PSE&G

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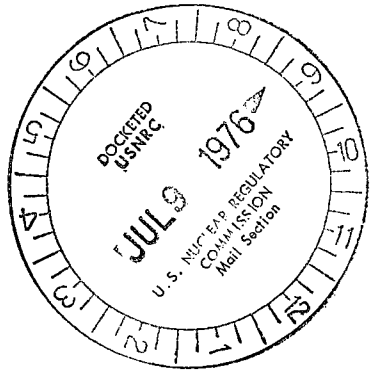
June 30, 1976

Regulatory Docket File

Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Karl Kneil, Chief
Light Water Reactors Branch 2



Gentlemen:

REPORT ON ULTRASONIC EXAMINATION
STEAM GENERATOR CLAD CRACKING
NO. 1 UNIT
SALEM NUCLEAR GENERATING STATION
DOCKET NO. 50-272

Public Service Electric and Gas Company hereby transmits its final report regarding ultrasonic examination of steam generator clad cracking. This report contains a description of the examination performed, results, conclusions and our proposed inservice inspection program in this matter.

Very truly yours,

R. L. Mittl
General Manager - Projects
Engineering and Construction
Department

EAL:adb

Attachment

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The Energy People

REPORT OF ULTRASONIC EXAMINATION
STEAM GENERATOR CLADDING CRACKING
NO. 1 UNIT
SALEM NUCLEAR GENERATING STATION

INTRODUCTION

An ultrasonic examination measuring the extent of cladding cracks in the No. 14 steam generator on Unit No. 1, Salem Nuclear Generating Station, has been completed. This inspection together with our letter of May 28, 1976 discussing liquid penetrant and metallographic evaluation completes the investigation of steam generator cladding cracking on No. 1 Unit.

RESULTS

The ultrasonic inspection has lead to the determination that cladding cracks can be detected from the O.D. surface and that those examined do not penetrate into base metal.

BACKGROUND

Liquid penetrant inspection of the steam generator channel heads on Unit No. 1 revealed the presence of cladding cracks. These cracks were most heavily concentrated in a 2' x 4' area in the upper half of the cold leg side of the No. 14 steam generator. The ASME Boiler and Pressure Vessel Code accepts surface indications in cladding providing such indications are confined to the cladding itself (Code Case No. 1738).

Exploratory grinding of four areas within the 2' x 4' zone was conducted to determine the extent of the surface dye penetrant indications. Grinding was initiated to a depth of 1/8" below the top surface of the cladding, at which time a dye penetrant re-examination was performed. Of four areas excavated and dye penetrant inspected, three revealed cracking still present. Excavation was then halted to avoid possible exposure of base metal.

To determine whether the cracks progressed through the cladding into base metal an ultrasonic examination was initiated. A cladding crack 4" in length, located at a distance of 5" from the interface between the Inconel back cladding and the channel head cladding in No. 14 steam generator was selected for examination. (Photograph No. 1) This defect was judged to be representative of the defects in the upper head and throughout the balance of the steam generators. This defect was also selected for examination in view of its location in the highest stressed area of the channel head and its ease of inspectability using existing UT methods.

ULTRASONIC TEST METHOD

Ultrasonic test procedures and equipment were developed by Westinghouse in collaboration with Automation Industries (A.I.) at Danbury, Connecticut. The procedures and equipment were then supplied by Westinghouse to Public Service for examination of the No. 14 S.G. These procedures and equipment were applied successfully at the Indian Point No. 3 Nuclear Generating Station. Results of the Indian Point program are described in a supplement to Westinghouse Report No. TD-MET-75-080.

It was decided that UT surveillance would be limited to a single patch on the cold leg side of No. 14 steam generator. The hot leg side of No. 14 steam generator, and both legs of the remaining steam generators did not reveal any evidence of the extensive, concentrated cracking present in the cold leg side of No. 14. All steam generators will also be monitored by periodic visual examination.

A calibration block was prepared by A.I. Nuclear Engineering Services Division for Westinghouse from a section of the same scrap channel head used for the U.T. standard at Consolidated Edison's Indian Point No. 3 Nuclear Generating Station. The block, approximately 12" x 13-1/2", was sectioned from the upper edge of the SA-216 Grade WCC channel head after cladding with the same submerged arc process used on production heads. Although the steam generators at Indian Point No. 3 are series No. 44 and Salem No 1 has series No. 51, the channel head configuration is essentially the same. The 309 S.S. cladding was ground smooth and four notches, 3/4" long by .125", .250", .375" and .450" deep respectively were cut perpendicular to the clad surface by the electro discharge machining process. A scanning fixture was fabricated to provide guided straight line manual scanning at fixed intervals and mounted to the calibration block O.D. (unclad) surface.

On June 8, 1976 the calibration procedure was demonstrated to PSE&G representatives by Westinghouse at Danbury, Connecticut with a model UM-775 Reflectroscope, a 1 MH_z 1-1/8" diameter 48° search unit, and an X-Y recorder. The recorder was attached to the Reflectoscope and the scanning fixture so that the recording pen was moved in the X direction by amplitude response from Reflectoscope and Y direction by vertical movement of the search unit. Calibration was done essentially to Westinghouse Procedure NPT-61. The calibration block was traversed in 5" long scans at 1/4" intervals until maximum response was obtained from the four reference notches. Then the four appropriate 5" scans were recorded, using the top corner reflection as the end point of each scan. The test was considered satisfactory in that the notches were detectable and provided a reasonably linear response up to the .375" notch.

On June 9, 1976 Westinghouse and A.I. personnel measured the cladding thickness at Salem on No. 14 steam generator ultrasonically. On June 10, 1976 a base line examination was performed on the selected patch using the same equipment and procedures described above. Locator holes approximately 3/16" diameter x 3/16" deep for the scanning fixture were developed by drilling through the mounting feet of the fixture into the channel head after the fixture had been attached to the channel head magnetically. Prior to drilling of the locator holes, proper location of the fixture was established by through-transmission technique using a receiving crystal on the I.D. of the channel head to determine the point of exit or reflection of the sound beam from a transmitting crystal on the O.D.(co-ordinates 58 H-5v). After mounting the fixture, 24 five-inch vertical scans were made at 3/4" intervals using the Inconel 182 back cladding to 309 S.S. channel head clad interface reflection as the end point of the upper travel.

Dual traces were made of each scan on the X-Y recorder. Several reflections of approximately 20 to 25% of screen height were recorded indicating that the cracking 5" from the tube sheet was detectable but not significantly deeper than 1/8". All scanning was done from the cyclindrical portion of the channel head O.D. with the 48° 1-1/8" diameter, 1 MH_z shear wave search unit focused upwards towards the channel head-to-tube sheet weld. No surface preparation was required other than wire brushing to remove loose rust and dirt. USP grade glycerine was used as the couplant as in the on-site calibration and Danbury demonstration.

Copies of NPT-61 and traces made during calibration and scanning are attached.

CONCLUSIONS

The data shows that the 4" long cladding crack determined previously by dye penetrant inspection was detectable by ultrasonic examination from the O.D. of the channel head. More importantly, the depth of the crack was indicated to be no greater than 1/8" below the cladding surface and therefore still within the boundary of the stainless steel cladding.

PROPOSED SURVEILLANCE PROGRAM

The ultrasonic inspection will serve as the base line preservice surveillance examination for the cracked cladding. Public Service will continue to monitor the above cracking on a schedule consistent with the first three re-fueling outages.

The inspection will consist of monitoring the same area (defined by the existing locator points) discussed in the preceding discussion with the same U.T. procedure.

In addition, a supplementary surface examination technique is under investigation.

After the first three refueling outages, the program will be re-evaluated from the standpoint of crack propagation to determine if the examination frequency can be reduced or eliminated.

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PURPOSE: Ultrasonic surveillance procedure for periodically determining the extent and possible growth of clad cracking in designated areas of steam generator channel heads. The procedure includes the means to measure clad thickness as a baseline process and the fixturing necessary to duplicate the test program periodically.

QUALIFICATION OF PERSONNEL: Personnel performing the examination under this procedure shall be qualified in accordance with ASNT-TC-1A, Supplement "C", Level II or III.

OPERATIONS:

Part I: Clad Measurement:

1. Measure clad thickness in the approximate center of designated areas using the procedure detailed in Automation Industries' Report #TR-71-24A.
2. Record clad thickness determined in each area.
3. Clean and check clad surfaces in examination areas.

Equipment:

a) UM 771 instrument "Automation" (must fit through 18 inch manway).
b) 10S db. pulser/receiver 50B 1815 modification.
c) Search unit fixture 57A6878
57A3615 SIZ transmitter search unit
57A2796 SIL receiver search unit
d) Reference standard S/N 1
e) Glycerine for couplant

Calibration:

a) Ensure that display selector switch on inside of 10S db. pulser/receiver is set at Position "D".
b) Turn on instrument and allow proper warm up.
c) Connect cables from transmitter and receiver search units in fixture 57A687S to their respective jacks on the 10S db. pulser/receiver.
d) Adjust the instrument controls to the following preliminary settings:

UM 771

1) Sweep Delay
Push button 5-50
Slide control 1/3 towards max.
Vernier - max. (ccw)
2) Sweep Range
Push button - 1
Slide control - calibrate
Material Vernier - mid range
3) Vertical - adjust to locate baseline at 0 vertical position
4) Altn. - max. (ccw)
5) Rate - max. (cw)
6) Horizontal - adjust to center baseline on scope screen
7) Mode - out

10S db

1) Reference - max. (cw)
2) Sens. db control - 30
3) Video Filter - 3
4) Reject - set to reduce 30% FSD signal to 5% FSD
5) Test - Through
6) Low Z
7) Pulse tune - max. (ccw)
8) Pulse length - max. (cw)
9) Freq.-2.25 MHz

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Calibration: (continued)

e) Position transigate switch to "Off".
f) Apply couplant (glycerine/water mix) to reference block, place inspection fixture on reference block and locate signal from block front surface.
g) Position front surface signal near left side of Reflectoscope screen and mark location on screen with grease pencil.
h) Manipulate fixture and adjust sensitivity db control as required until signal is obtained from reference hole A. Position front surface signal at mark obtained in (g) above, using sweep delay Vernier. Mark location of hole "A" signal on Reflectoscope screen with grease pencil.
i) Repeat step (h) for reference holes B, C and D, and mark the respective locations on the Reflectoscope screen. The reference marks from holes A-D represent cladding thickness of 0.20", 0.25", 0.30" and 0.35" respectively.

Part II. Surveillance Procedure

Equipment:

a) UM 775 Reflectoscope (Automation)
b) 5N Weld Pulser/Receiver
c) Alarm and recording module (Transigate)
d) Westinghouse Immersion/contact search fixture 20° incident angle
e) 1.0 MHz 1-1/8" dia., heavy backing, 51Z transducer, Style #57A3453
f) Scanning fixture (WTD)
g) X-Y Recorder - Mosely Autograph Model #2D-2A
h) Clad channel head (casting) reference block with 3/4 in. long by 1/8", 1/4", 3/8" and 3/16" deep Elox notches
i) Couplant: 2 parts glycerine, 1 part water, 4-5 drops wetting agent per pint

Calibration:

a) Reject off
b) Set response from the 3/8" deep Elox notch to 90% of full screen height (FSH) note and record response from the 1/4" and 1/8" deep notches - should be approximately 50% ± 5% (FSH) and 36% ± 5% (FSH) respectively. (Note response from 3/16" deep notch).

Procedure:

1. Set "feet" on search unit fixture as follows:
   a) Place assembled "empty" search unit fixture on 0.040-0.045 inch thick shim on flat surface.
   b) Adjust feet to touch flat surface.
2. Fill fixture with water and pressurize so that approximately 75-80% of flexible bladder width touches flat surface on which four "feet" are resting.
3. Mount scanning fixture including search unit on reference block so that sound beam is projected perpendicular to notches.
4. Set response from 3/8" deep notch to 90% of full screen height (FSH). Note response from 1/4" and 1/8" deep notches.

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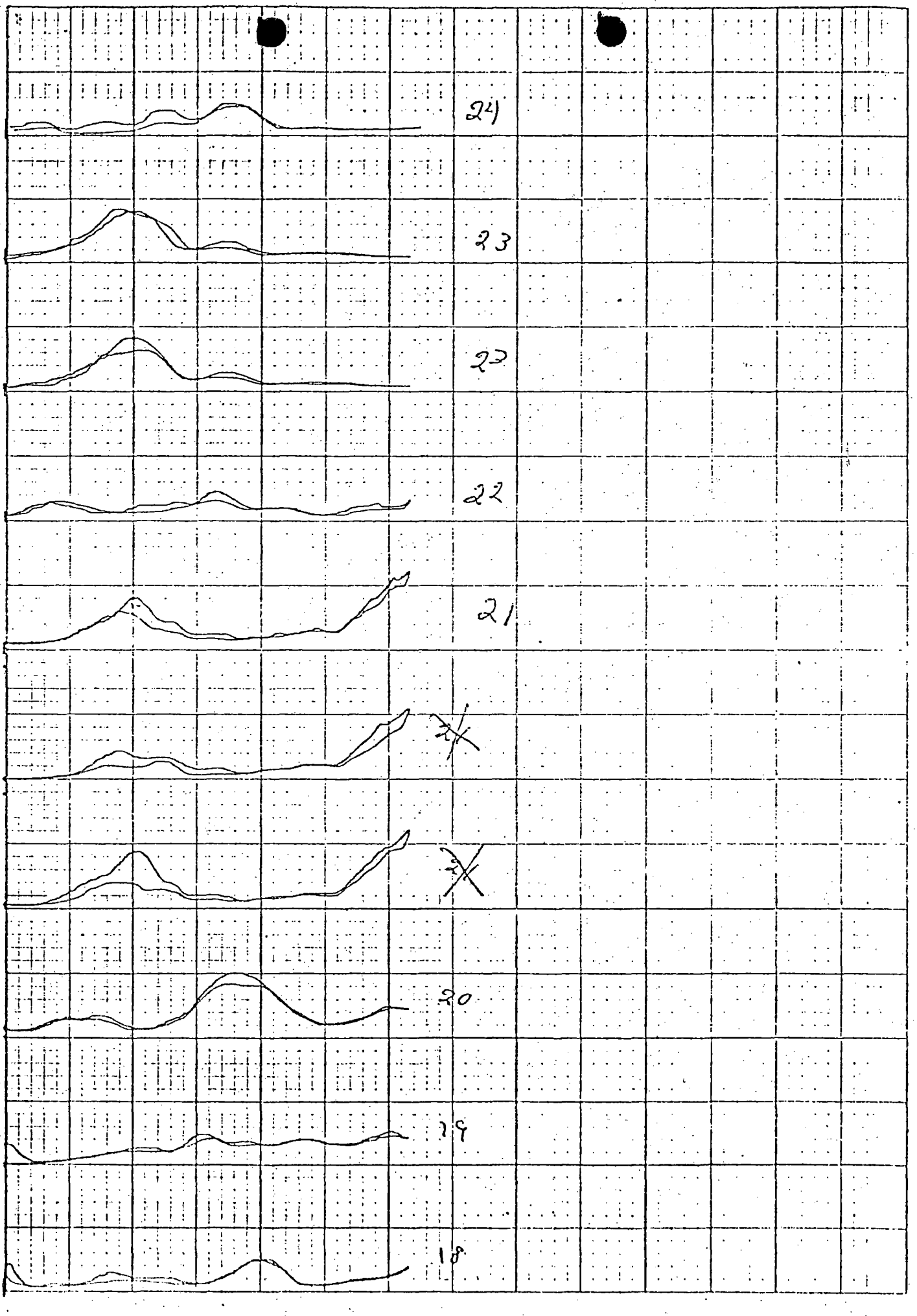
Procedure: (continued)

5. Set recording gate "start" at peak point of 1/8" notch indication minus 1" of test metal distance. Set recording gate "END" at peak point of 1/8" notch indication plus 3/4" of test metal distance.
6. Set recording threshold at 10% of screen height below peak response from 1/8" deep notch.
7. Connect data potentiometer of scanner (5 inch scan length) to Y coordinate of X-Y recorder. Connect amplitude response to X coordinate of X-Y recorder.
8. Record calibration by scanning across reference block at appropriate (approx. 1/4") increments to record maximum responses and locations from reference notches. Set pen manually to duplicate scan spacings.
9. Place scanner on selected area of channel head. Set search unit on left hand edge of area to be scanned. Move search unit to top of scan (5") and return to bottom of scan length. Move search unit 3/4" to right, move pen on recorder 3/4" and repeat 5" scan. Repeat process at 3/4" increments until 12" wide (circumferential direction on channel head) has been traversed.
10. Maintain records for comparison with periodic in-service recordings made in the same manner as described.
11. Clean and identify areas.
12. Follow the above procedure on channel head by placing the search unit fixture "feet" in drilled holes for each position.
13. Record UT results for each area scanned on channel head.
14. Maintain records for comparison with periodic in-service recordings made in the same manner as described.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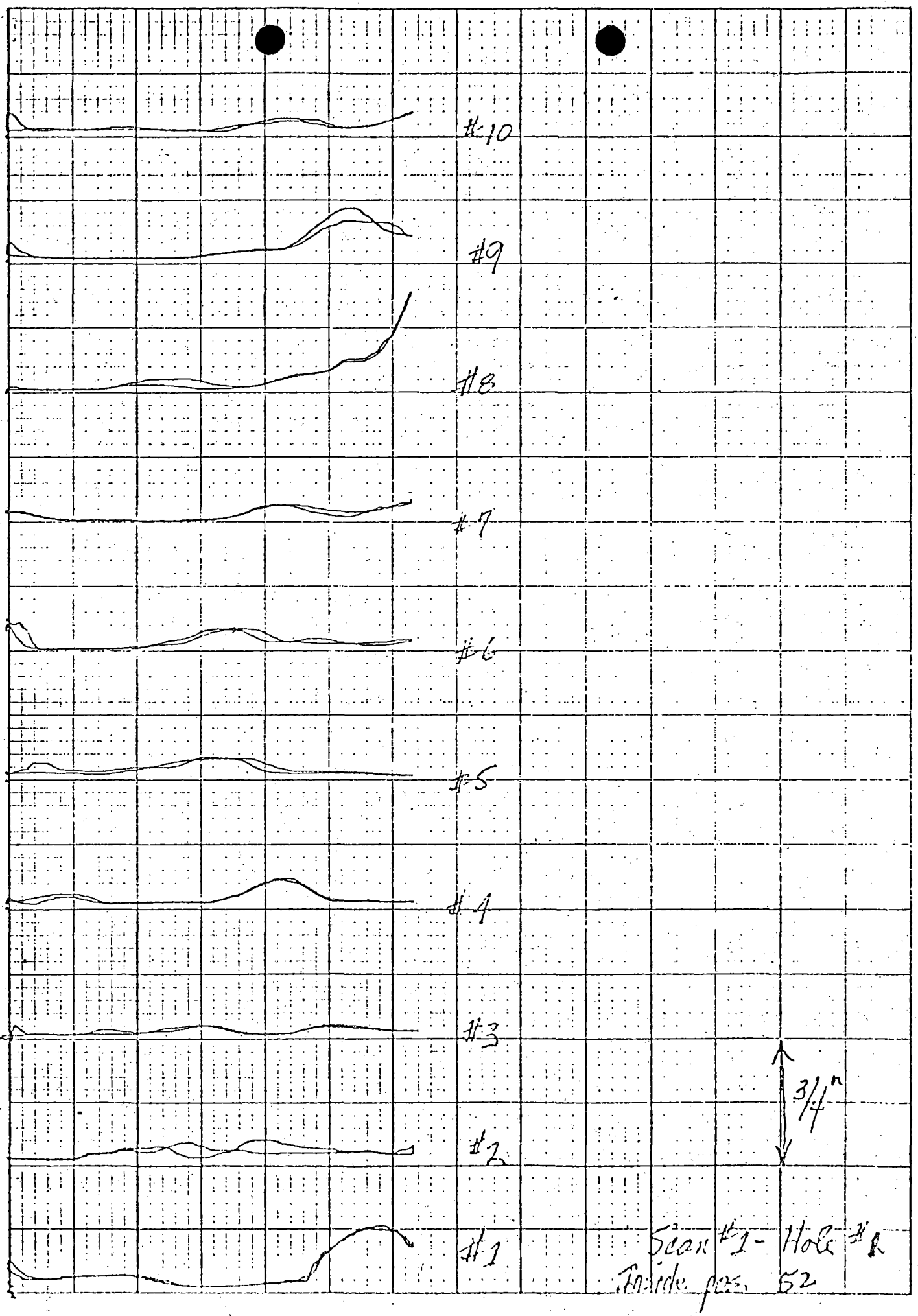

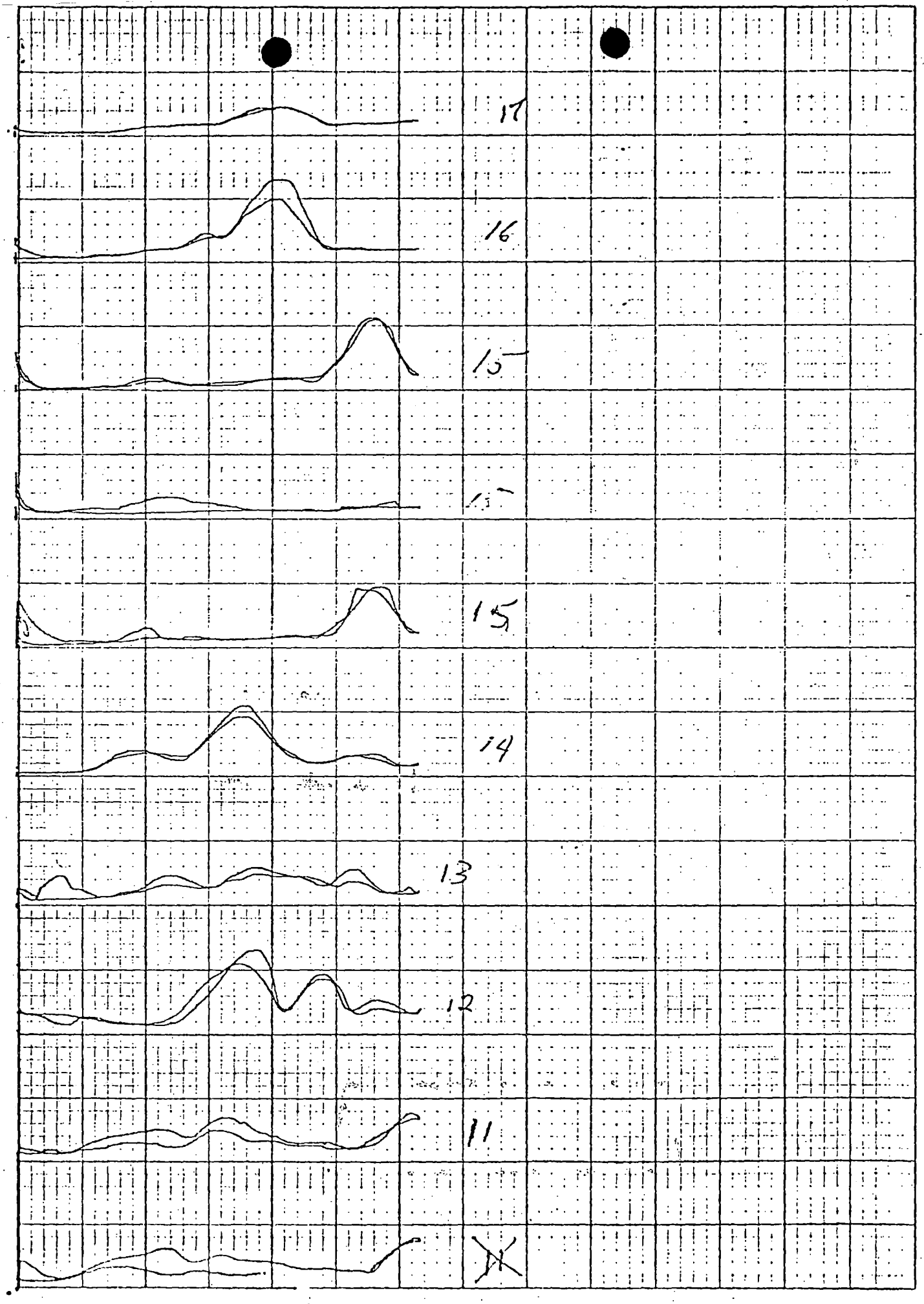
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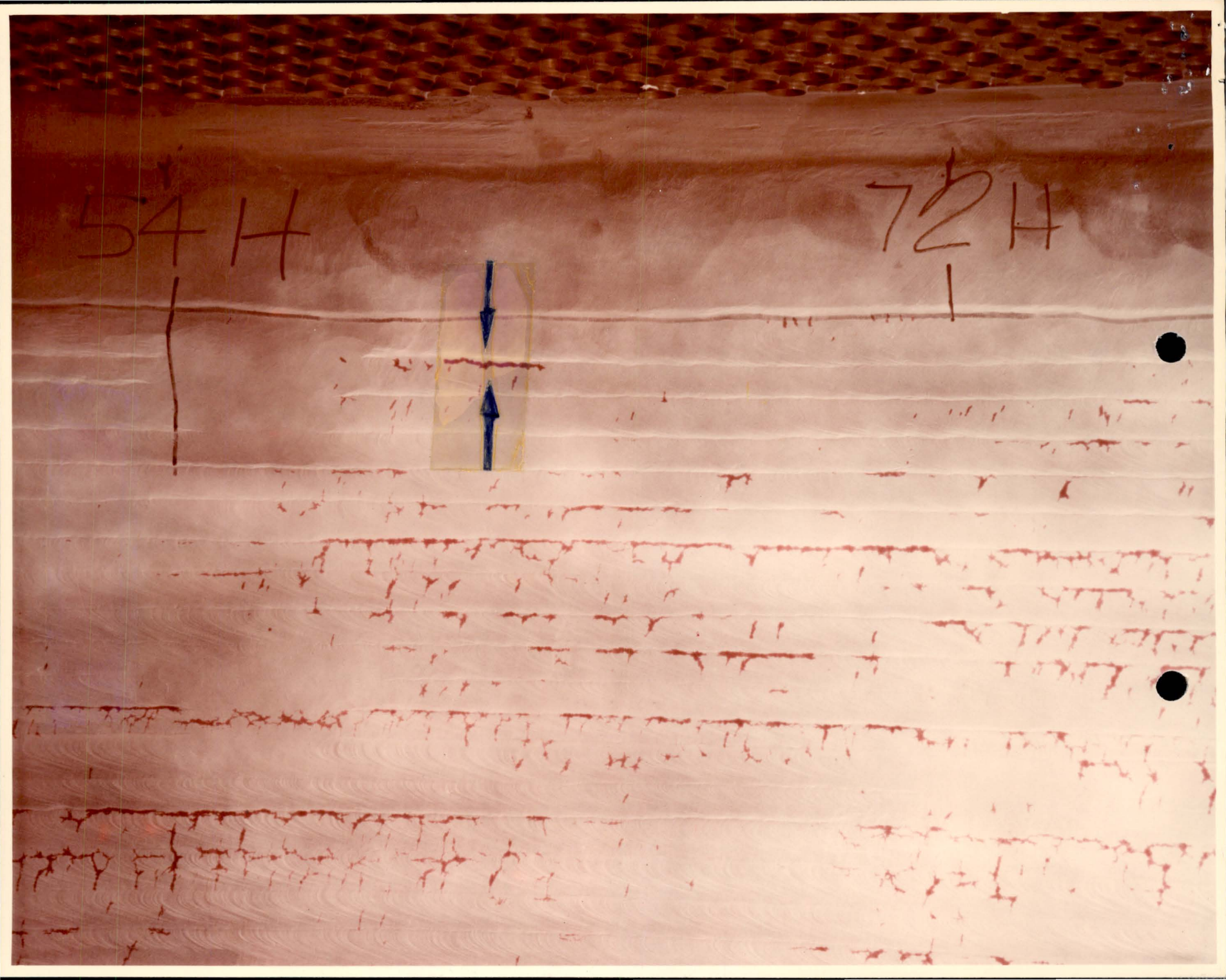
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