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NUCLEAR SAFETY-RELATED

EVALUATION OF IN-PLACE CONCRETE
MARBLE HILL NUCLEAR GENERATING STATION
UNITS 1 AND 2

REPORT PREPARED FOR

PUBLIC SERVICE COMPANY OF INDIANA, INC.

VOLUME I

REPORT SL-3753

NOVEMBER 20, 1979

SARGENT & LUNDY
ENGINEERS

KENNETH T. KOSTAL
PARTNER
312-269-7713

November 20, 1979

Mr. S. W. Shields
Vice President of Electrical Systems
Public Service Indiana
1000 East Main Street
Plainfield, Indiana 46168

Dear Mr. Shields:

Enclosed are thirteen copies of the following report:

Report SL-3753
Evaluation of In-Place Concrete
Marble Hill Nuclear Generating Station
Units 1 and 2
Dated November 20, 1979

This report contains our evaluation of the test results of the in-place concrete at Marble Hill and our conclusion that the quality of concrete is acceptable.

The report is divided into two volumes: Volume I contains the main report and Exhibits 1, 2, and 4 through 7. Volume II contains Exhibit 3 which is the Portland Cement Association report.

If you have any questions or comments, we will be glad to discuss them with you.

Yours very truly,

K. T. Kostal

K. T. Kostal
Assistant Manager
Structural Department

KTK:rg
Enclosures

NUCLEAR SAFETY-RELATED

EVALUATION OF IN-PLACE CONCRETE

MARBLE HILL NUCLEAR GENERATING STATION

UNITS 1 AND 2

REPORT PREPARED FOR

PUBLIC SERVICE COMPANY OF INDIANA, INC.

VOLUME 1

REPORT SL-3753

NOVEMBER 20, 1979

SARGENT & LUNDY
ENGINEERS

EVALUATION OF IN-PLACE CONCRETE
MARBLE HILL NUCLEAR GENERATING STATION – UNITS 1 AND 2

PUBLIC SERVICE COMPANY OF INDIANA, INC.

I INTRODUCTION

A. Statement of Problem and Solution Methodology

The Nuclear Regulatory Commission has expressed concern that the repairing of honeycombed areas in the concrete of Marble Hill Category I structures has not been done properly and that, in general, the concrete may not be of a high quality. The Portland Cement Association (PCA) was retained to perform nondestructive examination of in-place concrete. Sargent & Lundy (S&L) was retained to independently specify the test areas, to review the testing program and its results, and to assess the quality of the concrete work.

A nondestructive examination of in-place concrete has been performed on a statistical basis as required by the NRC in its letter of June 27, 1979 (Exhibit 1). A total of 60 areas representing congested and noncongested locations in the structures have been examined using the pulse-echo and through-transmission testing methods. These methods are capable of locating the following discontinuities in concrete: lack of bond between concrete and rebar; separation of layers of concrete (lamination); excessive entrapped air; honeycombing or voids. Some discontinuities are inevitable in concrete construction. If they are localized and limited in size, they will not affect the strength, durability, or leak-tightness of the concrete. The primary objective of this examination is to provide assurance that there are no excessive discontinuities that would impair the structural integrity or the shielding capability of concrete structures.

B. Summary of Test Results

The nondestructive examination indicated that 24 of the 60 areas examined had some form of discontinuity. A thorough investigation of these areas by the PCA, using design drawings, shop drawings, and a review of the construction

sequence and embedded field-routed piping with the field personnel, provided explanations for the pulse-echo readings indicating possible discontinuities in 16 of the 24 areas. The suspected discontinuities were localized and were attributed to reinforcing steel congestion, embedded pipes, and structural or reinforcing steel supports for structural items embedded in concrete. Such localized discontinuities are not detrimental to the quality of the concrete and are common in concrete construction.

In the remaining eight areas, core samples were taken to determine the nature of the discontinuities. The core samples confirmed that all discontinuities were due to excessive entrapped air. The cores were tested for compressive strength, and the test results ranged between 5,950 psi and 7,800 psi for the concrete placed in areas requiring a 3,500 psi design strength and between 6,750 psi and 8,550 psi for the concrete placed in areas requiring a 5,500 psi design strength. The average unit weight measured 148 pcf and ranged between 145 pcf and 152 pcf. This meets the shielding density requirements, since it is greater than the expected average unit weight of 145 pcf. Therefore, the PCA has concluded that no defective areas were observed in the field examination of the 60 areas. On a statistical basis, these tests assure with a high degree of confidence that the concrete placement at Marble Hill meets both the structural integrity and biological shielding requirements.

C. Conclusions

Based on the review of the investigation carried out on the in-place concrete, S&L has concluded that the quality of the concrete in the structures at Marble Hill Station is acceptable. Therefore, no further destructive or nondestructive testing is required.

II DISCUSSION

A. Background

The concern that proper concrete placement procedures may not have been used in the concrete structures of the Marble Hill Station arose when allegations of

improper and unacceptable repairs of surface defects were made by Mr. Cutshall, a former employee of Gust K. Newberg. Subsequent inspection of the repaired honeycomb areas confirmed the improper procedure charges. In addition, a large cavity was discovered below a portion of the auxiliary building base slab. While local honeycombing and other surface defects are not uncommon in construction and do not jeopardize the strength, durability, or radiological shielding capacity of the concrete, excessive internal voids in the concrete are not acceptable. Recognizing this, Public Service Company of Indiana ordered a detailed examination to assess the condition of the in-place concrete. PCA performed nondestructive and destructive testing on the concrete structures at locations specified by S&L.

This report describes the statistical basis for the testing program (Section III), the nondestructive testing program (Section IV), and the results of the destructive and nondestructive testing (Section V). Repairs of the patches are discussed in Section VI. The large cavity found below the auxiliary building base slab will be repaired using the proper procedures described in Section VII of this report.

B. Concrete Discontinuities

The term "discontinuity" in this report means a locus of certain abrupt property change. Basic forms of discontinuities are defined below.

Lack of Bond - A reduction in shear transfer capacity between the rebar and the concrete.

Separation or Lamination - An interface between two pours of concrete with limited capabilities of load transfer.

Honeycombing - An occurrence of mortar not completely filling the space between the coarse aggregate particles.

Entrapped Air - Air in the form of small bubbles dispersed throughout the concrete matrix during placement.

C. Concrete Under Examination

Due to the large void found below the auxiliary building base slab and the surface honeycombing observed in the concrete work, the quality of construction has come under question. Lack of consolidation in concrete, resulting in honeycombing or voids, is more likely to occur in areas congested with reinforcement. It is for this reason that half of the areas selected by S&L for testing are areas of congested reinforcement.

D. Sample Selection

Concrete structures were examined by selecting a representative sample of 60 locations from congested and noncongested areas. The statistical basis for this sample, the test locations, and the results of the examination are described in subsequent sections.

III STATISTICAL BASIS FOR TESTING PROGRAM

A. Methodology

The pulse-echo test indicates either the presence or the absence of concrete discontinuities (e.g., voids). If a discontinuity is present, the acceptability of that concrete depends on the size of the discontinuity. The testing procedure for examining for discontinuities is of a "pass/no pass" type, depending on the acceptability of the discontinuity. If the discontinuity is unacceptable for structural or shielding reasons, the sample is termed "defective." The quality of the entire population is determined by testing a random number of samples. The statistical program for this type of testing is known as "sampling by attributes."

The appropriate number (n) of samples to be tested depends on the size of the population (N), the confidence level (C), and the acceptable maximum fraction of defectives (p) in the population. By testing a number of random samples (n out of population N), we can establish with confidence C that the maximum

fraction defective is p if the observed number of defectives is r, using the following equation:*

$$C = 1 - \sum_{x=0}^{r} \frac{\binom{Np}{x}\binom{Nq}{n-x}}{\binom{N}{n}} \qquad (1)$$

In the above equation, $q = 1-p$ and the permutation symbol $\binom{N}{n}$ means $\frac{N!}{n!\,(N-n)!}$. In this testing program, the values of p, C, and N are given and the equation is solved for n.

If n is small relative to N, equation (1) can be approximated by

$$C = 1 - \sum_{x=0}^{r} \binom{n}{x} p^x q^{n-x} \qquad (2)$$

The following statistical testing program is developed to establish with 95% reliability and 95% confidence level, as required by the Nuclear Regulatory Commission (Exhibit 1), that the concrete quality meets the design requirements. Using equation (2) and the above parameter values, the number of samples, n, required to establish the quality of concrete has been calculated. As an example, with C = 0.95 and p = 0.05, n is calculated as 59 for r = 0.

As a first step, a sample of 59 areas is to be tested. In order to establish with a confidence level of 95% that no more than 5% of the population is defective (i.e., reliability of 95%), none of the samples should fail the test. The sampling program is sequential in that if a defective area is encountered in the first 59 samples, the sample size is increased to a total of 93. In this larger sample, there should be no more than one defective sample. Table III-1 gives the sampling program.

*A. H-S, Ang, and W.H. Tang, Probability Concepts in Engineering Planning and Design, Volume I, "Basic Principles," John Wiley & Sons, Inc., New York, New York. 1975, p. 361.

B. Overall Concrete Quality

Generally, there are no external indicators of the presence of small discontinuities in concrete. Concrete construction is such that there are usually small discontinuities in the form of entrapped air and laminations around rebar, rebar splices and embedments. The collective experience of the engineering profession is that such discontinuities do not adversely influence the structural integrity, durability, and leak-tightness of the concrete. Therefore, the objective of the testing program is to ensure with a high confidence level that no excessive discontinuities are present in the concrete placed at the Marble Hill Station. This is achieved by the statistical testing program described here.

The pulse-echo test is performed over an area ranging in size from 10 to 100 square feet. The concrete of this area is examined for discontinuities. This volume of concrete is denoted as a unit of concrete. There are a large number of such units in the concrete placed at the Marble Hill Station so that the use of equation (2) is appropriate for calculating the number of units to be examined. Furthermore, if the area exhibits unexplainable discontinuities at the boundaries of the test grid, further readings are taken to define the extent of the discontinuities. The sample size for establishing with 95% confidence that no more than 5% of the population is defective is given in Table III-1. The testing procedure is as follows:

- Identify and test at least 59 locations (units).
- If there is no defective unit observed, stop further testing.
- If one defective unit is observed, increase the sample size to 93 units.
- If no further defective units are observed in this increased sample, stop further testing.
- If more defective units are observed, further testing of random samples must be done according to the sizes shown in Table III-1.

C. Selection of Test Locations

The sketches in Exhibit 2 show the locations of areas where the pulse-echo test has been performed. The test areas have been selected to include both congested (by rebar and embedment arrangement) and noncongested locations. Fifty-four areas were chosen for testing in Category I structures and six areas in Category II structures. The inclusion of test areas from the Category II structures in the statistical sample increases the conservatism of the test approach since the QA/QC requirements on Category II concrete are not as stringent as those for Category I concrete. The test areas cover the containment, fuel handling building, auxiliary building, and turbine room, at different elevations. Various structural elements (i.e., base mat, wall, beam, column, and floor slab) are included in the sample. Therefore, the test locations selected are representative of the concrete construction at the Marble Hill Station. Though this selection is not random in the strict statistical sense, a conservative bias is introduced by using congested areas for half of the sample, since a greater potential for discontinuities exists in these areas. Therefore, the conclusions from the examination of this sample will be conservative.

D. Acceptance Criteria from a Statistical Standpoint

The Nuclear Regulatory Commission, in its letter of June 27, 1979 (Exhibit 1), required volumetric examination of in-place concrete to ensure with 95% reliability and 95% confidence that the concrete quality meets requirements. The statistical testing program adopted for this examination is aimed at providing this assurance through the testing of at least 59 units. If no defective unit is encountered in this sample, the concrete placement at the Marble Hill Station is judged to be acceptable.

TABLE III-1

SAMPLING PROGRAM FOR OVERALL

CONCRETE QUALITY

Maximum Number of Defectives	Sample Size[a]
0	59
1	93
2	124
3	153

[a] For a 95 percent reliability with 95 percent confidence (see Exhibit 1).

IV TESTING PROGRAM

A nondestructive examination of in-place concrete using the pulse-echo technique was performed by R. Muenow and Associates, consultants to PCA. The results of the examination have been correlated with the details shown in the design and shop drawings and with the core samples taken in specified locations.

A. Description of the Pulse-Echo Technique*

The pulse-echo method of nondestructive examination is a technique for microseismic evaluation of in-place concrete. Microseismic test data are interpreted using the laws of reflection. A mechanical wave producer and an electro/mechanical transducer are placed side by side on a concrete surface. The mechanical wave imparted into the concrete is displayed on a cathode ray tube (CRT). If the concrete is homogenous and contains no discontinuities, the initial signal and the signal reflected off the rear surface of the concrete element will be displayed on the CRT. Any discontinuity (e.g., a lamination or a void) provides a reflecting surface that will result in a signal being displayed on the CRT somewhere between the front and rear surface signals. The relative location of the intermediate signal displayed on the CRT will correspond to the location of the discontinuity in the concrete section being examined. A polaroid picture is made of at least one out of every 15 readings taken at a particular test location. In addition, a polaroid picture is made of every reading where a discontinuity is indicated on the CRT display. The complete test procedure using the pulse-echo method for detecting internal discontinuities in concrete is described in the PCA report (Exhibit 3).

B. Qualification of Test Equipment

The pulse-echo technique is used to detect, locate, and photographically record physical and mechanical discontinuities within solids. It has been used successfully in a number of nuclear and non-nuclear projects for qualifying the adequacy of in-place concrete. PCA has provided the qualification documents for the testing equipment in its report (Exhibit 3).

*The through-transmission testing method used on areas 37, 49, and 50 is described in Exhibit 2.

Demonstration of this technique on five prepared concrete specimens with known and observable inhomogeneities (honeycomb, reinforcing steel, and air voids) was witnessed by the NRC inspector. This testing disclosed all of the known and observable conditions (cracking, honeycomb, and embedments) with complete accuracy as to depth, extent, and description. Subsequently, microseismic examination of six of the existing concrete patches (all of which are to be repaired later, see Section VI) again demonstrated that the test system and R. Muenow's interpretation are highly reliable (NRC Report No. 50-546/79-07; 50-547/79-07, September 18, 1979).

In the process of this investigation, data for 15 additional locations became available for establishing the reliability of prediction by the pulse-echo technique. In each of these locations, the pulse-echo test readings have been taken and have been verified by examining the core samples or by removing the concrete. The excellent correlation observed between the nondestructive examination readings and the core findings testifies to the predictability of the pulse-echo test equipment.

C. Location of Test Areas

The examination of in-place concrete at the Marble Hill Station has been performed on 60 locations. Chapter III established that at least 59 areas have to be examined. The locations have been selected to include both congested and noncongested areas in the structures. Sketches SKCT-1 through SKCT-33 (Exhibit 2) give the details of these locations. Exhibit 4 lists the locations. It can be observed that the selected areas include various structural elements such as base mat, floor slab, shear wall, shield wall, beam, and column. In each location, the pulse-echo test is performed at several points on a grid system. The grid size is defined in the PCA report (Exhibit 3).

D. Pulse-Echo Test Results

The nondestructive examination indicated that no discontinuities exist at 36 locations. These are called "solid" areas in the PCA report (Exhibit 3). The design drawings and shop drawings have been reviewed by PCA to detect the causes for the discontinuities in the remaining areas. The construction

sequence and the field-routed embedded piping were also reviewed for this purpose. Sketches showing the details of rebar splices, cold joints, and embedments have been prepared to correlate the pulse-echo test readings and are included in PCA's report (Exhibit 3). This detailed review has provided an explanation of the discontinuities in 16 of the remaining 24 areas tested. These are termed "explainable areas." The remaining eight areas are denoted as "questionable areas," and require additional testing. Exhibit 4 identifies the solid, explainable, and questionable areas.

E. Coring of Questionable Areas

The discontinuities recorded by the pulse-echo testing equipment in eight questionable areas could not be attributed to the presence of congested reinforcing steel, embedded pipes, rebar supports, or cold joints. Therefore a 3-inch nominal diameter core was taken in each of these locations. A visual examination of these cored samples indicated no major discontinuities such as voids, laminations, or internal honeycombing. The discontinuities observed in the pulse-echo testing are attributed to excessive entrapped air. The core samples were photographed to document the absence of major discontinuities before they were tested for compressive strength and unit weight. The photographs are shown in Exhibit 5.

The PCA has conducted tests on the core samples for compressive strength unit weight and absorption and has performed petrographic analysis. The test results are described in the PCA report (Exhibit 3). The core samples have indicated compressive strengths between 5,950 psi and 7,800 psi for the 3,500 psi concrete and between 6,750 psi and 8,550 psi for the 5,500 psi concrete. The unit weight ranged between 145 pcf and 152 pcf. In addition, petrographic analysis of the cores was performed to assess the overall quality of concrete, as discussed in the PCA report; it has indicated that the in-place concrete is of acceptable quality.

V DISCUSSION OF RESULTS

In the following, the results of the pulse-echo testing and the subsequent testing of core samples are discussed. The acceptance criteria for evaluating these test results are established.

A. Acceptance Criteria

The objective of the nondestructive examination has been to detect the presence, if any, of unacceptable discontinuities and to assess the quality of the in-place concrete. The localized discontinuities observed by the pulse-echo test in some locations could be explained by the presence of rebar splices, pipe embedments, cold joints, and steel supports. Where the discontinuities could not be explained, core samples have been taken. The core samples have been examined for strength and radiation shielding requirements according to the following criteria:

- Visual Examination: The surface of the core shall be examined for the presence of excessive voids and laminations.

- Strength: The cores shall be tested to determine the ultimate compressive strength. This strength shall not be less than the specified compressive strength of the concrete.

- Unit Weight: The unit weight of in-place concrete shall not be less than 137 pcf for acceptable radiation shielding.

- Porosity: A petrographic examination shall be conducted on the core samples to assess the overall quality of the concrete.

B. Evaluation of Test Results

The core samples from areas 17, 23, 30, 35, 36, 51, 53, and 60 have been visually examined; no excessive voids or laminations were observed. The ultimate compressive strength recorded from these core samples has a minimum value of 5,950 psi for the 3,500 psi concrete and a minimum value of 6,750 psi for the 5,500 psi concrete. Since the ultimate compressive strength of core samples

exceeded the specified compressive strength, these areas are acceptable by the structural strength criterion. The average measured unit weight of concrete is 148 pcf, which is greater than the minimum acceptable of 137 pcf from the consideration of radiation shielding. The results of the petrographic analysis discussed in Exhibit 3 have confirmed the quality of the in-place concrete as acceptable.

Based on the results of the visual examination and testing of the core samples, no defective sample has been found in the questionable areas. Therefore, all 60 areas examined in the concrete structures of the Marble Hill Station have passed the nondestructive and destructive examinations. This assures with a high level of confidence that there are no unacceptable discontinuities in the in-place concrete.

Moreover, additional cores were taken from the "explainable" and "solid" regions in the following test areas: 9, 22, 23, 25, 26, 27, and 28. These, too, showed no unacceptable discontinuities. In addition, the strength test results of concrete work have been monitored and evaluated periodically over the entire construction period using the procedures of ACI-214-77. The allowable design strength of the in-place concrete computed from the entire set of strength tests to date is 5,023 psi for concrete placed in areas requiring a minimum specified ultimate compressive strength of 3,500 psi. The corresponding allowable value is 6,126 psi for concrete placed in areas requiring a minimum specified strength of 5,500 psi.

VI DISCUSSION OF PATCHED AREAS

A. Surface Defects

A detailed examination was performed of the repaired honeycomb areas in the concrete structures. A limited number of surface defects such as honeycombing and entrapped air at the surface are inherent in concrete construction. The American Concrete Institute recognizes the existence of surface defects in concrete in its published literature. ACI 301, "Specifications for Structural Concrete for Buildings," addresses this subject in Chapter 9, "Repair of Surface Defects." Surface defects, when properly repaired, will not affect the

structural integrity and the radiation shielding capability of concrete structures.

B. Repair of Patched Areas

A field inspection of the areas of honeycombing, or patched areas, repaired by Gust K. Newberg quality control personnel has revealed that 170 out of 513 patched areas in Category I structures are not acceptable. The Public Service Company of Indiana has instructed that all patches be removed and repaired properly. Gust K. Newberg has developed a procedure (Exhibit 6) for repairing honeycombed areas.

VII DISCUSSION OF THE VOID IN THE AUXILIARY BUILDING SLAB

A. Background

A large void was discovered along the formed surface at the bottom of the 36-inch-thick concrete slab in the auxiliary building. The top of the slab is at elevation 373 feet 6 inches. The void was at the west edge of the slab along column row N (Exhibit 7). It extended vertically from the bottom layer of the slab reinforcing steel to the mud mat below, a distance of approximately 10 inches. It was 4 feet 6 inches wide in the east-west direction.

The reinforcing steel in the area of the void is congested because of the presence of wall dowels in addition to the slab reinforcing.* S&L recommended an investigation in the form of nondestructive examination in other areas of this 39 foot by 75 foot slab having a similar reinforcing pattern, where no voids were visible on the surface. On May 7-8, 1979, the PCA performed a nondestructive examination using the pulse-echo method. The nondestructive examination readings were taken at 1-foot intervals along the north, west, and south sides of the slab, as well as on top of the slab, to determine whether or not any unknown voids or areas of honeycombing existed. No evidence of any additional voids or unsound concrete was found.

*The congestion was primarily due to the bars from the sump in the diesel fuel oil storage tank area. Since sump areas are typically congested, other sump areas in the auxiliary building were included in the concrete testing program.

B. Repair of the Void

A repair of the void along the west side at column N-36 was implemented by first excavating enough material under the slab to allow access for workmen and tools. All unsound concrete was removed. The intended configuration of the bottom of the slab was then restored with shotcrete. The shotcrete repair was tested using the same pulse-echo testing method and was found to be acceptable.

An approved procedure written by Gust K. Newberg (see Exhibit 6) will be utilized for filling in the remainder of the void and for backfilling the excavated material under the slab.

SARGENT & LUNDY

Prepared by: _____
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Supervisor
Probabilistic Analysis Section

_____
A. M. Weiss,
Concrete Technologist

_____
R. Hooks,
Supervising Design Engineer

KENNETH T. KOSTAL
REGISTERED
No. 17410
INDIANA
RESIDENT OF ILLINOIS
PROFESSIONAL ENGINEER

Reviewed by: _____
A. Walser,
Engineering Assistant to
Structural Department
Manager

Approved by: _____
K. T. Kostal,
Assistant Manager
Structural Department

EXHIBITS

EXHIBIT 1
SL-3753
11-20-79

NRC LETTER ADDRESSING THE MARBLE HILL CONCRETE

EXHIBIT 1
SL-3753
11-20-79

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
799 ROOSEVELT ROAD
GLEN ELLYN, ILLINOIS 60137

June 27, 1979

Docket Nos. 50-546
50-547

Public Service of Indiana
Attention: Mr. S. W. Shields
Vice President
Electric System
1000 E. Main Street
Plainfield, IN 46168

Gentlemen:

This refers to the discussion between you and I and others of our respective staffs on June 26, 1979, regarding the quality of concrete construction activities at the Marble Hill Units 1 and 2 plant site. We understand based on these discussions that Public Service of Indiana will:

1. With its contracted organizations, continue surface and volumetric examination of existing concrete to establish its adequacy and randomly select and test a statistical sample, representative of both congested and other concrete volumes to assure with 95% reliability and 95% confidence level, that concrete quality meets requirements. This examination program shall be expeditiously implemented and completed.

   Evaluate and take appropriate corrective actions of all identified deficiencies and assess them in terms of their impact on safety related concrete construction activities.

2. Identify and evaluate concrete repair areas for adequacy. This effort is to include no less than those areas referenced by existing QA/QC documentation for repaired areas and those identified by 100% visual/mechanical examination of existing concrete structures.

3. Limit future concrete placement to non-safety related structures to permit the NRC to review and evaluate the corrective measures instituted on or about May 16, 1979 by PSI as a result of previously identified concrete deficiencies. During the existence of this concrete placement limitation, QA/QC controls for non-safety related concrete activities will be the same as would be used for safety related structures.

EXHIBIT 1
SL-3753
11-20-79

Not resume concrete placement for safety related structures until the NRC is satisfied by comprehensive demonstration that your upgraded QA/QC program and process controls are adequate.

5. Following resumption of concrete placement for safety related structures, provide complete (100%) "overview" of all safety related concrete activities at the site. This "overview" is to continue until adequate confidence is established to the satisfaction of PSI and NRC.

   Evidence of PSI's overview of the involved contractor's quality related activities is to be documented.

6. Stop all safety related concrete activities until the cause and consequent conditions are fully rectified if significant deficiencies are identified during the course of completing the above actions. NRC is to be immediately informed of such occurrences.

Please inform us if your understanding of this program is different from that stated.

Sincerely,

James G. Keppler
Director

cc: R. M. Brown, Construction
Project Superintendent
Central Files
Reproduction Unit NRC 20b
PDR
Local PDR
NSIC
TIC
LeBoeuf, Lamb, Leiby & MacRae

EXHIBIT 2
SL-3753
11-20-79

DRAWINGS DEFINING TEST AREAS

The test areas shown in these drawings are also listed in Exhibit 4 for cross-reference.

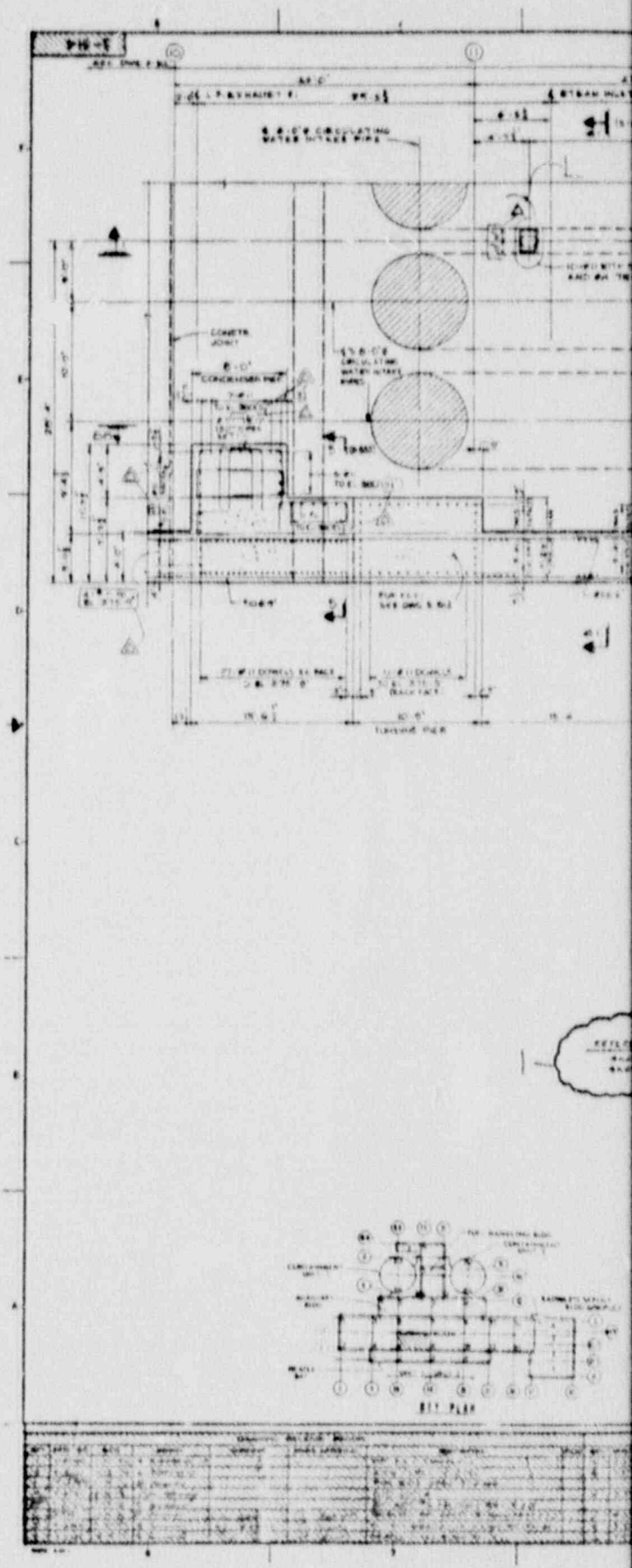
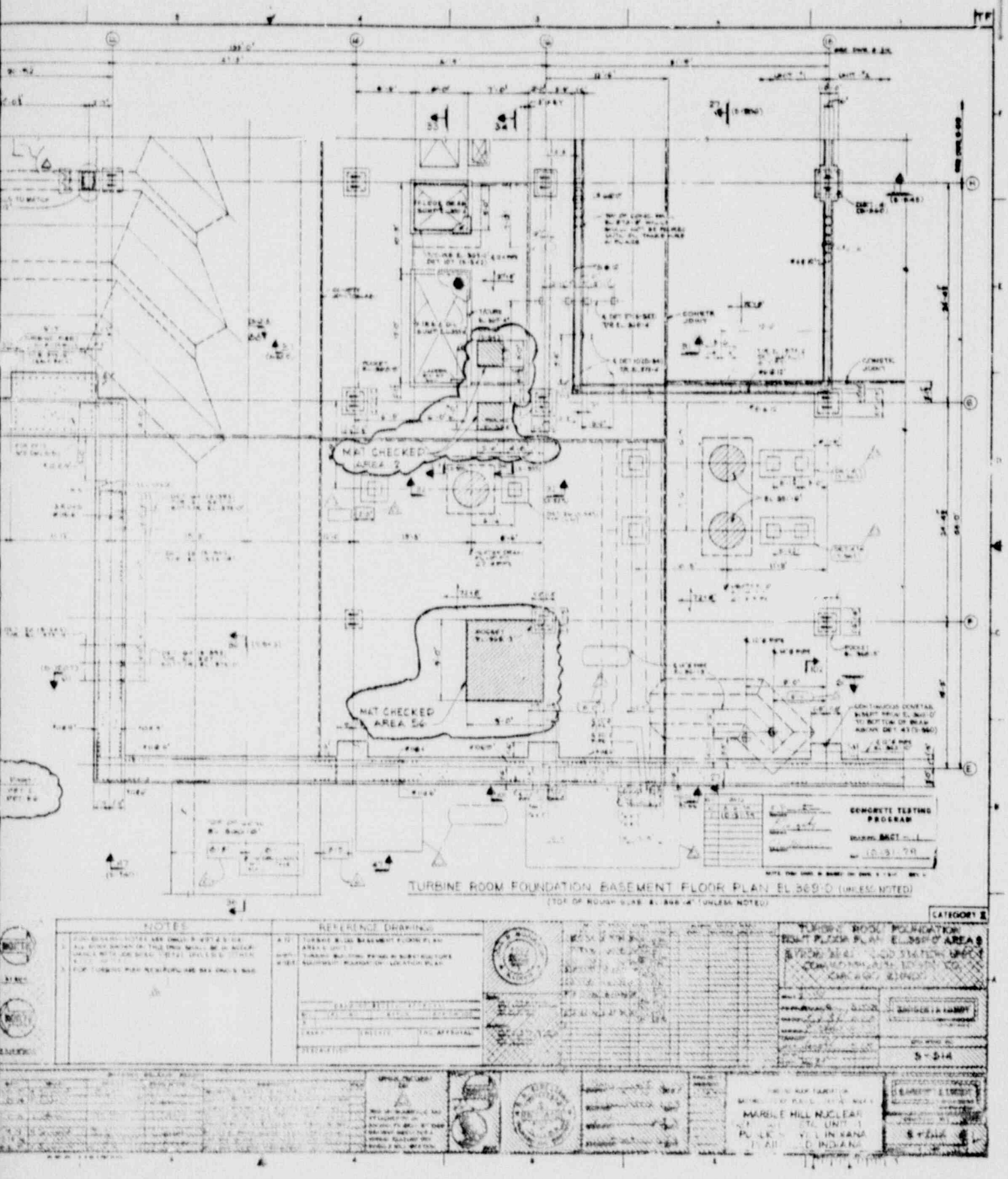


EXHIBIT 2
SL-3753
11-20-79



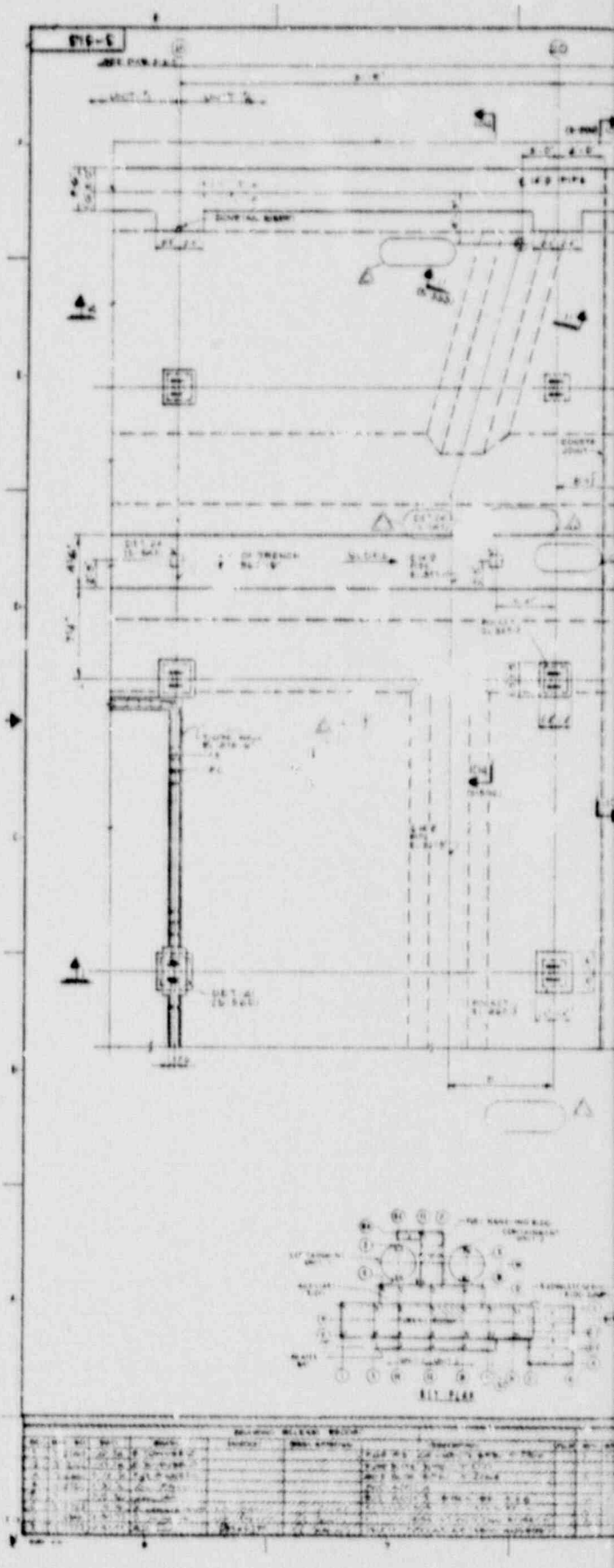
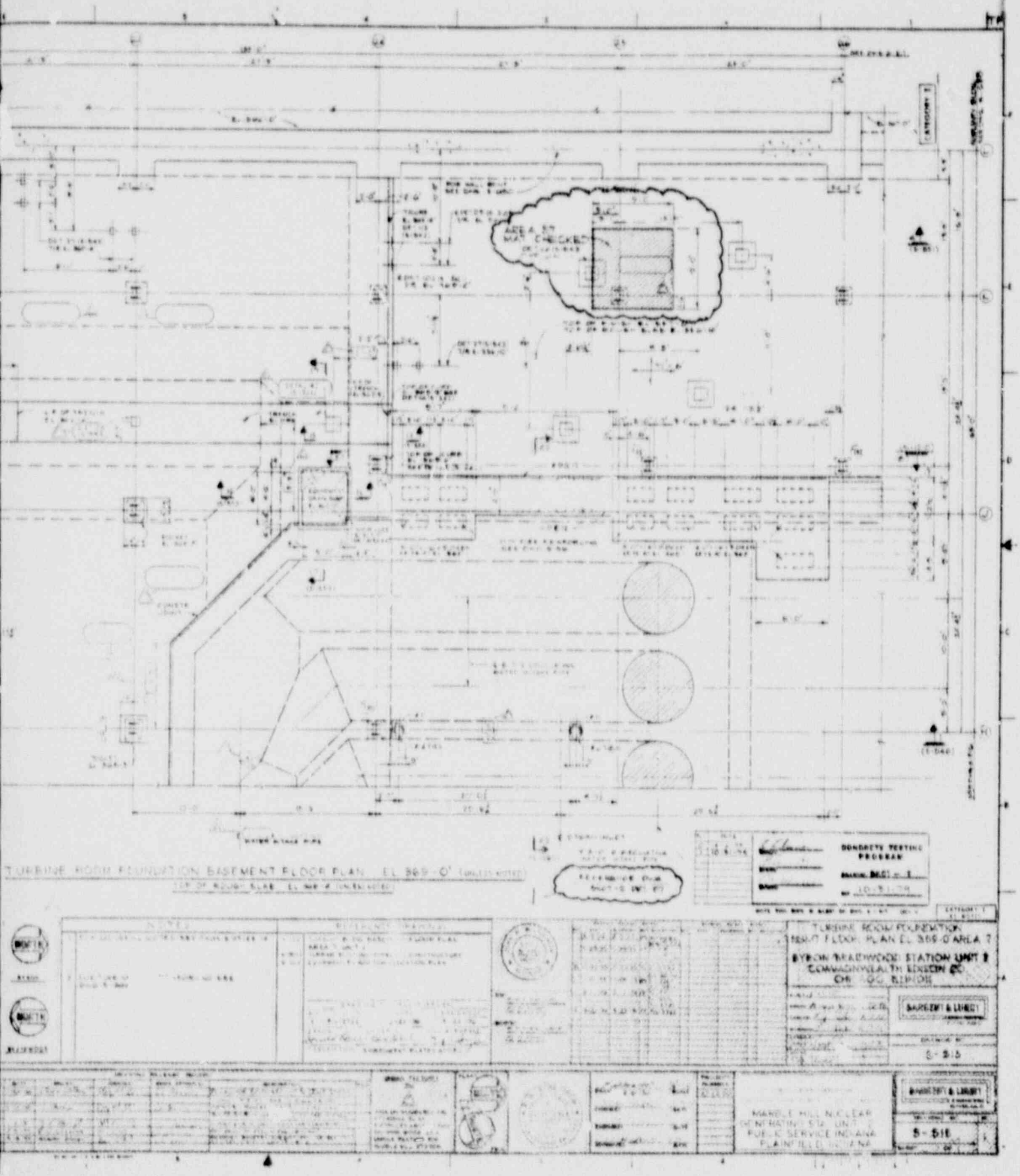


EXHIBIT 2
SL-3753
11-20-79



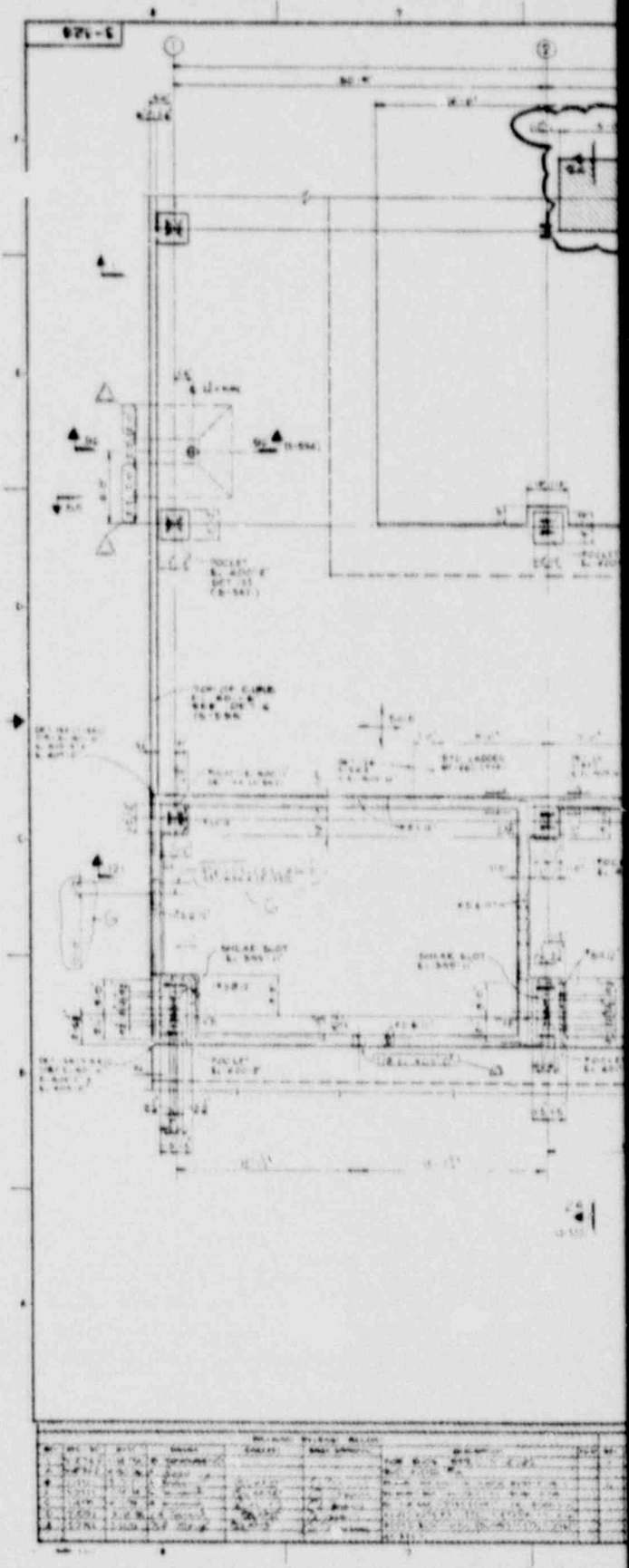
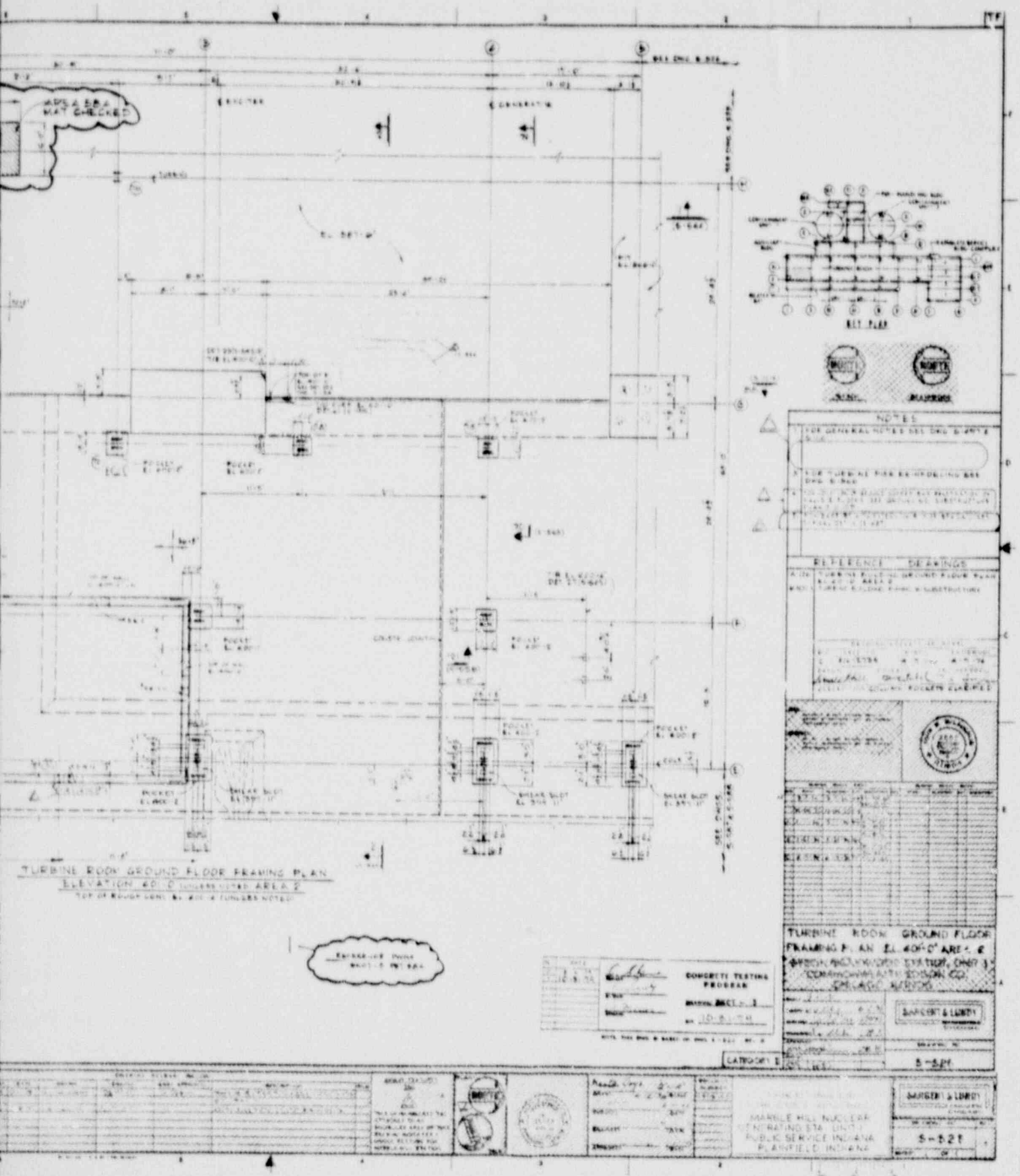


EXHIBIT 2
SL-3753
11-20-79



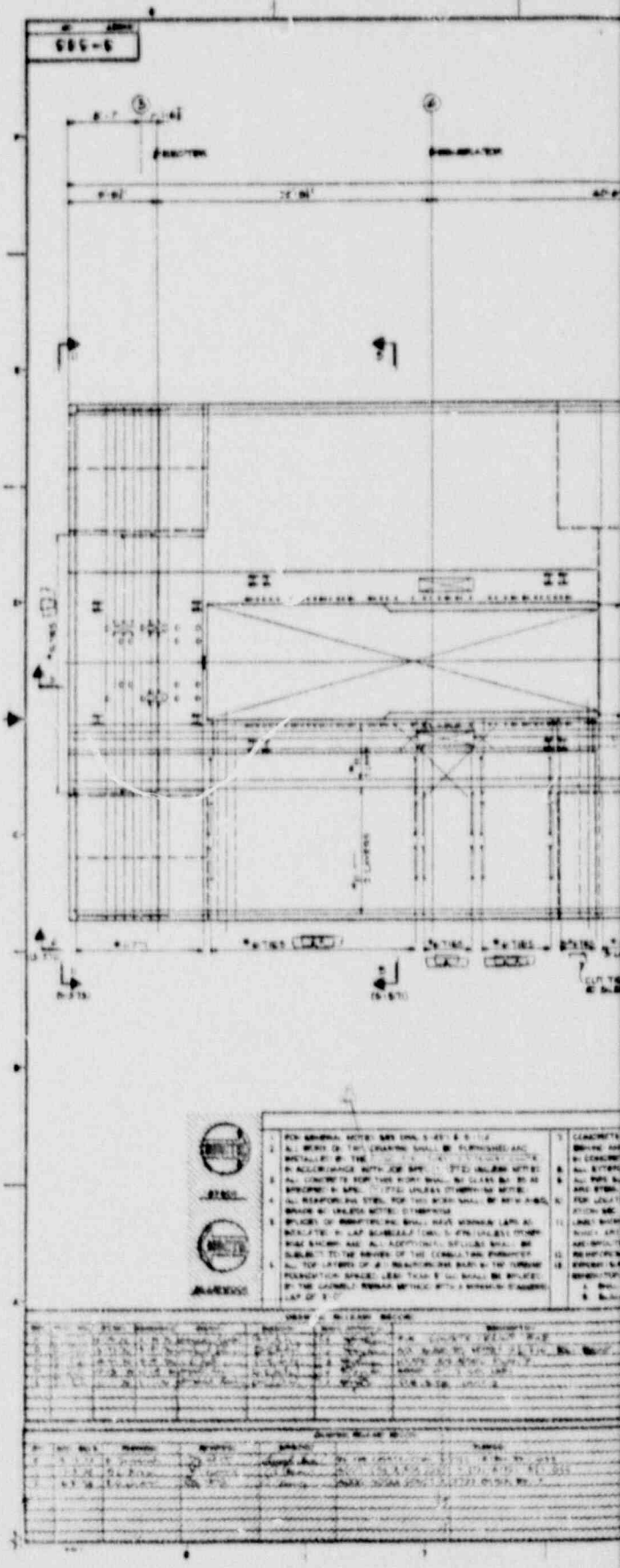
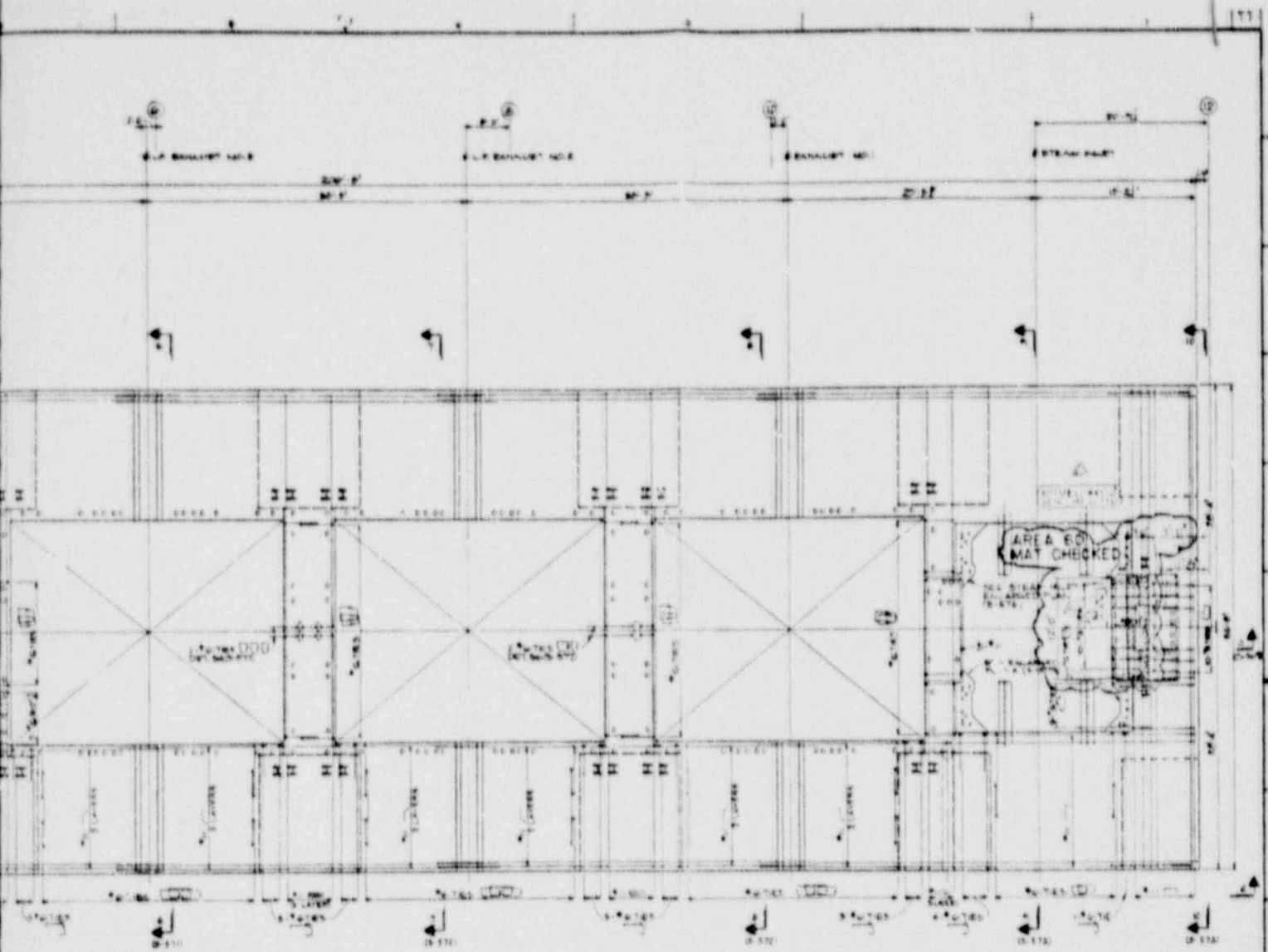


EXHIBIT 2
SL-3753
11-20-79



TOP REINFORCING PLAN

TURBINE FOUNDATION NOTES

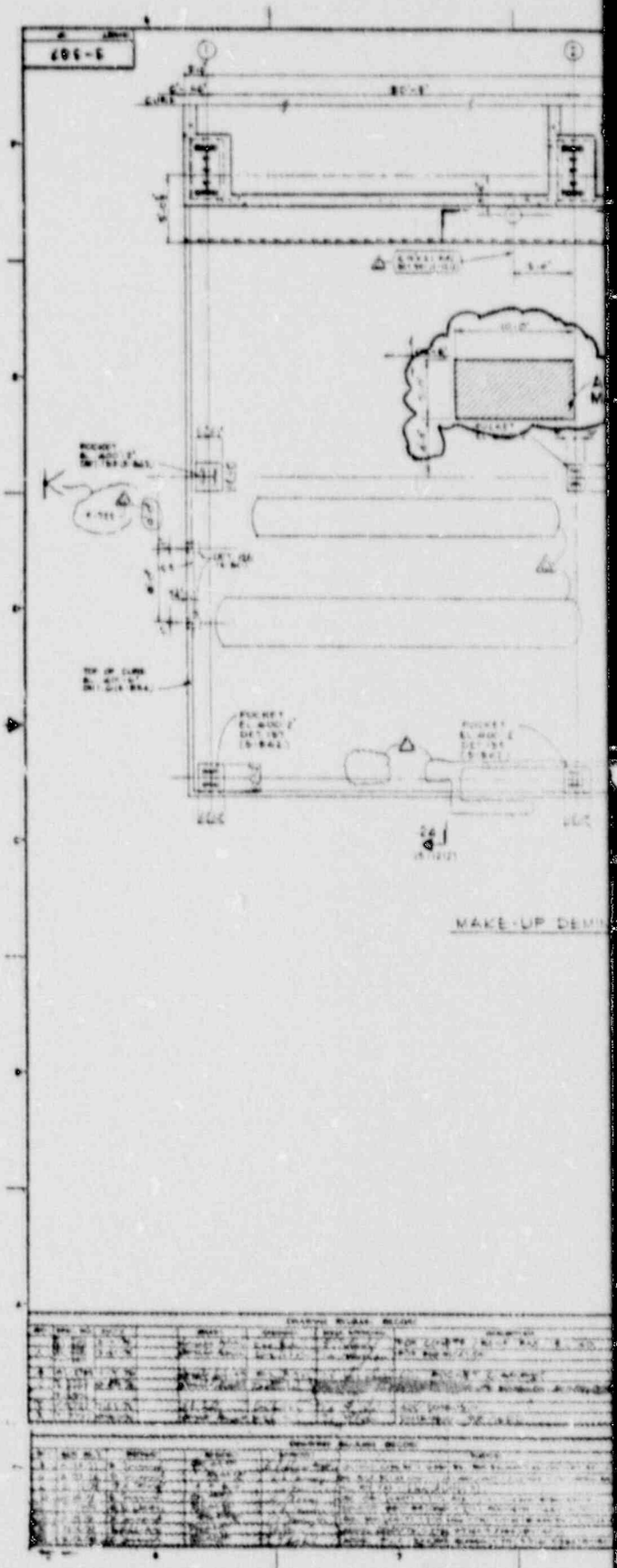
REFERENCE DRAWINGS

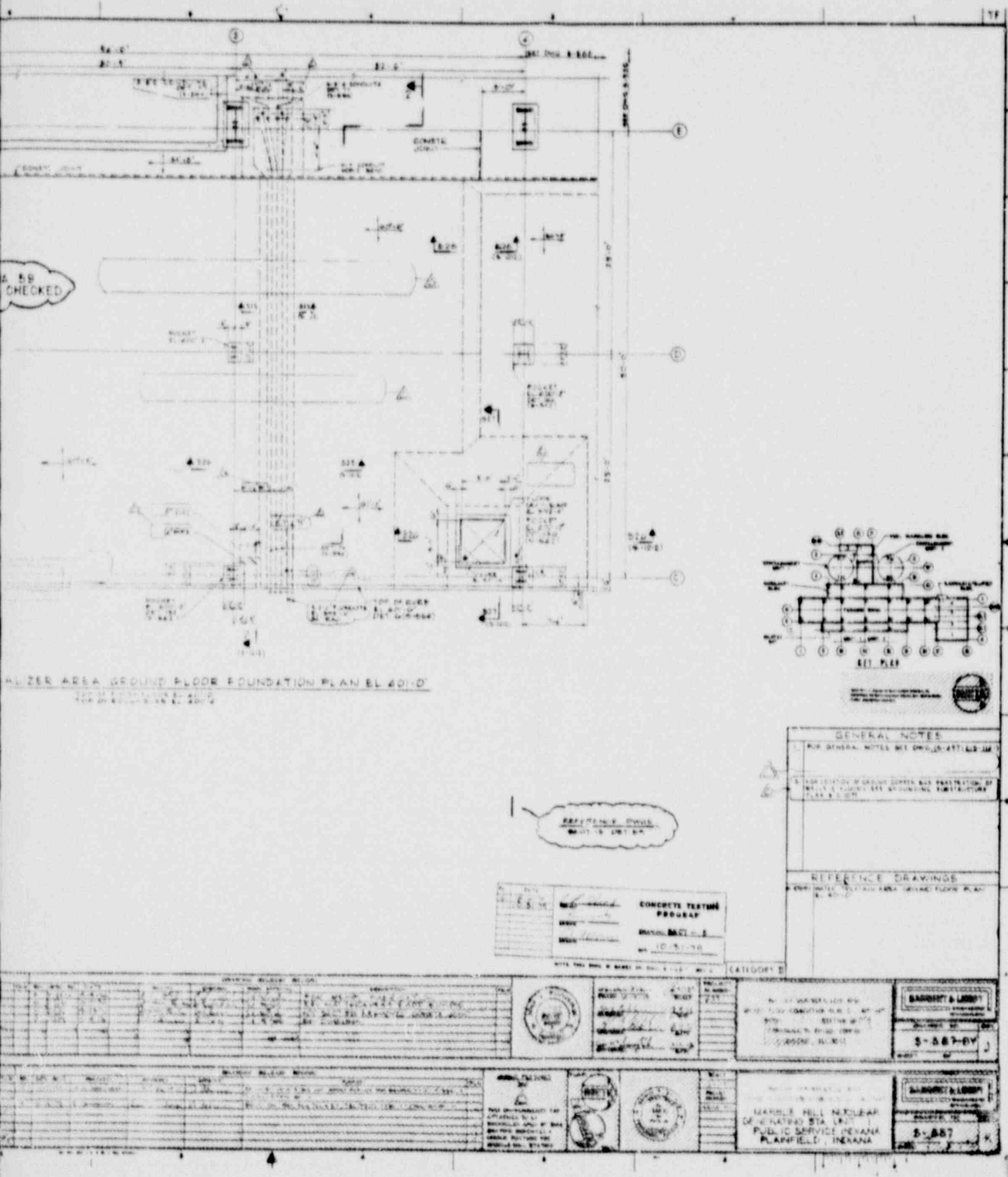
CONCRETE TESTING PROGRAM

MARBLE HILL NUCLEAR GENERATING STATION
PUBLIC SERVICE INDIANA
PLAINFIELD, INDIANA

BARGETT & LOOFT

S-565


MAKE-UP DEM


A 59
CHECKED
ALIZER AREA GROUND FLOOR FOUNDATION PLAN EL 401-0"
KEY PLAN
GENERAL NOTES
REFERENCE DRAWINGS
REFERENCE DWGS.
CONCRETE TESTING PROGRAM
CATEGORY II
SARGENT & LUNDY
MARBLE HILL NUCLEAR GENERATING STA. UNIT 1
PUBLIC SERVICE INDIANA
PLAINFIELD, INDIANA
S-887

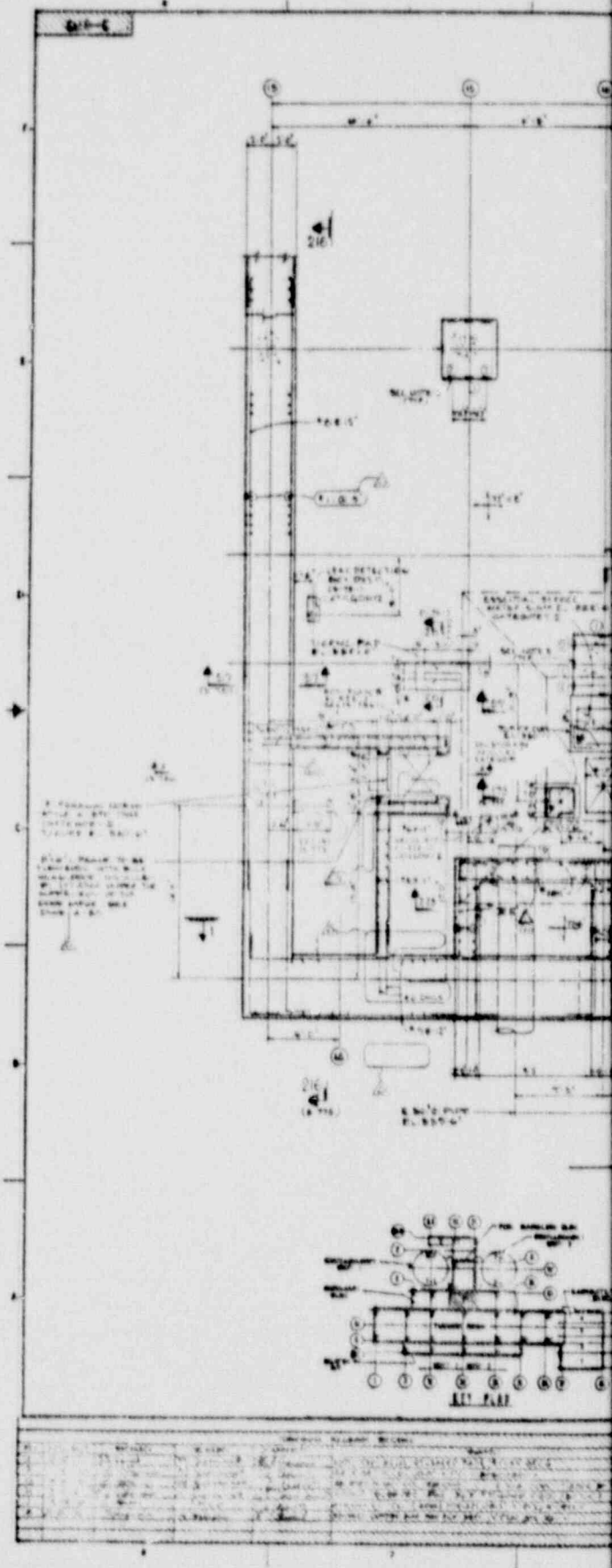
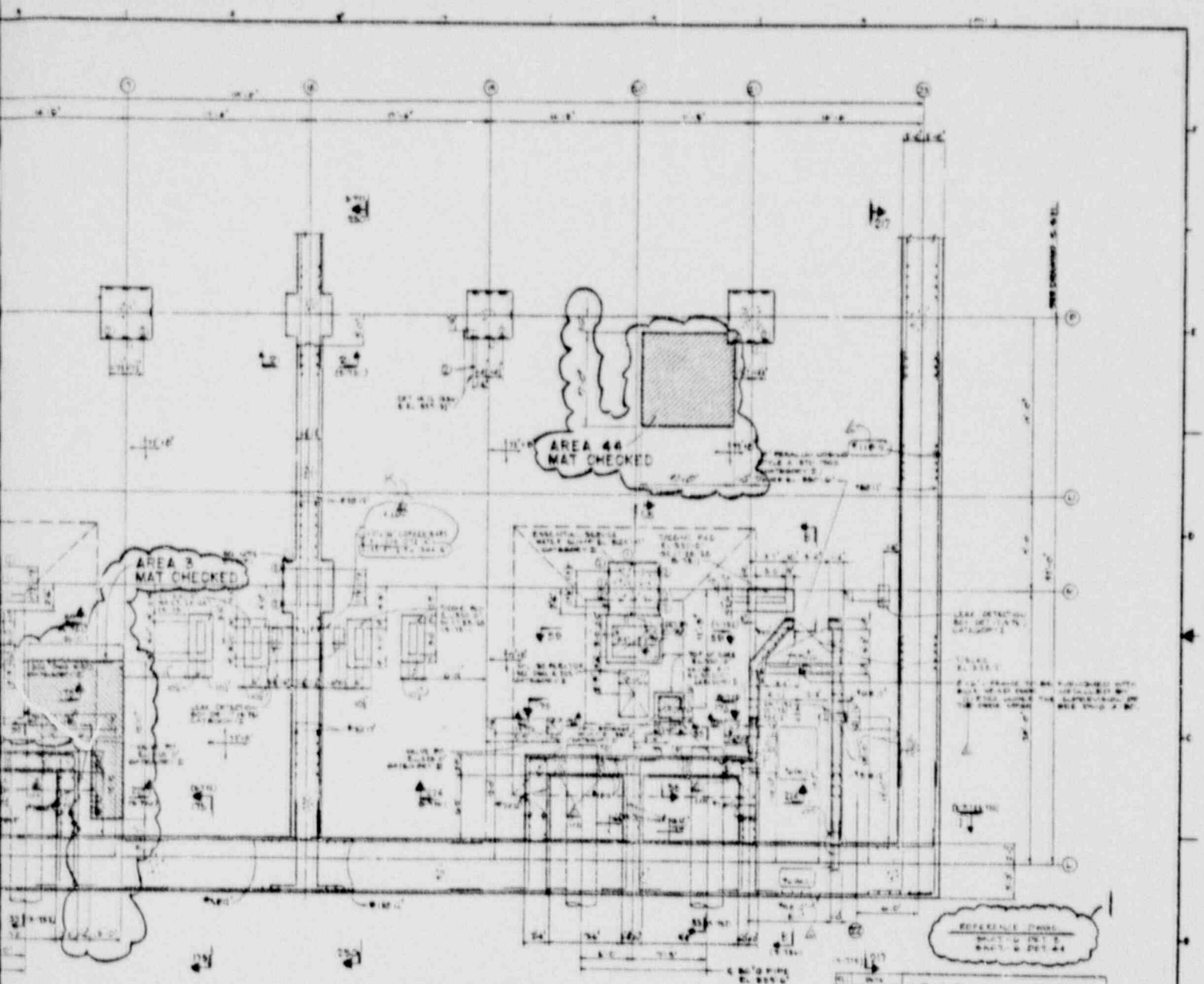


EXHIBIT 2
SL-3753
11-20-79



XILIARY BUILDING ESSENTIAL SERVICE WATER PUMP ROOM EL 330'0"

CONCRETE TESTING PROGRAM

CATEGORY I

REFERENCE DRAWINGS

A/X BUILDING ESSENTIAL SERVICE WATER PUMP ROOM EL 330'-0"
MARBLE HILL NUCLEAR GENERATING STA UNITS 1&2
COMMONWEALTH EDISON CO
CHICAGO, ILLINOIS

S-670

MARBLE HILL NUCLEAR GENERATING STA UNITS 1&2
PUBLIC SERVICE INDIANA
PLAINFIELD, INDIANA

S-670

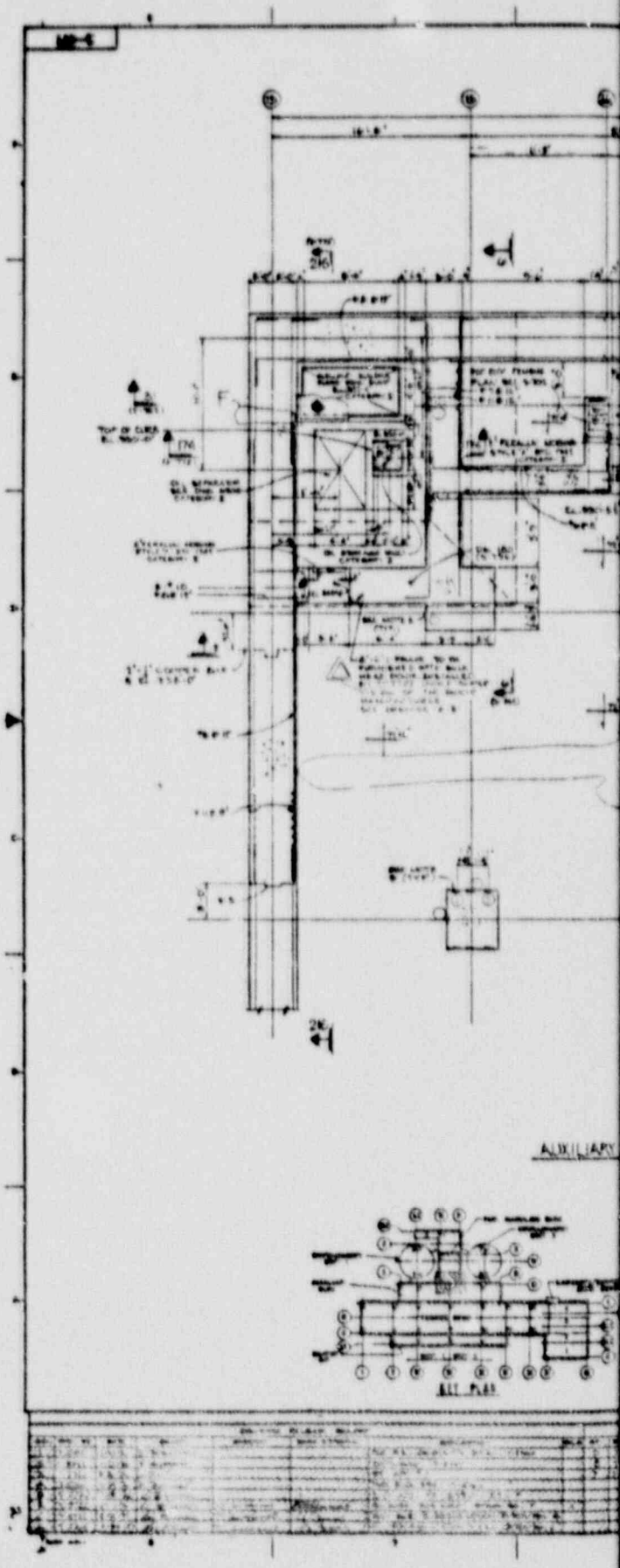
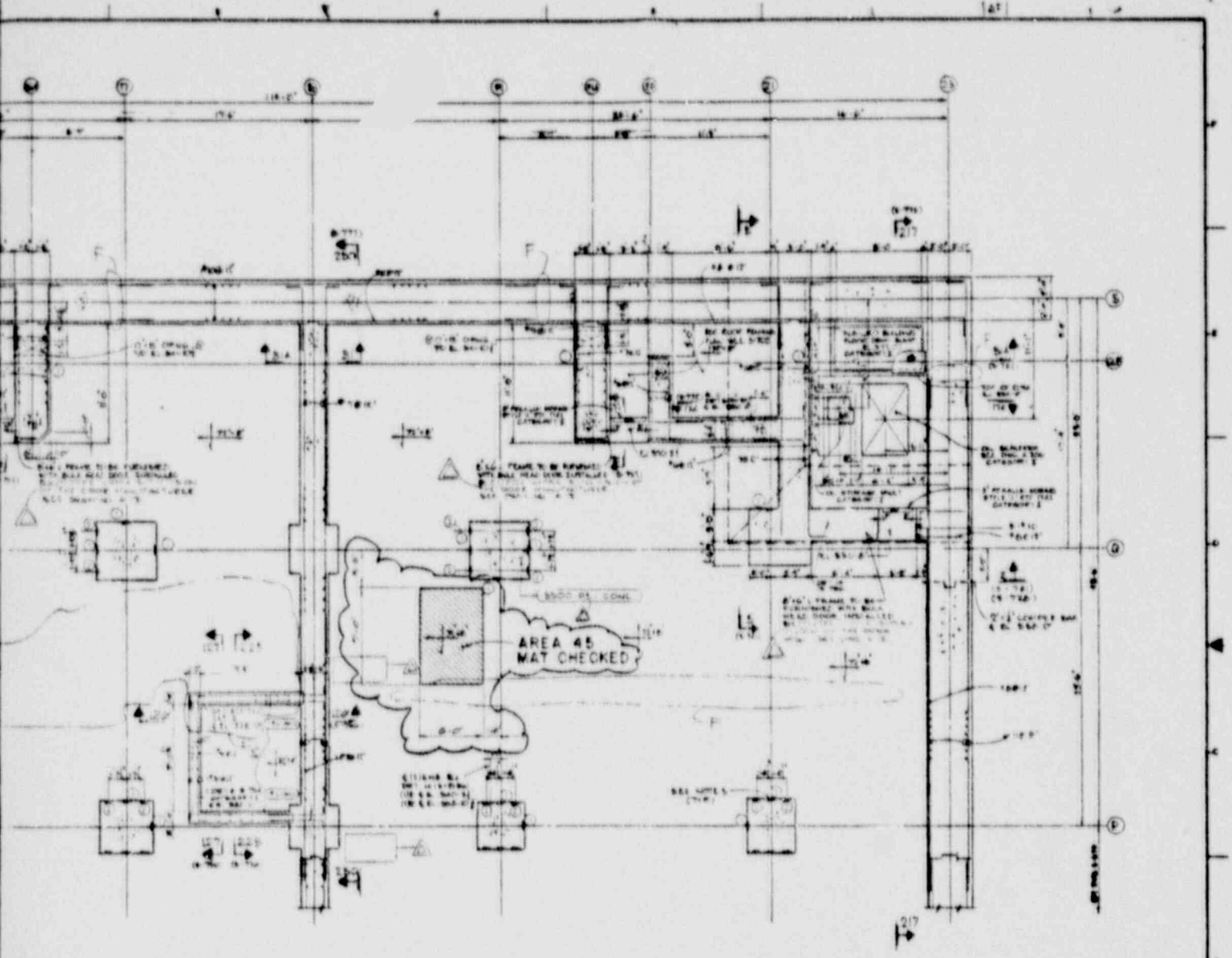


EXHIBIT 2
SL-3753
11-20-79



UILDING ESSENTIAL SERVICE WATER PUMP ROOM EL 836'0"

NOTES

REFERENCE DRAWINGS

CATEGORY I

AUX BUILDING ESSENTIAL SERVICE WATER PUMP ROOM

S-871

MARBLE HILL NUCLEAR GENERATING STA UNITS 1 & 2
PUBLIC SERVICE INDIANA
PLAINFIELD, INDIANA

S-871

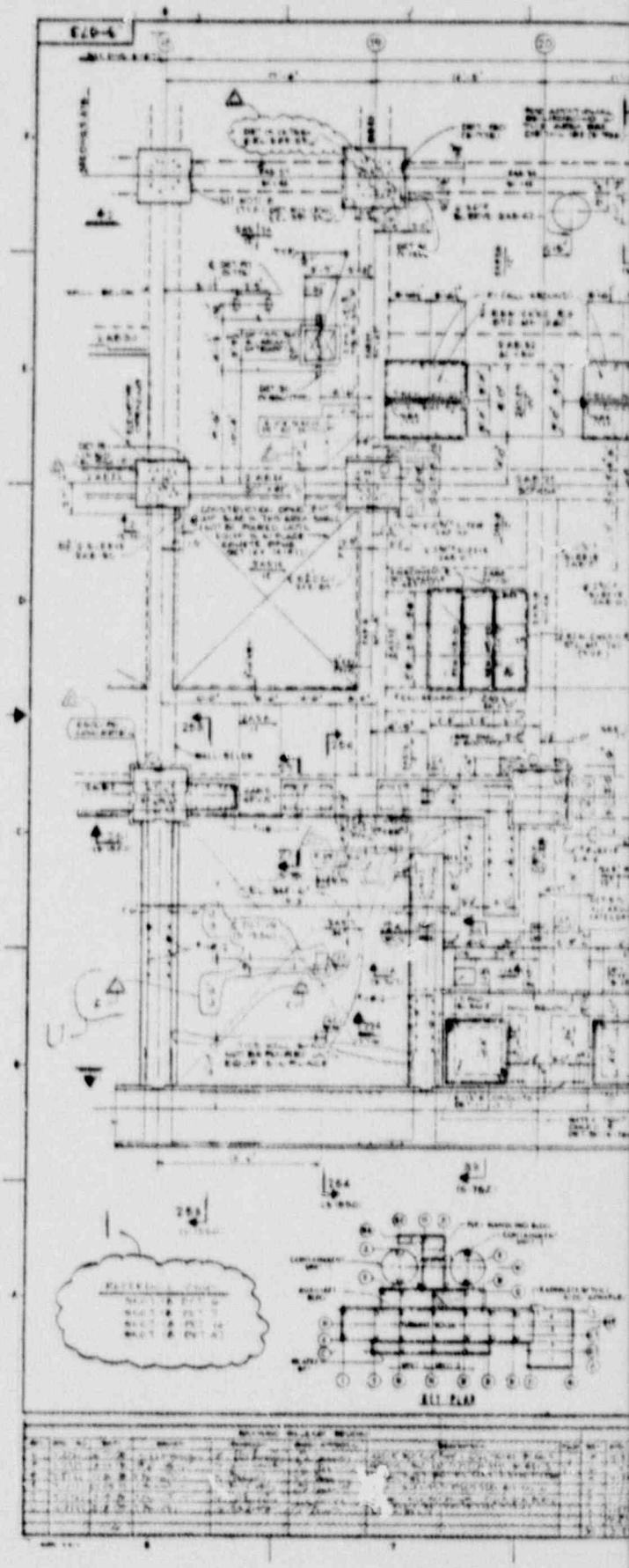
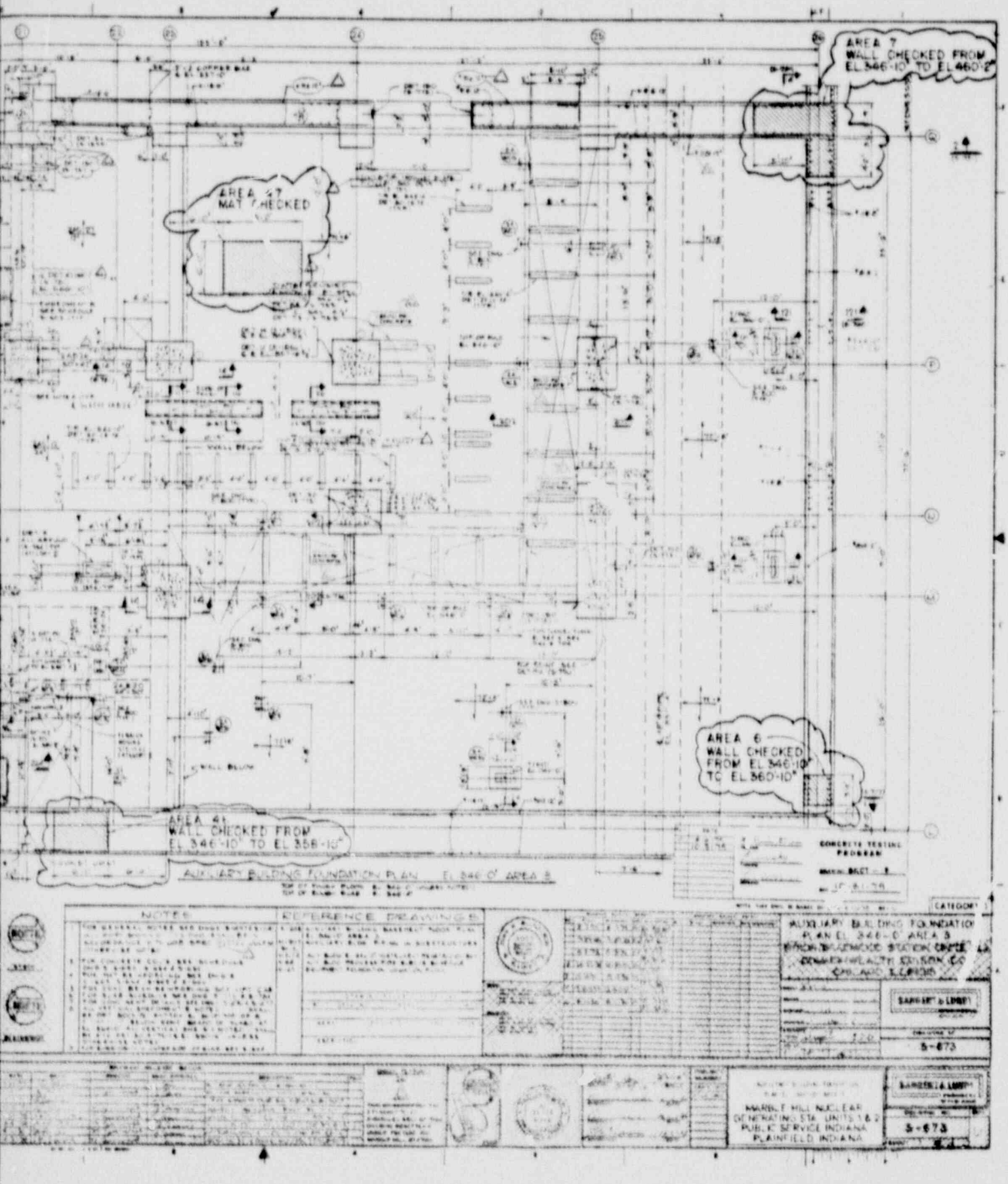


EXHIBIT 2
SL-3753
11-20-79



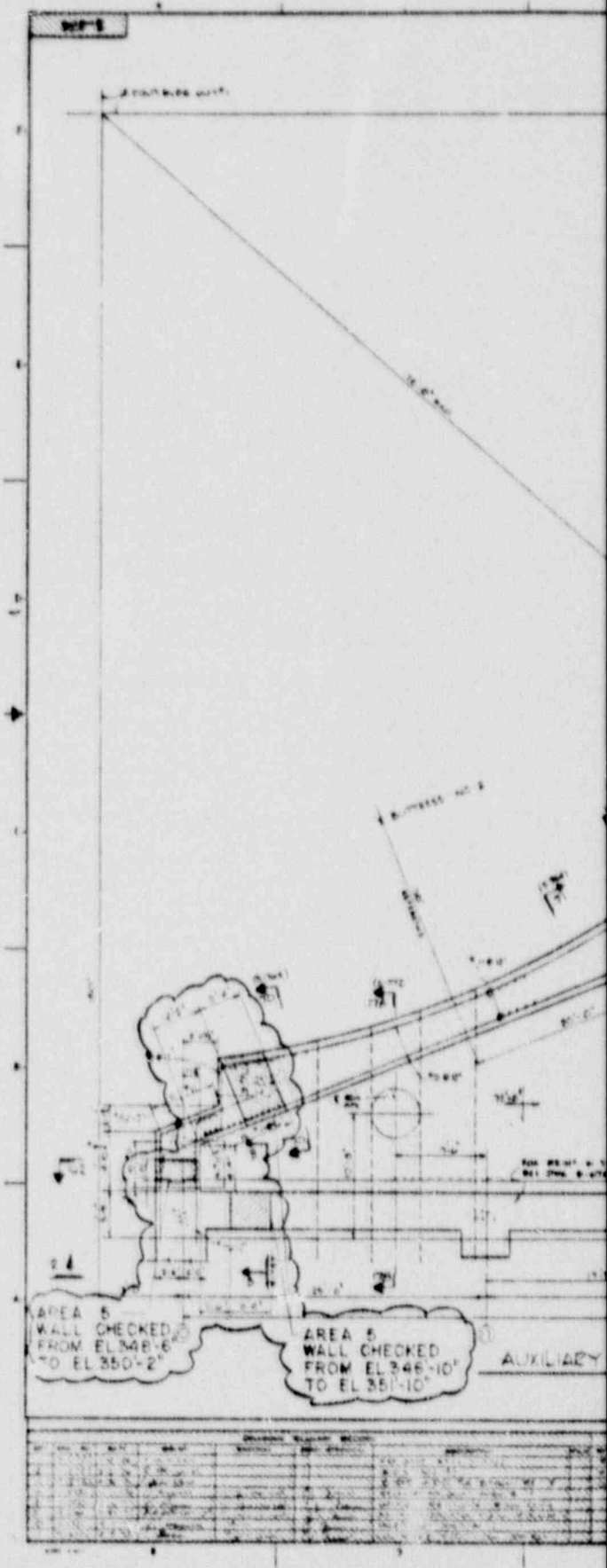
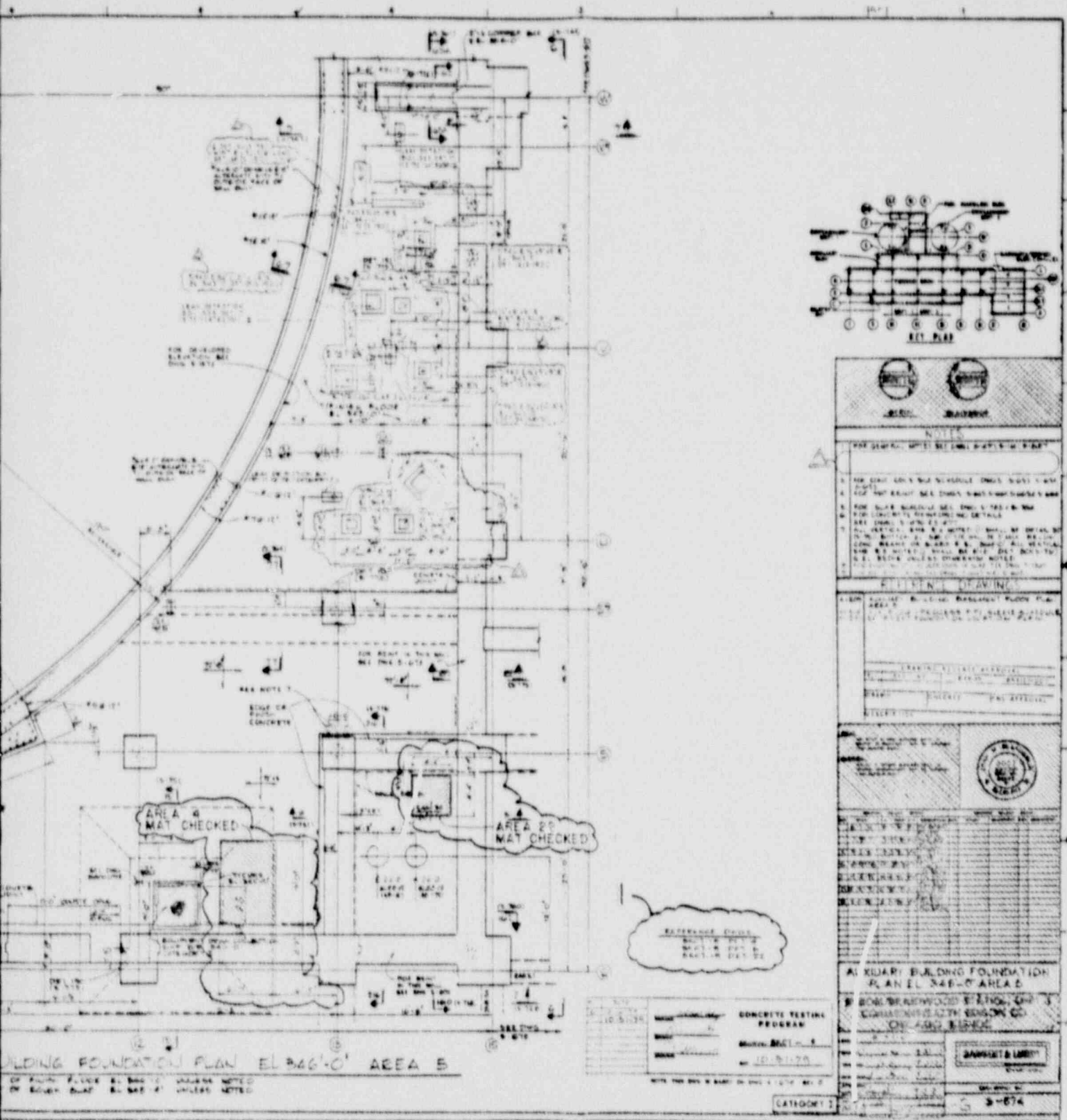

AREA 5
WALL CHECKED
FROM EL 348'-6"
TO EL 350'-2"
AREA 5
WALL CHECKED
FROM EL 346'-10"
TO EL 351'-10"
AUXILIARY

EXHIBIT 2
SL-3753
11-20-79



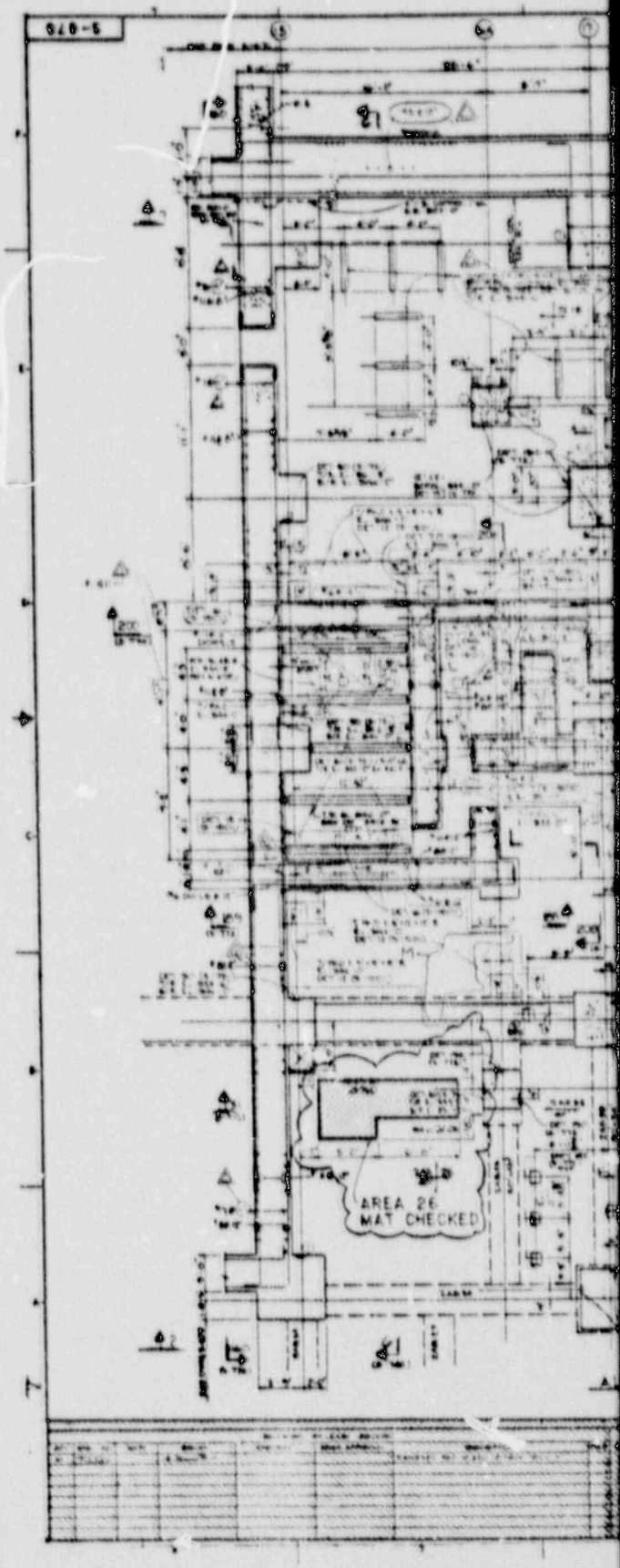
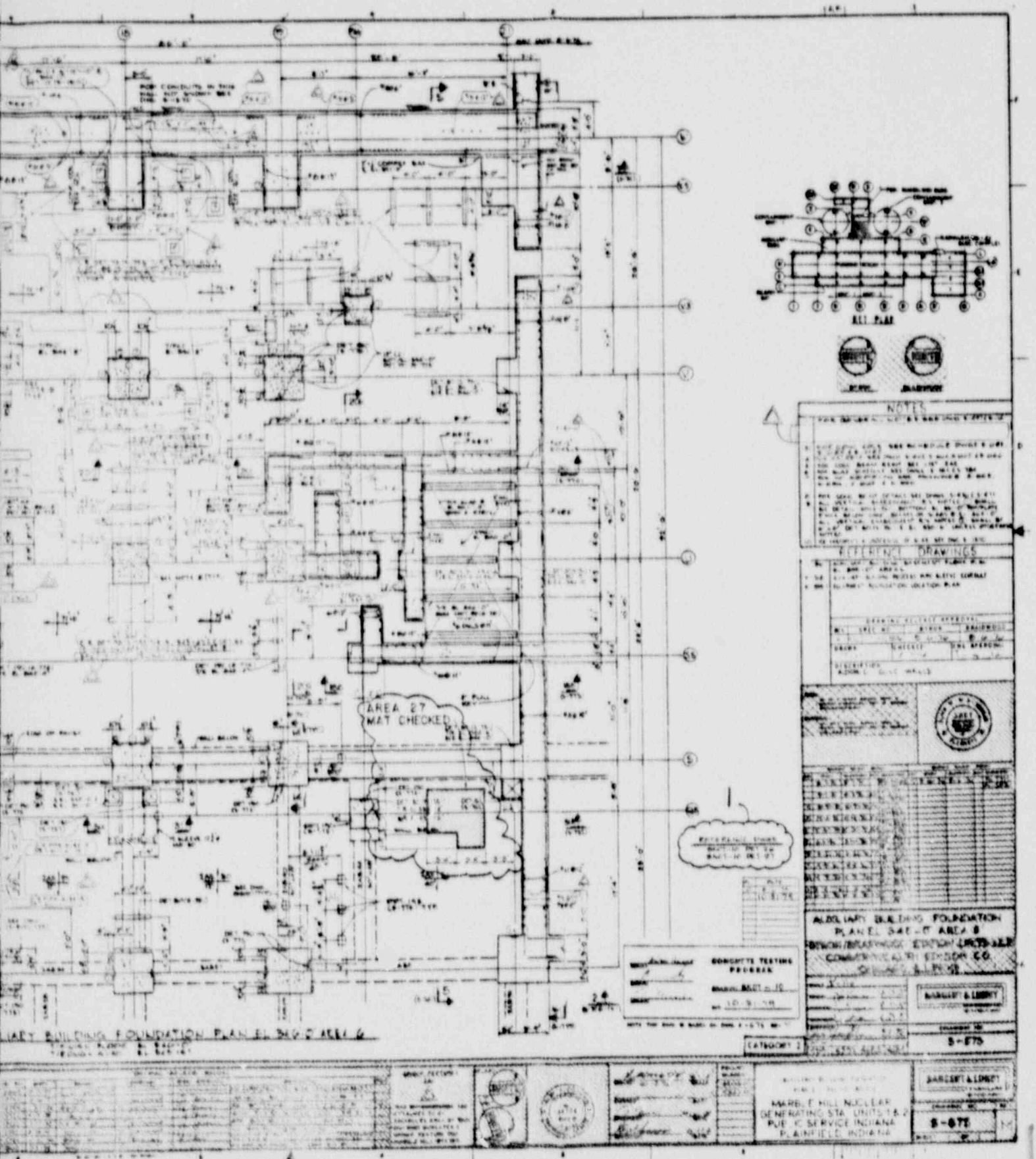

AREA 26
MAT CHECKED

EXHIBIT 2
SL-3753
11-20-79



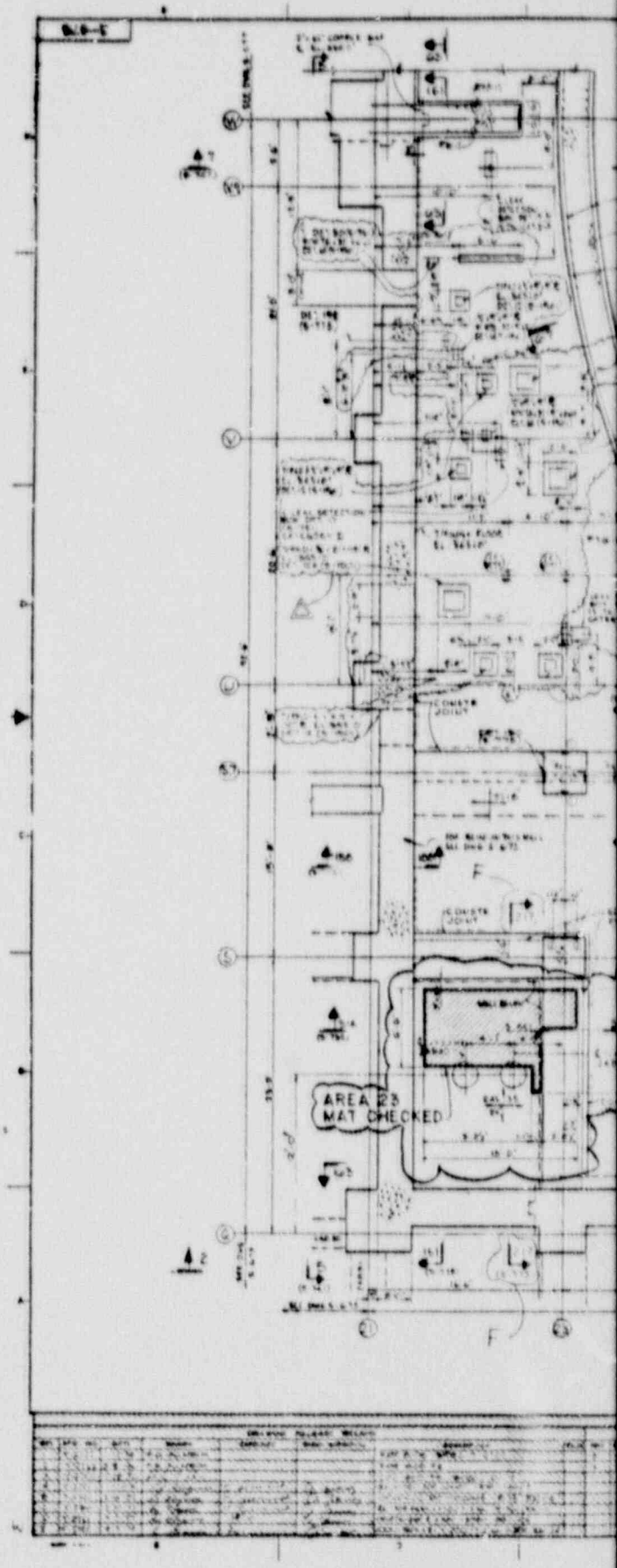
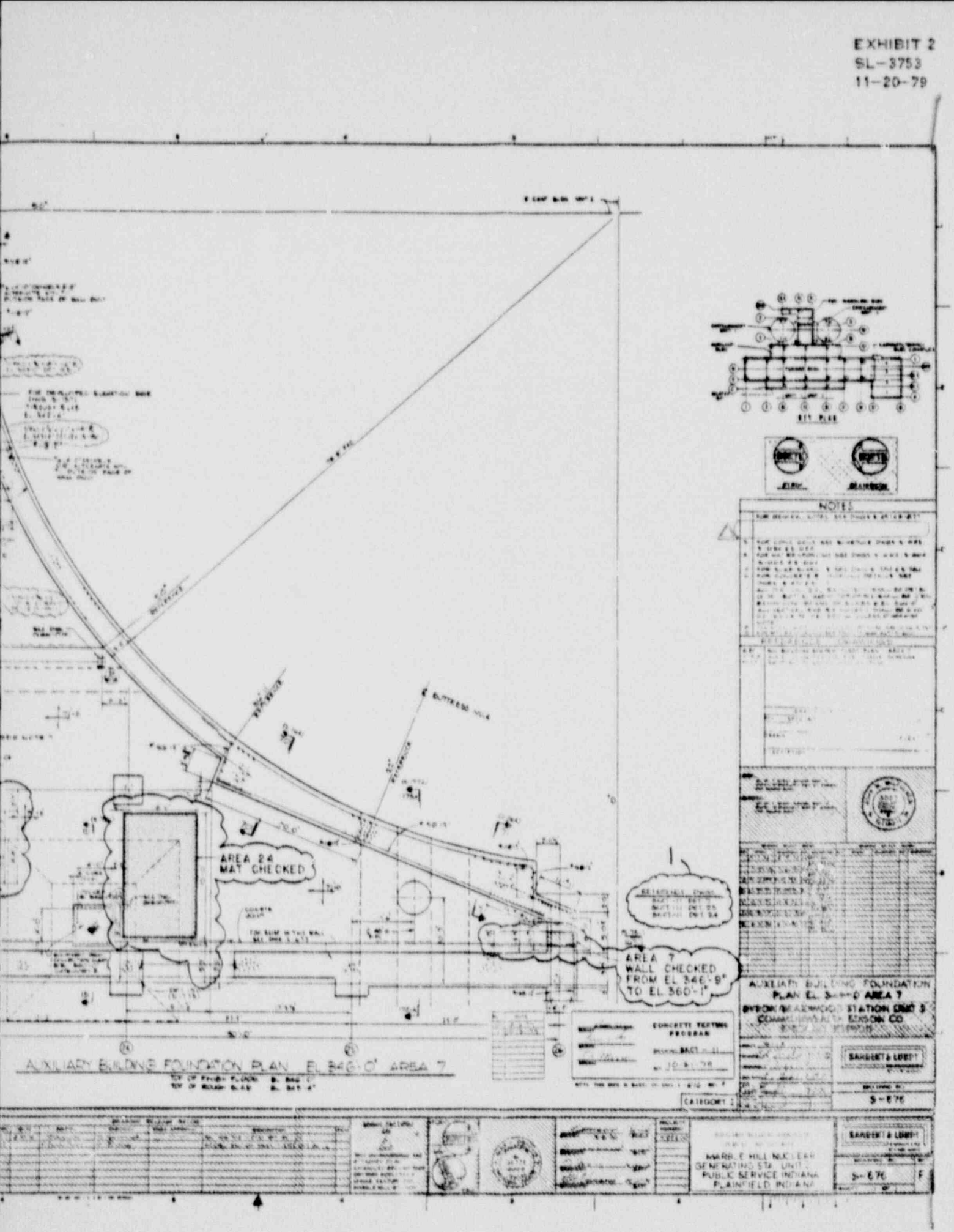

AREA 23
MAT CHECKED

EXHIBIT 2
SL-3753
11-20-79



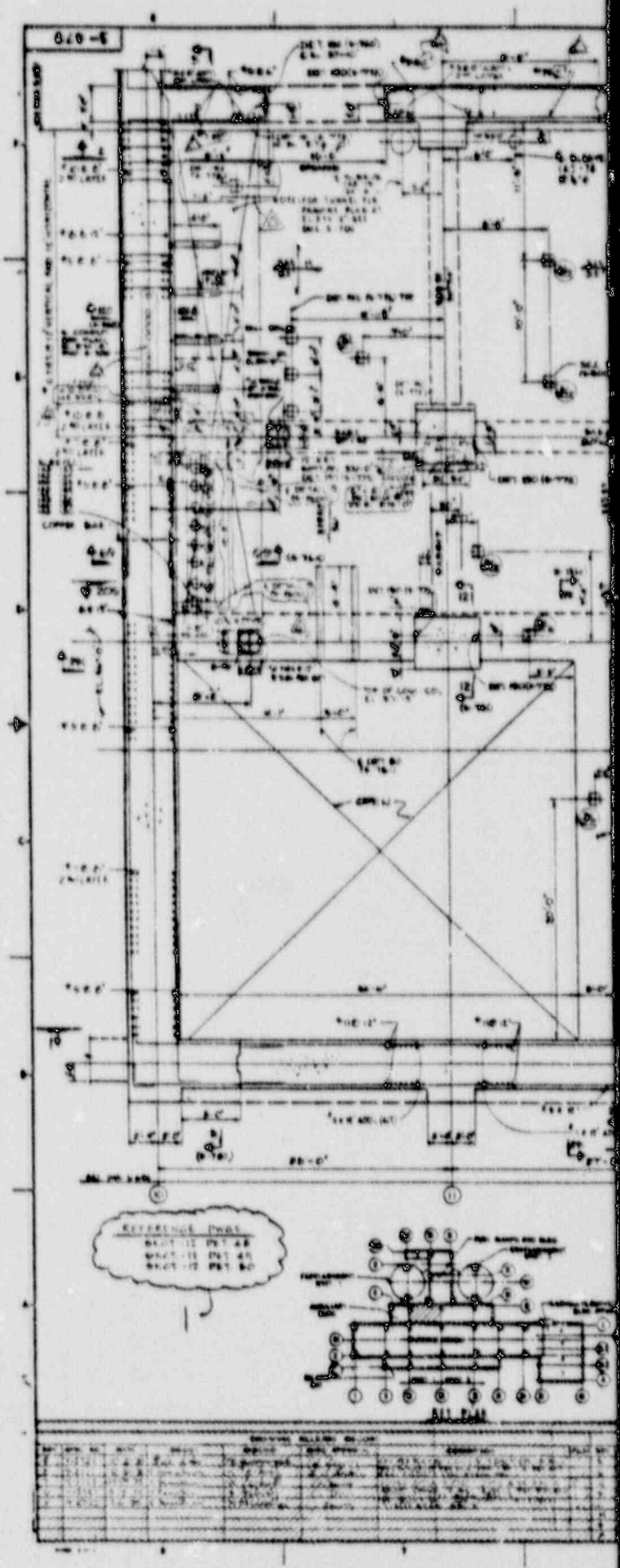
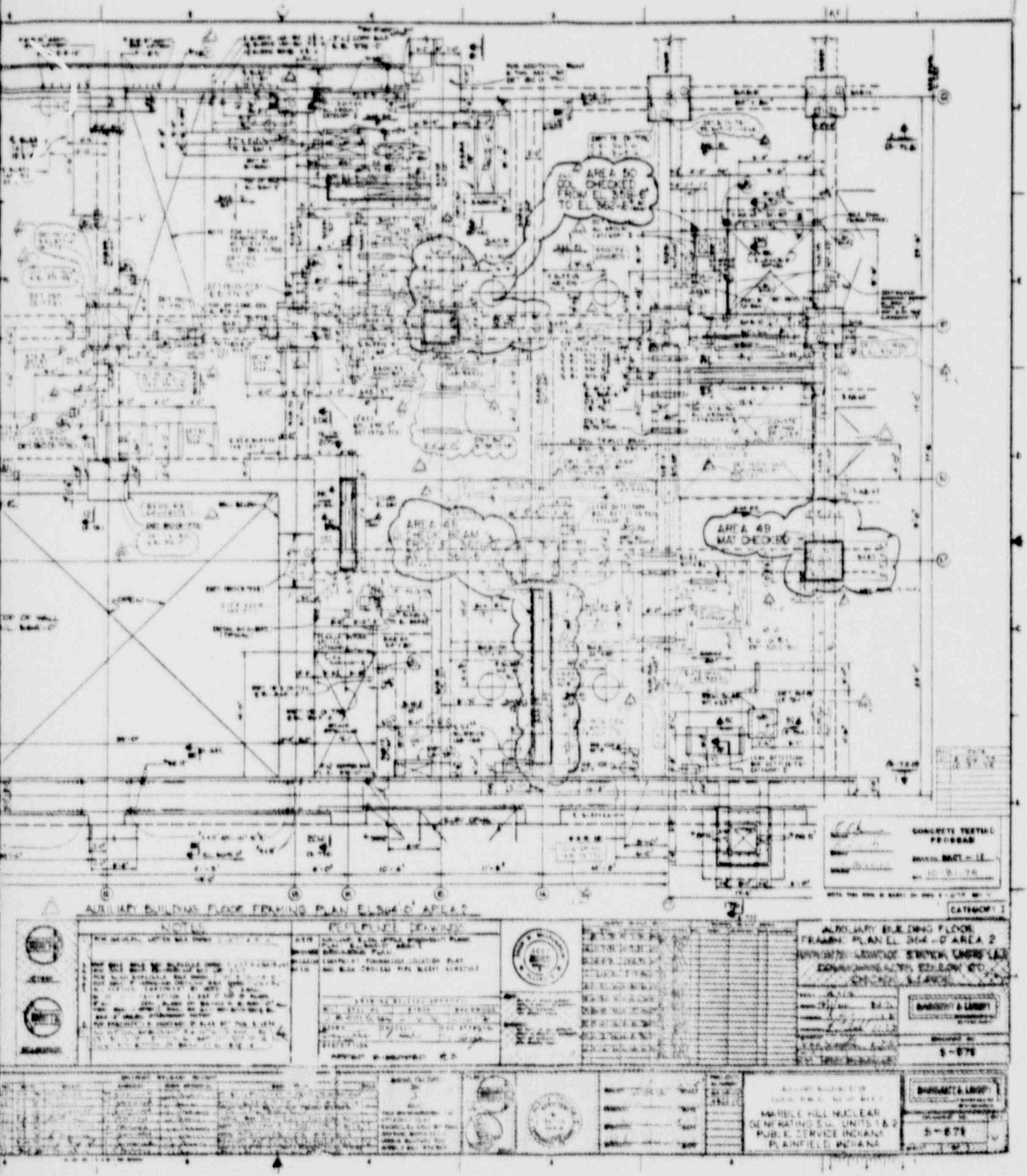


EXHIBIT 2
SL-3753
11-20-79



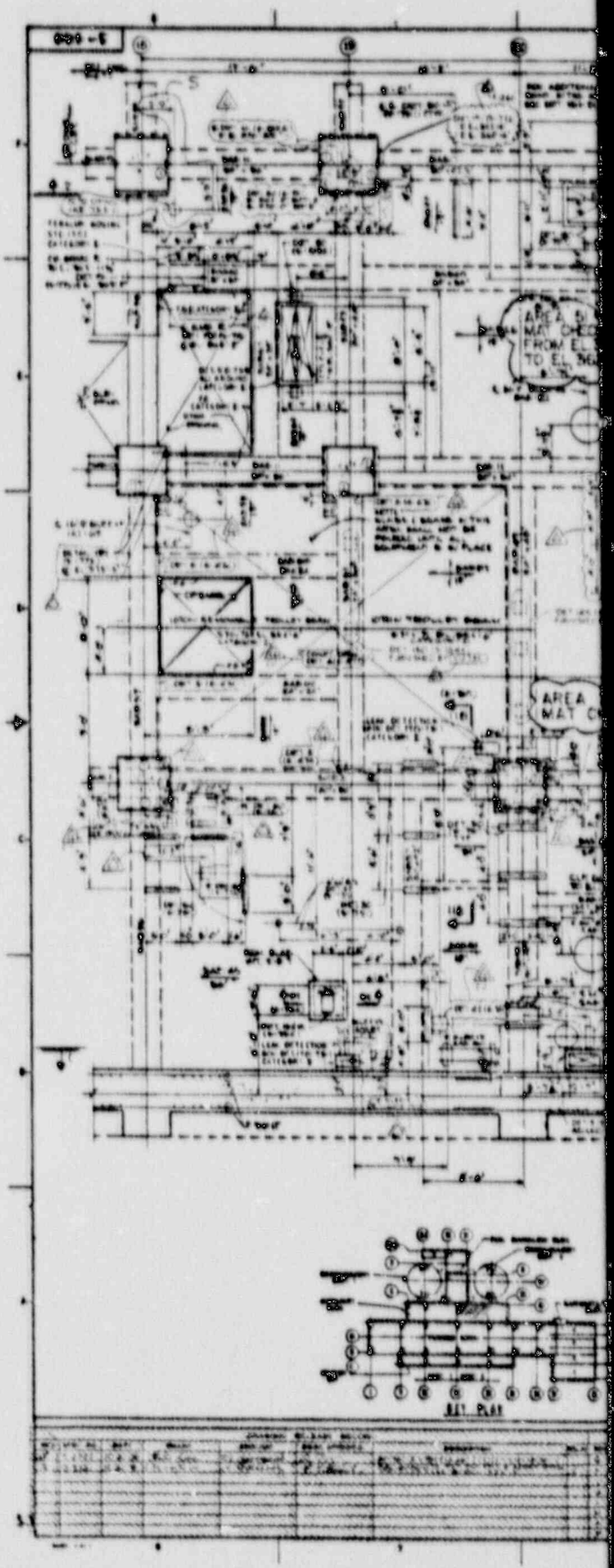
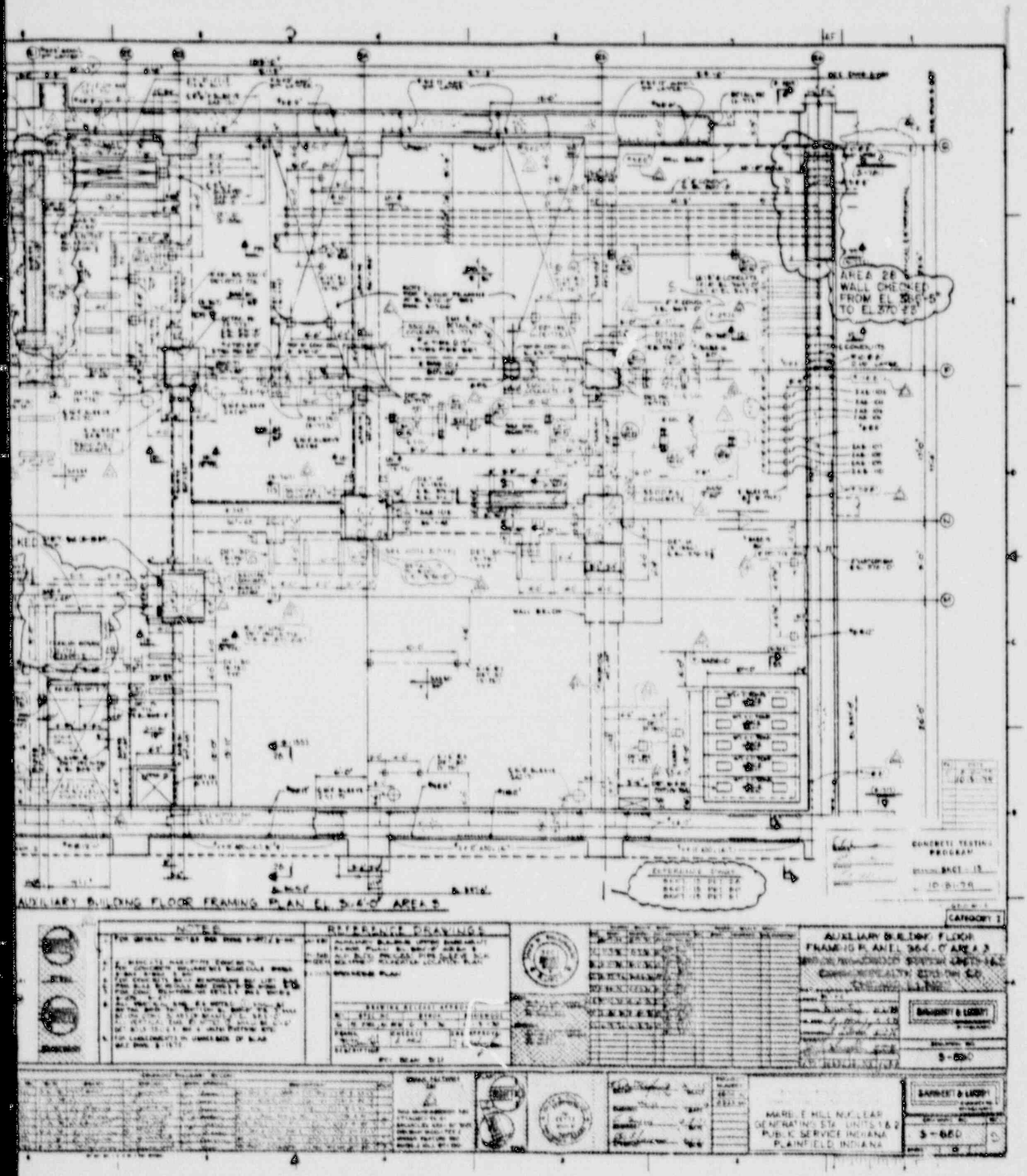


EXHIBIT 2
SL-3753
11-20-79



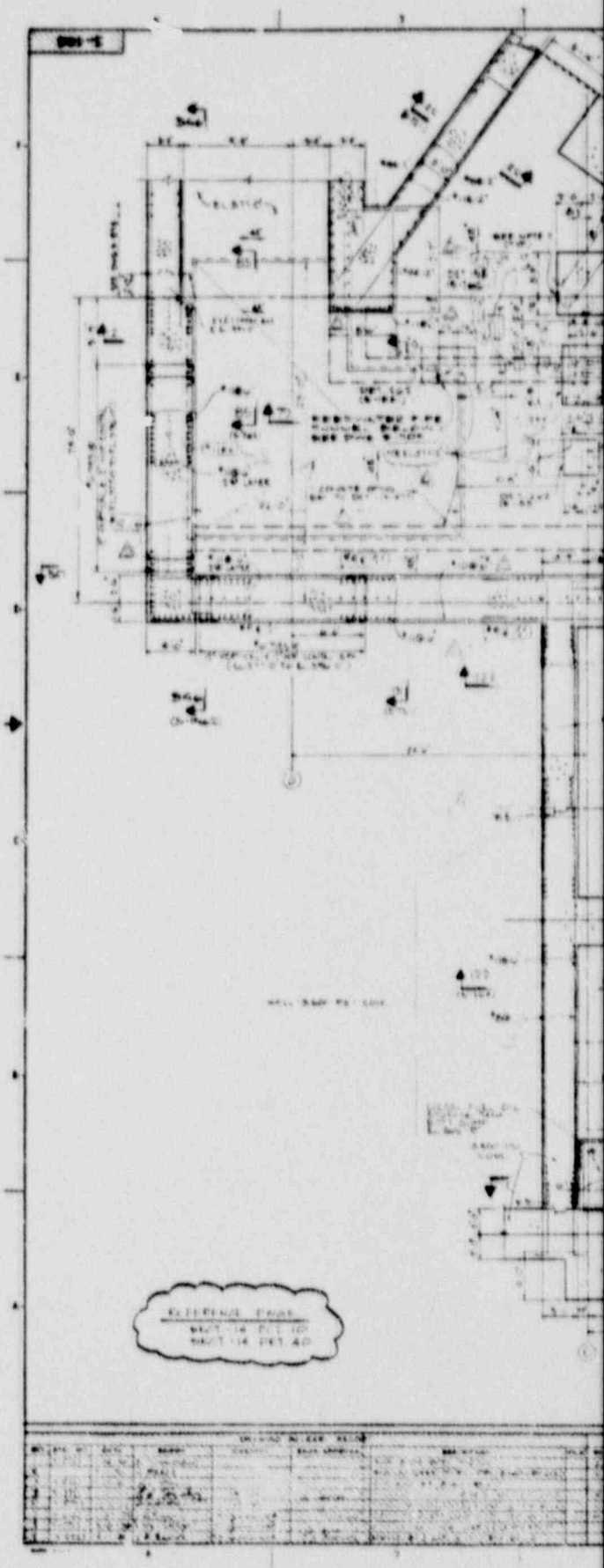
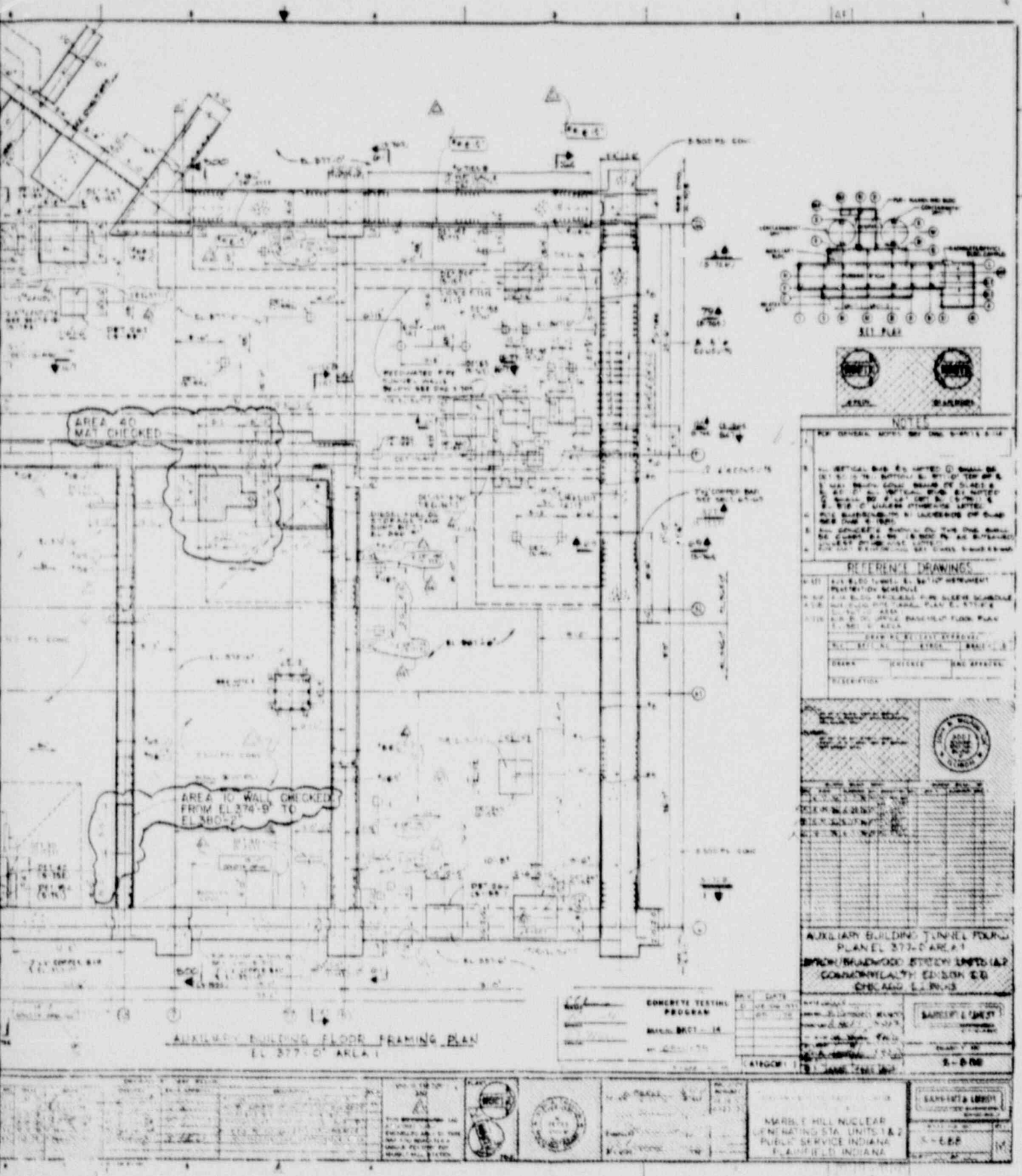


EXHIBIT 2
SL-3753,
11-20-79



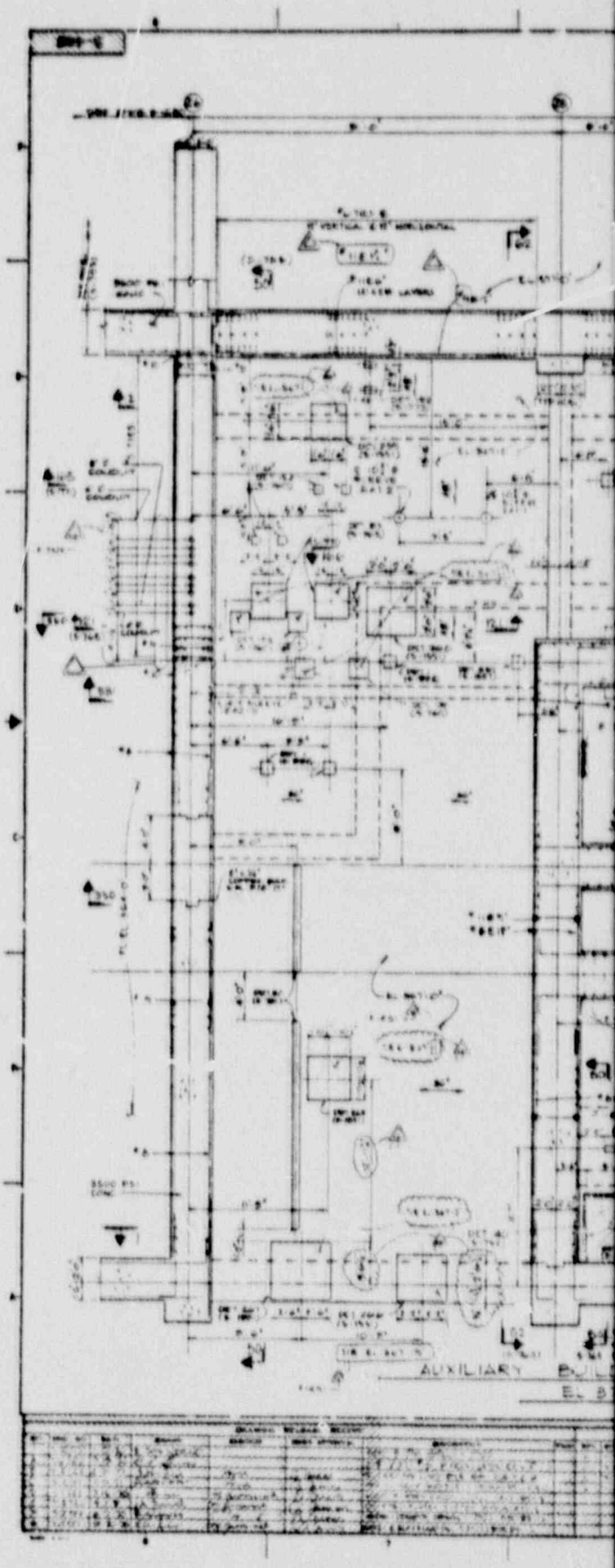
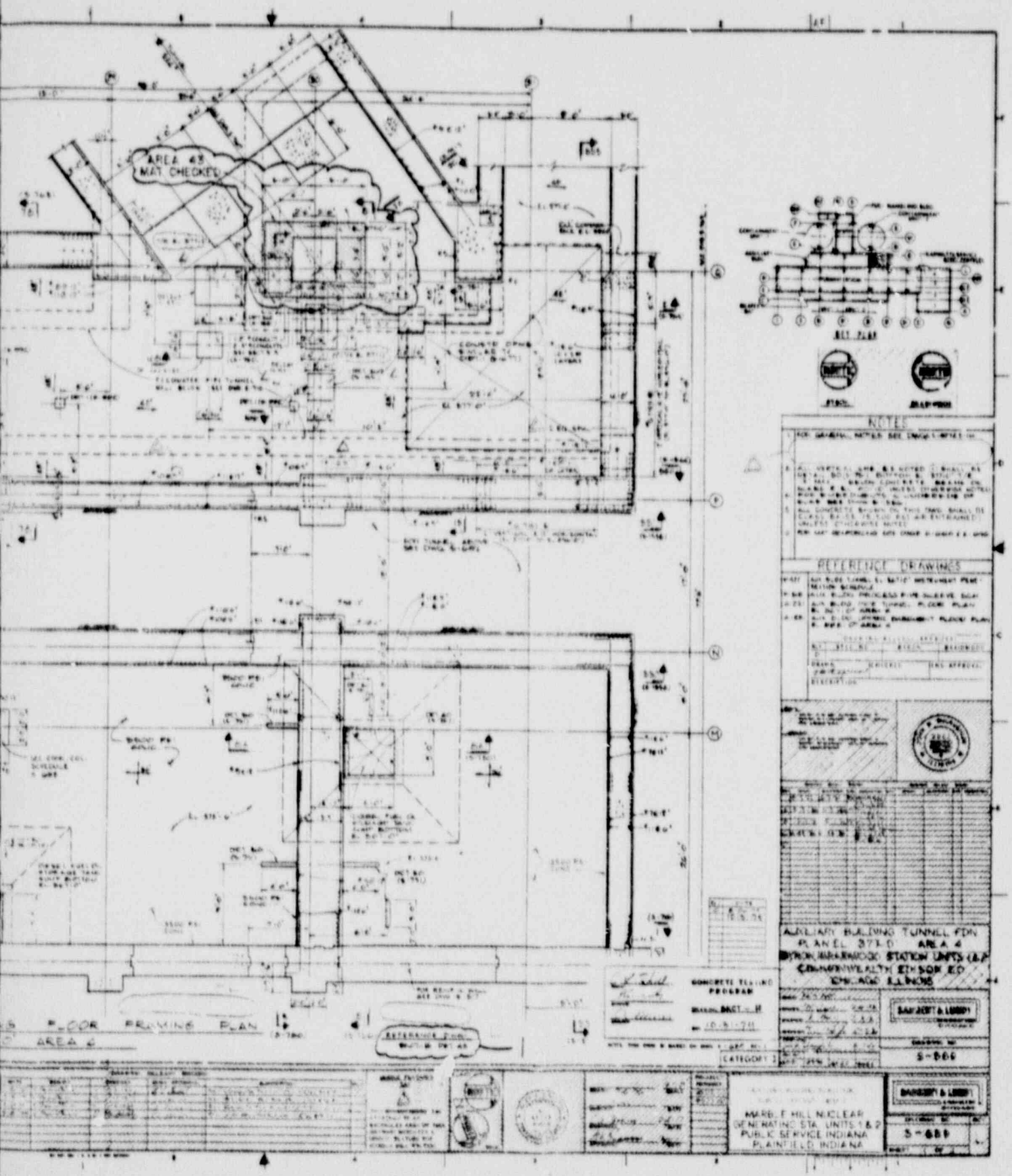

AUXILIARY

EXHIBIT 2
SL-3753
11-20-79



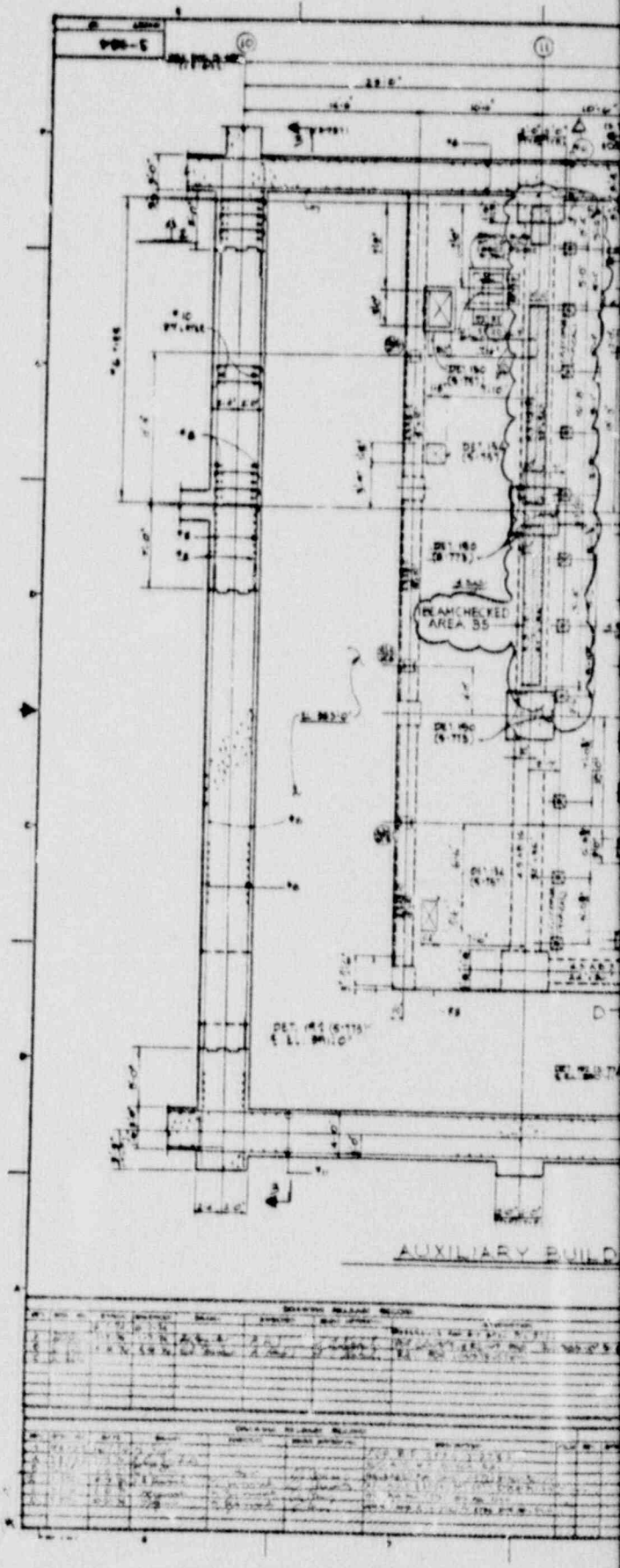
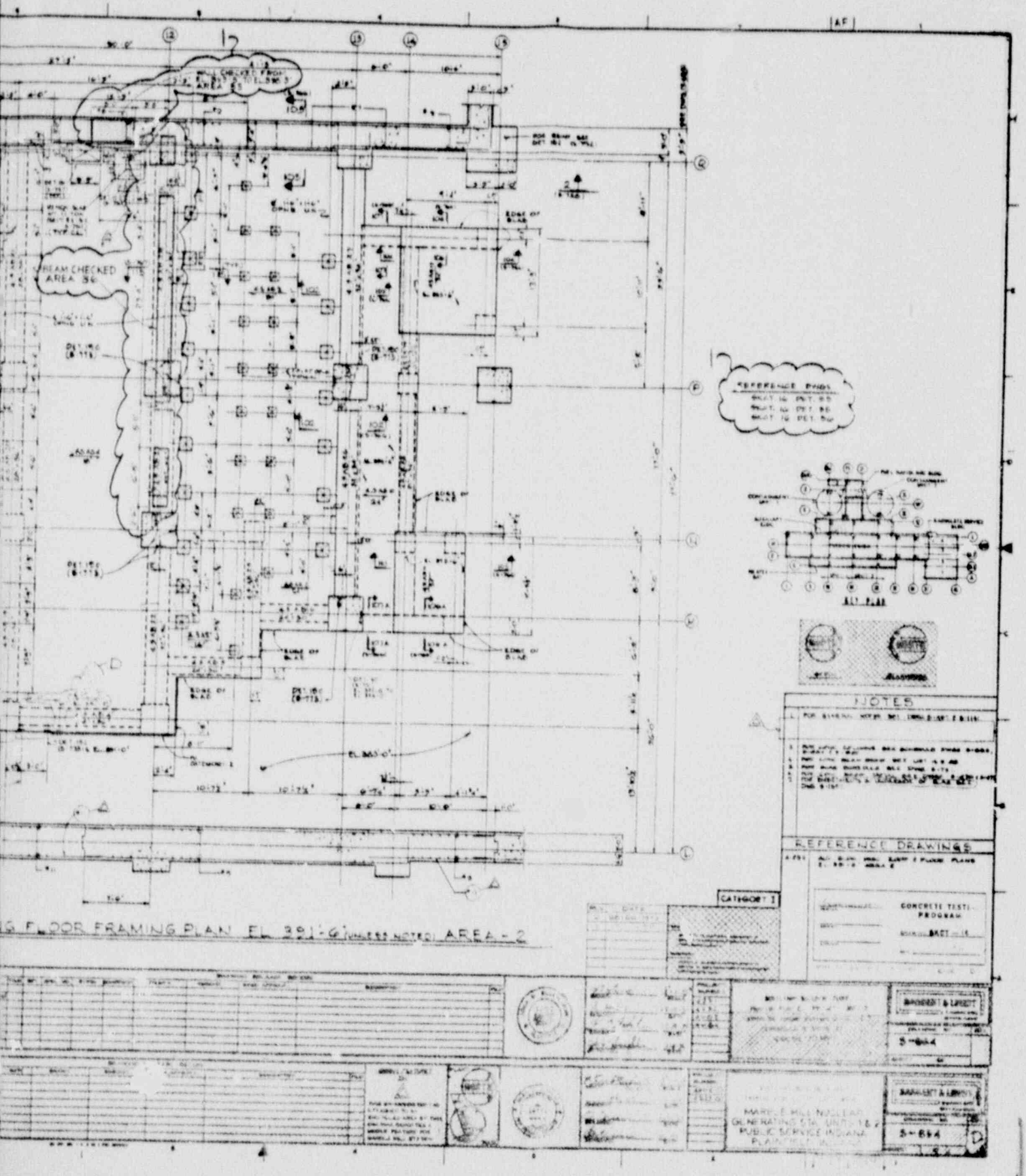
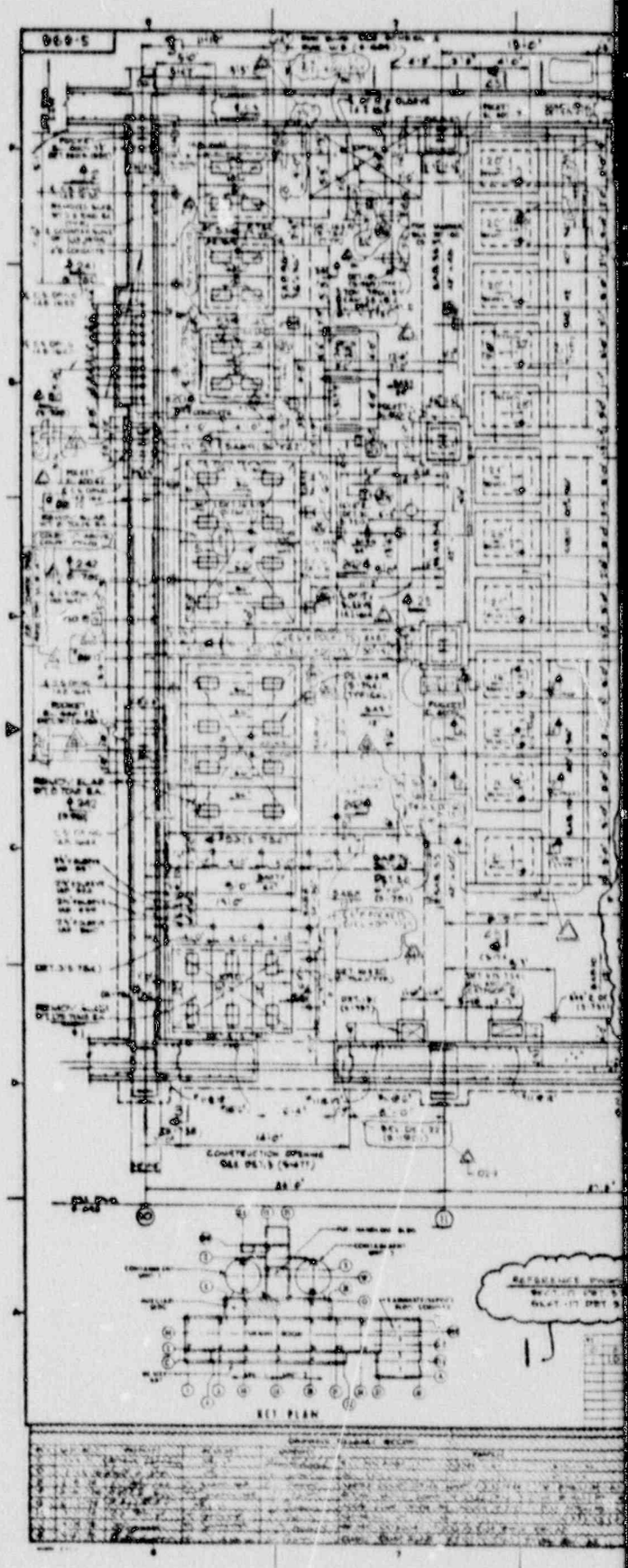

REANCHECKED
AREA '85
AUXILIARY BUILD

EXHIBIT 2
SL-3753
11-20-79





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SL-3753
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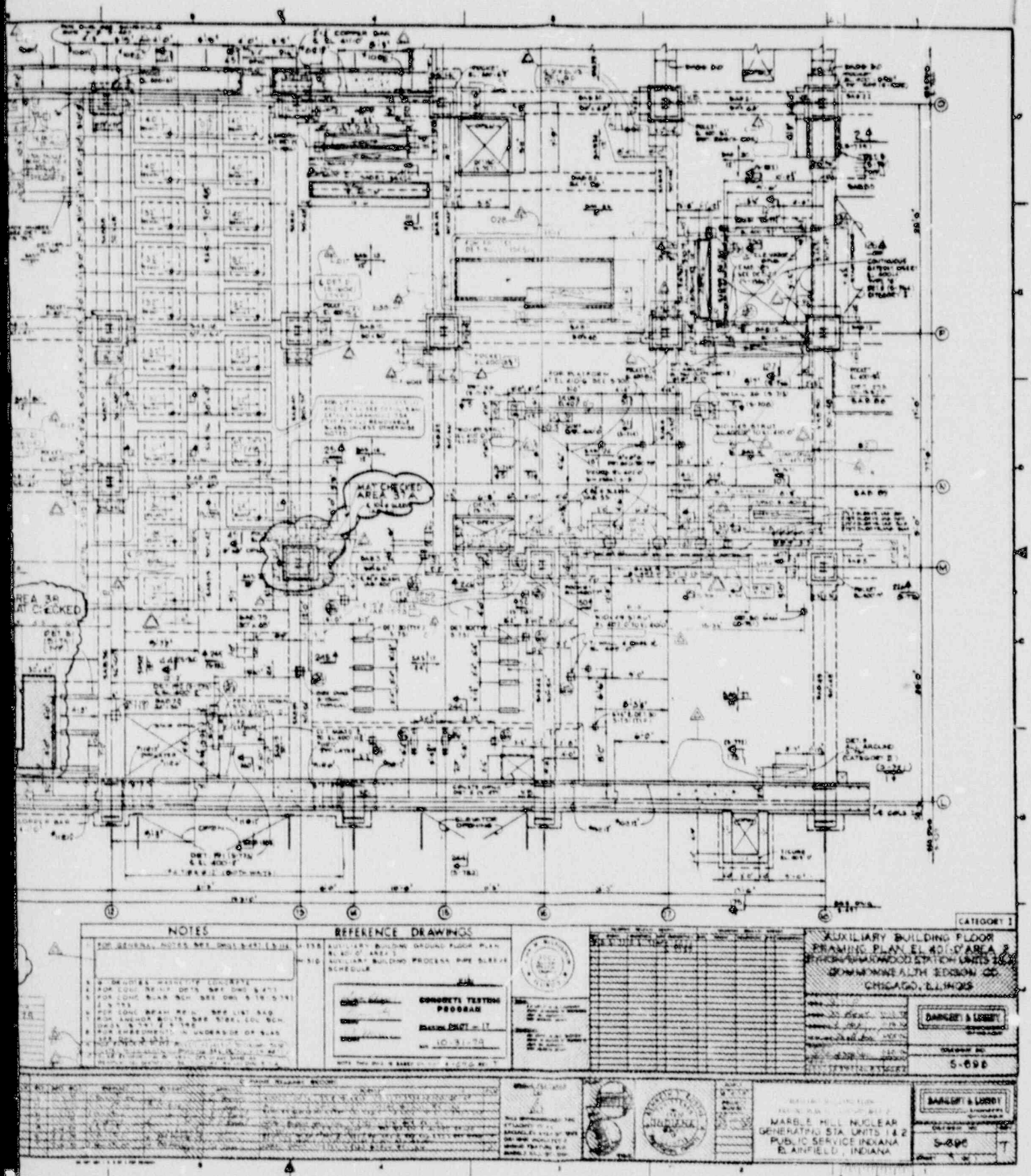


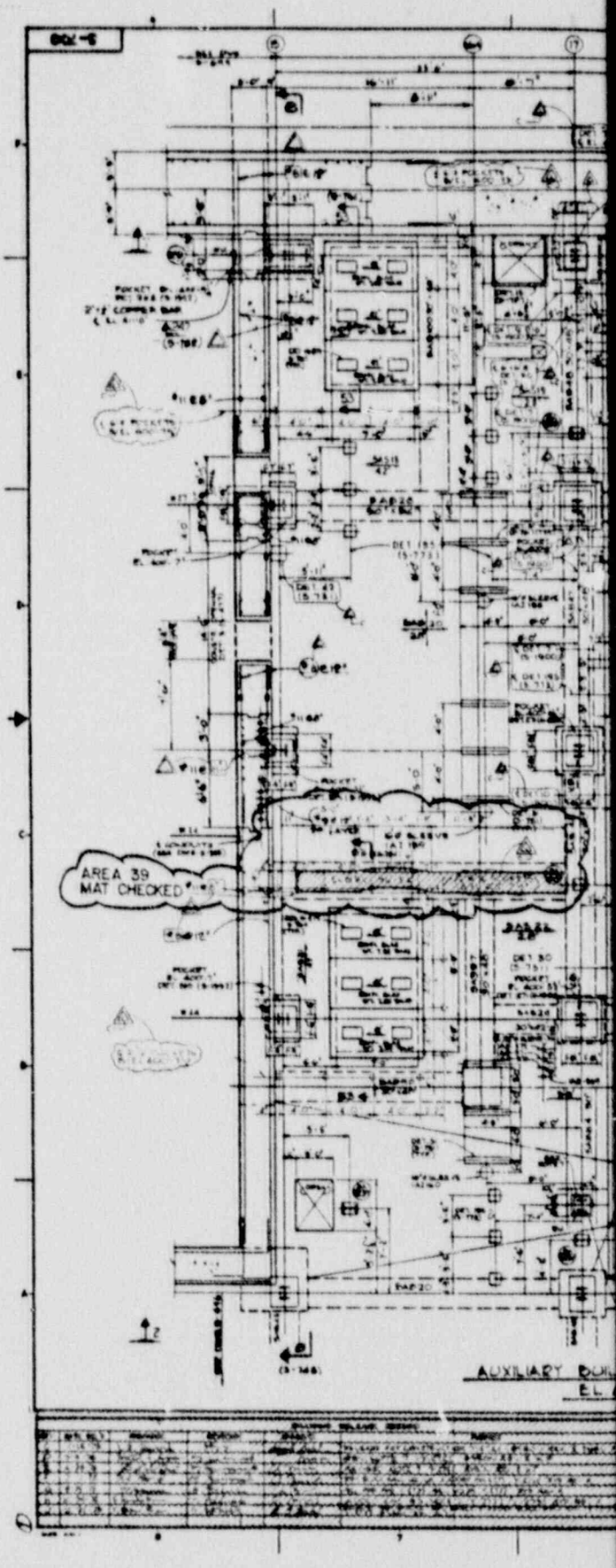
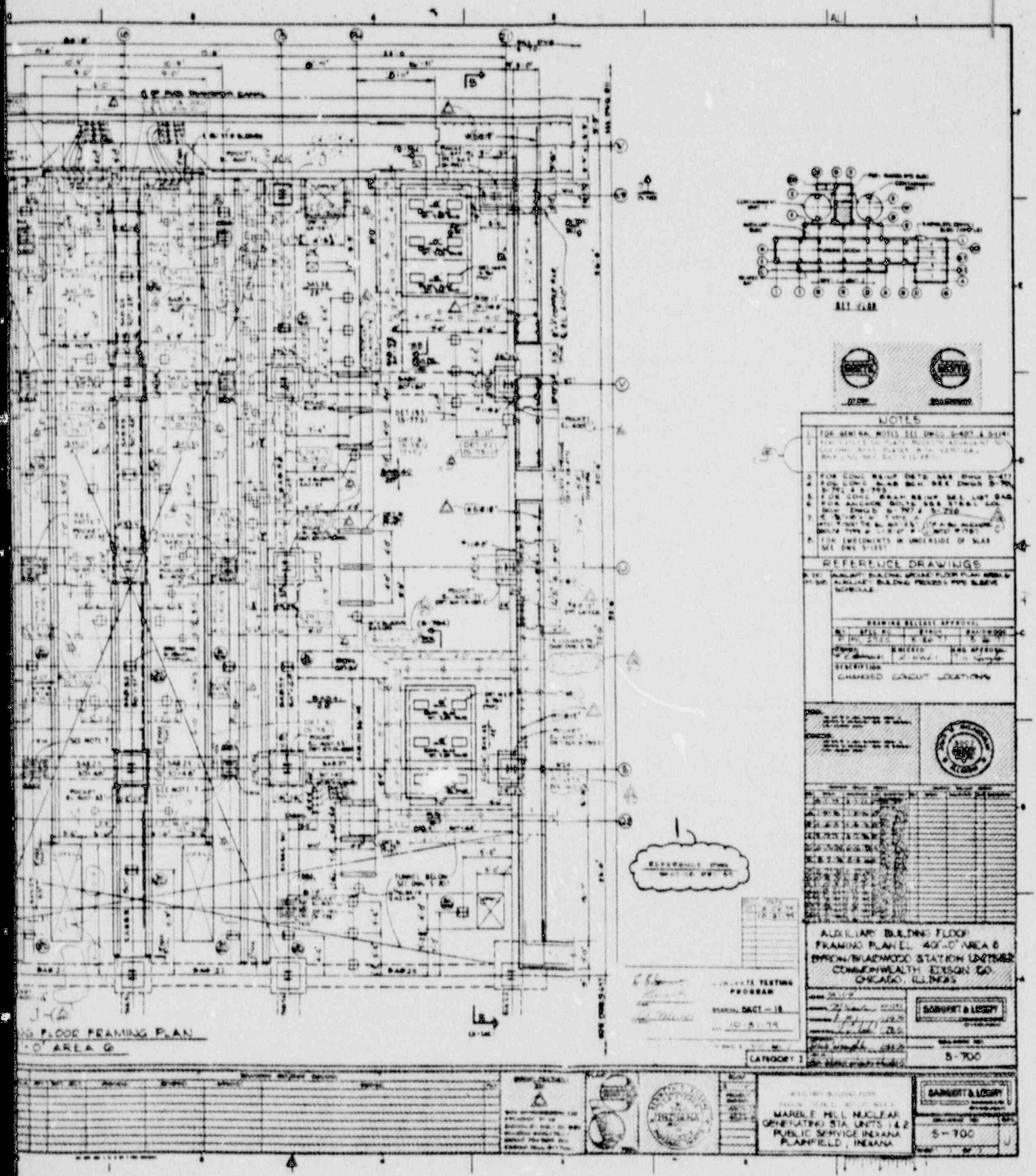
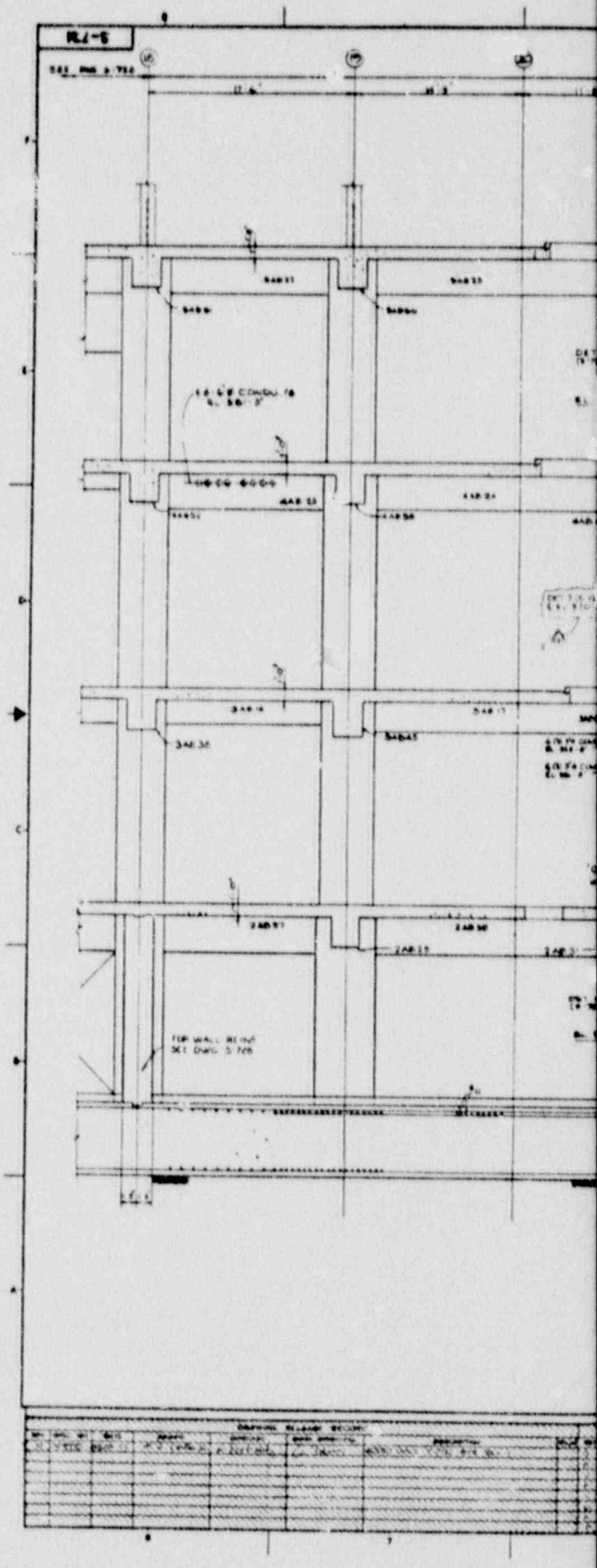

AREA 39
MAT CHECKED

EXHIBIT 2
SL-3753
11-20-79





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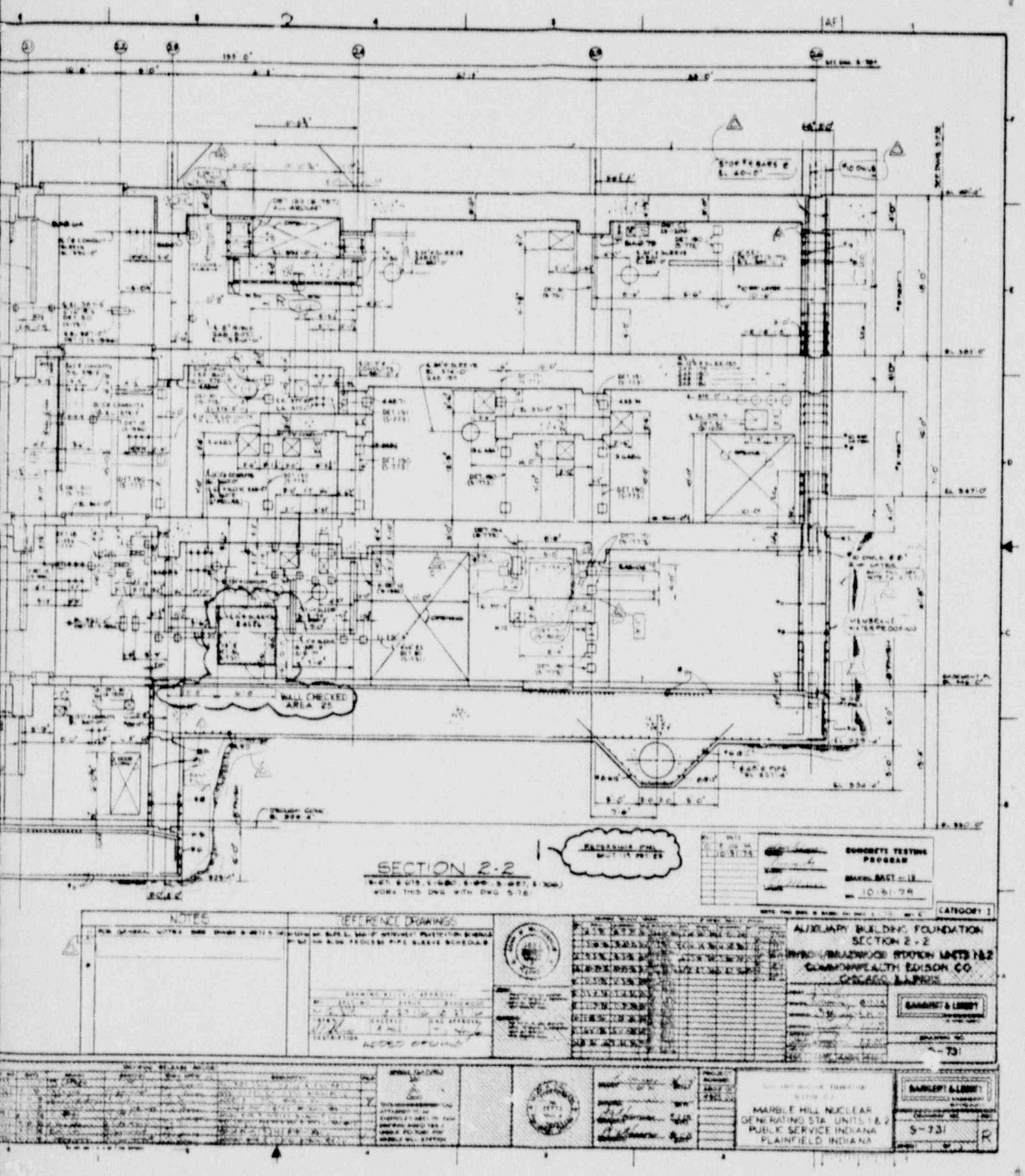
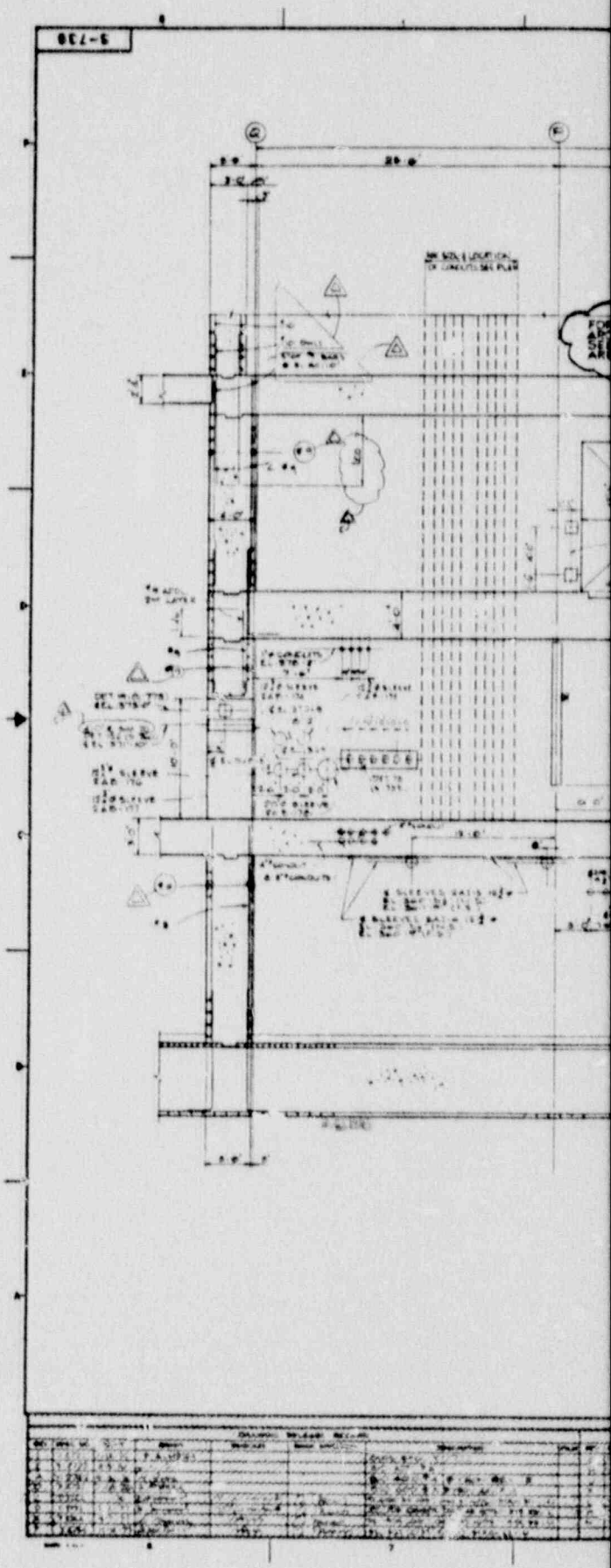
SL-3753
11-20-79





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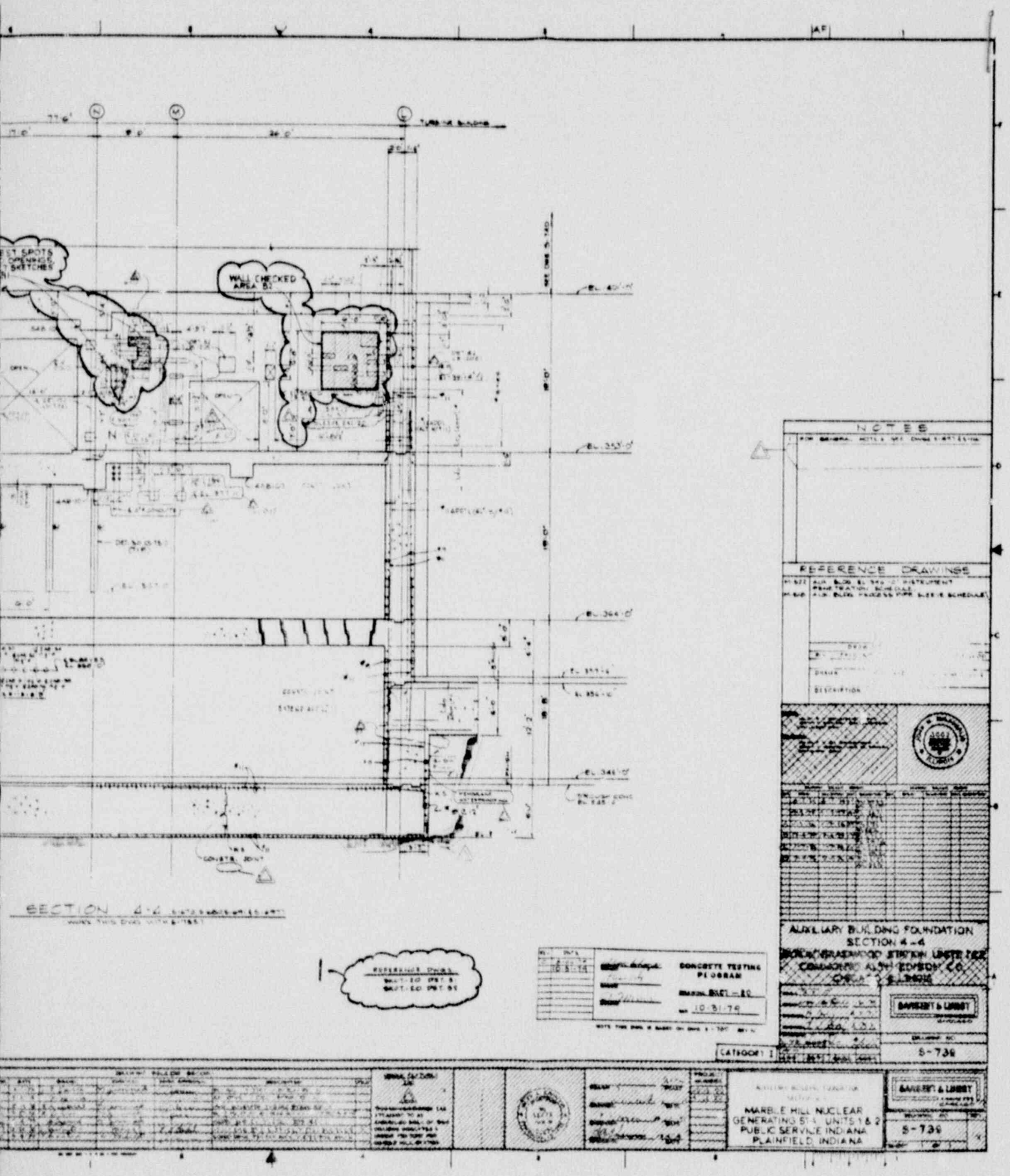
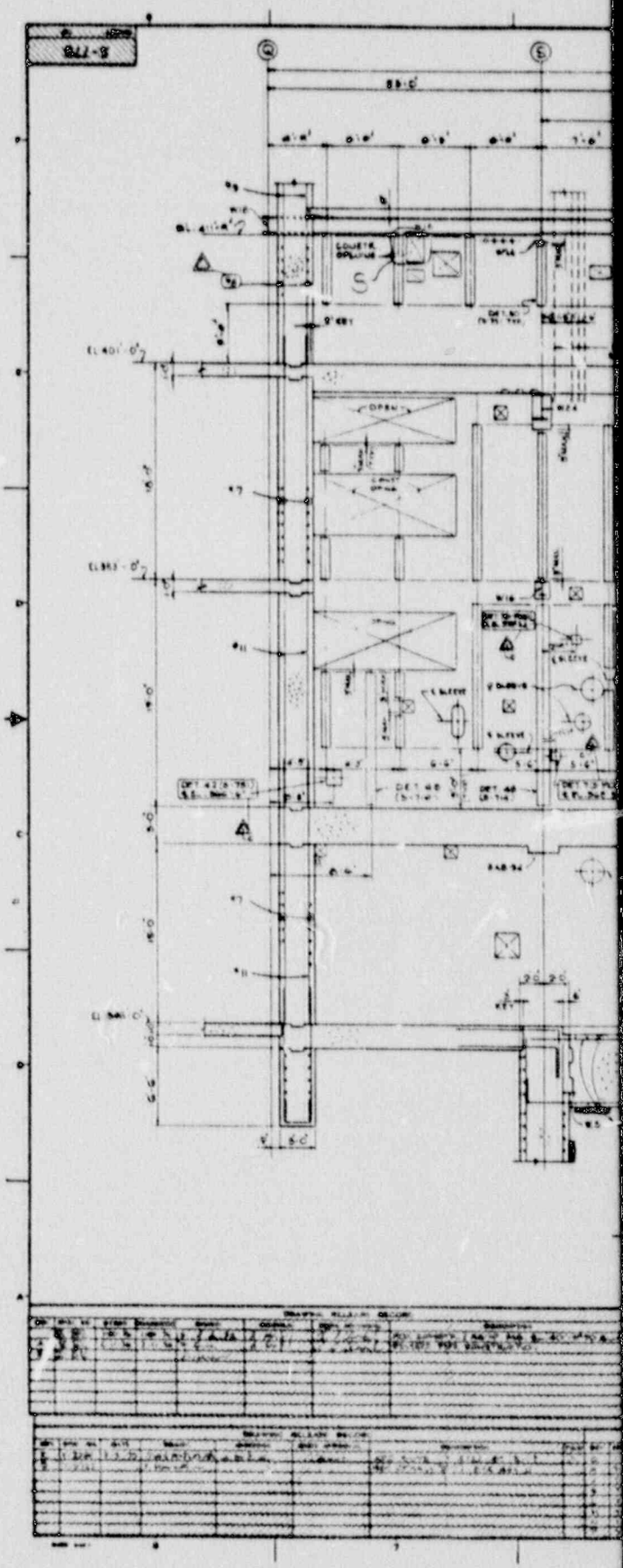
SL-3753
11-20-79





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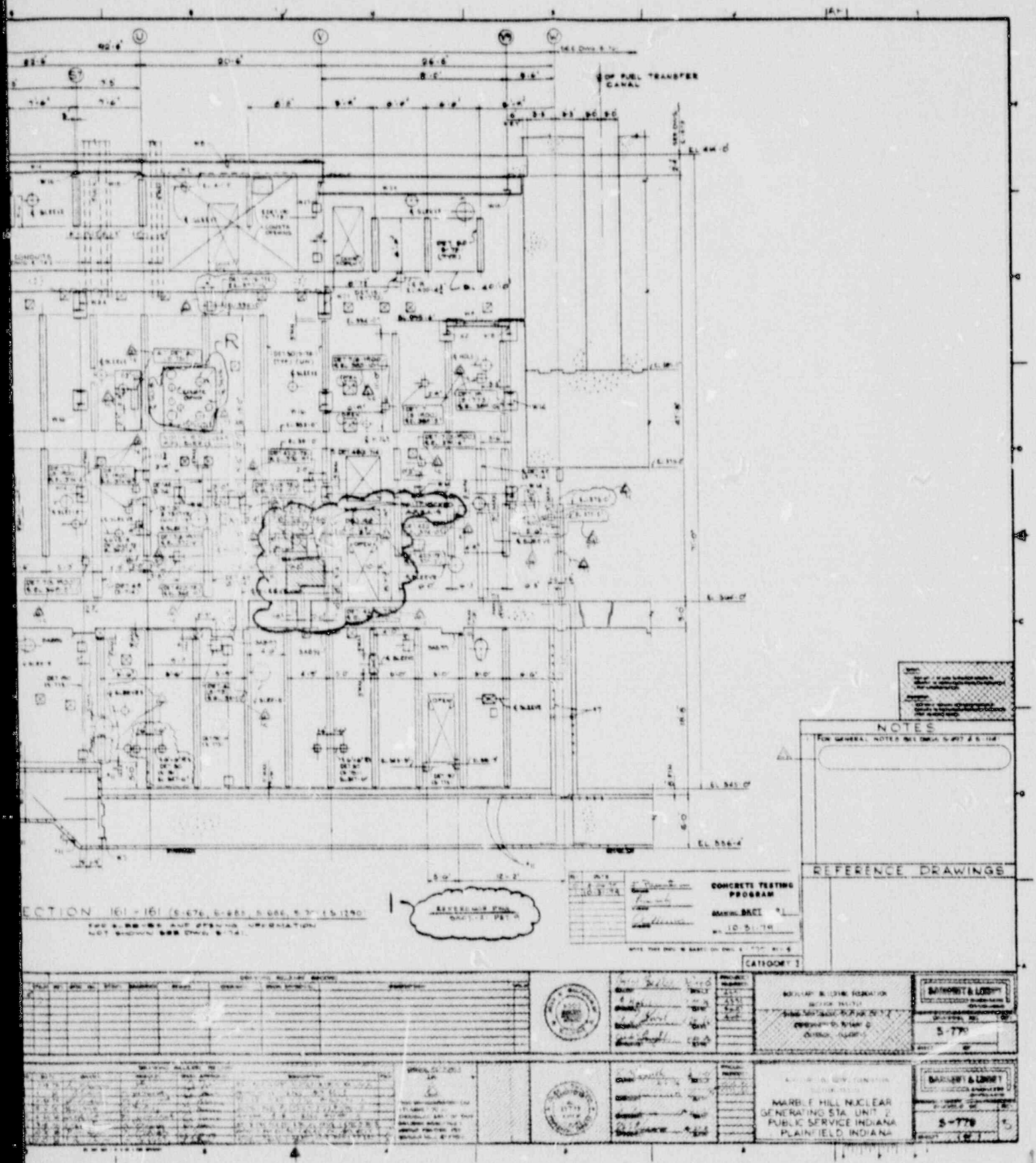
SL-3753
11-20-79



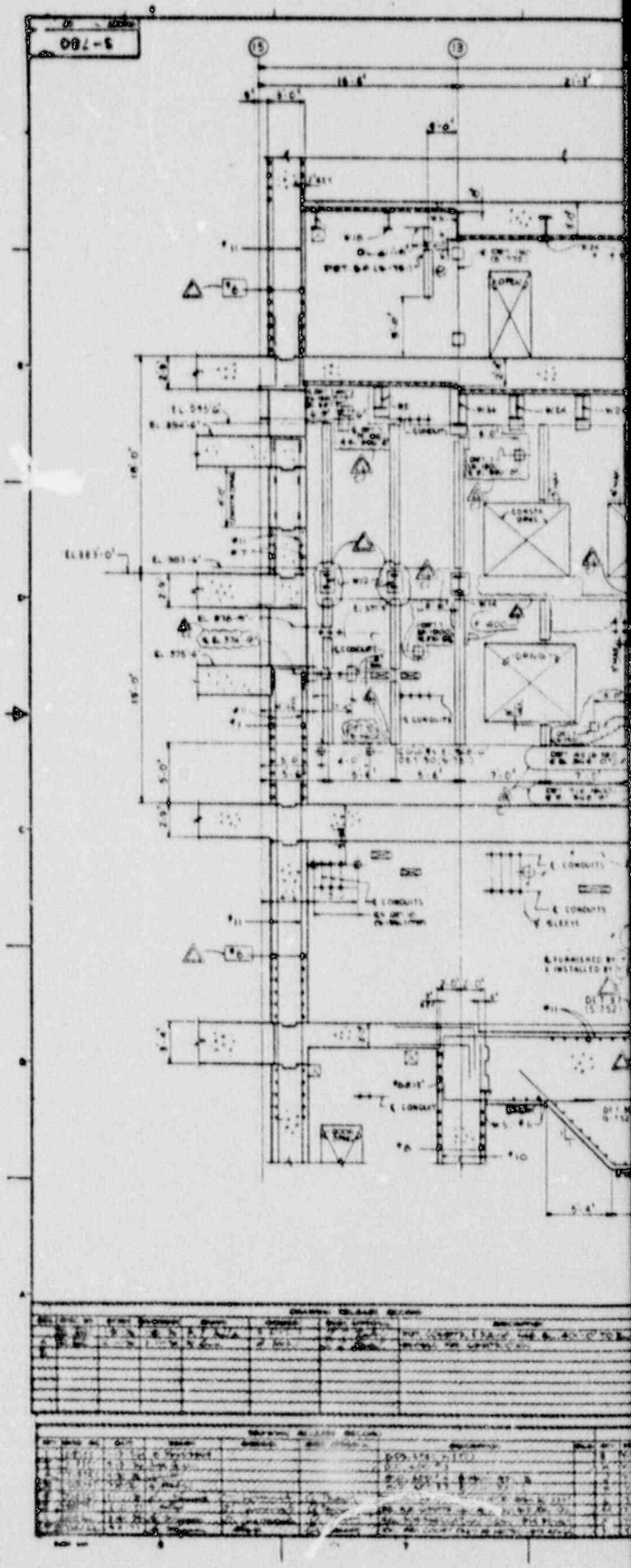
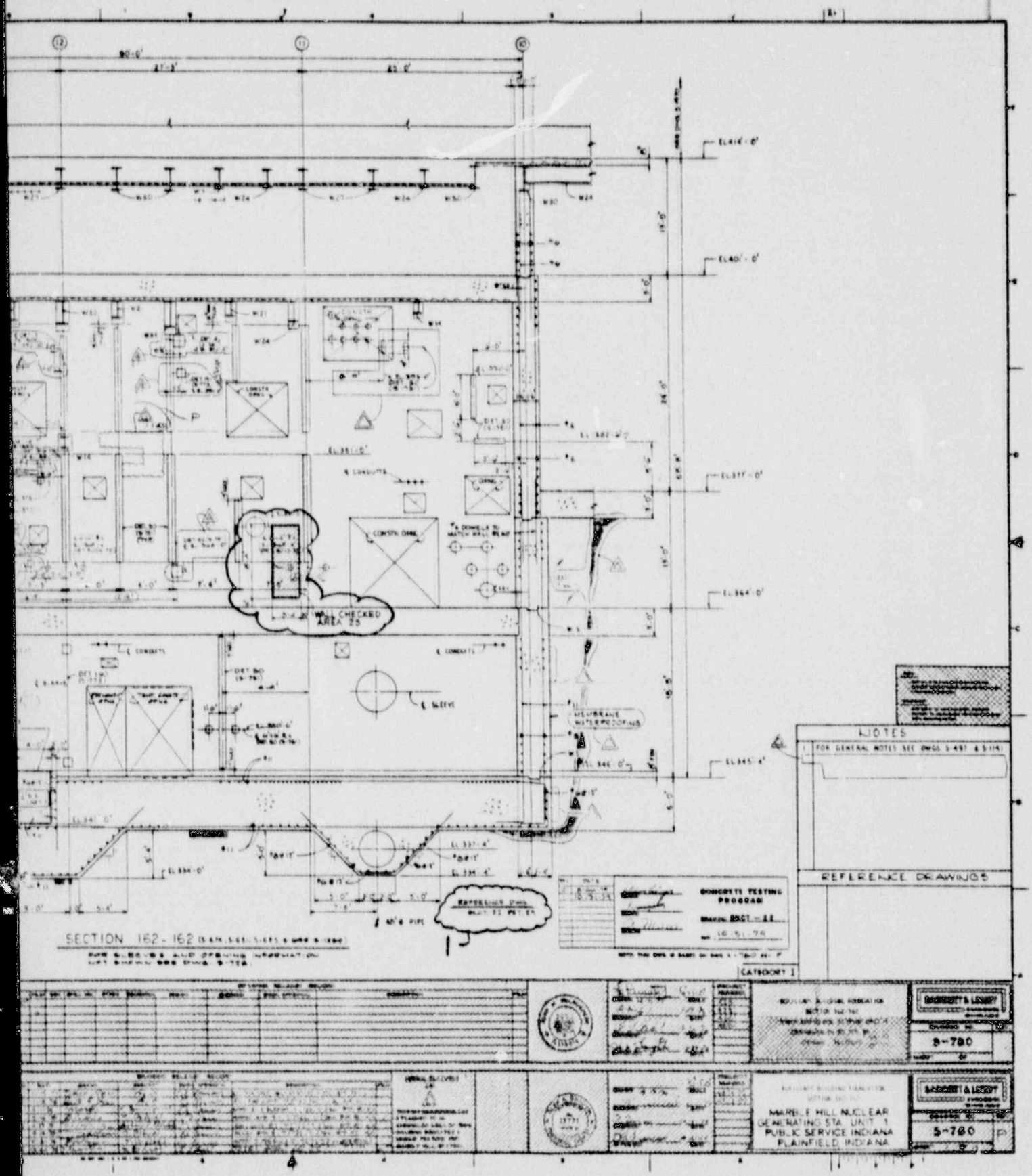


EXHIBIT 2
SL-3753
11-20-79



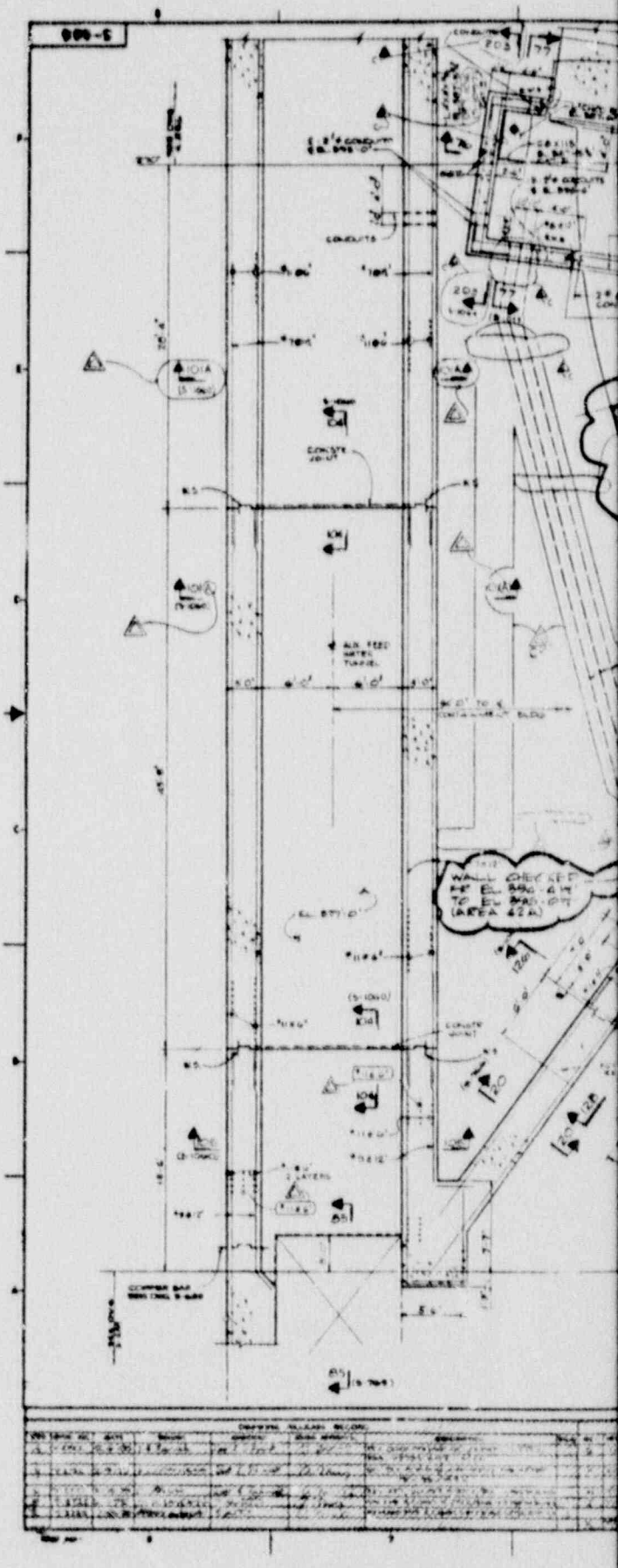
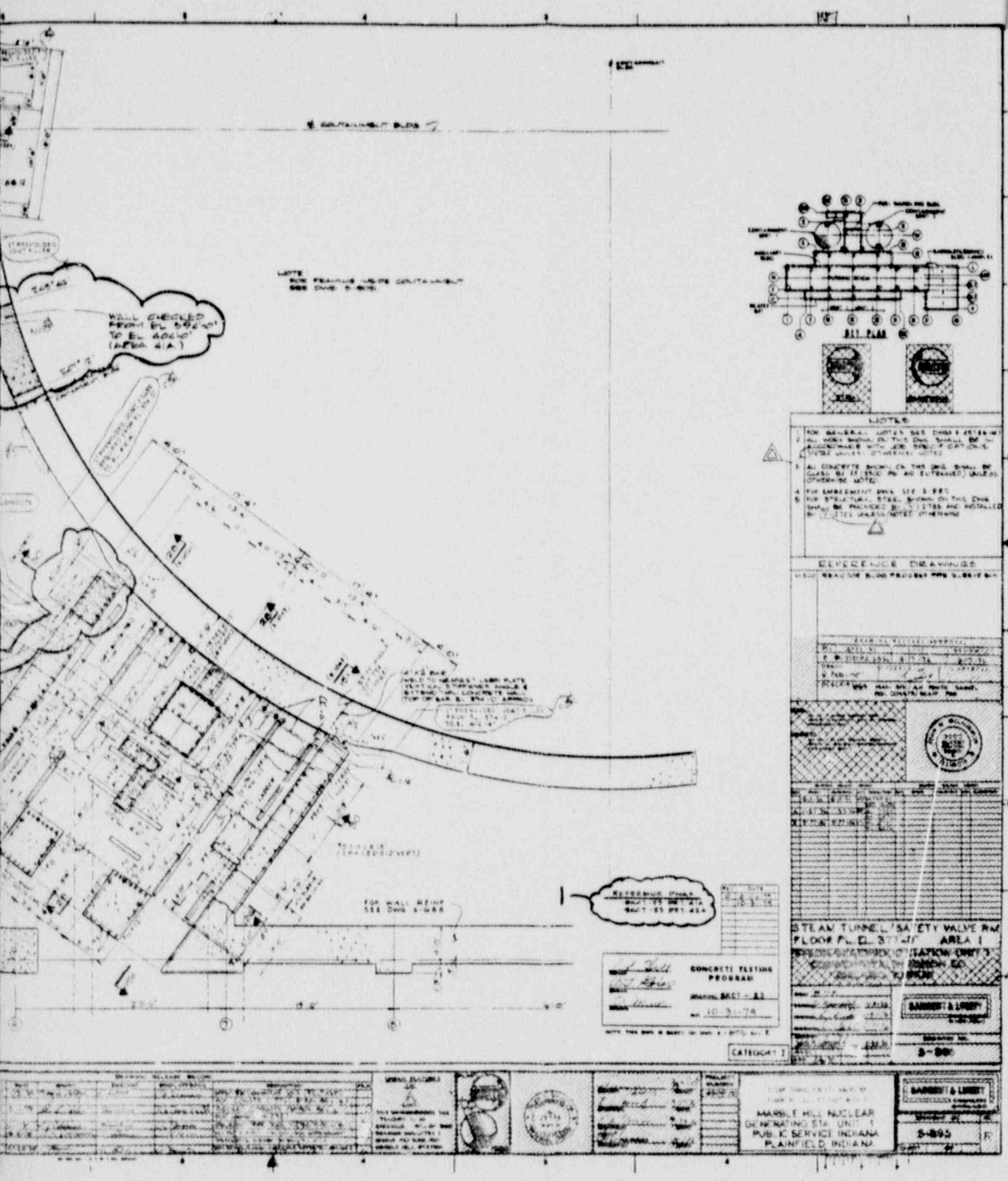


EXHIBIT 2
SL-3753
11-20-79



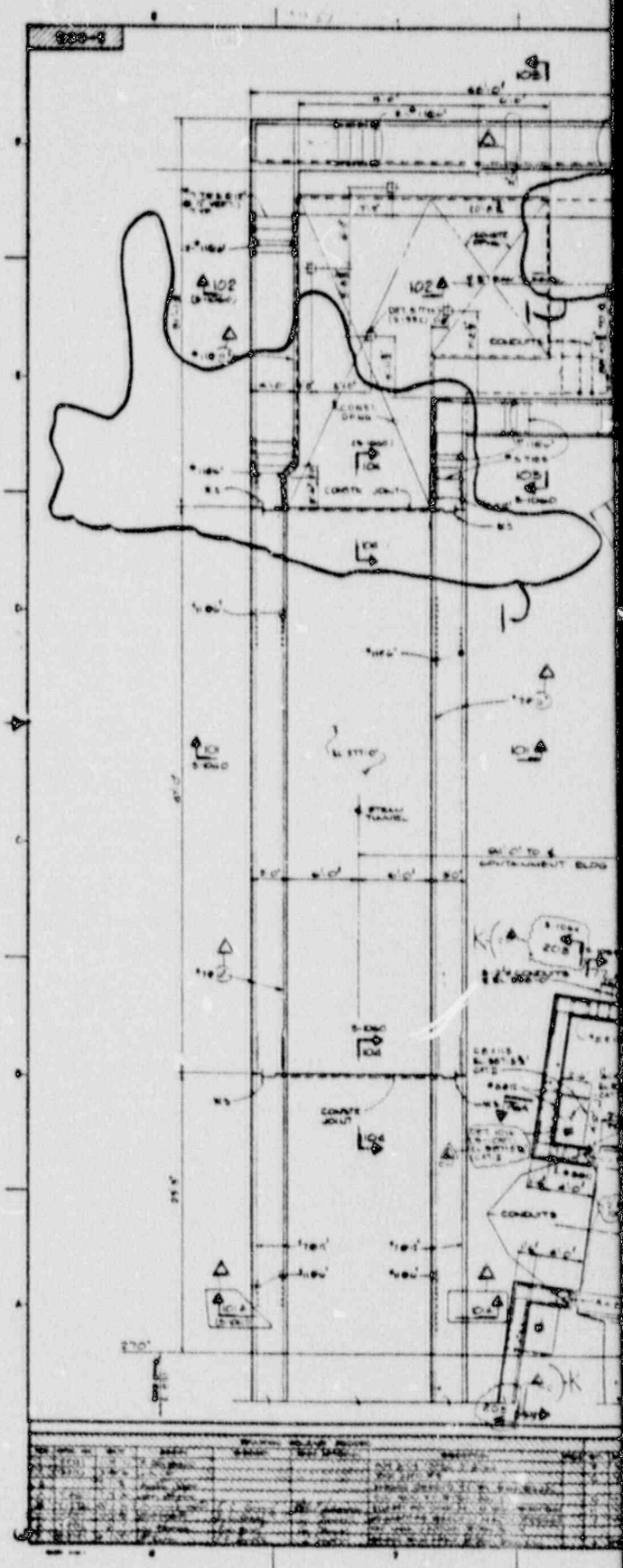
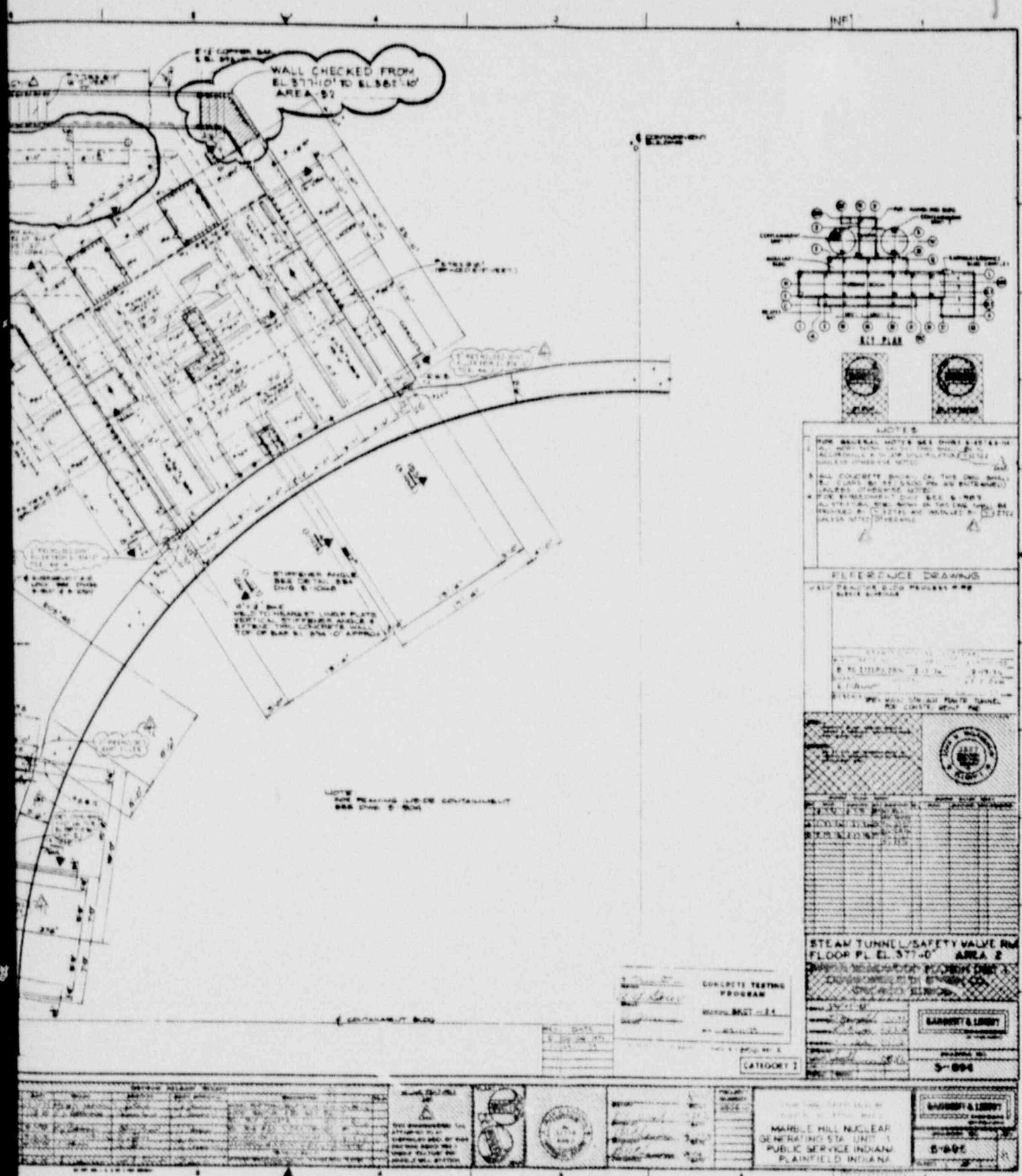
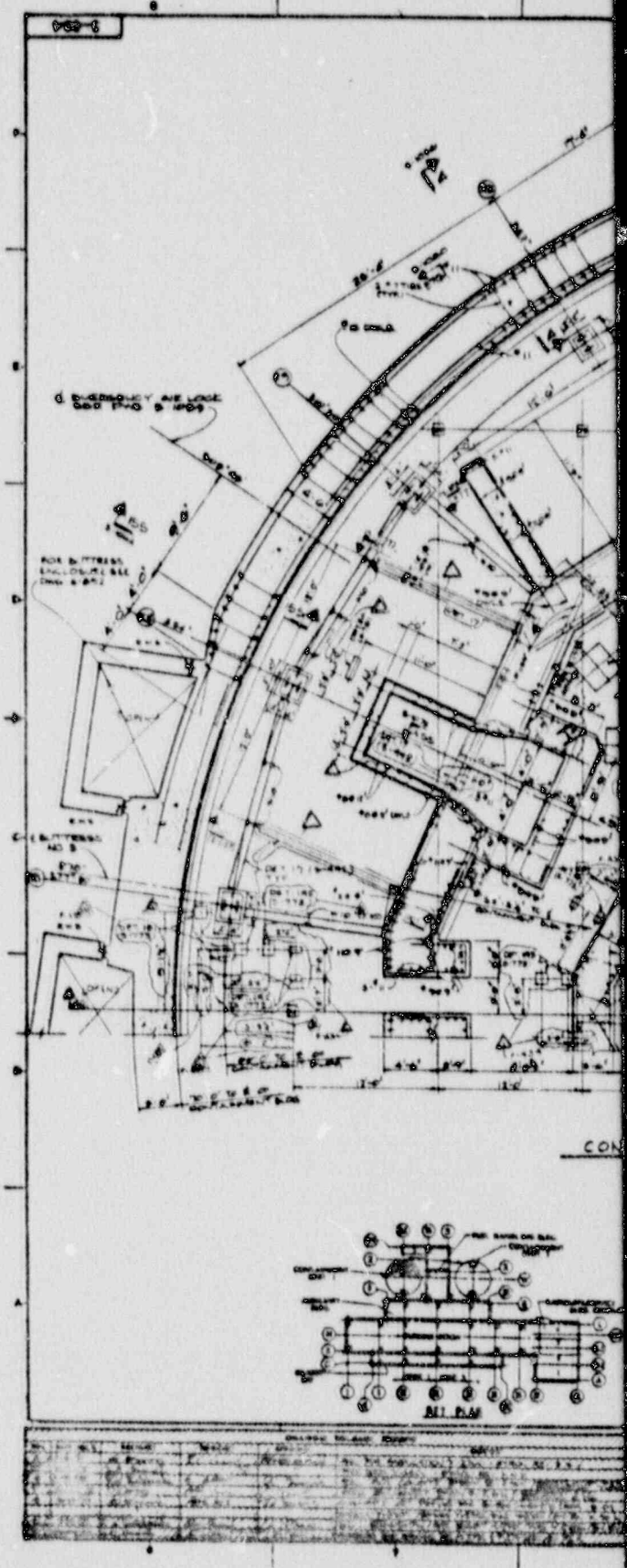


EXHIBIT 2
SL-3756
11-20-79





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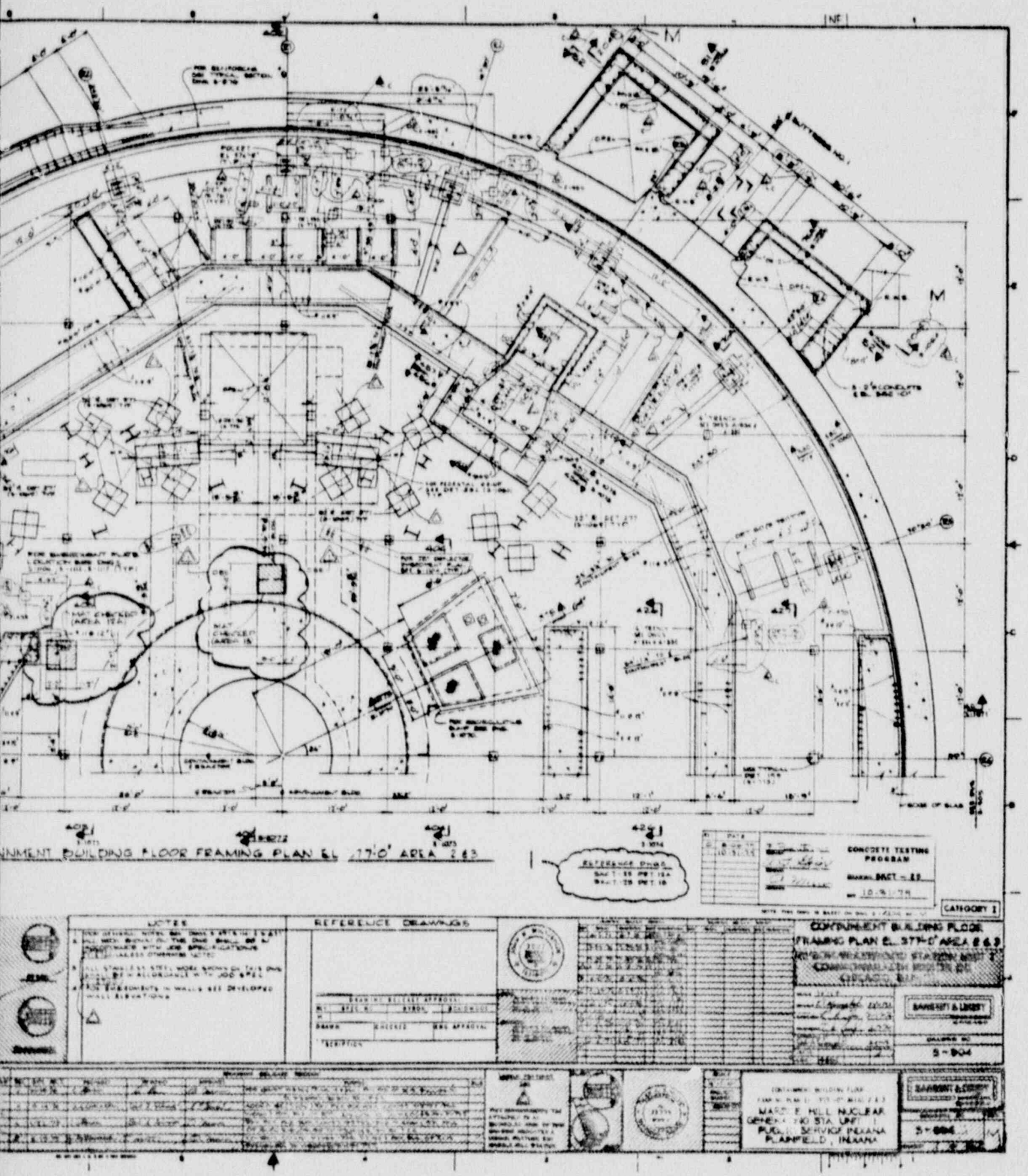
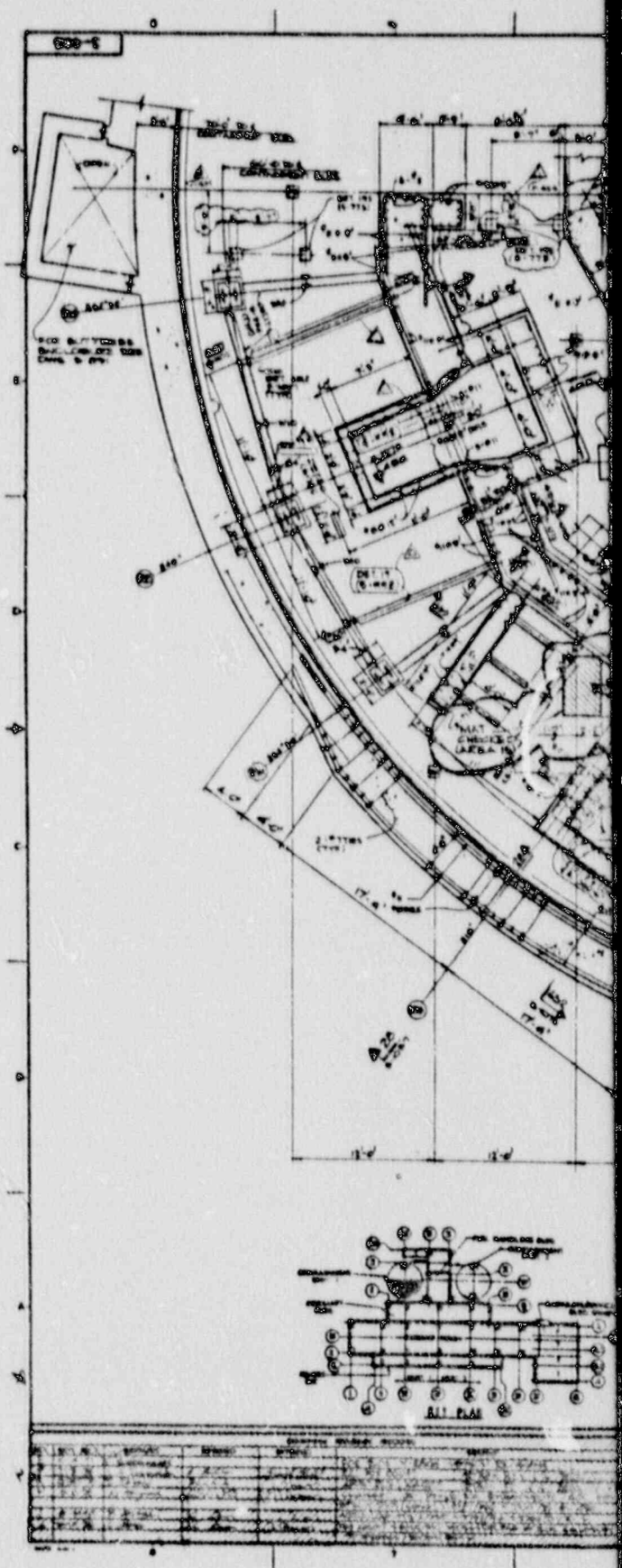
SL-3753
11-20-79





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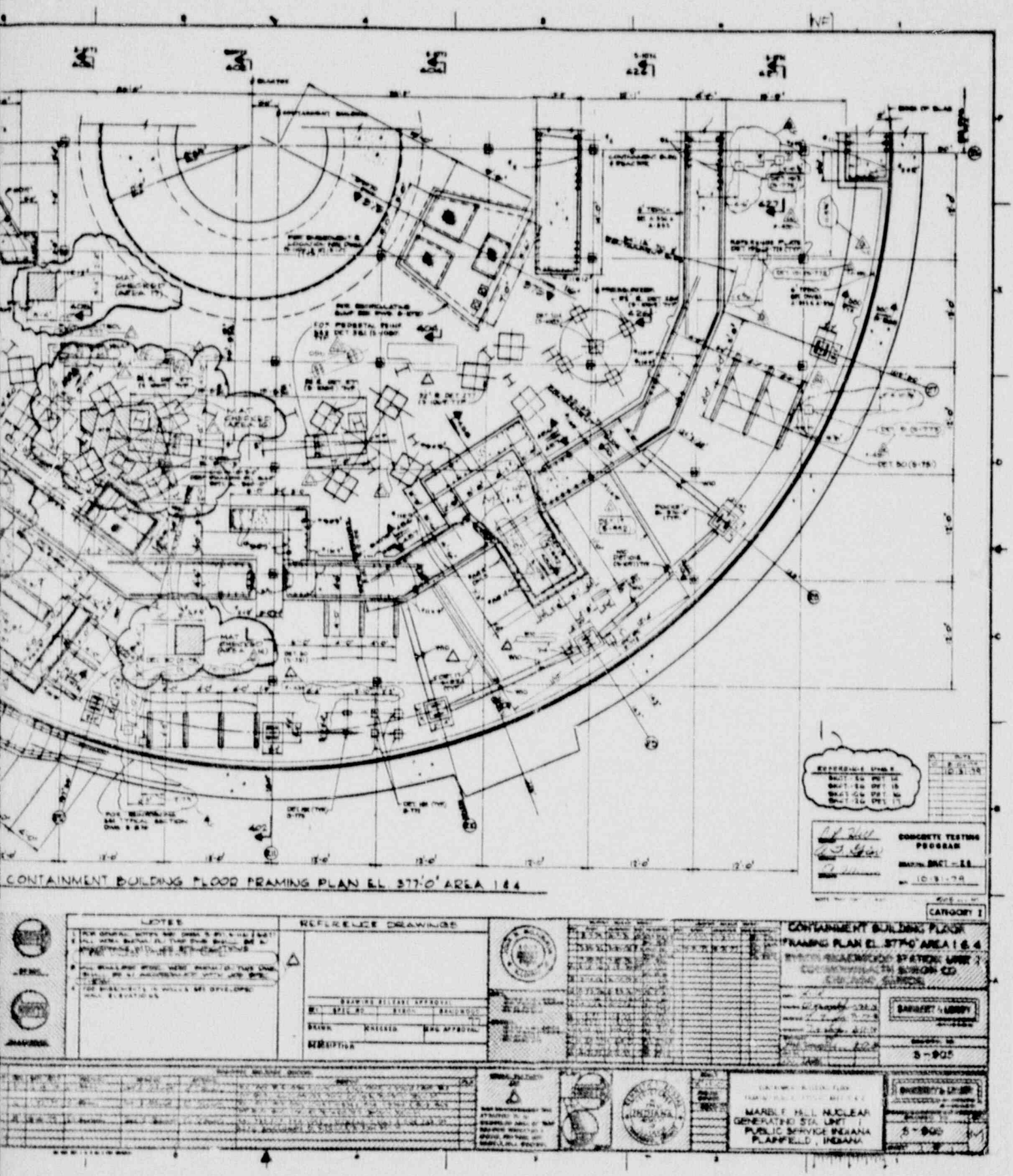
11-20-79



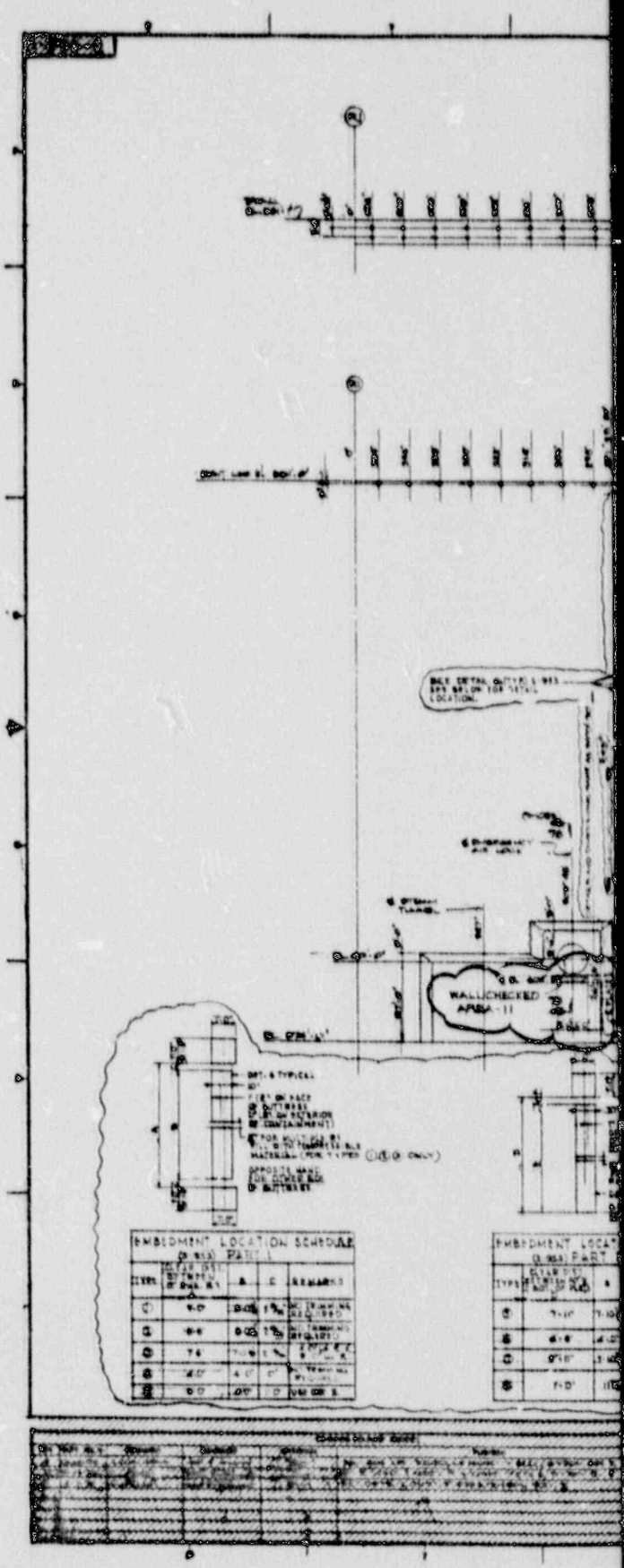
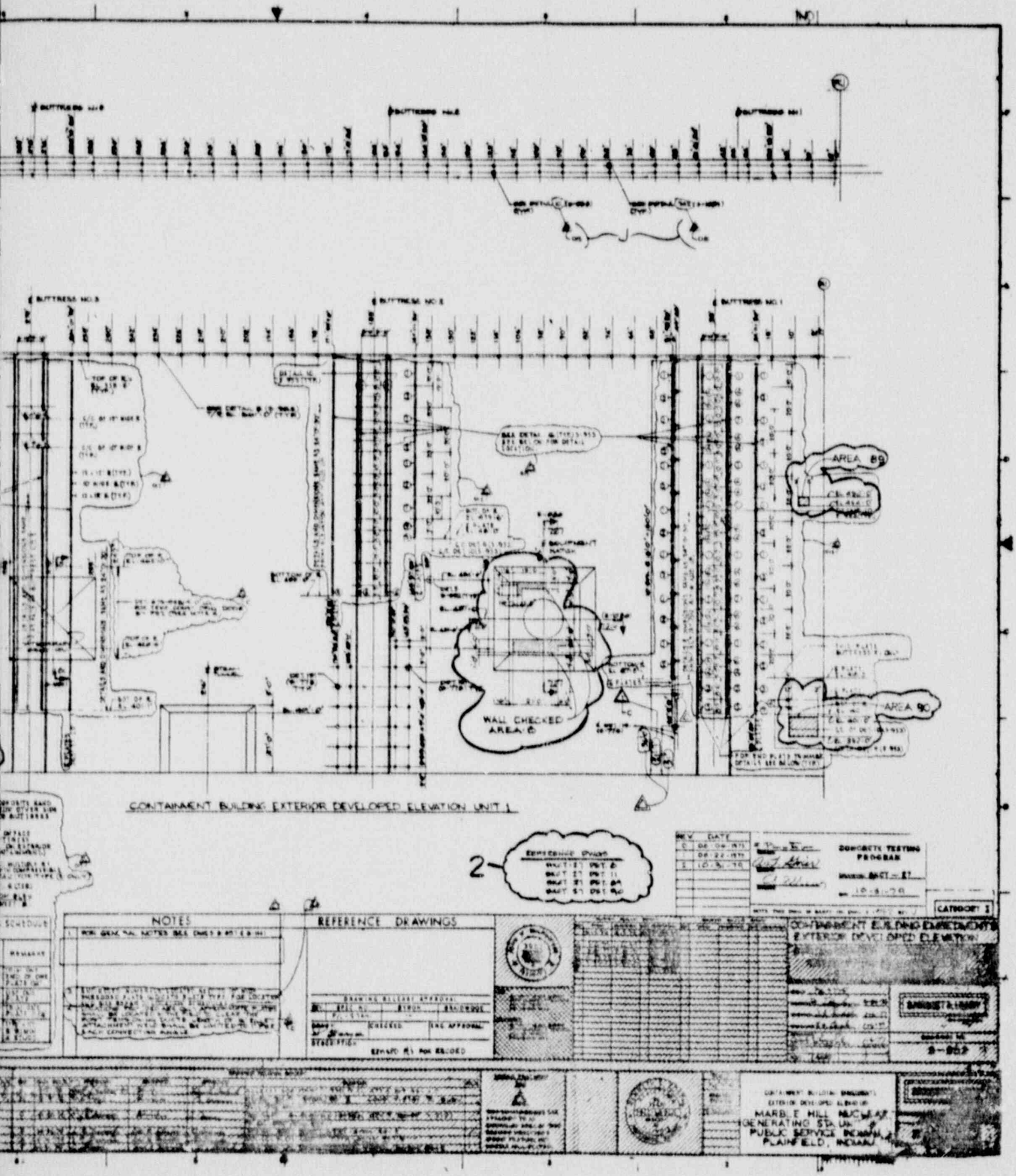

WALL CHECKED
AREA - II
EMBEDMENT LOCATION SCHEDULE
EMBEDMENT LOCATION SCHEDULE

EXHIBIT 2
SL-3753
11-20-79



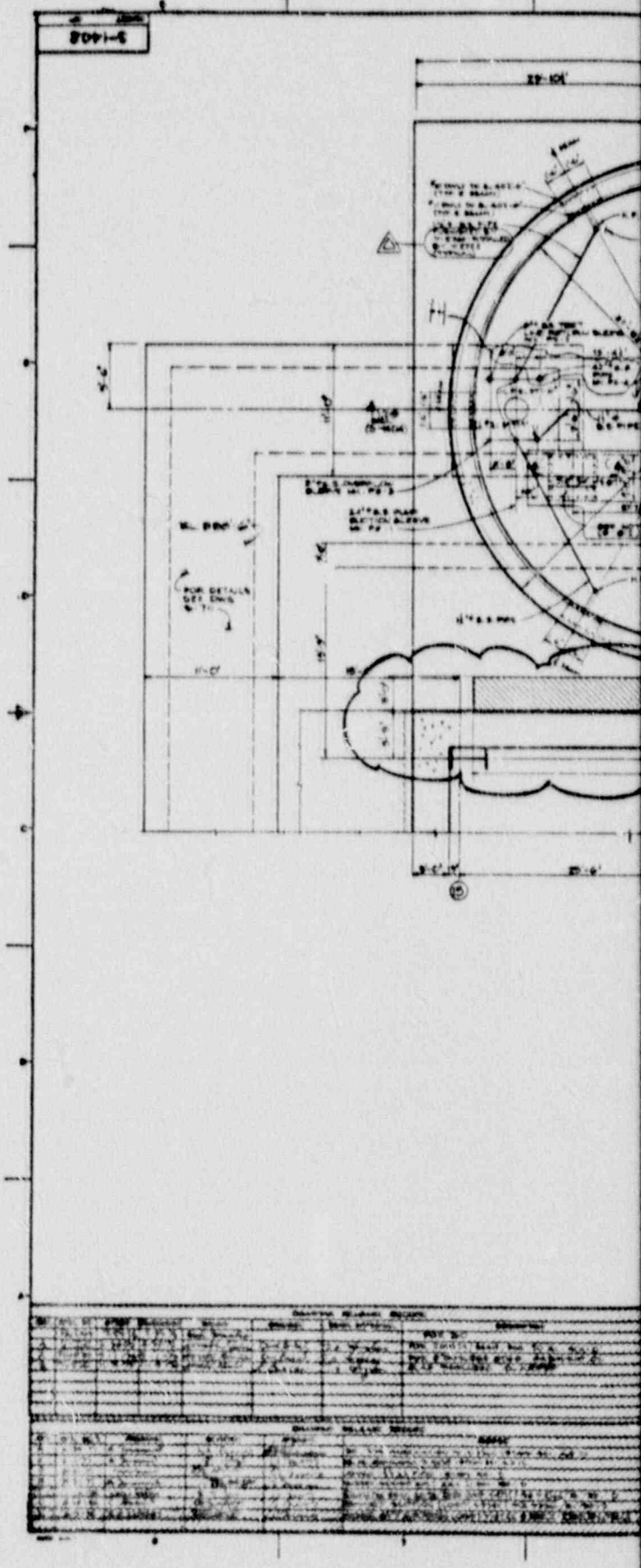
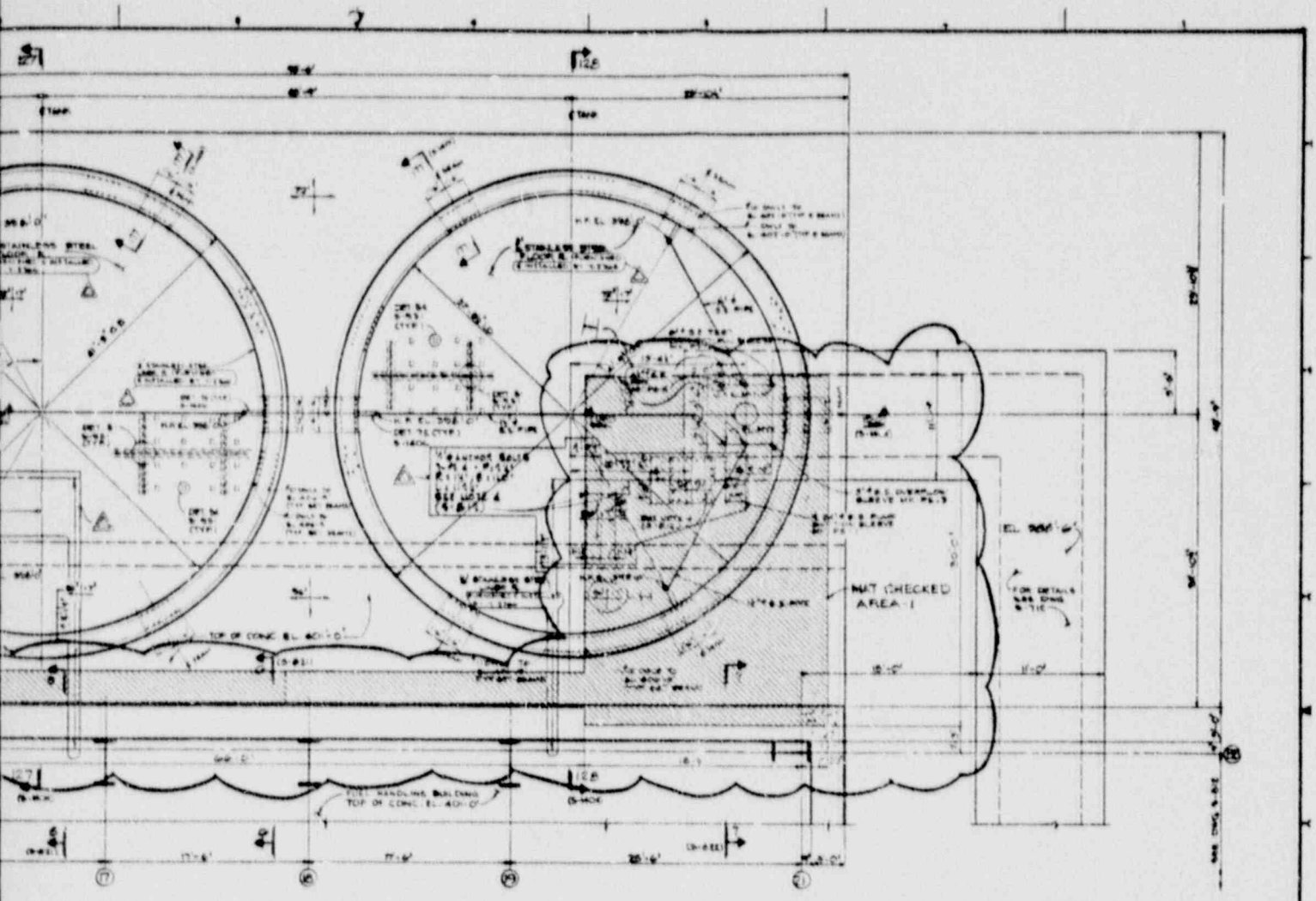
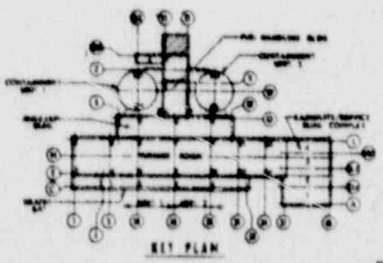


EXHIBIT 2
SL-3753
11-20-79



REFUELING WATER STORAGE TANK FOUNDATION PLAN



NOTES

REFERENCE DRAWINGS

CONCRETE TESTING PROGRAM

CATEGORY I

MARBLE HILL NUCLEAR GENERATING STA. UNITS 1 & 2
PUBLIC SERVICE INDIANA
PLAINFIELD, INDIANA

BARGERT & LESSEY

S-1402

S-1403

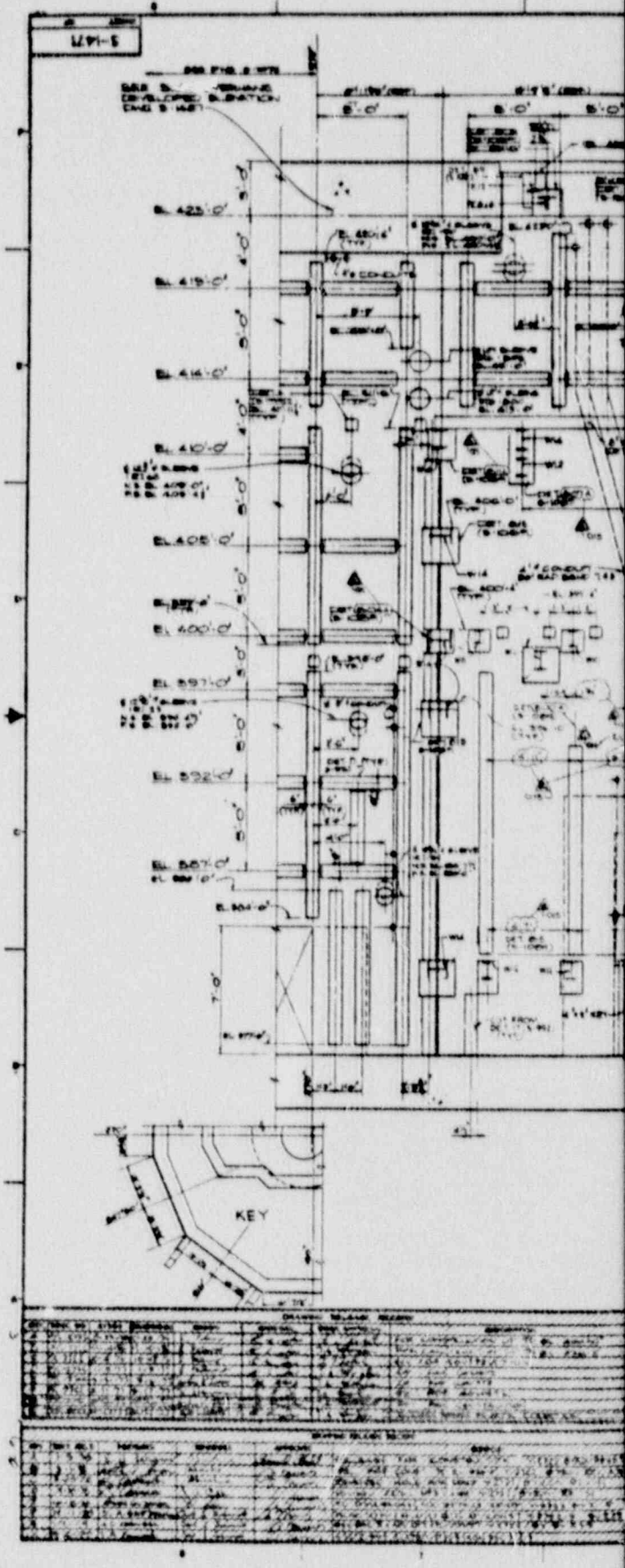

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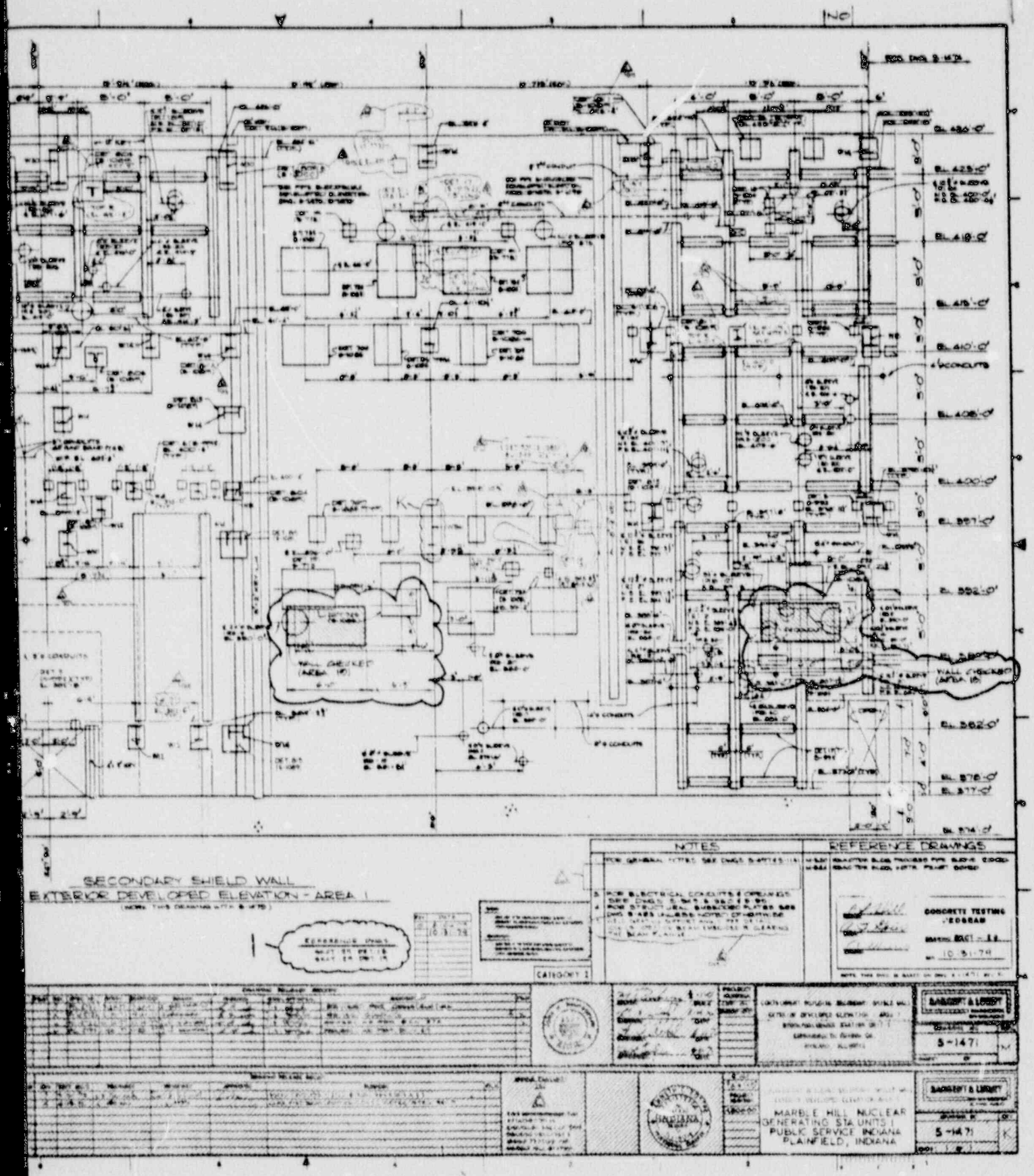
EXHIBIT 2
SL-3753
11-20-79



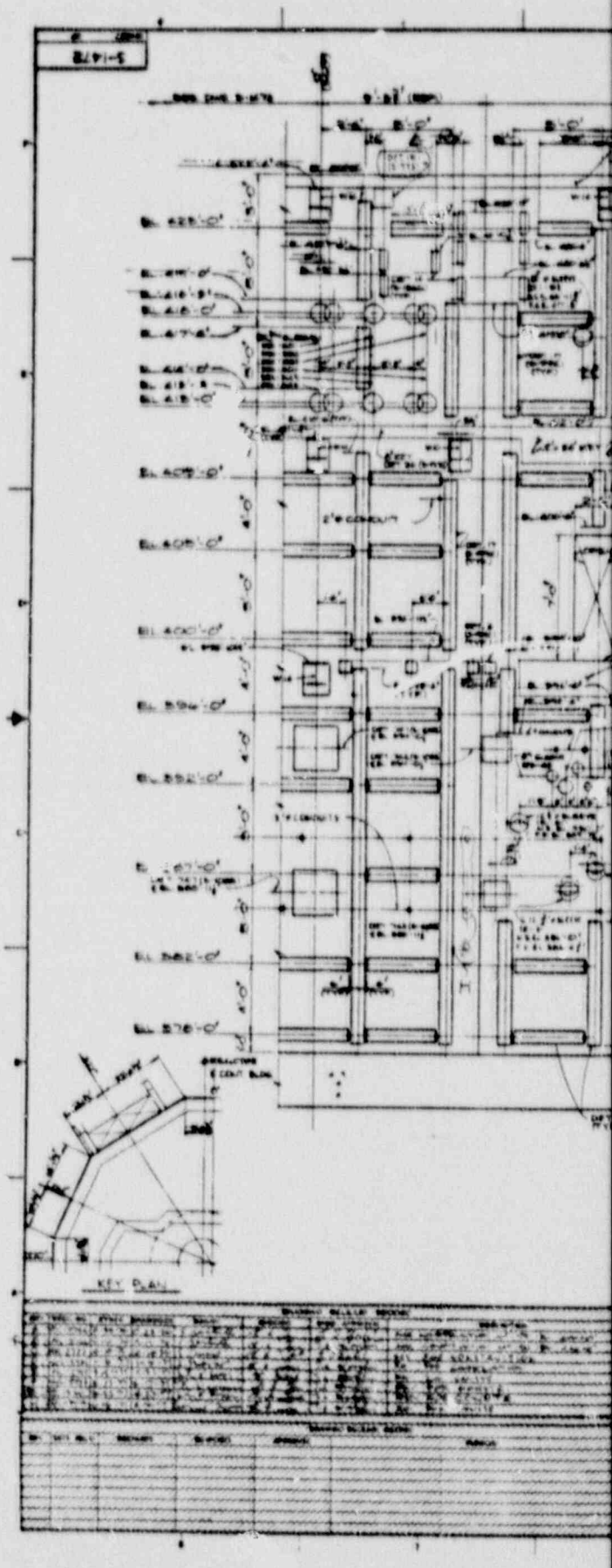
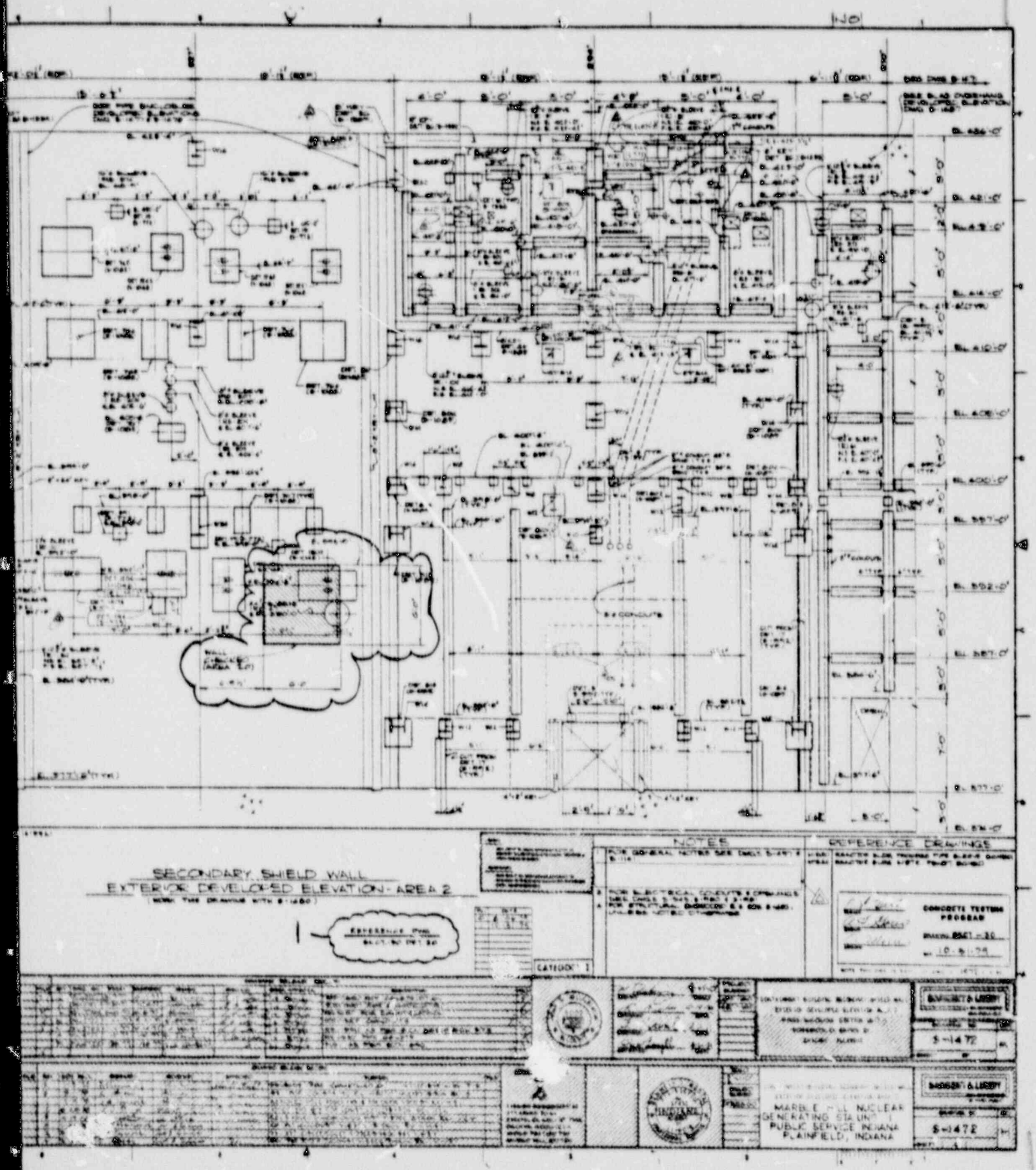

KEY PLAN

EXHIBIT 2
SL-3753
11-20-79



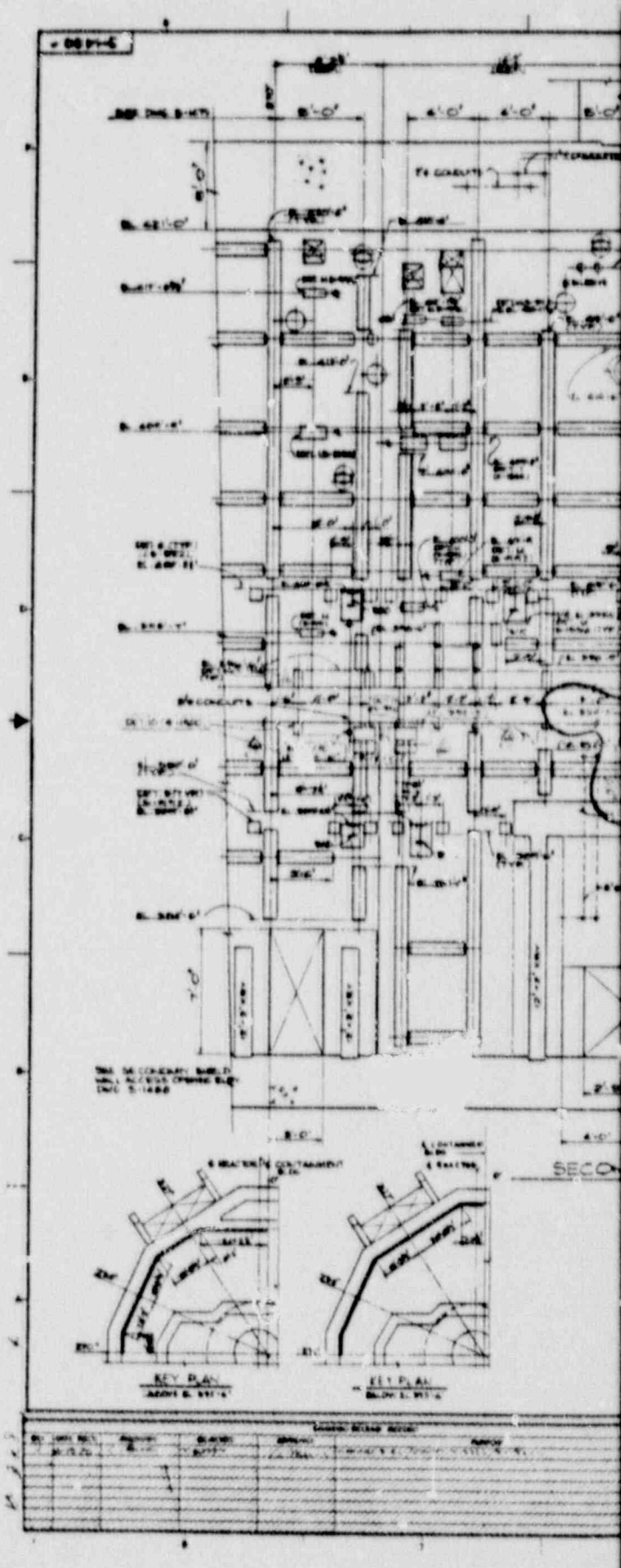
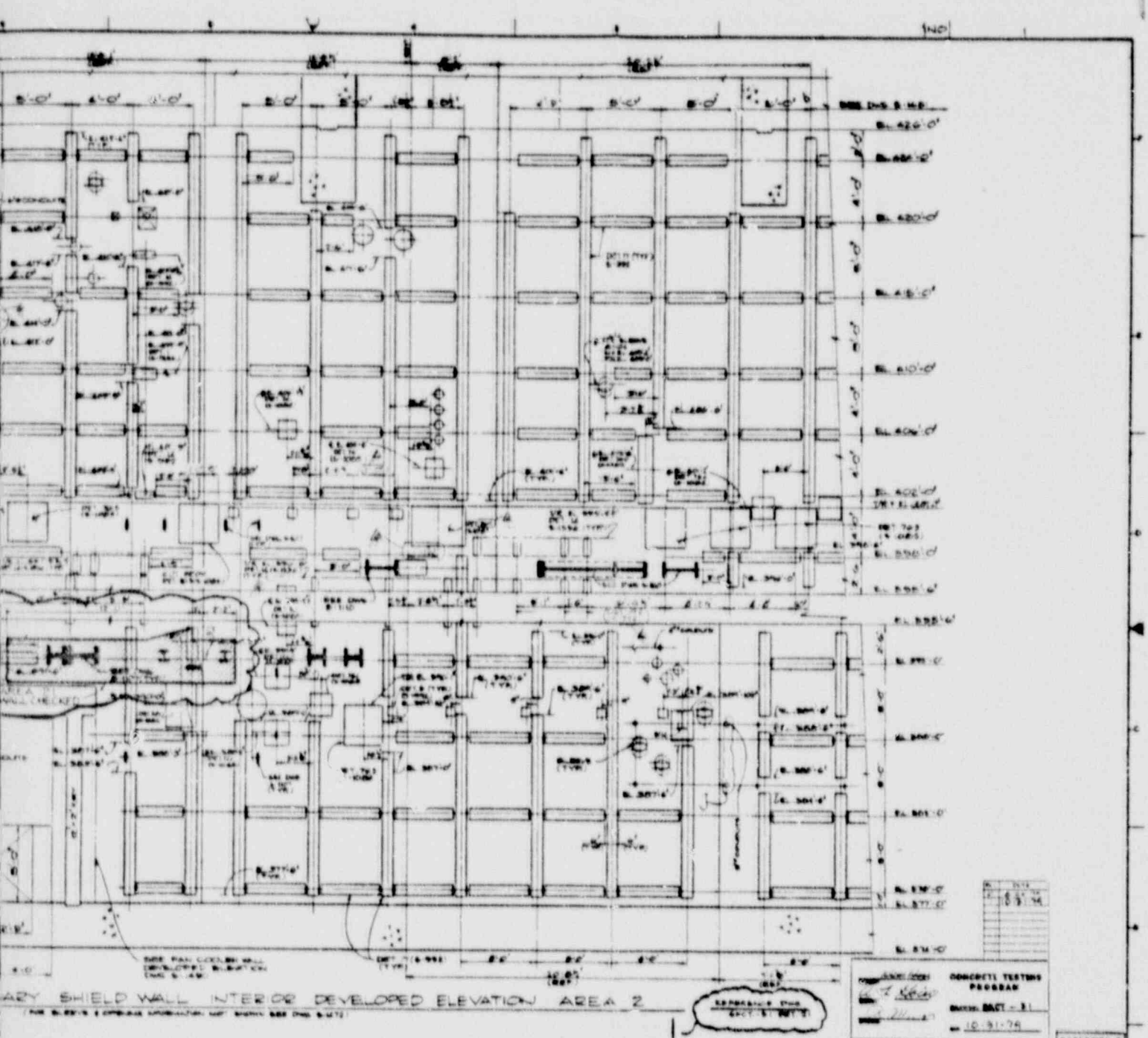


EXHIBIT 2
SL-3753
11-20-79



ARY SHIELD WALL INTERIOR DEVELOPED ELEVATION AREA 2

CONCRETE TESTING PROGRAM

NOTES

REFERENCE DRAWINGS

CONTAINMENT BLDG. SECONDARY SHIELD WALL INT. DEVELOPED ELEV. AREA 2

CATEGORY I

BARGENT & LOISEY

S-1480

MARBLE HILL NUCLEAR GENERATING STATION UNIT 1
PUBLIC SERVICE INDIANA
PLAINFIELD, INDIANA

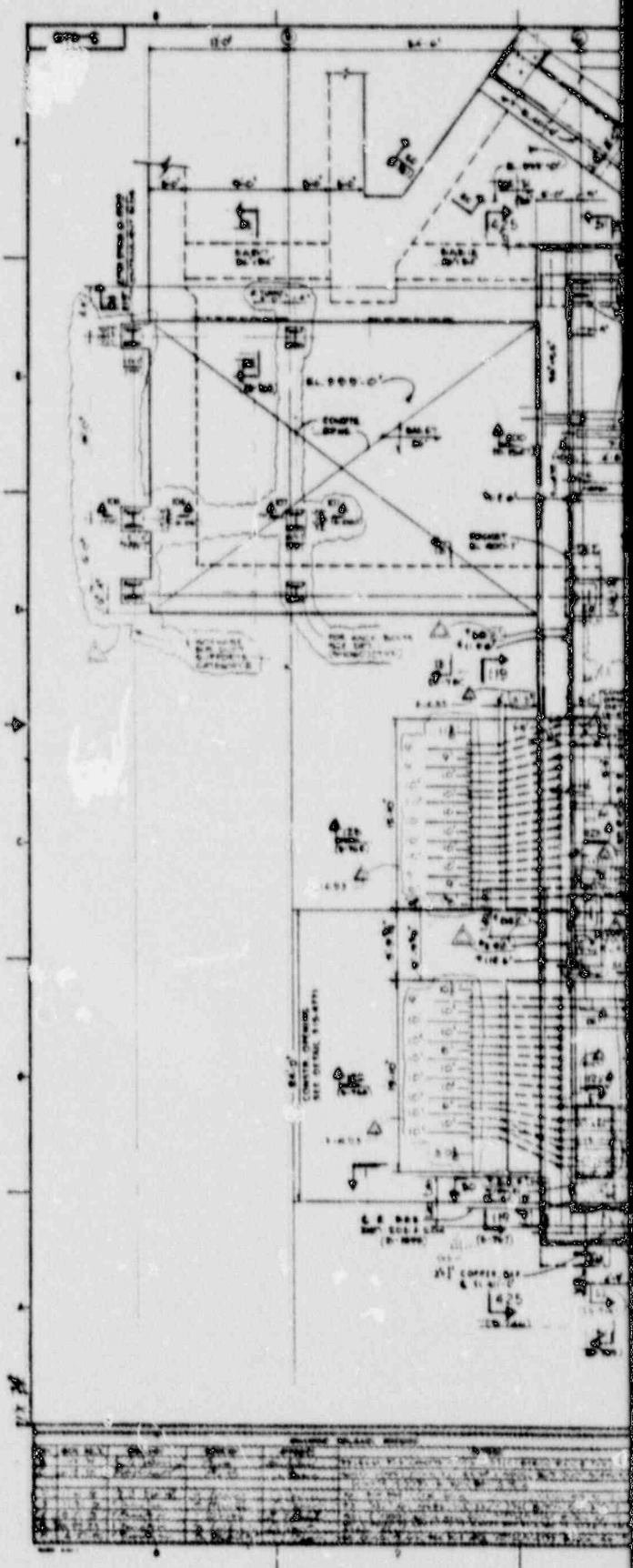
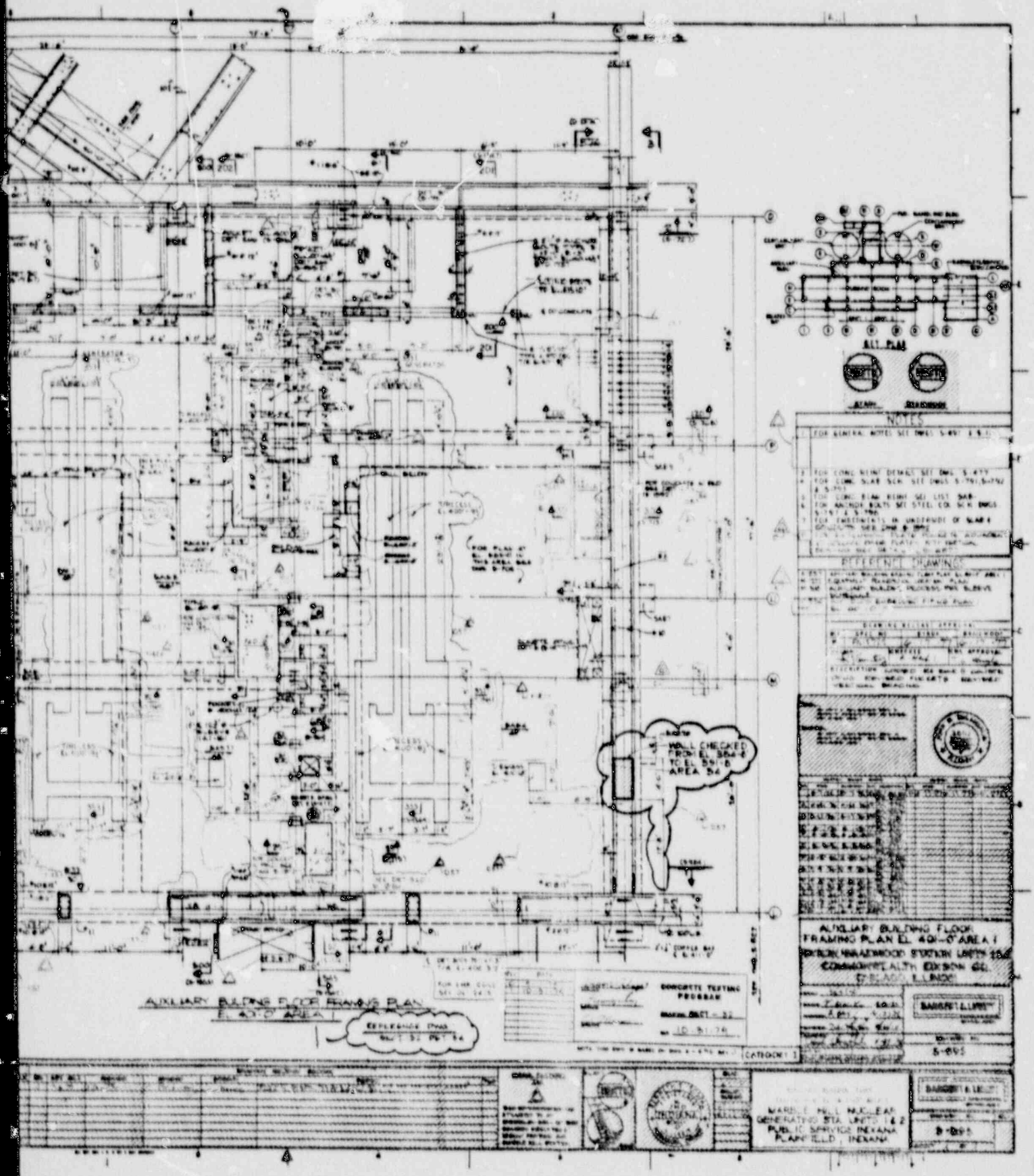


EXHIBIT 2
SL-3753
11-20-79



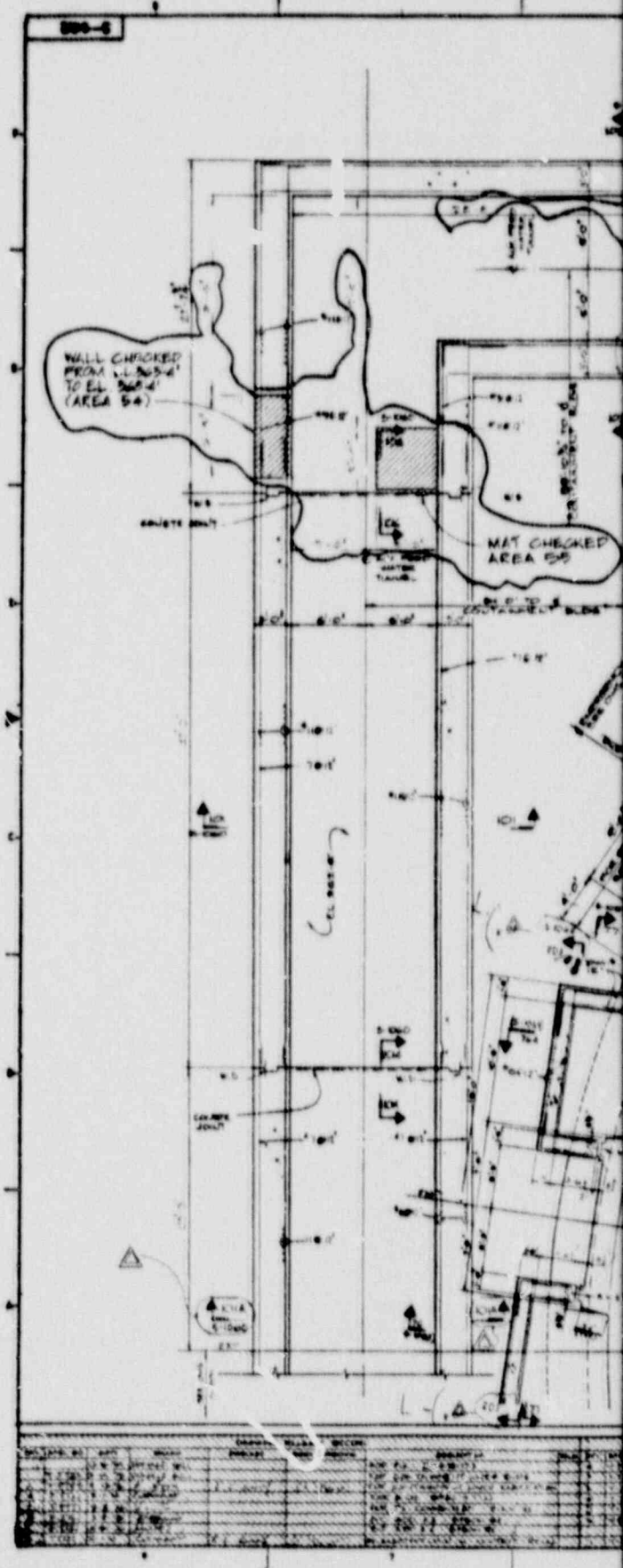

WALL CHECKED
AREA 54
MAT CHECKED
AREA 54

EXHIBIT 2
SL-3753
11-20-79

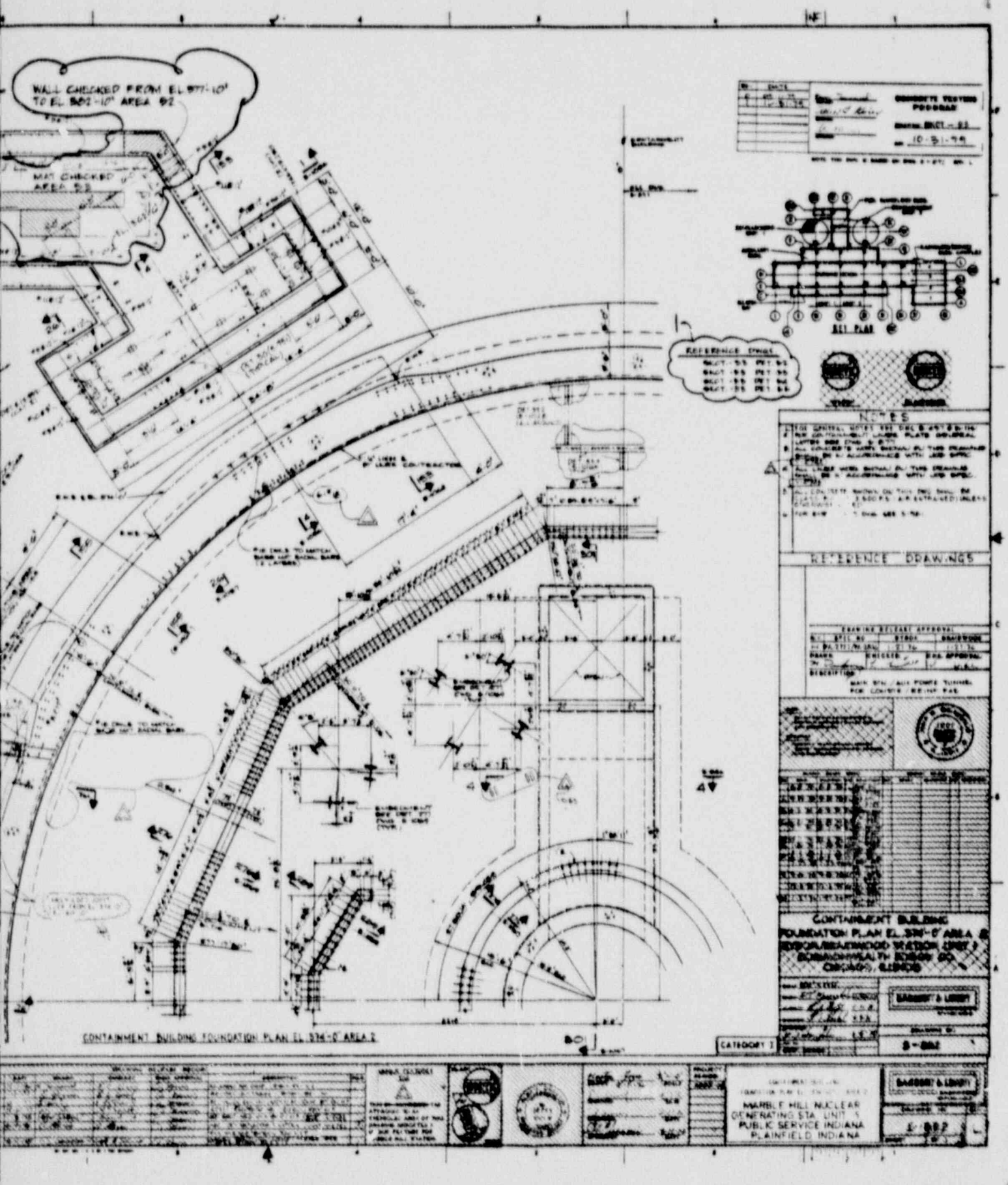


EXHIBIT 3
SL-3753
11-20-79

PORTLAND CEMENT ASSOCIATION REPORT

SELF-CONTAINED DOCUMENT
(SEE VOLUME II)

EXHIBIT J
SL-3753
11-20-79

LIST OF TEST AREAS

The following table gives the location and type (congested location or uncongested location) of test areas and the type and details of nondestructive examinations performed.

AREA	STATUS ⊛	CATEGORY OF CONC.	DWG. NO.	METHOD OF TESTING	DATE TESTED	C/U ▲	REMARKS	Location	BLDG ■
1	O.K.	I	S-1402 SKCT-28	Pulse Echo	6-27-79	C	36" Grid	Floor Slab El.401'-8"	A
2	O.K.	II	S-514 SKCT-1	Pulse Echo	6-27-79	C	9" Grid	Floor Slab El.368'-4"	T
3	O.K.	I	S-670 SKCT-6	Pulse Echo	6-28-79	C	36" Grid	Floor Slab El.329'-4"	A
4	E	I	S-674 SKCT-9	Pulse Echo	7-17-79	C	36" Grid	Floor Slab El. 345'	A
5	E	I	S-674 SKCT-9	Pulse Echo	7-17-79	C	20" Grid	Wall El. 346'	A
6	O.K.	I	S-673 SKCT-8	Pulse Echo	6-28-79	C	20" Grid Rechecked 7-07-79	Wall El. 346'	A
7	O.K.	I	S-673 SKCT-8, 11	Pulse Echo	6-28-79	C	20" Grid Partial Rechecked 7-07-79 Finished 7-17-79	Wall El. 346'	A
8	E	I	S-952 SKCT-27	Pulse Echo	6-28-79	C	36" Grid	Equipment Hatch	C
9	E	I	S-779 SKCT-21	Pulse Echo	6-29-79	C	20" Grid	Wall El. 364'	A
10	O.K.	I	S-688 SKCT-14	Pulse Echo	6-29-79	U	13" Grid	Wall El.373'-6"	A
11	O.K.	I	S-952 SKCT-27	Pulse Echo	7-06-79	C	30" Grid Wall	Ext. Wall under Em. Air Lock #7	C

E = Explainable; Q = Questionable; O.K. = Acceptable

▲ C: CONGESTED LOCATION
U: UNCONGESTED LOCATION

■ C: CONTAINMENT A: AUXILIARY BLDG.
T: TURBINE ROOM

SARGENT & LUNDY ENGINEERS

Client P.S.I.
Project MARBLE HILL
Proj. No 4808 / 4923

LIST OF TEST AREAS

Calc No —
Rev — Date —
Page 1 of 6

EXHIBIT 4
SL-3753
11-20-79

AREA	STATUS ⊛	CATEGORY OF CONC.	DWG. NO.	METHOD OF TESTING	DATE TESTED	C/U ▲	REMARKS	Location	BLDG. ■
12-A	O.K.	I	S-904 SKCT-25	Pulse Echo	7-20-79	U	20" Grid	Cont. #1 Floor Slab El 377'	C
13	E	I	S-904 SKCT-25	Pulse Echo	7-06-79	U	20" Grid	Cont. #1 Floor Slab El. 377'	C
14	O.K.	I	S-905 SKCT-26	Pulse Echo	7-06-79	U	20" Grid	Cont. #1 Floor Slab El. 377'	C
15	O.K.	I	S-905 SKCT-26	Pulse Echo	7-06-79	U	20" Grid	Cont. #1 Floor Slab El. 377'	C
16	E	I	S-905 SKCT-26	Pulse Echo	7-06-79	C	20" Grid	Cont. #1 Floor Slab El. 377'	C
17	Q	I	S-905 SKCT-26	Pulse Echo	7-06-79	U	20" Grid	Cont. #1 Floor Slab El. 377'	C
18	O.K.	I	S-1471 SKCT-29	Pulse Echo	7-06-79	C	36" Grid	Cont.#1Sec Sh. Wall El. 392'	C
19	O.K.	I	S-1471 SKCT-29	Pulse Echo	7-06-79	C	36" Grid	Cont.#1Sec El. 392'-6"	C
20	O.K.	I	S-1472 SKCT-30	Pulse Echo	7-06-79	C	36" Grid	Cont.#1Sec El. 395'	C
21	O.K.	I	S-1480 SKCT-31	Pulse Echo	7-20-79	C	36" Grid	Cont.#1Sec (Int. Face) El.395'-3"	C
22	O.K.	I	S-674 SKCT-9	Pulse Echo	7-17-79	U	Core per Stewart Mech. RFI 454 One Point on Core 454A 13" Grid	Floor Slab El. 346'	A

E = Explainable; Q = Questionable; O.K. = Acceptable

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■ C: CONTAINMENT T: TURBINE ROOM A: AUXILIARY BLDG.

SARGENT & LUNDY ENGINEERS

Client P.S.I.
Project MARBLE HILL
Proj. No 4808 / 4923

LIST OF TEST AREAS

Calc No -
Rev - Date -
Page 2 of 6

EXHIBIT 4
SL-3753
11-26-79

AREA	STATUS ⊛	CATEGORY OF CONC.	DWG. NO.	METHOD OF TESTING	DATE TESTED	C/U ⚠	REMARKS	Location	BLDG. ▣
23	Q	I	S-676 SKCT-11	Pulse Echo	7-07-79	U	Core per Stewart Mech. RFI 454 One point on ℄ Core 454B 13" Grid	Floor Slab El. 346'	A
24	E	I	S-676 SKCT-11	Pulse Echo	7-07-79	C	36" Grid	Floor Slab El.345'-9"	A
25	O.K.	I	S-731 SKCT-19	Pulse Echo	7-07-79	U	Core per Stewart Mech. RFI 456 One point on ℄ Core 456A 20" Grid	Wall El. 346'	A
26	O.K.	I	S-675 SKCT-10	Pulse Echo	7-07-79	U	Core per Stewart Mech. RFI 457 One point on ℄ Core 457A 20" Grid	Floor Slab El. 346'	A
27	O.K.	I	S-675 SKCT-10	Pulse Echo	7-07-79	U	Core per Stewart Mech. RFI 457 One point on ℄ Core 457B 20" Grid	Floor Slab El. 346'	A
28	E	I	S-739 SKCT-13	Pulse Echo	7-07-79	U	Variable Grid	Wall El. 346'	A
29	O.K.	I	S-780 SKCT-22	Pulse Echo	7-18-79	U	20" Grid	Wall El. 346'	A
30	Q	I	S-680 SKCT-13	Pulse Echo	7-18-79	U	13" Grid	Floor El. 346'	A
31	E	I	S-739 SKCT-20	Pulse Echo	7-07-79	C	No Grid	Wall El. 383'	A
32	O.K.	I	S-739 SKCT-20	Pulse Echo	7-07-79	C	20" Grid	Wall El. 383'	A
33	E	I	S-780 SKCT-16	Pulse Echo	7-06-79	U	20" Grid	Wall El 391'-6"	A

E = Explainable; Q = Questionable; O.K. = Acceptable

⚠ C: CONGESTED LOCATION U: UNCONGESTED LOCATION

▣ C: CONTAINMENT T: TURBINE ROOM A: AUXILIARY BLDG.

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Project MARBLE HILL
Proj. No 4808 / 4923

LIST OF TEST AREAS

Calc No —
Rev — Date —
Page 3 of 6

EXHIBIT 4
SL-3753
11-20-79

AREA	STATUS ⊛	CATEGORY OF CONC.	DWG. NO.	METHOD OF TESTING	DATE TESTED	C/U ▲	REMARKS	Location	BLDG. ■
34	O.K.	I	S-695 SKCT-32	Pulse Echo	7-07-79	U	12" Grid 52"H x 104"V	Wall El. 383'	A
35	Q	I	S-696 SKCT-16	Pulse Echo	7-06-79	U	20" Grid Col. 11	Beams #4.5 AB 17 & 18	A
36	Q	I	S-696 SKCT-16	Pulse Echo	7-06-79	U	20" Grid Col. 12	Beams #4.5 AB 23 & 24	A
37	O.K.	I	S-696 SKCT-17	Thru Transmission	7-21-79	C	No Grid	Column #5AB3, 5AB 39 & 40	A
38	O.K.	I	S-696 SKCT-17	Pulse Echo	7-18-79	U	9" Grid	Floor Slab El. 401'	A
39	O.K.	I	S-700 SKCT-18	Pulse Echo	7-18-79	C	20" Grid	Beam 5AB 92	A
40	E	I	S-688 SKCT-14	Pulse Echo	7-19-79	C	20" Grid	Fuel Tank Room Floor Slab El. 372'	A
41-A	O.K.	I	S-895 SKCT-23	Pulse Echo	7-20-79	C	20" Grid	Cont. #1, Ext. Wall El. 394'	C
42-A	O.K.	I	S-895 SKCT-23	Pulse Echo	7-19-79	U	20" Grid	East Steam Tunnel S-W Wall, El. 396'-10"	C
43	E	I	S-689 SKCT-15	Pulse Echo	7-19-79	C	20" Grid	Tunnel Foundation El. 377'	A
44	E	I	S-670 SKCT-6	Pulse Echo	7-07-79	U	36" Grid	Floor Slab El. 329'4"	A

E = Explainable; Q = Questionable; O.K.= Acceptable

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U: UNCONGESTED LOCATION

■ C: CONTAINMENT A: AUXILIARY BLDG.
T: TURBINE ROOM

SARGENT & LUNDY ENGINEERS

Client P.S.I.
Project MARBLE HILL
Proj. No 4808 / 4923

LIST OF TEST AREAS

Calc. No —
Rev. — Date —
Page 4 of 6

EXHIBIT 4
SL-3753
11-20-79

AREA	STATUS ⊛	CATEGORY OF CONC.	DWG. NO.	METHOD OF TESTING	DATE TESTED	C/U ▲	REMARKS	Location	BLDG. ■
45	E	I	S-671 SKCT-7	Pulse Echo	7-07-79	U	36" Grid	Floor Slab El. 329'-4"	A
46	O.K.	I	S-675 SKCT-8	Pulse Echo	7-07-79	U	36" Grid	Wall El. 345'4"	A
47	O.K.	I	S-673 SKCT-8	Pulse Echo	7-07-79	U	36" Grid Grid moved, NMH has loc	Floor Slab El. 345'4"	A
48	E	I	S-679 SKCT-12	Pulse Echo	7-18-79	C	13" Grid Check from 346	Beam 3AB29LTOM	A
49	O.K.	I	S-679 SKCT-12	Thru Transmission	7-21-79	C	No Grid Check from 346	Column @3AB 2,3, 36 & 37	A
50	O.K.	I	S-679 SKCT-12	Thru Transmission	7-21-79	C	No Grid Check from 346	Column @3AB 8, 9, & 28	A
51	Q	I	S-680 SKCT-13	Pulse Echo	7-07-79	C	13" Grid Check from 346	Beam 3AB50 P to ?	A
52	O.K.	I	S-896 SKCT-33	Pulse Echo	7-18-79	C	20" Grid	#1 Steam Tunnel #a:l El. 377'	C
53	Q	I	S-892 SKCT-33	Pulse Echo	7-18-79	C	20" Grid	#1 Steam Tunnel Floor Slal El. 362'6"	C
54	O.K.	I	S-892 SKCT-33	Pulse Echo	7-18-79	C	20" Grid	#1 Steam Tunnel South Wall El. 362'-6"	C
55	O.K.	I	S-892 SKCT-33	Pulse Echo	7-18-79	U	20" Grid	#1 Steam Tunnel Floor Slab El. 362'-6"	C

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SARGENT & LUNDY ENGINEERS

Client P.S.I.
Project MARBLE HILL
Proj. No 4808 / 4923

LIST OF TEST AREAS

Calc No
Rev - Date
Page 5 of 6

EXHIBIT 4
SL-3753
11-20-79

AREA	STATUS ⊕	CATEGORY OF CONC.	DWG. NO.	METHOD OF TESTING	DATE TESTED	C/U ▲	REMARKS	Location	BLDG. ■
56	O.K.	II	S-514 SKCT-1	Pulse Echo	7-19-79	U	36" Grid	Basemat El 368'4"	T
57	O.K.	II	S-515 SKCT-2	Pulse Echo	7-19-79	U	36" Grid	Floor Slab El. 356'10"	T
58	E	II	S-526 SKCT-3	Pulse Echo	7-19-79	U	36" Grid	Floor Slab El. 387'-6"	T
59	O.K.	II	S-587 SKCT-5	Pulse Echo	7-19-79	U	30" Grid	Floor Slab El 400'4"	T
60	Q	II	S-565 SKCT-4	Pulse Echo	7-20-79	C	36" Grid	Unit #1 Fwd. End Journal Support El.451'10"	T

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SARGENT & LUNDY ENGINEERS

Client P.S.I.
Project MARBLE HILL
Proj. No. 4808 / 4923

LIST OF TEST AREAS

Calc. No. —
Rev. — Date —
Page 6 of 6

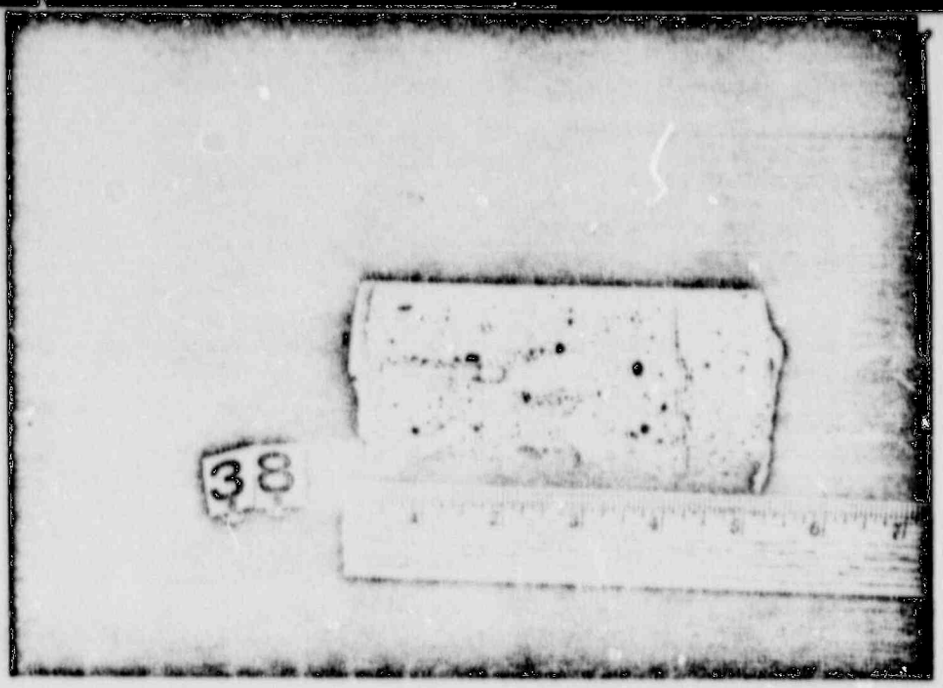
EXHIBIT 4
SL-3753
11-20-79

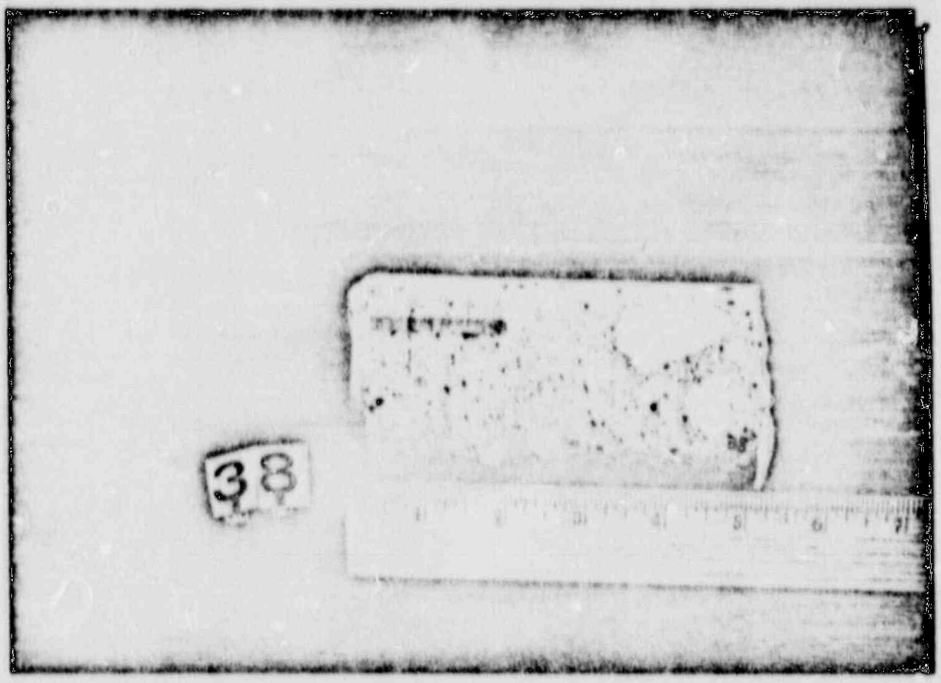
EXHIBIT 5
SL-3753
11-20-79

PHOTOGRAPHS OF CORE SAMPLES

The following photographs show the details of entrapped air in the in-place concrete. Core samples from the test areas (9, 17, 22, 23, 25, 26, 27, 28, 30, 35, 36, 51, 53, and 60) are displayed here. There are three photographs for each core sample, taken at a 120° angle, and depicting the entire surface of the sample.

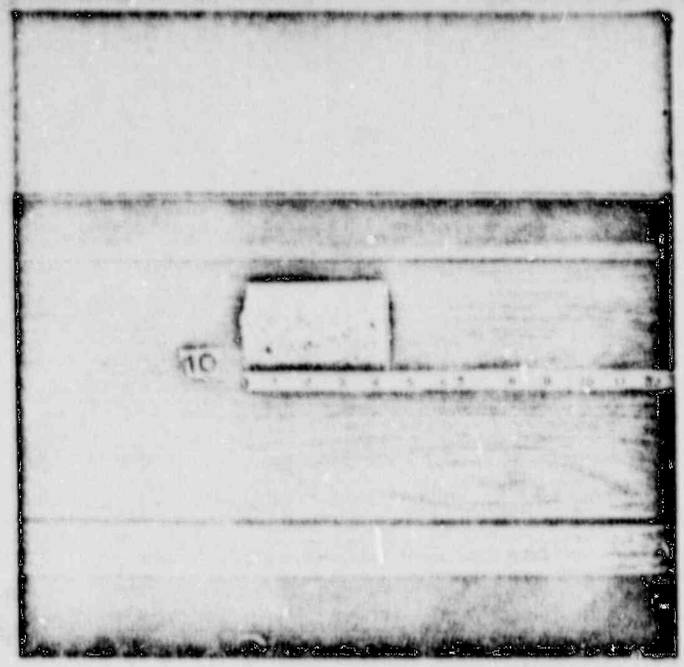
EXHIBIT 5
SL-3753
11-20-79

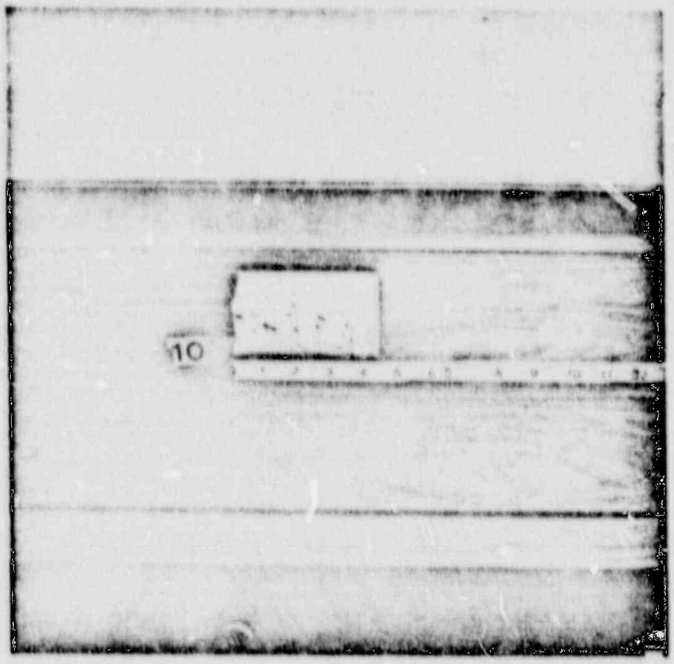




CORE SAMPLE
FROM TEST
AREA NO. 9

EXHIBIT 5
SL-3753
11-20-79





CORE SAMPLE FROM
TEST AREA NO. 17

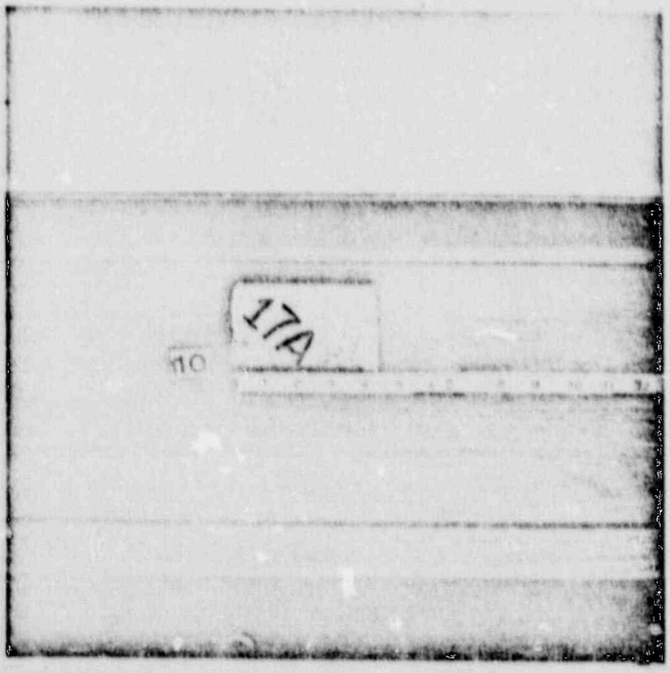
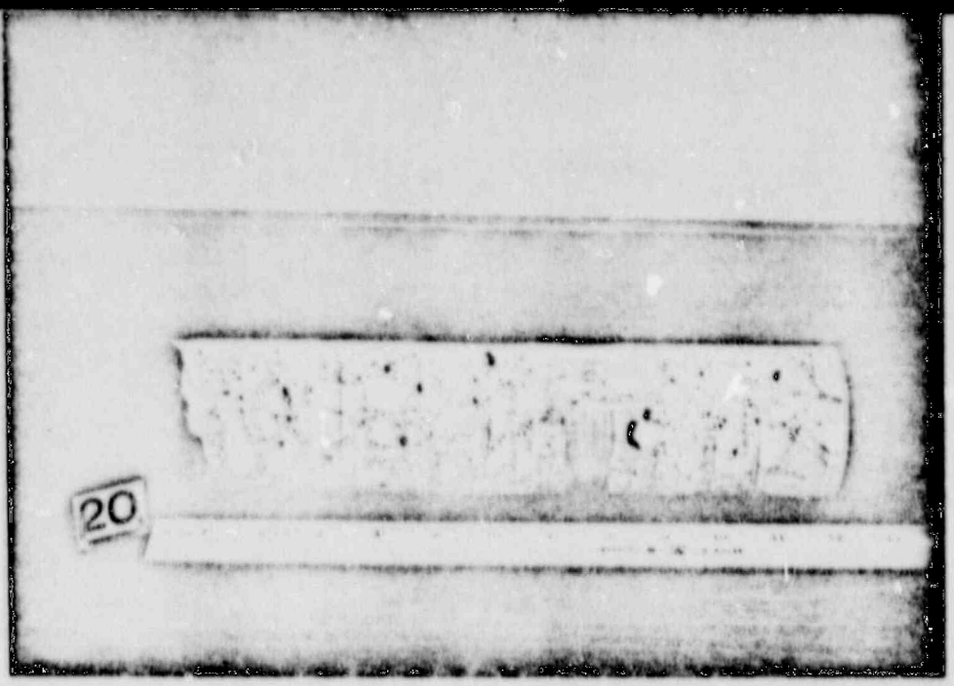
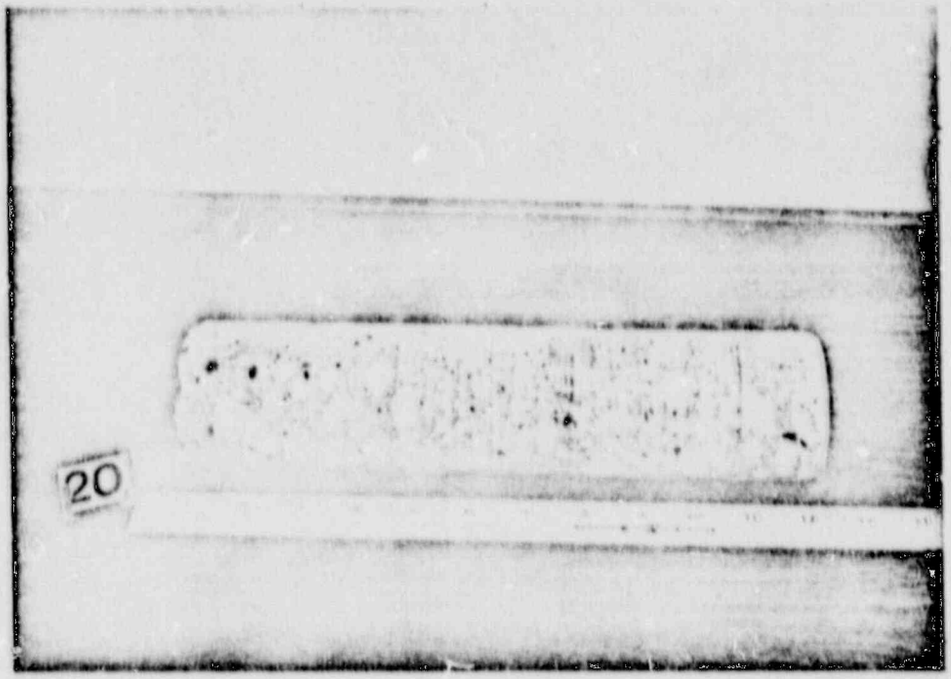
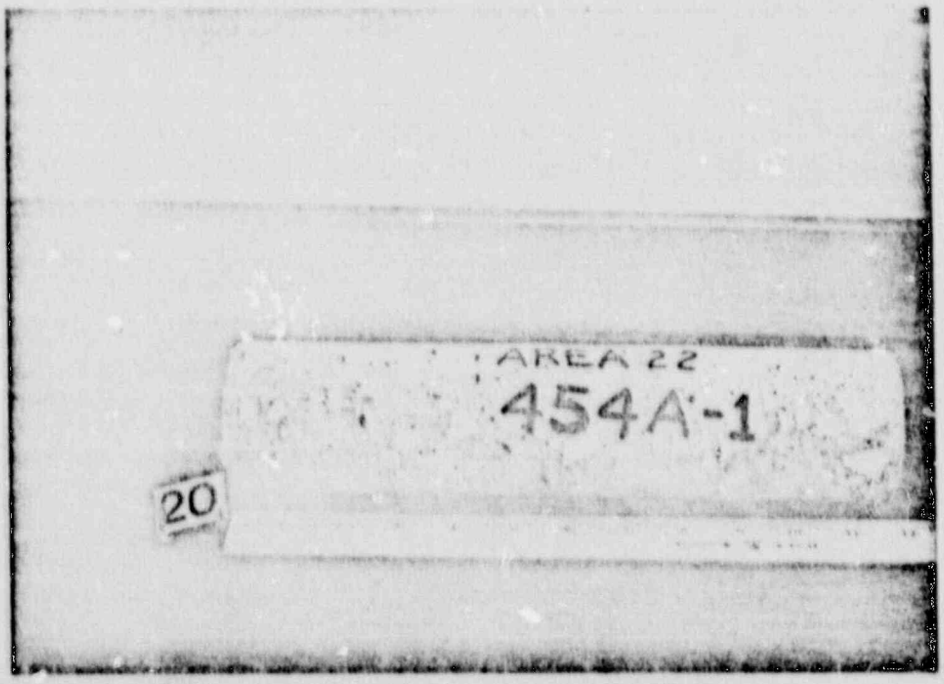


EXHIBIT 5
SL-3753
11-20-79

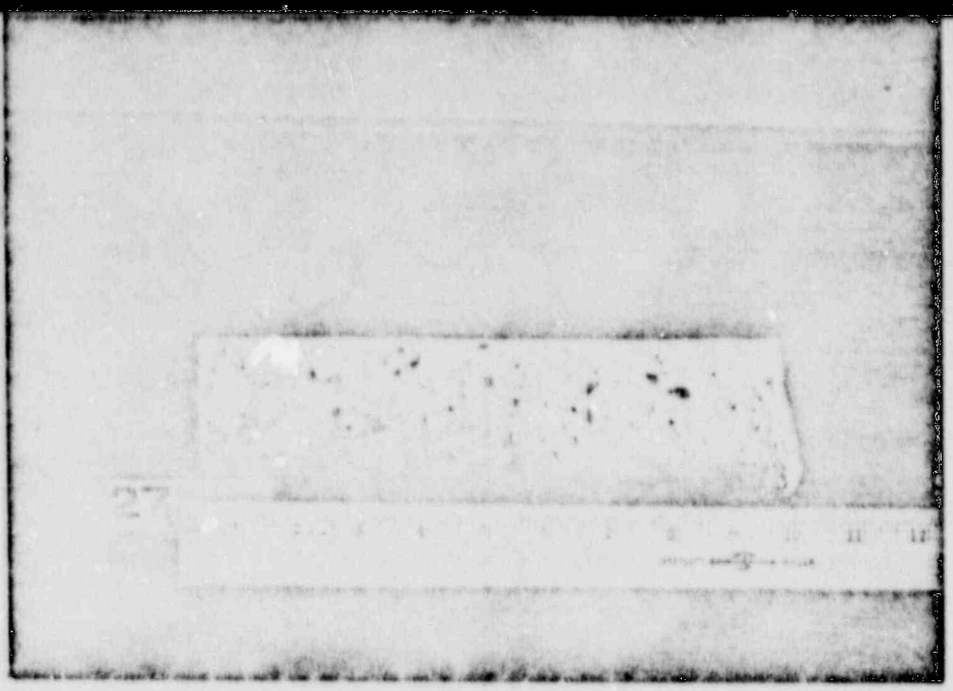






CORE SAMPLE
FROM TEST
AREA NO. 22

EXHIBIT 5
SL-3753
11-20-79



CORE SAMPLE
FROM TEST
AREA NO. 23
B2

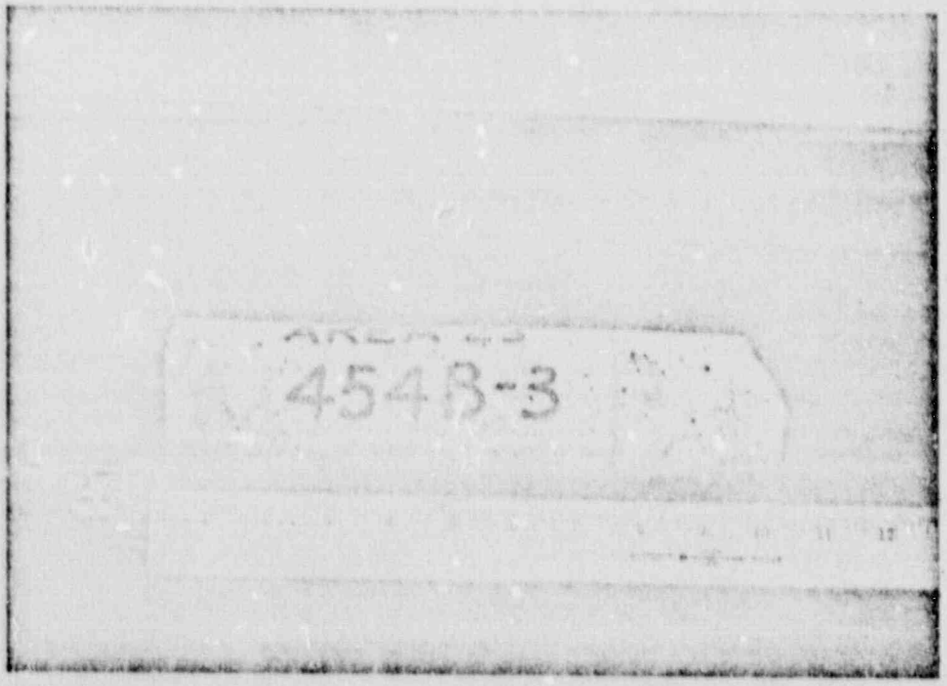
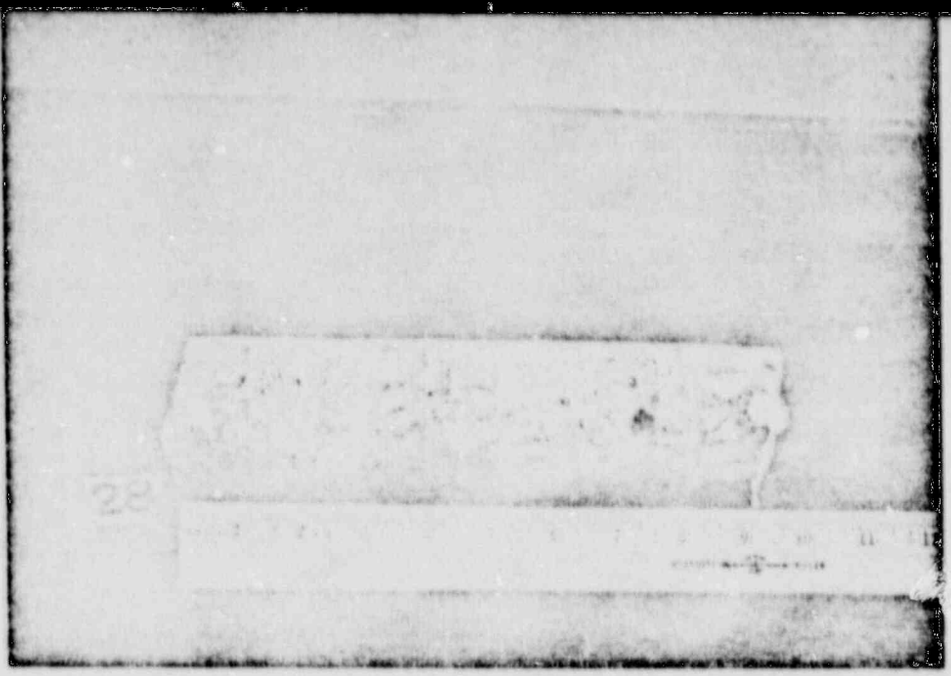
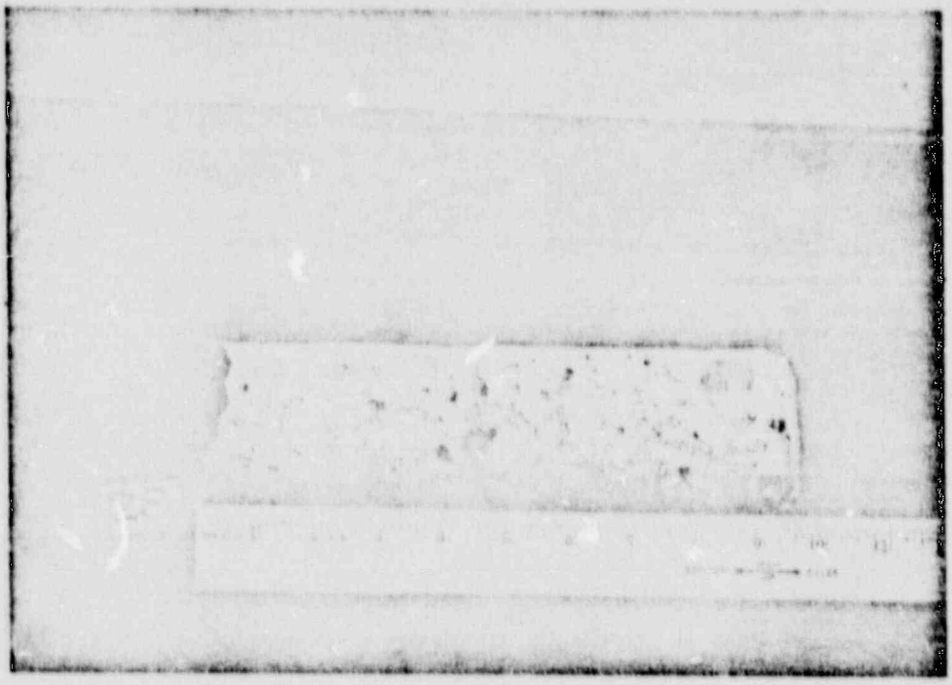


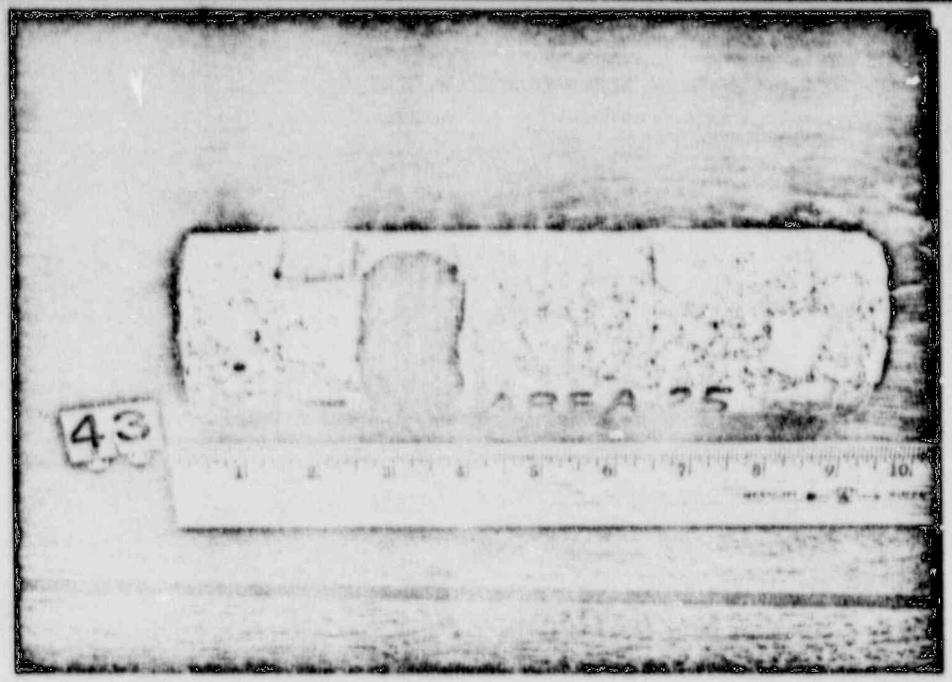
EXHIBIT 5
SL-3753
11-20-79

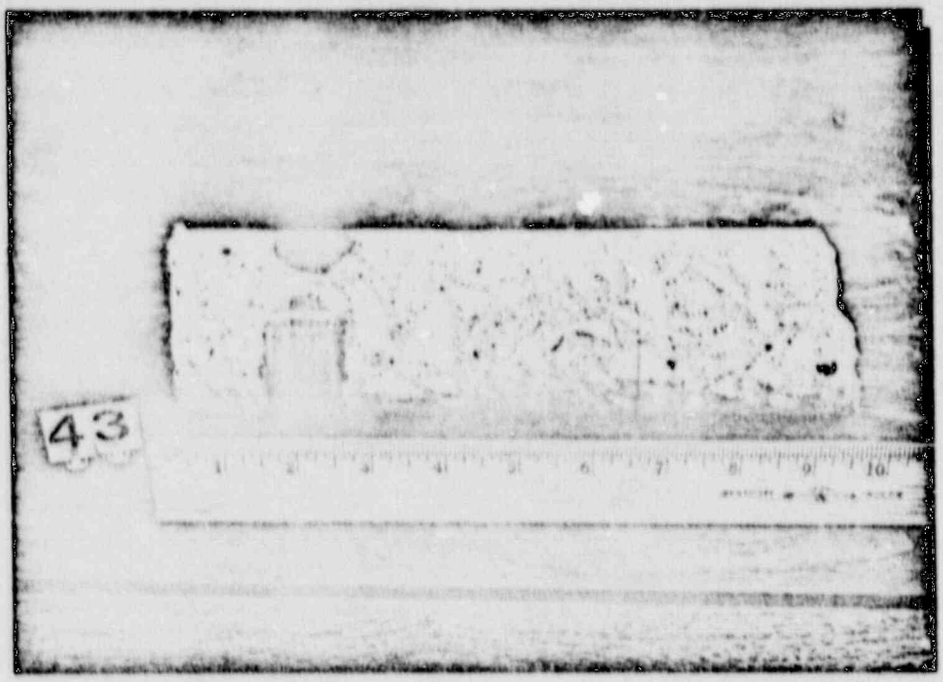




CORE SAMPLE
FROM TEST
AREA NO. 23
B3

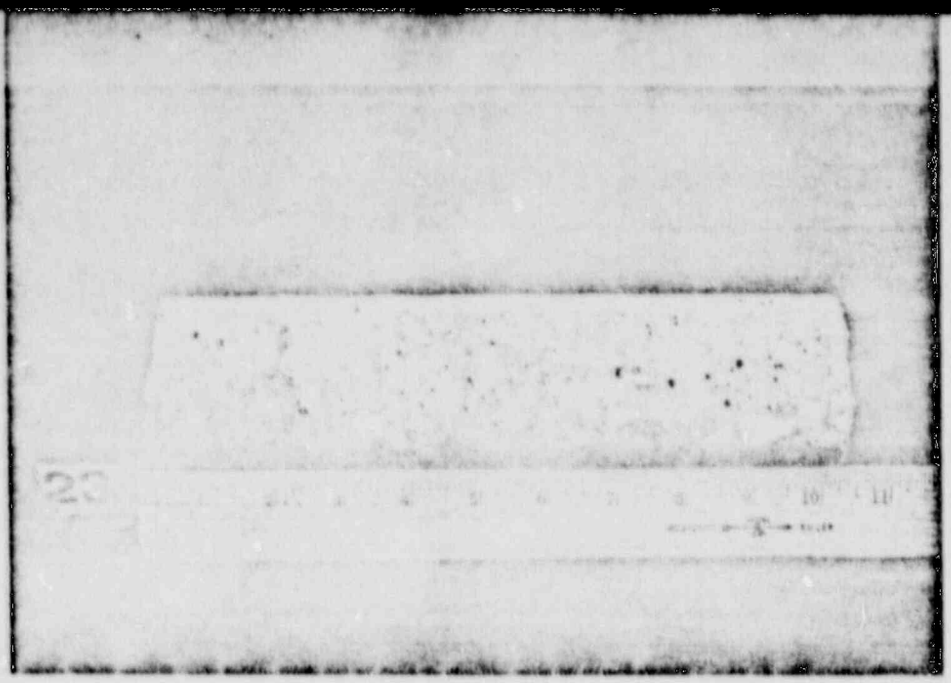
EXHIBIT 5
SL-3753
11-20-79

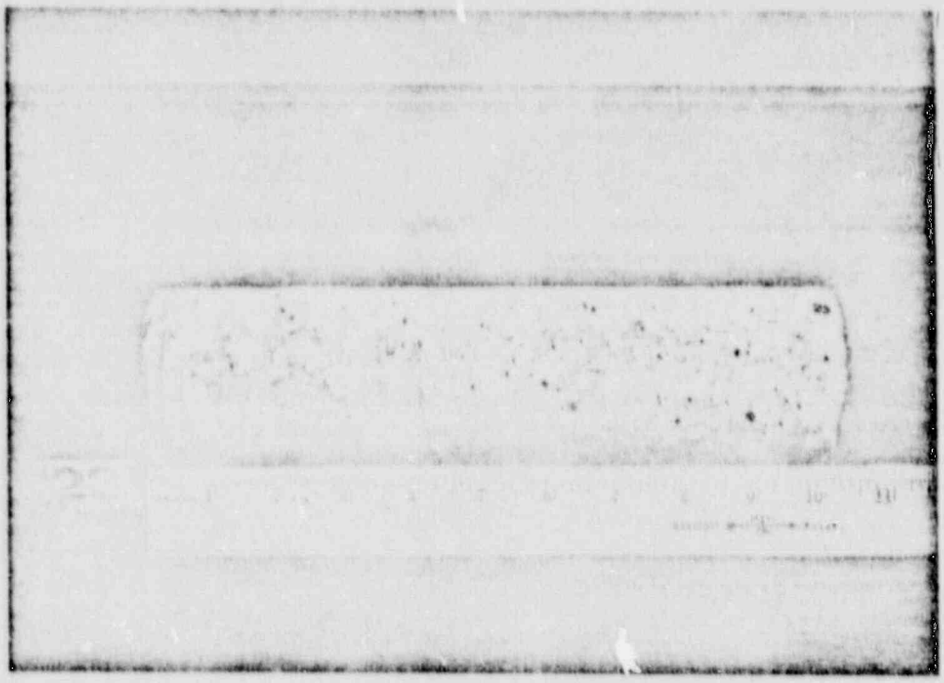




CORE SAMPLE
FROM TEST
AREA NO. 25

EXHIBIT 5
SL-3753
11-20-79





CORE SAMPLE
FROM TEST
AREA NO. 26

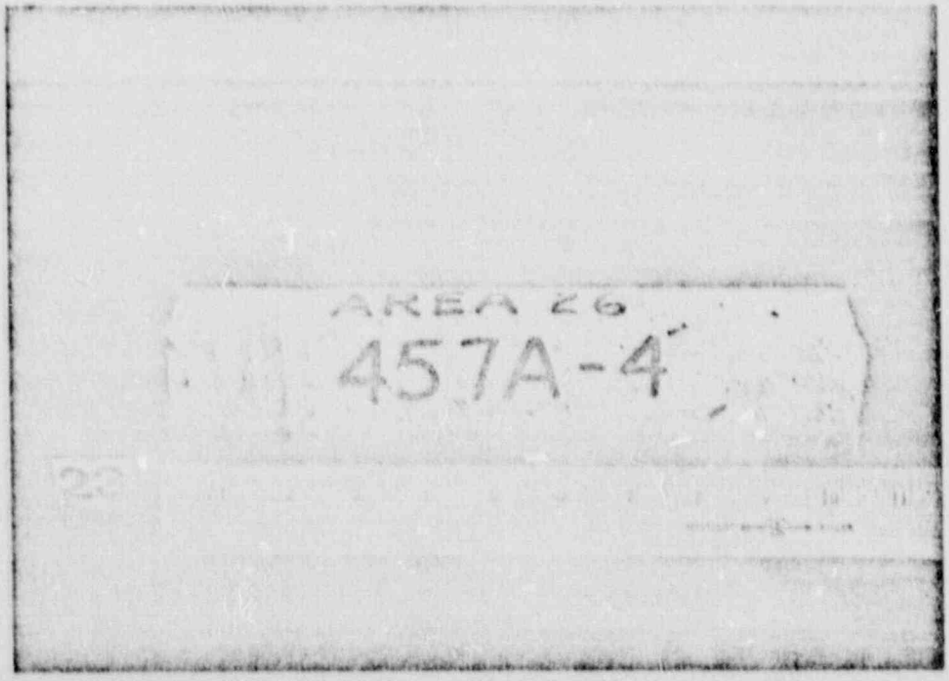
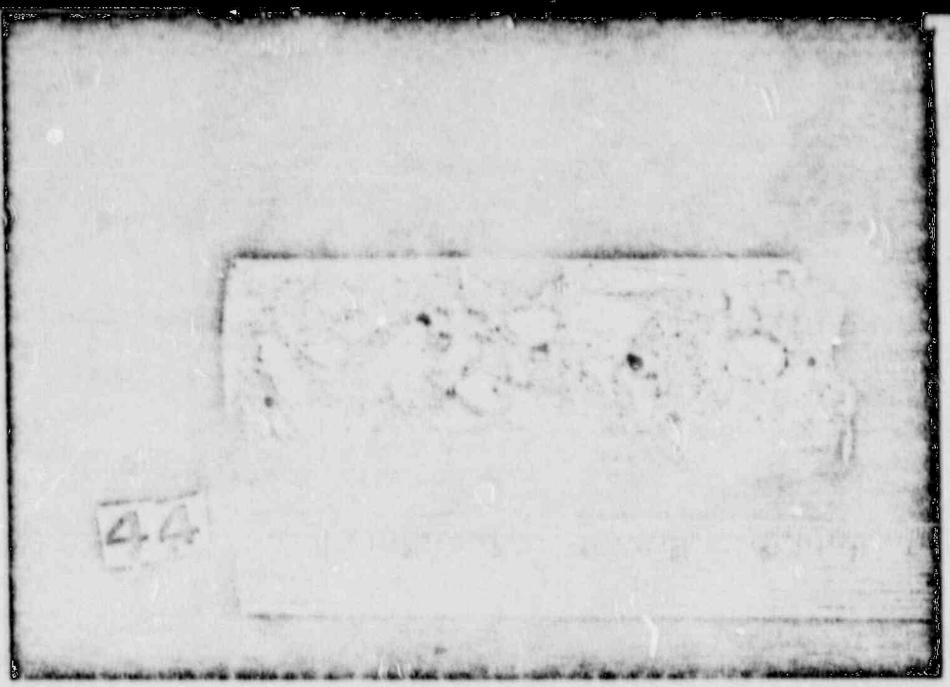
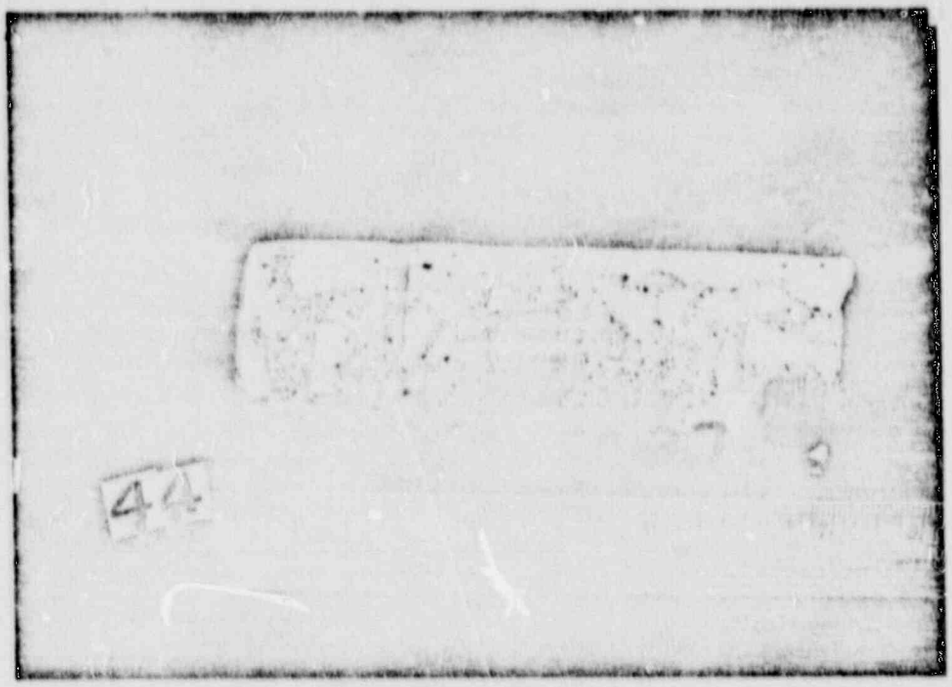


EXHIBIT 5
SL-3753
11-20-79





CORE SAMPLE
FROM TEST
AREA NO. 27

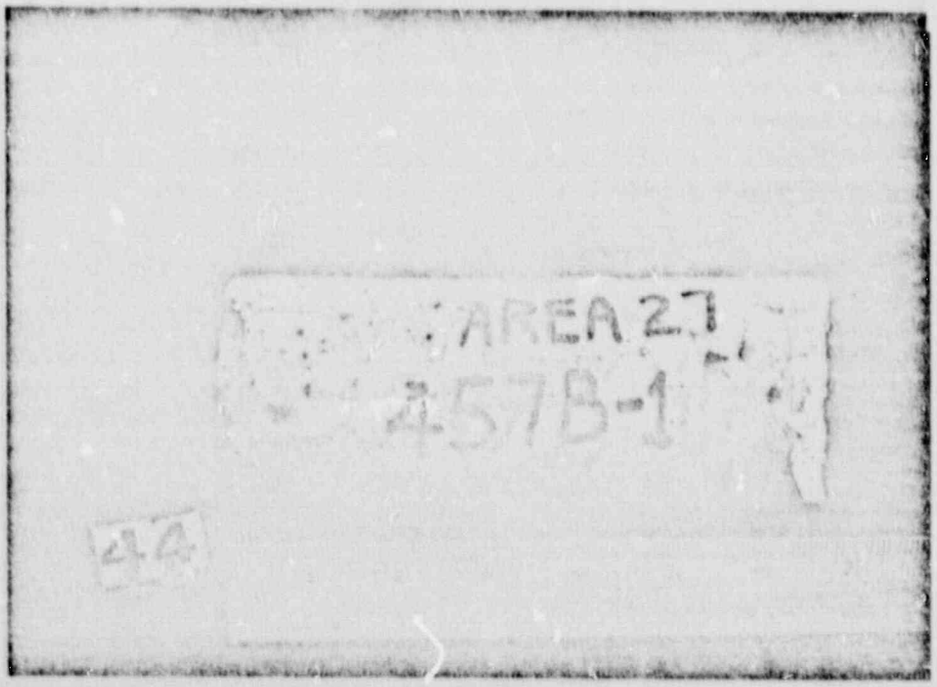
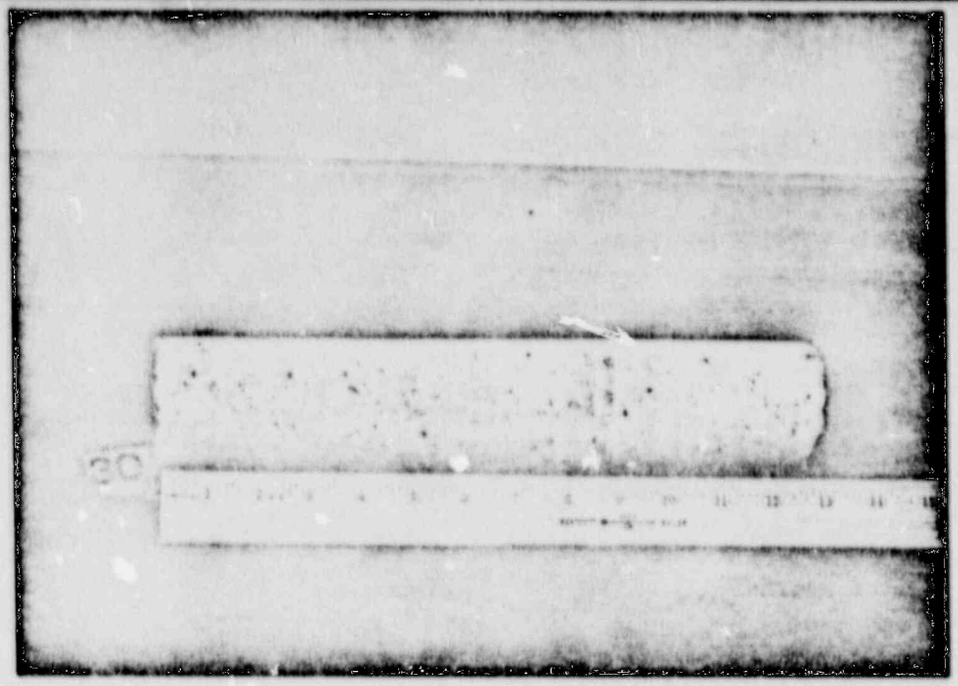
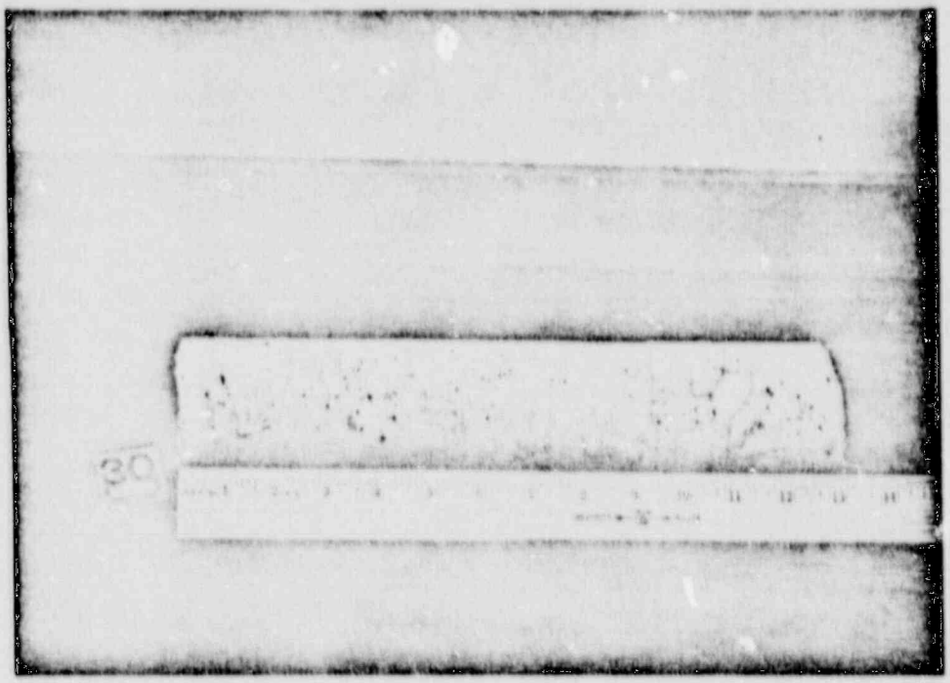


EXHIBIT 5
SL-3753
11-20-79





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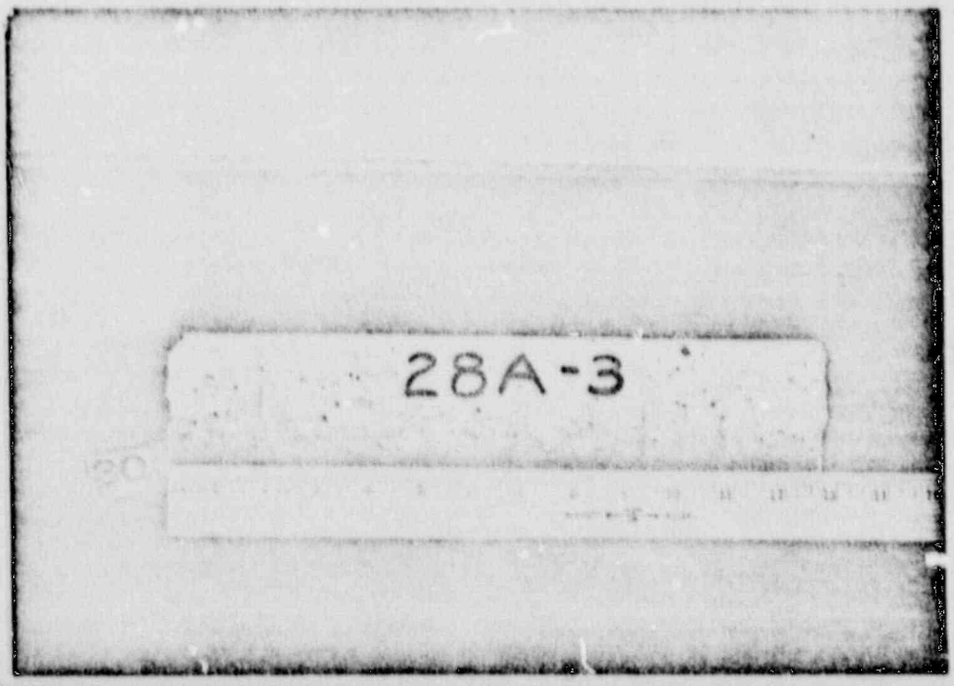
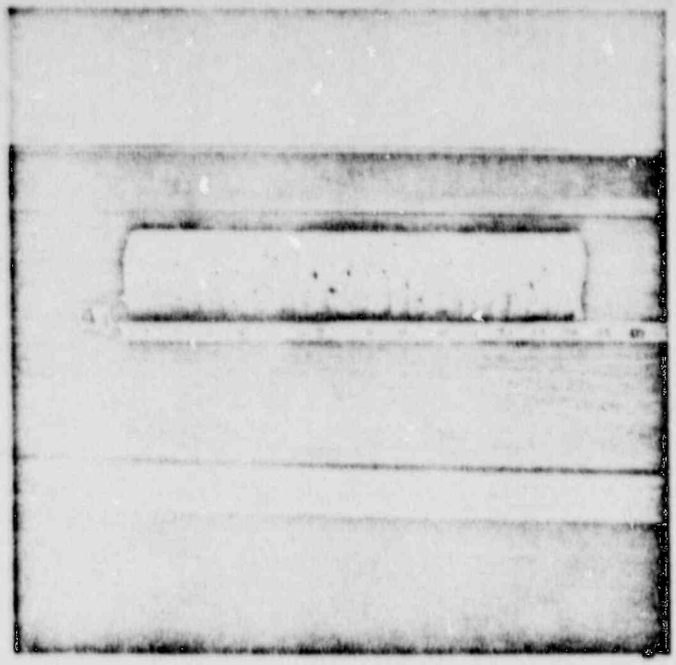
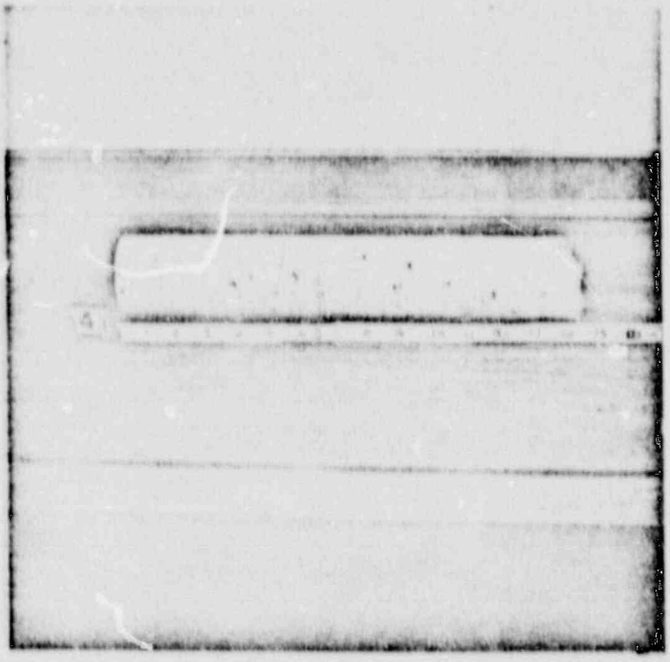


EXHIBIT 5
SL-3753
11-20-79





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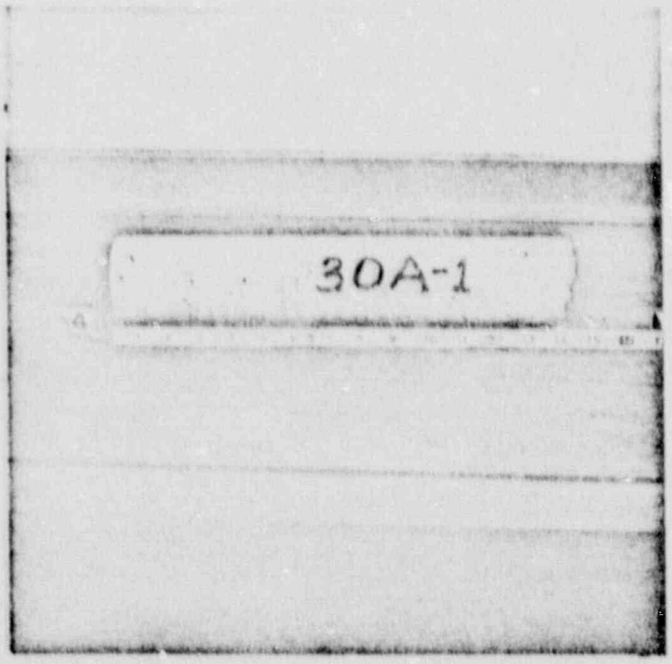
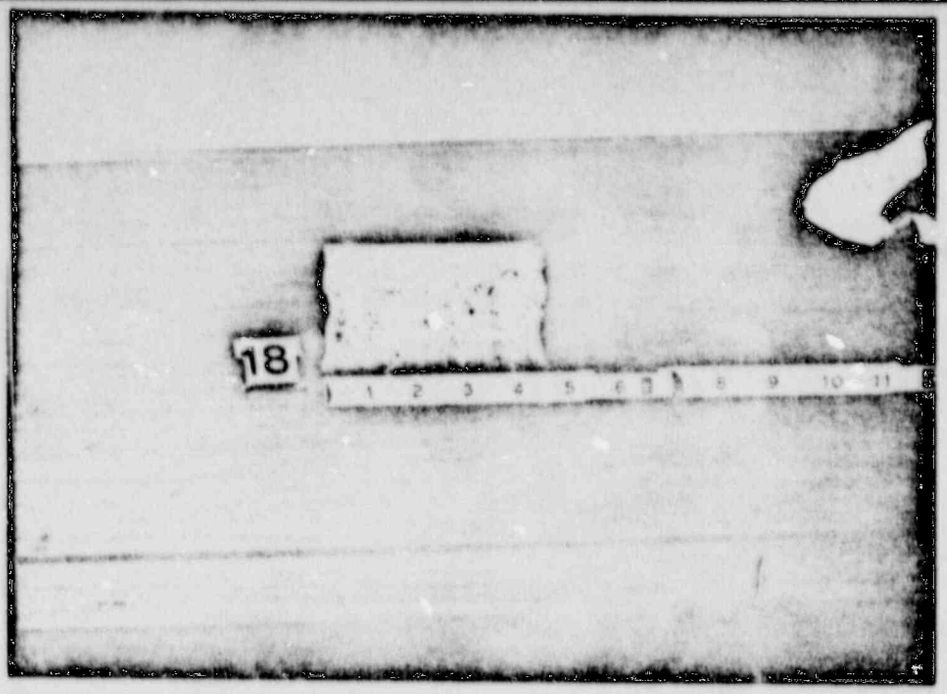
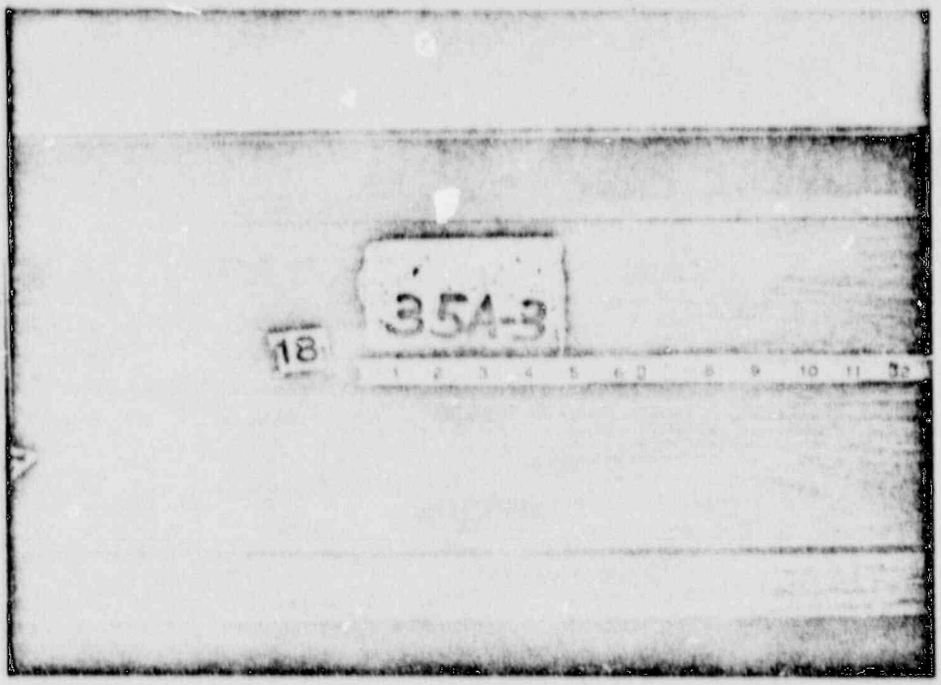


EXHIBIT 5
SL-3753
11-20-79





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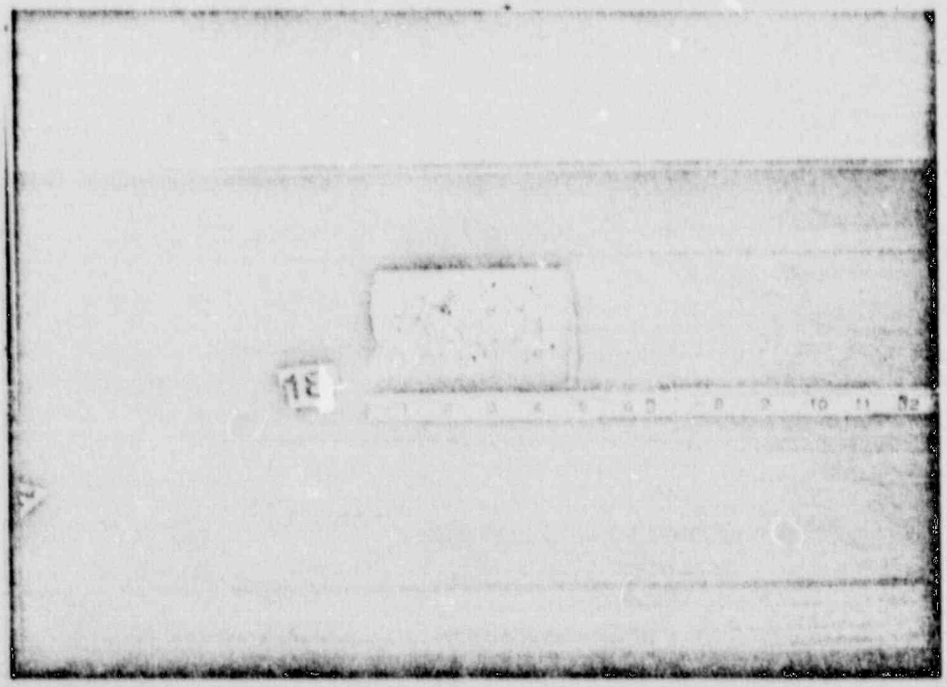
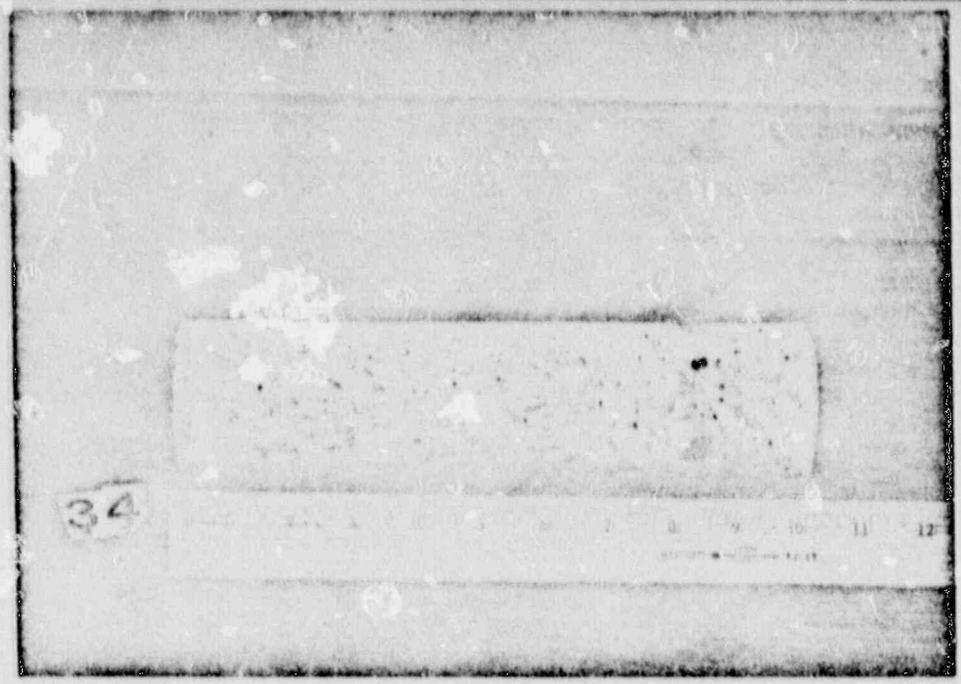


EXHIBIT 5
SL-3753
11-20-79



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FROM TEST
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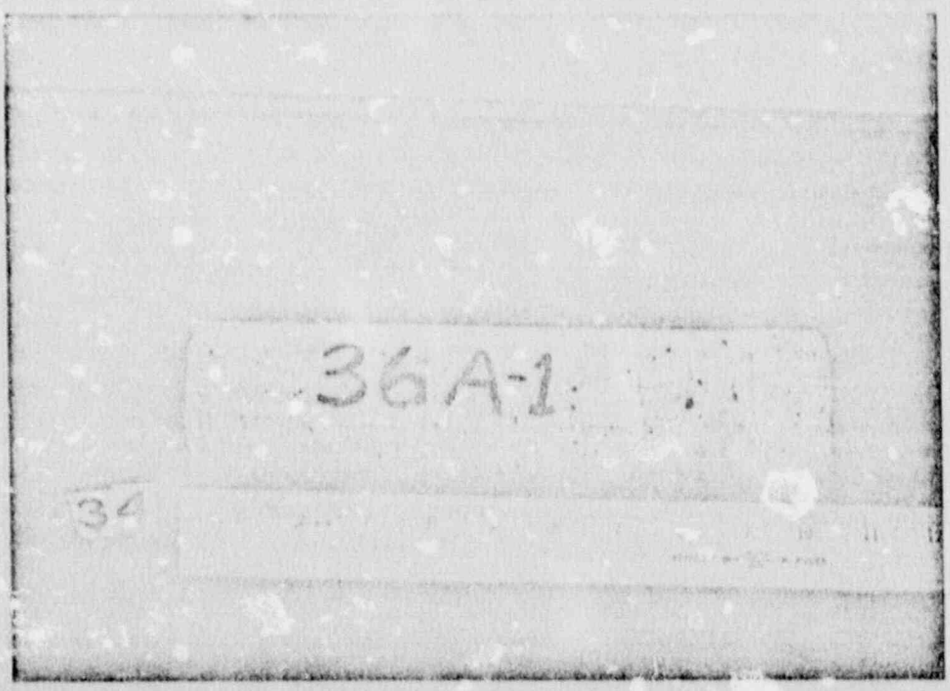
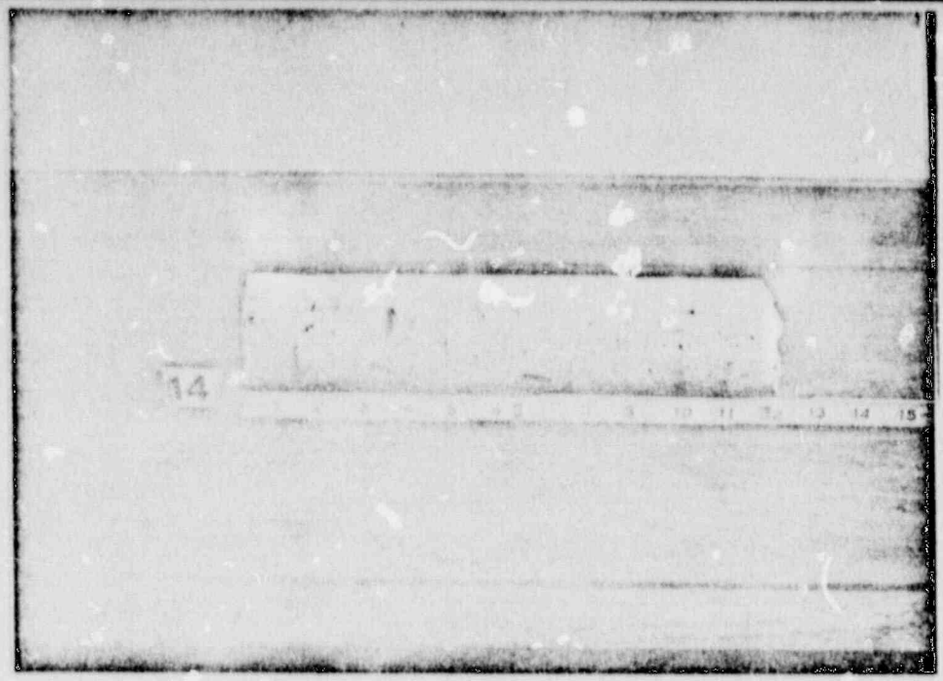
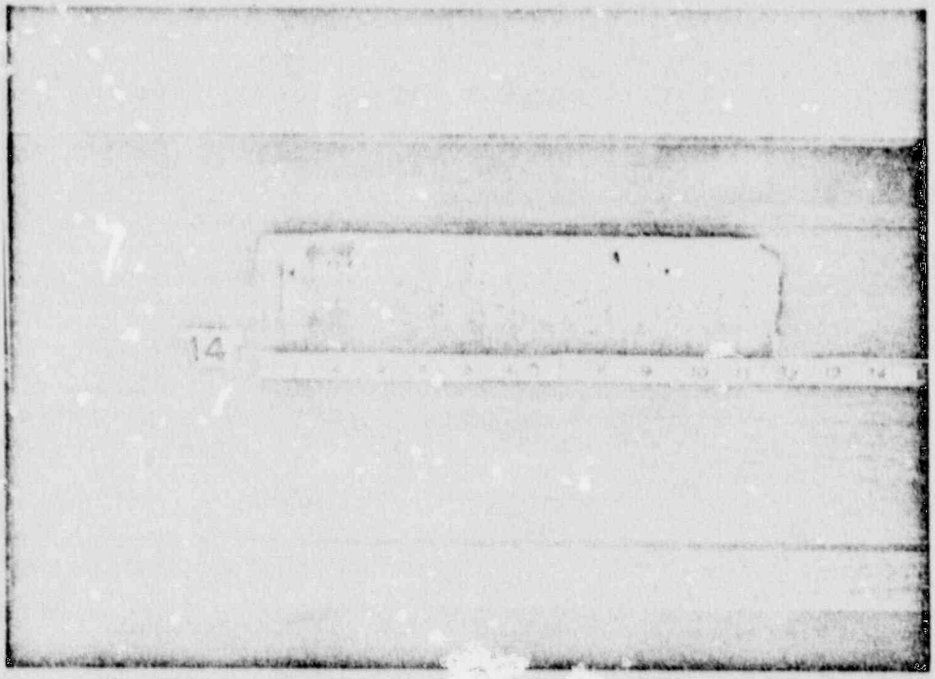


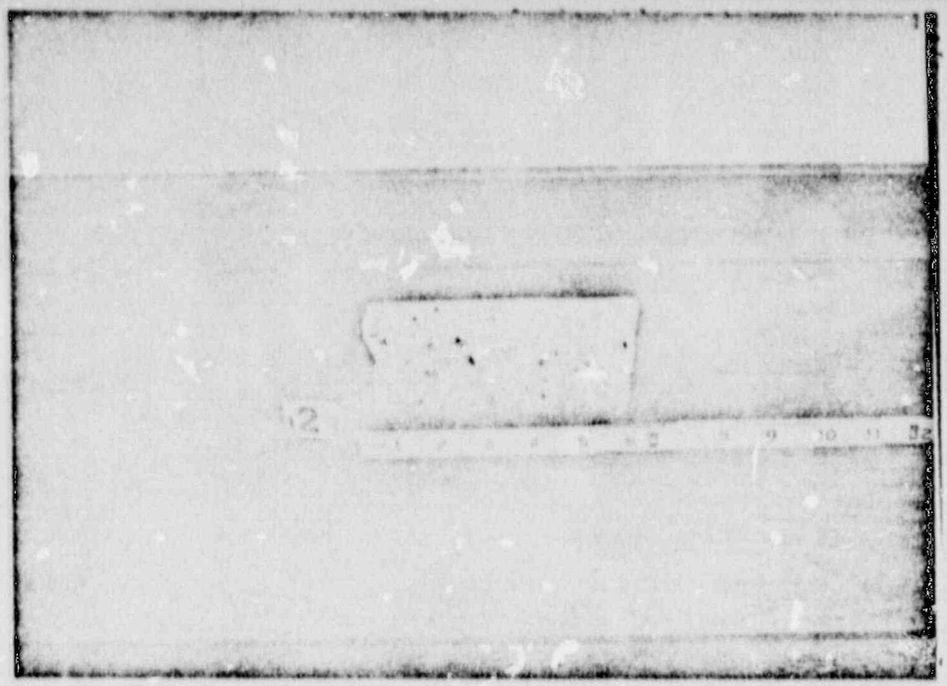
EXHIBIT 5
SL-3753
11-20-79

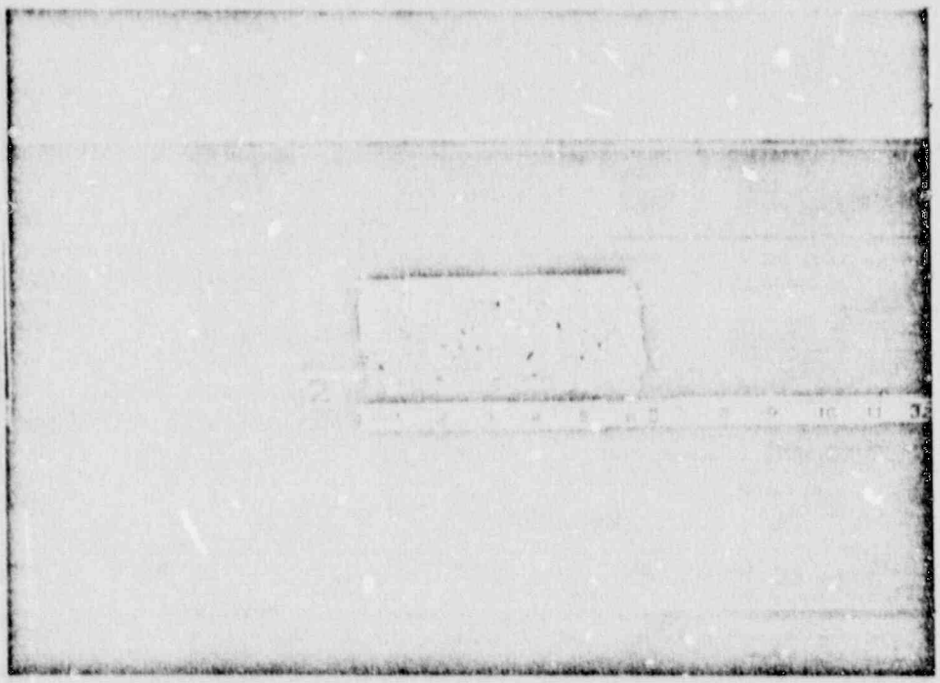




CORE SAMPLE
FROM TEST
AREA NO. 51

EXHIBIT 5
SL-3753
11-20-79





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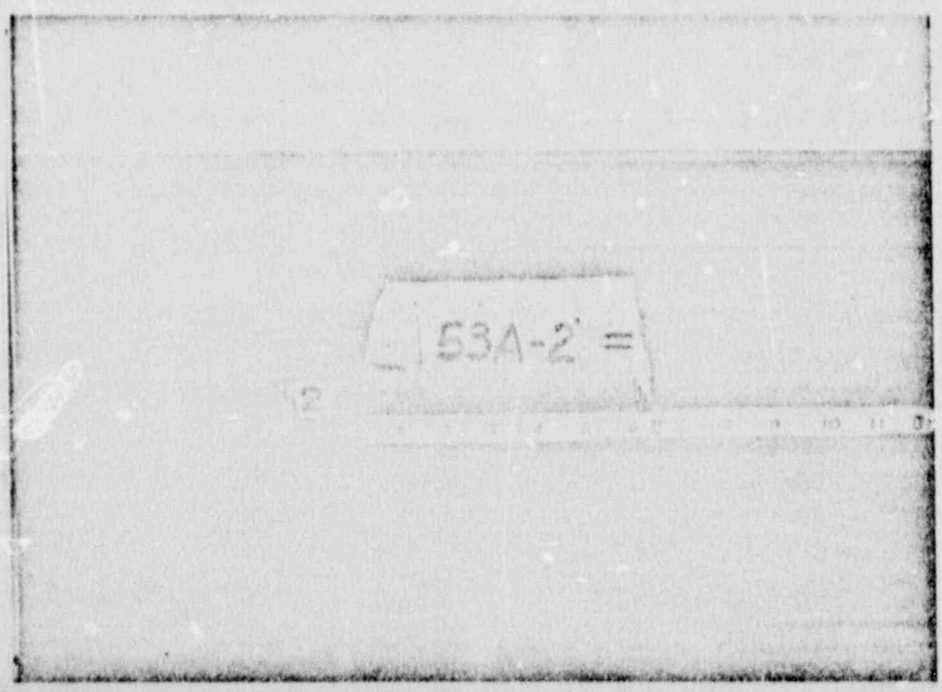
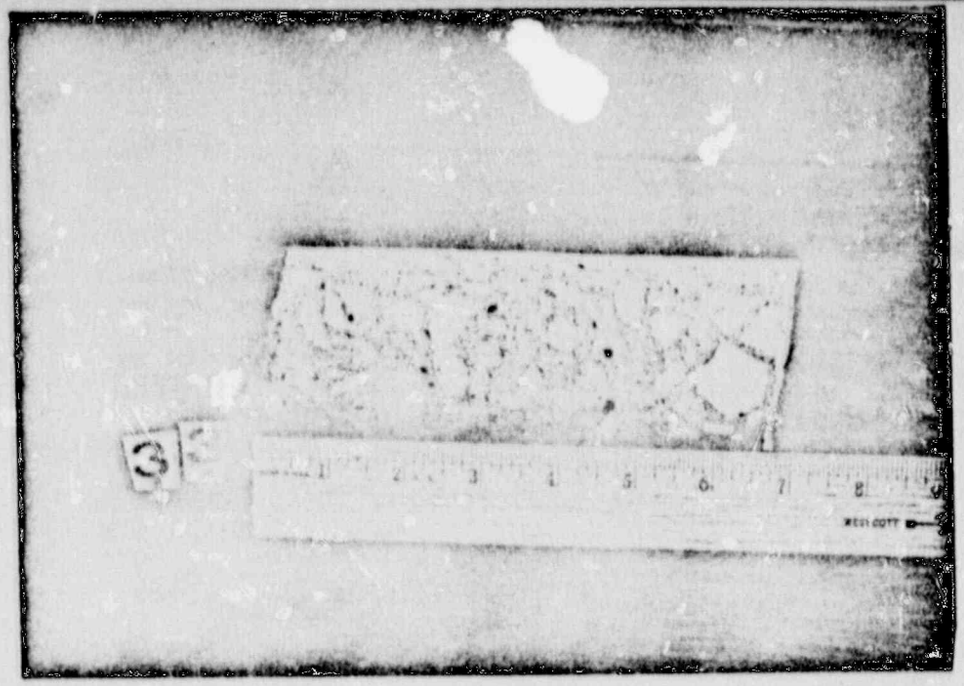
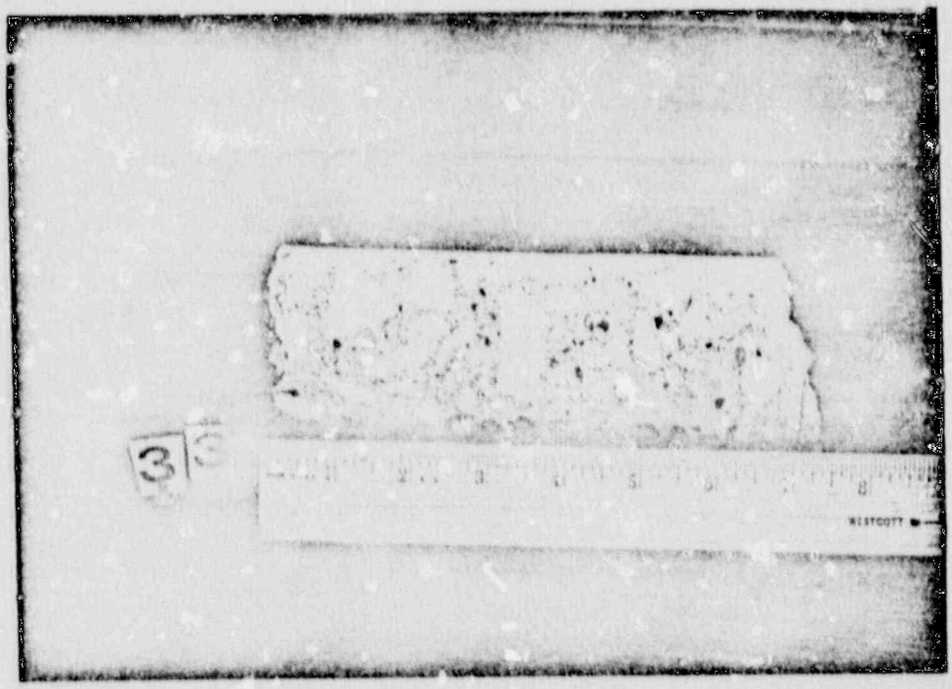


EXHIBIT 5
SL-3753
11-20-79





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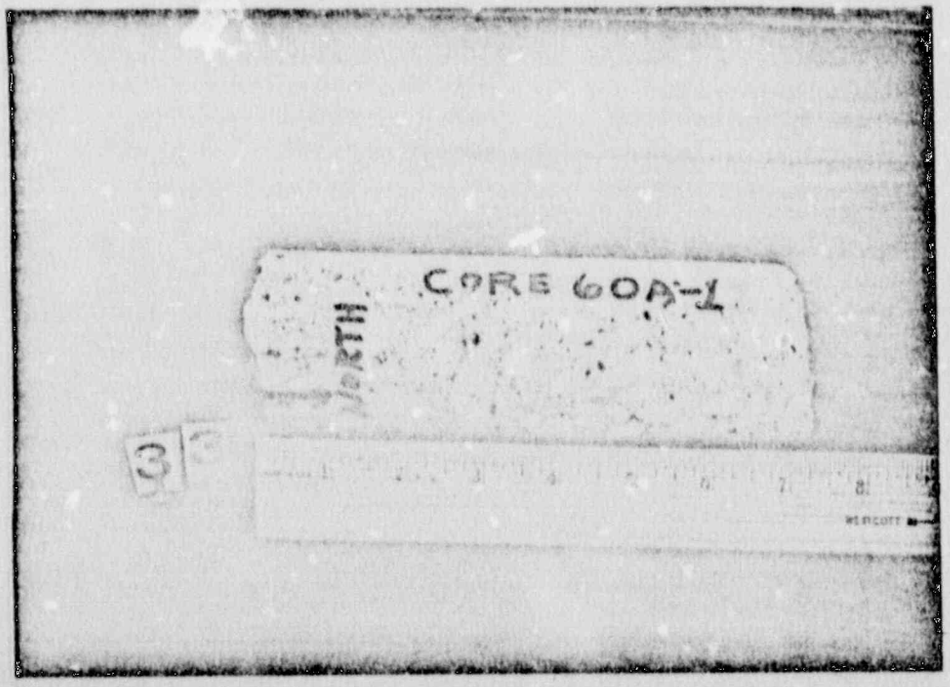


EXHIBIT 6
SL-3753
11-20-79

NEWBERG PROCEDURES

Two quality assurance procedures developed by Gust K. Newberg are included here:

WPN-25 Major Void Concrete Repair

WPN-36 Concrete Core Drilling

NEWBERG
MARBLE HILL

MARBLE HILL GENERATING STATION
QUALITY ASSURANCE MANUAL

Date 07-25-78
Revision 0
Page ____ of ____

Title: WPN-25 MAJOR VOID CONCRETE REPAIR

TABLE OF CONTENTS

NEWBERG
MARBLE HILL

MARBLE HILL GENERATING STATION
QUALITY ASSURANCE MANUAL

Date 07-25-78
Revision 0
Page ____ of ____

Title: WPN-25 MAJOR VOID CONCRETE REPAIR

1.0 PURPOSE

To describe the methods for repairing major concrete defects.

2.0 APPLICABILITY

This procedure shall apply to all concrete defects that are classified as major in accordance with QAPN-10, "Inspection and Test Control", that require forming.

3.0 DEFINITIONS AND ABBREVIATIONS

Refer to Appendix A of the Newberg-Marble Hill Quality Assurance Manual.

4.0 PROCEDURE

4.1 Void Preparation

Remove all unsound material using automatic chipping hammers or by hand. Extreme care will be taken to avoid nicking reinforcing steel. Cross sections of individual bars shall not be reduced more than 5% of the nominal area within a length of 3 bar diameters. Larger notches shall be reported to the Consulting Engineers for evaluation. Bottom and sides of void shall be cut sharply at least 90° with face of concrete surface. The top edge of void should be cut to a fairly horizontal line or if the configuration makes it advisable the top cut may be stepped down and continued on the horizontal line. The top edge will also be cut on an upward slope from the back of void toward the face of finish surface to prevent air entrapment. All interior corners shall be rounded to a minimum radius of 1". Inside void surfaces will be treated with the Weld-Crete Bonding Agent (Attachment A), and the area inspected as per QAPN-10, "Inspection and Test Control".

4.2 Forming

Void area will be formed to the design surface. Forms shall be mortar tight. A "chimney" will be incorporated in the form top to allow for insertion of grout or concrete into void area. If conditions warrant, forms may be placed in sections so that concrete may be placed in lifts of 12" deep. Small diameter holes (<¼") will be drilled at 12" intervals to act as vent and inspection points.

4.3 Fill Material

Grout the same compressive strength as the structural member will be used in voids that have a high rebar density that could prevent proper consolidation. Other voids will be filled with concrete of the same compressive strength as the structural member.

4.4 Consolidation

Consolidation will be accomplished by use of pencil vibrators for voids equal or larger than 4" deep, or tapping face of form by use of hammers for voids less than 4" deep. Above methods will be used during placement until grout weeps thru the inspection holes.

4.5 Curing

If forms are removed prior to completion of the seven-day cure period, the surface will be sprayed with an approved curing compound immediately after the forms are removed. A second application of curing compound will be made at seven days.

4.6 Clean-Up

Concrete or grout protrusions will be chipped off and area ground to match adjacent area. Protrusions shall be removed by working up from the bottom to avoid concrete breaking out of the repair.

5.0 REFERENCES

5.1 "Concrete Manual", Water Resources Technical Publication, Eight Edition.

5.2 QAPN-10, "Inspection and Test Control".

NEWBERG
MARBLE HILL

MARBLE HILL GENERATING STATION
QUALITY ASSURANCE MANUAL

Date 07-25-78
Revision 0
Page ____ of ____

Title: WPN-25 MAJOR VOID CONCRETE REPAIR

ATTACHMENT A

Weld-Crete Bonding Agent

TECH-DATA BULLETIN NO. 130

BONDED CONCRETE SHEAR WALL

The following has been used to successfully place a reinforced concrete shear wall bonded to an existing concrete shear wall:

[1] PREPARATORY WORK--Surfaces to receive Weld-Crete® MUST BE STRUCTURALLY SOUND and CLEAN, free from loose material, dust, oil, grease, wax, loose paint, mildew, rust, laitence, efflorescence or any foreign material.

Weld-Crete® may be applied over dry or damp surfaces (eliminate all water puddles). DO NOT APPLY where hydrostatic pressure is present in the substrate. Any curing or form-release compounds applied on surfaces to receive cementitious toppings must be compatible with Weld-Crete®.

Anchors or other wall ties must be set into existing wall prior to application of Weld-Crete®.

[2] APPLICATION OF WELD-CRETE®--Weld-Crete® is ready to use--DO NOT ADD WATER. Apply Weld-Crete® undiluted like a coat of paint using brush, roller, or spray to form a continuous blue film over entire bonding surface of existing concrete wall and allow to dry. Erect steel reinforcing and formwork, then, anytime up to 10 days after application of the bonding agent, place the new concrete wall as specified. In the interval between the application of the bonding agent and placement of concrete, the Weld-Crete® film should be protected from dirt, dust and debris as well as the elements. Prior to placement of concrete, inspect surfaces to assure that a continuous blue film of Weld-Crete® covers the bond area.

Coverage--Weld-Crete® covers approximately 200-300 sq. ft. per gallon, depending upon type of surface and method of application.

NEWBERG MARBLE HILL	MARBLE HILL GENERATING STATION QUALITY ASSURANCE MANUAL	Date 07-25-78 Revision 0 Page ____ of ____
	Title: WPN-25 MAJOR VOID CONCRETE REPAIR	

ATTACHMENT A

Weld-Crete Bonding Agent

1. PRODUCT NAME
Bonding agent for concrete
WELD-CRETE®

2. MANUFACTURER
LARSEN PRODUCTS CORP
5420 Randolph Road
Rockville, Maryland 20852
Phone (301) 770-5200

3. PRODUCT DESCRIPTION
Basic Use: Weld-Crete® is a ready-to-use ... [illegible]

Weld-Crete® eliminates the need for ... [illegible]

Color: Blue (in film bonding)

Standards: Military Specification MIL-B-19235A (Docks); General Services Administration for Bond Adhesive; Corps of Engineers Specification CE 240.01; Canadian Standard CSA A261-1970

4. TECHNICAL DATA
Performance Properties: See Table I.

Three-Way Bond: Weld-Crete® becomes an integral part of the interface between the cementitious material and the surface to be bonded because of a unique three-way bond—mechanical, adhesive and chemical (see Figure 1).

Life Expectancy: The bonding film keeps its strength indefinitely—will not crack, oxidize, dry out or deteriorate. It is also vermin proof and unaffected by temperatures from –35° F to 310° F. Weld-Crete® bonding dependability and durability have been proven on the job since 1953.

SPEC DATA

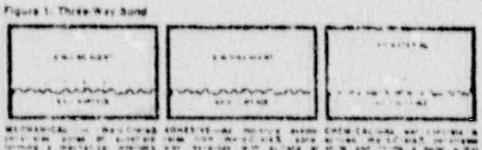
This Spec-Data Sheet conforms to editorial style prescribed by The Construction Specifications Institute. The manufacturer is responsible for technical accuracy.

5. INSTALLATION
Surface Preparation: Dust, dirt, oil, grease, wax, chalky or loose paint, remove rust, efflorescence and other foreign material as well as disintegrated ... [illegible]

Table I. Performance Properties

PROPERTY	TEST METHOD*	RESULT	CONCLUSION
Tensile Bond Strength	ASTM C-190 [illegible]	[illegible]	[illegible]
Flexural Bond Strength	ASTM C-78 [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Figure 1: Three-Way Bond



LARSEN PRODUCTS CORP June, 1975

CONCRETE MATERIALS
Bonding Agents

NEWBERG MARBLE HILL	MARBLE HILL GENERATING STATION QUALITY ASSURANCE MANUAL	Date 07-25-79 Revision 0 Page ____ of ____
	Title: WPN-25 MAJOR VOID CONCRETE REPAIR	

ATTACHMENT A

Weld-Crete Bonding Agent

Material must be removed. An economical method for cleaning concrete surfaces is to use a 10 percent muriatic acid solution followed by a thorough washing. Degreasing solvents such as Varsol are also effective.

New concrete must be cured according to approved industry standards. Painted surfaces must be sound, washable and firmly adhered to the substrate. Glossy painted surfaces should be dulled with an abrasive. Over newly plastered surfaces wait 60 days before applying bonding agent.

Application: Apply Weld-Crete® undiluted as a coat of paint using brush, roller or spray to form a continuous blue film. Bonding agent will dry to touch in approximately 1 hour depending upon humidity. Large areas can be covered in a single application. Weld-Crete® can be put on over dry or damp surfaces; water puddles must be eliminated. Three way bonding action (figure 1) [illegible] cementitious materials to interlock with base structure either immediately after Weld-Crete® is touch dry or a day to 10 days later with no effect on bond performance. Once the bonded assembly has cured and Weld-Crete® has dried, it is unaffected by humidity or condensation.

Concrete Overlays: Cementitious toppings over the Weld-Crete film should have a minimum thickness of ½ inch and should be abutted to an adjacent edge. See Figure 2. Follow Portland Cement Association or ANSI standards in preparing, applying, and curing the concrete overlay. Seal all joints against water penetration. Isolation joints should either be formed or cut with a dry-vacuum saw. Control joints should match joints in substrate and should be cut to not more than one half the depth of the concrete overlay. Do not allow standing water to remain on newly bonded concrete surfaces.

Figure 2. Minimum Depth

Precast Floor Systems: Follow above procedures for leveling precast concrete floor systems.

Featheredging and Finished Topping: Mix one part Weld-Crete® to three parts water. Add to cement mix and proceed to place and featheredge where traffic is not heavy, as in Figure 3.

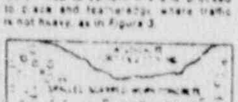


Figure 3. Featheredging

Portland Cement Terrazzo: For ½-inch portland cement terrazzo, T-strips should be anchored to the slab before applying Weld-Crete®. Do not allow standing water to remain on newly bonded terrazzo surfaces. Weld-Crete® equalizes suction, speeds placement and permits uniform finishing. Follow NTMA recommended procedures for ½" monolithic terrazzo.

Concrete Shear Walls: Distinct advantage of Weld-Crete®'s delayed bonding action allows bonding agent to be applied prior to placing reinforcement and/or [illegible] cables, erecting formwork and placing concrete. See Figure 4.

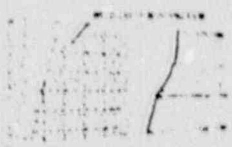


Figure 4. Shear Wall

Cold Joints: For construction joints or interrupted placement apply Weld-Crete® and allow to dry prior to placing fresh concrete.

Concrete Columns: Where refacing is necessary apply Weld-Crete® prior to placing reinforcement and formwork, then proceed to place concrete. Where existing concrete is to be repaired, such as in straightening columns, apply Weld-Crete® and allow to dry, then build layers using a cement mix [illegible] maximum thickness until area is plumb. CAUTION—Allow a full 24 hours between application of each layer.

Gunite Applications: When mechanical keying is not possible, apply Weld-Crete® and allow to dry prior to applying gunite.

Cracks and Joints: Add Weld-Crete® to water 1:1 and mix with portland cement to prepare a patching compound.

Coverage: 200 to 300 sq. ft. per gallon, approximately, depending upon method of application, temperatures, porosity and texture of the substrate.

Drying Time: Weld-Crete® dries to the touch in approximately one hour depending upon humidity. A unique advantage with Weld-Crete® is that it is not necessary to apply concrete or terrazzo topping immediately over dry Weld-Crete®; a lapse of several days will not affect bonding properties.

Precautions: Protect Weld-Crete® from freezing. Surfaces must be structurally sound and clean. Parting compounds (form release agents) and curing compounds applied on surfaces to receive cementitious toppings must be compatible with Weld-Crete®. Protect the applied film from dirt and debris until the fresh concrete overlay is in place. A visual inspection of the bonding agent application should be made prior to final placement of concrete to assure a continuous blue film over the bonding surface. Follow accepted industry standards for protection of newly bonded concrete. Do not use a [illegible] saw to cut isolation joints on newly bonded concrete overlays.

Approvals: New York City Board of Standards and Appeals under Cal. No. 620-52-SM. City of Los Angeles Board of Building and Safety Commissioners (File No. 18.401.1.[illegible]). State of California has approved stucco bonded with Weld-Crete® for a 2 hr. fire rating. File No. A1080-261.1, August 22, 1964.

6. AVAILABILITY AND COST

Availability: Weld-Crete® is available in all principal cities from building supply dealers throughout the United States and Canada.

Cost: Material cost is approximately [illegible] per square foot.

7. GUARANTEES

Larsen Products Corp. warrants Weld-Crete® to be suited for the purposes described when used according to directions and has been continuously tested and used in practical applications since 1953. Buyer agrees in purchasing this product that Seller's liability for breach of warranty shall in no case exceed the price of the product. Because of the broad range of conditions beyond our control which may be encountered in the use of the product, Larsen Products Corp. makes no other warranty, express or implied, and no agent or other person is authorized to do so.

8. MAINTENANCE

None required.

9. TECHNICAL SERVICES

Technical services and laboratory facilities are available through the manufacturer. Write for name of nearest representative or distributor. Guide specifications arranged in standard CSI Section Format are also available.

Distributors in principal cities throughout the United States and Canada can assist specification writers.

10. FILING SYSTEMS

Sweet's Architectural Catalog
Spec-Data® II

NEWBERG MARBLE HILL

MARBLE HILL GENERATING STATION
QUALITY ASSURANCE MANUAL

Date 10-29-79
Revision B
Page ___ of ___

Title: CONCRETE CORE DRILLING WPN-36

TABLE OF CONTENTS

NEWBERG MARBLE HILL

MARBLE HILL GENERATING STATION
QUALITY ASSURANCE MANUAL

Date 10-29-79
Revision B
Page 3 of 7

Title: CONCRETE CORE DRILLING WPN-36

1.0 PURPOSE

To describe the methods for drilling of cylindrical holes in concrete floors and walls and/or concrete block walls to allow penetration of member for other work.

2.0 APPLICABILITY

This procedure applies to concrete core drilling as indicated above, performed by Newberg-Marble Hill as approved by the Owner.

3.0 DEFINITIONS AND ABBREVIATIONS

Refer to Appendix A of the Newberg-Marble Hill Quality Assurance Manual.

4.0 PROCEDURE

4.1 General

Written notification shall be given to the Owner on a case-by-case basis listing location, elevation, building and appropriate S&L reference drawings prior to commencement of the work. Written acknowledgement and approval shall be received before the actual drilling takes place. This information and approval shall be supplied on the Core Drilling Record Log (Attachment A). Also, an investigation of the A-E drawings and/or the reinforcing steel placement drawings will be made to locate reinforcing and any other embedded items, and documented on the Drilling Release Form (Attachment B).

4.2 Equipment

The drilling machine shall be of a type that is specifically designed for concrete core drilling that can be properly secured to the surface to prevent movement during the drilling operation. Bits shall be of a size and type to adequately permit the efficient and proper drilling of the surface and to provide the opening size required. Bits shall be maintained in good working condition and shall be checked periodically for excessive wear.

4.3 Metal Detection

4.3.1 If required by Owner on the Core Drilling Record Log, a deep magnetic detector shall be used in conjunction with the S&L drawings and/or the rebar placement drawings to locate reinforcement and any other embedded metal in the area to be drilled. If metal detection indicates the presence of metal, it will be reported in accordance with QAPN-12, "Design Changes", using the Contractor Change Request.

4.3.2 The deep magnetic detector used for the above shall be as approved for installation of concrete expansion anchors (See WPN-28, "Expansion Anchors"), and shall be calibrated per QAPN-11, "Control of Measuring/Test Equipment".

4.4 Drilling

4.4.1 Wherever possible, the core drilling machines shall be anchored by the vacuum method. Where vacuum is not possible or practicle, anchoring shall be done with concrete expansion anchors. Where the method of anchoring shall require the drilling or chipping of any concrete, written approval from the Owner shall be obtained prior to anchoring.

4.4.2 Bit Selection and Core Removal

After properly securing the drilling equipment to the wall or floor surface, the selection of the proper size and type of bit, drilling is to commence to the depth of the particular size drill bit. After achieving this depth, the drill bit is to be extracted from the surface for removal of the concrete core. The concrete core is to be removed using electric or pneumatic chipping hammers. With removal of each successive concrete core, the drill bit is inserted into the hole to its next succeeding bit depth. This process is continued depending on the thickness of the core and/or wall or floor.

4.4.3 Embedments Encountered

If reinforcing or other embedded metal, which was not anticipated or discovered by use of the magnetic detector, is encountered and/or damaged, the drilling operation will be suspended and the damage will be reported in accordance with QAPN-12, "Design Changes", using the Contractor Change Request.

4.5 Personnel

4.5.1 Drill Crew

Shall consist of a driller and helper who are experienced in this type of operation. The driller shall be responsible for the maintenance and operation of the drilling equipment. This shall include but not be limited to utilization of proper bits and drilling pressures. The drillers' qualifications and training shall be documented in accordance with QAPN-3, "Training and Qualifications of Personnel". The drill crew shall be

under the direct supervision of the Drilling Superintendent whose qualifications will also be made a matter of record in accordance with QAPN-3.

4.6 Documentation

Documents will be maintained in accordance with QAPN-18, "Q.A. Document Control", and QAPN-17, "Data Packages".

5.0 REFERENCES

WPN-28, "Expansion Anchors"
QAPN-3, "Training and Qualifications of Personnel"
QAPN-11, "Control of Measuring/Test Equipment"
QAPN-12, "Design Changes"
QAPN-17, "Data Packages"
QAPN-18, "Q. A. Document Control"

NEWBERG
MARBLE HILL

MARBLE HILL GENERATING STATION
QUALITY ASSURANCE MANUAL

Date 10-29-79
Revision B
Page 6 of 7

Title: CONCRETE CORE DRILLING WPN-36

ATTACHMENT A

CORE DRILLING RECORD LOG

NEWBERG
MARBLE HILL

1. LOCATION
Fab Dwg. Ref.:
Building:
Member: [ ] Slab [ ] Wall [ ] Other:
Safety Category: [ ] I [ ] II
Elevation:

2. HOLE DATA
Diameter: Depth:
3. EQUIPMENT
Drill:
Method of Anchoring:
4. GENERAL
Reason for hole and or special instructions:

Responsible Organization Mgt. Date

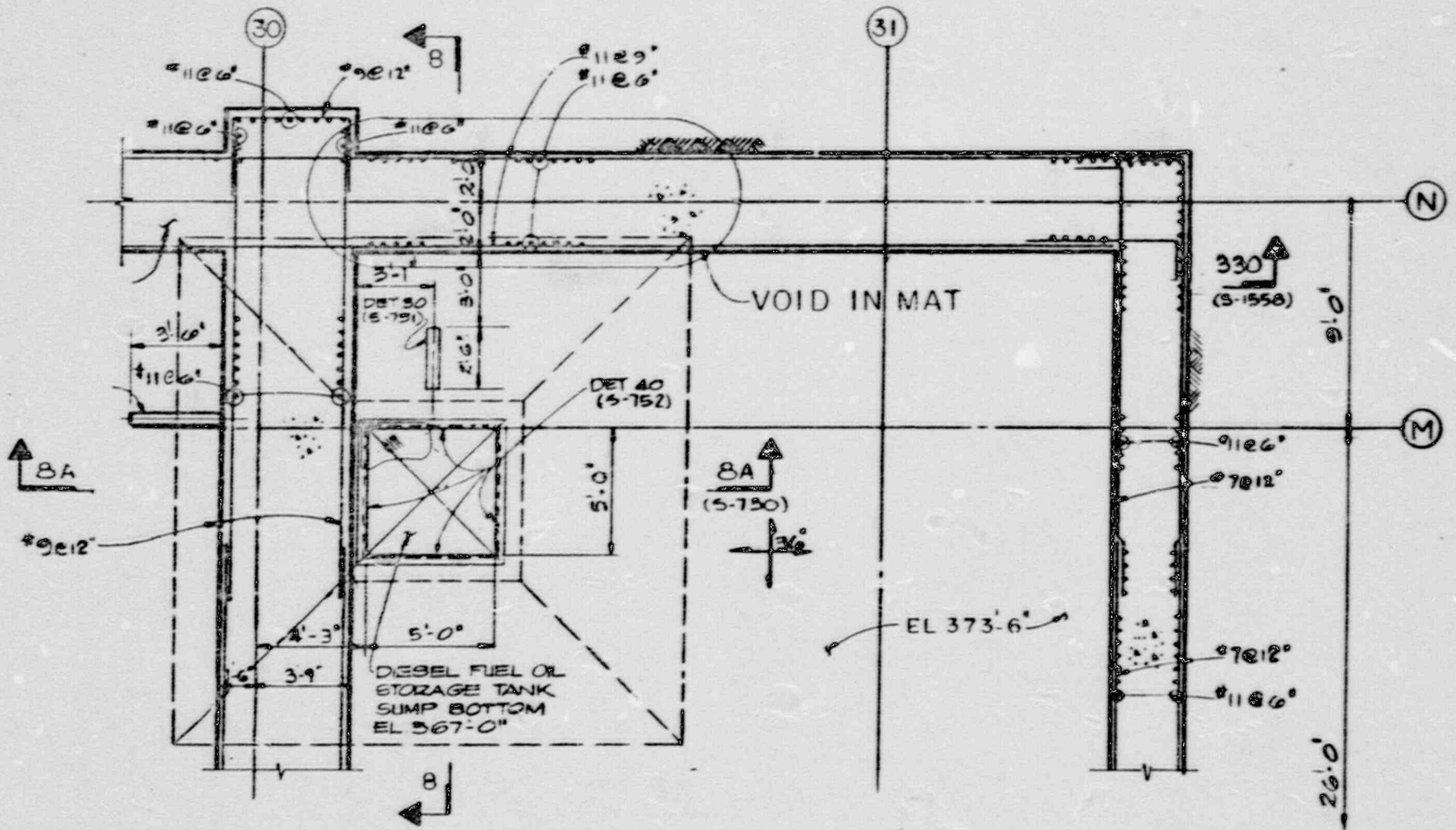
[ ] Acceptable [ ] Rejected
Magnetic Detector Required: [ ] Yes [ ] No
Cutting of Rebar Allows: [ ] Yes [ ] No
Special Instructions:

PSI SOCB SUPV. DATE S & L DATE

PSI QA CONST SUPV DATE PSI CONST PROJ ENG DATE

EXHIBIT 7
SL-3753
11-20-79

LOCATION OF VOID IN AUXILIARY BUILDING SLAB



AUXILIARY BUILDING FLOOR FRAMING PLAN

EL 377 0 AREA 4

SARGENT & LUNDY
ENGINEERS
CHICAGO

EXHIBIT 7
SL-3753
11-20-79

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EXHIBIT 7
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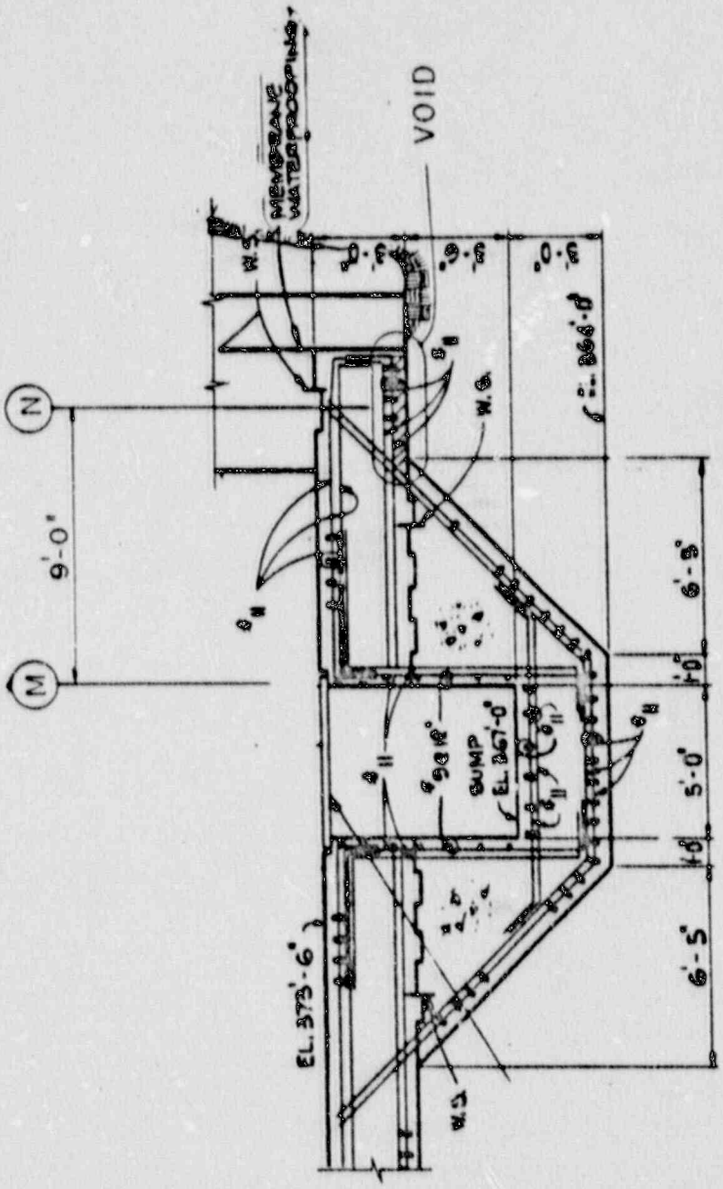

SECTION 8-8