

November 29, 2005

Mr. Tony Westrich
Ultrafryer Systems
P.O. Box 5369
San Antonio, TX 78201

Re: Heat Exchanger Weld Evaluation

Dear Mr. Westrich:

As requested, we have examined the submitted tube-to-sheet weld samples to assess the quality and appearance of each. As previously discussed via telephone, all of the samples appear to have good weld penetration based on cross sectioning of areas found visually to be questionable. Very minor incomplete penetration was found on weld samples II and III. Weld sample I appeared to be the most uniformly welded, with sample II being the next most uniform.

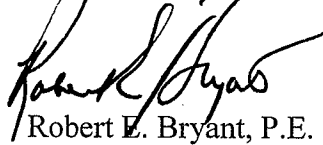
As discussed, the weld joint configuration makes inspection difficult. If no burn through is apparent, i.e. sharp linear indication at junction of tube to sheet, it is difficult to know exactly where the weld root is located. Very careful inspection with low power magnification at such areas can detect slight melting at the tube-to-sheet junction, indicating full penetration. However, such critical inspection may not be practical or possible in your manufacturing operation. A more realistic approach to assessing weld quality is to confirm burn through (obvious penetration) around a percentage of the weld joint with emphasis on the curved or more crack-prone areas. Such an assessment should be made at the earliest stages of manufacture.

The three weld samples submitted were comprised of an assembly of three tube stubs to sheet welds each. To facilitate inspection of each weld area, each sample was cut into three individual tube-to-sheet specimens. Figure 1 shows a resulting specimen of a typical tub stub and sheet weld. Each of the specimens (nine in all) was examined visually and with the aid of a low power (20x) light microscope. Observations made in the four quadrants of each specimen are tabulated in the attached Table I. Following the examinations, selected areas were cross sectioned and finished to 400 grit polishing paper for further study. Specimen IIC was sectioned in quadrants three and four as shown in Figures 3, 4, 5 and 6. The appearance of the weld joint in cross section can be seen in Figures 7 and 8. As can be seen, the weld joint exhibits minor lack of penetration at quadrant three, but not at quadrant four. The limited length and depth of lack of penetration compared to what visual inspection might indicate illustrates the difficulty in trying to inspect these welds.

Further sectioning was done on specimens IIIA and IIIB. The areas sectioned and the resulting weld cross sections are shown in Figures 9, 10, 11 and 12. Both of these weld areas exhibit very minor lack of penetration. Again, the significance of this discontinuity is difficult to assess based on visual inspection.

All in all, the overall quality of the welding represented by the test samples appears good. Inspection of the weld joint and fabricated assembly is very difficult; the quality of the weld joint is difficult to assess visually. The observations made in this test program point out this difficulty. As stated earlier, an acceptance criterion based on the amount of burn through present and its location in the joint is probably the most realistic method for assessing weld quality.

Yours very truly



Robert E. Bryant, P.E.

Reviewed by: David Lee (P.E.)

REB/jdh

File: BL05249

TABLE I
Visual Inspection Results
Weld Assembly I

Weld Specimen	Quadrant	Comments
A	1	Uniform, continuous burn through. No obvious gaps in weld.
	2	Same as 1
	3	Same as 1
	4	Same as 1
B	1	Uniform, continuous burn through. No obvious gaps in weld.
	2	Same as 1
	3	Same as 1
	4	Same as 1
C	1	Uniform, continuous burn through. No obvious gaps in weld.
	2	Same as 1
	3	A little excessive penetration.
	4	Same as 1

Weld Assembly II

Weld Specimen	Quadrant	Comments
A	1	Some indication of root burn through – majority unknown penetration
	2	Same as 1
	3	Burn through is not continuous, but appears to be full penetration.
	4	Same as 1
B	1	Evidence of root burn through, but spotty. Some areas have sharp joint line.
	2	Same as 1
	3	Same as 1
	4	Same as 1
C	1	Continuous burn through.
	2	Same as 1
	3	Uneven burn through. Section to see.
	4	Uneven, spotty burn through. Section area.

Weld Assembly III

Weld Specimen	Quadrant	Comments
A	1	Continuous burn through.
	2	Continuous to long side. Appears full at low magnification. Section this area.
	3	Curved area may have lack of penetration.
	4	Appears continuous.
B	1	Continuous burn through.
	2	May have lack of penetration along straight area.
	3	Looks like lack of penetration in curve.
	4	Appears to have continuous penetration.
C	1	Continuous penetration.
	2	Spotty burn through along section. Appears to be full penetration.
	3	Entire quadrant shows no burn through. Questionable penetration.
	4	Spotty burn through along straight, but looks to be full penetration.

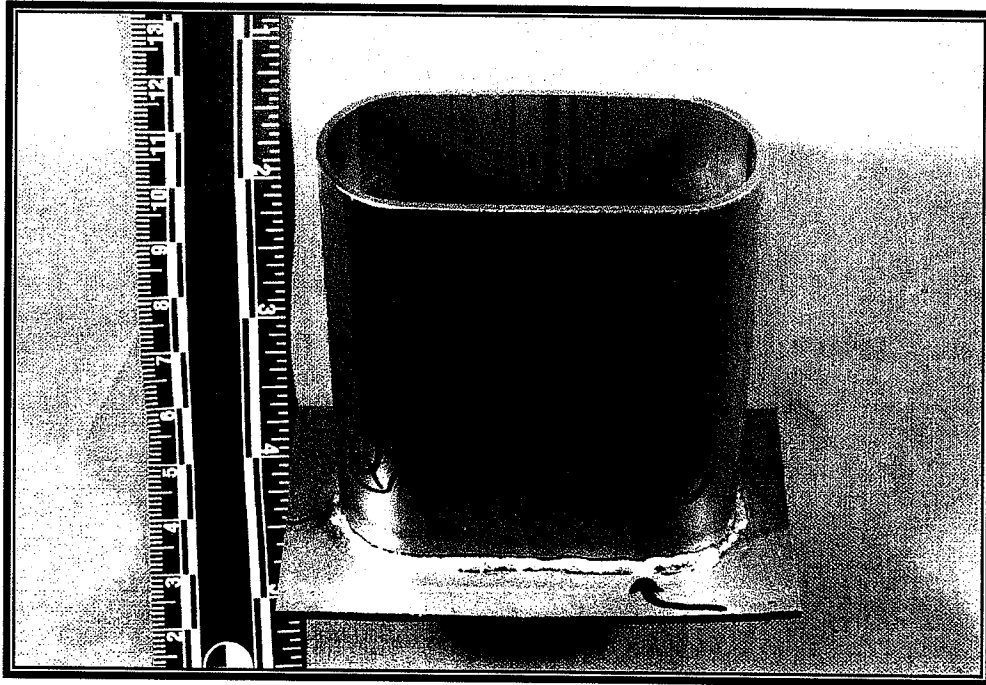


Figure 1 – Typical weld specimen after separating the test sample into sections.

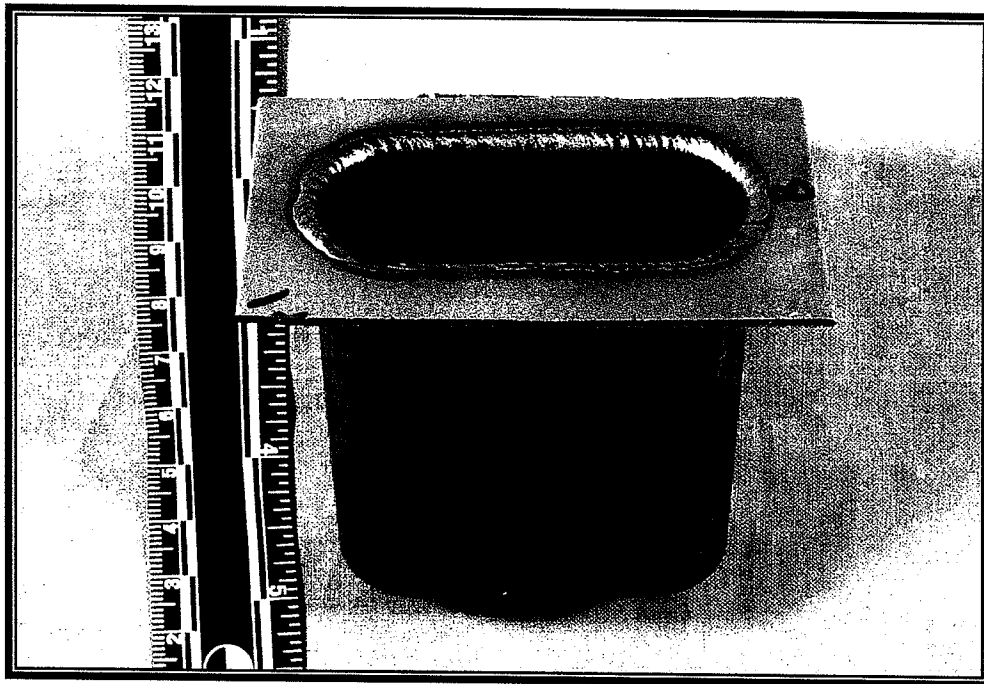


Figure 2 – Welding side of the tube-to-sheet joint.

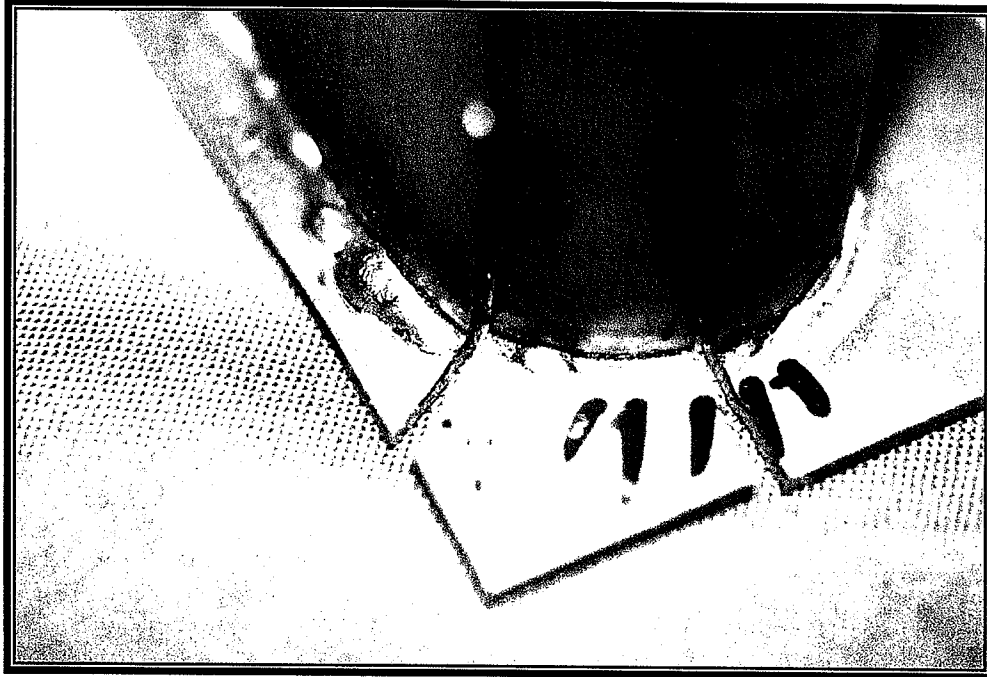


Figure 3 – The weld in specimen IIC, quadrant three.



Figure 4 – Close up of weld area in IIC, quadrant three.

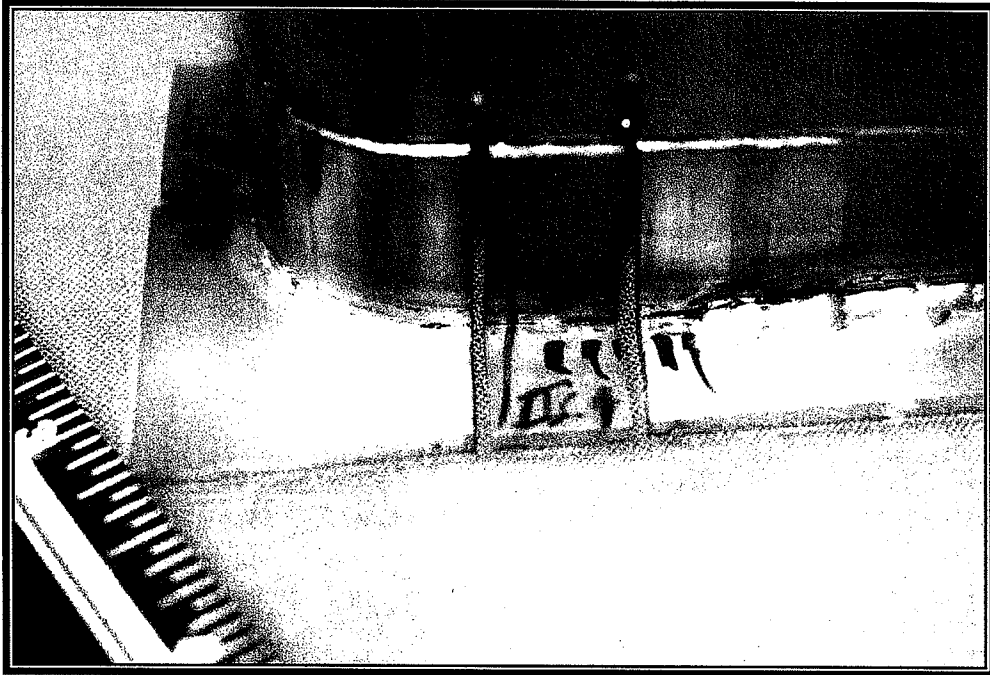


Figure 5 – The weld in specimen IIC, quadrant four, was cross sectioned for examination.

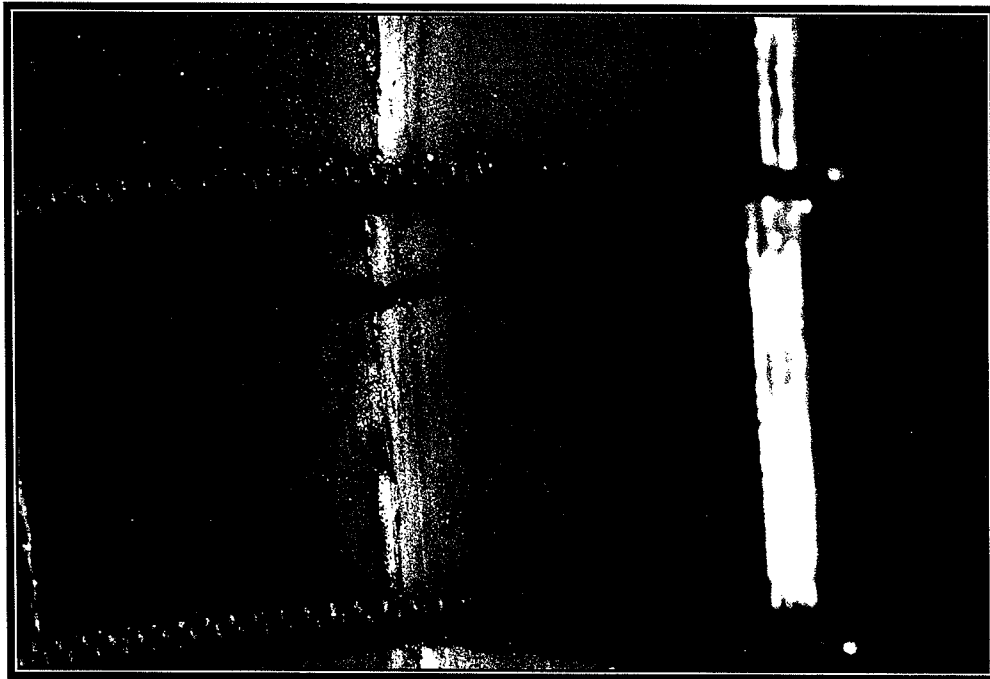


Figure 6 – Close-up of weld area in IIC, quadrant four.

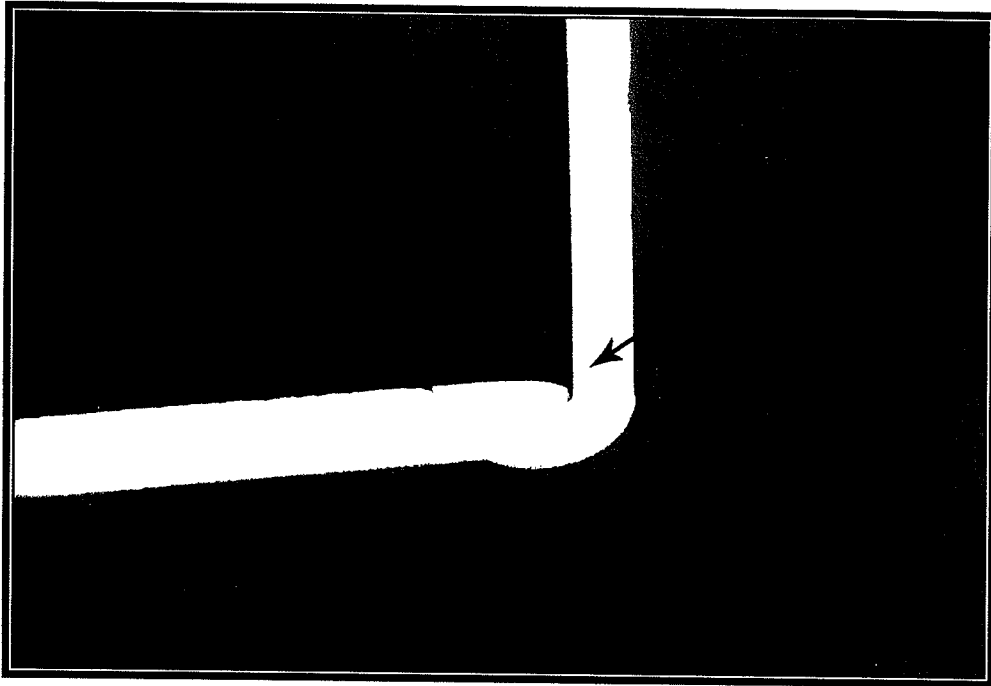


Figure 7 – Photograph of weld cross section IIC, quadrant three, showing some lack of penetration (arrow).

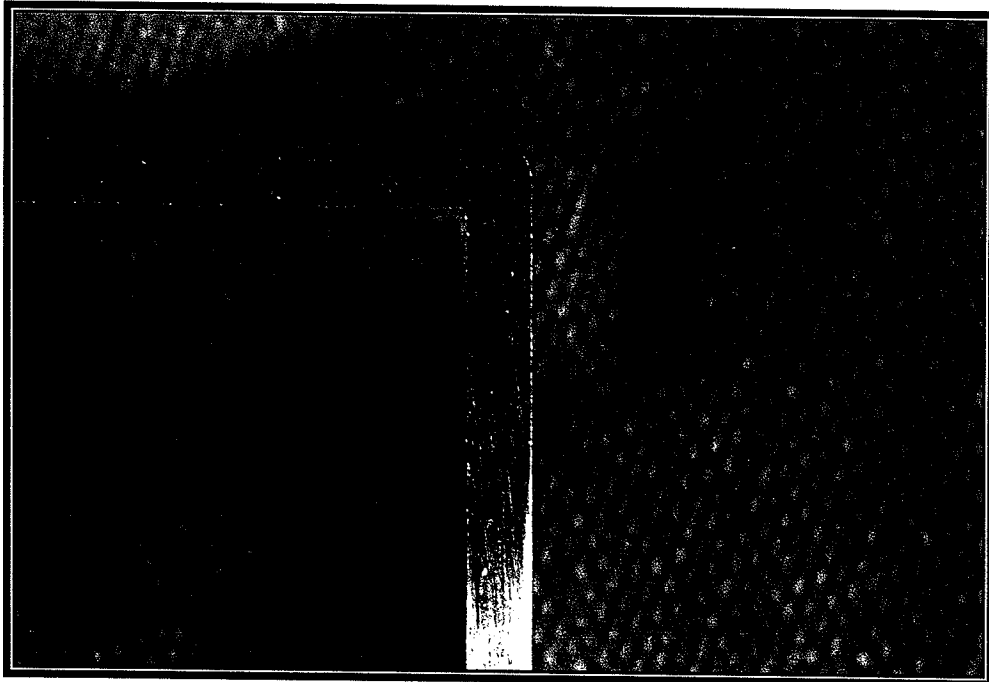


Figure 8 – Photograph of weld cross section IIC, quadrant four, showing good weld penetration.

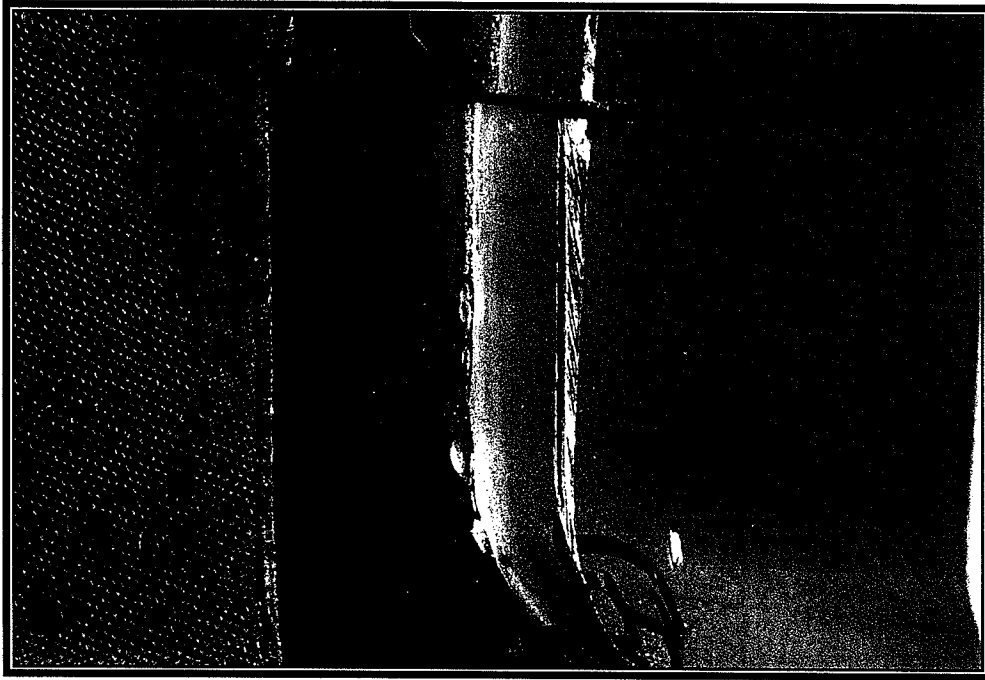


Figure 9 – Close-up of weld area in IIIA, quadrant three, that was cross sectioned.

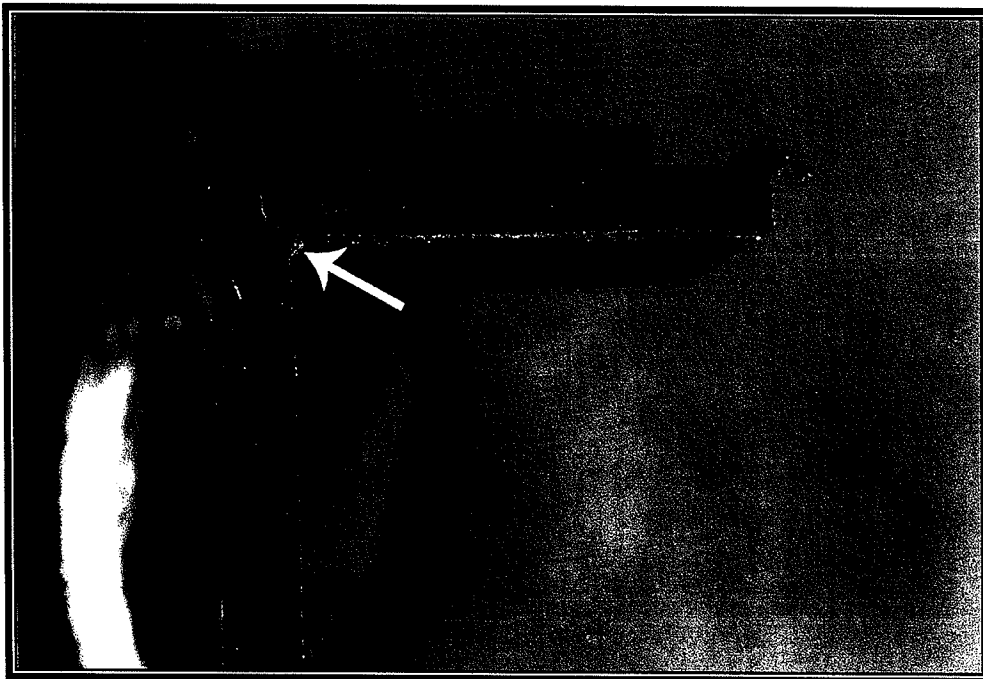


Figure 10 – Slight lack of penetration observed in IIIA, quadrant three (arrow).



Figure 11 – Close up of weld area III B, quadrant three, that was cross sectioned.

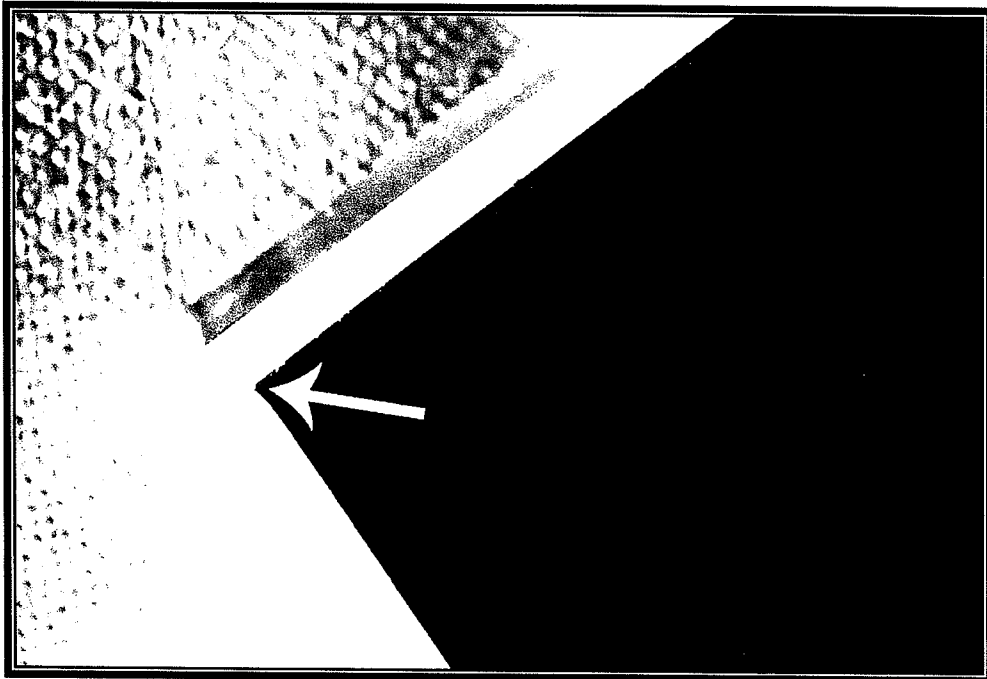


Figure 12 – Slight lack of penetration observed in III B, quadrant three (arrow).