RHO-RE-ST-8 P

EVALUATION OF WEST VALLEY NEUTRALIZED WASTE TANK PHOTOGRAPHIC, VIDEO TELEVISION AND ULTRASONIC MEASUREMENT INSPECTION RECORDS

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Process Design Department

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Under Contract DE-AC06-77RL01030

Rockwell International
Rockwell Hanford Operations
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ABSTRACT

The nuclear fuel reprocessing operations, conducted at the Western New York State Nuclear Service Center, West Valley, New York, between 1966 and 1972, produced approximately 572,000 gallons of high-level liquid waste which is presently being stored in underground tanks. The Nuclear Regulatory Commission, with concurrence of the U.S. Department of Energy, contracted with Rockwell Hanford Operations to obtain photographic, video television, and ultrasonic inspection records of two underground carbon steel tanks.

The results of an evaluation of these photographic, video television, and ultrasonic inspection records are contained herein. Also provided is a description of the methods used, the inspection procedures, the inspection equipment and operation, and the evaluation processes.

EXECUTIVE SUMMARY

The Western New York State Nuclear Service Center, West Valley, New York, is the site of a former nuclear fuel reprocessing facility. The resulting high-level radioactive waste generated between 1966 and 1972 is presently stored at West Valley in underground tanks.

The Nuclear Regulatory Commission (NRC), with the concurrence of the U.S. Department of Energy (DOE), contracted with Rockwell Hanford Operations, a DOE contractor, to obtain photographic, video television, and ultrasonic inspection records of the two carbon steel tanks at West Valley. The purpose for performing this inspection/surveillance is to assess the condition of the storage tanks at West Valley.

The two neutralized underground waste tanks (8D-1 and 8D-2), fabricated of carbon steel plate, have a 750,000 gallon storage capacity each. At the time of the inspection, the active tank, 8D-2, contained about 560,000 gallons of neutralized waste consisting of supernatant and sludge; the standby tank, 8D-1, contained approximately 142,000 gallons of liquid that was only slightly contaminated with radionuclides at the time of the inspection.

The onsite tank inspections were accomplished by use of a Large Area Scanner, developed by Rockwell Hanford Operations, which accessed the annulus space between the tank and vault walls via a 30 inch diameter riser. The functions performed with the Large Area Scanner, on an approximately 13 foot wide by 27 foot high surface area of each of the steel tank walls are listed as follows:

- 35 mm still photographs and real time video television images to show the visual condition of the tank walls.
- Wire brushing of the tank wall to remove any surface deposits in preparation for ultrasonic (UT) inspection. Real time video television

images of the wire brushing operation.

- 35 mm still photographs and real time video television images to show the cleaned condition of the steel tank walls.

- UT inspection to determine existing tank wall thicknesses.

Review and evaluation of 5 inch by 7 inch prints of the 35 mm exposures and the real time video television images taken before the wire brushing operations indicate that a considerable amount of a whitish substance, assumed to be a calcium-based material, has accumulated on the outside surface area of the 8D-2 tank wall. Essentially no whitish deposits were noted on tank 8D-1. However, the heaviest rust concentration of deposited material was worse on the cooler tank, 8D-1, than on 8D-2 and was located near the top of the tank wall in line with the 30 inch diameter access riser, with decreasing amounts near the bottom of the tank and at the outer edges of the surface area inspected.

Photographs taken of both tanks after wire brushing showed that this operation was generally very successful in removing the deposited material, and produced a relatively clean surface. Surface pitting was observed to have occurred. The photographs showed that tank 8D-2 has experienced much less corrosion than tank 8D-1. This is assumed to be because of 8D-2's higher temperature being effective in driving off the moisture and eliminating the electrolyte (water). During the video inspection, the three observers estimated that the worst pits ranged from 0.04 to 0.06 inch in depth. Pit depth was not extrapolated from the ultrasonic measurements.

No unusual or suspicious geometry changes (bumps, buckling, warping, etc.), surface defects such as cracks, gouges, etc., or evidence of leaks were observed on either of the tanks. However, on tank 8D-1, dark moist areas were noted to originate from weepholes in a circumferential steel ring on top of the tank. These weepholes were designed to be drainage ports for the vault roof condensate, and the dark areas result from moisture seeping through these

weepholes and down the tank wall. No evidence of moisture was observed on tank 8D-2 because of its higher temperature (approximately 170°F).

The ultrasonic measurements, which were capable of measuring thickness to the nearest 0.01 inch, indicated that the plates for both tanks are, as a whole, thicker than originally specified. Therefore, a corrosion allowance slightly greater than the original design corrosion allowance of 0.250 inch presently exists. The actual allowance varies with location along the wall.

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INTRODUCTION

PURPOSE

This report documents the results of an evaluation of photographic, video television and ultrasonic measurement inspection records of portions of two carbon steel waste storage tanks at West Valley, New York. This evaluation is intended to provide information to be used to assess the condition of the storage tanks at West Valley, New York. Due to the volume and format of the data contained in the Appendices, only a single master copy, to be located at West Valley, has a complete set of Appendices.

BACKGROUND

The Western New York Nuclear Service Center (WNYNSC), located near West Valley, New York, has served as a site of a commercial nuclear fuel reprocessing facility. Operation of the center was managed by Nuclear Fuels Services, Inc. (NFS), under a lease with the state of New York from the time construction began in 1963 until February 1982, and subsequently, by West Valley Nuclear Services Company, Incorporated.

The fuel reprocessing portion of the center began operation in 1966 and was shut down in 1972. High-level liquid waste was generated during operation and at the time of inspection there were approximately 572,000 gallons of high-level radioactive waste stored in two underground tanks at West Valley. One carbon steel tank, 8D-2, contained approximately 560,000 gallons of neutralized waste at the time of the inspection; a stainless steel tank contained approximately 12,000 gallons of acid liquid waste. A second set of tanks (one carbon steel and one stainless steel) is maintained as backup for these active tanks.

Early in 1978, the E.I. duPont de Nemours and Company, Savannah River Laboratory, Aikin, South Carolina, issued an analysis of available information relating to the waste storage system at West Valley. This document, "Safety

Related Information Available on NFS Waste Tanks," filed under NRC Docket Number 50-201 (Reference 1), provides recommendations for studies to obtain additional safety-related information on the existing storage system and to allow for enhanced future planning.

Accordingly, in November 1978, the NRC, with the concurrence of the U.S. Department of Energy (DOE), requested Rockwell Hanford Operations (Rockwell), a DOE contractor, to propose a plan for inspection of the West Valley waste storage tanks, determine their condition, and generally achieve the information gathering objectives recommended in the above referenced analysis. This proposal, therefore, formed the basis of this work and consisted of obtaining onsite photographic, video television, and ultrasonic inspection records of two carbon steel waste storage tanks at West Valley (Reference 2). The results of an evaluation of these inspection records are contained herein.

SCOPE

The results of an evaluation of photographic, video television, and ultrasonic measurement inspection records of limited portions of two carbon steel waste tanks (8D-1 and 8D-2) designated for the storage of neutralized waste at West Valley, New York, are presented. The methods, techniques, and procedures implemented for obtaining the inspection records are also provided. All figures for this report follow the main text and are in the figure section.

TANK DESCRIPTIONS

About 30 mi. south of Buffalo, New York, is the approximately 3,300-acre New York State controlled reservation; the 156-acre site controlled by DOE where the waste storage tanks are located is within this area. The waste storage facilities at West Valley, situated in the north western region of the reservation (Figure 1), consist of two pairs of underground tanks within close proximity of each other. One pair of the tanks (8D-1 and 8D-2) are designated

for containment of neutralized wastes; the other pair (8D-3 and 8D-4) for acid liquid waste (Figure 2). Only one tank in each pair is an active waste storage tank; the other is a spare. The acid waste tanks (8D-3 and 8D-4) are not included in the scope of this evaluation effort and, therefore, will not be discussed further.

The neutralized waste tanks, identified as 8D-1 and 8D-2, are 70 feet in diameter by 27 feet high and have a 750,000 gallon storage capacity each. The tank walls consist of approximately equal section heights of 0.500, 0.534 and 0.656 inch thick carbon steel plate from top to bottom, respectively. The floors and roofs of the tanks are flat and consist of 0.656 and 0.438 inch thick carbon steel plate, respectively. The ASTM-A-201, Grade A carbon steel walls, roofs and floors have been postweld heat treated (stress-relieved) and provide, by design, for a 0.250 inch thick corrosion allowance (originally estimated to have a design life of 50 years).

Each primary tank rests on perlite blocks laid on a 3 inch layer of pea gravel, all retained in a 72 foot 6 inch diameter by 15 inch high carbon steel ring which in turn sits on a carbon steel pan, 75 feet in diameter by 63 inches high. This pan rests on a second layer of pea gravel placed on the floor inside of a 75 foot 7 inch diameter outer reinforced concrete vault. The steel tanks and concrete vaults were built in 1964 and 1965 to the Uniform Building Code, Zone III, specifications.

A single 30 inch diameter access opening is located directly above the annulus space between the steel tank wall and concrete vault wall. See Figure 3 for a cross-section of the tank.

A more detailed description of the tank features may be found in Reference 3.

TANK CONTENTS

The active waste tank, 8D-2, contained approximately 560,000 gallons of neutralized waste at the time of inspection. Past and present conditions of the waste in the tank which may affect tank wall surface deposits and condition are the following:

- The wastes were originally close to boiling temperatures (present temperatures are 180 to 185°F).
- Air is continuously admitted via four airlift circulators at a rate of 2 $feet^3$/minute per air lift.
- During its lifetime, a liquid-air interface has existed at least at one and probably at several liquid depths for extended periods of time.
- The tank contents are continuously being cooled by evaporation from the liquid's surface. At the time of the inspection, 8D-2's evaporation rate was approximately 3 gallons per hour.

Tank 8D-1, which contains the condensed water from 8D-2, was approximately one-third full of slightly contaminated water at the time of inspection.

ONSITE EXAMINATION

PHOTOGRAPHIC

One set of 35-mm photographs was taken of each tank to evaluate the initial "as-is" condition of the tank wall surface area; a second set of photographs was taken of each tank after wire brushing of the areas to evaluate the "after wire brushing" condition. A total of one thousand five hundred seventy-eight, 35-mm photographs were taken. Wire brushing was performed to remove surface deposits which have accumulated on the tank wall during its existence.

All photographs taken of both tanks before wire brushing were spaced on a gridwork of 9.9 inches horizontally and 6.5 inches vertically. Photographs taken after wire brushing of tank 8D-1 are spaced on a gridwork of 19.8 inches horizontally and 13.0 inches vertically; for tank 8D-2 they are spaced 14.8 inches horizontally and 9.8 inches vertically. All photographs were taken using a Nikon F2 single lens reflex camera equipped with a Nikon 35-mm F2.8 lens. Exposures were made on Ektachrome slide duplicating film 5071, which has an ASA rating of approximately 4, with the use of a Lowel 1,000 watt Tota-Light light source at exposure times of 1/60 of a second. The very slow ASA 4 film was used to allow for a longer residence time in the 1500 R/hr radiation field.

Each exposed slide was reproduced as a 5 inch by 7 inch print which resulted in approximately a 1/2 inch overlap for the photos taken with a 9.9 inches horizontal spacing. The center to center spacing of these prints is about 6 3/8 inches; thus, the 5 inch x 7 inch prints represent approximately a 2/3 scale image.

VIDEO TELEVISION

Real time video tape inspection records of both tanks were made during the photographic and wire brushing operations. These recordings were made using an

Edo Western Corporation television camera, Model CH-1831-30531, with an 8.5-mm lens, and a Sony VO 2800 video recorder. The Lowel 1,000 watt Tota-Light was used as a light source with proper control being maintained with a Variac voltage regulator.

The continuous real time video television scans made during photographic operations include 0.5 to 1.0 second pause time interruption to allow for operation of equipment and exposure of the film at each photograph location. The video television scans made during the wire brushing of tank 8D-1 record the continuous horizontal passes along the tank wall at a travel speed of 2.415 inches/second and incremental vertical steps of 2 inches for each pass. For tank 8D-2, the video television records show continuous horizontal passes along the tank wall at a speed of 17.7 inches/second and incremental vertical steps of 1 inch for each pass.

ULTRASONIC INSPECTION

Ultrasonic inspection records of each tank were obtained after wire brushing removed the loose scale and rust from the tank walls. For tank 8D-1, UT inspection readings were taken on a gridwork of 1 inch spacings for both the horizontal and vertical directions; for tank 8D-2, readings were taken on a gridwork of 2 inch spacings for both directions, as the photographs showed significantly less signs of corrosion.

One longitudinal and four shear mode UT transducers were used to obtain data at each location on the gridwork patterns. The longitudinal mode transducer measured wall thickness and identified any external or internal flaws within the wall. The four shear mode transducers, two left and right looking and two up and down looking, propagated ultrasonic waves at 45° to the wall surface area for location of internal or external flaws which would not be detected by the longitudinal transducer.

All UT data generated and collected at each data point location on the gridwork patterns, in addition to X and Y reference coordinates, were recorded and stored in mass storage on magnetic disk.

Continuous monitoring of the UT inspection data was performed during the inspection process by visual observation of a graphical representation of the wall thickness and wall condition on two separate cathode ray tube monitors. One monitor was used to determine the validity of the data and to observe the thickness and condition of the tank wall at a given data point of the gridwork. A second monitor displayed a graphical representation of the tank wall thickness and condition based on the data accummulated from the most recent 24 points evaluated. An on-the-spot judgmental evaluation of the data was made during the inspection process, and where necessary, localized areas of the tank wall were reinspected using a data point gridwork of 1/8 inch spacings. The operator was also able to determine if low readings (i.e., 0.32 inch or less) were due to poor coupling. The operator thus has to assist in the evaluation of the output to delete the standing wave spikes (typical in UT measurements), which printed as 0.32 inch. His input was also valuable in identifying double reflections, which might otherwise be interpreted as thickness anomalies.

RESULTS AND DATA EVALUATIONS

Radiation levels were monitored continuously during operations and equipment was surveyed upon removal. No contamination of equipment was experienced, and none of the tank walls were observed to have leakage after wire brushing. Radiation levels increased, as indicated by an air monitor alarm during wire brushing. This was determined by the West Valley personnel to be because of naturally occuring radon gas.

PHOTOGRAPHIC

Photographs of the outside walls of both steel tanks, showing the before and after wire brushed conditions, were reviewed and evaluated for obvious features expected to be visible on the outer surfaces. These items include: geometry changes (bumps, buckling, warping, etc.), corrosion deposits, surface defects (cracks, gouges, etc.), and deposits of leaking material.

All of the 35 mm still exposures (slides) to be reviewed were first printed in a 5 inch x 7 inch format. For tank 8D-2, prints of all exposures, for both the before and after wire brushed conditions, were reviewed. For tank 8D-1, prints of all exposures taken after wire brushing and prints of the corresponding exposures taken before wire brushing were reviewed.

Reviews of photographs taken prior to the wire brushing operation showed a heavy deposit of an unknown whitish material to have accumulated on the outside surface of tank 8D-2 (the hot tank). The heaviest rust concentration was on 8D-1 (the cold tank). Both the rust and whitish deposits were located near the top of the tank and centered under the 30-inch diameter access riser, with decreased deposits being observed near the bottom of the tank and at the outer edges of the surface area investigated. Figure 11 shows the general distribution of deposited material, both rust and whitish material, relative to the area inspected.

Other localized heavy concentrations of the corrosion material were observed to be accumulated on weldments extending to the limits of the weld heat affected area, or in the form of striations, believed to be associated with surface scratches or marks made during fabrication, which resulted in disturbing the protective action provided by the mill scale.

Positive identification of the whitish substance was not included in the work scope of this evaluation effort and, consequently, was not performed. However, it appears to be a calcium-based material that presumably came from the concrete vault. It is hypothesized that the rust deposits and whitish material were worse under the 30-inch diameter access riser because of an environmental condition created within the vault annulus area which is a result of circulating air currents and temperature conditions associated with the riser or rain water leaching through the shielding sand in the access port riser and draining around the access port plug onto the tank.

The whitish material was described by members of the field tank inspection team as a light, rather porous, flaky, powdery, chalky material with an off-white to grayish color except for larger pieces showing a rust color on the back surface which had been against the steel. (The gold color of the 8D-2 photographs was due to radiation damage to the film.) The whitish material came off in chunks or crumbled when wire-brushed.

The amount of corrosion deposit accummulated on tank 8D-2 (the hotter tank) was much less than was observed on tank 8D-1. In fact, the amount of deposit over a major portion of the area evaluated on tank 8D-2, near the bottom and the outer edges, was so slight that the construction identification markings placed on the steel plates during fabrication could easily be identified and read; thus, these areas of the tank 8D-2 appeared relatively clean except for a very slight whitish powdery film deposited on the surface over the mill scale. Tank 8D-2 is judged to be in excellent condition.

Because of the extent of deposited material on the wall of tank 8D-1, evaluation of the photographs taken before wire brushing proved to be questionable. Since a valid evaluation of the tank wall condition could only be made by evaluating a clean surface, it was decided to develop the prints of every other exposure of tank 8D-1 showing the wall condition before wire brushing. The video television records produced during the photographic and wire brushing operations further substantiate this decision.

Photos representing the typical "before wire brushing" condition of tanks 8D-1 and 8D-2, are shown in Figures 12 through 15 and 20 through 23, respectively.

Approximately six hundred twenty-five, 5 inch by 7 inch prints, 225 for tank 8D-1 and 400 for tank 8D-2, showing the steel tank surface after wire brushing were reviewed. These photographs showed that the wire brushing operation was very successful in removing the whitish material deposited on the surface of the tank 8D-2 leaving a relatively clean surface area. Surface pitting, as a result of corrosion, was observed. Most pitting appears to have occurred where the most corrosion material had been deposited. No attempt was made to determine the actual depth of the pitting from these photographs. However, it was estimated by the operators that, in the worst cases, the pits could range from 0.040 to 0.060 inch deep. In areas of heavy rust build-up, poor coupling of the UT head resulted in limited data. In these areas, the photographs were used to augment the data evaluation. Tank 8D-1 has experienced much more severe pitting than tank 8D-2. This is attributed to the fact that since tank 8D-1 is much cooler than 8D-2, the resulting condensation on tank 8D-1 has enhanced the corrosion process.

Typical photos of the most severe pitting observed on tanks 8D-1 and 8D-2 are shown in Figures 16 through 19 and 24 through 27, respectively.

No unusual or suspicious geometry changes (bumps, buckling, warping, etc.),

surface defects such as cracks, gouges, etc., or evidence of leaks were observed on any of the photographs for either of the tanks. However, the photos of tank 8D-1 did reveal some dark areas where moisture appeared to exist. These areas originate from cutouts in a circumferential ring around the top of the tank and are a result of moisture seeping through these drainage holes down the wall surface. No evidence of moisture was observed in the photos of tank 8D-2.

For more detailed inspection of the before and after wire brushed tank condition, Appendix B contains all 5 inch by 7 inch prints developed from the 35-mm exposures and maps correlating the photograph identification numbers with tank areas inspected.

VIDEO TELEVISION

All video television scans taken of both tanks during photography before wire brushing, during wire brushing, and during photography after wire brushing were reviewed in playback of the tapes. Copies of the video tapes are provided in Appendix C.

Viewing of video tapes substantiated conclusions drawn from reviewing the photographs taken before wire brushing with respect to the distribution of deposited material on the tank walls. These tapes correlated well with the photographs and confirmed that the least amount of material was deposited near the bottom of the tank walls and toward the edges of the area inspected and that the maximum deposits were located in line with the 30-inch diameter riser and near the top of the tank walls. In summary, the distribution of deposited material as shown in Figure 11 was confirmed.

Also, it was confirmed that much less corrosion material existed on tank 8D-2, the hotter tank, as compared to that on tank 8D-1. Most of the wall surface of tank 8D-2 appeared relatively clean and free of corrosion. Except for small localized areas, and other than that located under the 30-inch

diameter riser, the construction markings placed on the steel plates could be identified. Most of the localized areas which contained corrosion were along weldments.

Video television records made during the wire brushing operation showed large quantities of material being removed in pieces about 1-inch to 2-inches in diameter in regions of its highest concentration.

The video television records made during photography of the tanks after the wire brushing operation revealed that both tank walls had been cleaned to a bare metal or clean mill scale surface. In areas where the corrosion had been removed, pitting of the tank wall could be observed. However, because of the lack of contrasting colors, and the lack of depth perception on the video television screen, the extent and depth of pitting could not be assessed. It was noted, however, that the amount of pitting associated with tank 8D-2, the hotter tank, was much less than with tank 8D-1. This, again, is attributed to the lack of moisture on the wall of tank 8D-2.

The video television records of tank 8D-1 taken after wire brushing also revealed the presence of moisture on the tank wall extending from small cutouts in the steel ring around the top of the tank. The amount of moisture present could not be determined; however, free moisture in the form of water droplets was not observed. Instead, the moisture appeared to seep along the tank surface to form damp spots extending from each of the cutouts down the tank wall for an estimated distance of 2 to 4 feet and extending horizontally approximately 1 to 2 feet. This moisture is believed to have seeped through the small cutouts in the top ring from the top of the tank roof.

No other moisture or damp spots, other than those observed on tank 8D-1, were noted during the video tape reviews. Also, no indications of bumps, buckling, warping, cracks, gouges, or other surface irregularities were observed. Particular attention was given to the tank welds which, other than a

slight amount of pitting, showed no visible structural defects or evidence of leaking.

ULTRASONIC MEASUREMENTS

Ultrasonic measurements were taken of the tank wall thickness of both tanks 8D-1 and 8D-2. Scans were normally done on 1 inch by 1 inch grids for 8D-1 (e.g., a data point was recorded every 1 inch along the vertical and horizontal direction). The grid for 8D-2 was 2 inch by 2 inch as there was much less variation. All measurements were taken right after wire brushing of the surfaces had been completed. The equipment was unable to access the bottom 30 inches of the tank. The middle (0.543 inch thick) and top (0.500 inch thick) plates were measured and all plate areas were thicker than the drawings indicated they would be.

The UT data disk taken on the lower plate in tank 8D-2 was mechanically damaged while attempting to read the disk. The section of the disk containing the file identification field was gouged; a computer specialist was contracted to assist and the bulk of the data was read. The pattern relative to missing data points was quite similar to that found on the upper plates. The bottom plates of 8D-2 were consistently thicker than the drawings specified and the UT data showed little variations in thickness.

The initial data collection plan included making duplicate data disks to prevent just such time delays and costs. However, the controlling program to be used did not work while at West Valley, and copies could not be made.

Thickness data was much harder to obtain for tank 8D-1, especially where the photographs and video television showed heavy surface corrosion products and pitting, due to poor coupling. The data did confirm that the area shown in Figure 11 as having greater corrosion also was thinner than the areas showing less corrosion. A lot of data was not readable due to poor coupling (printed as

"**"). Blanks indicated values within a certain range (e.g., 0.51, 0.52 and 0.53 inch for the 0.500 inch thick region). A number of readings were 0.32 to 0.34 inch. These are felt to be caused solely by line signal noise due to poor coupling. They were most prevalent at weld transitions and badly pitted regions. Even if these were correct values, the 0.250 inch corrosion allowance from the specified plate thickness was not used up in any case. It is concluded that the plates, as a whole, are presently thicker than was specified. Also, tank 8D-1 wall was measurably thinner than 8D-2 wall in the vicinity of the 30-inch riser (area shown in Figure 11). A sample of the output is shown in Figure 28. A complete set of UT data sheets for the test runs is provided in Appendix D. UT data sheets for 8D-1 and 8D-2 Tanks are provided in Appendix E.

A video presentation (designed to aid the operator) of the cross section of the tank wall was generated as the UT scan progressed. The front surface, irrespective of conditions, was represented by a straight vertical line. Any variations in wall thickness were displayed as changes in the distance to the back surface of the wall. UT returns from the shear transducers were variable intensity amplitude signals displayed as a function of distance referenced to the back surface of the wall.

A comparison of tank 8D-2 printouts versus the video presentation was made to determine the cause of low values, high values and missing data. The audio track on the video tape contained comments made during the tests to explain various conditions of the displayed signal that might otherwise be misinterpreted. In evaluating these sections of the tank, both the video and audio were used.

Prior to the evaluation of the tank wall, a comparison of the test plate versus the video representation was made. The section evaluated includes seven test holes from 1/16" to 1/4", and a cross pattern milled in the plate. The wall thickness showed as two parallel lines. The holes caused the shear wave return to be displayed as echos clustered near the back wall proportionate to

the flaw size, and relative to the position as the scan approached and passed.

These video tapes were originally intended to be used as a field aid to operations only, and not as a permanent record. Therefore, the video tapes were reused and the following sections of tank 8D-2 were the only sections remaining on video tape:

X = 0 to 136"   Y = 151" to 211"

and

X = 0 to 136"   Y = 271" to 307"

Evaluation

Low Values - The computer program that generated the wall thickness printout was designed to ignore any signal return less than .32 inches. This was done to avoid signals from shear wave transducer transmission noise, which could show up in the longitudinal gate. Throughout the printouts are a very few .32 inch values. These should be ignored.

An analysis of the video tape indicates that all other low values are valid, and should be considered (particularly when clustered) as thinner areas. Areas of note are just above and below the horizontal weld between the center and upper plate.

High Values - There were very few extremely high readings, and all appear to be second echoes.

Missing Data - Approximately 10% of the data examined was missing. There were several causes for missing data including the following:

- Loss of couplant,
- Extremely bad front surface preventing the initial ultrasound penetration, and
- Bad alignment.

Shear Return - Though the extraction and printout of the inner tank wall condition was not within the scope of this report, it would be impossible to evaluate the video versus the printout without considering it. Tank 8D-2 was quite free of shear wave return which would indicate a fairly uniform back surface free of defects. However, two areas showed considerable shear return:

- The weld between the center and upper plate, and
- That portion of the upper plate that has been consistently above the liquid level.

Statistical Analysis - A statistical evaluation of a portion of the ultrasonic thickness data yielded the following results:

Tank	Expected Wall Thickness	Mean Thickness	Student Deviation	95% Confidence Interval for the True Thickness	Number of Readings
8D-1	0.534	0.543	0.021	0.531 to 0.555	13,445
8D-2	0.500	0.524	0.014	0.516 to 0.532	2,910

The units of the numbers are inches.

The 95% confidence intervals are to be interpreted as meaning that if 100 similar areas of the tank are inspected and the corresponding intervals computed, then 95% of the intervals will contain the true wall thickness. These are computed based upon Student's t distribution. The expected wall thickness for tank 8D-1 is contained in the confidence interval. This gives credibility

to statements that the wall thickness is within acceptable limits. The expected wall thickness for tank 8D-2 is less than the lower end of the confidences. This leads us to conclude, with a reasonable degree of confidence, that the true thickness of the tank is greater than we expected.

The distribution of the wall thickness for both tanks is bimodal. For 8D-1, the larger mode is located at 0.53 inches, 43% of the observations. The other mode is associated with 0.56, 0.57 and 0.58 inches, with 31% (10%, 13%, and 8%) of the observations. The larger mode for tank 8D-2 is 0.52 inches with 57% of the observations and the second mode between 0.54, 0.55 inches with 20% (9%, 11%) of the observations. This is to be interpreted to mean that in general the wall thickness of each tank is larger than expected.

Summary

Nothing definitive can be said about the welds without extracting the shear wave information. However, the video did verify that the low value signals, indicating thin areas, above and below the upper weld were valid. Though there were missing data throughout the scans, the video presentation enabled the viewer to see adjacent points, thus showing consistent wall thickness. The value of using a high density scanning grid was quite apparent.

Another aid provided by evaluating the video was seeing the shear wave return. The tank, in general, was free of excessive shear wave return indicating a uniform corrosion free inner surface (this was not true of tank 8D-1). However, in addition to a large amount of shear return at the upper weld, fairly constant shear return started at approximately 247 inches from the bottom. Historically, the liquid level (Reference Appendix A) has been at or below this level.

These video tapes were of scans that covered less than half of the tank 8D-2 scanned area.

COMPARISON OF RESULTS TO HANFORD EXPERIENCE

The purpose of this effort was to: (1) assess the extent of corrosion of the West Valley low-carbon steel tank which has been exposed to high-level nuclear waste similar in composition to that stored at Hanford for several years and (2) report results of corrosion study of thorax processing solution and 304L SS. The Nuclear Fuel Services (NFS) at West Valley, New York reprocessed both commercial nuclear power reactor and defense production reactor fuels at the Center from 1966 to 1972. Approximately 560,000 gallons of liquid high level radioactive wastes, stored in underground tanks, resulted from this reprocessing. The reprocessing plant is now being maintained in a shut down condition. There are two types of liquid high level waste and two types of waste storage tanks at NFS. There are two large carbon steel tanks (8D1 and 8D2) housed in separate concrete vaults. Tank 8D2 contains about 550,000 gallons of neutralized high level waste from the Purex processing of uranium-based fuels, and Tank 8D1 is a spare. There are also two smaller tanks (8D3 and 8D4) constructed of stainless steel and housed in a common concrete vault. Tank 8D4 contains about 12,000 gallons of acidic high level waste from the Thorex processing of thorium-based fuels, and Tank 8D3 is a spare. The two low-carbon steel tanks were thermally stress relieved prior to completion of the concrete vaults.

At Hanford, essentially all neutralized alkaline wastes were stored in low-carbon steel, single shell tanks surrounded by reinforced concrete. The first double shell tank farms at Hanford were constructed and stress relieved in the late 60's and early 70's. These were the AY and AZ tank farms. Tank 101 AY received some neutralized alkaline waste from the Zerflex processing of N reactor fuel just before Purex was put on standby in 1971.

Prior Corrosion Studies

Low-Carbon Steel

In-tank corrosion tests were made at Hanford in Busmuth Phosphate, Redox, and Purex-type alkaline high-level waste. Corrosion specimens were 1020 mild steel coupons, weldments and stressed (bent beam) specimens. Coupons and weldments were 1/8" x 1/2" x 1-1/2", whereas the bent beam specimens were 1/8" x 1/2" x 1-1/2". Exposures were made in the liquid and in the vapor phases for periods ranging from 0.5 to 6 years. General corrosion rates of 1020 mild steel based on weight loss ranged from about 0.5 to 7 mils/year. Pitting appeared to be somewhat more severe in the vapor phase than in the liquid phase. No significant difference in the corrosiveness of Redox and Purex wastes was found and no stress corrosion cracking (SCC) of bent beam specimens was observed in any case. The in-tank corrosion rate data indicated the tank liners would eventually (perhaps 100 years) be penetrated by pitting attack.

Associated laboratory tests using simulated neutralized alkaline solutions tended to yield corrosion rates equivalent or slightly higher than those reported above. General corrosion rates ranged from 0.02 to 5.0 mils/year whole pitting ranged from zero to 5.0 mils in depth.

Other than the Hanford in-tank tests and associated laboratory tests with simulated solutions, little work was done to further define the corrosiveness of alkaline high-level waste on low-carbon steel until failure of an underground tank occurred at Savannah River in 1965 through stress corrosion cracking. A Savannah River report describes the history of the tank, service conditions, inspection of the tank walls and metallographic inspection of specimens removed from areas of the leaks. Further laboratory work with test specimens exposed to simulated waste solutions confirmed that the failure was due to stress corrosion cracking. Studies were made both at Savannah River and at Hanford to determine the variables that effect the SCC of mild steel in waste solution. Material variables that were evaluated included stress level, base metal composition, weld metal composition, welding procedure and the presence of weld repair areas. Environmental variables included nitrate concentration, nitrate plus nitrite concentration, effect of added sulfate, temperature, pH and the effect of a cathodic current.

Consistent SCC results were obtained only with large (3' x 3' and 3' x 1') weldments presumably due to the higher stress level attained during fabrication. No cracking was observed with stress relieved weldments in any case; a partial stress relief produced by passing a wide gas burner over the welded areas was not completely effective whereas a complete thermal stress relief prevented SCC. The cracking propensity of as-welded weldments was independent of carbon content between the limits evaluated, 0.08 to 0.26 percent; cracking was not alleviated when a nickel-base alloy (not susceptible to SCC in nitrate solution) was used as filler metal. Weldments fabricated from low alloy steels were also found to be susceptible to SCC in nitrate solution. Weld repair areas were especially susceptible presumably due to increased plastic deformation in the weld area. The nitrate concentration required to produce cracking of as-welded weldments in alkaline nitrate solution was found to be about four molar, whereas the presence of nitrite appeared to exert little effect on SCC of mild steel. Added sulfate (and probably other anions) inhibited SCC in nitrate solution. No cracking of Savannah River tanks which contained F Area waste occurred probably because of the higher content of sodium sulfate, 5.8 *vs* 2.3 wt percent for H Area waste.

Interest in the corrosion of underground tank liners was again revived with the advent of the in-tank solidification program. Failure of cooling coils by pitting corrosion in high-level waste tanks became common at the Savannah River facility after sludge removal operations were initiated. The proposed corrosion mechanism was based on oxygen depletion cells formed in crevices between the coils and the support fixtures. The corrosion was propogated by an aeration cell, accelerated by sulfate made soluble by sludge removal operations and made possible by sluicing with water which diluted the nitrite to the extent that it became only partially effective as an anodic inhibitor. Sluicing with supernatant solution or with dilute alkaline nitrite solution should eliminate this type of attack. Hanford tanks contain no cooling coils however and sluicing has been done largely with supernatant solution.

Stainless Steel

The 8D4 stainless steel tank at the NFS contains about 12,000 gallons of acidic high level waste from thorex processing of thorium-based fuels. The only data available at Hanford was developed from a short study in which sensitized (1250 degrees Fahrenheit heat treatment for one hour plus a water quench) A151 304L stainless steel specimens were exposed to disolver solution and vapor for 975 hours at boiling and waste concentrator solution for 650 hours. Results were 0.046 inches/year in dissolver solution and 0.028 inches/year in the vapor. For the waste concentrator the corrosion rate was 0.23 inches/year.

Conclusions

- Because of the similarity of early Hanford neutralized alkaline waste composition to that stored in tank 8D2 at NSF, a conservative general corrosion rate for the NFS can be assumed.

- Based on in-tank and laboratory studies conducted at Hanford a conservative estimate for pitting would be .007 inches/year.

- Stress corrosion cracking should not be a potential problem since the low-carbon steel tank has been stress relieved. $SO_4^{=}$ and OH^- inhibit SCC, and tank temperatures by now should be below that required.

- While the data base for judging the condition of the 8D4 SS tank may be marginal, it is felt that a conservative estimate of expected general corrosion rate would lie in the range 0.03 to 0.05 inches per year. It is probably much lower since these data are for boiling conditions.

CONCLUSIONS

The area of each tank wall which could be evaluated was approximately 13 feet by 27 feet, or a total of approximately 351 feet^2 representing about 5% of each tank wall surface area. Photography covered a slightly larger area than the UT due to the equipment setup.

Review of the photographs and video tapes show that the extent of corrosion products on the outside surface of tank 8D-2, the active tank, is considerably less than that observed on tank 8D-1, the standby tank. This most likely arises because the active tank is at a higher temperature (approximately 170°F). This elevated temperature has minimized the presence of moisture and thereby retarded the corrosion process. Consequently, the condition of tank 8D-1 provides a reference basis for comparison and the overall condition of tank 8D-2 would most likely be assessed as somewhat better.

No contamination of equipment occurred. No leakage or evidence of leakage was observed either before, during, or after the wire brushing operation. An increase in detectable airborne contamination observed during the wire brushing operation was attributed to naturally occurring radon by the resident health physicist.

Visual observation of the corrosion pattern on the outside surface of the tanks does not correlate with the fluid fill levels. There is however, some correlation of the deposited material and the amount of corrosion with the weldments and weld heat affected areas. In addition, some minor striations were observed on the tank walls which are believed to be associated with surface scratches or marks which disturbed the protective mill scale and were placed on the tanks during fabrication.

The amount of whitish material deposited on tank 8D-2 was notably more than on 8D-1. The surface area of the 8D-2 tank not covered by corrosion, was only

slightly covered with a very light whitish powdery film which was easily removed by wire brushing. This powdery film was so light that construction markings placed on the steel plates during fabrication were still visible and readable. Wire brushing of these areas did not remove the markings or base metal; thus, indicating sound material.

Both the rust and whitish deposits on the tank walls appeared to be concentrated most heavily under the 30-inch diameter access riser with decreased amounts of deposits near the edges of the area inspected.

The worst pitting observed from review of the photographs was judged by the operators to be from 0.040 to 0.060 inch deep, which is considerably less than the 0.250 inch thick corrosion allowance provided for during design of the tanks. Specific data on pit depth was not obtained from the UT data.

The inside wall surfaces of the tanks were inspected by UT only and the data evaluation is not within the scope of this document.

RECOMMENDATIONS

Because the amount of corrosion which has been observed to date is far from approaching the 0.250 inch corrosion limit provided by design, the urgency for further inspection efforts does not appear to be critical at this time.

Since the worst corrosion was observed on tank 8D-1, this tank could be established as a base line for evaluation and monitoring of the waste tank storage system. Manned entry of the annulus space of 8D-1 could be developed to include, but not be limited to, the following considerations:

1. Actual determination of the maximum depth of pitting in the area which has been wire brushed under the 30-inch diameter access riser.

2. Visually inspect the entire exposed outside tank surface area to locate the areas of heaviest deposits and then evaluate these areas for depth of pitting. This visual inspection should also include the top of the tank roof. Actual determination of the maximum depth of pitting of the tank wall.

3. Perform detailed visual inspection, and possible nondestructive testing of critical stress areas, such as around nozzles, welds and penetrations.

4. Attempt to obtain photographs of the inside surface area of the tank to supplement inspection of the outside surface area.

5. Attempt to obtain photographs or video television records of the outside surface of the tank wall from the annulus space around the interior vault roof support columns.

6. Wirebrush tank 8D-1 exterior and coat with a rust inhibitor.

EQUIPMENT DESCRIPTION AND OPERATION

Inspection of the sections outside wall of nuclear waste storage tanks 8D-1 and 8D-2 at West Valley, New York, was conducted with an annulus inspection system developed by Rockwell for this purpose.

The annulus inspection system, referred to herein as the Large Area Scanner (LAS), consisted of: a mechanical drive mechanism for entrance and egress vertically into and out of the tank annulus region; a vertical carriage assembly consisting of a set of manipulator arms with drive tracks for extending along the tank walls into the annulus region; a horizontal carriage assembly for traversing horizontally on the manipulator arms to conduct the inspection operations remotely; and a microprocessor based control console for remote control of the scanning motions, data collection and local identification.

The LAS was used to transport both visual and ultrasonic (UT) inspection instruments. This provided for two inspection methods: (1) visual inspection of the wall surface by video television and photographs, and (2) UT of the existing wall thickness.

Access to each tank wall was through the 30 inch diameter access riser located just above the annulus space between the steel tank and concrete vault. Because of the curvature of the steel tank wall, and the existence of only a single access riser, inspection was limited to approximately 5% of the tank wall (an area 13 feet wide by about 27 feet high).

The equipment developed to accomplish the inspection task has several unique features. When in position for scanning, the frame and track look like an inverted "T". The vertical support is approximately 54 feet long; the horizontal arms are approximately 13 feet long. For insertion and withdrawal the horizontal arms fold upward into two 6 foot 6 inch sections along side and parallel to the vertical support. Collapse and extension of the horizontal arms

are accomplished using a winch to pull a cable attached to the arms. Constant force extension springs are used to take up and play out the cable during vertical scanning. The horizontal arms are attached to the vertical scanning carriage which travels on a track mounted to the vertical support. A second carriage travels horizontally across the horizontal arms. All inspection components are mounted on this second carriage.

Centering within the annulus space is maintained by two outriggers, one attached to each of the horizontal arms. Mechanical linkage between the outriggers and the horizontal arms provide for automatic positioning of the outriggers as the horizontal arms are folded down to their operating position. When the horizontal arms are retracted the outriggers automatically retract to a position parallel to the arms allowing for insertion or withdrawal from the annulus space. Figures 4 and 5 show the LAS in the folded positions, for insertion into the tank annulus space, and in the opened position, for performing the inspection operations, respectively.

The driving power for both the horizontal and vertical carriages is provided by two stepping motors. Each motor is capable of very accurate position control. The horizontal position can be controlled to within 0.006 inch. Vertical position can be controlled to within 0.002 inch. Limit switches are used as horizontal and vertical reference positions. All location information is referenced to the fixed reference switch positions. Any position may be repeated within an estimated 0.75 inch, the uncertainty being due primarily to flexing of the vertical support and the horizontal arms.

Overall system control is provided from control consoles which house two motor controllers, a counter, video character generator, video monitor, switch panel, limit switch light panel, an AIM 65 microprocessor and the UT instrumentation. Limit switch lights indicate critical carriage positions (i.e., vertical and horizontal reference positions, upper and lower limit, left and right limit, horizontal carriage center position, and horizontal arm folded

or unfolded position). Electrical interlocks prevent vertical travel unless the horizontal arms are either completely folded or completely unfolded. The microprocessor controls the motor drive functions as well as triggering the camera. A desired number of frames is keypunched into the microprocessor and a start command given. The system automatically scans and takes photographs until the specified number of frames is reached. At that point the system stops automatically and awaits further operator instructions. One system control console and microprocessor is shown in Figure 5. A second control console which houses the UT instrumentation is not shown.

The LAS was initially positioned with the use of a crane while the vertical support was bolted to a support framework. The support framework rested on the access riser flange. With the two manipulator arms folded to the vertical position (Figure 4), the LAS was lowered under its own power under manual control through the 30 inch access riser into the annulus space. The manipulator arms were then lowered or unfolded to the horizontal position (Figure 5). Concurrent with this operation, the smaller outrigger arms extended, perpendicular to the manipulator arms, to position the drive tracks radially within the annulus space. The scanner carriage was then positioned under manual control to an X and Y reference coordinate as a starting position. From this position the scanning motion was accomplished by stepping motors whose controllers accepted either digital instructions from the microprocessor or manual instructions from the control panel for stepping directions and rates.

Once the LAS was in place on a given tank, all inspections were done without moving the vertical support. All maintenance, film changes, and other work on the inspection equipment was done by driving both carriages out of the riser and driving the horizontal carriage to the end of one horizontal arm. All hands-on work was then done away from the radiation field emanating from the open riser.

Prior to the actual scanning operation, the apparatus was switched to

microprocessor control and the programmed routine called up fom the keyboard. Commands were then entered via the keyboard into the microprocessor, as required, to obtain the desired scanning control. Thus, the actual scanning operation was automatic until the scanner reached a control position that was keypunched into the microprocessor.

)eration of the LAS was similar for all the three basic functions; visual inspection, UT inspection and wire brushing. Visual inspection by photographs was accomplished by mounting a 35-mm camera head (Figure 6) on the carriage assembly and controlling the scanner to stop as required for the camera to obtain the desired exposures. Location coordinates were exposed onto the film and video image simultaneously, by means of a commercially available camera "data back" (Figure 7) with video character generator. Location data was supplied by counting the stepping motor pulses, processing them, and sending the information to the data back and character generator.

Ultrasonic inspection was accomplished by replacing the camera head with a UT transducer assembly (Figure 8); wire brushing was accomplished by using a power driven wire brush assembly (Figure 9).

In addition to the 35 mm still photographs, the visual inspection also included a small television camera which allowed for re[illegible] time inspection during the scanning operations (Figure 10). Video televisi[illegible]n records were made of portions of both the photographic and wire br[illegible].

Upon completion of the scanning operations, the [illegible]turned to the center position, the track support arms were fol[illegible]ical position, the controls were switched to manual operatio[illegible]nd th[illegible]AS was manually driven out of the annulus space through the access riser.

A complete parts list and a set of fabrication drawings for the LAS is provided in Appendix A.

The complete microprocessor package consisted of a RM65 modular microprocessor with operator access from an AIM 65 microprocessor, a Shugarte Disc Storage system, and a KB6000 computer controllable ultrasonic generator and signal processor.

Automated operation of the equipment was accomplished by programming the AIM 65 microprocessor to perform the following tasks:

- ° Define the limits of the area to be inspected.
- ° Monitor and keep track of the position of the device being used (i.e., camera, UT detector, or wire brush).
- ° Operate the device in use.

The operation of the camera consisted of moving the selected distances in the reference X and Y coordinate system, actuating the camera shutter, advancing the film, and recording the frame number. The functions required to perform UT inspection consisted of moving the selected distance in the reference X and Y coordinate system, operation of the UT pulser, monitoring the steel tank wall thickness, adjusting gate distances in order to gather shear wave information by controlling the UT signal processor, and store the wall thicknesses and flaw information in mass storage (disc) by reference to location.

The UT scans were performed using five transducers which were controlled by a set of programmed instructions given to the KB6000 UT generator and signal processor. One longitudinal mode transducer measured wall thickness and any internal flaws within the wall. Four shear mode transducers, two left and right looking and two up and down looking, propagated waves at 45°. No return of these signals indicated a clean backsurface; whereas, any return of the signal indicated some backsurface or internal anomaly. The system was set up only to look at the back surface.

The programmed instructions given to the KB6000 also controlled changes in

the distance gates in accordance with the wall thicknesses as measured by the longitudinal transducer, and stored all detected returns by amplitude and distance in buffers which, in turn, were placed in mass storage (disc) by location via the AIM 65.

SYSTEM OPERATION

The UT inspection system operation routine was initiated by providing specific information requested by the preprogrammed functions. These include the area to be scanned, the starting positions in the reference X and Y coordinate system, and the density or spacing of the sampling. After providing the required data, the computer responds by printing all entered data for verification. At this point, the automated UT scanning operation is initiated by a positive response from the operator.

Starting from the designated start position, each position is interrogated first with the longitudinal transducer to determine wall thickness; then the shear time gates are set to limit returns only from the area in question, and each shear transducer is pulsed. The wall thickness and any response from the shear transducers is stored in the buffer as each transducer is pulsed.

Based on the previously selected sampling density instructions provided to the computer, the console is then automatically relocated to the next sequential sampling location. After three points have been sampled, the data for each sample point contained in the buffers (location, wall thickness and shear signals returned) are transferred to mass storage (disc).

Upon transfer of the first data from the buffer to disc, a file name is automatically generated which references the first scan position. Fifteen blocks of data (45 samples) are stored in each file. A new file name is generated for each succesive file as the process automatically repeats. Each side of a disc contains 100 files.

All data was stored sequentially on the discs for the continuous scans. Data from special scans (i.e., welds or small localized areas in question which were redone) were stored on separate discs.

EQUIPMENT LIMITATIONS AND MEASUREMENT CONSTRAINTS

A number of external constraints limited the extent of detail obtained on the waste tanks. These are listed in this section, along with equipment calibration information. Accuracy of the equipment is also discussed.

The horizontal distance along the circumference of each tank inspected was constrained by the existence of only a single 30 inch diameter access riser. Thus, only one entrance to the annulus space of each tank was available for inspection of the tank walls. In addition, the size of the access opening (30 inches in diameter) restricted the length of the curved horizontal track to a total length of about 13 feet. Because of the curvature of the tank wall and the restricted access opening, the area of each tank wall which could be inspected was approximately 13 feet wide by 27 feet high, or a total of approximately 351 feet^2 which represents about 5% of the total wall surface area of each tank.

The high radiation fields (1500 R/hr) preclude any manned entry into the 8D-2 annulus. Although it is possible to have manned entry into the 8D-1 annulus, as had been done in the past, this was not included as part of this inspection program.

During the photographic scans of tank 8D-2, the radiation level of 1500 R/hr limited the camera time within the annulus space to about 25 minutes before damage to the film would have become unacceptable. All photographs are clear and have good resolution; however, the radiation field did alter the color balance which must be considered in evaluating these prints. Resolution of details approximately 1/64 inch in size or larger was accomplished.

Subsequent to starting the inspection operations, it was found that the temperature in the annulus space of tank 8D-2 was very close to the maximum operating temperature limit of the equipment. Precooling of the cooling air supplied to the equipment, and insulation of the video camera was necessary. The cameras were prefocused as both the distance from the wall and focal length were known.

The UT inspection of tank 8D-2 was restricted to cover only the tank wall area above the pan or from about 30 inches above the tank bottom. The LAS could not be lowered below the top edge of the pan without getting stuck and possibly resulting in permanent damage to the equipment.

A test plate was machined with accurately measured steps which matched the plate thicknesses and holes. This test plate was mounted above the tank and a test run made before and after each tank inspection. All steps and holes were accurately mapped to 0.01 inch. There were no observed variations between test runs. The UT measurement equipment was capable of measuring tank wall thicknesses to the nearest 0.01 inch.

The tank wall consistantly tested thicker than shown on the design drawings. There are no plate samples (taken during tank construction) left from the wall area. Therefore, it must be assumed that thicker plate than specified was used in the walls of both tanks though no records exist to confirm this. Though this did not affect the results of the UT inspection in determining the present condition, it did hinder the interpretation of the data, as the beginning plate thicknesses were not known. This meant that if a uniform thickness decrease had occurred, it could go undetected as the true starting point is not known.

The video television recordings are in black and white, thus interpretation of these inspection records is limited due to lack of color contrast. The photographs show true representation of surface images and were useful when

compared to the video recordings to confirm patterns of deposits, etc.

Each of the horizontal manipulator arms deflects downward approximately 1/2 to 3/4 inch as the horizontal carriage traverses to the end of the arm. Thus, the path of each horizontal scan can be described as being very close to an arc projected on the wall of the tank. The inspection head moved laterally along the horizontal arm of the LAS. This was monitored so the location of the UT head was known at all times.

REFERENCES

1. "Safety Related Information Available on NFS Waste Tanks," filed under NRC Docket No. 50-201, E.I. duPont De Nemours and Company, Aikin, South Carolina (1978).

2. R.E. Smith and D.B. Cartmell, "Inspection and Evaluation of Nuclear Fuel Services High-Level Waste Storage System Program Plan," RHO-CD-882, Rev. 1, Rockwell Hanford Operations, Richland, Washington (August 1981).

3. G.P. Janicek, "West Valley Waste Removal System Study," RHO-LD-146, Rockwell Hanford Operations, Richland, Washington (April 1981).

FIGURE SECTION

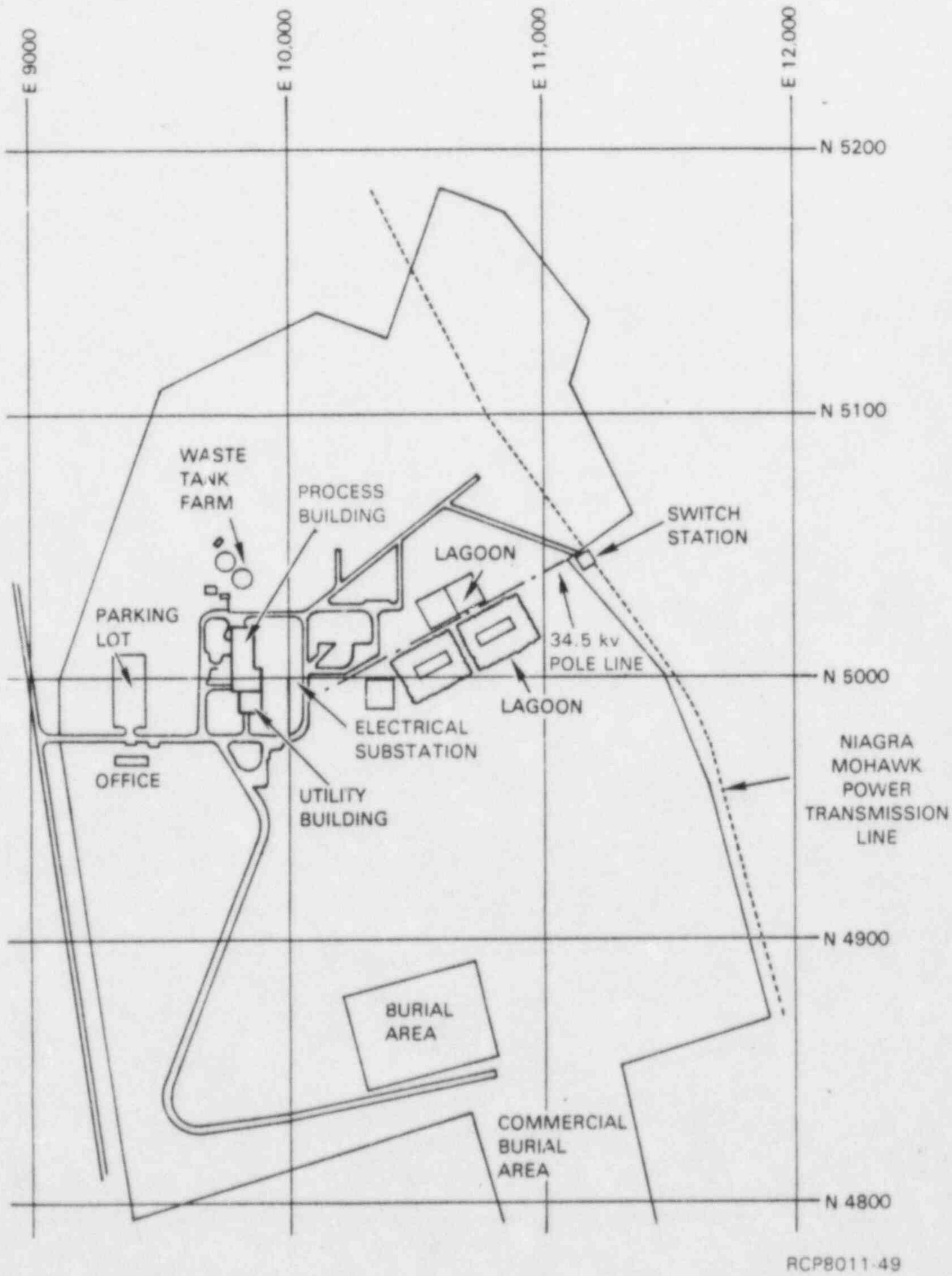

FIGURE 1. Western New York State Nuclear Service Center, West Valley, New York, Site Plan.

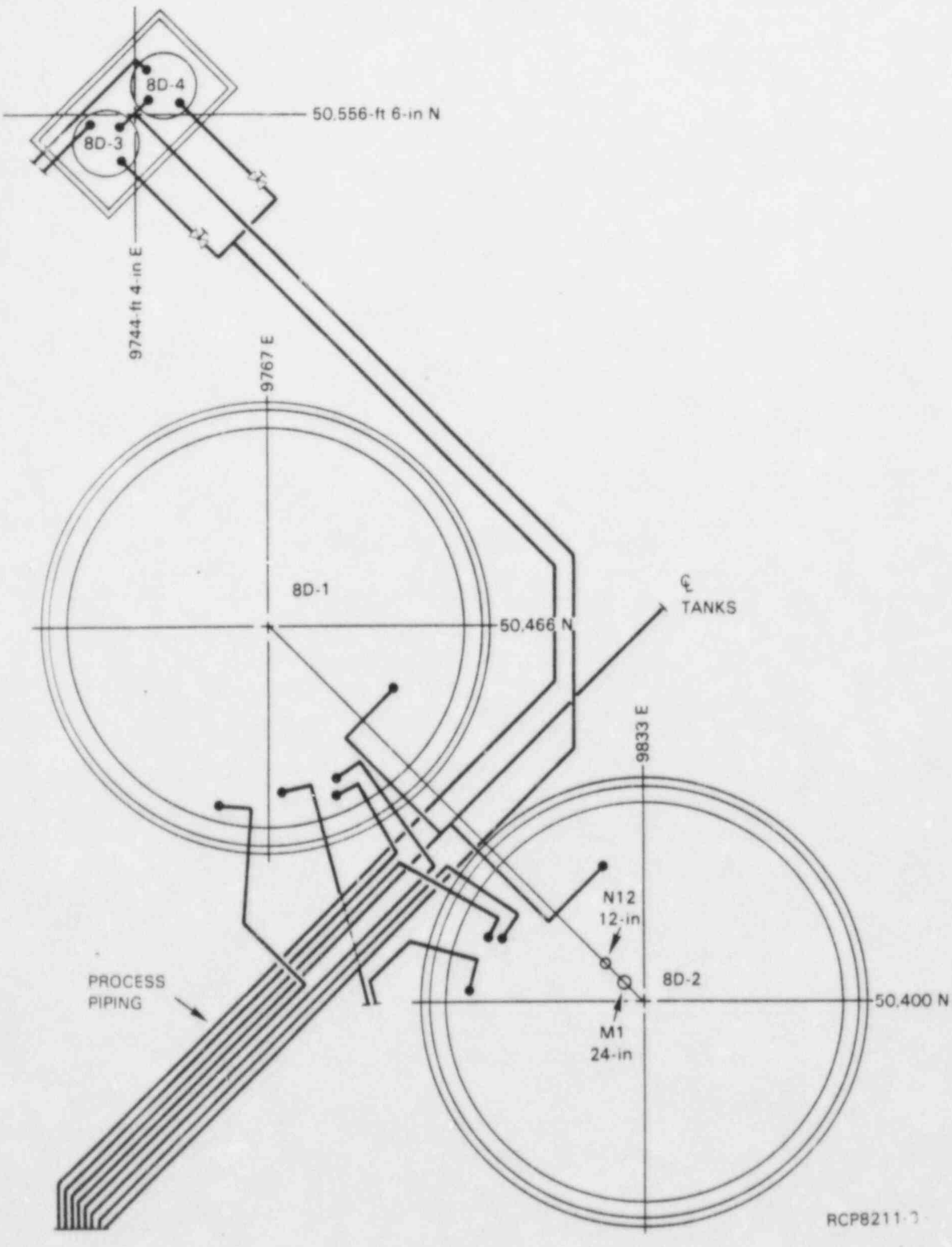

FIGURE 2. West Valley Tank Farm Plan.

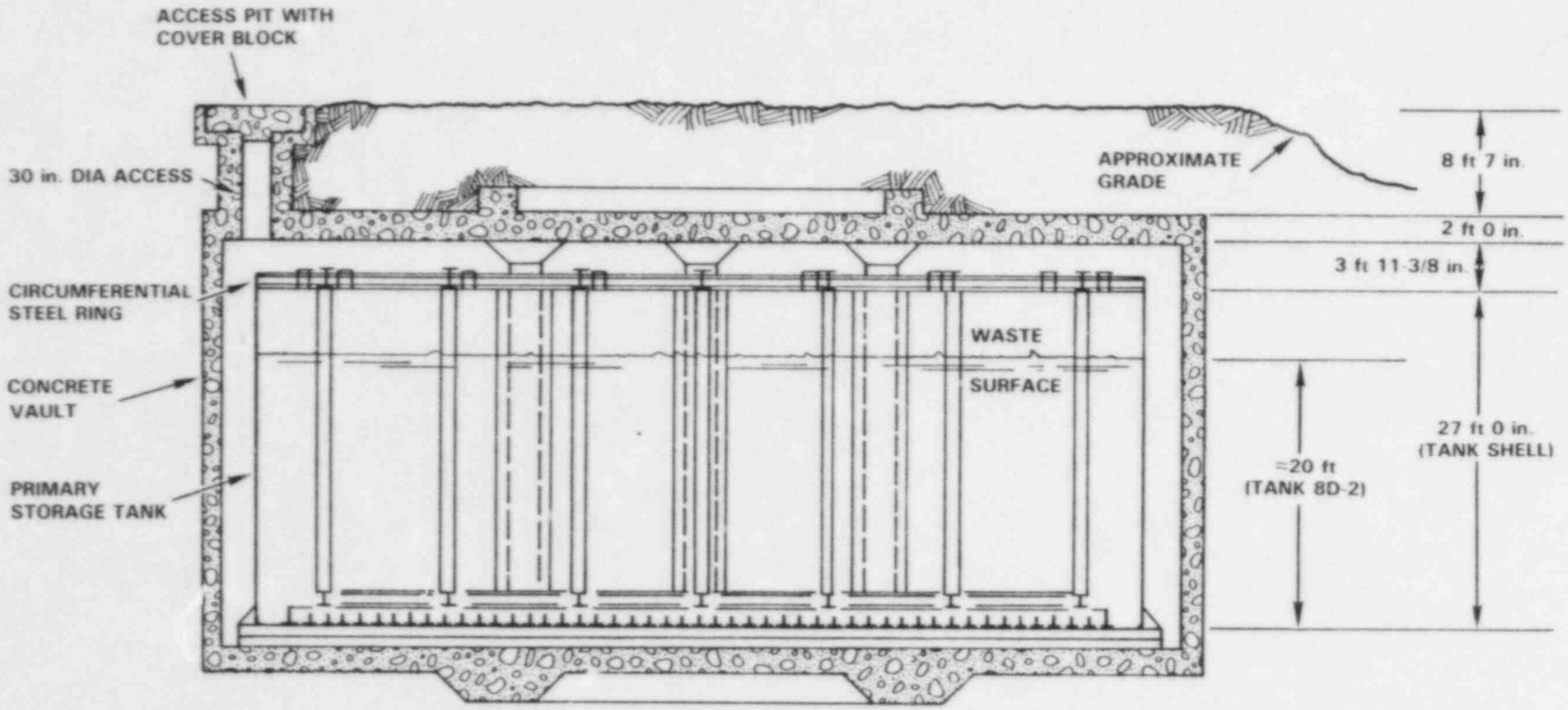

FIGURE 3. Neutralized Waste Storage Tank and Vault Cross Section/Elevation.

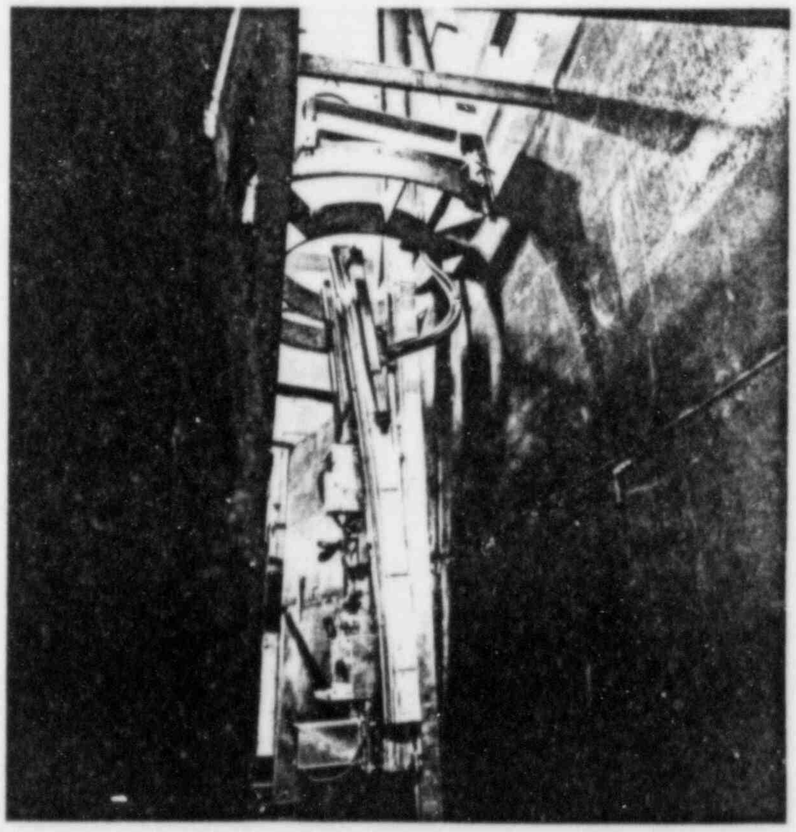

FIGURE 4. LAS in Folded Position.

FIGURE 5. LAS in Open Position with Control Console and Microprocessor to the Side.

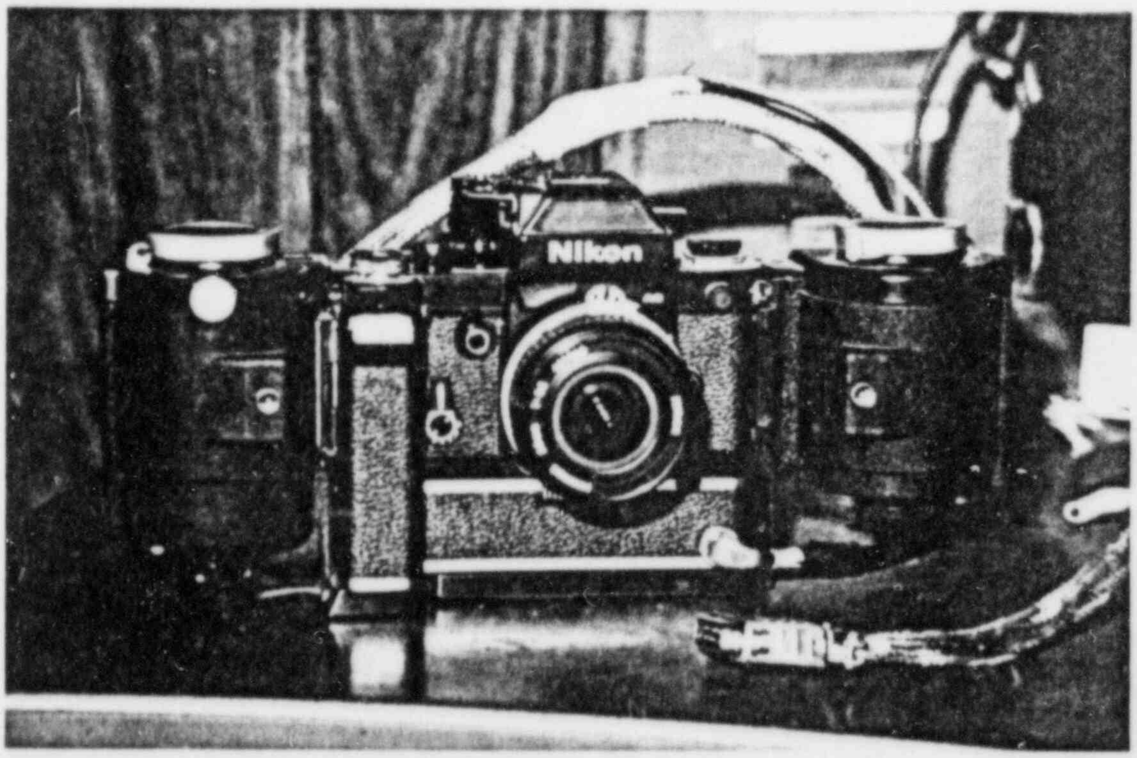

FIGURE 6. 35-mm Camera.

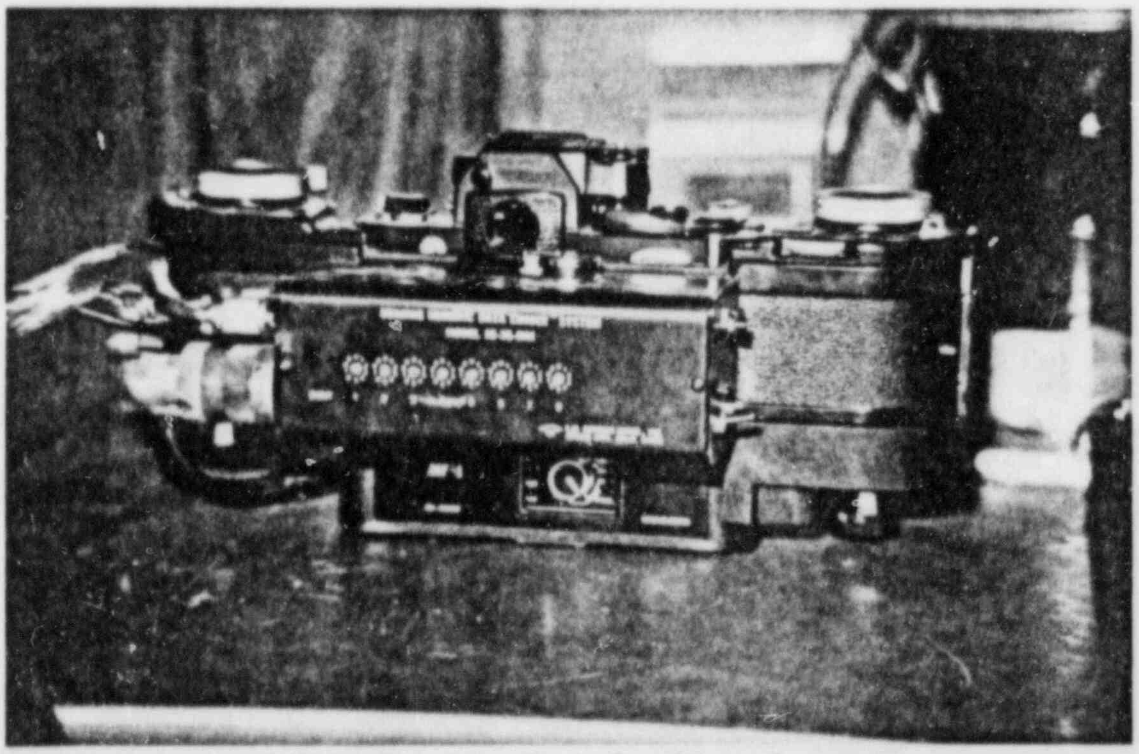

FIGURE 7. Data Back for 35-mm Camera.

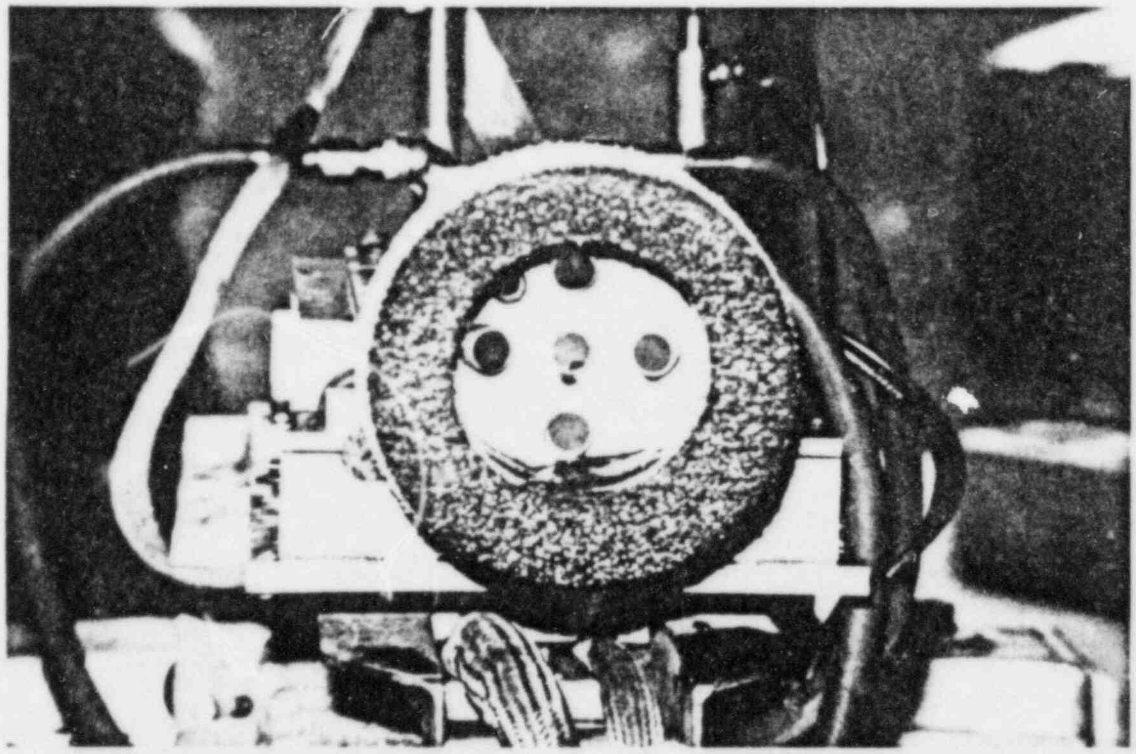

FIGURE 8. Ultrasonic Head and Transducer Assembly.

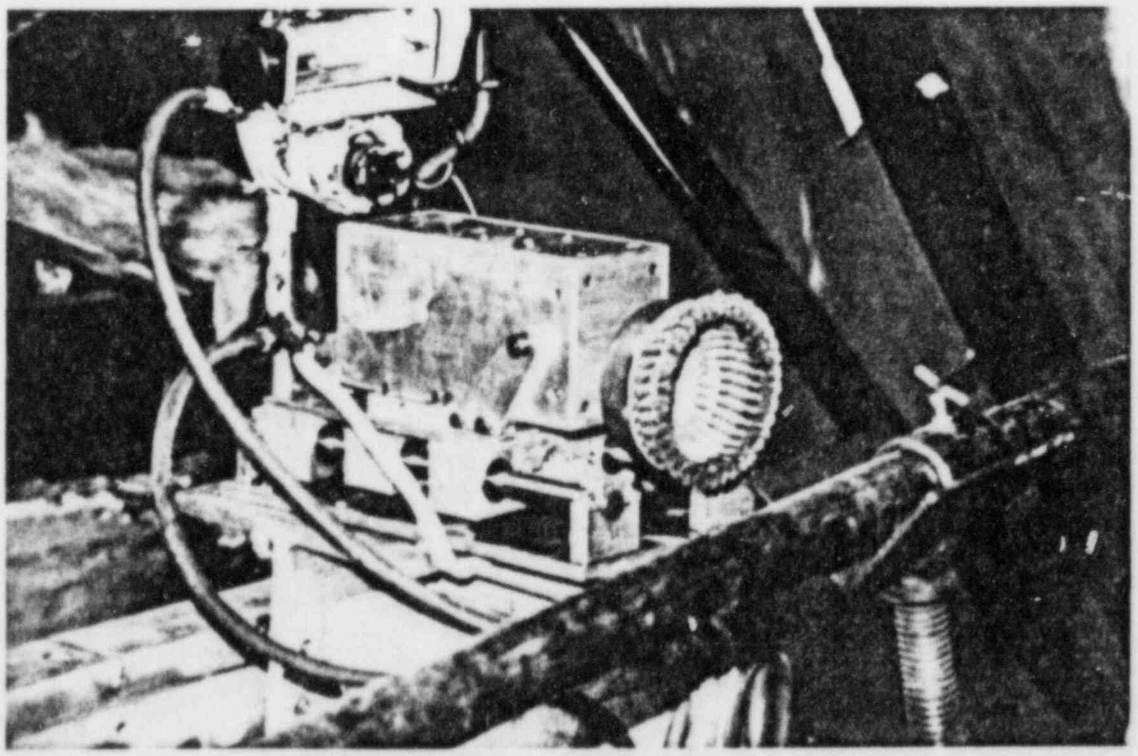

FIGURE 9. Wire Brush Assembly.

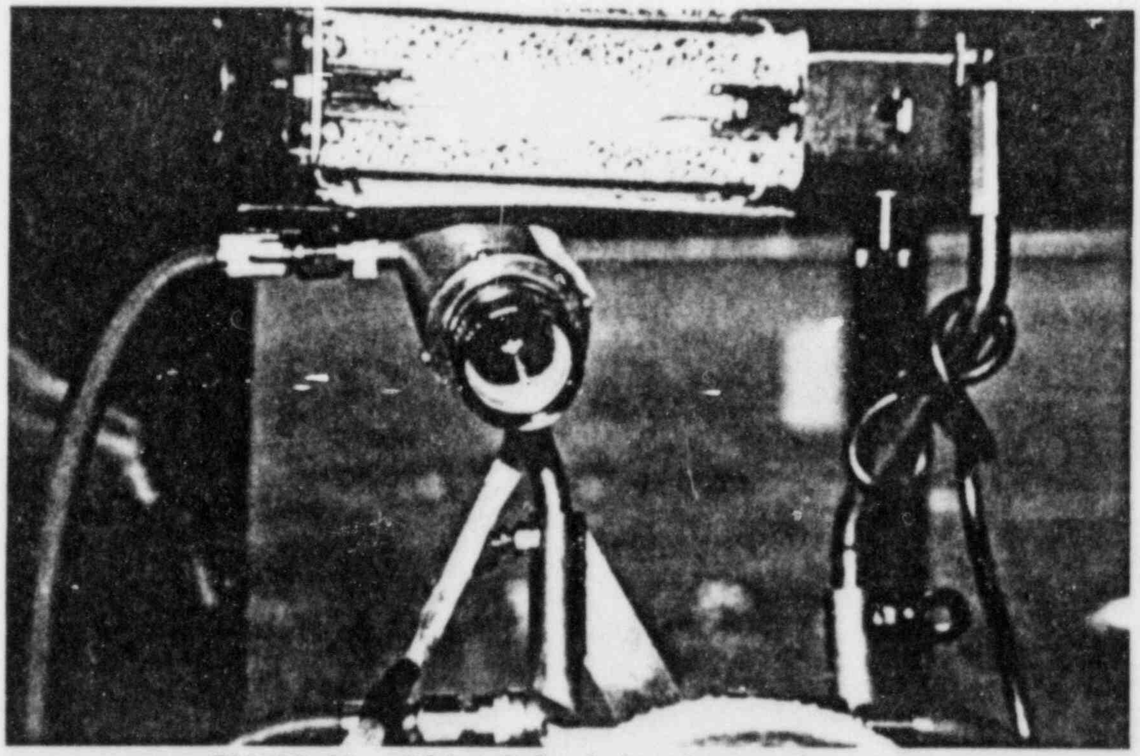

FIGURE 10. Video Television Camera Assembly.

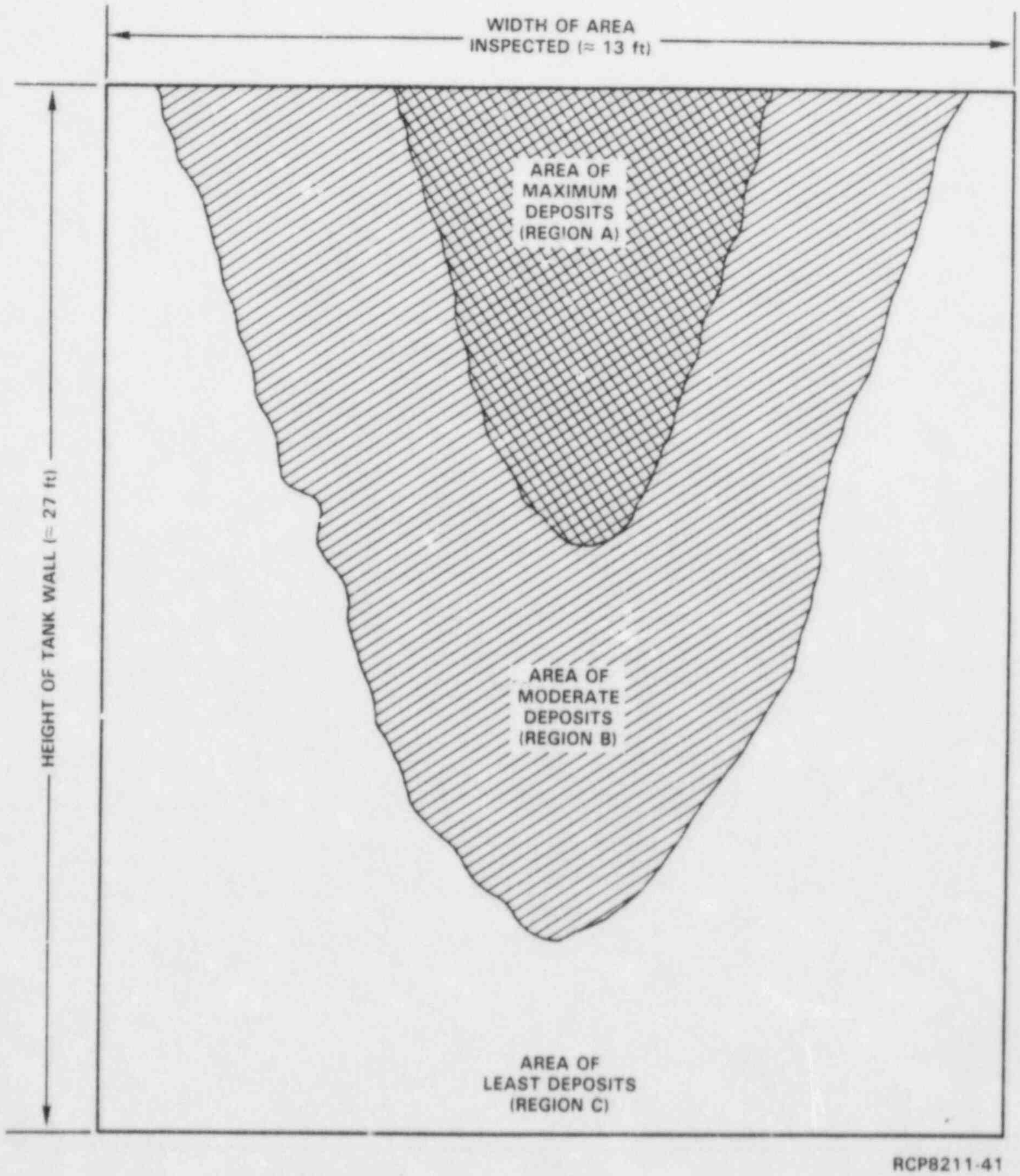

FIGURE 11. General Description of Areas Covered by Depositing Material.

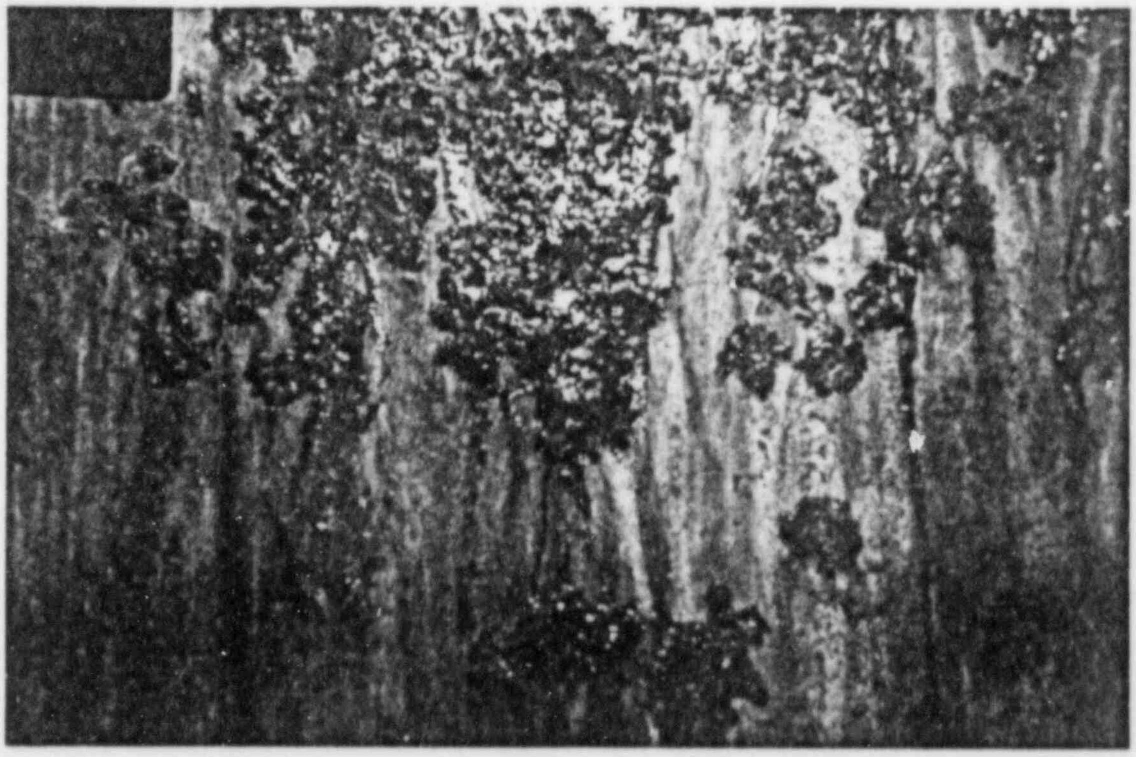

FIGURE 12. Tank 8D-1 Before Wire Brushing, Near Center of Area Inspected.

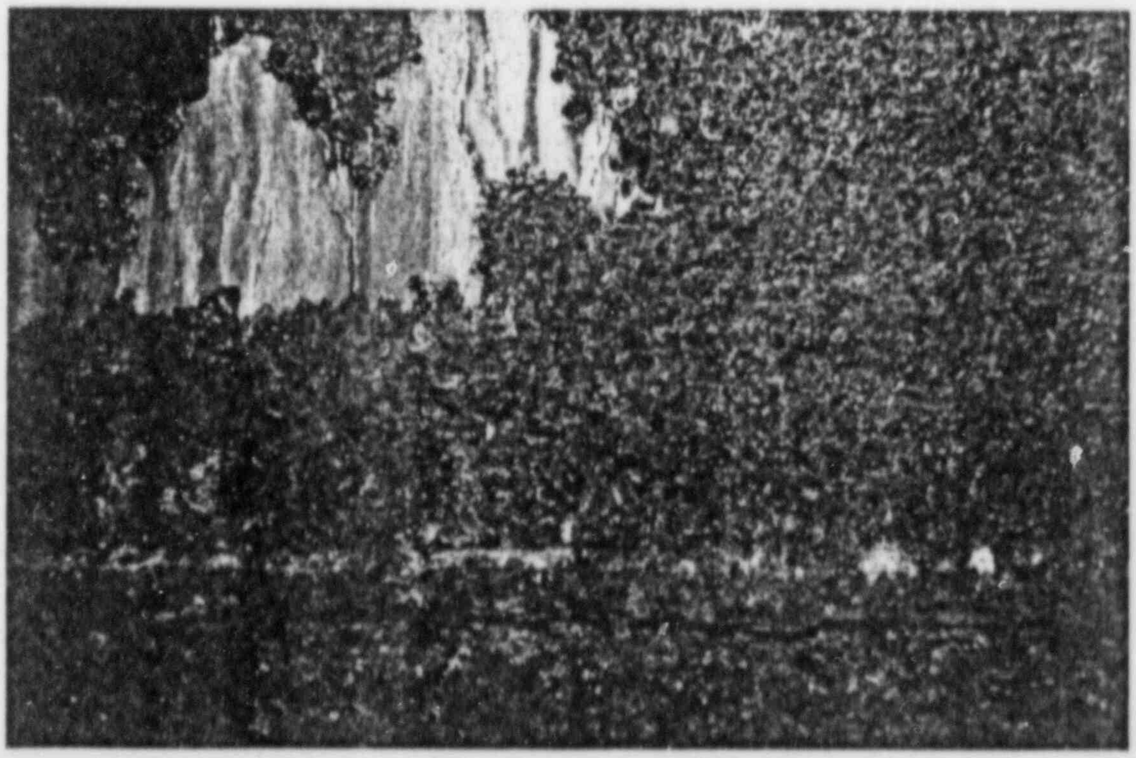

FIGURE 13. Tank 8D-1 Weldment Before Wire Brushing, Near Center of Area Inspected.

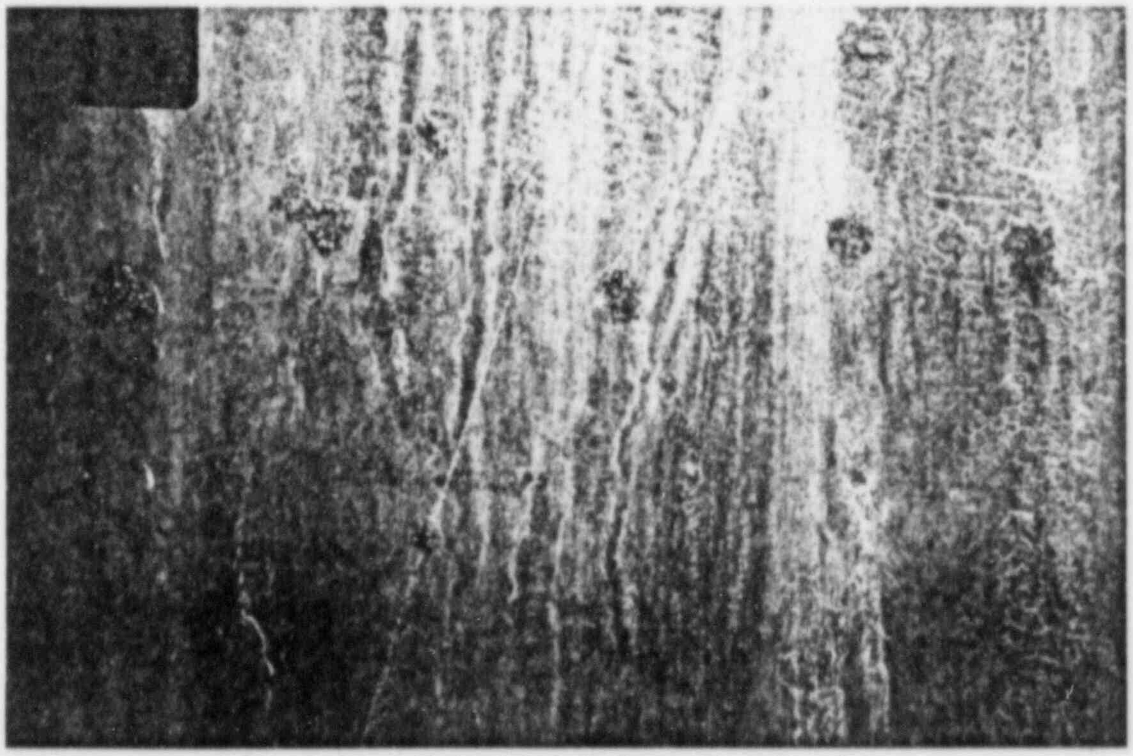

FIGURE 14. Tank 8D-1 Before Wire Brushing, Near Edge of Area Inspected.

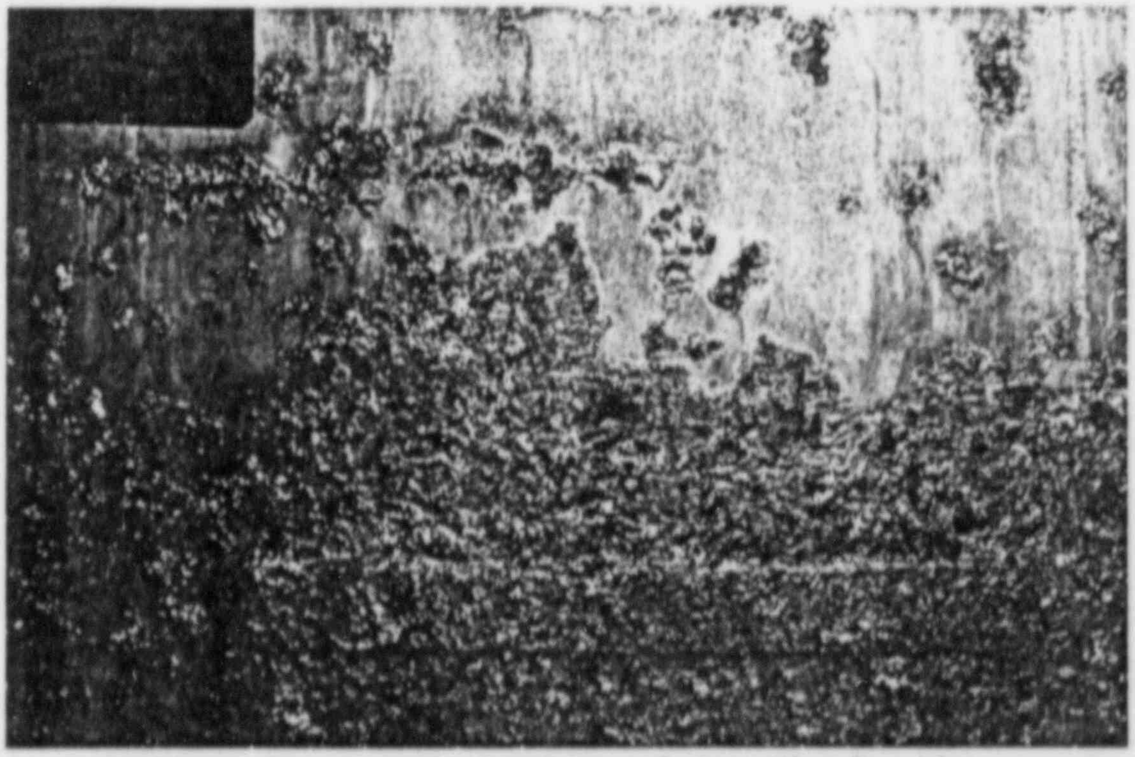

FIGURE 15. Tank 8D-1 Weldment Before Wire Brushing, Near Edge of Area Inspected.

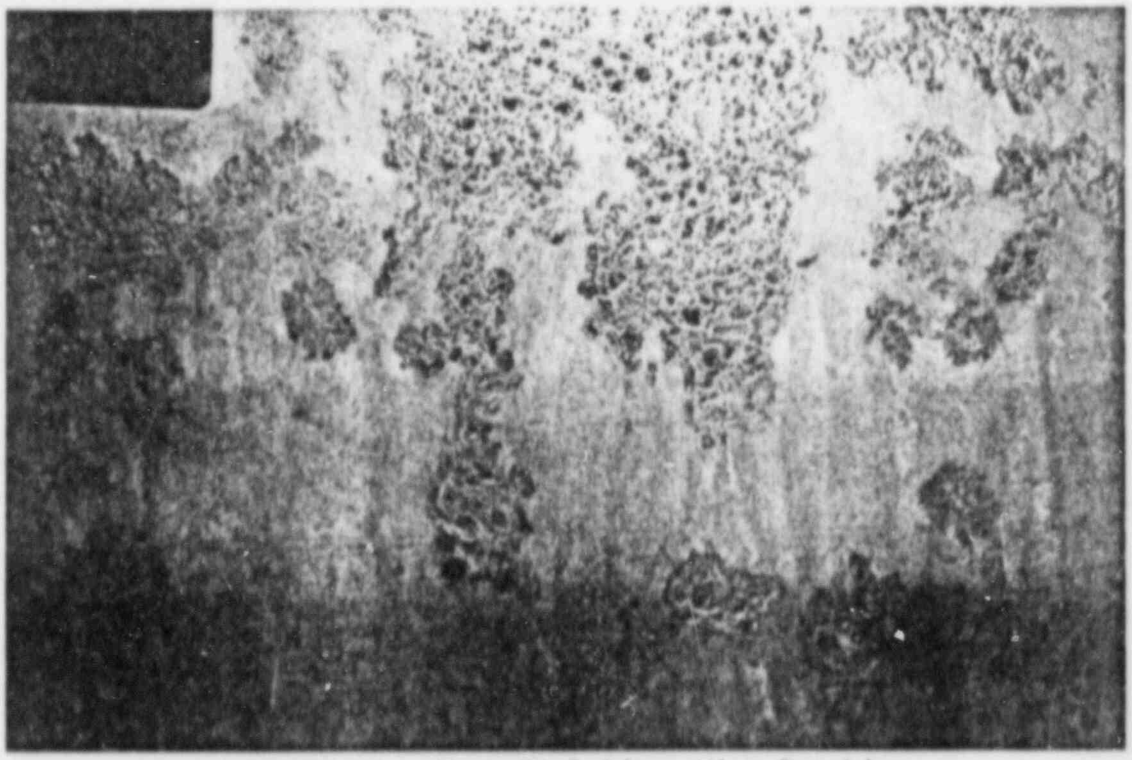

FIGURE 16. Tank 8D-1 After Wire Brushing, Near Center of Area Inspected.

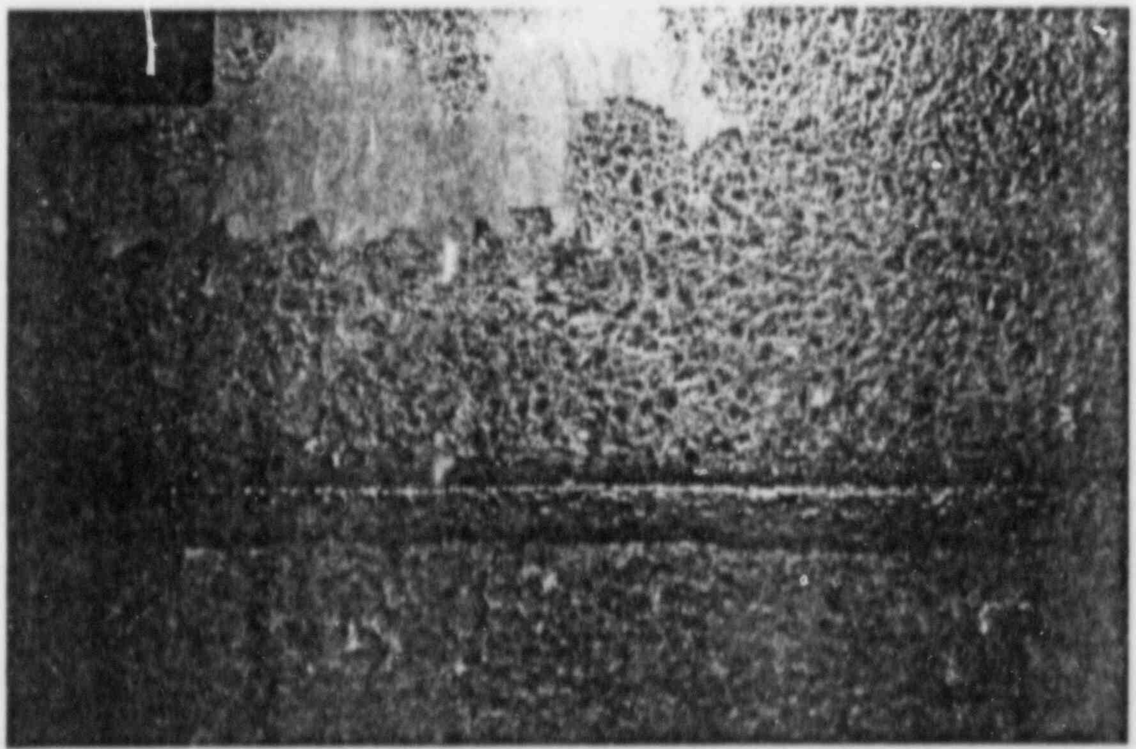

FIGURE 17. Tank 8D-1 Weldment After Wire Brushing, Near Center of Area Inspected.

FIGURE 18. Tank 8D-1 After Wire Brushing, Near Edge of Area Inspected.

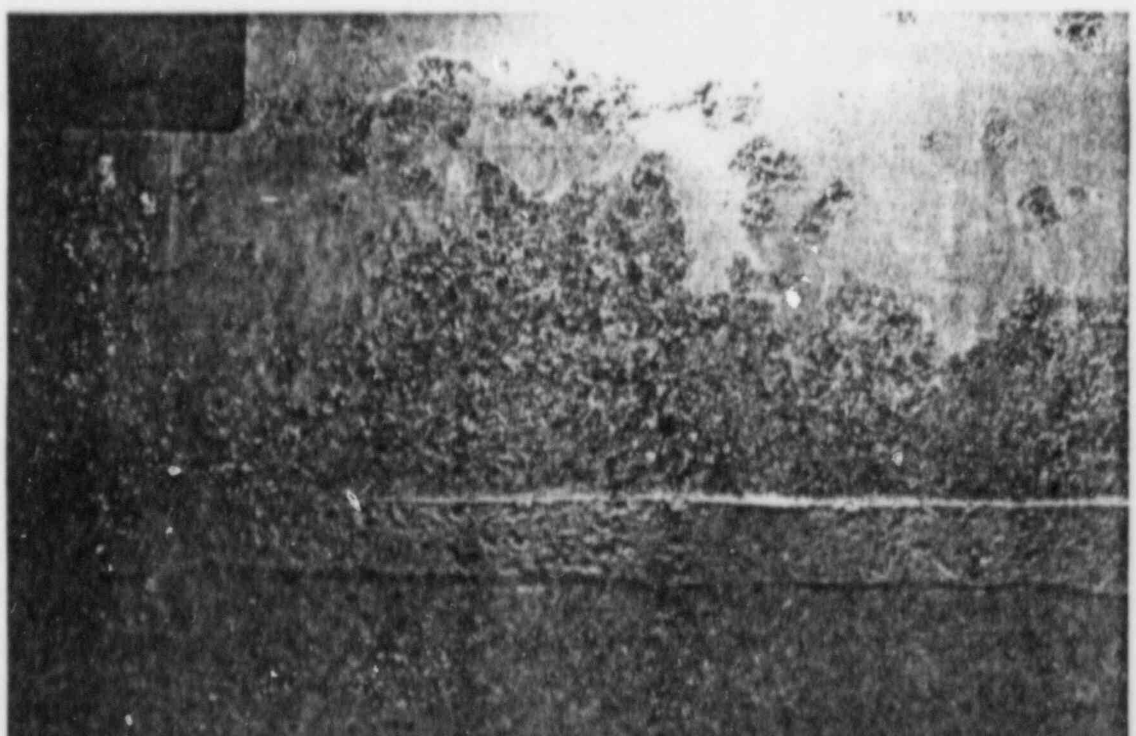

FIGURE 19. Tank 8D-1 Weldment After Wire Brushing, Near Edge of Area Inspected.

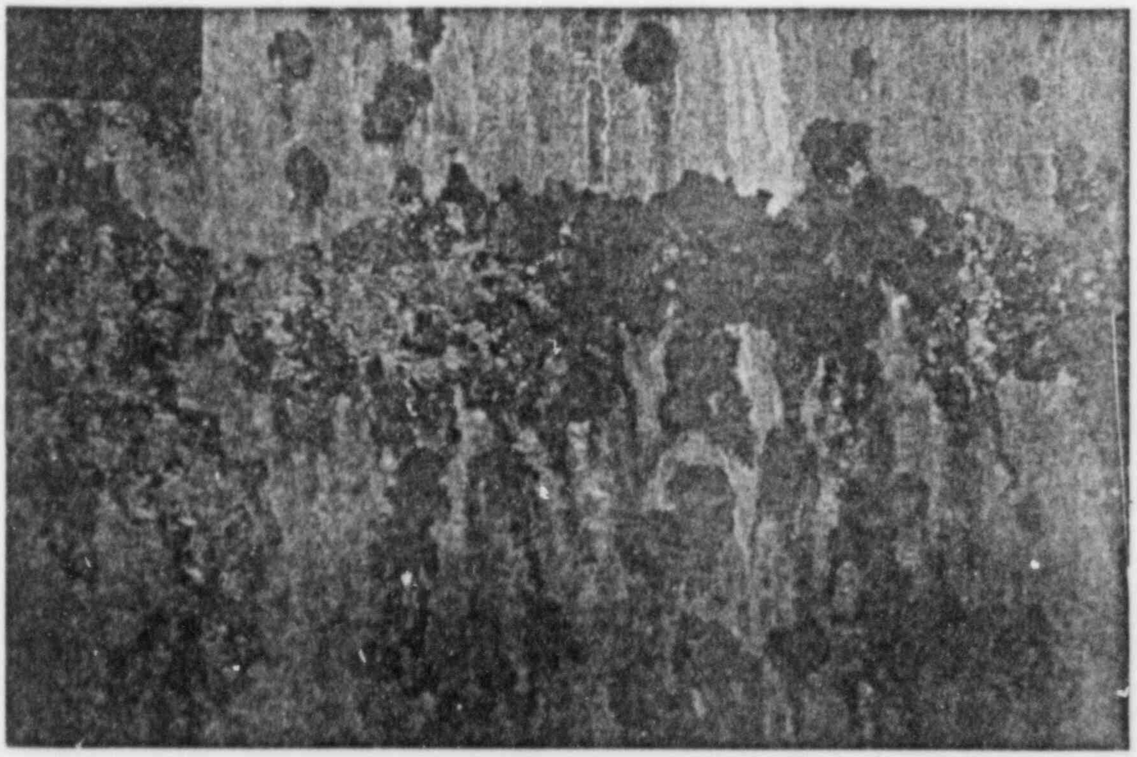

FIGURE 20. Tank 8D-2 Before Wire Brushing
Near Center of Area Inspected.

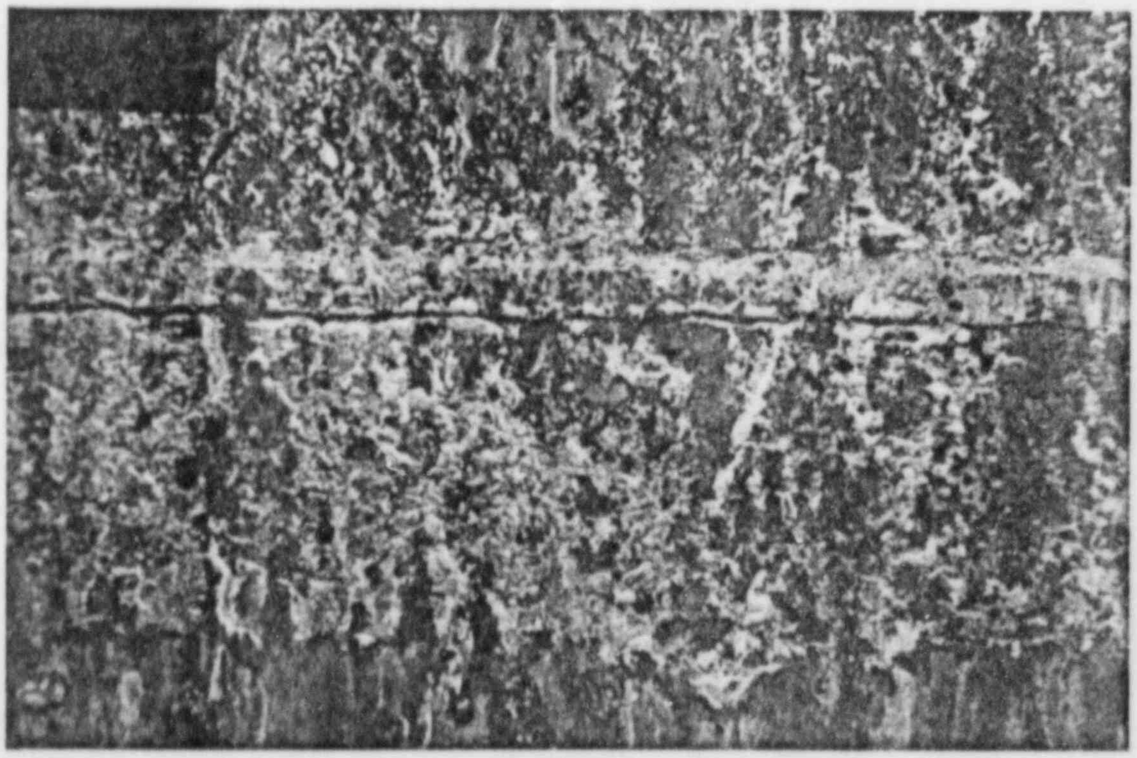

FIGURE 21. Tank 8D-2 Weldment Before Wire Brushing,
Near Center of Area Inspected.

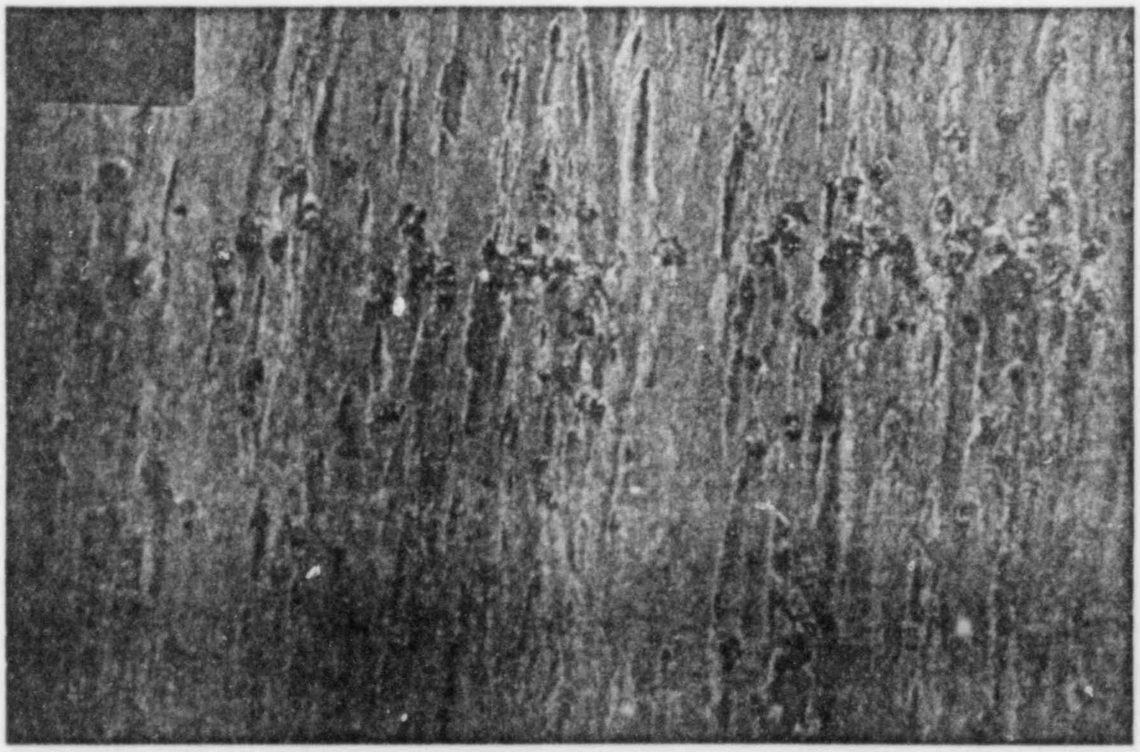

FIGURE 22. Tank 8D-2 Before Wire Brushing, Near Edge of Area Inspected.

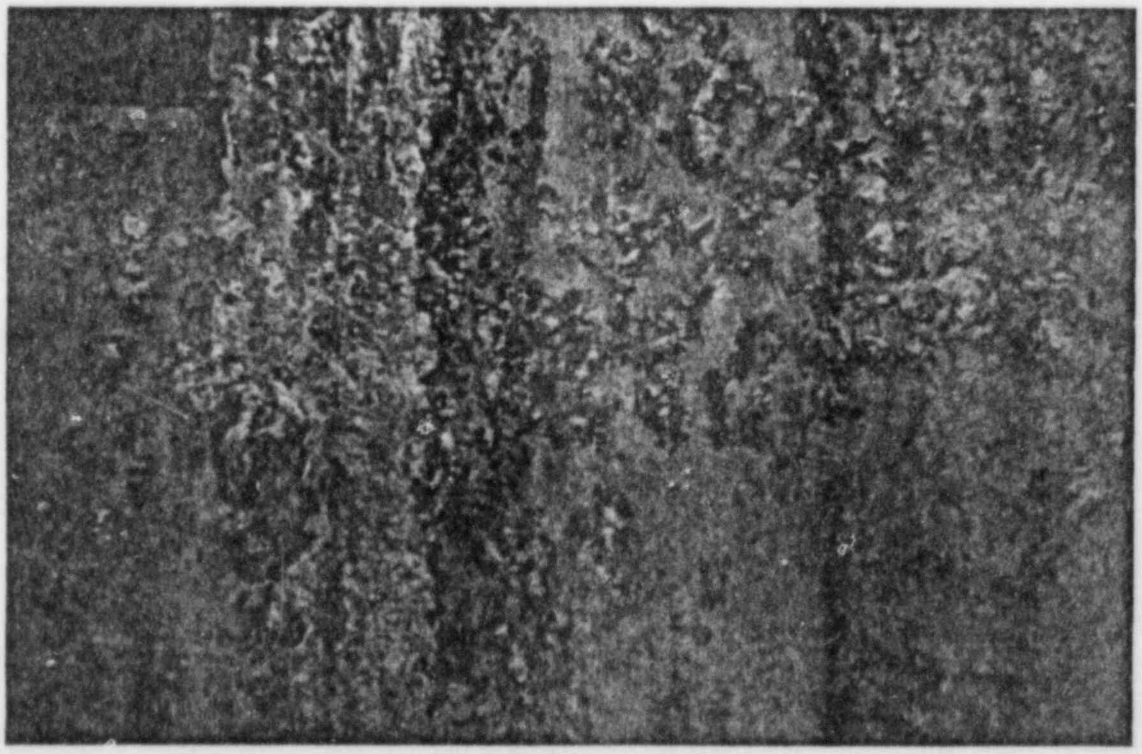

FIGURE 23. Tank 8D-2 Weldment Before Wire Brushing, Near Edge of Area Inspected.

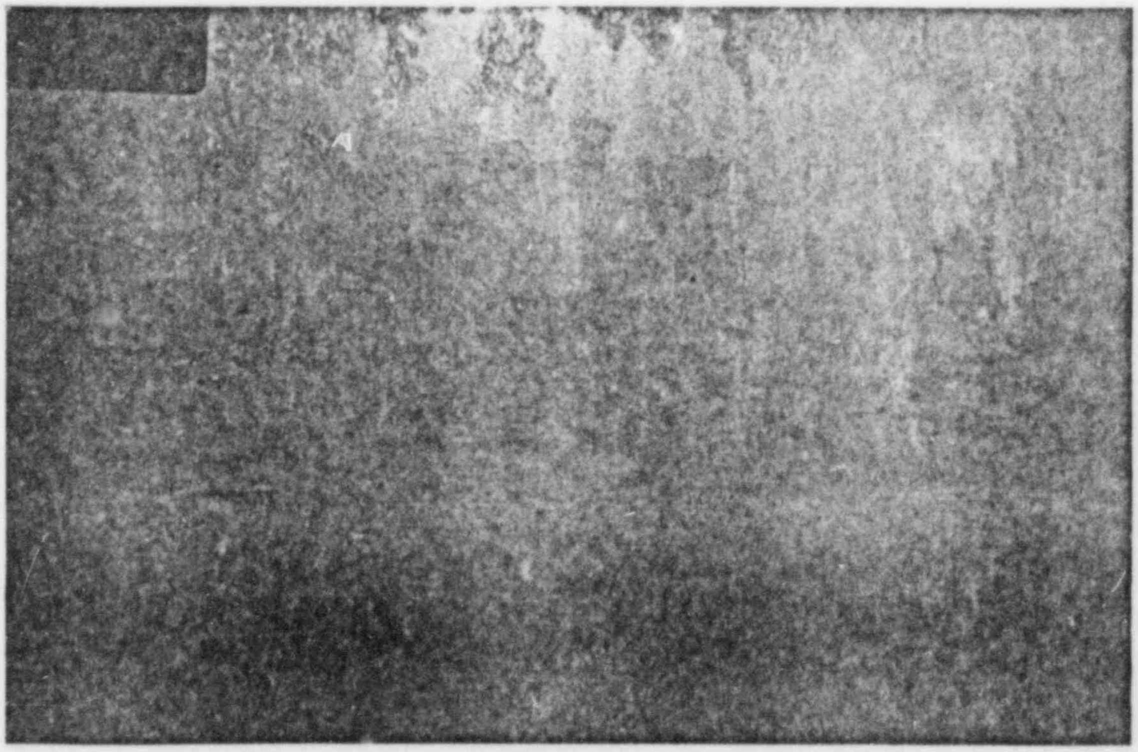

FIGURE 24. Tank 8D-2 After Wire Brushing, Near Center of Area Inspected.

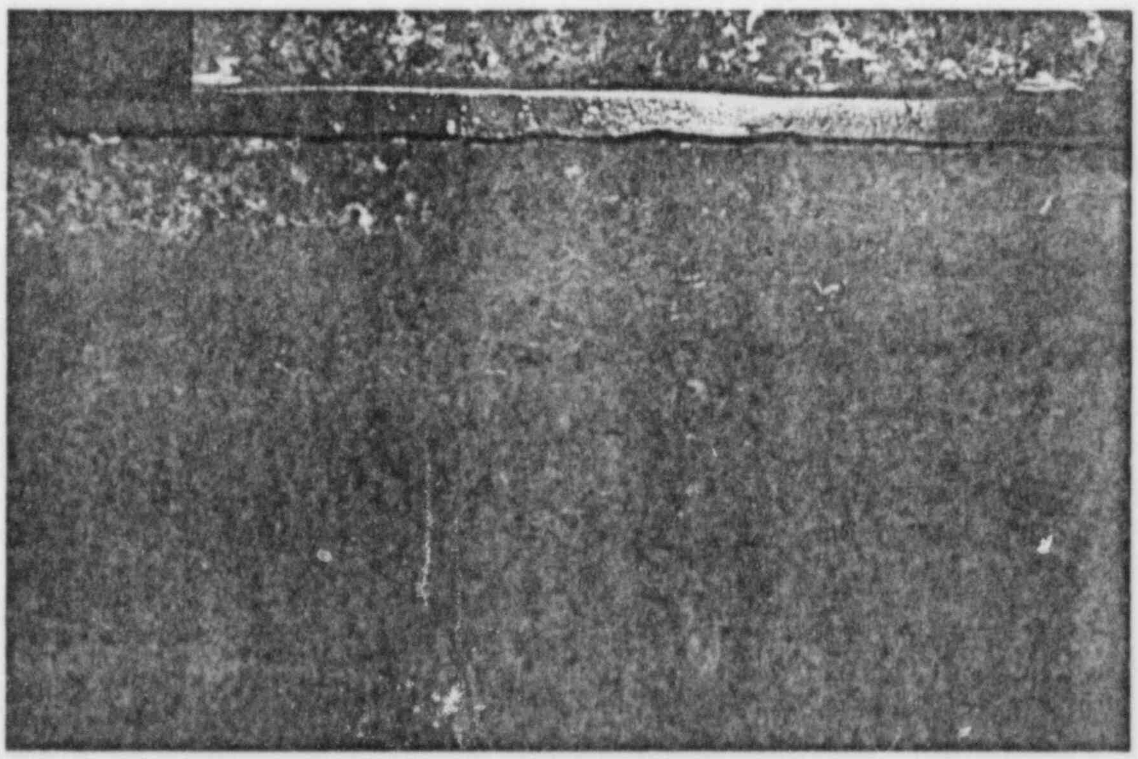

FIGURE 25. Tank 8D-2 Weldment After Wire Brushing, Near Center of Area Inspected.

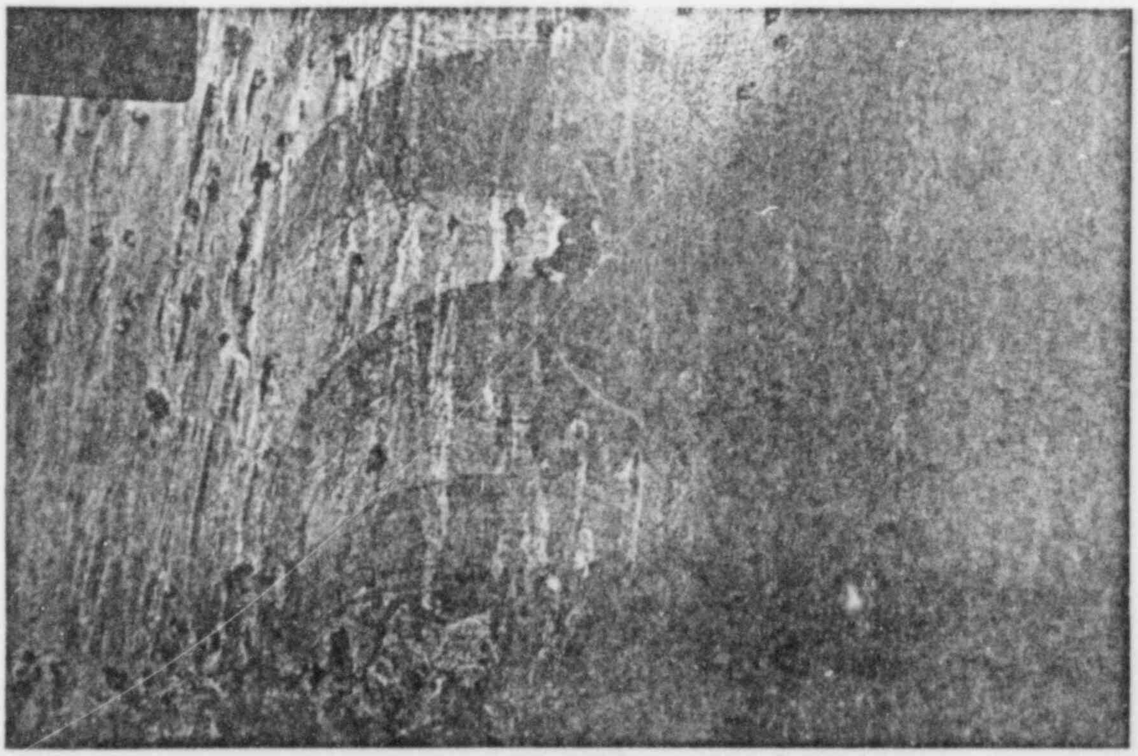

FIGURE 26. Tank 8D-2 After Wire Brushing, Near Edge of Area Inspected.

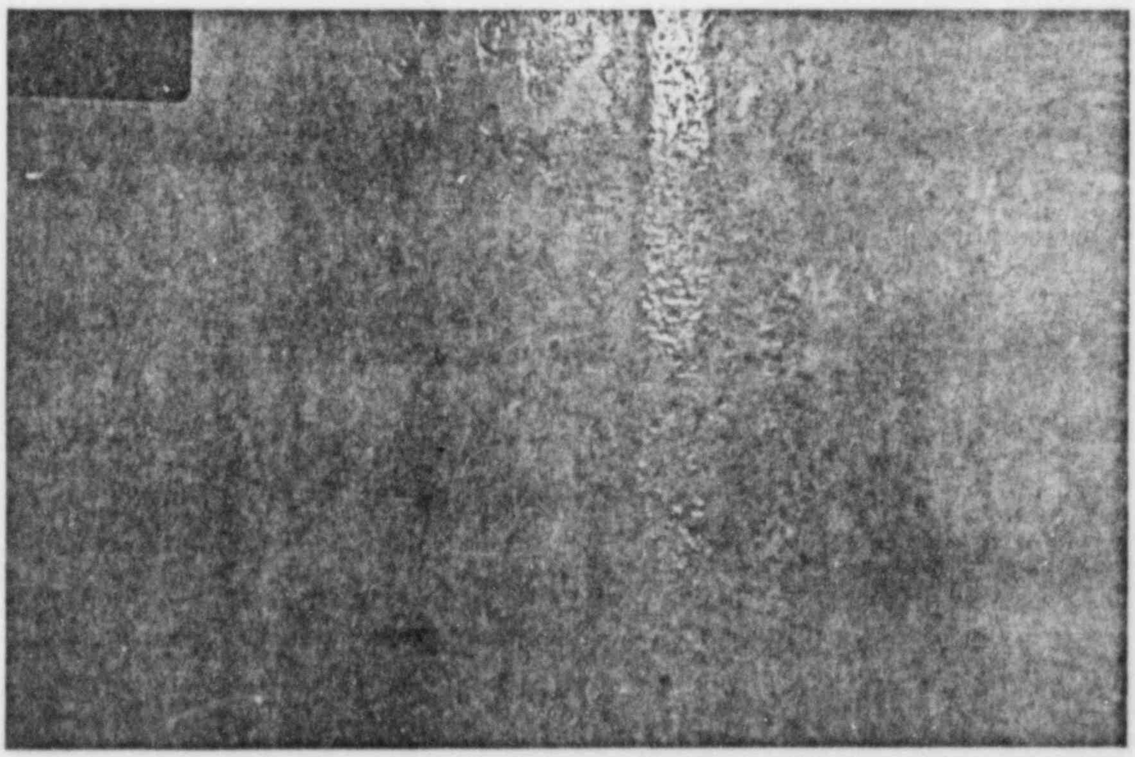

FIGURE 27. Tank 8D-2 Weldment After Wire Brushing, Near Edge of Area Inspected.

Sample Data Key: 0.656 in. design thickness; 67, 68, and 69 values not printed; grid is 1 in. by in.; ** are values less than 32

————> Y (vertical) direction

————> X (horizontal) direction

71	71	**	**	**	72	**		**	73	71	71	**	71	**	73	**	73	**	71
	72	72	**	**	72	72	72	72	72	72	73	72	72	72	73		73		72
71	72	72	**	**	71	72				72	74	72	72	72	73	73	73	73	
	72	72	**	**	71	72	70				72		72	72	73	73	71	74	
71	72		**	**	72	71	72	71		72	71	72	72	72	70	73	71	73	72
71	66	72	**	**	71	71	71	71		72	72	70	72	72	73	73	73	74	72
	72	72	**	**	72	71	71		72	72	72	72	72		73	72	73	73	73
70	72	72	**	**	71	72	72		72	72	73	72	73	72		72		73	73
	72	72	**	**	72		72	72	70	72	72	70	72	72	72	72	73	74	
	72	70	**	**	72	70	72			72	70	72	71	72		72	72	72	
	72	72	**	**	71	72	70	72	72	72		71	73	72	73	72	72	73	73
71	72	72	**	**	71			72	72	70	72	71		72		70		72	70
		72	**	**	71		72	72			73	72	72	72		72	72	73	70
72	72	71	**	**	71	70		72	72	72	72	72		72	73			72	73
71		72	**	**	70		72	72	72		72	72		72		72	72		70
72	72	72	**	**	70			72		72	72	72	72	72				73	
		73	72	**	71				72	72	72	71	71	72	71	74	71	71	72
39	65	70	72	**	71	72	73		72		71	72		72		73	70	73	73
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73	72	72	72	72	72			71	72	72	71	72	72	72				72	75
71	74	72	71	70		73			72			72		72		73	73	72	74

FIGURE 28. Sample of Ultrasonic Data

APPENDIX A

LARGE AREA SCANNER FABRICATION DRAWINGS

FABRICATION DRAWING LIST

MECHANICAL

DRAWING NUMBER	NO. OF SHT	DRAWING TITLE
H-2-92116	1	DRAWING LIST WV ANNULUS INSP. SYSTEM
H-2-75341	5	TANK WALL CAMERA ASSEMBLY WV ANNULUS INSP. SYSTEM
H-2-75342	1	ARMS WV ANNULUS INSP SYSTEM
H-2-75343	2	ADJUSTING ARM ASSY. WV ANNULUS INSP. SYSTEM
H-2-75344	4	HOLDER WV ANNULUS INSP SYSTEM
H-2-75360	3	BACK PLATE WV ANNULUS INSP SYSTEM
H-2-75361	2	WINCH STAND WV ANNULUS INSP SYSTEM
H-2-75362	4	CARRIAGE ASSEMBLY WV ANNULUS INSP SYSTEM
H-2-75373	1	HOUSING ASSEMBLIES WV ANNULUS INSP SYSTEM
H-2-91855	3	VERTICAL RAIL ASSY. WV ANNULUS INSP SYSTEM
H-2-91882	2	TERMINAL RACK ASSY. WV ANNULUS INSP SYSTEM
H-2-91934	6	CABLE REEL ASSEMBLY WV ANNULUS INSP. SYSTEM
H-2-92094	3	SLIDE ASSEMBLY WV ANNULUS INSP SYSTEM
H-2-92095	3	BRUSH & TRAVERSE ASSY WV ANNULUS INSP SYMTEM
H-2-92115	1	BRUSH AND TRAVERSE MOUNT ASSEMBLIES WV ANNULUS INSP. SYSTEM
H-2-92192	3	LIGHT AND CAMERA ASSEMBLY AND DETAILS WV ANNULUS INSP. SYSTEM
H-2-92298	1	DETAILS WV ANNULUS INSP SYSTEM

ELECTRICAL

DRAWING NUMBER	NO. OF SHT.	DRAWING TITLE
H-2-91764	1	SCANNER SYSTEM BLOCK DIAGRAM WV ANNULUS INSP SYSTEM
H-2-91765	1	ELECTRICAL RACK ASSEMBLY WV ANNULUS INSP SYSTEM
H-2-91766	1	ELECTRICAL POSITION COUNTER WV ANNULUS INSP SYSTEM
H-2-91767	1	SCANNER POSITION COUNTER SCHEMATIC WV ANNULUS INSP. SYSTEM
H-2-91768	3	INDICATOR CONTROL PANEL ASSEMBLY WV ANNULUS INSP SYSTEM
H-2-91769	1	INDICATOR CONTROL PANEL SCHEMATIC DIAGRAM WV ANNULUS INSP SYSTEM
H-2-91770	1	COMPUTER INTERFACE PC BOARD ASSEMBLY WV ANNULUS INSP SYSTEM
H-2-91771	1	COMPUTER INTERFACE SCHEMATIC WV ANNULUS INSP SYSTEM
H-2-91772	1	RACK CABLE DIAGRAM WV ANNULUS INSP SYSTEM
H-2-91773	1	ELEC PHOTOSCANNER ASSEMBLY WV ANNULUS INSP SYSTEM
H-2-91774	1	PHOTOSCANNER SCHEMATIC-WIRING DIAGRAM WV ANNULUS INSP SYSTEM
H-2-91775	1	PHOTOSCANNER CABLE ASSEMBLY WV ANNULUS INSP SYSTEM
H-2-91776	1	PHOTOSCANNER CABLE ASSEMBLY WV ANNULUS INSP SYSTEM

1 SET OF FABRICATION
DRAWINGS ARE PART OF THE FINAL
PACKAGE TO WEST VALLEY (SEPARATE COVER)

APPENDIX B

PHOTOGRAPHS OF TANK 8D-1 AND 8D-2 TANK EXTERNAL SURFACE

ALL PHOTOGRAPHS WILL BE BOXED AND SENT TO WEST VALLEY IN THE FINAL PACKAGE. ONLY ONE SET WAS MADE.

APPENDIX C

VIDEO TAPES OF TANK 8D-1 AND 8D-2 EXTERNAL SURFACE

ONE COPY OF VIDEO TAPES IS AT
WEST VALLEY NUCLEAR SERVICES
A SECOND SET IS AT
ROCKWELL

APPENDIX D

ULTRASONIC INSPECTION OUTPUT FOR TEST PLATES

ONE SET OF THE UT TEST PLATE DATA
WILL BE SENT UNDER SEPARATE COVER TO
WEST VALLEY IN THE FINAL PACKAGE.
ONLY ONE SET WAS MADE.

APPENDIX E

ULTRASONIC OUTPUT FOR 8D-1 AND 8D-2 TANKS

ONE SET OF THE ULTRASONIC DATA
WILL BE SENT UNDER SEPARATE
COVER TO WEST VALLEY IN
THE FINAL PACKAGE.

ONLY ONE SET WAS MADE.

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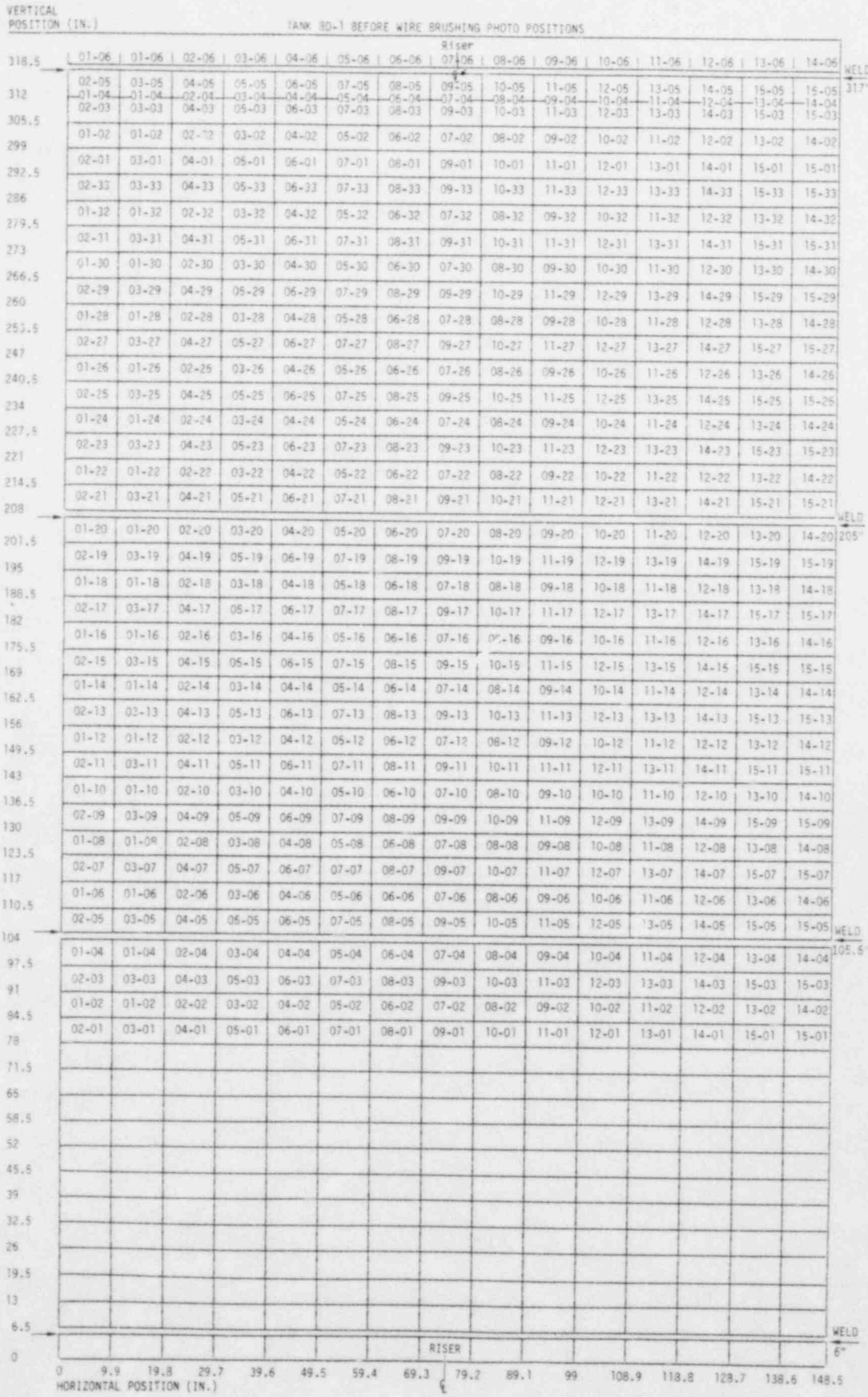

FIGURE B-1. Tank 8D-1 Before Wire Brushing Photo Positions.

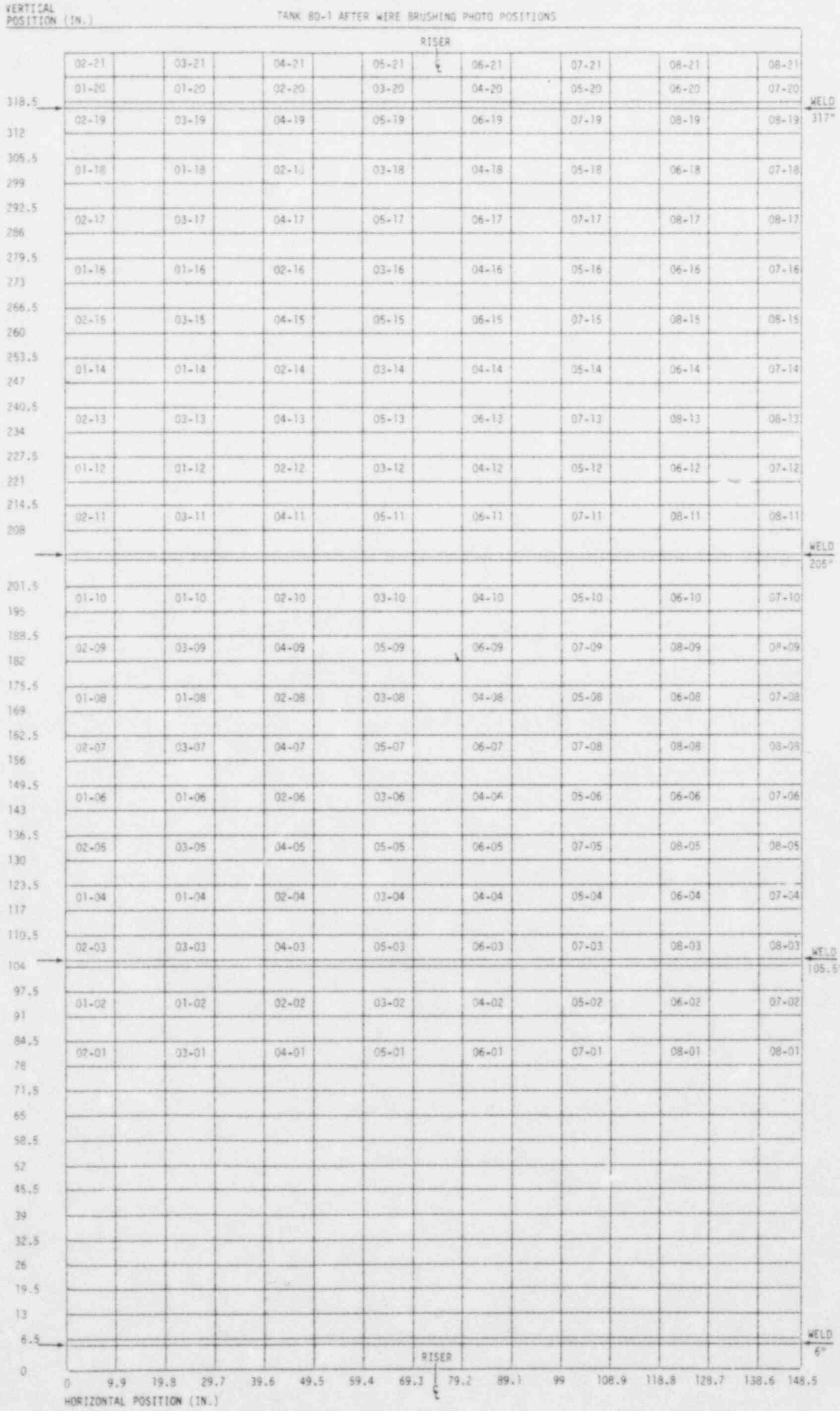

FIGURE B-2. Tank 8D-1 After Wire Brushing Photo Positions.

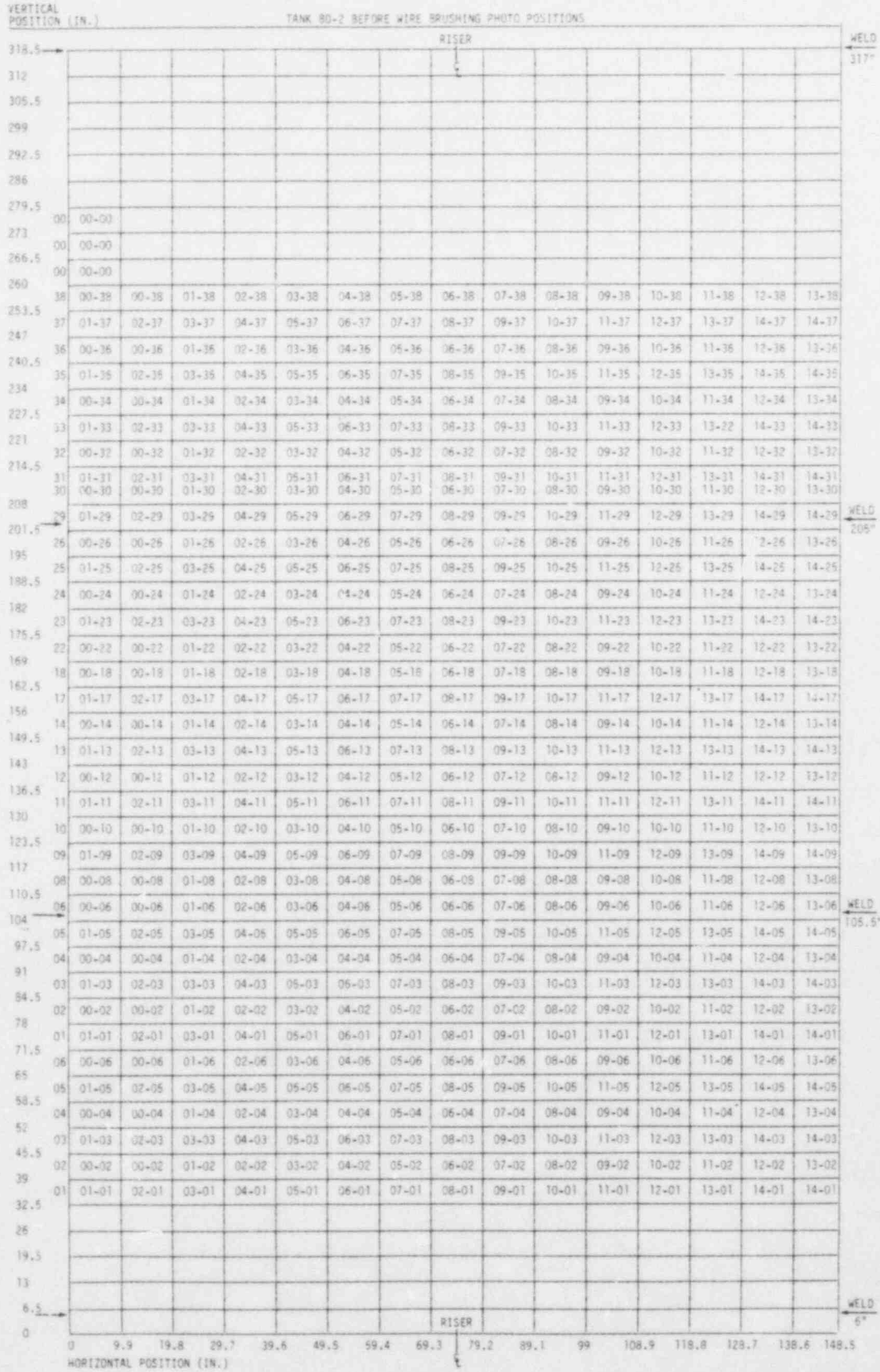

FIGURE B-3. Tank BD-2 Before Wire Brushing Photo Positions.

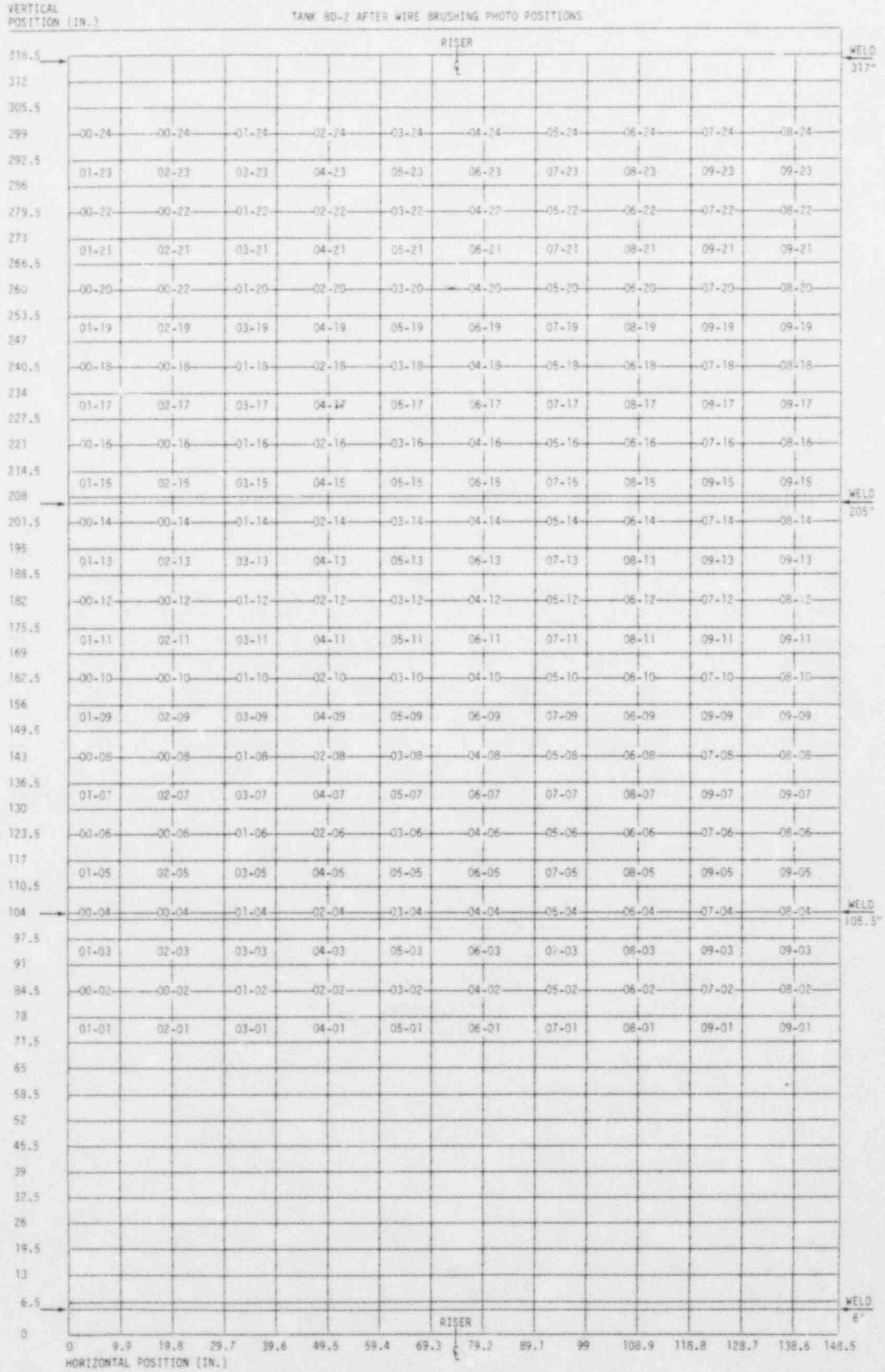

FIGURE B-4. Tank 8D-2 After Wire Brushing Photo Positions.