A 05/09/94

REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)
DISTRIBUTION FOR INCOMING MATERIAL 50-331

REC: DENTON H ORG: LIU L DOCDATE: 07/31/78
NRC IA ELEC LIGHT & PWR DATE RCVD: 08/07/78

DOCTYPE: LETTER NOTARIZED: NO COPIES RECEIVED
SUBJECT: LTR 1 ENCL 10
FORWARDING REPT ENTITLED: "DUANE ARNOLD ENERGY CENTER RECIRCULATION INLET SAFE-END REPAIR PROGRAM", AND ADVISING INITIAL CUT ON THE N2A SAFE-END IS PRESENTLY EXPECTED TO OCCUR APPROX 08/08/78.

PLANT NAME: DUANE ARNOLD REVIEWER INITIAL: XJM
DISTRIBUTOR INITIAL: DL

********** DISTRIBUTION OF THIS MATERIAL IS AS FOLLOWS **********

GENERAL DISTRIBUTION FOR AFTER ISSUANCE OF OPERATING LICENSE.
(DISTRIBUTION CODE A001)

FOR ACTION: BR CHIEF ORB#3 BC**W/7 ENCL

INTERNAL:
REG FILE**W/ENCL
I & E**W/2 ENCL
HANAUER**W/ENCL
AD FOR SYS & PROJ**W/ENCL
REACTOR SAFETY BR**W/ENCL
EEB**W/ENCL
J. MCGOUGH**W/ENCL
NRC PDR**W/ENCL
OELD**LTR ONLY
CORE PERFORMANCE BR**W/ENCL
ENGINEERING BR**W/ENCL
PLANT SYSTEMS BR**W/ENCL
EFFLUENT TREAT SYS**W/ENCL

EXTERNAL:
LPDR'S
CEDAR RAPIDS, IA**W/ENCL
TERA**W/ENCL
NSIC**W/ENCL
ACRS CAT B**W/16 ENCL

DISTRIBUTION: LTR 40 ENCL 39 CONTROL NBR: 7822003340
SIZE: 1P+4P+4P
MTE GD 2

********** THE END **********

IOWA ELECTRIC LIGHT AND POWER COMPANY

General Office

CEDAR RAPIDS, IOWA

July 31, 1978

IE-78-1159

LEE LIU
SENIOR VICE PRESIDENT — ENGINEERING

Mr. Harold Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20545

Dear Mr. Denton:

During the meeting with the NRC staff concerning the recirculation inlet nozzle safe-end July 7, 1978, we stated that we would provide a repair report. Enclosed is a report titled "Duane Arnold Energy Center Recirculation Inlet Safe-End Repair Program." A copy of this report is also being provided to Mr. J. G. Keppler. The initial cut on the N2A safe-end is presently expected to occur approximately August 8, 1978.

If you have any questions, please feel free to contact us.

Very truly yours,

Lee Liu
Senior Vice President - Engineering

LL/KAM/jo

cc: K. Meyer
D. Arnold
R. Lowenstein
H. Rehrauer
File B-31G

A001
S 1/1 0*

7/31/78

Duane Arnold Energy Center
Recirculation Inlet Safe-End
Repair Program

On June 17, 1978, during weekly control valve testing an automatic reactor scram occurred due to problems in reactor protection system relays associated with the testing. The resulting plant shutdown provided an opportunity to perform a drywell inspection to determine the source of 3 GPM of unidentified leakage. The plant technical specifications limit unidentified leakage into the primary containment to 5 GPM. Water was found leaking from the shield blocks around the "B" recirculation system N2A inlet nozzle. The reactor was placed in a cold shutdown condition and the shield blocks removed for further inspection of the nozzle area. The leakage was found to be the result of a circumferential through wall crack 4 to 6" in length in the nozzle safe-end. The details of this event were reported in DAEC License Event Report 78-030 and in subsequent meetings with NRC staff personnel.

Ultrasonic testing and radiographic examinations were performed to determine the full extent of the cracking in the N2A safe-end and to check for similar problems in the other 7 safe-ends. The visible portion of the through wall crack in the N2A safe-end appears to be located along the fusion line of the weld repair of a fabrication machinining error as shown in Figure 1. The geometry of the crack through the safe-end wall could not be determined exactly; however, it is possible that the crack initiated in the crevice at the mating surface of the thermal sleeve on the inside of the safe-end. The examinations revealed linear indications in 4 other safe-ends, none of which were through wall cracks. Another safe-end showed some non-linear indications, but meets the NDE acceptance requirements. The remaining 2 nozzle safe-ends had no indications. Representatives of the NRC Region III Office of Inspection and Enforcement have reviewed these preliminary NDE results. A summary of these preliminary findings were presented to the NRC at a meeting in Bethesda on June 27. Further details and preliminary plans for the replacement program were presented to the NRC at another meeting on July 7.

The cracking mechanism is likely to be either fatigue or crevice corrosion cracking. Possible contributing factors include the crevice geometry, stress levels, the plant operating history, and the weld repair. Checks are being conducted on the recirculation loop pipe whip restraints to verify that these did not contribute to abnormal stresses. The records of the weld repairs indicate that they were performed in accordance with ASME code requirements.

A more definitive determination of the cracking mechanism will be made through chemical and metallurgical analyses on the safe-end after it has been removed. The analyses will be performed in the laboratories of a qualified independent contractor employed by Iowa Electric. It is expected that specialists at General Electric will also participate. Although the scope of the analyses cannot be finalized before further examination of the safe-end, it is expected that the following elements will be included in the investigative program.

- Ultrasonic inspection of the outside of the sample to establish location and extent of cracking.

- Metallographic examination of representative sections through the crack to establish relationship between crack path and micro-structure of safe-end material. Identification of the mode of cracking, either intergranular or transgranular. Establishment of the micro-structure of safe-end base metal, thermal sleeve attachment weld and repair weld zone.

- Visual, low magnification and scanning electron microscope examination of crack surfaces to assist in establishing the mechanism and mode of fracture and to identify other pertinent fractographic features, ie.: point(s) of initiation, direction of propagation, extent of surface deposits, etc.

- Chemical analysis of safe-end material to verify conformance with applicable specifications.

- Preparation of detailed report and findings.

The analysis program is being organized to provide for early determination of the principal metallurgical factors and to maintain the safe-end in a condition suitable for such additional examination as may be necessary. The NRC staff will be consulted as the program is developed. A copy of the analysis report will be transmitted to the NRC for their review.

The NRC has been consulted in the development of the safe-end replacement program and NRC meeting comments have been addressed. Review of the proposed replacement program and the proposed cutting sequence was conducted by the I&E office on July 17. The entire N2A safe-end will be removed and replaced with a newly fabricated safe-end in accordance with the requirements of ASME Section XI, 1974 Edition, Summer 1975 Addenda, Repair Procedure No. 3, IWB-4410. Modifications have been incorporated in the replacement safe-

end which will reduce the susceptibility of the safe-end to cracking. Iowa Electric has employed NUTECH corporation to perform a second party verification of these modifications. As shown in Figure 2, the replacement safe-end incorporates a tuning fork configuration to eliminate the contact crevice and has an increased cross-section thickness. These modifications also reduce stress concentrations and allow access for liquid penetrant, radiographic and ultrasonic examinations. A portion of the existing thermal sleeve will also be replaced with an adaptor compatible with the new safe-end. The replacement safe-end will be analyzed in accordance with the original stress report requirements under ASME Section III, 1965 Edition Summer 1967 Addenda. An amendment to the original stress report will be prepared for the replacement safe-end.

As shown in Figure 3 the cracked safe-end will be removed by cutting the safe-end and thermal sleeve at a point approximately 2 inches inboard of the crack. A second cut will be made near the elbow in the recirculation line allowing the safe-end with its attached stainless steel transition piece and attached section of recirculation line to be removed as a unit. This will provide access for the repairs and minimizes the number of cutting operations required to be performed in the radiation area. The transition piece and section of recirculation line will be cut from the cracked safe-end (approximately 2 inches from the crack) to be reinstalled later along with the replacement safe-end. This also avoids the need for any bimetallic welds during the repair process. The cutting sequence has been reviewed by Region III I&E personnel. Iowa Electric will notify the Region III office at least 2 days prior to commencement of cutting operations.

The welding sequence for installing the replacement safe-end assembly is shown in Figure 4. The replacement safe-end will be installed using welding materials meeting the requirements of ASME Section III, 1974 Edition, Summer 1975 Addenda, NB-2400, or a later edition of the Code, depending on material availability. All welds will be examined by radiography and liquid penetrant within the limits afforded by the access and structure. These nondestructive examinations will be in accordance with ASME Section III, 1974 Edition, Summer 1975 Addenda, NB-5000. An ultrasonic inservice "baseline" examination will be performed on all new butt welds in accordance with ASME Section XI, 1974 Edition, Summer 1975 Addenda, in accordance with the present DAEC inservice inspection program. A hydrostatic test of the primary system including all welds made during this repair will be performed in accordance with ASME Section XI, 1974 Edition, Summer 1975 Addenda, Section IWB-5222.

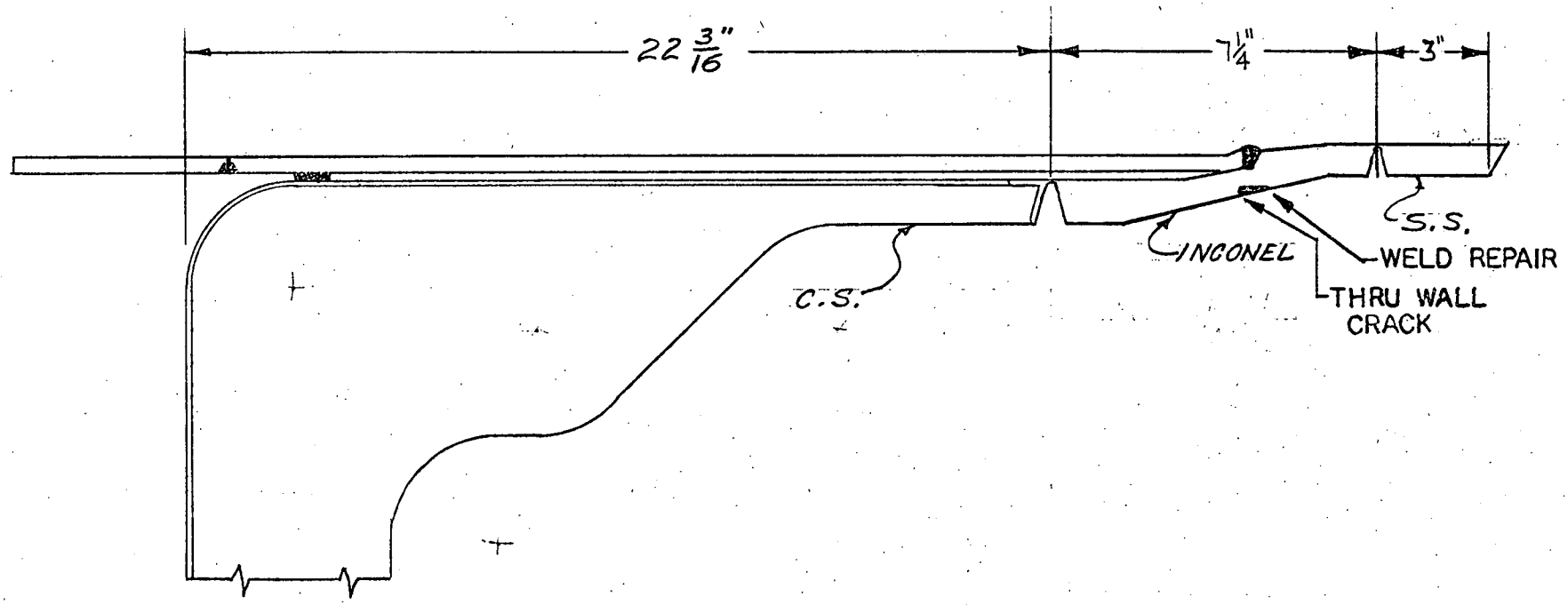
Repairs will be conducted with all fuel removed from the vessel, the recirculation line riser drained and the jet pump annulus level lowered. DAEC has employed a radiation consultant to assist in the design of shielding and to assist in developing special procedures for controlling exposure to personnel. Shielding will be constructed from lead blocks and the reactor vessel head replaced to provide additional shielding. A radiation survey was conducted with the annulus level lowered to verify the adequacy of the shielding provisions. Repair procedures including erection of shielding will be tested on mock-ups to further reduce personnel exposure.

It is currently planned that the remaining 7 inlet nozzle safe-ends will be replaced in a manner identical to the N2A safe-end. Iowa Electric will provide a safe-end to the NRC to allow performance of an independent metallurgical analysis.

The safe-end replacement program is being conducted by DAEC plant personnel under established plant procedures. A repair task force has been organized under the head of the DAEC maintenance group and has overall responsibility for accomplishing the replacement program. Consultants and contractors are being employed for certain tasks such as fabrication of the replacement safe-end, metallurgical analyses, shielding design, and manpower support. Special written procedures are being developed as necessary for accomplishing the repairs, with special emphasis on QA/QC and on maintaining worker exposure as low as reasonably achievable. These procedures are being prepared, reviewed, and approved in accordance with the DAEC Quality Assurance program and plant technical specifications. Procedures are also being reviewed by Region III I&E office personnel. In addition, at least 2 working days notice will be provided to the Region III I&E office prior to irreversible operations. Written procedures are being provided for the cutting sequence, installation sequence, and related operations such as shielding installation and reactor vessel draining.

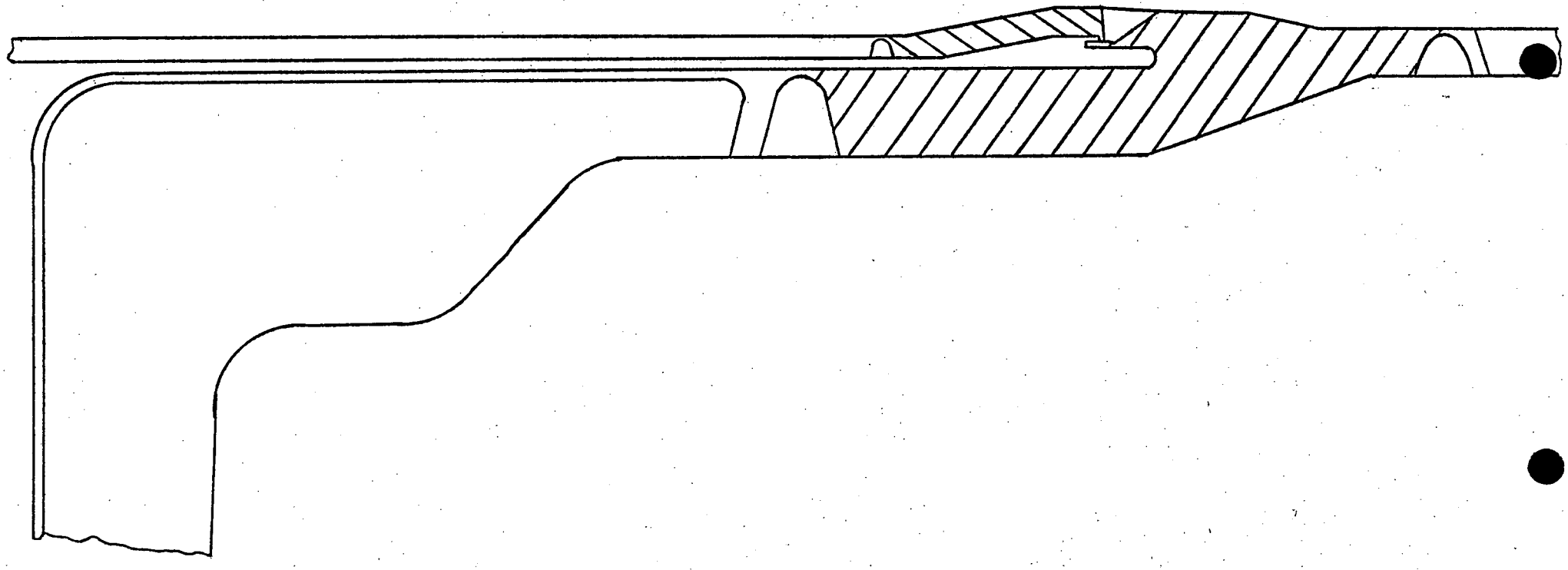
It is noted that on July 21, examinations performed under the DAEC QA program determined that the materials which had been obtained for use in the manufacture of the replacement safe-ends were not acceptable due to improper grain size. New materials meeting necessary requirements are being fabricated.

Preparations are underway so that cutting operations to remove the cracked safe-end may begin about August 1. The core has been off-loaded and shielding and temporary piping supports are under construction. Shielding, temporary supports, and instrumentation will be installed and work enclosures erected prior to the start of cutting work.



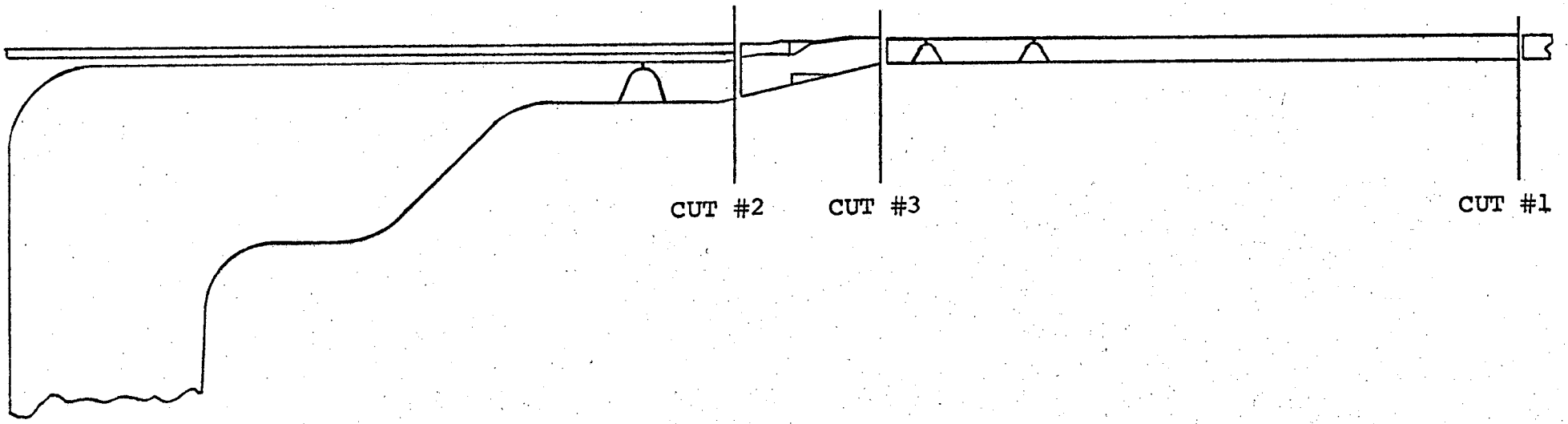
N2-SAFE END

Figure 1



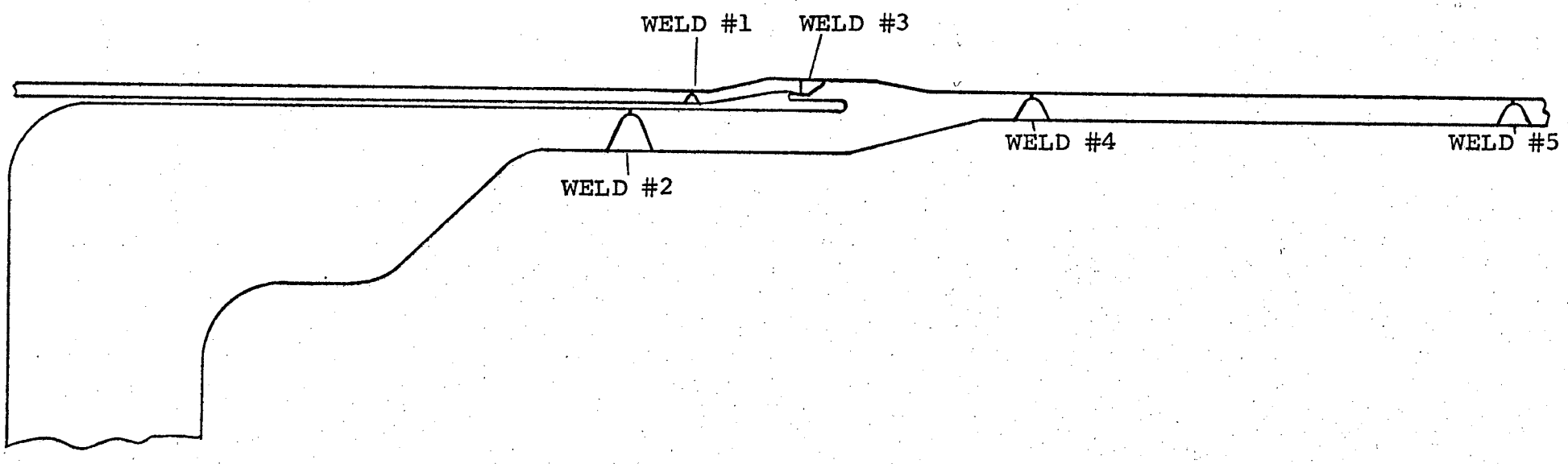
REPLACEMENT SAFE-END ASSEMBLY

Figure 2



CUT SEQUENCE FOR SAFE END REMOVAL

Figure 3



WELD SEQUENCE FOR REPLACEMENT SAFE END ASSEMBLY

Figure 4