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ACOUSTIC EMISSION MONITORING OF TIG WELDING.(U)  
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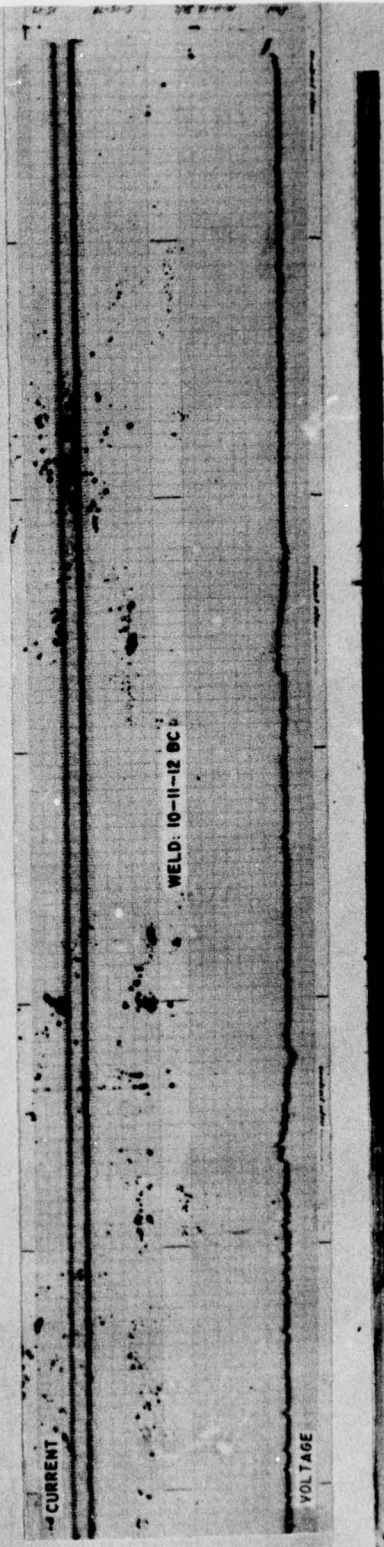
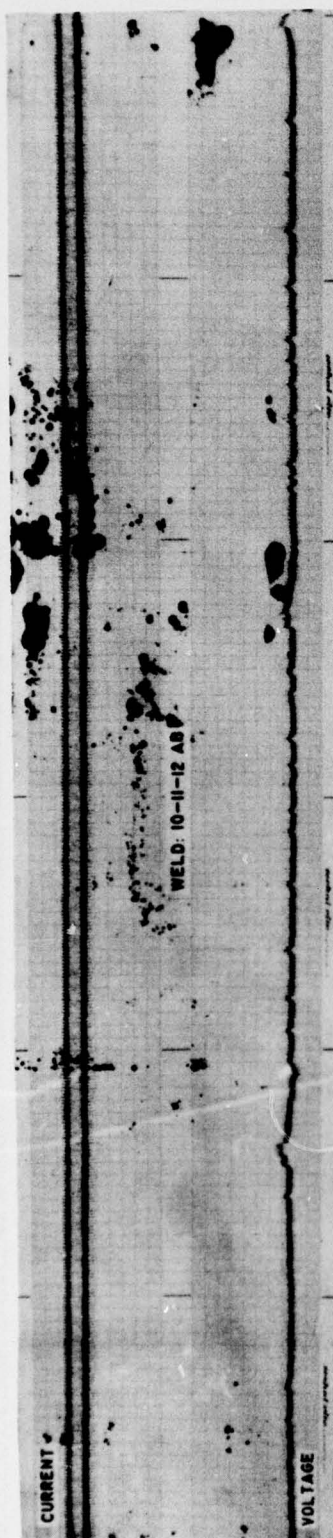
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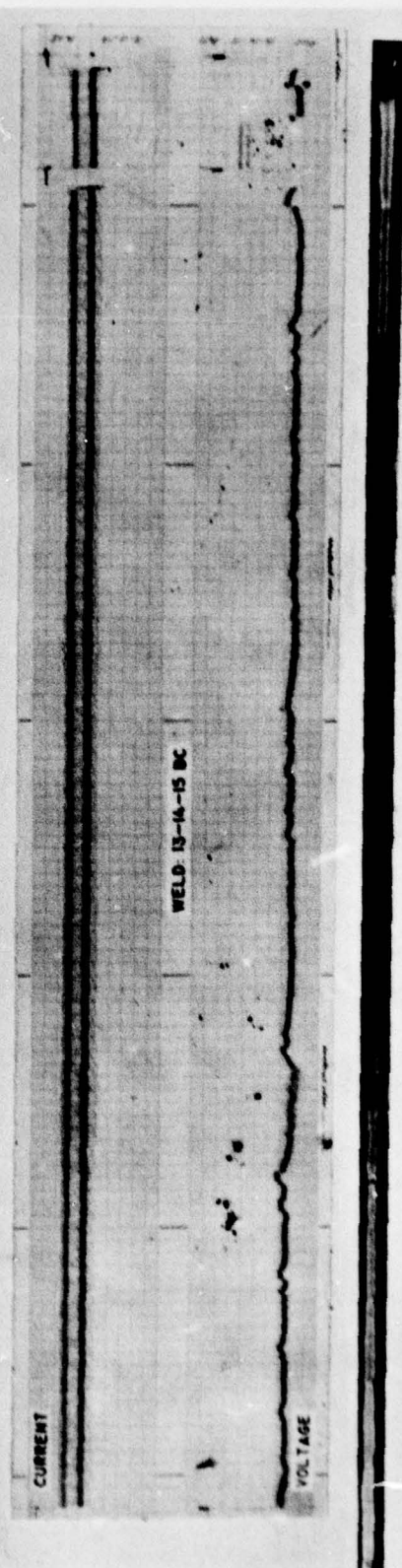
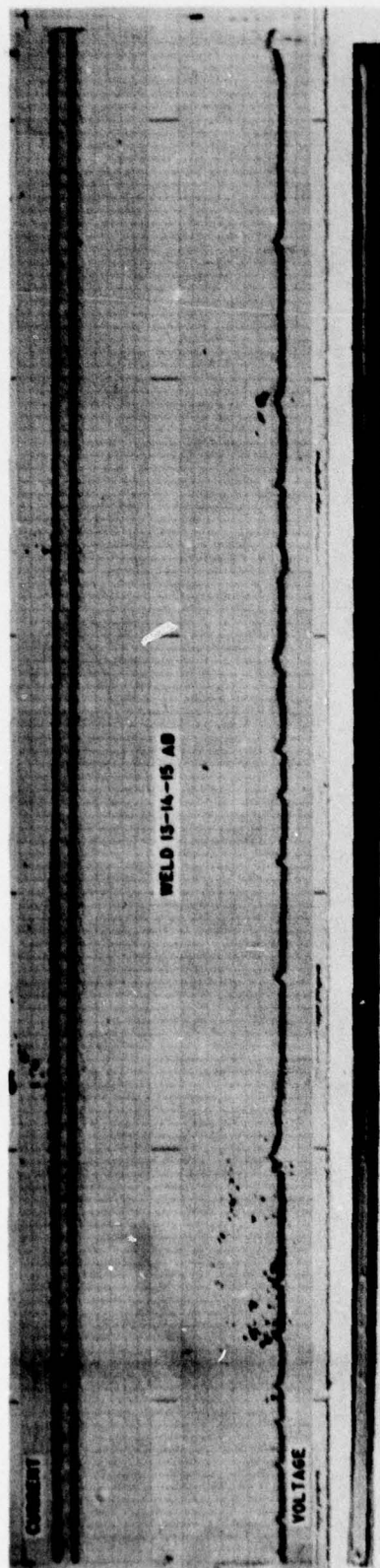
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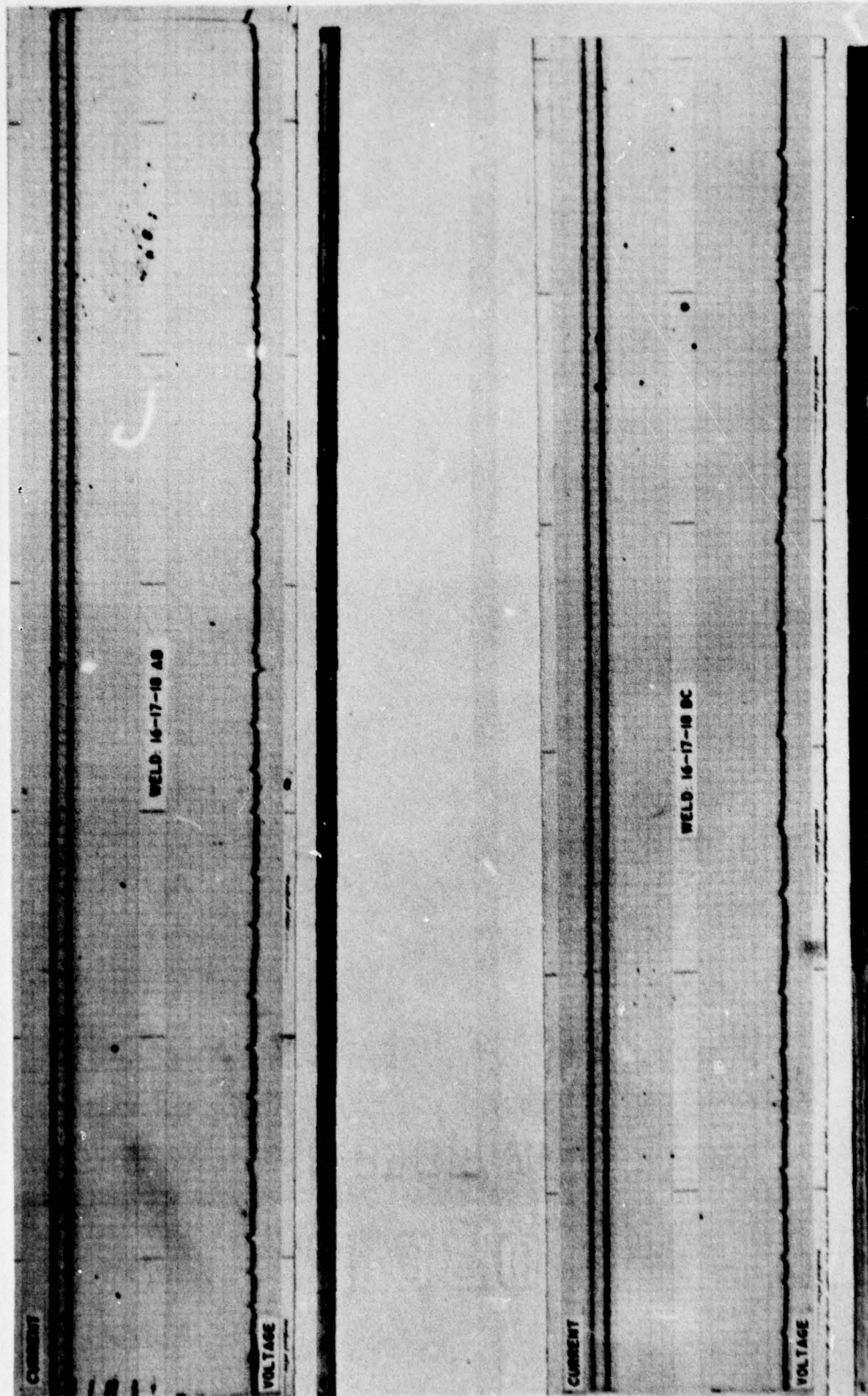
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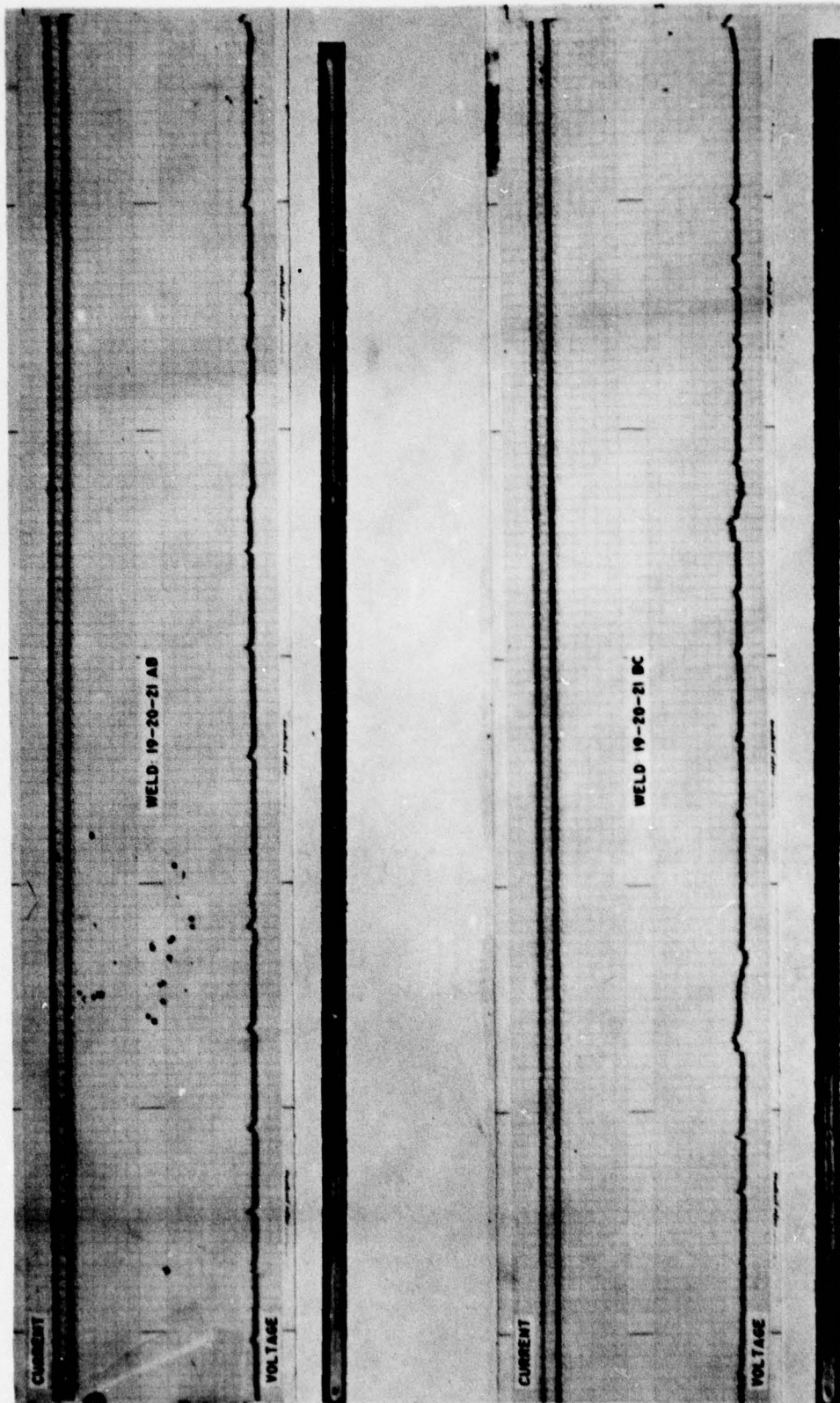


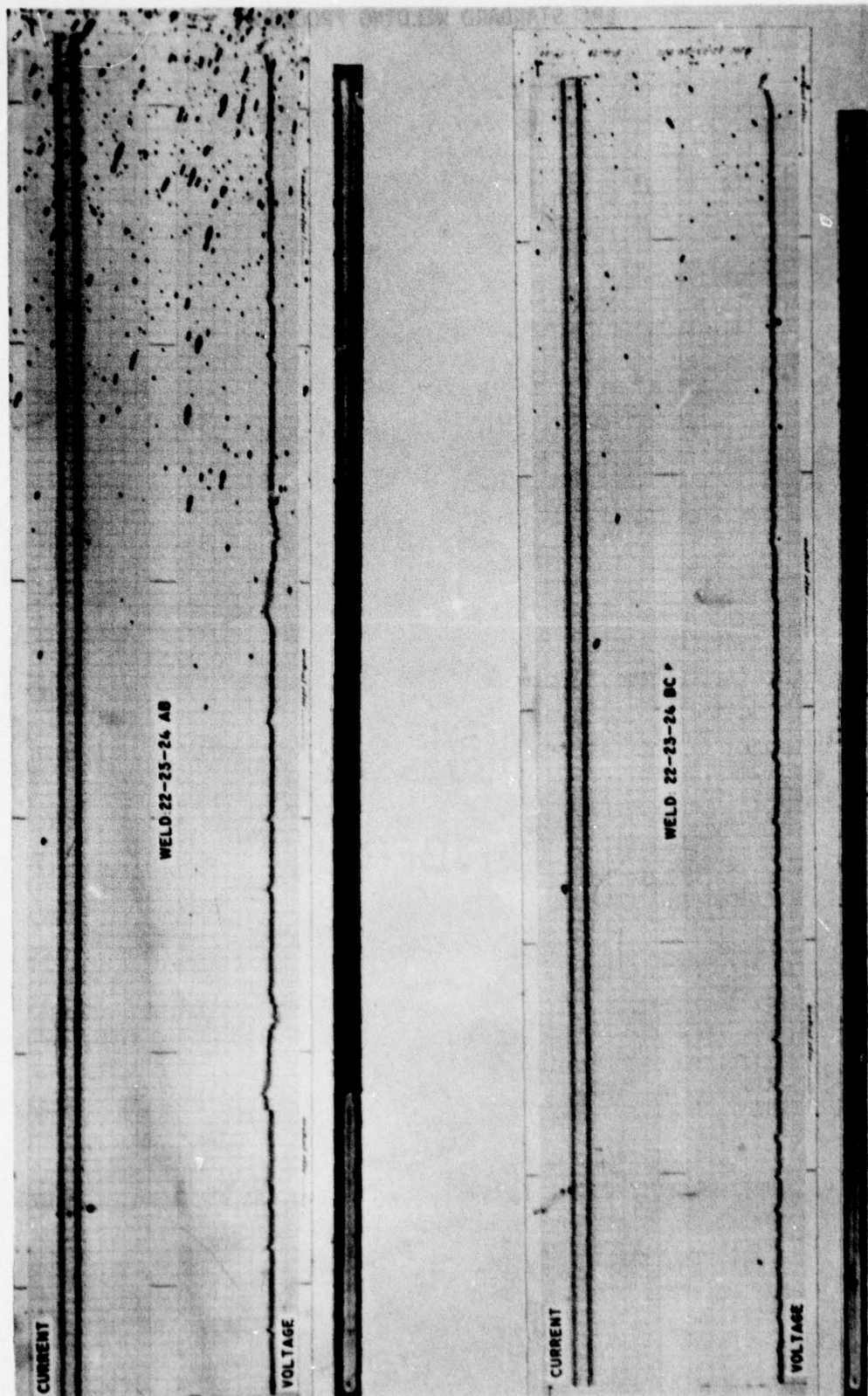












**APPENDIX A-3**

**LRC STANDARD WELDING PROCEDURE**



BABCOCK AND WILCOX  
RESEARCH AND DEVELOPMENT DIVISION

TECHNICAL PROCEDURE

NUMBER LRC-TP-72

TITLE ASSEMBLY OF PARTS BY INERT ARC FUSION WELDING

ISSUE NUMBER 07

ASSIGNED TO C.F. zur Lippe

PREPARED BY Klaus F. zur Lippe 5/23/78  
APPROVED BY J.B. Irons, PE 5/25/78  
APPROVED BY A.G. Ferrell 5/30/78

## TECHNICAL PROCEDURE

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1. Scope

This Technical Procedure establishes rules and requirements for machine-welding by the inert arc fusion welding process to assure the production of high-quality weldments.

## 2.0 Operator Qualification

- 2.1 The operator shall demonstrate his ability to set up and operate designated weld equipment by producing 3 test weldments of simulated joint design.
- 2.2 The operator qualification tests will be conducted by an examiner designated by the Manager, Nuclear Materials Technology Section.
- 2.3 Operator qualification shall be limited to the material groups and machine welding processes for which they have been specifically tested.
- 2.4 Whenever low or unacceptable quality weldments are produced by the operator, immediate corrective action shall be taken as follows:  
Machine settings shall first be checked for accuracy and repeatability. If the machine is not at fault, the operator's qualification shall be revoked. Only after additional training, may the operator be retested.
- 2.5 Operator qualification shall only be valid for six months beyond the date of testing.

### 3.0 Fabrication Welding Procedure

- 3.1 A weld schedule shall be established for each welding operation. All set-up parameters for a specific operation shall be shown on a weld schedule operations sheet (Table 3-1.). Instrument settings may be varied within the allowable ranges specified in Table 3-2.
- 3.2 Subassembly parts and fixture tooling shall be thoroughly cleaned by ultrasonic cleaning in CP acetone or in accordance with a designated cleaning specification prior to assembly and welding of components. Thereafter, operators shall wear clean, white, lint-free gloves when handling components.
- 3.3 Parts shall be assembled and positioned for welding using the fixtures and tools specified by the applicable operations sheet.
- 3.4 Joint fit-up conditions shall either meet or exceed engineering drawing requirements but may not exceed the maximum permissible joint mismatch conditions specified in Figure 3.1.
- 3.5 When tack-welds are required to position details or attach weld start and end tabs to the part, weld heat input shall be "balanced" to minimize shrinkage distortion. After tack-welding, metal vapor deposits shall be removed by stainless steel wire brushing.
- 3.6 Trailing shields shall be used in all instances when weld discoloration is not acceptable.
- 3.7 An inert gas weld chamber shall be used when it is necessary to shield the weld from atmospheric contamination. Residual oxygen concentration of the protective atmosphere shall be monitored continuously and shall not exceed 15 PPM at any time either prior to or during the welding operation. Acceptable weld deposits must have a bright silvery color. Dew point of backfill gas shall be maintained below -65F.



## RESEARCH AND DEVELOPMENT DIVISION

## TECHNICAL PROCEDURE

DATE 5/23/78

GTAW-Fusion Welding Schedule Sheet

Assembly Name:

Serial No.:

Assembly Drawing No.:

Weld Process:

Base Metal Mat'l:

Joint Configuration:

Heat Treat Cond.:

Weld Position:

Mat'l Thickness:

Weld Penetration:

Date Welded:

Power Supply:

| Welding Sequence (No. of passes)                  | 1 | 2 | 3 |
|---------------------------------------------------|---|---|---|
| Joint Description                                 |   |   |   |
| Weld Polarity, SP-RP-AC                           |   |   |   |
| Preheat Current, Amps                             |   |   |   |
| Preheat Dwell Time, sec.                          |   |   |   |
| Upslope Control Time, sec.                        |   |   |   |
| Low Pulse Current, Amps                           |   |   |   |
| High Pulse or Steady State Current, Amps          |   |   |   |
| "ON"-Time, %                                      |   |   |   |
| Pulse Rate, PPS                                   |   |   |   |
| Voltage, V @ Peak Current                         |   |   |   |
| Downslope Control Time, sec.                      |   |   |   |
| Postheat Current, Amps                            |   |   |   |
| Postheat Dwell Time, sec.                         |   |   |   |
| Weld Travel Speed, IPM                            |   |   |   |
| Speed Control Setting, %                          |   |   |   |
| Weld Travel Delay, sec.                           |   |   |   |
| Filler Wire Mat'l (Spec.)                         |   |   |   |
| Wire Diameter, in.                                |   |   |   |
| Wire Feed Speed, IPM                              |   |   |   |
| Feed Start Delay, sec.                            |   |   |   |
| Wire Feed Time, sec.                              |   |   |   |
| Joint Preheat Temperature, F                      |   |   |   |
| Interpass Temperature, F                          |   |   |   |
| Weld Post Heat Temperature, F                     |   |   |   |
| Torch Make and Model No.                          |   |   |   |
| Shield Cup/Nozzle Size                            |   |   |   |
| Torch Rake Angle, deg.                            |   |   |   |
| Standoff Dist.: Shield Cup-Workpiece, in.         |   |   |   |
| Electrode Mat'l Type and Size                     |   |   |   |
| Tip Geometry (pointed-blunt)                      |   |   |   |
| Standoff Dist.: Electrode-Workpiece, in.          |   |   |   |
| Shielding Gas or Mixture                          |   |   |   |
| Gas Flow Rates, CFH:                              |   |   |   |
| a) Torch Shield Cup                               |   |   |   |
| b) Torch Orifice (Plasma Arc only!)               |   |   |   |
| c) Overhead Trailing Shield                       |   |   |   |
| d) Underhead Trailing Shield                      |   |   |   |
| Underhead Gas Back Pressure, in. H <sub>2</sub> O |   |   |   |
| Preflow/Postflow Times, sec.                      |   |   |   |
| Inert Atmosphere Chamber Make & Size              |   |   |   |
| Positive Pressure, in. H <sub>2</sub> O           |   |   |   |
| Purge Gas Flow Rate, CFH                          |   |   |   |
| Weld Fixture Tooling:                             |   |   |   |
| a) Type                                           |   |   |   |
| b) Tool Number                                    |   |   |   |
| Weld Energy Input, KJ/in.                         |   |   |   |

Cleaning & Tacking  
Instructions:

Table 3-1

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## TECHNICAL PROCEDURE

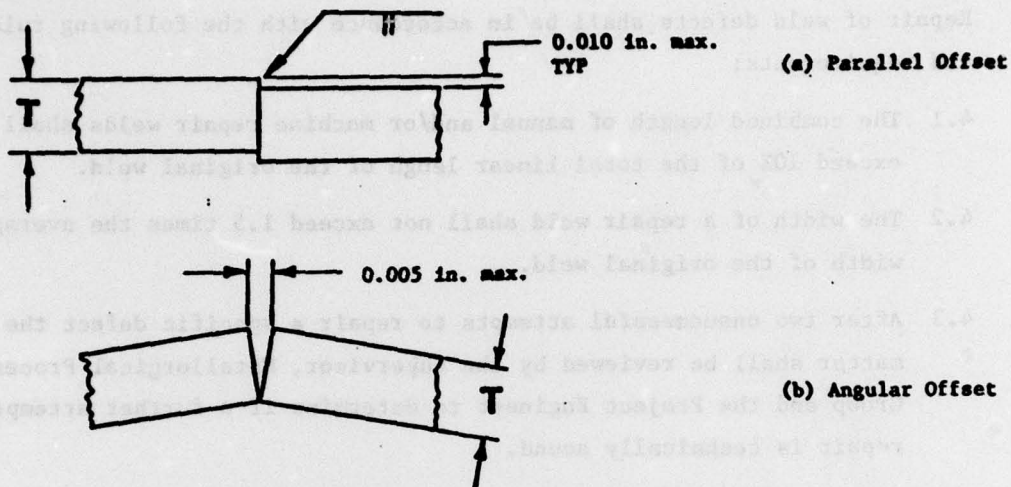
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**Setpoint Allowables for Non-Consumable and Consumable  
Type Electrode Inert Arc Welding Processes**

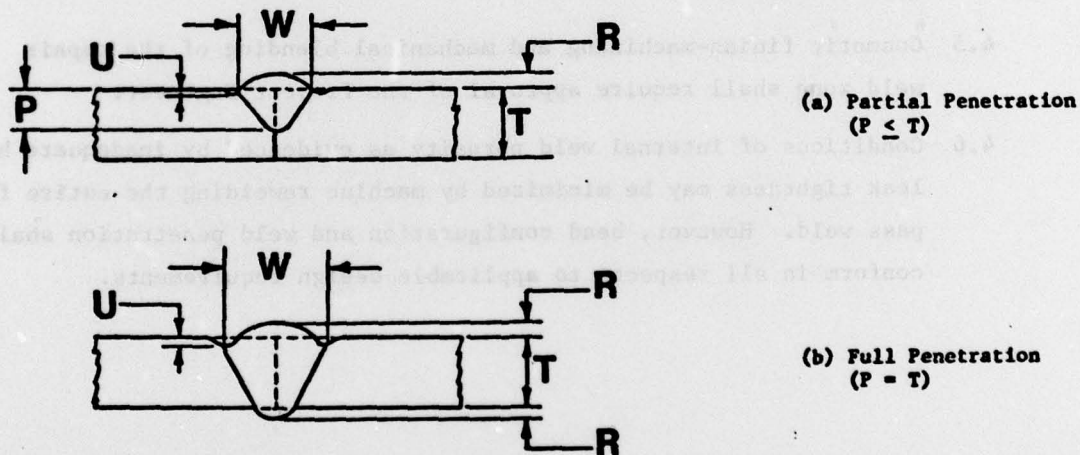
|                                        | <u>GTAW &amp; PAW</u> | <u>GMAW</u> |
|----------------------------------------|-----------------------|-------------|
| Amperage                               | ±10%                  | ±15%        |
| Voltage                                | ± 2 V                 | ±10%        |
| Gas Flow Torch                         | ± 3 CFH               | ± 5 CFH     |
| Shield Gas Flow<br>Over- and Underbead | ± 5 CFH               | ± 5 CFH     |
| Welding Speed                          | ± 4%                  | ± 3%        |
| Wire Feed Speed                        | ±10%                  | ± 5%        |

Table 3-2

## (1) Pre-Weld Misalignment Limits



## (2) Weld Bead Geometry

W, Overbead Width:  $2 T$  max.R, Weld Reinforcement:  $0.1 T$  max.U, Undercut:  $0.15 T$  max.

P, Penetration: Per applicable specification or drawing

Figure 3.1. Maximum Permissible Joint Mismatch During Weld Constraint  
(Square butt weld, no filler wire addition)



#### 4.0 Weld Repair

Repair of weld defects shall be in accordance with the following rules and requirements:

- 4.1 The combined length of manual and/or machine repair welds shall not exceed 10% of the total linear length of the original weld.
- 4.2 The width of a repair weld shall not exceed 1.5 times the average width of the original weld.
- 4.3 After two unsuccessful attempts to repair a specific defect the matter shall be reviewed by the Supervisor, Metallurgical Process Group and the Project Engineer to determine if a further attempt at repair is technically sound.
- 4.4 Filler wire additions, when required, shall match the base metal composition. Wire shall be wiped clean with lint-free cloths and approved solvent.
- 4.5 Cosmetic finish-machining and mechanical blending of the repair weld zone shall require approval of the Project Engineer.
- 4.6 Conditions of internal weld porosity as evidenced by inadequate helium leak tightness may be minimized by machine rewelding the entire first pass weld. However, bead configuration and weld penetration shall conform in all respects to applicable design requirements.

5.0 Quality Control

- 5.1 Reactive metal and refractory metal weldments with blue or darker discoloration shall be rejected. The welding process shall be stopped until the source of contamination is found and eliminated.
- 5.2 Test weldments of simulated joint design shall be metallographically prepared to reveal the outline of the fusion zone.
- 5.3 Weld assembly of parts shall not proceed until repeatability of weld schedule parameters has been confirmed to enable consistent production of desired weld penetration and bead configuration.
- 5.4 Nondestructive examination and leak-tightness inspection, when required, shall be performed in accordance with applicable specifications.

### 6.0 Documentation

A copy of all records pertaining to operator qualifications, test and fabrication weld schedules, and quality control shall be maintained in an appropriate project file by the Project Engineer.



7.0 Application

Application of this Technical Procedure shall include the foregoing rules and requirements and the following specific instructions:

- 7.1 Reactor Vessel Material Surveillance Program, End Fittings:  
Table 7-1.

RESEARCH AND DEVELOPMENT DIVISION  
TECHNICAL PROCEDURE

APPENDIX A-4

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FIXTURE DRAWINGS

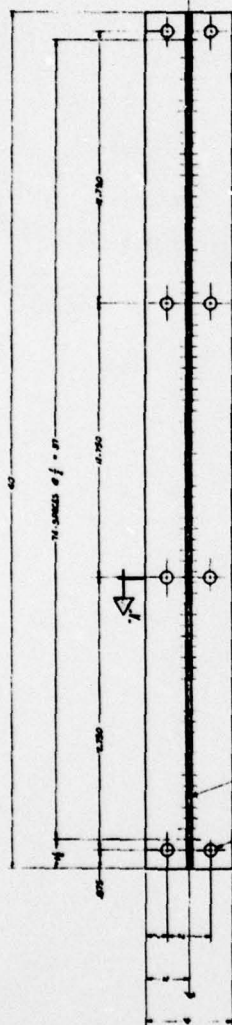
2.0 Application

Application of this Technical Procedure shall include the following rules and recommendations and the following specific considerations:

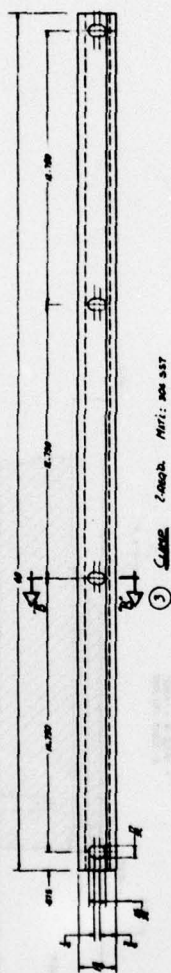
2.1 Master Vessel Material Surveillance Program and Fixtures

Table 2-1

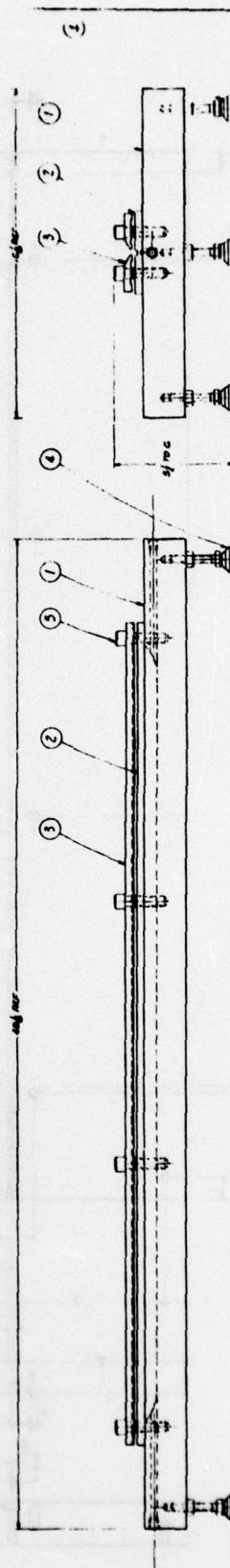
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R.S. Williams and C.F. zur Lippe,  
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