

3395 APPENDIX B

3396 **ROUND ROBIN HEIGHT AND LENGTH**
3397 **MEASUREMENTS**

3398 B.1 Flaw Height Measurement Scatter

3399 Along with collecting data on the detection and rejection of known weld flaws using the current
3400 acceptance criteria, one of the primary objectives of the round robin testing program was to evaluate the
3401 ability of PAUT and TOFD technicians to accurately measure the overall dimensions of internal flaws (i.e.,
3402 flaw height and flaw length) and to determine best practices for flaw sizing.

3403 The flaw height reported by each PAUT, TOFD, and FMC/TFM technician is shown in the following
3404 plots. The originally intended flaw sizes are noted in the legend as the “Drawing”. As can be seen in the
3405 following figures, the reported flaw height for FMC/TFM is very consistent with the intended flaw height
3406 and, where available, was the size used for the actual flaw height shown in the round robin flaw details.
3407 Note that PAUT3 technician only reported flaw height for two of the eight flaws that were detected. Also,
3408 TOFD1 technician only reported flaw height for twelve of the eighteen flaws that were detected since it
3409 was reported that the extents of the flaw could not be discerned. TOFD2 technician did not report a location
3410 for Flaw 12. Table B-1 shows the standard deviation of the reported flaw height for each UT method
3411 compared to the intended flaw height (i.e. “Drawing”). FMC/TFM had the lowest standard deviation for
3412 reported flaw height and PAUT had the greatest standard deviation.

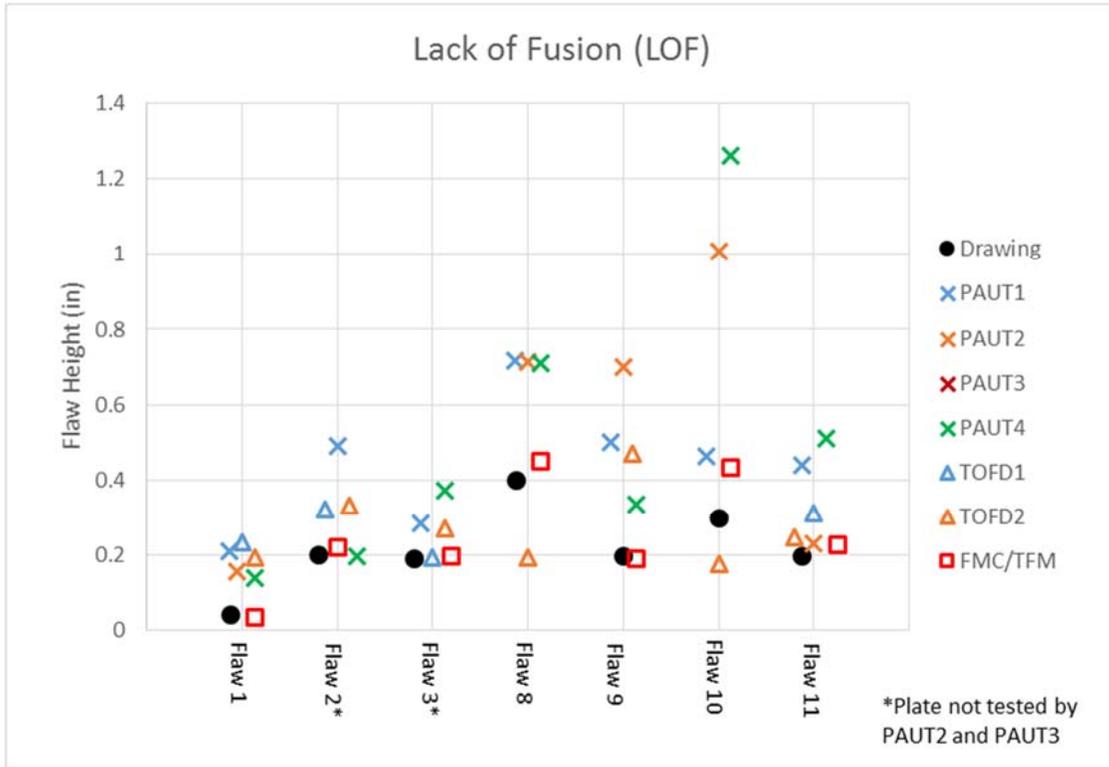
3413 **Table B-1. Standard Deviation of Reported Flaw Height**

UT Method	Standard Deviation
PAUT	0.27”
TOFD	0.16”
FMC/TFM	0.05”

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3415 Figure B-1 displays all of the reported flaw height data for LOF flaws. The flaw height was oversized
3416 by PAUT and TOFD for all of the flaws, except for the results from TOFD2. A large amount of scatter
3417 was seen for the reported height of the same flaw. Some interesting results are Flaw 10 and Flaw 8. Flaw
3418 10 had one reported result very similar to the FMC/TFM result and two reported results that were oversized
3419 by 2-3 times. Flaw 8 had almost no scatter between the three PAUT hits, but they were consistently
3420 oversized by 1.5 times the height reported by FMC/TFM.

3421 Figure B-2 displays the reported flaw height scatter data for all of the cracks. Compared with the LOF
3422 flaws the scatter of the height sizing of the cracks was typically much smaller. Once again, the cracks were
3423 typically oversized. Figure B-3 displays the reported flaw height data for all of the porosity flaws. The
3424 porosity flaws were also oversized, with Flaw 12 up to almost 2 times the FMC/TFM height and Flaw 16
3425 approximately 3 times the FMC/TFM height. Figure B-4 displays the reported flaw height data for all of
3426 the slag flaws. Once again, these flaws were typically oversized by up to 2 to 3 times the height reported
3427 by FMC/TFM.

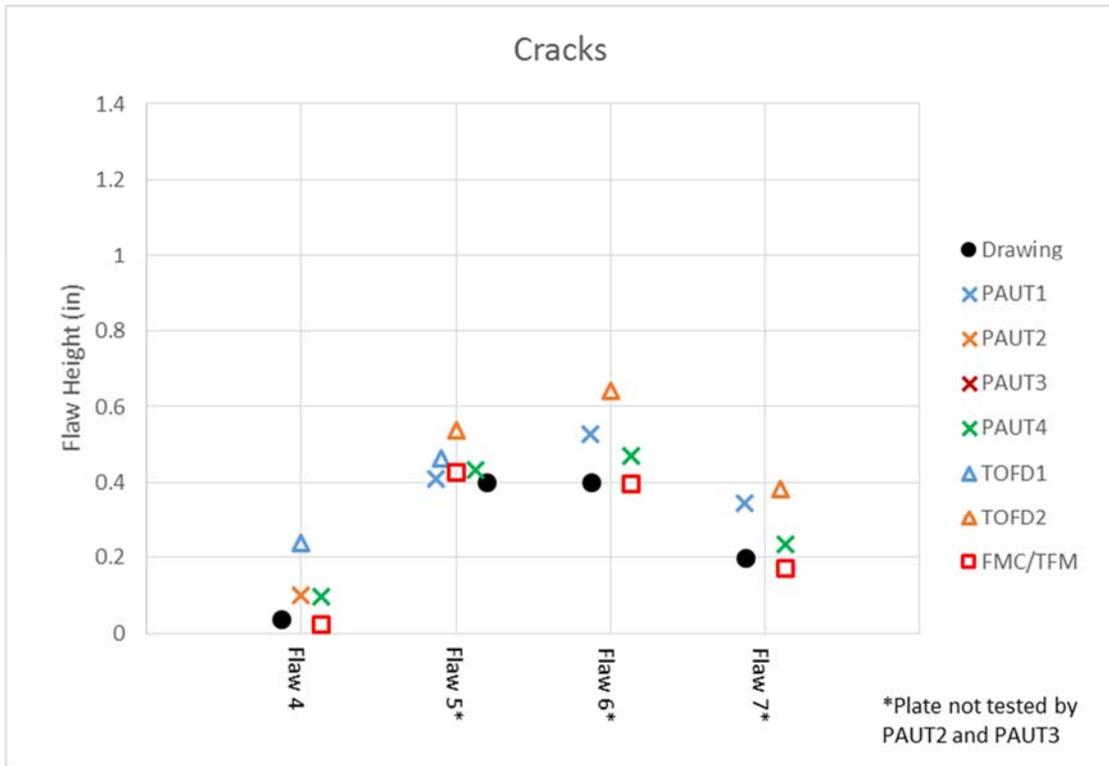
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Figure B-1. Flaw Height Scatter for LOF Flaws



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Figure B-2. Flaw Height Scatter for Cracks

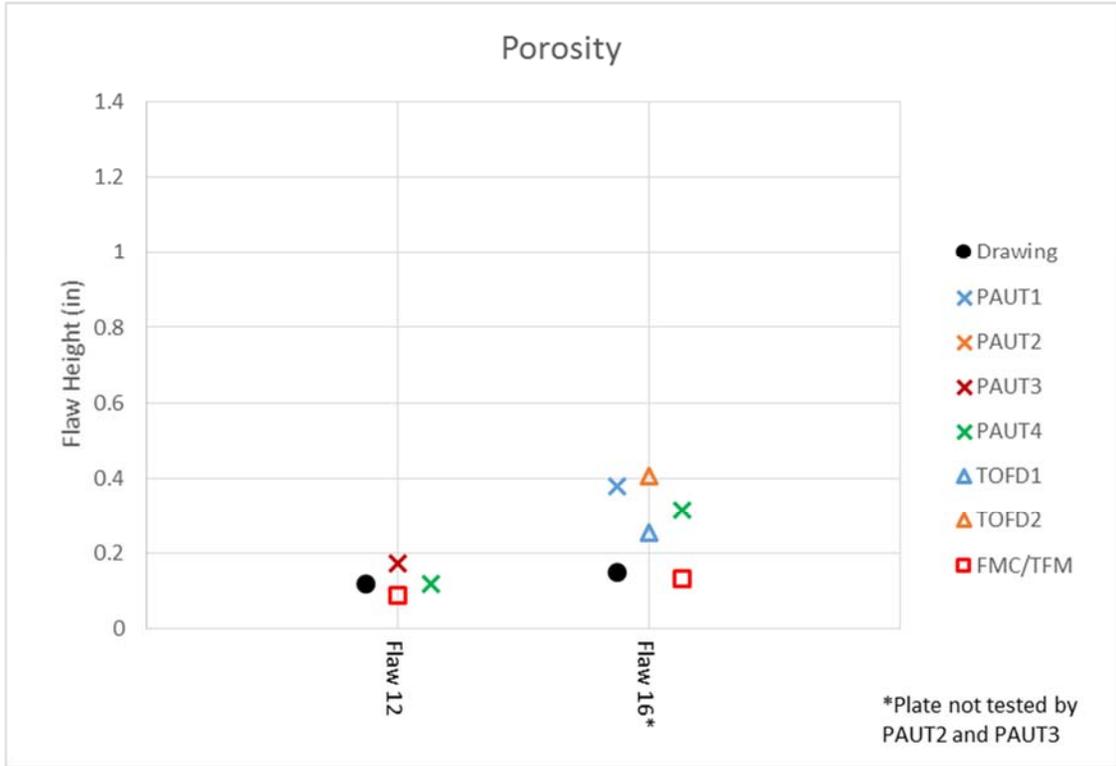


Figure B-3. Flaw Height Scatter for Porosity

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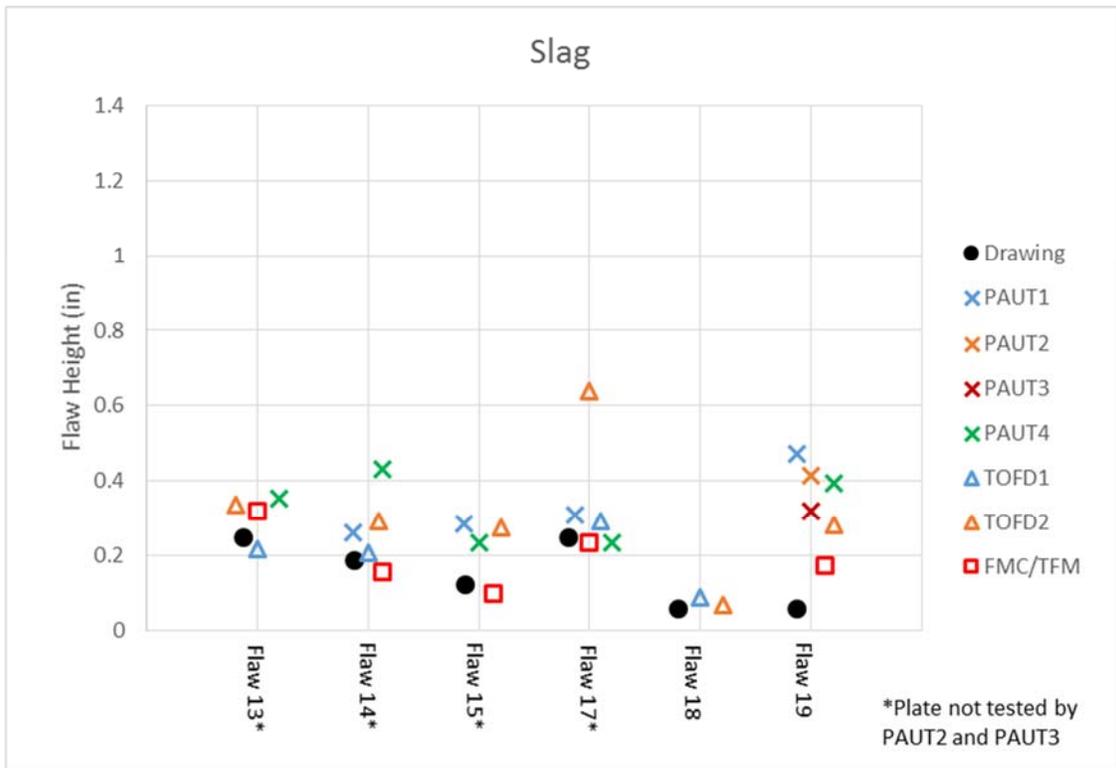


Figure B-4. Flaw Height Scatter for Slag

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3437 B.2 Flaw Length Measurement Scatter

3438 Flaw length was reported for all inspection methods including: PAUT, conventional UT, TOFD,
 3439 FMC/TFM, and digital RT. Table B-2 shows the standard deviation of the reported flaw length for each
 3440 UT method compared to the intended flaw length (i.e. "Drawing"). FMC/TFM had the lowest standard
 3441 deviation for reported flaw length and conventional UT had the greatest standard deviation.

3442 **Table B-2. Standard Deviation of Reported Flaw Length**

UT Method	Standard Deviation
PAUT	0.48"
TOFD	1.03"
FMC/TFM	0.36"
Conventional UT	1.11"

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 3444 Figure B-5 displays the reported flaw length data of LOF flaws. Flaw 1 is the only flaw which was
 3445 apparent on the digital RT inspection. For all of the other flaws, the best estimate of the flaw length is the
 3446 intended flaw length from the FlawTech drawings. It is apparent that the reported flaw length was typically
 3447 oversized for PAUT, conventional UT, and FMC/TFM. The PAUT results for LOF flaws were typically
 3448 oversized by up to 0.5". The conventional UT results for LOF flaws were typically oversized by up to 1",
 3449 except for Flaw 11 which was undersized by conventional UT by 0.6".

3450 Figure B-6 displays the flaw length scatter data for cracks. It should be noted that the vertical scale is
 3451 much larger for this plot since Flaw 4 had a tremendous amount of scatter. After reviewing the digital RT
 3452 data, it was apparent that the plate with this flaw had scattered porosity throughout its length. While this
 3453 would account for the reason for some of the large reported length measurements, it still does not account
 3454 for the large scatter in results since all technicians scanned the same plate. Therefore, it would be expected
 3455 that the technicians would still have had similar reported lengths encompassing all of the unintended flaws.
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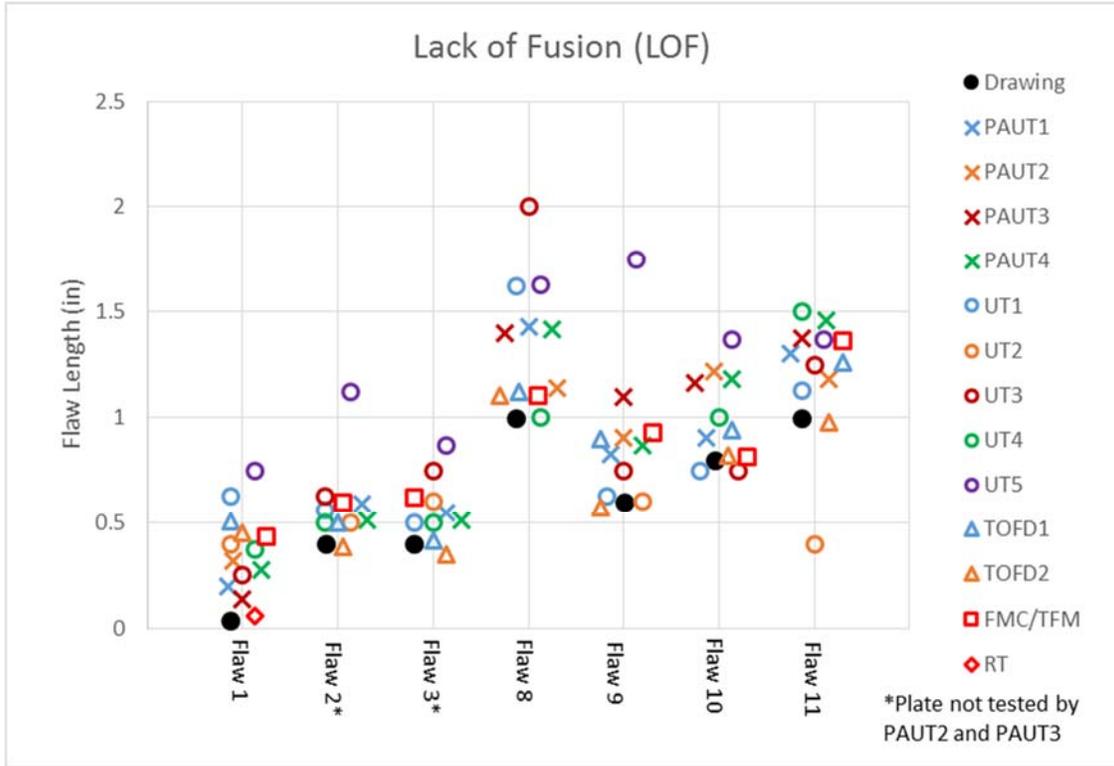


Figure B-5. Flaw Length Scatter for LOF Flaws

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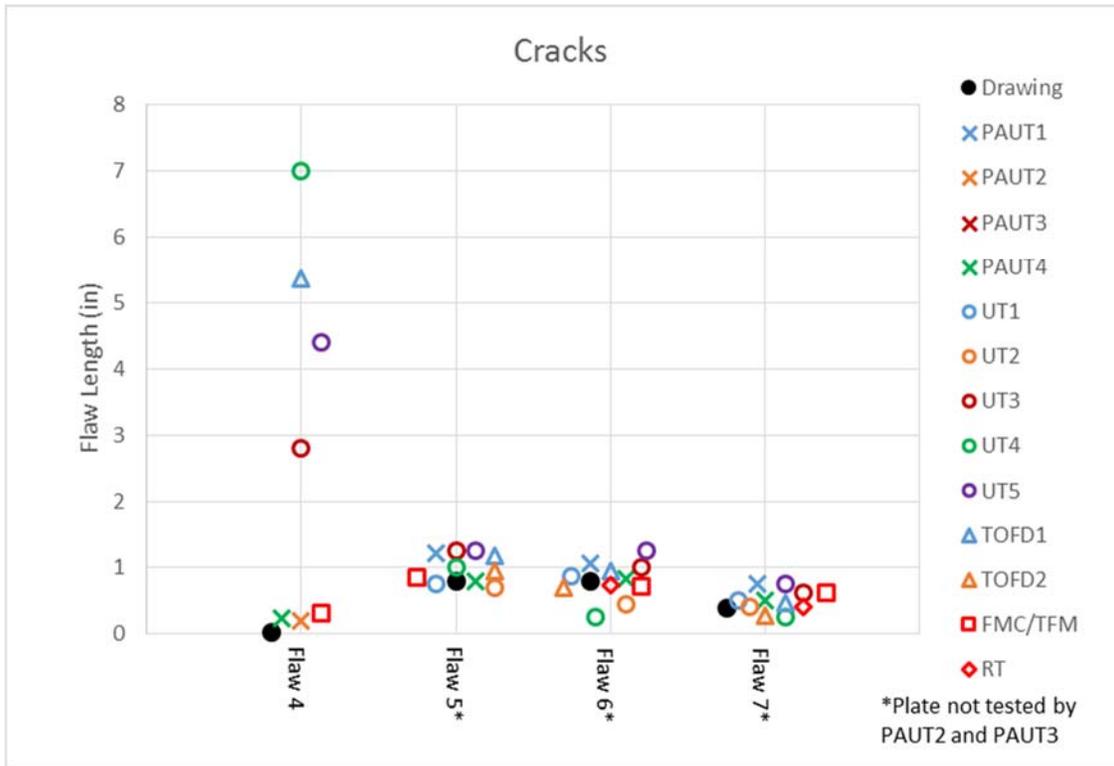
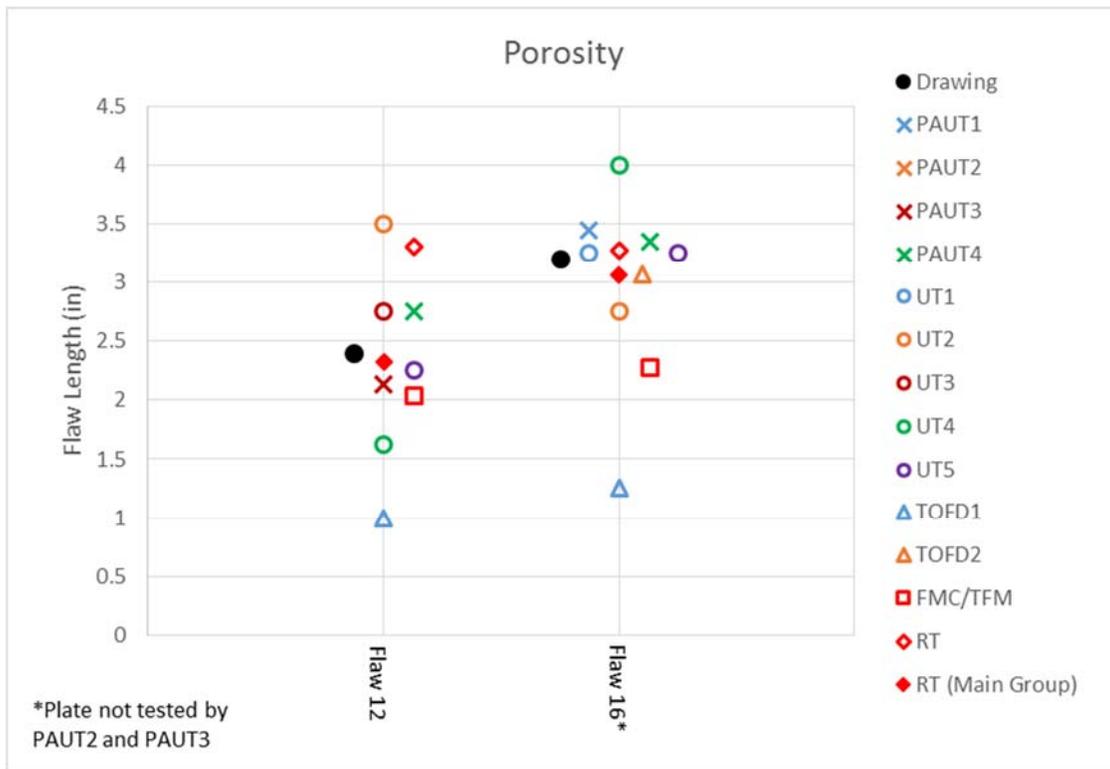


Figure B-6. Flaw Length Scatter for Cracks

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3462 Figure B-7 displays the reported flaw length data for the porosity flaws. Two lengths are reported for
 3463 the digital RT inspection since, as reported previously, some of the weld flaws had unintended peripheral
 3464 flaws outside the main grouping of porosity. It can be seen that porosity had a large scatter in reported
 3465 results with some technicians overestimating the length and some underestimating the length. It seems that
 3466 PAUT was slightly more consistent at measuring the flaw length than conventional UT. TOFD and
 3467 FMC/TFM reported greatly undersized length for the porosity flaws in some cases.

3468 Figure B-8 displays the reported flaw length data for slag flaws. Flaw 13-17 were typically oversized by
 3469 PAUT and conventional UT with the oversizing up to 1” for conventional UT while the PAUT results were
 3470 within 0.5”. Flaw 18 was the small slag inclusion which was not detected by any of the conventional UT
 3471 or PAUT technicians. It was measured to be only 0.03” long in the digital RT results. Flaw 19 had a main
 3472 grouping of slag and peripheral flaws. As can be seen in the reported results, some technicians reported the
 3473 total flaw length while others reported a flaw length corresponding to the length of the main grouping of
 3474 slag. Therefore, there were large variation of reported results for the same plate being tested by different
 3475 technicians according to the same code.
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3477 **Figure B-7. Flaw Length Scatter for Porosity**
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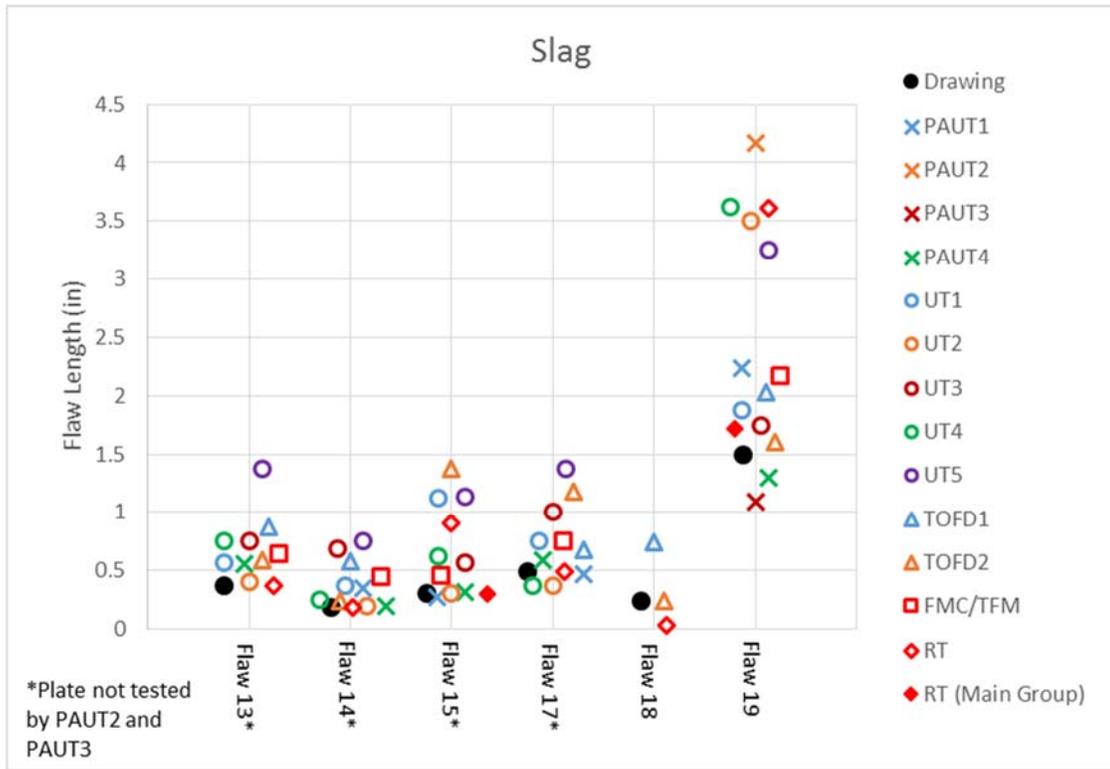


Figure B-8. Flaw Length Scatter for Slag

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