WSRC-RP-90-396

SUMMARY REPORT FOR 1990 INSERVICE INSPECTION (ISI) OF SRS 100-K REACTOR TANK (U)

May 15, 1990

Westinghouse Savannah River Company
P. O. Box 616
Aiken, SC 29802

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT DE-AC09-88SR18035

DISCLAIMER

WSRC-RP--90-396

DE92 009099

Savannah River Laboratory
Equipment Engineering Section
Reactor Tank Inspection Program

Keywords: Irradiation
Degradation Mechanisms
ISI
IGSCC
Robot
Restart

Retention - Permanent

SUMMARY REPORT FOR 1990 INSERVICE INSPECTION (ISI) OF SRS 100-K REACTOR TANK (U)

Prepared by:

J. M. Morrison, System Integrity Section, Reactor Programs
M. W. Loibl, Equipment Engineering Section, SRL

Issued: May 15, 1990

SRL SAVANNAH RIVER LABORATORY, AIKEN, SC 29808
Westinghouse Savannah River Company
Prepared for the U. S. Department of Energy Contract DE-AC09-88SR18035

DOCUMENT: WSRC-RP-90-396

TITLE: SUMMARY REPORT FOR 1990 INSERVICE INSPECTION (ISI) CYCLE OF SRS 100-K REACTOR TANK

DATE: May 15, 1990

APPROVALS

S. K. Formby
Equipment Engineering

A. F. McFarlane, Manager
Reactor Programs

TECHNICAL REVIEWERS

E. J. Majzlik
Equipment Engineering

W. L. Daugherty
Materials Technology

R. L. Sindelar
Materials Technology

N. G. Awadalla
Materials Technology

C. D. Cowfer
Reactor Engineering

R. L. Malloy
Quality Assurance

V. Cech
Equipment Engineering

B. D. Howard
Equipment Engineering

SUMMARY REPORT FOR 1990 INSERVICE INSPECTION (ISI) OF SRS 100-K REACTOR TANK

INTRODUCTION

The integrity of the SRS reactor tanks is a key factor affecting their suitability for continued service since, unlike the external piping system and components, the tanks are virtually irreplaceable. Cracking in various areas of the process water piping systems has occurred beginning in about 1960 as a result of several degradation mechanisms, chiefly intergranular stress corrosion cracking (IGSCC) and chloride-induced transgranular cracking. IGSCC, currently the primary degradation mechanism, also occurred in the "knuckle" region (tank wall-to-bottom tube sheet transition piece) unique to C Reactor and was eventually responsible for that reactor being deactivated in 1985.

A program of visual examinations of the SRS reactor tanks began in 1968, with 20 percent of the accessible weld area being inspected on a five-year frequency. In late 1986 and early 1987 the scope of these inspections was expanded to include a 100 percent visual examination of accessible welds in P, L, and K reactors. No evidence of cracking was detected in any of these inspections. As noted in the Inservice Inspection (ISI) Plan for the process water system prepared in 1988, volumetric and surface examinations are preferred and are currently being implemented (1): SRL Equipment Engineering Section (EES) efforts to develop such a capability using ultrasonic (UT) and eddy current (ET) techniques, culminated in a robotic inspection system ready for deployment in 1989. The 1989 P Reactor inspection, covering 40% of the accessible weld heat affected zones (HAZ), was the first inspection using the new system. The equipment performed well and no evidence of degradation of the tank wall weld zones by IGSCC was found (2).

During the period of the P Reactor inspection DOE directed that all reactors be similarly inspected prior to restart (3). Accordingly, plans were developed to inspect the K Reactor tank as soon as practical following completion of the P examination at the end of October 1989, since K is the first reactor scheduled for restart. This report documents the results of the K Reactor tank inspection, which was conducted during the period January through March 1990 and covered approximately 60% of the accessible weld HAZ. The test was performed under Test Authorization TA1-2300 and Special Procedure 2455, Rev. 1 (4, 5).

SUMMARY

The purpose of this inspection was to determine if selected welds in the K Reactor tank wall contained any indications of IGSCC. These portions included areas in and beyond the weld HAZ, extending out as far as two to three inches from the centerline of the welds, plus selected areas of base metal at the intersection of the main tank vertical and mid-girth welds. No evidence of such degradation was found in any of the areas examined.

A number of other non-relevant indications which were determined to be a result of tank fabrication processes were detected and were recorded in the permanent data base for reference in future inspections. These include areas of weld repair during original fabrication; evidence of current and former attachments to the tank (both outside and inside); geometric and subsurface reflectors associated with some welds; weld surface irregularities; and imperfections in the tank wall surface, such as minor dents and gouges. These findings were acceptable to the original tank construction codes and standards, are within the acceptance standards applicable for these ultrasonic inspections, and do not constitute a concern with respect to the structural integrity of the tank.

This inspection comprised approximately 60% of the accessible weld length in the K Reactor tank. Initial setup of the tank, which prior to inspection contained Mark 60B target assemblies but no Mark 22 fuel assemblies, began on January 14, 1990. The inspection was completed and

equipment removed from the 105-K Process Room on March 9, 1990. The total elapsed time for the overall inspection, therefore, was 55 days, a significant improvement over the 72 days required for the 40% inspection of P tank. The improvement was a result of several factors, a major one being the Quality Improvement Program (QIP) implemented during the P tank inspection. The absence of fuel in the K tank, assignment of additional inspection support personnel directly to the shifts, and an aggressive program to enhance coordination among participating organizations also contributed significantly to the success of the K Reactor tank inspection.

PURPOSE AND SCOPE OF INSPECTION

This inspection comprised the initial volumetric inspection required by the ISI Plan for the 100-K Reactor tank. The primary objective of the K tank inspection was the detection and sizing of IGSCC in the HAZ of the accessible weldments of the reactor tank, and the evaluation of any such IGSCC with respect to the approved acceptance criteria (6). Additionally, any indications of anomalies resulting from the original tank fabrication welding process were investigated, evaluated against the acceptance standards, and documented for future reference.

In accordance with the provisions of the ISI Plan and requirements specified by DOE, the following weld areas were examined by UT and ET techniques:

100%	Tank shell vertical welds (K-VC1, K-VC2, K-VD1, K-VD2)[a]
56%	Tank-to-expansion ring horizontal weld (K-H2) and horizontal weld in expansion ring immediately above (K-H1)[b]
57%	Tank shell horizontal mid-girth weld (K-H3)
57%	Tank shell-to-tank bottom nozzle assembly (TBNA) extension ring horizontal weld (K-H4)
57%	TBNA extension ring-to-TBNA horizontal weld (K-H5)
58%	Outlet nozzle-to-tank vertical welds (K-VF1, K-VF2, K-VF3, K-VF4, K-VF5, K-VF6, K-VF11)
33%	TBNA extension ring vertical welds between K-H4 and K-H5 (K-VE2)
50%	Vertical welds in expansion ring between K-H1 and K-H2 (K-VB1, K-VB2, K-VB3)

The area to be examined was specified in Reference 7 as base metal and the HAZ within two inches on either side of the weld centerline. In most cases this coverage was extended to three inches on each side of the weld centerline, for the UT scans perpendicular to the weld. The parallel UT scans covered two inches on either side of the weld centerline, as specified. In addition, regions of the tank base metal in the vicinity of the intersection of the main tank shell vertical and horizontal welds were scheduled for inspection. Due to the inclusion of all the main tank vertical weld HAZ, this K tank inspection program comprised approximately 60 percent of the accessible welds, on either a weld count or weld length basis (8).

The area of the expansion ring in the vicinity of welds K-H1 and K-H2 was inspected by ET only, consistent with the tank inspection procedure. An alternate UT transducer and procedure designed for the 3/16-inch thick expansion ring were qualified and available for backup use to the ET procedure if results should so indicate.

---

[a] See weld identifications in Figures 1-A and 1-B.

[b] Not required by ISI Plan.

As in the P Reactor inspection, inspection of some of the welds in the vicinity of the outlet nozzles was limited by the capability of the robotic system to access geometrically complex areas. Also, inspection of the T-joint weld joining the TBNA to the bottom tube sheet could not be accomplished with the present robot; this capability is still under development. For reference purposes, Figures 1-A and 1-B are unfolded views of the major weld areas in the vertical section of the tank. The view is from the center of the tank looking outward.

INSPECTION SYSTEM DESCRIPTION

The reactor tank inspection system was developed by the Equipment Engineering Section (EES) of the Savannah River Laboratory (SRL) according to the requirements of the Functional Specification (9) and NDE Methodology (7). These references contain details of the equipment and inspection techniques. The basic inspection system consists of: (1) a remotely operated robotic manipulator capable of conducting ultrasonic and eddy current examinations of all accessible areas of the reactor tank wall; (2) equipment for in-tank lighting, cameras, and calibration of the UT/ET system; (3) instrumentation and controls for the full range of UT, ET, and video operations; (4) a two-ton gantry crane for insertion and removal of equipment to and from the reactor tank; and (5) support equipment for communication between the process room and the control trailer, including lighting, closed circuit television, audio, etc. In addition, the onsite facility mockup of the P, L, and K Reactor tanks in Building 305-A was used to test, qualify, and demonstrate the in-tank tooling prior to its first use in P Reactor, and to train and qualify inspection personnel.

The NDE data acquisition system is based on an Intraspect/98™ Ultrasonic (UT) imaging system and a Zetec™ MIZ 18 ET system. The capabilities of the Intraspect/98™ have been evaluated in detail with respect to SRS applications (10). The NDE data acquisition system is supplemented by high-resolution in-tank REES™ cameras. In all, the complement of in-tank inspection equipment consists of one UT/ET robot, one calibration mast, and three tools, each containing one camera and two lights. The system used for the K inspection was essentially the same as that used in P except for a few modifications made as part of the QIP to improve reliability and performance. Chief among these changes were those associated with the cable management system. Photographs of the various equipment pieces in K Area are shown in Figures 2-5.

PROGRAM OVERSIGHT AND IMPLEMENTATION

A number of reviews were conducted at different times during the development of the inspection system to guide its development and implementation, as described in Reference 2.

As soon as the P tank inspection was completed in October 1989, a Reactor Tank Inspection Implementation Team was formed to coordinate the plans and activities required to prepare for the K tank inspection scheduled to begin in January 1990. The team met weekly until the inspection equipment was deployed. It included representatives of EES, Reactor Engineering, Reactor Operations, Reactor Operations-Component Handling, Engineering and Projects Division, Reactor Programs, and Outage Management. This was the same approach that led to the successful start of the P tank inspection, and similar good results were achieved in the K Reactor tank inspection.

A formal Preservice Review was conducted immediately prior to deployment of the equipment in K Reactor, to review the capability of the inspection system to perform satisfactorily from a functional standpoint, as well as the readiness of the reactor systems for the start of testing operations. Representatives of EES, Reactor Engineering, Reactor Operations, Reactor QA, DOE, and DOE consultants participated in the review. The findings of this review were favorable and were documented in a final report (11).

Prior to the start of the inspection, a number of training/briefing sessions were held by the RTIP personnel for representatives of Reactor Operations, Component Handling, and DOE. The purpose of these sessions was to communicate the purpose, nature, and details of the upcoming inspection to as wide a cross section of K Reactor personnel as possible, in order to enhance understanding and teamwork at the working level. Subsequent informal feedback indicated that this effort produced positive results.

In addition to internal WSRC oversight, DOE employed two consultants to review inspection activities. The DOE consultants maintained an active presence on a weekly basis during the course of the inspection. They performed independent reviews of the UT/ET inspection data. In addition, DOE Restart Operations and Restart Engineering personnel performed periodic audits of inspection program activities and status.

QUALITY ASSURANCE PROGRAM

The Reactor Tank Inspection Program (RTIP) QA Plan (12) is applicable to both the development of NDE inspection equipment systems and the implementation of the NDE inspection program.

The QA Plan defines the responsibilities and procedural controls to be administered by the Program Management Team to assure that pre-established requirements (Functional Specification and NDE Methodology) are attained. The QA Plan is consistent with the SRS/SRL Quality Assurance Program requirements.

Procedures applicable to the implementation of the program are listed in the RTIP QA Plan and are supplemented by task-specific procedures, identified in Appendix B.

A Quality Improvement Plan (QIP) is also required by the RTIP procedures. The QIP was implemented with two postinspection reviews. In the first review, suggestions for improvements in all categories (equipment design and maintenance, safety, procedures, QA, etc.) were contributed by members of the EES and RTIP staffs. These suggestions were used as inputs to a second review, in which similar suggestions were sought from representatives of Reactor Operations, Component Handling, Health Physics, Reactor Maintenance, DOE, and others. Action items resulting from these reviews have been prioritized and are being incorporated in the preparations for the L Reactor tank inspection scheduled to begin later in 1990. A similar QIP was developed following the 1989 P tank inspection and is credited for being instrumental in the overall success of the K Reactor tank inspection.

RTIP QUALIFICATIONS

The WSRC inspection team was supplemented by ten Amdata subcontracted NDE specialists. Contracted personnel who participated in the K Reactor tank ultrasonic examination had a high degree of experience in the detection and sizing of IGSCC in the commercial nuclear industry. All data analysts possessed current certifications from the EPRI NDE Center, which represents the industry standard for applications in piping. In addition, all contracted analysts and the EES RTIP UT Level III personnel were required to comply with the two basic elements of the RTIP UT qualification program:

- All WSRC and contracted UT personnel must be certified to a minimum of Level II in accordance with the applicable document which implements the American Society for Nondestructive Testing (ASNT) Recommended Practice No. SNT-TC-1A. Certifications of contracted personnel were reviewed and accepted by a RTIP EES Level III.

- WSRC and contracted UT personnel, the Amdata Intraspect/98 ultrasonic system, and the EES RTIP ultrasonic inspection procedure RTIP 008 (13) must successfully pass a site-specific performance demonstration developed and administered by the EPRI NDE Center.

Performance demonstrations utilized test plates fabricated from SA240-Type 304 stainless steel which represented the material used to fabricate the SRS reactor tanks. The plates contained artificially induced IGSCC. The plates were characterized by the EPRI NDE Center and subsequently used for the performance demonstrations. All demonstrations were proctored by EPRI personnel and certificates of achievement were issued by EPRI to personnel who successfully met the program requirements.

The following personnel successfully completed the EPRI performance demonstration:

Personnel who met the requirements for UT Data Acquisition:

B. D. Howard, EES RTIP UT Level III
J. D. Buchanan, Contracted UT Level II
W. P. Gunnels, Contracted UT Level II

Personnel who met the requirements for IGSCC Detection (Data Analyst):

B. D. Howard, EES RTIP UT Level III
M. A. McKaig, Contracted UT Level III
I. D. Hill, Contracted Level II
C. L. Allen, Contracted Level II
L. D. Kidd, Contracted Level II

Personnel who met the requirements for IGSCC Length Sizing (Data Analyst):

B. D. Howard, EES RTIP UT Level III
M. A. McKaig, Contracted UT Level III
I. D. Hill, Contracted UT Level II
C. L. Allen, Contracted UT Level II
L. D. Kidd, Contracted UT Level II

Personnel* who met the requirements for IGSCC Depth Sizing (Data Analyst):

M. A. McKaig, Contracted UT Level III
I. D. Hill, Contracted UT Level II
C. L. Allen, Contracted UT Level II

*B. D. Howard, the EES RTIP Level III, and Larry Kidd, a contracted UT Level II, also satisfactorily passed the IGSCC depth sizing proficiency examination on March 1 and March 8, respectively.

In addition to the UT qualifications, the ET personnel, system, and RTIP Procedure 009 (14) were subjected to a Qualification Program similar to that which was administered to the UT program.

The plates which were developed for the UT qualification were used for the ET Procedure Qualification. The ET System capabilities were witnessed by EPRI personnel and attested to. Also, a formal procedure demonstration was performed by the EES RTIP ET Level III with SRS

Quality Assurance personnel in attendance per the requirements of RTIP 009, Attachment 1. These procedure demonstrations are considered to meet ASME Code requirements.WSRC and contracted ET personnel were qualified as follows:

- All WSRC and contracted ET personnel were certified to Level III in accordance with the applicable document which implements ASNT Recommended Practice No. SNT-TC-1A.
- Adequate capability to accurately locate the centerline of vertical and/or horizontal welds.
- Adequate capability to detect and size length of IGSCC.

Personnel who have met the requirements for ET qualification:

V. Cech, EES RTIP ET Level III
W. Downs, Contracted ET Level III

REACTOR TANK UT ACCEPTANCE CRITERIA

Prior to performing the P Reactor tank UT inspection in 1989, acceptance criteria were developed to disposition any indications that might be found. The criteria were developed by a special working group that included nationally recognized experts. The criteria are contained in three documents, which are attached to a summary document, WSRC-RP-89-208 (15). Reference 15 is the original version of the criteria approved by DOE (16).

As described in Reference 2, the acceptance criteria provide specific response requirements for indications that meet or exceed any of three standards. These standards are developed specifically for IGSCC, or more generally for planar indications that are open to the tank surface. The three size criteria and required responses are summarized as follows:

(1) An indication greater than or equal to 20 percent throughwall and 5 inches in length exceeds the reexamination standard. These indications are acceptable for continued operation but must be reexamined within 18 months.

(2) An indication greater than or equal to 20 percent throughwall and 10 inches in length exceeds the acceptance standard. These indications require additional analysis using specific configuration, location, and material property data to demonstrate acceptability for continued operation. If acceptable, they shall be reinspected at an interval to be determined by the analysis.

(3) An indication less than 20 percent throughwall and greater than 20 inches in length is also subject to additional analysis and/or supplemental examination. If found to be acceptable for continued operation, it shall be reinspected at an interval determined by the analysis.

(4) An indication which does not exceed any of the above standards is acceptable for continued operation. The ISI Plan for the SRS Reactor Process Water System requires reinspection of all areas every five years (1).

As noted above, these criteria apply specifically to IGSCC. As worded originally, the criteria might be interpreted to apply to weld metal also. However, only the heat affected zone portions of the weldments are susceptible to IGSCC; the weld metal is not susceptible to IGSCC. Accordingly, the original criteria approved by DOE were modified by adding guidelines for

addressing any indications that might be found within the weld metal or UT signals resulting from geometric reflectors. The added guidelines are as follows:

(1) Any UT signal that is interpreted by the level III inspectors as a reflector due to weld geometry is acceptable. It should be documented for future reference (see item 4 below).

(2) Any UT signal that is interpreted by the level III inspectors as a discontinuity which is embedded entirely within the weld and does not penetrate the tank surface is acceptable as is. Such discontinuities are assumed to be a result of tank fabrication. As such, these weld imperfections would have been accepted by the code of record enforced during tank fabrication. There is no known mechanism for the propagation of weld flaws in the SRS reactor tanks. Thus, they present no concern to the structural integrity of the tank. These indications should be documented for future reference (see item 4 below).

(3) Any UT signal that is interpreted by the level III inspectors as a discontinuity within the weld volume which penetrates the tank surface should be evaluated in accordance with the acceptance criteria Reference 6.

(4) Since the UT qualification is based on cracks of 3.0" ± 0.5", shorter cracks may not be detected. Similarly, geometric or embedded weld reflectors shorter than 2.5" may not be detected. These weld reflectors need not be considered for combination with adjacent indications. Embedded weld flaws whose length is greater than or equal to 2.5" shall be documented for future reference and should include, to the extent to which the equipment and inspectors are qualified, the location coordinates and a cross-sectional plot showing the location of the reflector with respect to the weld. Hard copy data from an automatic data acquisition system (such as the Intraspect 98) which is capable of providing an overlay for direct comparisons with subsequent inspections is considered adequate for this purpose.

The above guidance for weld evaluations was incorporated in Reference 6 and was used as the applicable criteria throughout the K Reactor tank inspection. Formal approval was received from DOE on March 13, 1990 (17).

INSPECTION PERFORMANCE

The 1990 K Reactor tank inspection was accomplished during the period January-March, 1990. A total elapsed time of 55 calendar days was consumed, including time required to relocate components in the tank to create sufficient vacant positions to charge the inspection equipment for the first phase of the test, time to rearrange these components for the second phase of the test, and time to remove the inspection equipment from the Process Room following completion of the inspection.

The above does not include the time required to return the tank components to normal following the inspection, because the return to normal was actually accomplished in increments as other post-UT activities were carried out. These activities included: internal reactor component inspections per DPSOL 105-1851B; replacement of two plenum-top shield tie bolts; underwater suction cleaning of debris from the tank bottom; and removal of two deactivated motion-measurement instrument rods from one-inch positions on the periphery of the tank.

The 55-day total also includes all other noninspection time such as crew rest on weekends, inspection equipment moves in the reactor tank, troubleshooting and maintenance, etc. The total time was divided about equally between inspection and noninspection-related activities. The inspection activities took place over about a 28-day period, while 27 days were required for tank setup, rearrangement, and other non-UT operations. The 28-day inspection period for the 60% K-tank inspection compares favorably to the 32-day period required to inspect the P Reactor tank with

a 40% inspection scope. The gains in efficiency realized in the K Reactor tank inspection primarily reflect the following improvements:

- Enhanced equipment reliability by improving the cable management system
- Reduced non-productive time and risk of damage by streamlining robot handling procedures
- Additional support personnel assigned to shifts to be available when needed
- Availability of improved UT acceptance criteria and of tank fabrication/construction at the beginning of the inspection
- Improved interaction among participant organizations by conducting pre-inspection training sessions

The overall time for the inspection, 55 days, also reflects a significant benefit due to the absence of fuel in the K Reactor, which made it possible to open up half of the tank for inspection at the beginning of the test. As was the case in P Area, only 3 sectors at a time can be opened up if there is a full charge of fuel in the tank, in which case more time is required to relocate components within the tank.

The dates corresponding to the key activities in the K-tank inspection are:

Begin preparations for component moves for Phase 1 test	January 14
Begin equipment installation and checkout	January 28
Begin Phase 1 inspection (9 sectors)	February 2
Complete Phase 1 inspection	February 26
Begin Phase 2 inspection (1 sector)	March 6
Complete Phase 2 inspection	March 8
Remove inspection equipment from Process Room	March 9

The two inspection phases referred to above correspond to the two regions of the tank vacated to permit insertion of the inspection equipment. These regions are outlined on the reactor face map in Figure 6. The reactor tank was subdivided into 18 inspection sectors, each corresponding roughly to the extent of the tank circumference that can be reached by the robot from a single four-inch position. The 10 sectors examined in this inspection were:

Test Phase	Sector	Tank Coordinate of UT/ET Robot
1	2C	X25-Y15
1	2B	X31-Y15
1	2A	X37-Y21
1	1F	X43-Y27
1	1E	X46-Y36
1	1D	X46-Y48
1	1C	X46-Y60
1	1B	X43-Y69
1	1A	X37-Y75
2	3E	X25-Y81

The vertical inspection range of the UT/ET end effector in each robot position was adjusted in three discrete increments, or "windows" (upper, middle, and lower) to cover the entire accessible height of the tank. The locations of these windows are indicated by the horizontal dashed lines in Figures 1-A and 1-B.
A total of about 177 feet of reactor weld HAZ was inspected in this test (8). Including overlap of the inspection areas of the circumferential welds between adjacent sectors, the UT/ET probes actually examined a total of about 200 feet of weld HAZ.

REPORTING

In accordance with the requirements of inspection procedure RTIP 002 (18), the inspection results were reviewed by a WSRC Inspection Review Committee (IRC). The members of the 1990 K-tank IRC were:

J. M. Morrison, Chairman	Reactor Programs
E. G. Caveness	Equipment Engineering/RTIP
D. R. Ketcham	Reactor Engineering
K. W. Atkinson	Reactor Operations
R. L. Malloy	Quality Assurance
E. J. Majzlik	Equipment Engineering/Materials
C. D. Cowfer	Reactor Engineering

The IRC was responsible for reviewing the UT/ET results and data packages, as presented by the appropriate Level III analysts, in accordance with the requirements of the approved flaw acceptance criteria (6). In so doing, the IRC was responsible for dispositioning the results, such as by acceptance or by deferral with request for additional inspection and analysis, and issuing a formal report following each committee meeting. The IRC was further responsible for reporting the results to WSRC and DOE management on a daily basis as the inspection progressed, for conduct of daily briefings on progress and status, and for preparation of this final summary report.

For purpose of data review and disposition, the IRC met a total of 14 times and generated 14 formal daily reports, numbered 1 through 14. Copies of these reports are presented in Appendix A. The IRC reviewed a total of 22 UT data packages and 30 ET data packages, as follows:

UT: SRS-008-K-001 through SRS-008-K-022

ET: SRS-009-001K through SRS-009-030K

Original copies of the above data packages have been archived in the permanent inspection records file (15).

INSPECTION RESULTS

The primary goal of this inspection was to determine if the inspection areas of the accessible K-Reactor tank weld HAZ indicate any signs of IGSCC. The inspection results clearly showed no evidence of such degradation. As was the case in the P-Reactor inspection (2), other UT indications that reflect tank fabrication processes were found. These were included in the analysts' detailed reports and are available for reference in future inspections as required. Some examples are described below. None of these findings represented an adverse impact on the structural integrity of the reactor tank. The criteria underlying this conclusion are embodied in the updated UT acceptance criteria (6). All UT and ET data obtained during the inspection were permanently recorded on magnetic tape. These tapes and selected videotape records have been

placed in archival storage for future reference (19). No Non-Conformance Reports (NCRs) were generated during the K-Reactor tank inspection. Specific results of note are summarized below.

(1) Vertical welds:

The main tank vertical welds in K tank were located in Sectors 2B and 3E, consistent with their locations based on historical records from visual examinations prior to 1986. (These are also the same as the locations of the vertical welds in P tank). As in P, the upper and lower vertical welds are not continuous over the entire height of the main tank shell, but are offset about four inches at the mid-girth weld as indicated in Figures 1-A and 1-B. The bottom vertical weld is rotated clockwise from the top weld as viewed from the center of the tank.

(2) Weld repairs:

Evidence of nine definite weld repairs was found. Eight of these were associated with weld K-H4, the main field weld joining the tank shell to the tank bottom nozzle assembly extension ring. These repairs varied in length up to 10 inches, in width up to a maximum of 2 inches (normal weld width of K-H4 is 3/8 to 5/8 inch), and occurred on both O.D. and I.D. surfaces of the tank. As specified in the UT acceptance criteria, these repair areas do not pose a concern with respect to structural integrity of the tank. In nearly every case there was nothing unusual about the repair areas.

The repair in Sector 1F, however, possessed somewhat unique characteristics and was investigated in more detail. This particular reflector is parallel to weld K-H4 and is just off the edge (toe) of the weld, extending over approximately a 5-inch length. The location and appearance of the reflector, together with the absence of other similar reflectors in the same window, prompted further evaluation to determine conclusively the presence or absence of degradation such as by IGSCC.

Three ET flaw detection scans were made in the area of concern, to further investigate the reflector. These scans showed negative results; the reflector was indicated to have no depth. Additional ET analysis revealed the weld is considerably wider in this area than normal. This was corroborated by visual examination, using the high-magnification lens (25X) of the overhead camera. No surface breaks or flaw indications were found. The wider-than-normal weld area is indicative of repair. Additionally, the area showed some visible evidence of grinding characteristic of a repair area. Examination of the original fabrication shop radiographs was difficult due to their poor condition. Nevertheless, it was possible to reconstruct the orientation of the radiographs, with the result that the area in question was indicated as having been repaired 3 separate times. The unanimous conclusion of the analysts, therefore, based on all the above evidence, was that this linear indication in weld K-H4 was a result of geometric anomalies associated with weld repairs performed during tank fabrication to remove welding defects, and does not constitute a concern regarding structural integrity. Additional details are contained in IRC Report #6, in the additional report by the UT/ET Level III analysts dated February 14, 1990, following IRC Report #6, and in the detailed report by the Level III Radiographic Analyst dated February 17, 1990, also following IRC Report #6 (see Appendix A).

(3) Attachments:

Considerable evidence of both present and former attachments to the tank was found during the inspection. Two of the six motion measurement brackets welded to the inside top of the 0.5-inch main tank shell immediately below the expansion ring were located; these two are in Sectors 2A and 1F. The motion measurement system is no longer in use, but the brackets

remain. The brackets could be inspected only visually and no evidence of cracking adjacent to the attachment fillet welds was apparent.

Elsewhere, evidence was found in about 50 separate locations where attachments had been originally welded to the tank and subsequently removed by cutting and/or grinding prior to service. About two-thirds of these occurred on the O.D. surface of the tank, where in most cases it was not possible to determine conclusively if the item is still there or removed. In Sectors 1A, 1B, and 2A the UT data suggest that the attachments are still present. In the case of Sector 2A, the data are indicative of beam redirection from the apparent attachment near weld K-H5; see IRC Report #7 and attached diagram, Appendix A.

These attachments included lifting lugs and alignment pins used during fabrication and construction, thermocouple pads for tank temperature measurement, etc. None of these areas of present or former attachments showed any indication of crack openings to the surface or depth into the tank wall.

(4) Other fabrication anomalies:

Geometric reflectors, weld surface irregularities, minor dents and gouges, pit-like occurrences in the oxide coating on the tank wall, and weld metal deposits associated with areas of former attachments were found in a number of areas. In another instance, weld K-VF11 (vertical weld in tank bottom nozzle assembly adjacent to System 6 outlet nozzle) was noted as appearing to be approximately 0.4 inch off-plumb (non-vertical) over the 12 inch length scanned. Since the off-plumb graphical presentation was evident from only one scanning direction, there may have been some "drift" in the robotic manipulator horizontal zero coordinate. Specific notes on these findings are contained in the IRC reports contained in Appendix A. None of these presents a concern to the structural integrity of the K tank.

Subsurface or "embedded" reflectors were detected within the fabrication weld nugget in at least six different weld locations. (Three similar reflectors were detected in the P tank inspection.) Each of the six reflectors occurred in a different weld:

Sector	Weld	Length
1E	K-VF3	Indeterminate
2B	K-VF5	3 inches
2B	K-H4	3
2C	K-VF6	11
3E	K-VC2	0.6
1D	K-H5	28

These reflectors were determined to be embedded at a depth ranging from 0.20 to 0.40 inch beneath the inside surface of the tank. UT and ET scan data showed that none of these reflectors were open to either the inside or outside surface of the tank.[c] Consequently, all of these reflectors were acceptable within the approved acceptance criteria. Nonetheless, because of its length, a stress estimate was made for the 28-inch embedded reflector in Sector 1D, weld K-H5. The results indicated that even with overly conservative assumptions (wall thickness of only 0.25-inch completely around the tank in this region, full normal plus seismic

---

[c] ET data applied only to the inside surface

loading), the calculated stress would still be less than the ASME Code allowable (20). Further evaluation of the data raised the possibility that this reflector might not even be a flaw, but rather a result of weld metallurgical structure at that particular location. These considerations strengthened the conclusion that this reflector does not present a concern to structural integrity. This and all other UT/ET data have been permanently archived and are available for reference in future inspections.

Another technical observation of note concerns the amplitude of the ET signals obtained from the main circumferential field weld K-H4. These signals were stronger in this weld than was observed elsewhere in K or in P tank. Areas of weld repair in the same field weld, however, appeared normal. Various factors, e.g., different ferrite contents of the weld material metallurgical or mechani al characteristics from post-welding finishing operations, etc., could be responsible for the observed characteristics. A program has been initiated to determine if the observed behavior can be duplicated in specially fabricated welded plate samples. No cracking was observed along this weld.

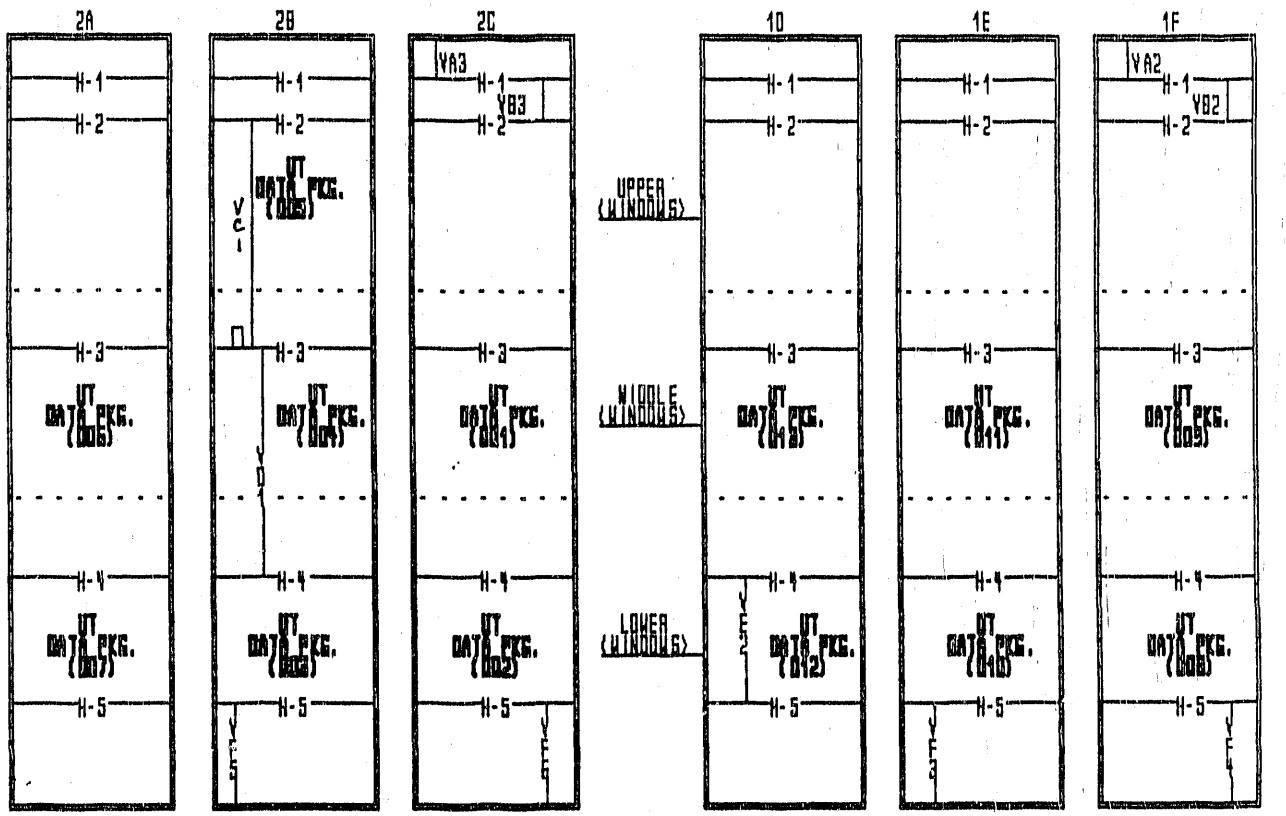


Figure 1-A. "K" Reactor Ultrasonic Scan Envelopes

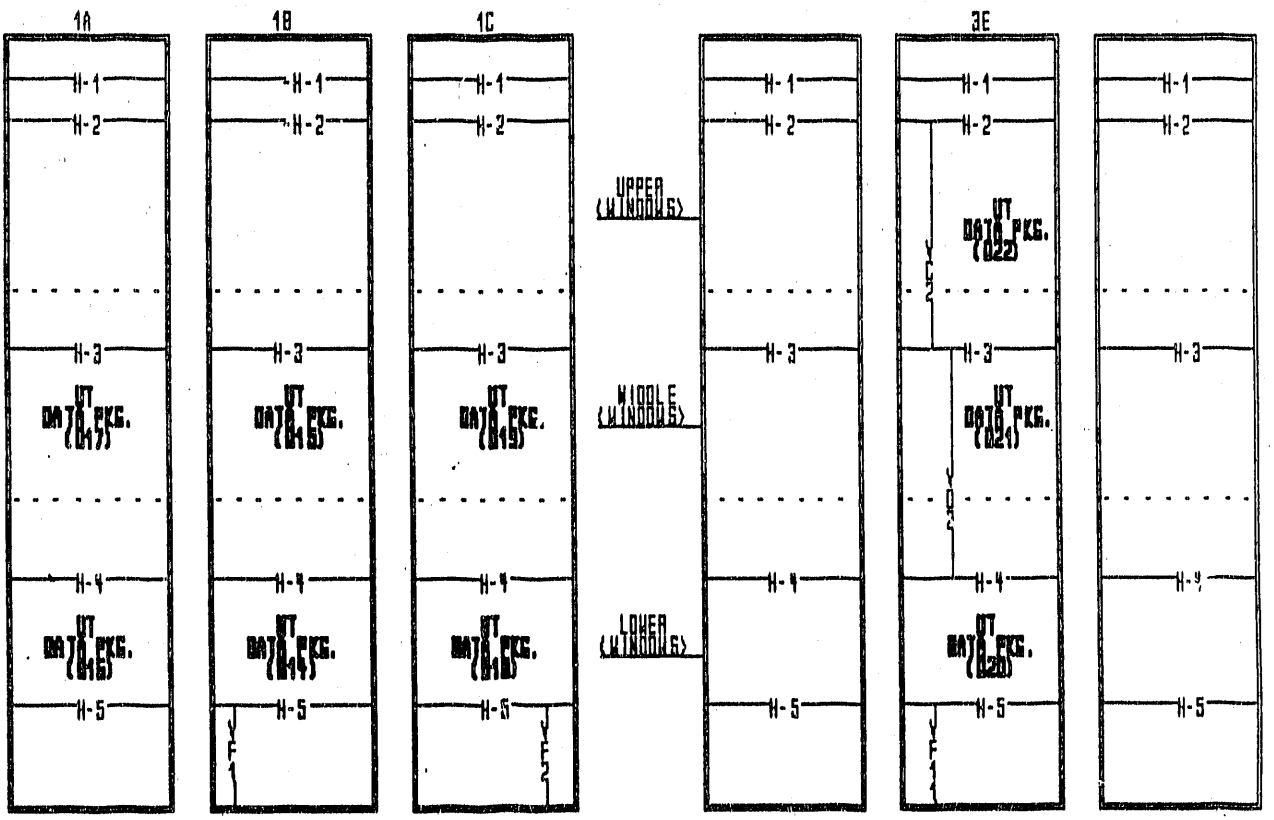


Figure 1-A. "K" Reactor Ultrasonic Scan Envelopes (Continued)

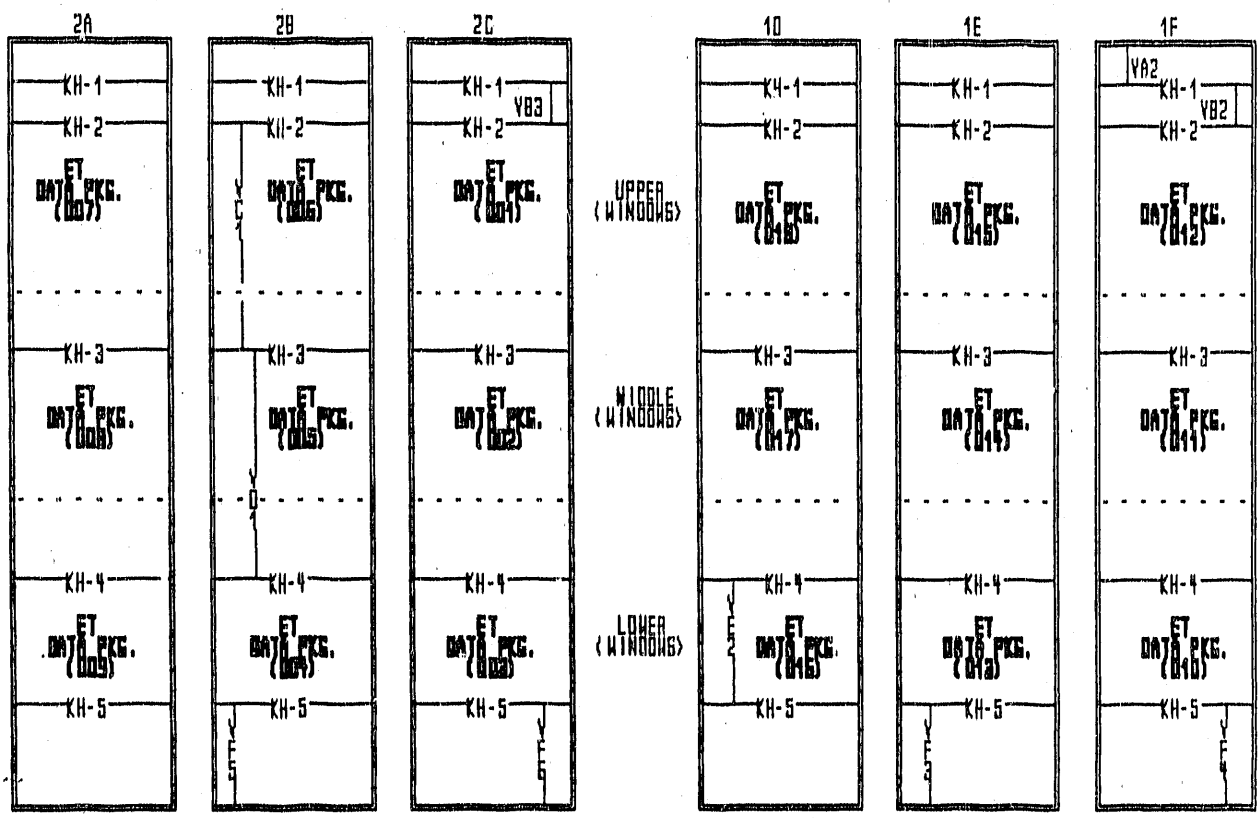


Figure 1-B. "K" Reactor Eddy Current Scan Envelopes

M9005006

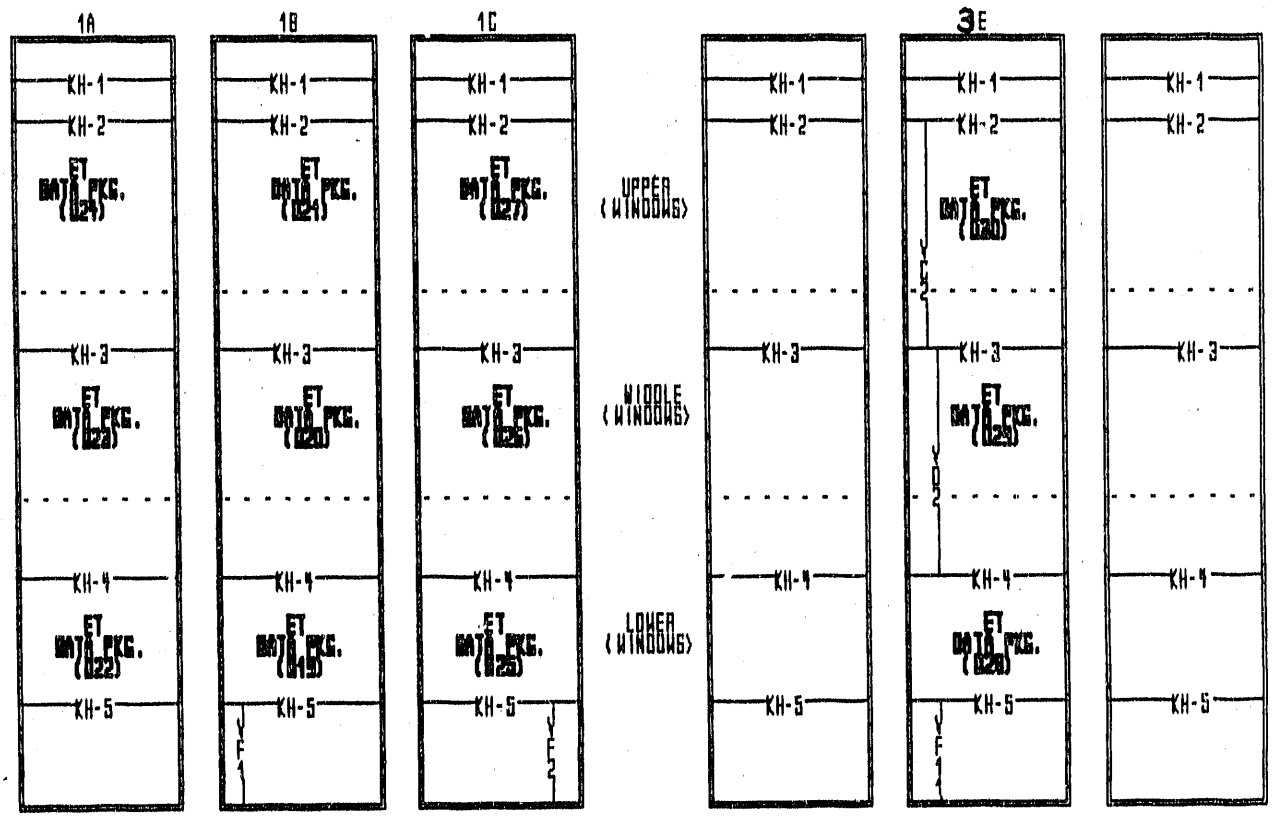


Figure 1-B. "K" Reactor Eddy Current Scan Envelopes (Continued)

M9005006

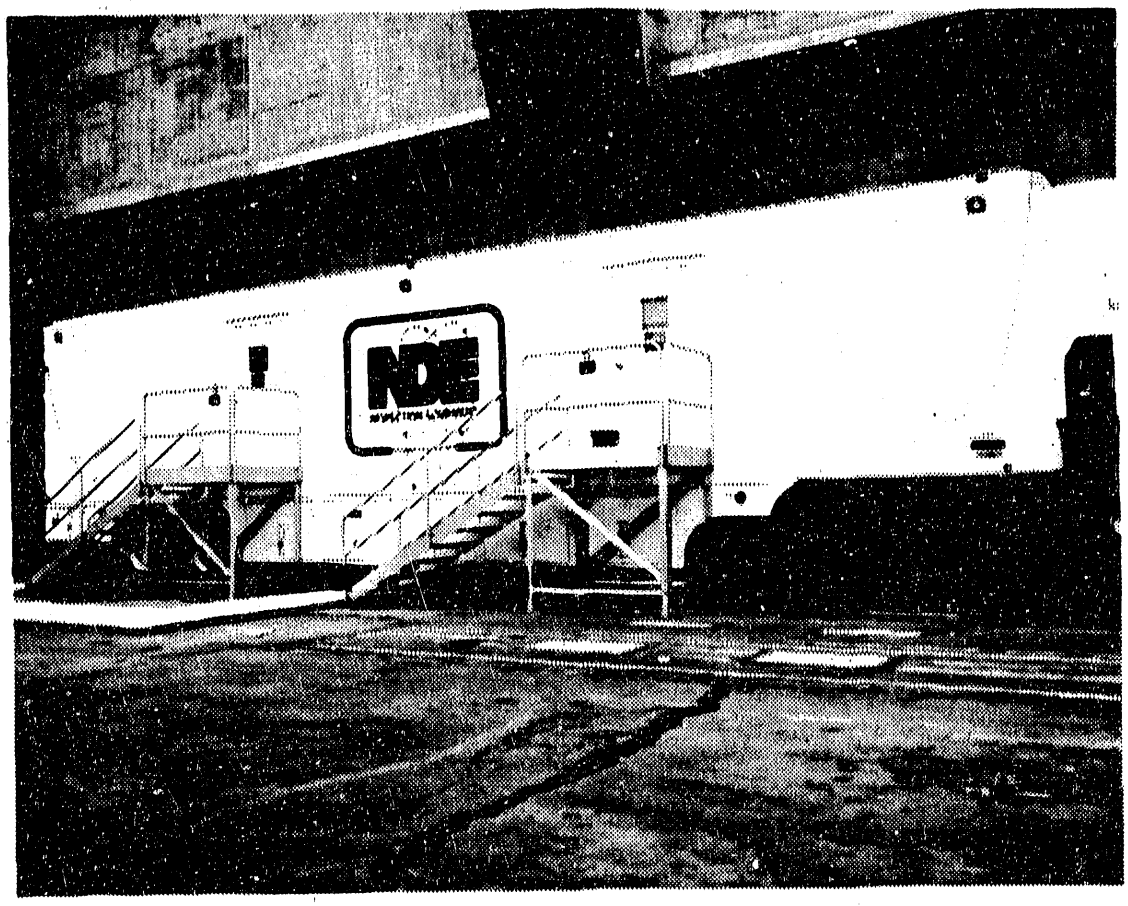


Figure 2. NDE Mobile Control Trailer in Place for K Reactor Tank Inspection

Figure 3. View of Two of the Five Control Consoles Inside the Mobile Control Trailer. The Robot Control Console is Shown in the Foreground with the Data Acquisition Console in the Background

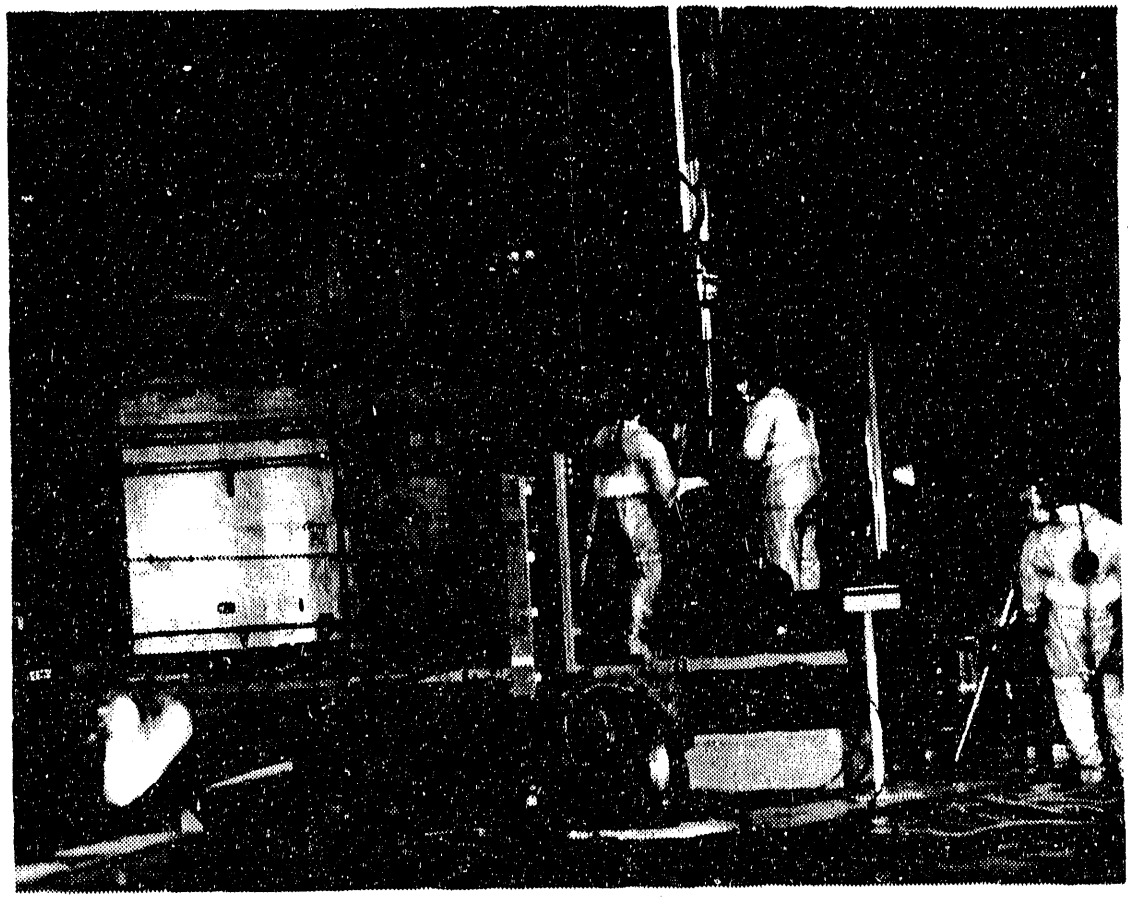


Figure 4. Personnel Charging a Remote Camera Tool to the K Reactor Tank

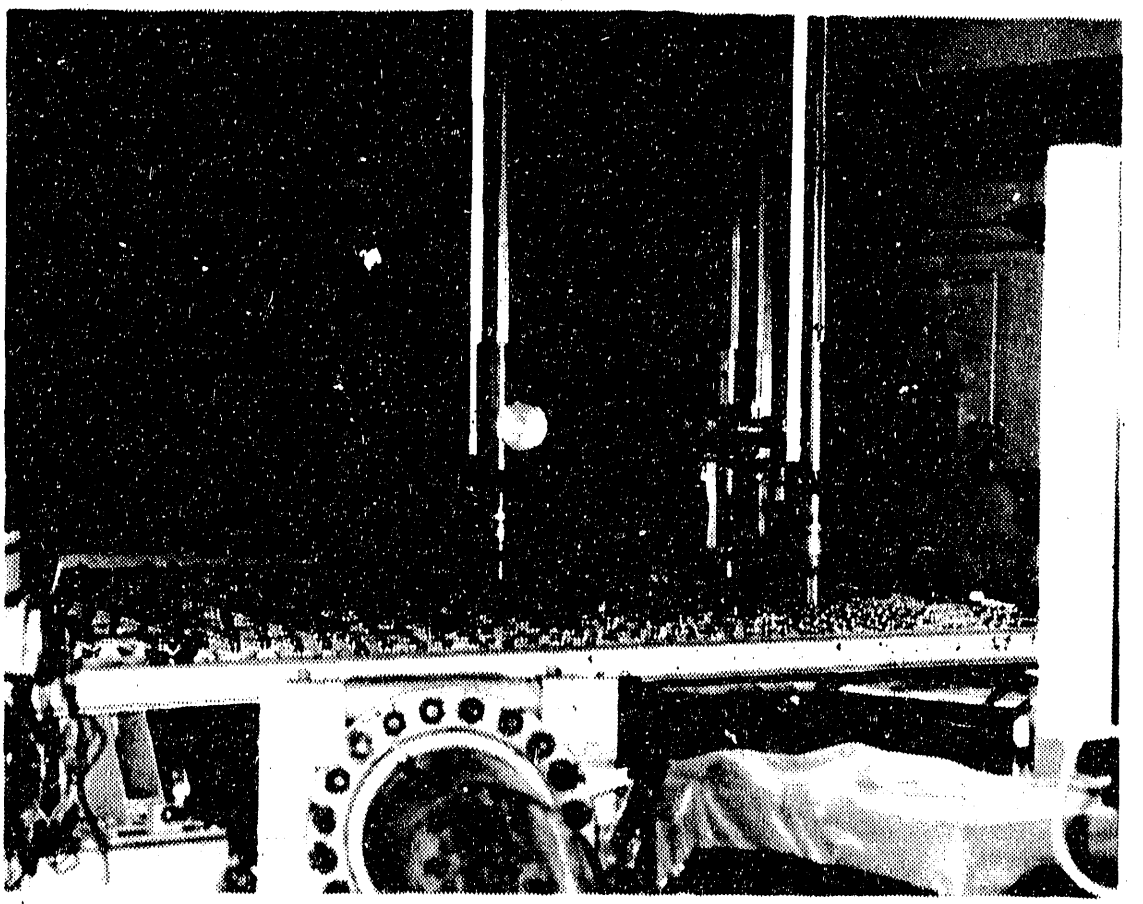


Figure 5. Top View of Three Robotic Inspection Tools Inserted in the K Reactor Tank

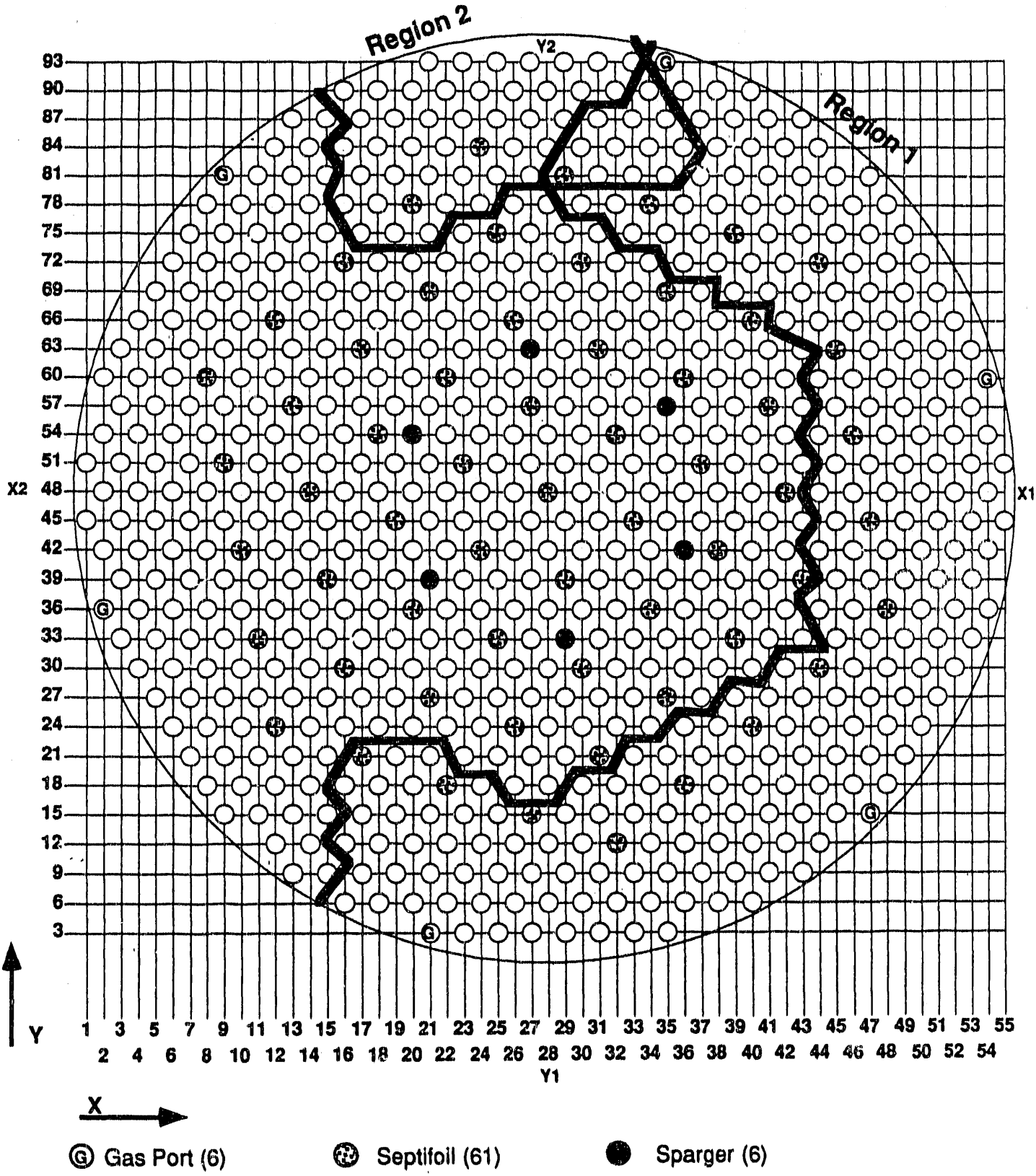


Figure 6. Regions of Vacant K Reactor Positions for Inspection Equipment

M9005006

REFERENCES

(1) DPSTM-88-100-1, "ISI Plan for the Savannah River Production Reactors Process Water System," December 1988.

(2) WSRC-RP-89-1311, "Final Summary Report for 1989 Inservice Inspection (ISI) of SRS 100-P Reactor Tank," December 15, 1989.

(3) R. E. Tiller, DOE, letter to J. L. Gallagher, WSRC, "Ultrasonic Testing (UT) of K and L Reactor Vessels," November 21, 1989.

(4) TA1-2300, "Ultrasonic Inspection of Reactor Tank Welds," WSRC-OX-89-9-001, July 12, 1989.

(5) SP-2455, Revision 1, "Ultrasonic Inspection of Reactor Tank-Without Fuel (TA1-2300, U)," TA WSRC-OX-89-00009-0001, TA expires 8/25/91.

(6) WSRC-RP-89-208, Revision 2, "Reactor Tank UT Acceptance Criteria," January 1990.

(7) Savannah River Laboratory, Technical Division, Equipment Engineering, Reactor Tank Inspection Program," NDE Methodology," Rev. 4, effective date January, 17, 1990.

(8) J. M. Morrison, Memorandum to A. F. McFarlane, "Fraction of K and P Reactor Tank Welds Inspected," OPS-PSI-900001, March 26, 1990.

(9) EED 870463, "Functional Specification for Ultrasonic Survey Capability of Savannah River Reactors, P, L, and K," September 1986; Rev. 4, January 17, 1990.

(10) IR-AMD-011, "Automated Detection and Sizing of Intergranular Stress Corrosion Cracking with the AmData Intraspect/98," January 1989.

(11) E. J. Majzlik, Jr., Memorandum to J. M. Morrison and E. G. Caveness, "Preservice Review - K-Area Reactor Inspection Summary Report," SRL-MAT-90007, February 23, 1990.

(12) EED 880364, "QA Plan-Reactor Tank Inspection Program," effective date May 27, 1988.

(13) Procedure RTIP-008, "Automated Ultrasonic Inspection of SRS Reactor Tanks," Rev. 2, January 9, 1990.

(14) Procedure RTIP-009, "Automated Eddy Current Examination," Rev. 1, January 9, 1990.

(15) WSRC-RP-89-208, Rev. 0, "Reactor Tank UT Acceptance Criteria," May 1989.

(16) R. E. Tiller, letter to J. L. Gallagher, "Comments on the Reactor Tank Ultrasonic Testing (UT) Inspection Acceptance Criteria," August 18, 1989.

(17) F. R. McCoy, III, letter to J. L. Gallagher, "Reactor Tank Ultrasonic Testing (UT) Inspection Acceptance Criteria, Revision 2 (letter, J. L. Gallagher to R. E. Tiller, 2-27-90)," March 13, 1990.

(18) Procedure RTIP-002, "Data Communication - Phase II," September 8, 1989.

(19) DPSOL 324-2-2005, EES Procedure, "EED Records," Rev. 2, July 14, 1988.

(20) G. E. Mertz, Memorandum to N. G. Awadalla, "Reactor Tank Stresses at Weld KHS," SRL-EDG-90-102, March 23, 1990.

Appendix A

Copies of Inspection Review Committee Daily Reports

RTIP IRC Daily Report — Report No.: 1

RTIP - 002 [Exhibit 1] — Date: 2-4-90

Members In Attendance:

	Name	Signature
Chairman:	J. M. Morrison	J M Morrison
EES/RTIP:	E. G. Caveness	E G Caveness
Rx. Eng.:	C. D. Cowfer / D. R. Ketchen	C D Cowfer / D R Ketchen
Rx. Ops.:	K. W Atkinson	K W Atkinson 2-4-90
EES/MAT :	E. J. Majzlik	E J Majzlik Jr 2/4/90
QA. :	R. L. Malloy	R L Malloy 2/4/90

Inspection Reports Reviewed: SRS-009-001K, for top window of Sector 2C (ET only)

Relevant Indication [Tank Location and Dimensions]:

None.

Classification of Indication:

N/A

NCR's Generated: (Yes/No)

NCR Nos.: N/A

Comments: No reportable indications. Similar to findings in P, evidence of former attachment on I.D. of expansion ring, ~1" square.

RTIP IRC Daily Report — Report No.: 2

RTIP - 002 [Exhibit 1] — Date: 2-7-90

Members In Attendance:

	Name	Signature
Chairman:	J. M. Morrison	J M Morrison
EES/RTIP:	E. G. Caveness	E. Gene Caveness 2/7/90
Rx. Eng.:	C. D. Cowfer / D. R. Ketchan	C D Cowfer / D. R. Ketchan 2/7/90
Rx. Ops.:	K. W. Atkinson	K W Atkinson 2/7/90
EES/MAT:	E. J. Majzlik	E J Majzlik Jr.
QA.:	R. L. Malloy	R L Malloy

Inspection Reports Reviewed: SRS-008-K-001 (UT) and SRS-009-002 K, for middle window of Sector 2C (weld K-H3)

Relevant Indication [Tank Location and Dimensions]:

None. No reportable indications were encountered.

Classification of Indication:

N/A

NCR's Generated: (Yes) (No)

NCR Nos.:

Comments: Limits of robot extension and rough weld contours limited UT scans to 2 vertical and 1 (rather than 2) horizontal scans. Additional ET scans were conducted in this area to assure adequate coverage.

RTIP IRC Daily Report — Report No.: 3

RTIP - 002 [Exhibit 1] — Date: 2-8-90

Members In Attendance:

	Name	Signature
Chairman:	J. M. Morrison	J M Morrison
EES/RTIP:	E. G. Caveness	E G Caveness 2/8/90
Rx. Eng.:	C. D. Cowfer/D. R. Ketchen	C D Cowfer / D R Ketchen 2/8/90
Rx. Ops.:	K. W. Atkinson	K W Atkinson 2-8-90
EES/MAT:	E. J. Majglik	E J Majglik 2/8/90
QA:	R. L. Mallory	R L Mallory

Inspection Reports Reviewed: SRS-008-002K (UT) and SRS-009-003K (ET), for lower window of Sector 2C (welds K-H4, K-H5, and K-VF6

Relevant Indication [Tank Location and Dimensions]:

None. No reportable indications.

Classification of Indication:

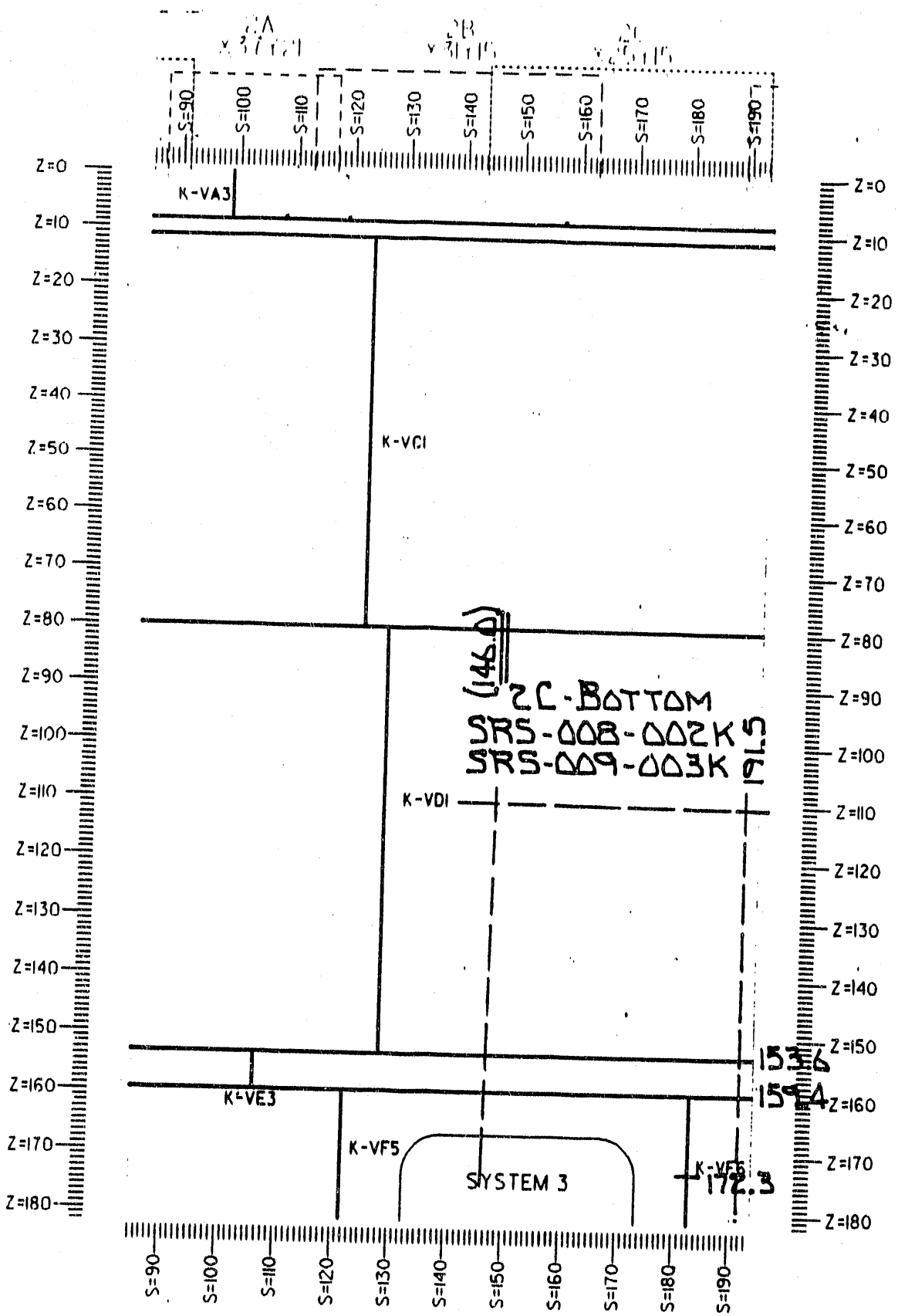
N/A

NCR's Generated: (Yes/No) No

NCR Nos.:

Comments: Several indications of interest were: 2 former attachments on O.D. of K-H4; a slight gouge above K-H4 indicative of a weld deposit subsequently removed; a weld repair area on K-H4 about 5 inches long, on both I.D. and O.D.; 2 small spots (possible punchmarks) above K-H5 with no depth; and an imbedded weld anomaly about 11 inches long in weld K-VF6, about 0.20 to 0.25 inches below the I.D., not breaking either surface. Weld contours are generally very round.

Page 6 of 6



K REACTOR TANK
WALL WELD MAP

RTIP IRC Daily Report — Report No.: 4

RTIP - 002 [Exhibit 1] — Date: 2-12-90

Members In Attendance:

	Name	Signature
Chairman:	J. M. Morrison	J M Morrison
EES/RTIP:	E. G. Caveness	E G Caveness
Rx. Eng.:	C. D. Cowfer/D. R. Ketchen	C D Cowfer D R Ketchen
Rx. Ops.:	K. W. Atkinson	K W Atkinson 2-12-90
EES/MAT :	E. J. Majzlik	E J Majzlik 2-12-90
QA. :	R. L. Malloy	R L Malloy

Inspection Reports Reviewed: UT data packages SRS-008-003K, -004K, and -005K. ET packages SRS-009-004K, -005K, and -006K. Covers all of Sector 2B.

Relevant Indication [Tank Location and Dimensions]:

No reportable indications. Main tank vertical welds in this sector.

Classification of Indication:

N/A

NCR's Generated: (Yes/No)

NCR Nos.:

Comments: Three items noted near weld K-H4: Embedded weld anomaly (3.1" long); surface imperfection 3.5" long, <0.10" deep, such as a gouge or dent; weld deposit 0.3" long such as from former attachment. All these were found in the area of weld and base metal (16" x 12") between junction of vertical welds. Embedded weld anomaly ~~[redacted]~~ ≈ 3 inches long, 0.31" beneath I.D., on K-VF5. A few other areas of former attachments also found, most near K-VC1.

Page 6 of 6

RTIP IRC Daily Report — Report No.: 5

RTIP - 002 (Exhibit 1) — Date: 2-13-90

Members In Attendance:

	Name	Signature
Chairman:	J.M. Morrison	J M Morrison
EES/RTIP:	E.G. Caveness	E G Caveness 2/13/90
Rx. Eng.:	C.D. Cowfer / D.P. Ketchen	C D Cowfer / D R Ketchen
Rx. Ops.:	K.W. Atkinson	K W Atkinson 2-13-90
EES/MAT:	E.J. Majlik	E J Majlik 2/13/90
QA:	R.L. Malloy	R L Malloy 2/13/90

Inspection Reports Reviewed: SRS-009-007K and -008K (ET), and SRS-008-006K (UT), for upper and middle windows of Section 2A.

Relevant Indication [Tank Location and Dimensions]:

No reportable indications.

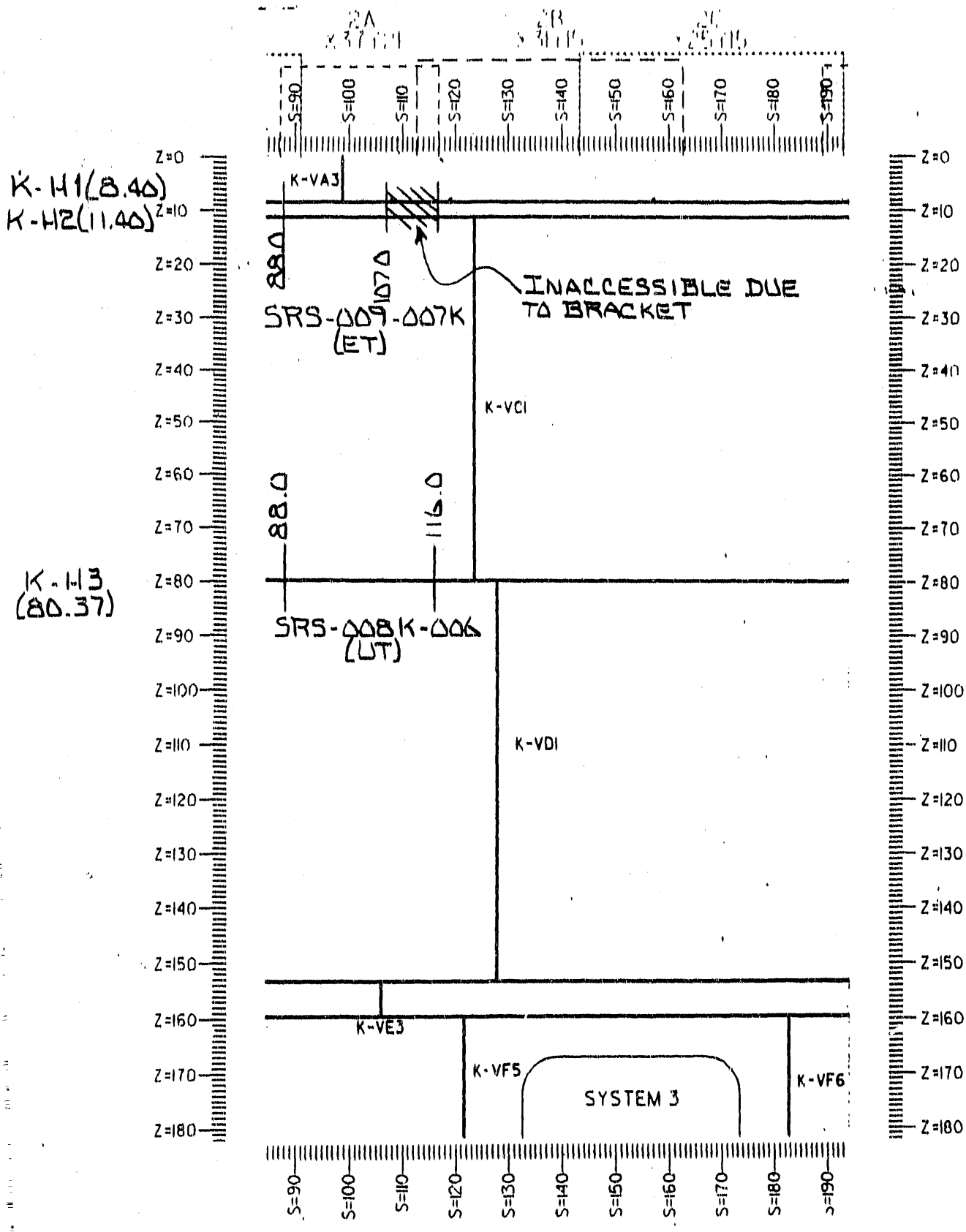
Classification of Indication:

N/A

NCR's Generated: (Yes/(No))

NCR Nos.:

Comments: Motion measurement bracket (vertical) in upper window expansion ring. Two indications about 2 inches apart on the OD, perpendicular to weld K-43, may indicate an attachment to the tank, which is still there.



K REACTOR TANK
WALL WELD MAP

RTIP IRC Daily Report — Report No.: 6

RTIP - 002 [Exhibit 1] — Date: 2-15-90

Members In Attendance:

	Name	Signature
Chairman:	J.M. Morrison	J M Morrison
EES/RTIP:	E.G. Caveness	E.G. Caveness 2/15/90
Rx. Eng.:	C.D. Cowfer, D.R. Ketchen	C.D. Cowfer D.R. Ketchen 2/15/90
Rx. Ops.:	S.C. Pye	S C Pye
EES/MAT:	E.J. Majlik	E J Majlik Jr 2/15/90
QA:	R.L. Malloy	R L Malloy 2/15/90

Inspection Reports Reviewed: SRS-009-012K, -011K, -010K (ET), and SRS-008-009K, -008K (UT), covering all 3 windows of Sector 1-F.

Relevant Indication [Tank Location and Dimensions]:

No reportable indications.

Classification of Indication:

N/A

NCR's Generated: (Yes/(No))

NCR Nos.:

Comments: Motion measurement bracket located in upper tank shell near expansion ring. Two areas of ET liftoff in expansion ring, close together, probably due to slight distortion caused by welding an attachment to the O.D. No indications of any kind associated with welds K-H3 and K-VF4. Two vertical indications below weld K-H5, about 2.7 inches apart, on I.D. surface that appear to be attachment removal areas; ET shows no penetration of the surface.

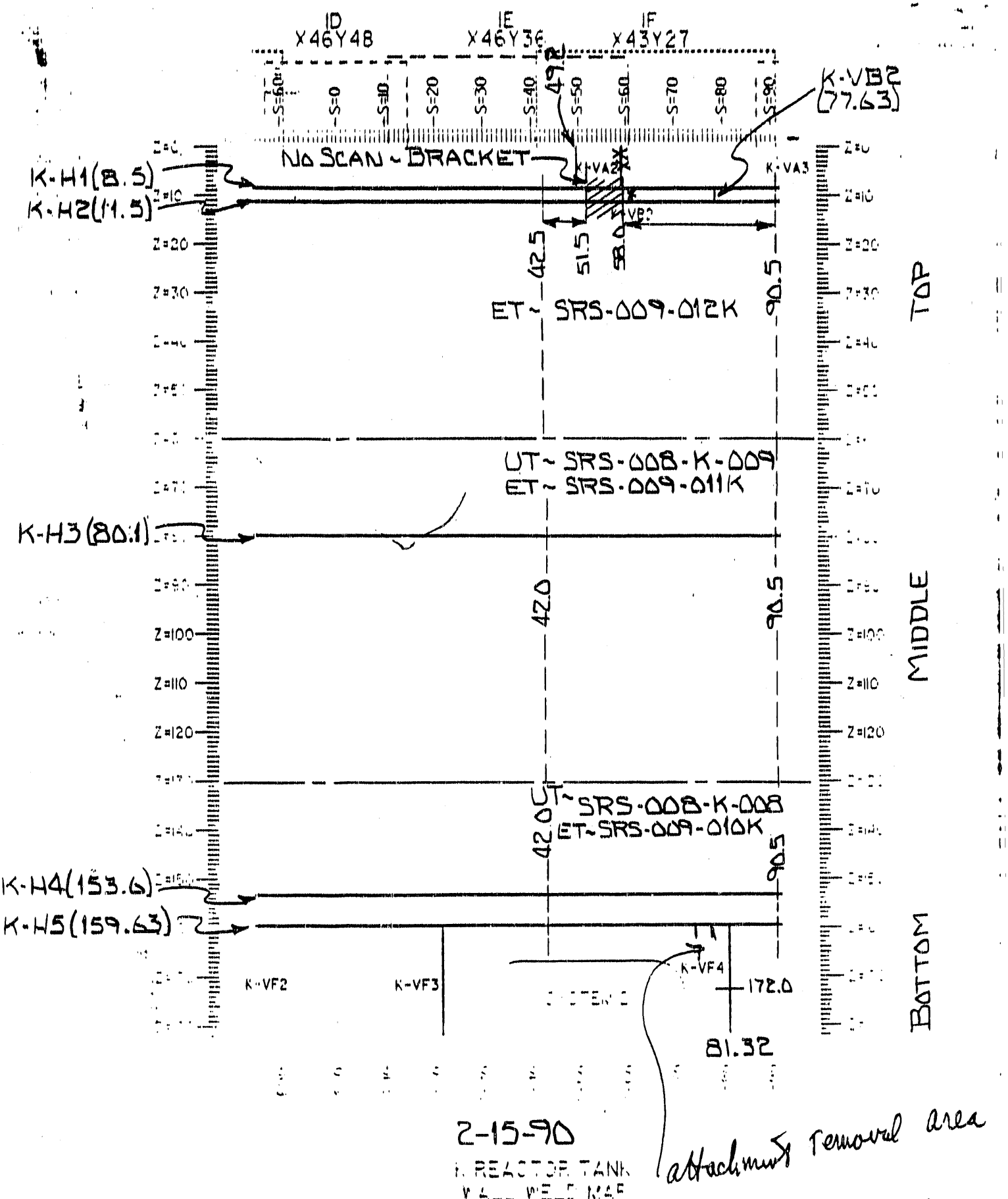
Page 6 of 6

[Cont'd. on attachment]

Comments attached to IRC Report #6, 2/15/90 (Cont'd.

On weld K-H4, a 4.2-inch long reflector was located at the toe of the weld. Three ET flaw detection scans were run with negative results. No depth was indicated. Additional ET revealed the weld was considerably wider in this area than normal. This was corroborated by video using the high magnification lens of the overhead camera. No surface breaker or flaw indications were found. The wider-than-normal weld area was indicative of an area of weld repair, including some visible evidence of grinding. Examination of the radiographs was difficult due to their very poor condition. Nevertheless, it was possible to reconstruct the orientation of the radiographs with respect to weld K-H4, and the area of concern showed clearly to be repaired 3 separate times, with the resultant weld width increased from 7/8-inch to about 1¼ inches. It was unanimously concluded by the IRC that this indication was clearly a result of weld repair and is not of significance to structural integrity.

J. M. Morrison



2-15-90

REACTOR TANK WALL WELD MAP

attachment removal area

3/15/90

WESTINGHOUSE/SRC
AUTOMATED ULTRASONIC EXAMINATION

DATE : FEBRUARY 14, 1990

SUBJECT : ANALYSIS OF WELD K-H-4 (1F Lower) X43 Y27

On February 14, 1990, during the data analysis of weld K-H4, the data acquired from hole 1F (bottom widow) revealed a linear reflector which warranted further investigation as to its extent and origin. This reflector, which appears to be adjacent and parallel to the weld is lying just off the weld edge (toe) and approximately 5 inches long. This reflector is imaged alone with no other similar reflectors within the same window and is therefore considered exclusive in its location and appearance.

A detailed analysis of the data, particularly the B-Scan images, depict two distinct ultrasonic responses projected at the weld edge area approximately 0.100" apart. This separation varies inconsistently through the length of this indication. The preliminary review suggests that one of the signals is located in the base metal heat affected zone (HAZ) while the other signal is produced from the weld edge (toe).

Eddy Current scans were performed on the upper portion of the weld prior to leaving the window to acquire additional information which could possibly be used as an aid in determining the weld area integrity. Upon analysis of these scans, it was later concluded that additional ET scans in this area would be required.

The decision to return to the K-H4 weld for an automated Eddy Current scan was based on the facts that; 1) the acquired Ultrasonic Data could not be improved upon using our EPRI qualified technique and that, 2) the first Eddy Current scans were to confirm the existence of any breach on the interior surface (flaw detection scan), while the second scans were to detail the weld itself to determine if a repair in this area would be indicated by a wider weld crown. Both of these ET scans were performed to provide a high level of confidence in the final analysis of the data. The potential acquisition of supporting evidence which would aid in resolution of this reflector was the basis for this decision.

A review of both the ET scans by separate ET data analysts failed to confirm the existence of crack-like signals at the toe of weld K-H4 between 84.0" and 89.0". In fact, the ET interpretation has the signals classified as apparent weld repair primarily due to the concurrence by ET analyst that a definitive widening of the weld in this area was observed.

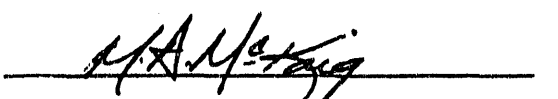
WESTINGHOUSE/SRC
AUTOMATED ULTRASONIC EXAMINATION

Subsequent review of the original radiographic film confirmed the suspicion of a weld repair in this area. Also, review of the video tape of the area in question visually disclosed the presence of a distinct edge of an indentation which projected above the normal weld edge line.

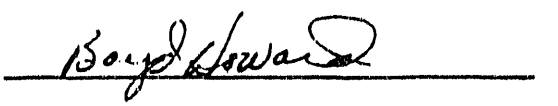
Final review of the ultrasonic data indicates an area of interest which does possess some characteristics indicative of IGSCC. There is no evidence of penetration beyond .100 inch, which is the UT demonstrated sizing capability. This reflector's location and orientation is characteristic of what is believed to be possible concerning serviced induced flaws. However, using the resources of Eddy Current scans, Video Camera pictures, and Radiographic Film interpretation, the presence of a repair or even several repairs at this location is obvious.

The ultrasonic data has been reviewed by three EPRI-IGSCC qualified Level II data analysts and two EPRI-IGSCC qualified UT Level III's. The Eddy Current data was reviewed by two ET Level III's while the radiographic film was reviewed by SRS RT Level III's.

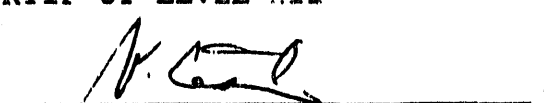
The final analysis of the linear indication detected in weld K-H4 is therefore concluded to be caused by geometric anomalies associated with a weld repair performed during original fabrication to remove welding defects at some time prior to operation. This conclusion is based on the results of the combined evaluation of the Ultrasonic, Eddy Current, Radiographic, and Visual data.



MICHAEL A. McKAIG
AMDATA UT LEVEL III



BOYD HOWARD
RTIP UT LEVEL III



VLADIMIR CECH
RTIP ET LEVEL III

WESTINGHOUSE SAVANNAH RIVER COMPANY

INTER-OFFICE MEMORANDUM

February 17, 1990 EPD-QCM-900255

TO: James M. Morrison, 773-56A

FROM: Otis L. Gaston, Jr., 730-A
SE&S-QA/QC

REVIEW OF ORIGINAL REACTOR TANK RADIOGRAPHS - K AREA (U)

Summary of Task

I was asked to review film believed to be that of the lower field girth weld (K-H4) of the 105-K Reactor Tank. This review was to determine if there was radiographic evidence of any anomaly that could cause an Ultrasonic indication approximately 4-5 inches long, slightly above the normal weld edge and approximately 40-45 inches left of a main tank vertical weld; no other welds (extension ring vertical welds, etc.) or other reference points had been detected by the tank inspections.

Identification of the Radiographs

The Film reviewed on February 15, 1990 and reported to your committee is the film for the lower field girth weld (K-H4). This conclusion is based on the following:

1) A review of Inter-Office Memorandum, EPD-QCM-89502, dated October 2, 1989 to Sam K. Formby, Subject: Original Reactor Tank Radiographs, revealed that the only K-Tank film not accounted for was that of the Tank Shell to Extension Ring Girth Weld (K-H4).

2) The tank thickness in this area is 0.500 inch nominal. The penetrameter (radiographic sensitivity indicator) is the appropriate designation for use on 1/2 inch material.

3) Each radiograph contained the radiographic image "105 K".

4) Each film of the original weld exposures were permanently stamped with the date "10-30-53". (The repair exposures were dated "11-2-53" and "11-3-53".

5) Each exposure covered approximately 15 inches of weld. The 41 original weld exposures is sufficient to cover the circumference of K-Tank.

6) Review of the film and the "repair tracings" revealed the presence of 2 main tank vertical welds and 3 extension ring vertical welds which is believed to be the configuration of K-Tank.

Results of the Review

Overall the film was in "Poor to Very Poor" condition as defined in EPD-QCM-89502 (referenced above).

Although the film is not of sufficient quality to interpret for weld integrity acceptance, it is usable (for the most part) for determining the presence of vertical weld junctions and the appearance of general weld profile. The inclusion of "repair exposures" (exposures taken after a repair to determine acceptability) and the "repair tracings" (onion skin tracings to show area to be repaired) allowed for accurately determining areas of repair and did confirm the presence of two vertical welds that were questionable due to the original film quality.

A graphic presentation of this review is included as Attachment 1. The specific review results are included as Attachment 2. Figure 1 is a simulated tracing of the original final radiograph of exposure 4-5 of weld K-H4 showing the extra weld crown width and its presence above the original weld edge.

Summary of Results

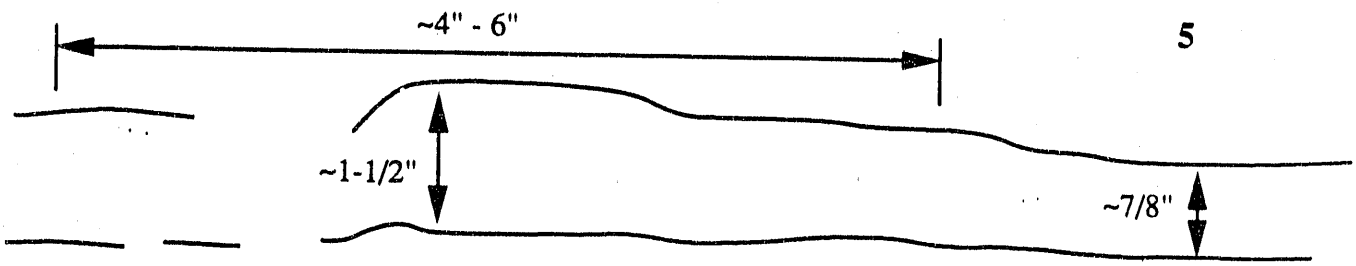
The radiographs are of the original field weld.

There is an area 4-6 inches long approximately 40-45 inches left of a main tank vertical weld that could cause ultrasonic indications to appear slightly above the assumed normal upper weld edge. The area corresponding to exposure interval 4-5 of the radiographs was repaired 3 times and the outline of the weld edges (as reconstructed from the repair radiographs) fits the data provided by the eddy current weld profiles and the ultrasonic test data.

cc: J. G. Angelos, SE&S-QA, 703-A
E. G. Caveness, EES, 730-A
J. G. Dickinson, SE&S-QA/QC, 730-A
M. E. Dupont, SE&S-QA/QC, 730-A
S. K. Formby, EES, 730-A
M. W. Loibl, EES, 305-A
R. E. Sprayberry, SE&S-QA/QC, 730-A
SE&S QA/QC Files, 730-A

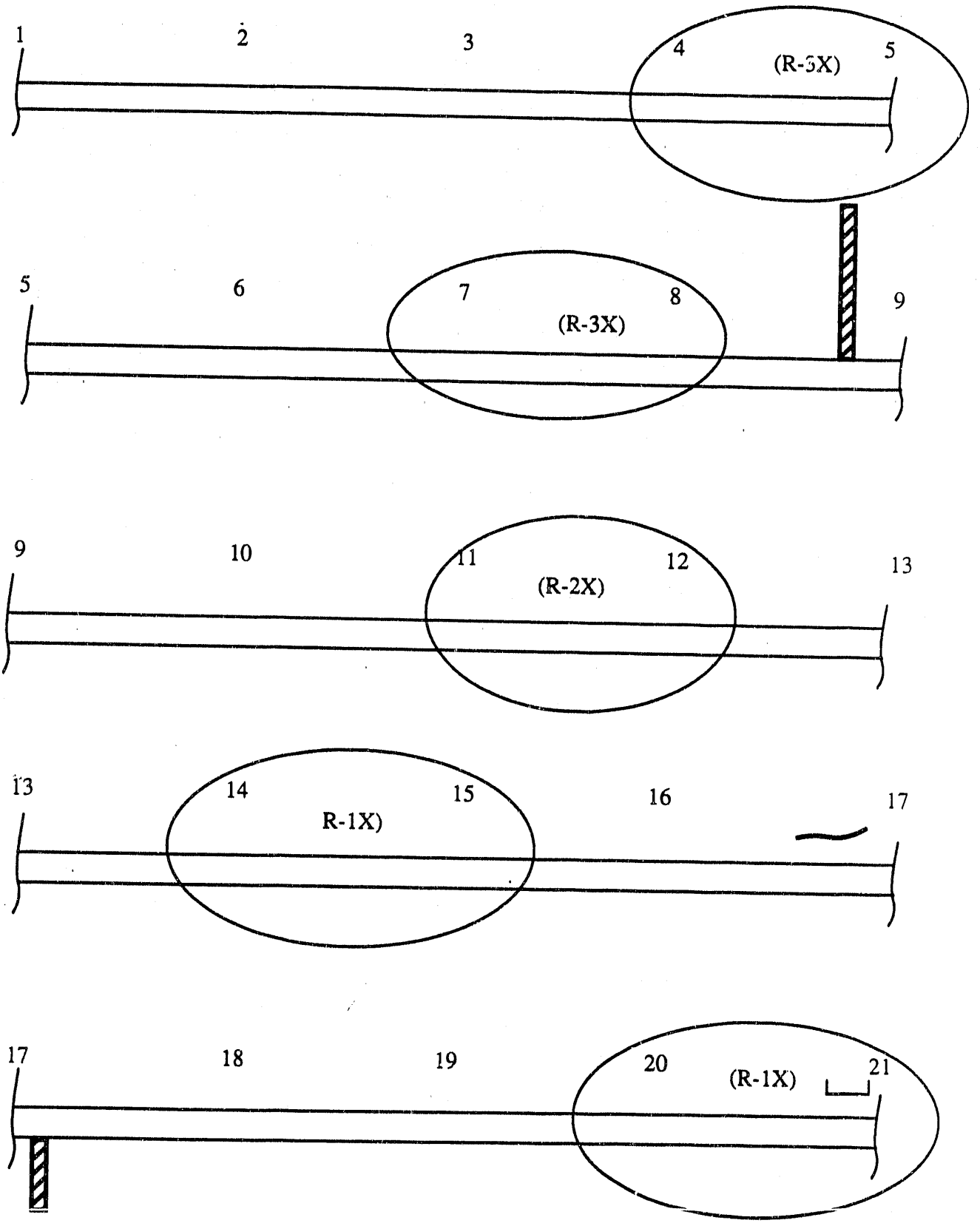
FIGURE 1

RX3

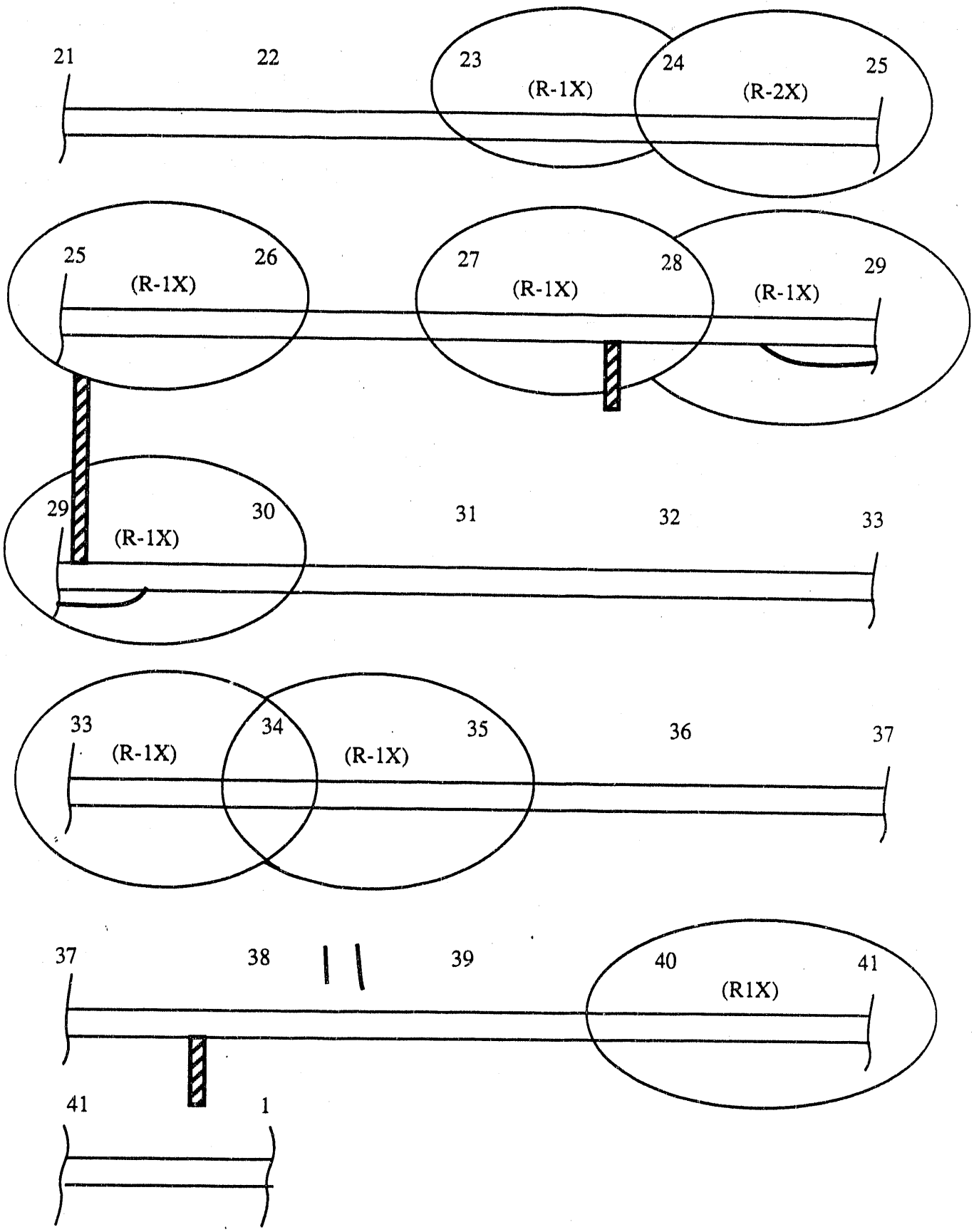


Simulated tracing from original final radiograph of Repair 3 to exposure interval 4-5 of Weld K-H4

ATTACHMENT 1



ATTACHMENT 1 (Cont'd)



ATTACHMENT 2

K-TANK EXTENSION RING TO MAIN TANK WELD

INTERVAL	MAIN TANK VERTICAL	EXTENSION RING VERTICAL	REMARKS
1-2			Porosity +1-1/2", Tungsten +11-1/2"
2-3			Irregular lower edge, Porosity +8-3/4"
3-4			
4-5			Tungsten +6-1/2" & 9-3/4"
4-5 RX1			Repaired for Porosity
4-5 RX2			Repaired for Lack of Fusion
4-5 RX3			Repaired for Lack of Fusion
5-6			
6-7			Tungsten +9-1/2"
7-8			Upper Weld Edge +8"
7-8 RX1			Repair for Lack of Fusion
7-8 RX2			Repaired for Lack of Fusion and Porosity ? or Lack of Pentration ?
7-8 RX3			
8-9	?~+10-1/2"?		(~180 Degrees From Vertical Weld in Exposure 29-30)
9-10			
10-11			
11-12			Porosity +7-3/4"
11-12 RX1			
11-12 RX2			
12-13			1/2" High Steel Stencil @ 13
13-14			Bottom Weld Edge +8"

ATTACHMENT 2 (Cont'd)

K-TANK EXTENSION RING TO MAIN TANK WELD

INTERVAL	MAIN TANK VERTICAL	EXTENSION RING VERTICAL	REMARKS
14-15			
14-15 RX1			
15-16			Bottom Weld Edge +7-1/2"
16-17			Weld Bead ~1/2" above weld ~4" Long +10-1/4"
17-18		+1-1/2" Positive!!	
18-19			
19-20			
20-21			Tungsten or Trash +3-3/4"; Patch or Bracket 1-1/4" Above Weld, 2-1/2" Long +11-1/2"
20-21 RX1			Tungsten Still Present; Bracket Not Evident (Film Positioned Lower??)
21-22			
22-23			
23-24			
23-24 RX1			
24-25			Film Previously Broken in Middle
24-25 RX2			Film for RX1 Not in Package
25-26			Tungsten +2-3/4"
25-26 RX1			
26-27			Tungsten @ 27
27-28		? +12-1/2" ?	Something Below Weld (Processing ?) +3-1/2"
27-28 RX1		+12-1/2" Definite	Not Artifacts, Unable to Interpret
28-29			Porosity/Undercut at Lower Weld Edge

ATTACHMENT 2 (Cont'd)

K-TANK EXTENSION RING TO MAIN TANK WELD

INTERVAL	MAIN TANK VERTICAL	EXTENSION RING VERTICAL	REMARKS
28-29 RX1			Lower Weld Edge Repaired for ~7" Starting at +7-1/2" ~1-1/2"-2"Wide
29-30	? +1-3/4" ?		
29-30 RX1	+1-1/2" Definite (Shown on Tracing)		Wide Weld Continued to ~ +3"
30-31			
31-32			
32-33			Bottom Weld Edge +6-1/2" to +13"
33-34			
33-34 RX1			
34-35			Evidence of Thin Wall +7-1/4"; Something at +11", Unable to Interpret
34-35 RX1			Something at +11", Unable to Interpret
35-36			
36-37			Low spot +10"
37-38		+11-1/2"	
38-39			? Stinger Beads Above Weld 4 Beads +4-1/2" & +5-3/4" ?
39-40			
40-41			
40-41 RX1			"Splotch" or Artifact Below Weld +5-3/4"
41-1			

RTIP IRC Daily Report — Report No.: 7

RTIP - 002 (Exhibit 1) — Date: 2-15-90

Members In Attendance:

	Name	Signature
Chairman:	J.M. Morrison	J.M. Morrison
EES/RTIP:	E.G. Cavenaugh	E.G. Cavenaugh 2/15/90
Rx. Eng.:	C.D. Cowles / D.R. Ketchen	C.D. Cowles / D.R. Ketchen 2/15/90
Rx. Ops.:	S.C. Pye	S.C. Pye
EES/MAT:	E.J. Majzlik	E.J. Majzlik 2/15/90
QA:	R.L. Malloy	R.L. Malloy 2/15/90

Inspection Reports Reviewed: SRS-008-007K (UT) and SRS-009-009K for lower windows of Sector 2A.

Relevant Indication (Tank Location and Dimensions):

No reportable indication.

Classification of Indication:

N/A

NCR's Generated: (Yes/No)

NCR Nos.:

Comments: Two attachment removal areas on I.D. perpendicular to K-H5 (and below). Elsewhere, there are 3 other deflectors, 2 of which represent/indicate an attachment area on the O.D.

(Cont'd.)

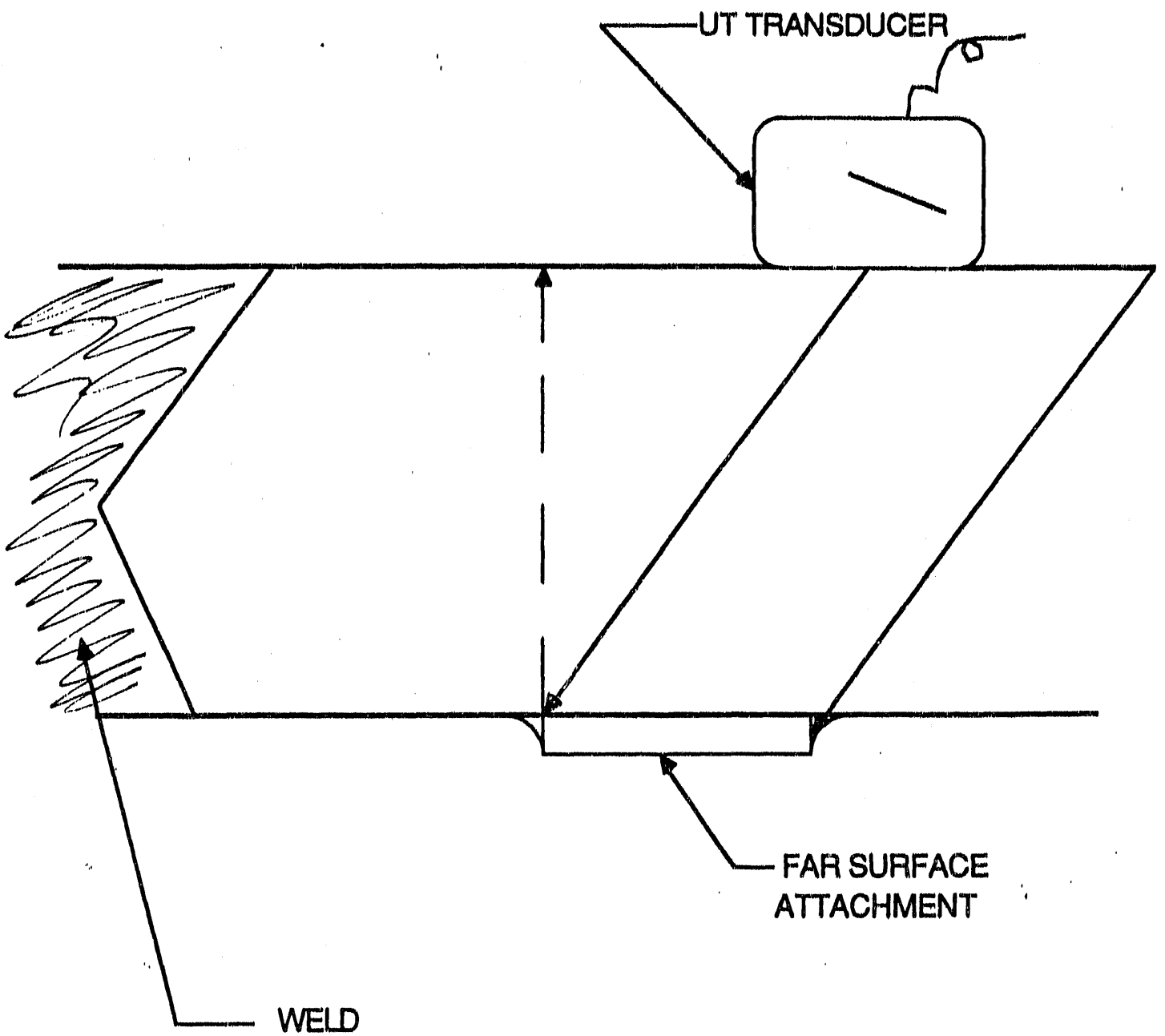
Attachment to IRC Report #7 2/15/

The third indication in this group was investigated further due to its location in base metal, and was concluded not to be relevant for the following reasons:

1. Location on O.D. 1½-inches from weld
2. Apparent shift in location when interrogated from opposing directions, ie, beam redirection with mode conversion.
3. Only observed in 2nd half vee – no 1st half vee response
4. I.D. ET inspection revealed no indication of flaw but verified I.D. surface irregularities.
5. Multiple attachment welds on O.D. and I.D. surfaces in near region.

J.M. Morrison

2/15/90
IRC #7



WELD K-H5 X (S) = 101.8" TO 102.9"

RTIP IRC Daily Report — Report No.: 8

RTIP - 002 (Exhibit 1) — Date: 2-20-90

Members In Attendance:

	Name	Signature
Chairman:	J.M. Morrison	J.M. Morrison
EES/RTIP:	E.G. Caveness	E.G. Caveness 2/20/90
Rx. Eng.:	D.R. Ketcham/C.D. Cowfer	D.R. Ketcham C.D. Cowfer
Rx. Ops.:	K.W. Atkinson	K.W. Atkinson 2/20/90
EES/MAT:	E.J. Mazglik	E.J. Mazglik 2/20/90
QA:	R.L. Malloy	R.L. Malloy 2-20-90

Inspection Reports Reviewed: Data packages SRS-009-013K, -014K, and -015K (ET) and SRS-008-K-010 and -011 (UT), for all windows of Sector 1-E.

Relevant Indication (Tank Location and Dimensions):

No reportable indications.

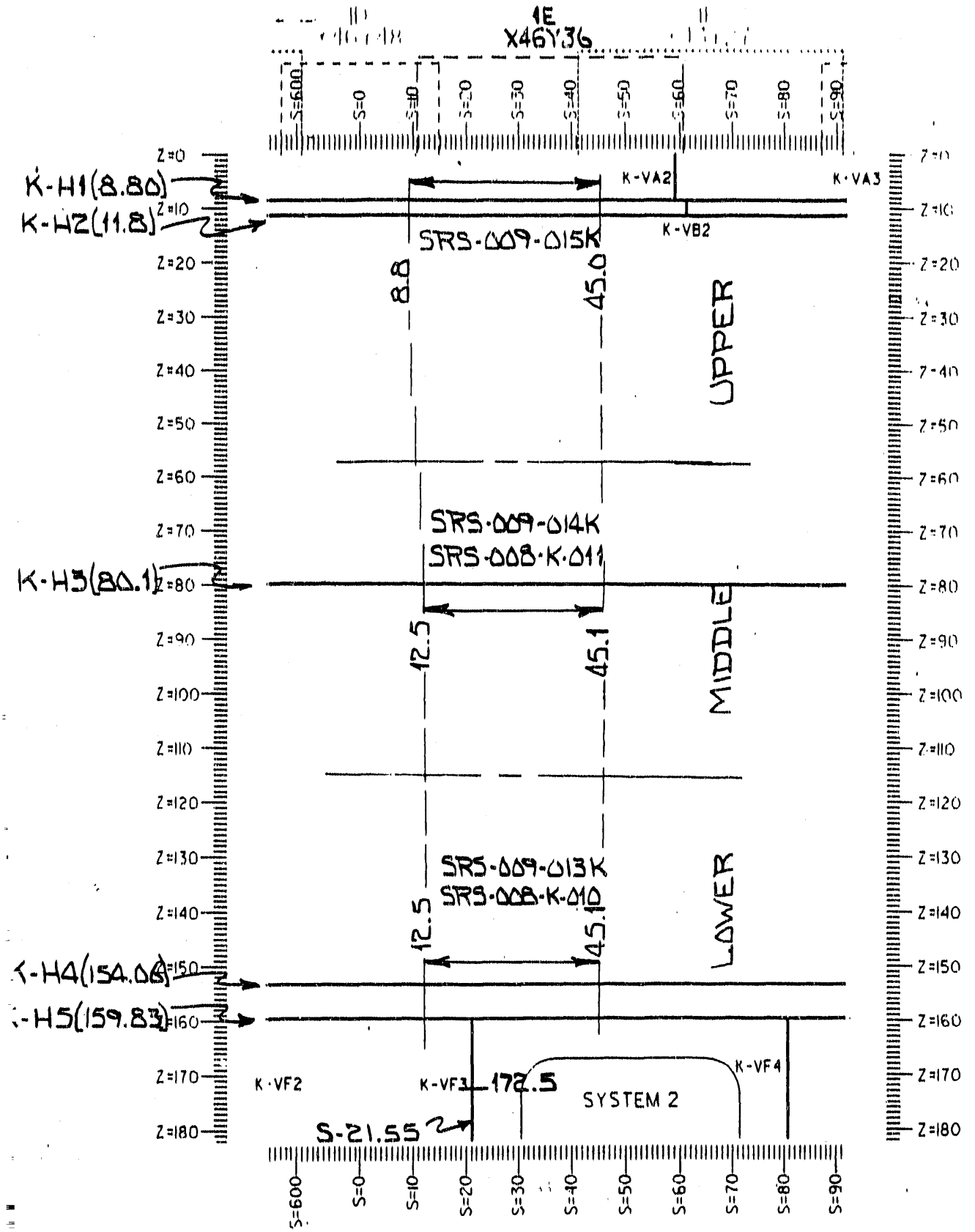
Classification of Indication:

N/A.

NCR's Generated: (Yes) (No)

NCR Nos.:

Comments: Several attachment removal areas on I.D. above weld K-H5 and others below K-H4; also one on O.D. below K-H5. Embedded flaws in K-VF3, indeterminate length, running beyond scan area, acceptable within acceptance criteria.



2-20-90

K REACTOR TANK
WALL WELD MAP

RTIP IRC Daily Report — Report No.: 9

RTIP - 002 (Exhibit 1) — Date: 2-21-90

Members In Attendance:

	Name	Signature	
Chairman:	J.M. Morrison	J M Morrison	
EES/RTIP:	E.G. Caveness	E G Caveness	2/21/90
Rx. Eng.:	C.D Cowfer/D.R. Ketchum	C D Cowfer	D.R. Ketchum
Rx. Ops.:	K. W. Atkinson	K W Atkinson	2/21/90
EES/MAT:	E.J. Majdik	E J Majdik	2/21/90
QA.:	R.L. Malloy	R L Malloy	2/21/90

Inspection Reports Reviewed: SRS-009-016K, -017K, and -018K (ET), and SRS-008-K-012 and -013 (UT), for all 3 windows of Sector 1D.

Relevant Indication (Tank Location and Dimensions):

No reportable indications.

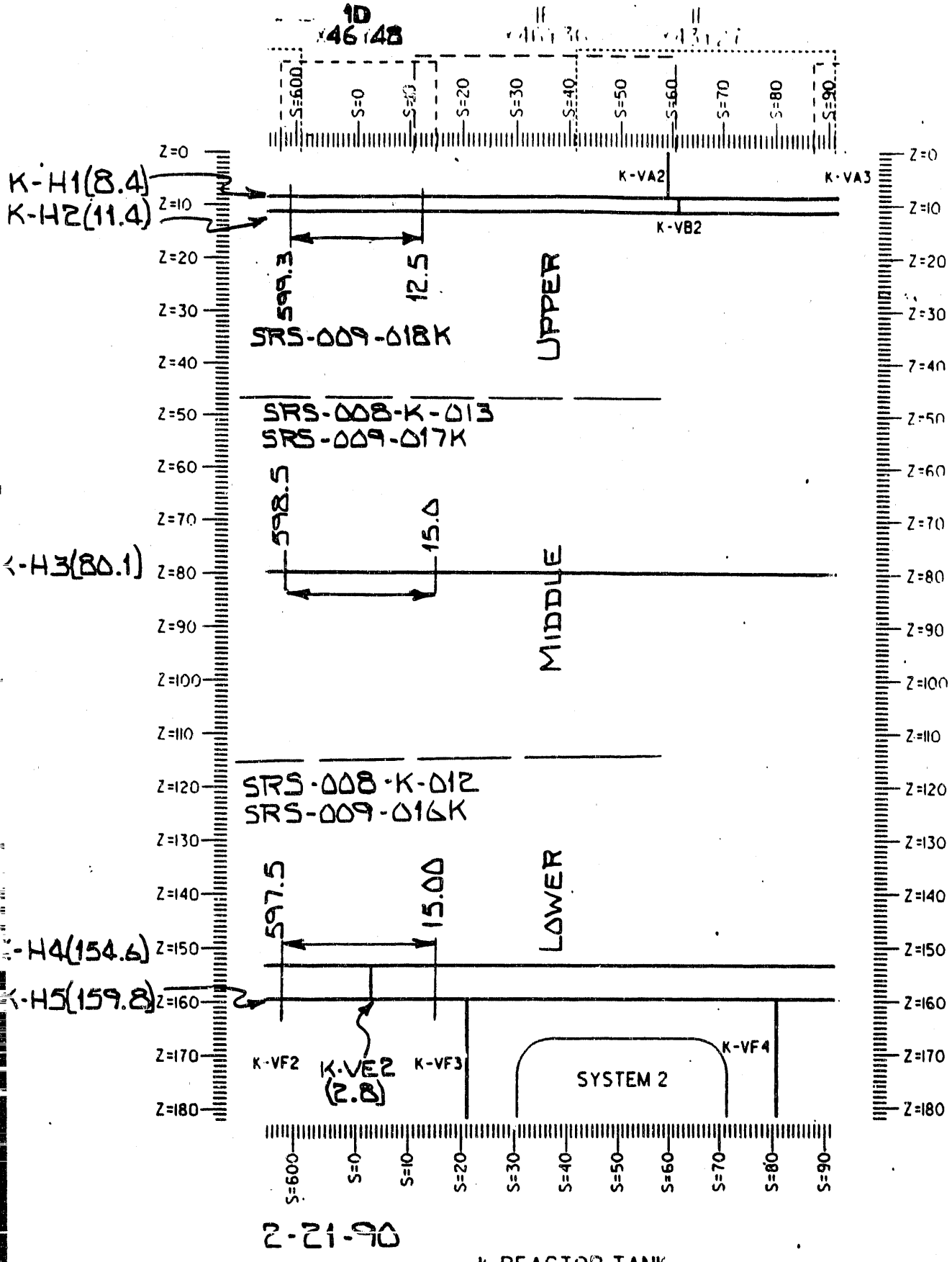
Classification of Indication:

N/A

NCR's Generated: (Yes/No)

NCR Nos.:

Comments: Vertical weld located between K-H4 and K-H5, designated K-VE2. A number of attachment removal areas were evident, on the inside of the top windows, on the O.D. of weld K-H3 on the middle window, and both O.D. and I.D. of weld K-H4. An embedded flaw exists over approximately 2 3/8-inch length of K-H5 in this window, about 0.40 inch beneath inside surface with no opening to either surface, within acceptance criteria.



K REACTOR TANK
WALL WELD MAP

RTIP IRC Daily Report — Report No.: 10

RTIP - 002 [Exhibit 1] — Date: 2/22/90

Members In Attendance:

	Name	Signature
Chairman:	———	———
EES/RTIP:	E.G. CAUDILL	E.G. Caudill
Rx. Eng.:	DR KOTCHMAN / E.D. Cooke	D.R. Kotchman / E.D. Cooke
Rx. Ops.:	K.W. ATKINSON	K.W. Atkinson 2-22-90
EES/MAT:	E.J. MAZLUK (Acting Chairman)	E.J. Mazluk 2/22/90
QA:	R.L. MALLOY	R.L. Malloy 2/22/90

Inspection Reports Reviewed: DATA PACKAGES SRS-009-021K, -020K, AND -019K (CUT) AND SRS-008-K-015, -014, (CUT), FOR ALL WINDOWS OF SECTOR 1B.

Relevant Indication [Tank Location and Dimensions]:

No Reportable indications.

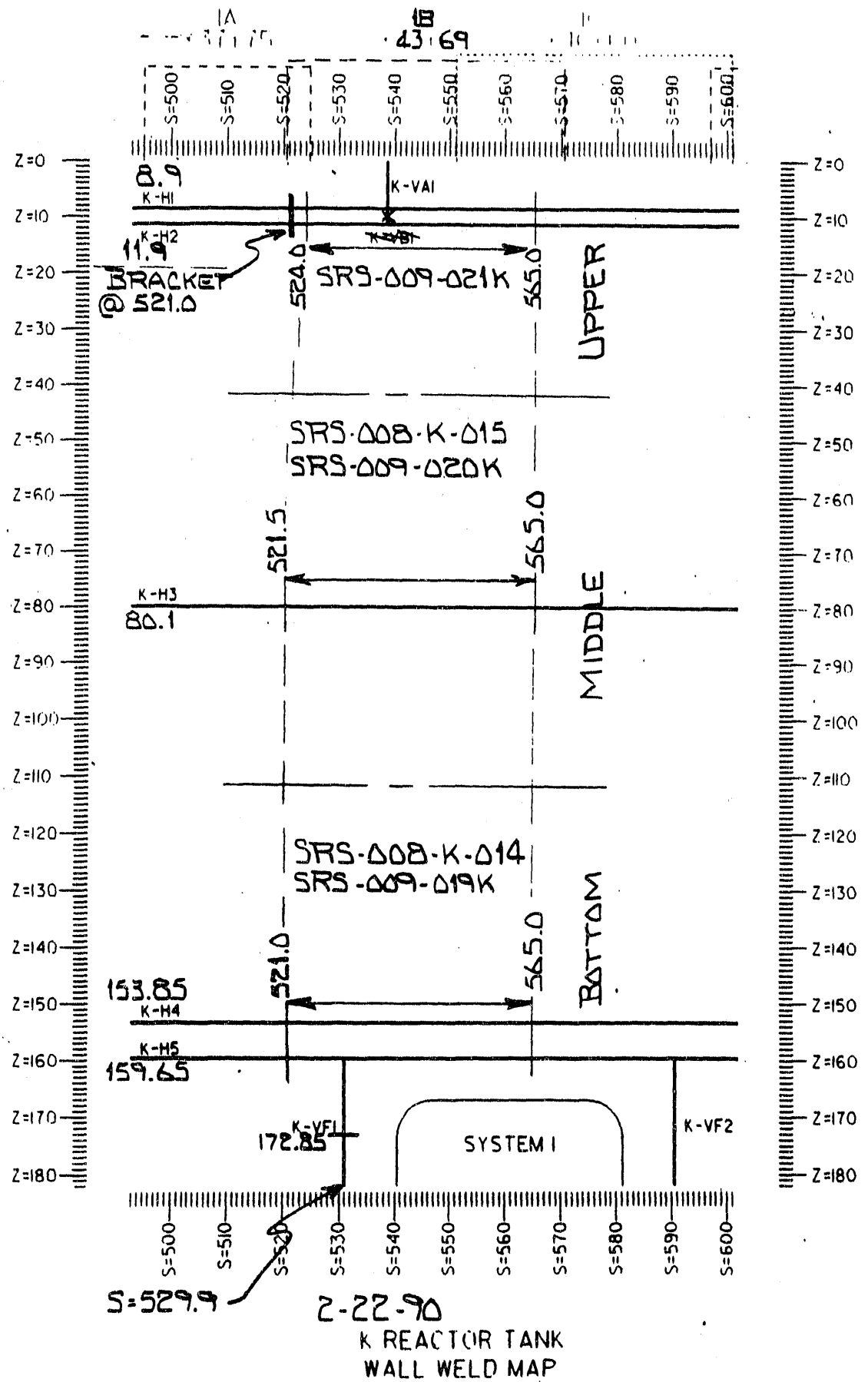
Classification of Indication:

N/A

NCR's Generated: (Yes) (No)

NCR Nos.:

Comments: 1 EXTERNAL ATTACHMENT AREA FOUND ABOVE K-43 AND AN INDICATION of a short AREA of UNDERCUT. ONE INTERNAL ATTACHMENT AREA IN ID BELOW K-45 AND ONE O.D. ATTACHMENT REMOVAL AREA. FOUR O.D. WELD ATTACHMENT AREAS AND A WELD REPAIR AREA ASSOCIATED WITH K-44. ALL ACCEPTABLE WITHIN ACCEPTANCE CRITERIA



2-22-90

K REACTOR TANK
WALL WELD MAP

RTIP IRC Daily Report — Report No.: 10-Rev.

RTIP - 002 [Exhibit 1] — Date: 2-23-90

Members In Attendance:

	Name	Signature
Chairman:	J.M. Morrison	J.M. Morrison
EES/RTIP:	E.G. Caveness	E.G. Caveness
Rx. Eng.	D.R. Ketcham/C.D. Cowfer	D.R. Ketcham C.D. Cowfer
Rx. Ops.:	K.W. Atkinson	K.W. Atkinson 2-26-90
EES/MAT :	E.J. Majzlik	E.J. Majzlik 2/26/90
QA. :	R.L. Malloy	R.L. Malloy 2/26/90

Inspection Reports Reviewed: SRS-008-K-017 for Sector 1A, middle window, was reviewed this date and prompted a revised interpretation of a finding noted in Report 10, dated 2/22/90, in Sector 1B, bottom window, Weld K-45.

Relevant Indication [Tank Location and Dimensions]:

No reportable indications

Classification of Indication:

N/A

NCR's Generated: (Yes/(No))

NCR Nos.:

Comments: Report 10 noted an "O.D. attachment removal area" below weld K-45. In the IRC meeting this area further described as about 1.6 inches long, and 1.5 inches from the seam. Based on Sector 1A data in the above referenced package (UT), where a similar set of signals was obtained, this interpretation has been revised by the Level III analysts to represent a probable pad still attached to the O.D.

RTIP IRC Daily Report — Report No.: 11

RTIP - 002 [Exhibit 1] — Date: 2-23-90

Members In Attendance:

	Name	Signature
Chairman:	J.M. Morrison	J.M. Morrison
EES/RTIP:	E.G. Cavenars	E.G. Cavenars 2/23/90
Rx. Eng.:	C.D. Cowfer / D.R. Fletcher	C.D. Cowfer / D.R. Ketchum
Rx. Ops.:	K.W. Atkinson	K.W. Atkinson 2-23-90
EES/MAT:	E.J. Majzlik	E.J. Majzlik 2/23/90
QA:	R.L. Malloy	R.L. Malloy 2/23/90

Inspection Reports Reviewed: SRS-009-022K, -023K, and -024K (ET), and SRS-008-016, -017 (UT) data packages for all 3 windows of Sector 1A.

Relevant Indication [Tank Location and Dimensions]:

No reportable indications.

Classification of Indication:

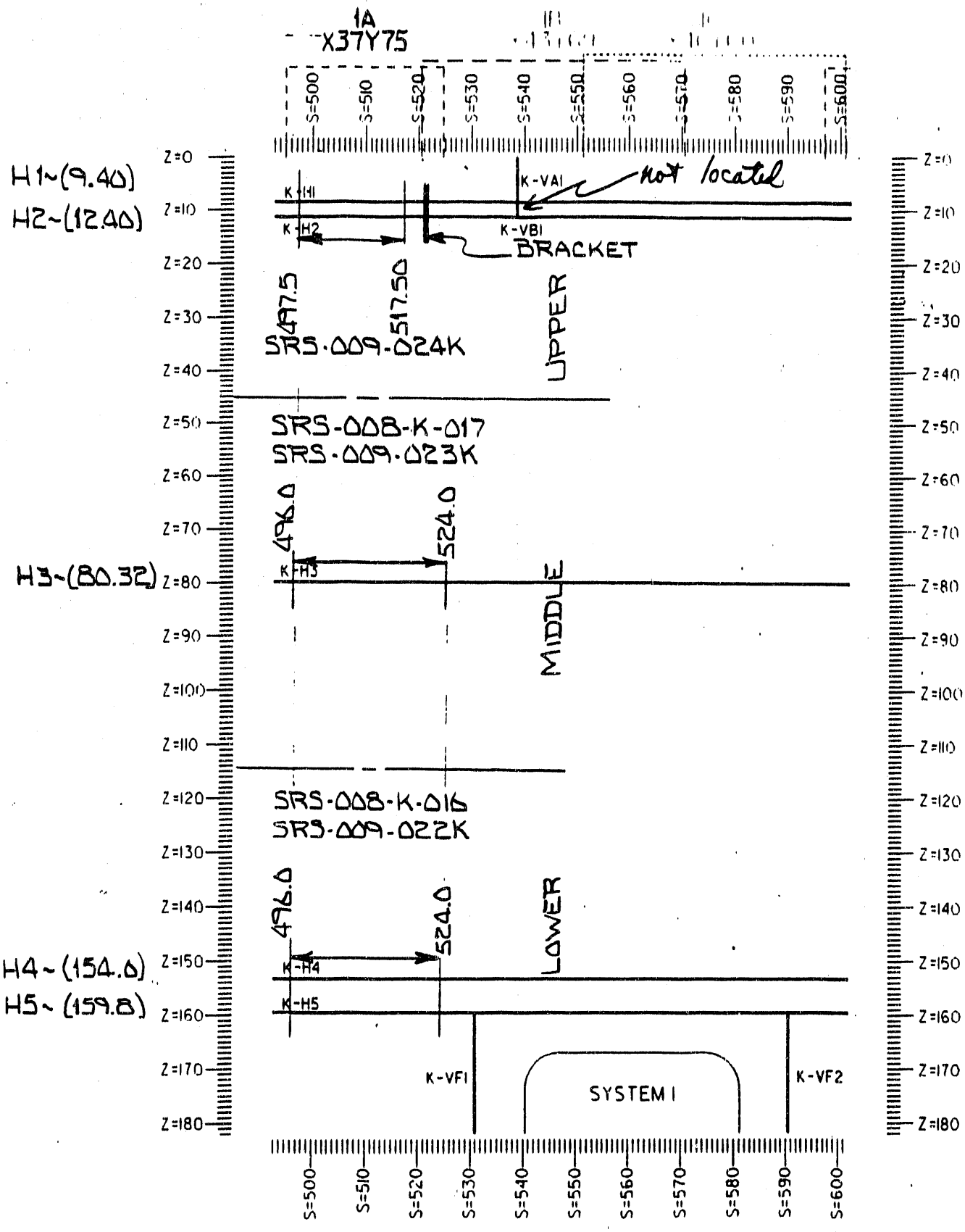
N/A

NCR's Generated: (Yes/No) (No)

NCR Nos.:

Comments: Numerous attachment / attachment removal areas located. One attachment apparent on O.D. about 1.5 inches from weld K-H3. On welds K-H4 and K-H5, attachment removal areas on both O.D. and I.D. Evidence of wide (1.5 inches) repair area beginning at left end of K-H4, possibly extending into Sector 3F. ET report SRS-009-024K has not yet been reviewed by second analyst, is promised by next IRC meeting.

Page 6 of 6



2-23-90

K REACTOR TANK
WALL WELD MAP

RTIP IRC Daily Report — Report No.: 12

RTIP - 002 [Exhibit 1] — Date: 2-26-90

Members In Attendance:

	Name	Signature
Chairman:	J.M. Morrison	J M Morrison
EES/RTIP:	E.G. Caveness	E G Caveness 2/26/90
Rx. Eng.:	C.D.Cawley/D.R.Ketchen	C D Cawley & D. R. Ketchen
Rx. Ops.:	K.W. Atkinson	K W Atkinson 2/26/90
EES/MAT:	E.J. Majzlik	E J Majzlik 2/26/90
QA.:	R.C Malloy	R C Malloy 2/26/90

Inspection Reports Reviewed: SRS-009-025K, -026K and -027K (ET), and SRS-008-K-018, -019 (UT), for all 3 windows of Sector 1C.

Relevant Indication [Tank Location and Dimensions]:

No reportable indications.

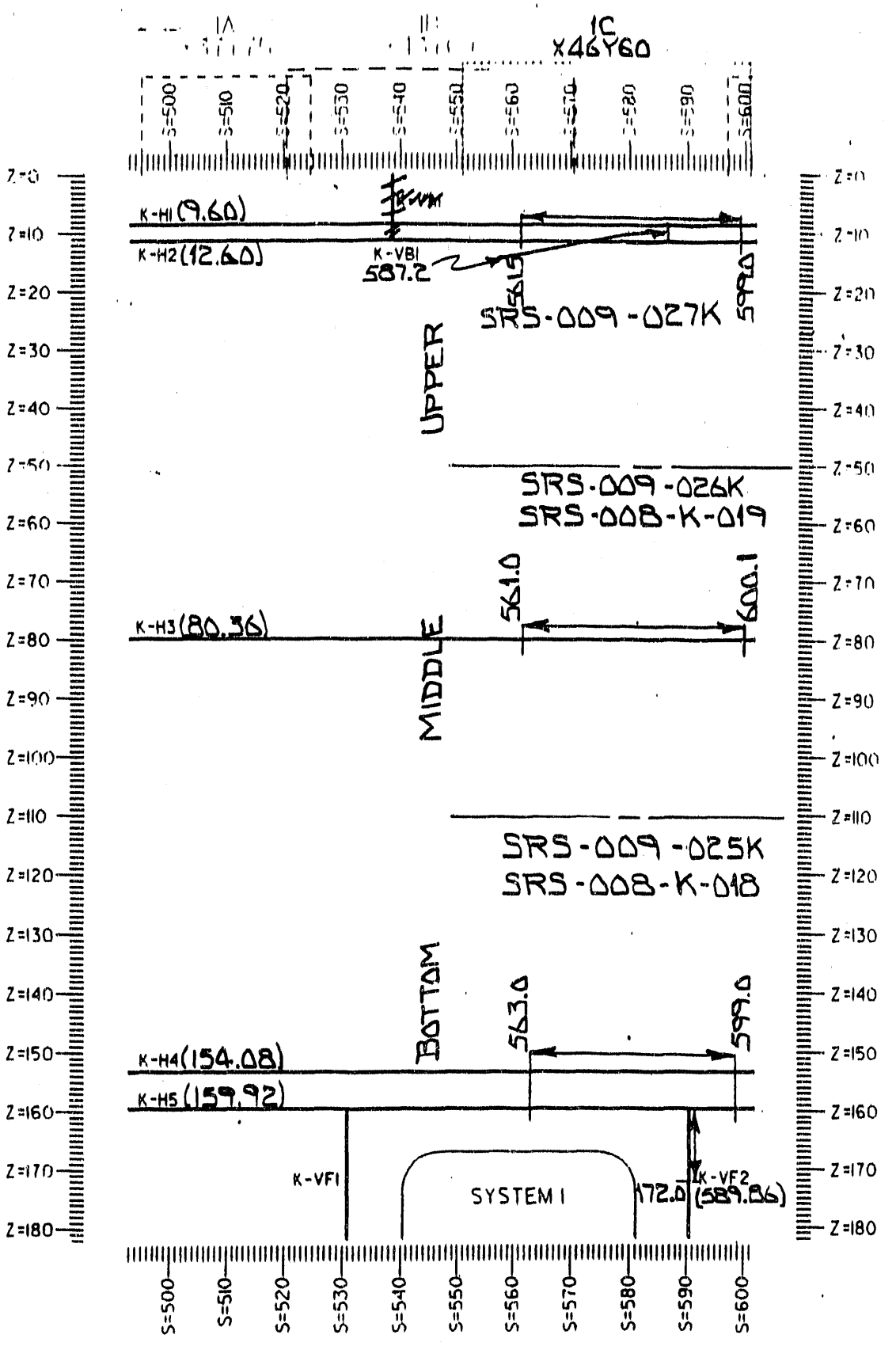
Classification of Indication:

N/A

NCR's Generated: (Yes/(No))

NCR Nos.:

Comments: Located vertical weld K-VS1 in expansion ring. Embedded reflector previously found in Sector 1D, K-H5, tracked out into first 0.5-inch of Sector 1C, therefore length is estimated as 27.5 inches total. A number of attachment removal areas on/near K-H4: On O.D., one above weld and three below (No ID attachments). Vertical weld K-VF2 in this sector, some bulge in weld at junction with K-H5.



2-26-90

K REACTOR TANK
WALL WELD MAP

RTIP IRC Daily Report — Report No.: 13

RTIP - 002 (Exhibit 1) — Date: 3-7-90

Members In Attendance:

	Name	Signature
Chairman:	J.M. Morrison	J.M. Morrison
EES/RTIP:	E.G. Caveness	E.G. Caveness 3/7/90
Rx. Eng.:	C.D. Cowfer/D.R. Kotchan	C.D. Cowfer / D.R. Kotchan
Rx. Ops.:	S.C. Pye	S.C. Pye
EES/MAT:	E.J. Majlik	E.J. Majlik 3/7/90
QA.:	R.L. Malloy	R.L. Malloy 3/7/90

Inspection Reports Reviewed: SRS-008-K-020 (UT) and SRS-009-028K (ET), for bottom windows of Sector 3E.

Relevant Indication (Tank Location and Dimensions):

No reportable indications.

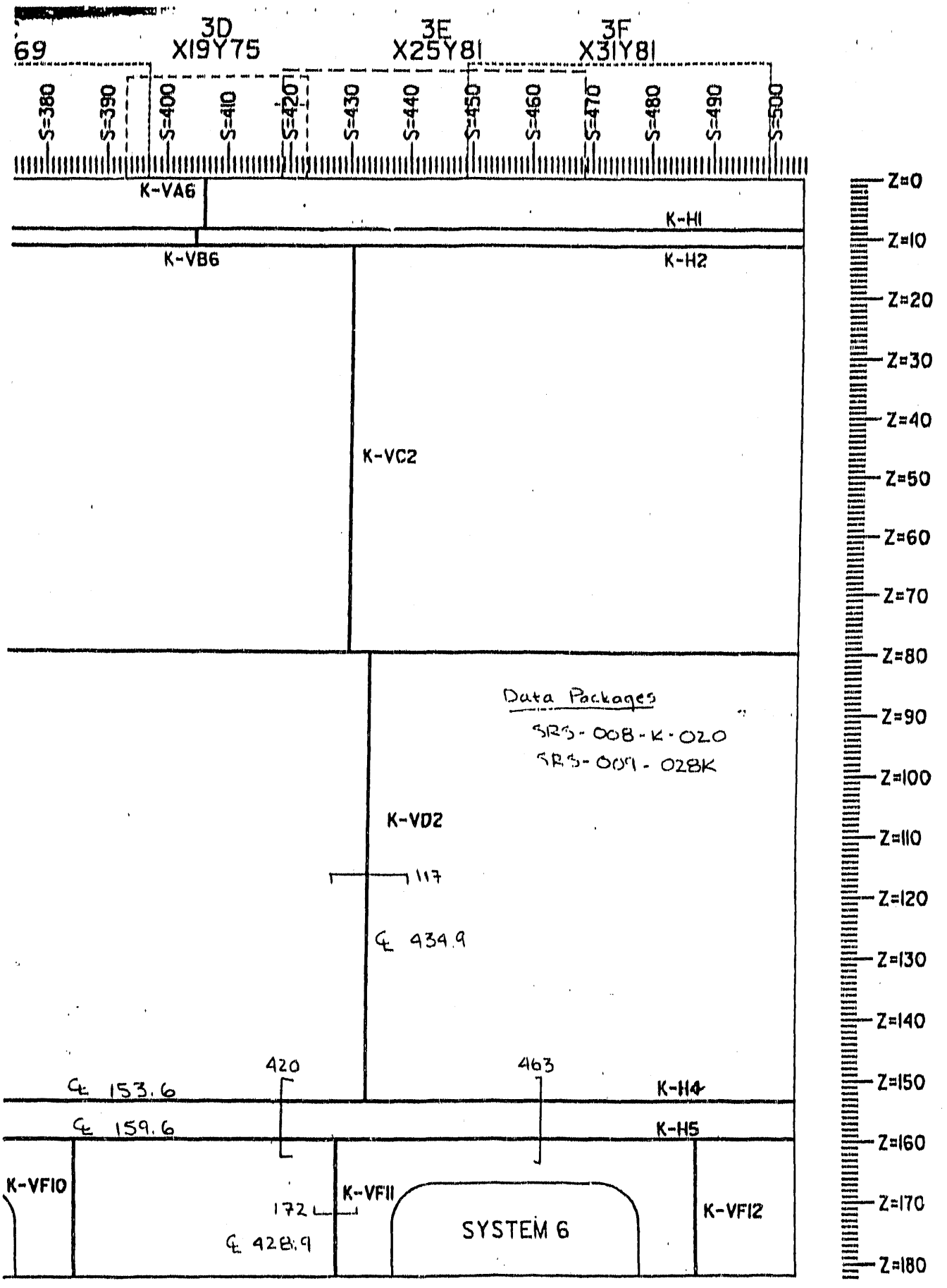
Classification of Indication:

N/A.

NCR's Generated: (Yes/No)

NCR Nos.:

Comments: Noted 3 areas of weld repair on I.D. of Weld K-H4, and one very wide repair (up to 2 inches), about 10" long, on O.D. Two attachment removal areas on I.D. on K-H4, Weld K-VF11, was noted as being about 0.4 inches off-vertical in the 12 inches scanned, One attachment removal area on O.D. of K-H4, below weld, and one on O.D. ~~inner~~ of weld K-VD2.


69
3D
X19Y75
3E
X25Y81
3F
X31Y81
S=380
S=390
S=400
S=410
S=420
S=430
S=440
S=450
S=460
S=470
S=480
S=490
S=500
K-VA6
K-H1
K-VB6
K-H2
K-VC2
Data Packages
SRS-008-K-020
SRS-009-028K
K-VD2
117
℄ 434.9
420
463
℄ 153.6
K-H4
℄ 159.6
K-H5
K-VF10
K-VF11
172
℄ 428.9
SYSTEM 6
K-VF12
Z=0
Z=10
Z=20
Z=30
Z=40
Z=50
Z=60
Z=70
Z=80
Z=90
Z=100
Z=110
Z=120
Z=130
Z=140
Z=150
Z=160
Z=170
Z=180

RTIP IRC Daily Report — Report No.: 14

RTIP - 002 (Exhibit 1) — Date: 3-8-90

Members In Attendance:

Chairman: J.M. Morrison (Name), J M Morrison (Signature)

EES/RTIP: E.G. Caveness (Name), E.G. Caveness (Signature) 3/8/90

Rx. Eng.: D.R. Ketcham/C.D. Carter (Name), D.R. Ketcham (Signature)

Rx. Ops.: S.C. Pye (Name), S C Pye (Signature)

EES/MAT: E.J. Majzlik (Name), E J Majzlik (Signature) 3/8/90

QA.: R.L. Malloy (Name), R L Malloy (Signature) 3/8/90

Inspection Reports Reviewed: SRS-008-K-021, -022(UT) and SRS-009-030K(ET), for the top and middle windows of Sector 3E.

Relevant Indication (Tank Location and Dimensions):

No reportable indications

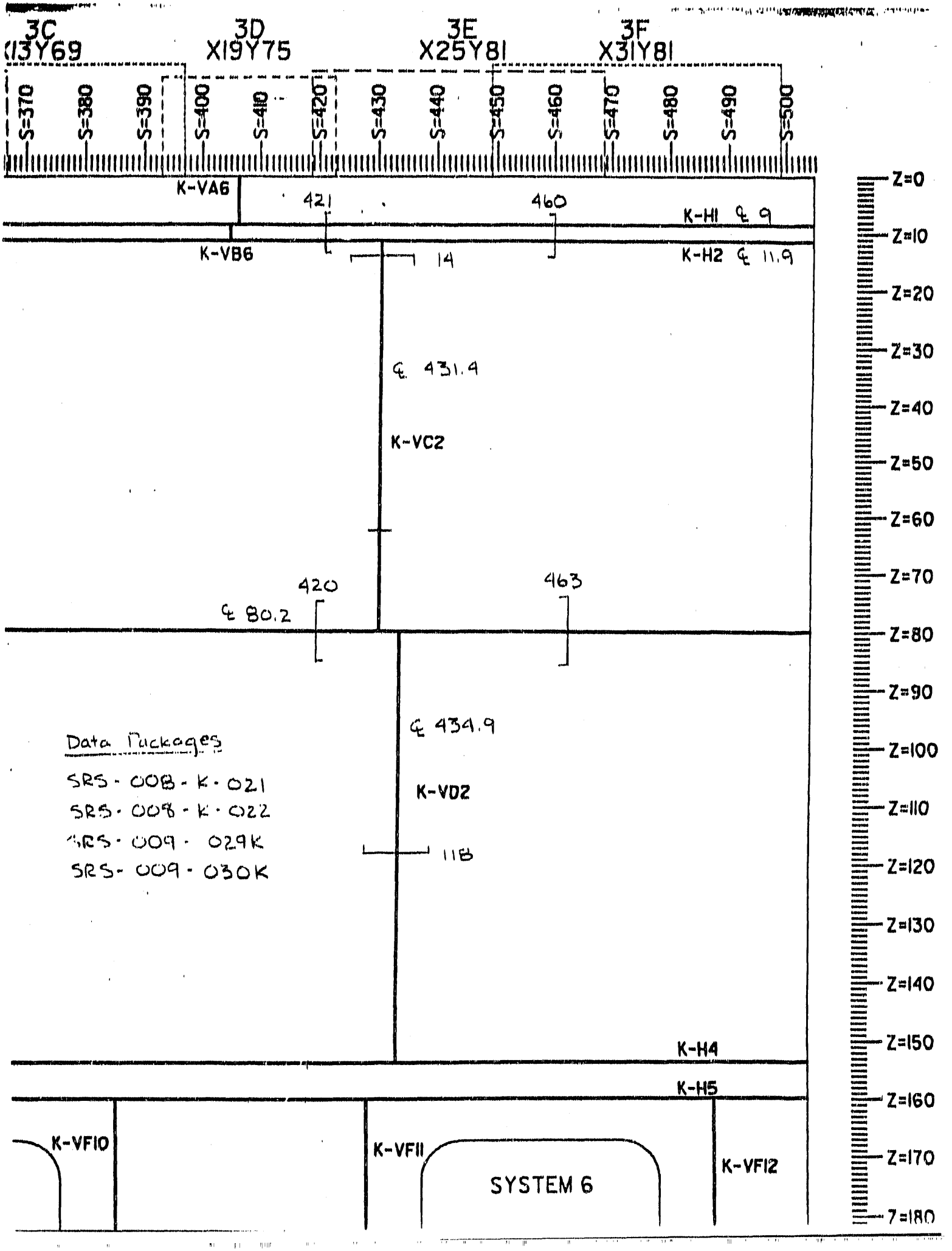
Classification of Indication:

N/A

NCR's Generated: (Yes/No) (No)

NCR Nos.:

Comments: 5 O.D. attachment removal areas, one O.D. weld repair, and weld geometry effects associated with vertical weld K-VD2. Possible weld repair area on K-H3 between vertical welds, on O.D. Small embedded weld reflector, 0.6 inches long, and two O.D. attachment removal areas associated with K-VC2. One I.D. attachment removal area also noted on K-VC2, along with a number of pit-like occurrences in page 6 of 6 oxide coating. One attachment removal area on I.D. of expansion ring about main tank shell,


3C
(13Y69
3D
X19Y75
3E
X25Y81
3F
X31Y81
S=370
S=380
S=390
S=400
S=410
S=420
S=430
S=440
S=450
S=460
S=470
S=480
S=490
S=500
K-VA6
421
460
K-H1 ℄ 9
K-VB6
14
K-H2 ℄ 11.9
℄ 431.4
K-VC2
420
℄ 80.2
463
℄ 434.9
K-VD2
118
Data Packages
SRS-008-K-021
SRS-008-K-022
SRS-009-029K
SRS-009-030K
K-H4
K-H5
K-VF10
K-VF11
SYSTEM 6
K-VF12
Z=0
Z=10
Z=20
Z=30
Z=40
Z=50
Z=60
Z=70
Z=80
Z=90
Z=100
Z=110
Z=120
Z=130
Z=140
Z=150
Z=160
Z=170
Z=180

Appendix B

RTIP Procedures

PROCEDURE TITLE	PRO. NO.	STATUS	AUTHOR	DRAFT/DUE
FIELD INSPECTION	Rev. 0 RTIP 001	8/24/89 APPROVED	LOIBL	JUN 26,89
DATA COMMUNICATION	Rev. 0 RTIP 002	8/24/89 APPROVED	FRENCH	JUN 22,89
DOCUMENT CONTROL	Rev. 1 RTIP 003-1	8/24/89 APPROVED	BRAGAN	
RECORDS CONTROL	Rev. 1 RTIP 003-2	8/24/89 APPROVED	BRAGAN	
INSTS.,PROC.,& DWGS.	Rev. 2 RTIP 003-3	1/24/90 APPROVED	BRAGAN	
NDE CONTROL	RTIP 003-4	COMBINED RTIP 008	MCKAIG	MAY 19,89
MATERIAL CONTROL	Rev. 1 RTIP 003-5	8/24/89 APPROVED	BRAGAN	
TELE ZOOM LENS OP	Rev. 0 RTIP 004	11/17/89 APPROVED	TURNER	MAY 19,89
OVERHD. CR.& TOOL ERT	Rev. 1 RTIP 005	1/18/90 APPROVED	PAK	JUL 21,89
MOBILE CNTRL. TRA.	Rev. 0 RTIP 006	8/22/89 APPROVED	SAMBORSKY	JUN 27,89
CBL. HK-UP & CK-OUT	Rev. 1 RTIP 007	1/18/90 APPROVED	SAMBORSKY	JUN 26,89
ULTRASONIC EXAM.	Rev. 2 RTIP 008	1/09/90 APPROVED	HOWARD	MAY 19,89
EDDY CURRENT EXAM.	Rev. 1 RTIP 009	1/09/90 APPROVED	CECH	MAY 19,89
INSP. TOOL MAINT.	Rev. 1 RTIP 010	1/18/90 APPROVED	PAK	JUL 24,89
CAM & AUDVIS EQUIP OPER.	Rev. 1 RTIP 011	1/18/90 APPROVED	KILLIAN	JUL 24,89
TOOL PLACEMENT	Rev. 1 RTIP 012	1/18/90 APPROVED	PAK	JUL 21,89
AIR COMPRESSOR AND AIR STATION OPERATION	Rev. 0 RTIP 013	8/28/89 APPROVED	PATTERSON	
ROBOT OPERATION	Rev. 1 RTIP 014	1/18/90 APPROVED	PARKS	JUL 19,89
QUALITY IMPROVEMENT	Rev. 0 RTIP 015	9/13/89 APPROVED	KITCEY	SEPT 11,89
SOFTWARE UPDATE	Rev. 0 RTIP 016	11/30/89 APPROVED	PARKS	

STATUS 1/24/90

CONTROLLED COPY
DATE 1/24/90

DATE
FILMED
5/01/92