

IN-SITU METALLOGRAPHY OF CRACKED WELDS IN AN AMMONIA TANK

EXAMPLE REPORT

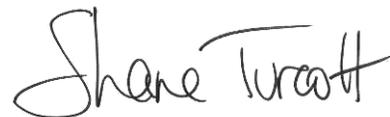
Modified from Original Report

OVERVIEW & OUTCOME

This work was completed within 24 hours.

In-situ metallography found that the cracks had formed due to copper contamination during original welding at the time of manufacture. These cracks had been formed during manufacture fifty years before and had not grown during service. Therefore, the tank had not experienced service degradation. The cracks were removed and re-welded.

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IN-SITU METALLOGRAPHY OF CRACKED WELDS IN AN AMMONIA TANK

SUMMARY

NDT inspection of a fifty year-old ammonia tank had found numerous indications along the internal welds. In-situ metallography was used to non-destructively determine the nature of these cracks. The evaluation including preparation of the tube surfaces, on-site examination, replication and examination under an optical microscope.

Each of the sites of interest were prepared for in-situ metallography by light grinding and polishing to a 1 μ m finish. These sites were replicated using an acetate in the as-polished condition and after etching using 3% nital. The replications were then examined using an optical microscope.

Figures 1 through 4 display the features and replicated structures of the welds evaluated. Both visual and optical examination found the cracks at the locations evaluated to be hot tears formed during original welding. The hot tears had formed due to copper contamination of the weld metal. Weld #2 exhibited copper visible after surface preparation (**Figure 3b,c**). Like Weld #2, the cracks on the other four welds had occurred in weld passes which (a) etched abnormally dark and (b) exhibited altered microstructures, also indicating that these welds had copper contamination.

The cracks had not formed nor grown during service. No evidence of service degradation was observed at the locations evaluated.

CONCLUSIONS

The cracks were hot tears formed during welding manufacture fifty years ago. The hot tears had been caused by copper tip blowout during submerged arc welding (SAW). This had injected copper into the weld and the contamination caused weld hot tears to form. These hot tear cracks had been benign in service.

No indications of service degradation were observed.

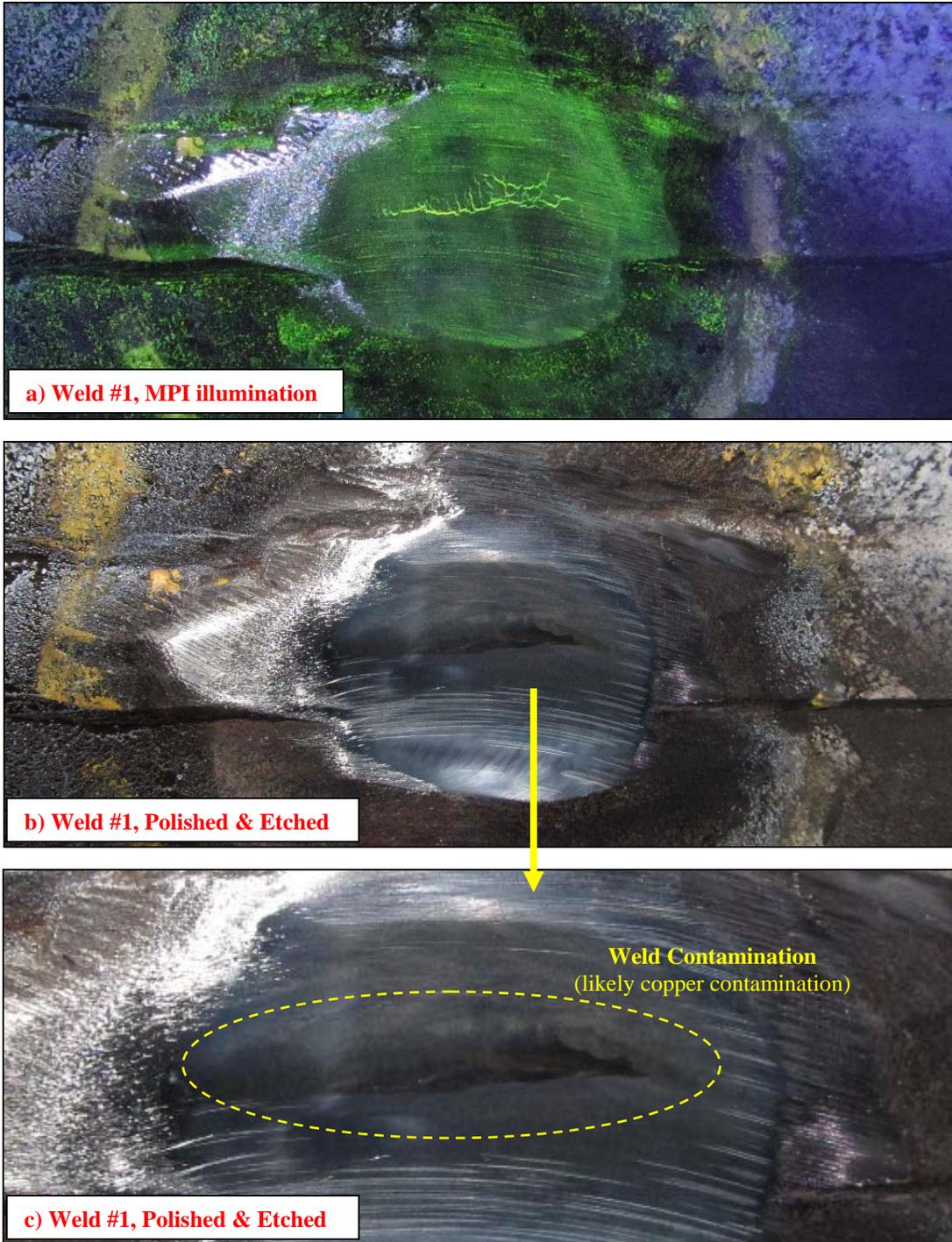


Figure 1: Photographs displaying the features of Weld #1 highlighted by (a) MPI illumination and (b,c) after in-situ preparation including etching. The cracked region of the weld corresponded to a portion of the weld which exhibited contamination. Examination of the structure found the microstructure to be altered, typical of copper contamination.

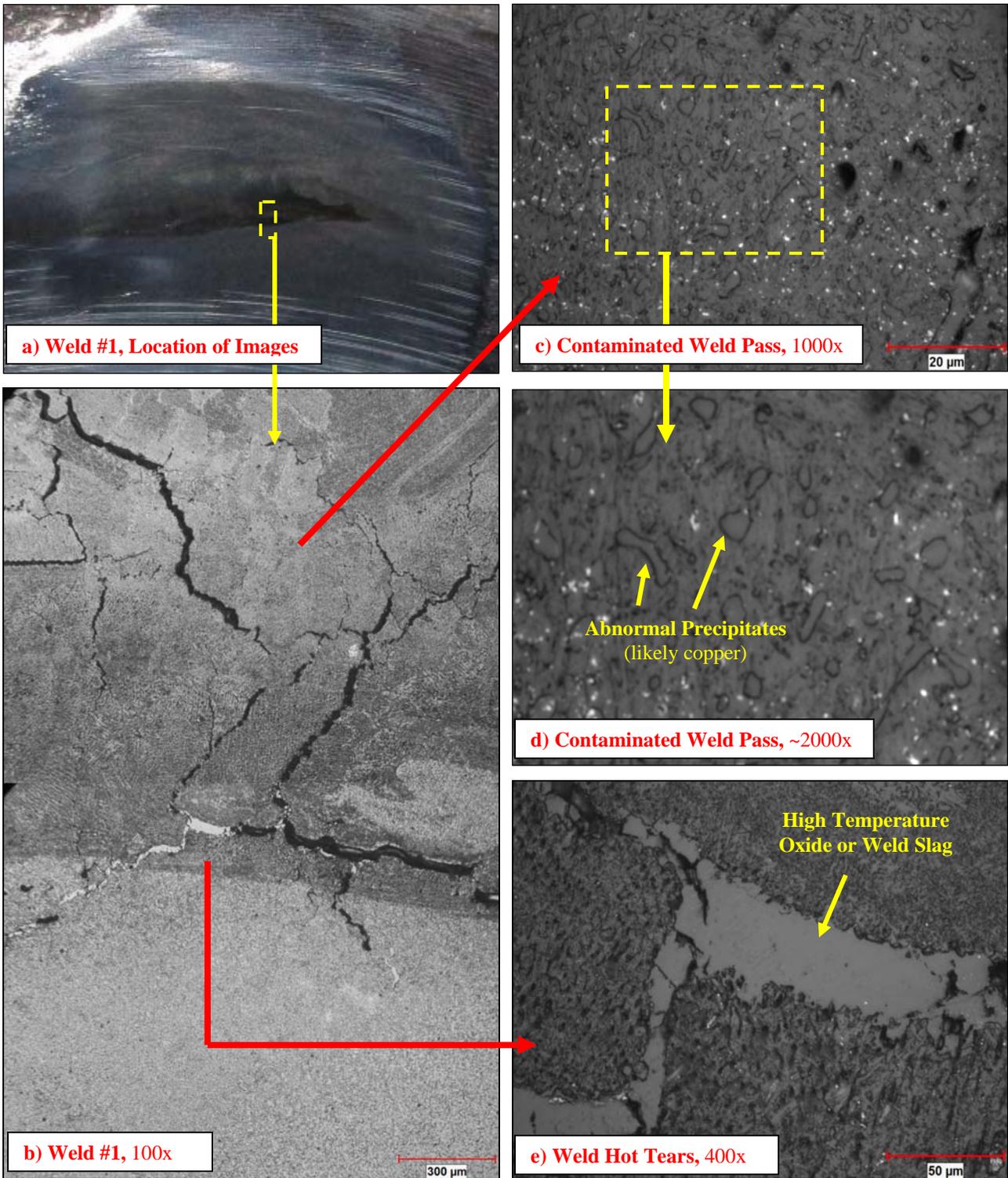


Figure 2: Micrographs taken from replicas of Weld #1. (b) Numerous hot tear cracks were observed throughout the contaminated portion of the weld. These cracks had formed during welding at initial construction. (c,d) The cracked portion of the weld exhibited an abnormal microstructure comprising of a precipitated phase, likely copper. (e) Oxides or weld slag were present within the weld, formed while hot from welding. Images taken from replications, etched on-site using 3% nital.

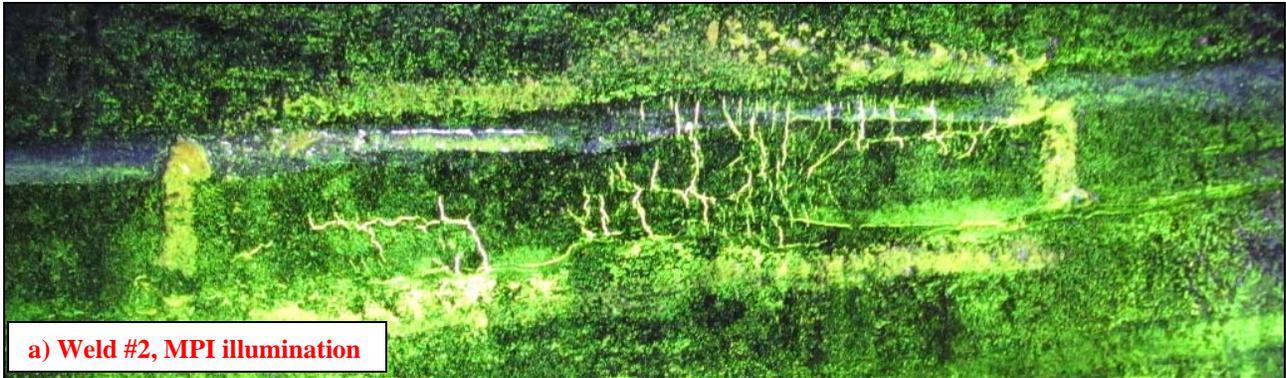


Figure 3: Photographs displaying the features of Weld #2 highlighted by (a) MPI illumination and (b,c) after in-situ preparation, including etching. The weld comprised of numerous cracks throughout. After polishing and etching, copper was visible. Portions of the weld contaminated with copper etched darker than the remainder of the weld. The copper contamination was responsible for the numerous hot tears which formed during initial welding.

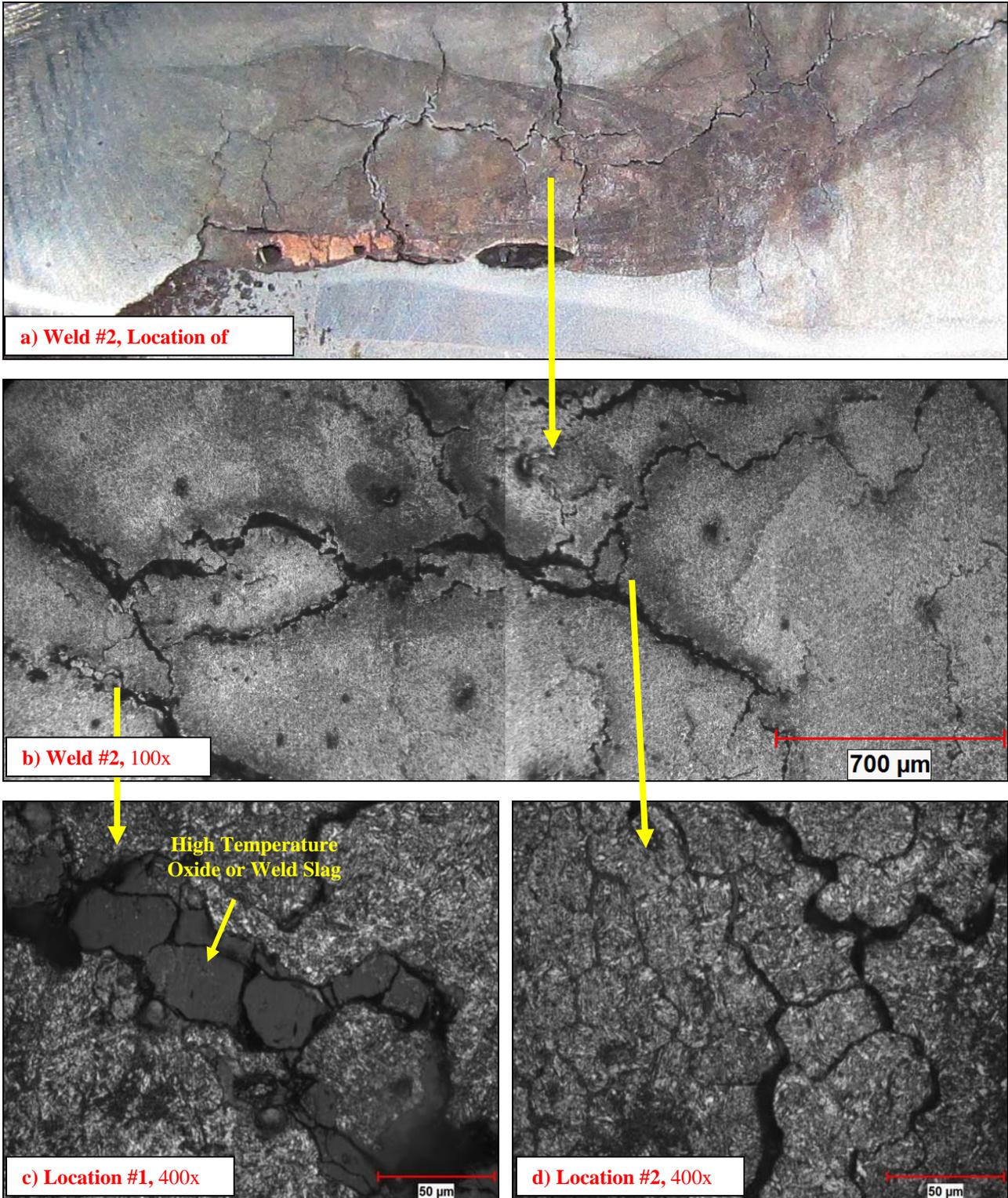


Figure 4: Micrographs displaying examples of the cracks and microstructure at Weld #2. The copper contamination had resulted in numerous hot tears during original welding. Images taken from replications, etched on-site using 3% nital.