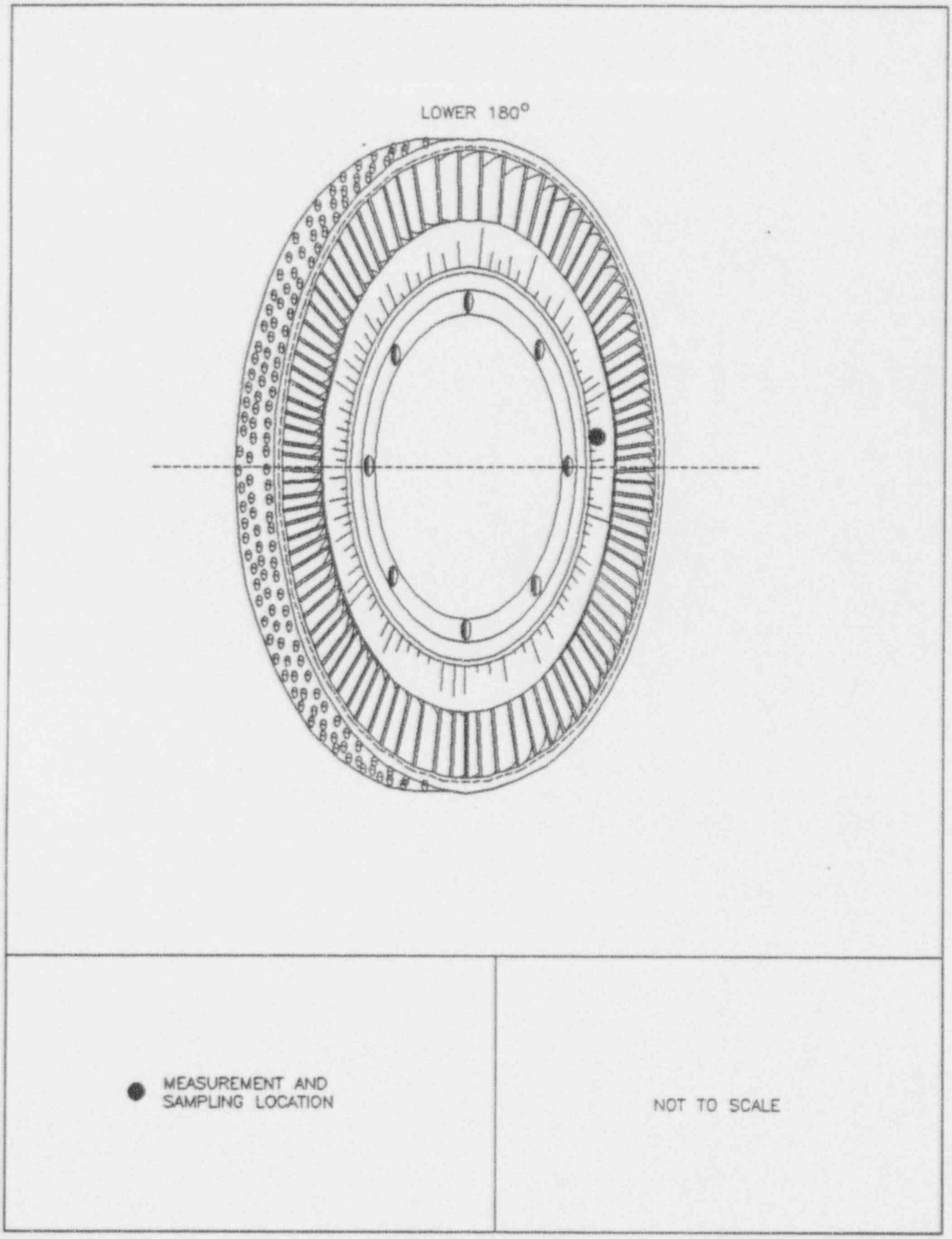


FIGURE 50: Main Turbine, Sixth Stage West (West Face) – Measurement and Sampling Location

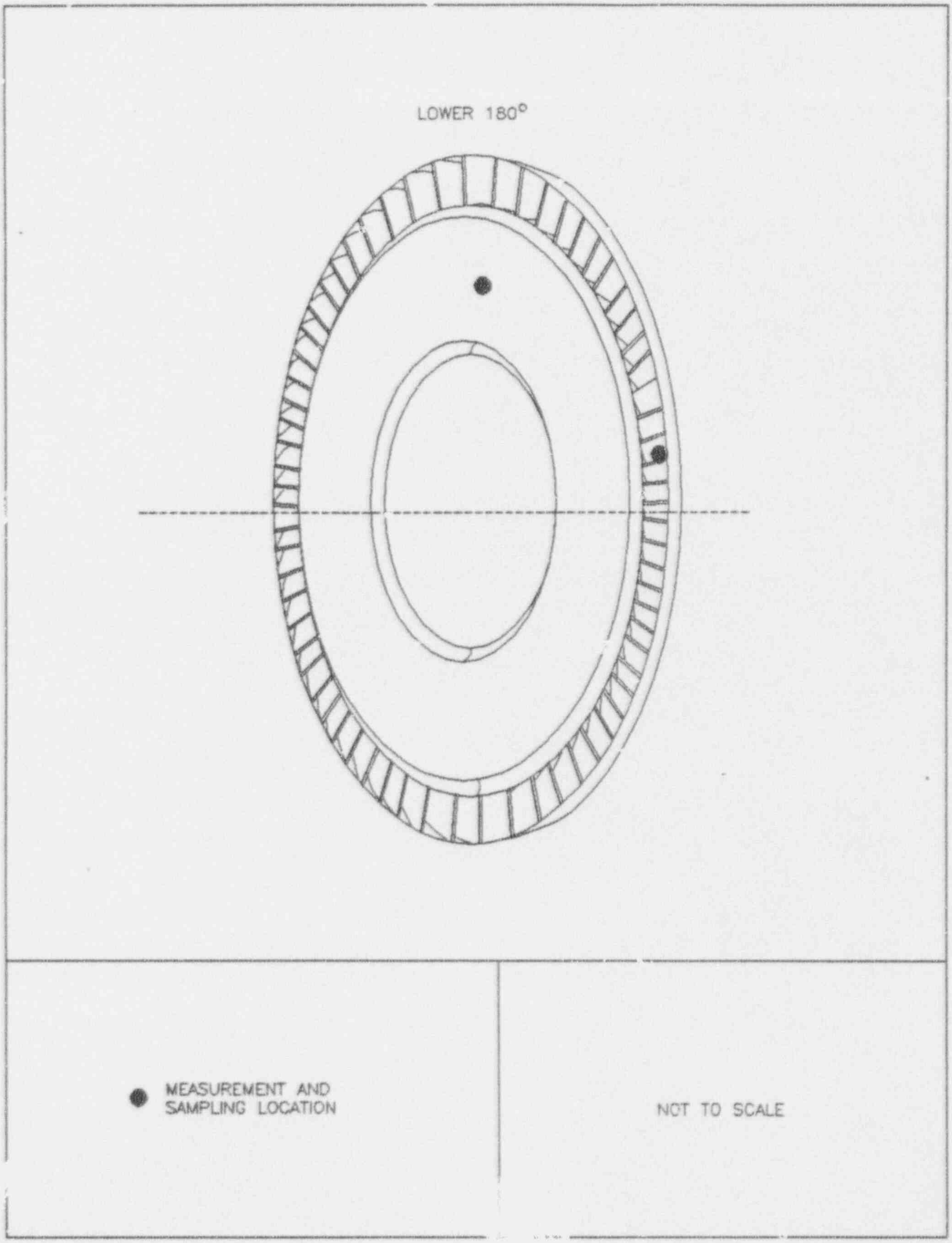


FIGURE 51: Main Turbine, Seventh Stage West (East Face) – Measurement and Sampling Locations

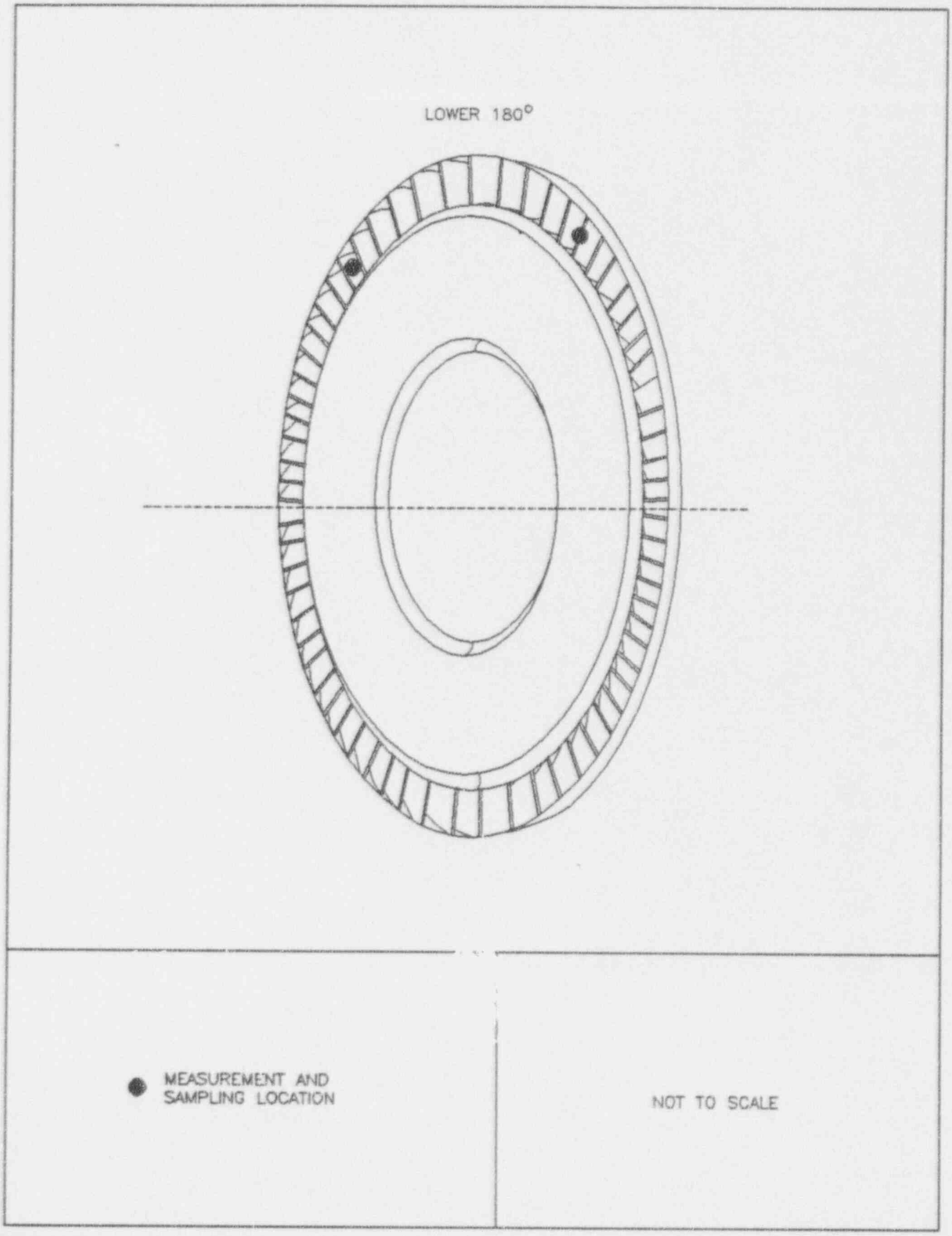


FIGURE 52: Main Turbine, Seventh Stage West (West Face) – Measurement and Sampling Locations

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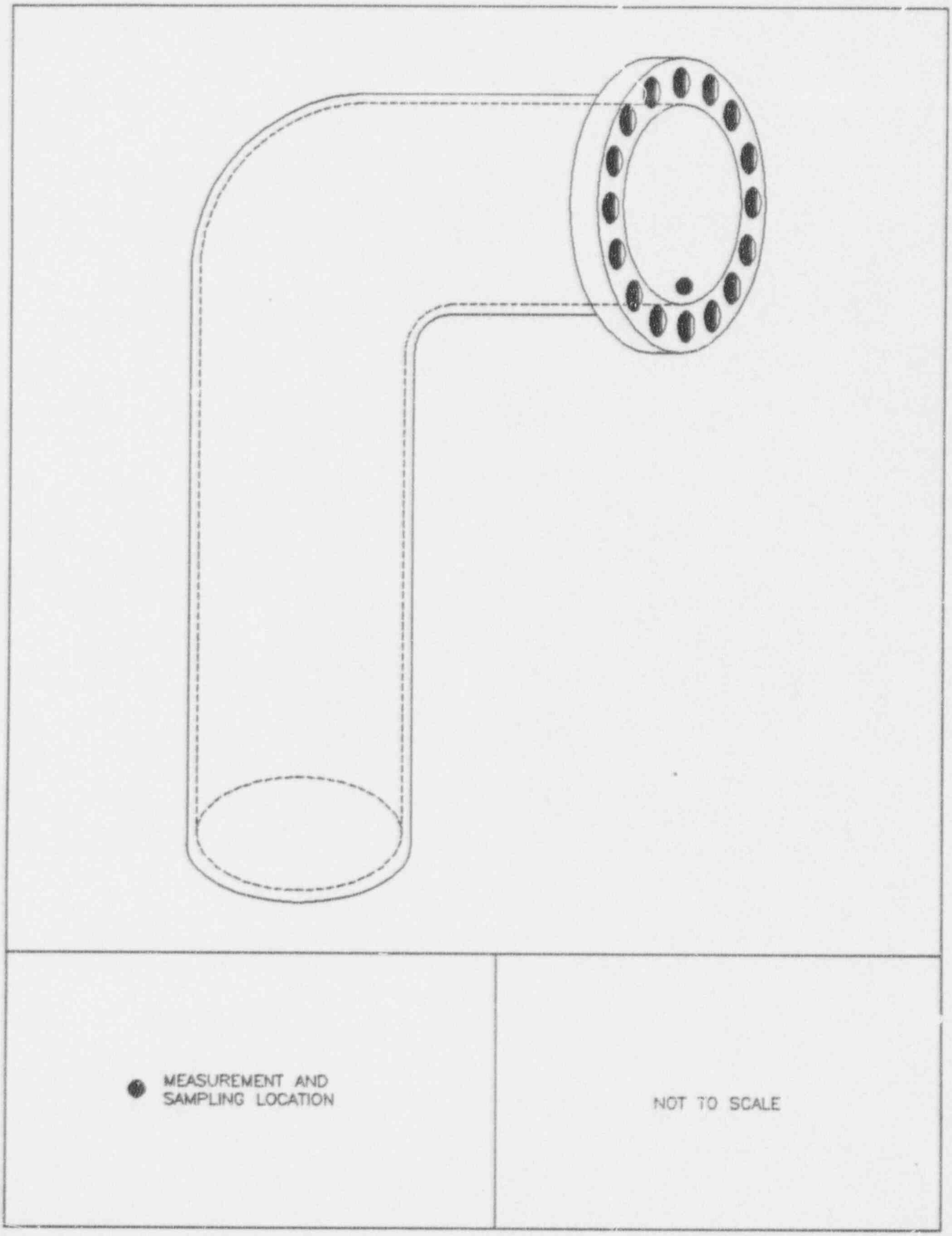

FIGURE 53: Main Turbine, North Main Steam Piping – Measurement and Sampling Location

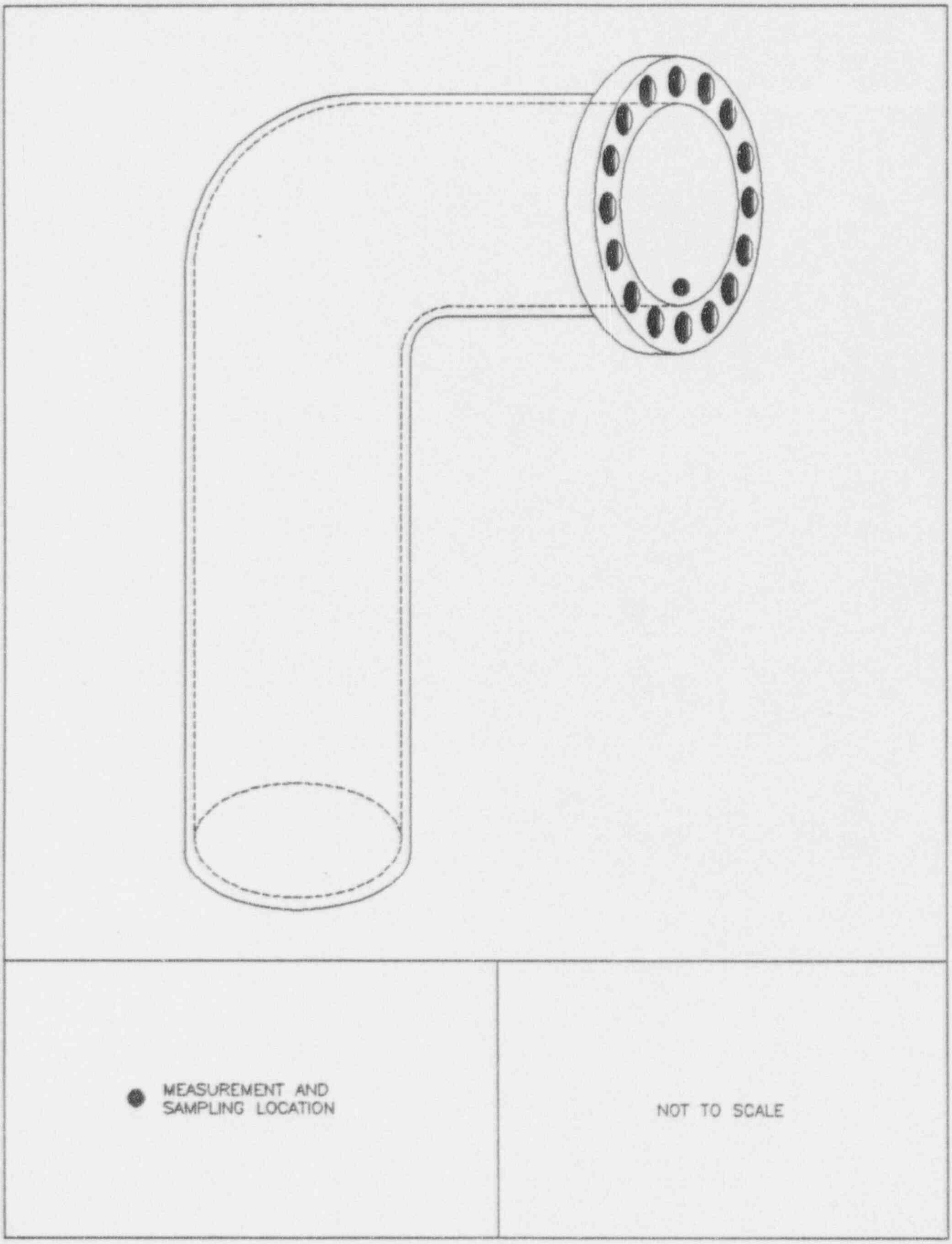

FIGURE 54: Main Turbine, South Main Steam Piping - Measurement and Sampling Location

TABLE 1

SURFACE ACTIVITY LEVELS
HIGH PRESSURE SECTION TURBINE COMPONENTS
SHOREHAM NUCLEAR POWER STATION
BROOKHAVEN, NEW YORK

Component[a]	Surface Activity Levels (dpm/100 cm²)		
	Total Beta Activity	Removable Activity	
		Alpha	Beta
Diaphragms			
#2G	<990	<12	<17
#2T	<990	<12	<17
#4G	<990	<12	<17
#4T	<990	<12	<17
#6G	<990	<12	<17
#6T	<990	<12	<17
#7G	<990	<12	<17
#7T	<990	<12	<17
Diffusers			
Northeast Diffuser	<990	<12	<17
Southwest Diffuser	<990	<12	<17
Northwest Diffuser	<990	<12	<17
Upper Casing, Interior			
1st Inset East	<990	<12	<17
2nd Inset East	<990	<12	<17
3rd Inset East	<990	<12	<17
4th Inset East	<990	<12	<17
5th Inset East	<990	<12	<17
6th Inset East	<990	<12	<17

TABLE 1 (Continued)

SURFACE ACTIVITY LEVELS
HIGH PRESSURE SECTION TURBINE COMPONENTS
SHOREHAM NUCLEAR POWER STATION
BROOKHAVEN, NEW YORK

Component[a]	Surface Activity Levels (dpm/100 cm^2)		
	Total Beta Activity	Removable Activity	
		Alpha	Beta
Upper Casing, Interior			
7th Inset East	<990	<12	<17
8th Inset East	<990	<12	<17
10th Inset East	<990	<12	<17
1st Inset West	<990	<12	<17
2nd Inset West	<990	<12	<17
3rd Inset West	<990	<12	<17
4th Inset West	<990	<12	<17
5th Inset West	<990	<12	<17
6th Inset West	<990	<12	<17
7th Inset West	<990	<12	<17
8th Inset West	<990	<12	<17
10th Inset West	<990	<12	<17
Upper Casing N. Main Steam Inlet Piping			
Turbine Stages			
1st Stage East (EF)[b]	<990	<12	<17
1st Stage East (WF)[c]	<990	<12	<17
4th Stage East (EF)	<990	<12	<17
4th Stage East (WF)	<990	<12	<17
5th Stage East (EF)	<990	<12	<17

TABLE 1 (Continued)

SURFACE ACTIVITY LEVELS
HIGH PRESSURE SECTION TURBINE COMPONENTS
SHOREHAM NUCLEAR POWER STATION
BROOKHAVEN, NEW YORK

Components[a]	Surface Activity Levels (dpm/100 cm²)		
	Total Beta Activity	Removable Activity	
		Alpha	Beta
Upper Casing N. Main Steam Inlet Piping			
5th Stage East (WF)	<990	<12	<17
6th Stage East (EF)	<990	<12	<17
6th Stage East (WF)	<990	<12	<17
7th Stage East (Top)	<990	<12	<17
7th Stage East (WF)	<990	<12	<17
2nd Stage West (EF)	<990	<12	<17
2nd Stage West (WF)	<990	<12	<17
3rd Stage West (EF)	<990	<12	<17
3rd Stage West (WF)	<990	<12	<17
5th Stage West (WF)	<990	<12	<17
6th Stage West (EF)	<990	<12	<17
6th Stage West (WF)	<990	<12	<17
7th Stage West (EF)	<990	<12	<17
7th Stage West (WF)	<990	<12	<17
Main Inlet Steam Piping			
North Pipe	<990	<12	<17
South Pipe	<990	<12	<17

REFERENCES

1. Long Island Lighting Company, "Shoreham Nuclear Power Station Site Characterization Program Final Report," May 1990, (with addendum; June and October 1990).

2. Long Island Power Authority, "Shoreham Nuclear Power Station Decommissioning Plan," NRC Docket No. 50-322, December 1990.

3. J.D. Berger, "Manual for Conducting Radiological Surveys in Support of License Termination", NUREG/CR-5849 Draft, June 1992.

4. Long Island Power Authority, "The Shoreham Nuclear Power Station Decommissioning Project Termination Survey for the Steam Turbine System (N31)," February 1993.

5. Long Island Power Authority, "Shoreham Decommissioning Project, Termination Survey Plan," Revision 0, October 1992.

6. ORISE, letter from T.J. Vitkus to Dave Fauver, U.S. Nuclear Regulatory Commission, "Proposed Confirmatory Survey Plan for the Turbine Internal Components, Shoreham Nuclear Power Station, Brookhaven, New York," February 8, 1993.

7. ORISE, letter from M.R. Landis to Dave Fauver, U.S. Nuclear Regulatory Commission, "Shoreham Decommissioning Project, Termination Survey Plan, Revision 0, Shoreham Nuclear Power Station, October 1992", January 1993.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a product is not to be construed as an endorsement of the product or its manufacturer by the authors or their employers.

DIRECT RADIATION MEASUREMENT

Instruments

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

Eberline "Rascal" Ratemeter-Scaler
Model PRS-1
(Eberline, Santa Fe, NM)

Detectors

Eberline GM Detector
Model HP-260
Effective Area, 15.5 cm^2
(Eberline, Santa Fe, NM)

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm Crystal
(Victoreen, Cleveland, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

Low Background Gas Proportional Counter
Model LB-5110
(Tennelec, Oak Ridge, TN)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. Surfaces were scanned using small area hand-held detectors. Identification of elevated radiation levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Beta	—	pancake GM detector with ratemeter-scaler
Gamma	—	NaI scintillation detector with ratemeter

Surface Activity Measurements

Measurements of total beta activity levels were performed using detectors with portable ratemeter-scalers.

Count rates (cpm), which were integrated over 1 minute in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. The beta activity background count rates for the GM detector averaged 22 cpm inside the Turbine Building on component steel. The beta efficiency factor was 0.16 for the GM detector. The effective window for the GM detectors was 15.5 cm^2.

Removable Activity Measurements

Removable activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear and approximately 100 cm^2 of the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

ANALYTICAL PROCEDURES

Radiological Analyses

Removable Activity

Smears were counted on a low background gas proportional system for gross alpha and gross beta activity.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. When the net sample count was less than the 95% statistical deviation of the background count, the sample concentration was reported as less than the detection limit of the measurement procedures. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

CALIBRATION AND QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following documents:

- Survey Procedures Manual Revision 7 (May 1992)
- Laboratory Procedures Manual Revision 7 (April 1992)
- Quality Assurance Manual Revision 5 (May 1992)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations,
- Participation in EPA and EML Quality Assurance Programs,
- Training and certification of all individuals performing procedures, and
- Periodic internal and external audits.

APPENDIX C

REGULATORY GUIDE 1.86
TERMINATION OF OPERATING LICENSES
FOR NUCLEAR REACTORS

U.S. ATOMIC ENERGY COMMISSION

June 1974

REGULATORY GUIDE

DIRECTORATE OF REGULATORY STANDARDS

REGULATORY GUIDE 1.86

TERMINATION OF OPERATING LICENSES FOR NUCLEAR REACTORS

A. INTRODUCTION

Section 50.51, "Duration of license, renewal," of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that each license to operate a production and utilization facility be issued for a specified duration. Upon expiration of the specified period, the license may be either renewed or terminated by the Commission. Section 50.82, "Applications for termination of licenses," specifies the requirements that must be satisfied to terminate an operating license, including the requirement that the dismantlement of the facility and disposal of the component parts not be inimical to the common defense and security or to the health and safety of the public. This guide describes methods and procedures considered acceptable by the Regulatory staff for the termination of operating licenses for nuclear reactors. The advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

B. DISCUSSION

When a licensee decides to terminate his nuclear reactor operating license, he may, as a first step in the process, request that his operating license be amended to restrict him to possess but not operate the facility. The advantage to the licensee of converting to such a possession-only license is reduced surveillance requirements in that periodic surveillance of equipment important to the safety of reactor operation is no longer required. Once this possession-only license is issued, reactor operation is not permitted. Other activities from the reactor and placing it in storage (either onsite or offsite) may be continued.

A licensee having a possession-only license must retain, with the Part 50 license, authorization for special nuclear material (10 CFR Part, 70, "Special Nuclear Material"), byproduct material (10 CFR Part 30, "Rules of General Applicability to Licensing of Byproduct Material"), and source material (10 CFR Part 40, "Licensing of Source Material"), until the fuel, radioactive components, and sources are removed from the facility. Appropriate administrative controls and facility requirements are imposed by the Part 50 license and the technical specifications to assure that proper surveillance is performed and that the reactor facility is maintained in a safe condition and not operated.

A possession-only license permits various options and procedures for decommissioning, such as mothballing, entombment, or dismantling. The requirements imposed depend on the option selected.

Section 50.82 provides that the licensee may dismantle and dispose of the component parts of a nuclear reactor in accordance with existing regulations. For research reactors and critical facilities, this has usually meant the disassembly of a reactor and its shipment organization for further use. The site from which a reactor has been removed must be decontaminated, as necessary, and inspected by the Commission to determine whether unrestricted access can be approved. In the case of nuclear power reactors, dismantling has usually been accomplished by shipping fuel offsite, making the reactor inoperable, and disposing of some of the radioactive components.

Radioactive components may be either shipped off-site for burial at an authorized burial ground or secured on the site. Those radioactive materials remaining on the site must be isolated from the public by physical barriers or other means to prevent public access to hazardous levels of radiation. Surveillance is necessary to assure the long term integrity of the barriers. The amount of surveillance required depends upon (1) the potential hazard to the health and safety of the public from radioactive material remaining on the site and (2) the integrity of the physical barriers. Before areas may be released for unrestricted use, they must have been decontaminated or the radioactivity must have decayed to less than prescribed limits (Table 1).

The hazard associated with the returned facility is evaluated by considering the amount and type of remaining contamination, the degree of confinement of the remaining radioactive materials, the physical security provided by the confinement, the susceptibility to release of radiation as a result of natural phenomena, and the duration of required surveillance.

C. REGULATORY POSITION

1. APPLICATION FOR A LICENSE TO POSSESS BUT NOT OPERATE (POSSESSION-ONLY LICENSE)

A request to amend an operating license to a possession-only license should be made to the Director of Licensing, U.S. Atomic Energy Commission, Washington, D.C. 20545. The request should include the following information:

a. A description of the current status of the facility.

b. A description of measures that will be taken to prevent criticality or reactivity changes and to minimize releases of radioactivity from the facility.

c. Any proposed changes to the technical specifications that reflect the possession-only facility status and the necessary disassembly/retirement activities to be performed.

d. A safety analysis of both the activities to be accomplished and the proposed changes to the technical specifications.

e. An inventory of activated materials and their location in the facility.

2. ALTERNATIVES FOR REACTOR RETIREMENT

Four alternatives for retirement of nuclear reactor facilities are considered acceptable by the Regulatory staff. These are:

a. **Mothballing.** Mothballing of a nuclear reactor facility consists of putting the facility in a state of protective storage. In general, the facility may be left intact except that all fuel assemblies and the radioactive fluids and waste should be removed from the site. Adequate radiation monitoring, environmental surveillance, and appropriate security procedures should be established under a possession-only license to ensure that the health and safety of the public is not endangered.

b. In-Place Entombment. In-place entombment consists of sealing all the remaining highly radioactive or contaminated components (e.g., the pressure vessel and reactor internals) within a structure integral with the biological shield after having all fuel assemblies, radioactive fluids and wastes, and certain selected components shipped offsite. The structure should provide integrity over the period of time in which significant quantities (greater than Table 1 levels) of radioactivity remain with the material in the entombment. An appropriate and continuing surveillance program should be established under a possession-only license.

c. Removal of Radioactive. Components and Dismantling. All fuel assemblies, radioactive fluids and waste, and other materials having activities above accepted unrestricted activity levels (Table 1) should be removed from the site. The facility owner may then have unrestricted use of the site with no requirement for a license. If the facility owner so desires, the remainder of the reactor facility may be dismantled and all vestiges removed and disposed of.

d. Conversion to a New Nuclear System or a Fossil Fuel System. This alternative, which applies only to nuclear power plants, utilizes the existing turbine system with a new steam supply system. The original nuclear steam supply system should be separated from the electric generating system and disposed of in accordance with one of the previous three retirement alternatives.

3. SURVEILLANCE AND SECURITY FOR THE RETIREMENT ALTERNATIVES WHOSE FINAL STATUS REQUIRES A POSSESSION-ONLY LICENSE

A facility which has been licensed under a possession-only license may contain a significant amount of radioactivity in the form of activated and

contaminated hardware and structural materials. Surveillance and commensurate security should be provided to assure that the public health and safety are not endangered.

a. Physical security to prevent inadvertent exposure of personnel should be provided by multiple locked barriers. The presence of these barriers should make it extremely difficult for an unauthorized person to gain access to areas where radiation or contamination levels exceed those specified in Regulatory Position C.4. To prevent inadvertent exposure, radiation areas above 5 mR/hr, such as near the activated primary system of a power plant, should be appropriately marked and should not be accessible except by cutting of welded closures or the disassembly and removal of substantial structures and/or shielding material. Means such as a remote-readout intrusion alarm system should be provided to indicate to designated personnel when a physical barrier is penetrated. Security personnel that provide access control to the facility may be used instead of the physical barriers and the intrusion alarm systems.

b. The physical barriers to unauthorized entrance into the facility, e.g., fences, buildings, welded doors, and access openings, should be inspected at least quarterly to assure that these barriers have not deteriorated and that locks and locking apparatus are intact.

c. A facility radiation survey should be performed at least quarterly to verify that no radioactive material is escaping or being transported through the containment barriers in the facility. Sampling should be done along the most probable path by which radioactive material such as that stored in the inner containment regions could be transported to the outer regions of the facility and ultimately to the environs.

d. An environmental radiation survey should be performed at least semiannually to verify that no significant amounts of radiation have been released to the environment from the facility. Samples such as soil, vegetation, and water should be taken at locations for which statistical data has been established during reactor operations.

e. A site representative should be designated to be responsible for controlling authorized access into and movement within the facility.

f. Administrative procedures should be established for the notification and reporting of abnormal occurrences such as (1) the entrance of an unauthorized person or persons into the facility and (2) a significant change in the radiation or contamination levels in the facility or the offsite environment.

g. The following reports should be made:

(1) An annual report to the Director of Licensing, U.S. Atomic Energy Commission, Washington, D.C. 20545, describing the results of the environmental and facility radiation surveys, the status of the facility, and an evaluation of the performance of security and surveillance measures.

(2) An abnormal occurrence report to the Regulatory Operations Regional Office by telephone within 24 hours of discovery of an abnormal occurrence. The abnormal occurrence will also be reported in the annual report described in the preceding item.

h. Records or logs relative to the following items should be kept and retained until the license is terminated, after which they must be stored with other plant records:

(1) Environmental surveys,

(2) Facility radiation surveys,

(3) Inspections of the physical barriers, and

(4) Abnormal occurrences.

4. DECONTAMINATION FOR RELEASE FOR UNRESTRICTED USE

If it is desired to terminate a license and to eliminate any further surveillance requirements, the facility should be sufficiently decontaminated to prevent risk to the public health and safety. After the decontamination is satisfactorily accomplished and the site inspected by the Commission, the Commission may authorize the license to be terminated and the facility abandoned or released for unrestricted use. The licensee should perform the decontamination using the following guidelines:

a. The licensee should make a reasonable effort to eliminate residual contamination.

b. No covering should be applied to radioactive surfaces of equipment of structures by paint, plating, or other covering material until it is known that contamination levels (determined by a survey and documented) are below the limits specified in Table 1. In addition, a reasonable effort should be made (and documented) to further minimize contamination prior to any such covering.

c. The radioactivity of the interior surfaces of pipes, drain lines, or ductwork should be determined

by making measurements at all traps and other appropriate access points, provided contamination at these locations is likely to be representative of 2contamination on the interior of the pipes, drain lines, or ductwork. Surfaces of premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement should be assumed to be contaminated in excess of the permissible radiation limits.

d. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated in excess of the limits specified. This may include, but is not limited to, special circumstances such as the transfer of premises to another licensed organization that will continue to work with radioactive materials. Requests for such authorization should provide:

(1) Detailed, specific information describing the premises, equipment, scrap, and radioactive contaminants and the nature, extent, and degree of residual surface contamination.

(2) A detailed health and safety analysis indicating that the residual amounts of materials on surface areas, together with other considerations such as the prospective use of the premises, equipment, or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

e. Prior to release of the premises for unrestricted use, the licensee should make a comprehensive radiation survey establishing that contamination is within the limits specified in Table 1. A survey report should be filed with the Director of Licensing, U.S. Atomic Energy Commission, Washington, D.C. 20545, with a copy to the Director of the Regulatory Operations regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report should:

(1) Identify the premises;

(2) Show that reasonable effort has been made to reduce residual contamination to as low as practicable levels;

(3) Describe the scope of the survey and the general procedures followed; and

(4) State the finding of the survey in units specified in Table 1.

After review of the report, the Commission may inspect the facilities to confirm the survey prior to granting approval for abandonment.

5. REACTOR RETIREMENT PROCEDURES

As indicated in Regulatory Position C.2, several alternatives are acceptable for reactor facility retirement. If minor disassembly or "mothballing" is planned, this could be done by the existing operating and maintenance procedures under the license in effect. Any planned actions involving an unreviewed safety question or a change in the technical specifications should be reviewed and approved in accordance with the requirements of 10 CFR § 50.59.

If major structural changes to radioactive components of the facility are planned, such as removal of the pressure vessel or major components of the primary system, a dismantlement plan including the information required by § 50.82 should be submitted to the Commission. A dismantlement plan should be submitted for all the alternatives of Regulatory Position C.2 except mothballing. However, minor disassembly activities may still be performed in the absence of such a plan, provided they are permitted by existing operating and maintenance procedures. A dismantlement plan should include the following:

a. A description of the ultimate status of the facility

b. A description of the dismantling activities and the precautions to be taken.

c. A safety analysis of the dismantling activities including any effluents which may be released.

d. A safety analysis of the facility in its ultimate status.

Upon satisfactory review and approval of the dismantling plan, a dismantling order is issued by the Commission in accordance with § 50.82. When dismantling is completed and the Commission has been notified by letter, the appropriate Regulatory Operations Regional Office inspects the facility and verifies completion in accordance with the dismantlement plan. If residual radiation levels do not exceed the values in Table 1, the Commission may terminate the license. If possession-only license under which the dismantling activities have been conducted or, as an alternative, may make application to the State (if an Agreement State) for a byproduct materials license.

TABLE 1
ACCEPTABLE SURFACE CONTAMINATION LEVELS

Nuclide[a]	Average[b,c]	Maximum[b,d]	Removable[b,e]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

[a]Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta- gamma-emitting nuclides should apply independently.

[b]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c]Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d]The maximum contamination level applies to an area of not more than 100 cm^2.

[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

Guidelines for Residual Concentrations of Thorium and Uranium Wastes in Soil

On October 23, 1981, the Nuclear Regulatory Commission published in the Federal register a notice of Branch Technical Position on "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations." This document established guidelines for concentrations of uranium and thorium in soil, that will limit maximum radiation received by the public under various conditions of future land usage. These concentrations are as follows:

Material	Maximum Concentrations (pCi/g) for various options			
	1[a]	2[b]	3[c]	4[d]
Natural Thorium (Th-232 + Th-228) with daughters present and in equilibrium	10	50	--	500
Natural Uranium (U-238 + U-234) with daughters present and in equilibrium	10	--	40	200
Depleted Uranium:				
Soluble	35	100	--	1,000
Insoluble	35	300	--	3,000
Enriched Uranium:				
Soluble	30	100	--	1,000
Insoluble	30	250	--	2,500

[a]Based on EPA cleanup standards which limit radiation to 1 mrad/yr to lung and 3 mrad/yr to bone from ingestion and inhalation and 10 μR/h above background from direct external exposure.
[b]Based on limiting individual dose to 170 mrem/yr.
[c]Based on limiting equivalent exposure to 0.02 working level or less.
[d]Based on limiting individual dose to 500 mrem/yr and in case of natural uranium, limiting exposure to 0.02 working level or less.