

Deterministic evaluation of L132 girth weld fitness for service in soil liquefaction zones

Redacted

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Background

- PG&E is conducting internal video inspection (IVI) of selected pipelines to characterize the seam, view and record stencils and markings, and document the approximate length of each pipe section.
- While conducting the IVI PG&E has observed lack of penetration in girth welds, requiring a process to evaluate fitness.

Scope

- Mission: Evaluate whether girth welds in L132 are able to withstand seismic event in soil liquefaction zones
- Inputs:
 - Applied strains from geotechnical study by Kleinfelder, Honneger
 - Weld ductility and mechanical properties tests by EWI
 - Characteristic weld quality based on sampled inspection data
- Determine critical flaw sizes using accepted standards

Weld Sampling

- 7 weld samples gives high confidence that material properties tests are representative
- With observed variation, confidence level is near 99%
- Sampling met requirements of applicable fitness for service standards

Material test results

| | CTOD (in.) | YS (ksi) | UTS (ksi) |
|---------|------------|----------|-----------|
| Minimum | 0.0026 | 48.9 | 70.1 |
| Average | 0.00767 | 50.4 | 75.6 |
| Maximum | 0.0166 | 52.3 | 80.1 |

Material test results interpretation

- CTOD results show ductile fracture behavior can be expected so welds have good flaw tolerance
- Brittle fracture is unlikely so welds are superior to acetylene welds
- Weld metal strength is similar to or better than the line pipe

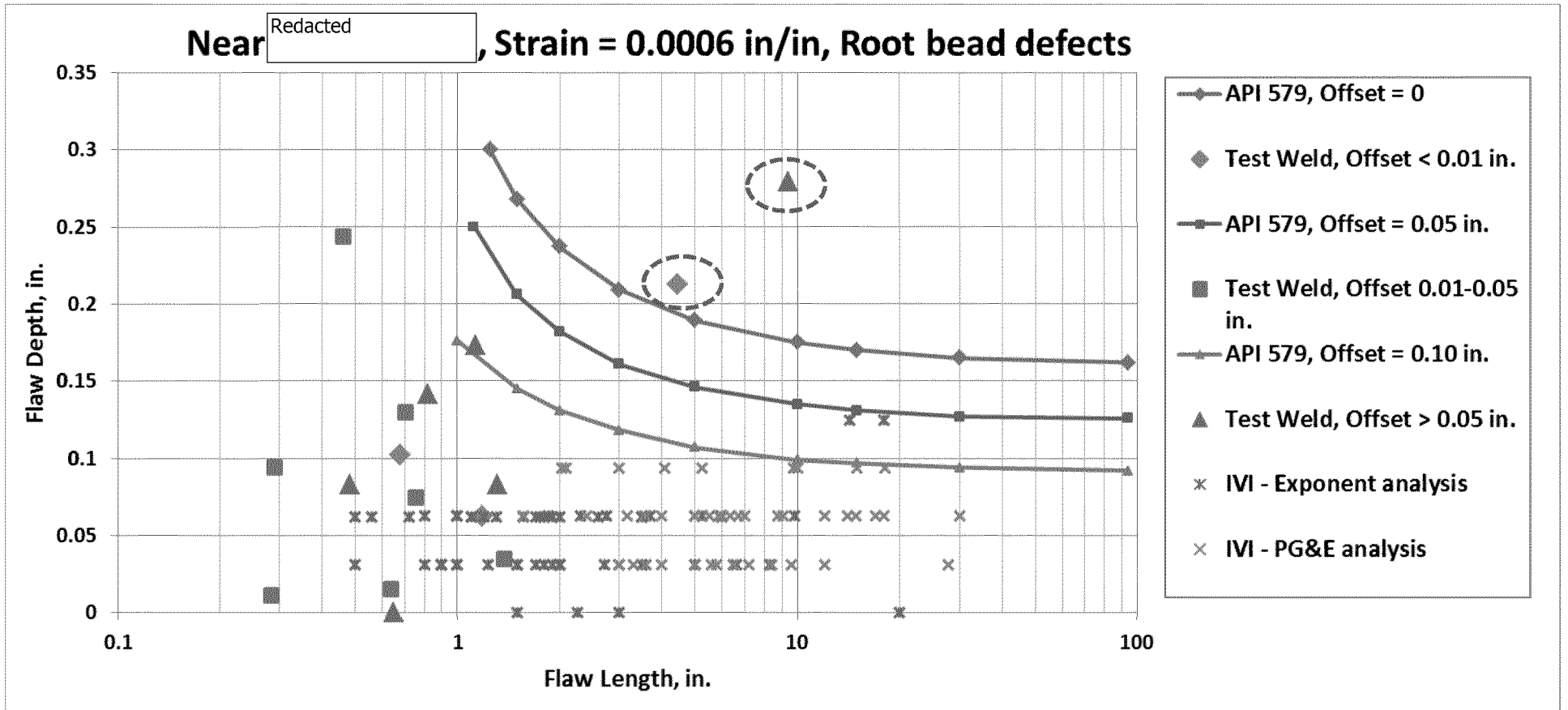
Applied stresses

- Operating stresses:
 - 2,400 psi at 200 psig internal pressure
 - 8,775 psi for 45 F thermal expansion
- Two seismic event cases considered:
 - At Redacted strain = 0.0006 in/in
 - Remote from creek, strain = 0.0004 in/in
- Total applied stress in the event of soil liquefaction:
 - Redacted stress = 29,175 psi = 56.1% SMYS
 - Other areas, stress = 23,175 psi = 44.6% SMYS

Critical flaw size criteria

- API 1104, Appendix A alternative welding workmanship standard
- API 579, Level 2 fitness for service standard
- API 579 is more rigorous and conservative and therefore was used in final assessment
- Confirmatory analyses performed using circumferential defect models in engineering literature

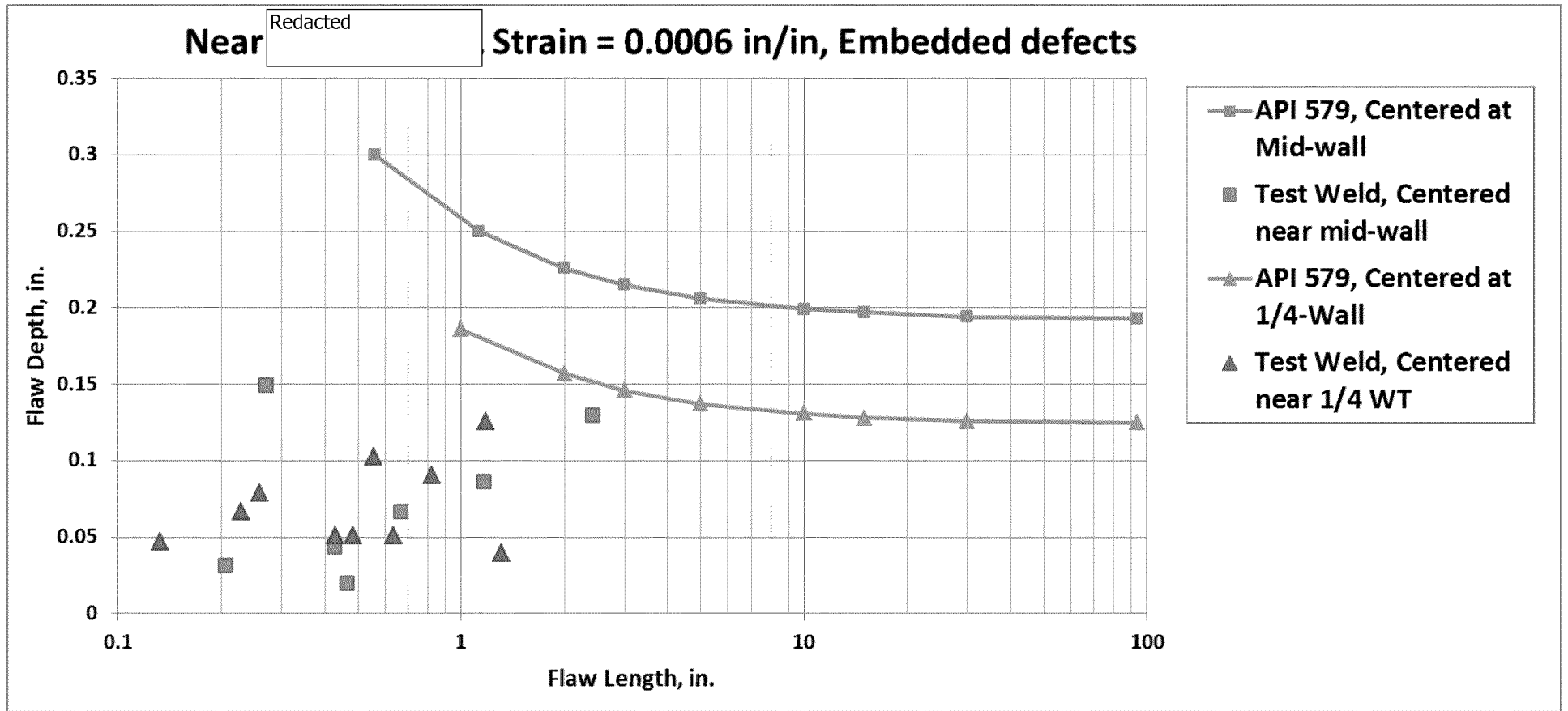
Adjacent to Redacted Root bead IP and burn-through



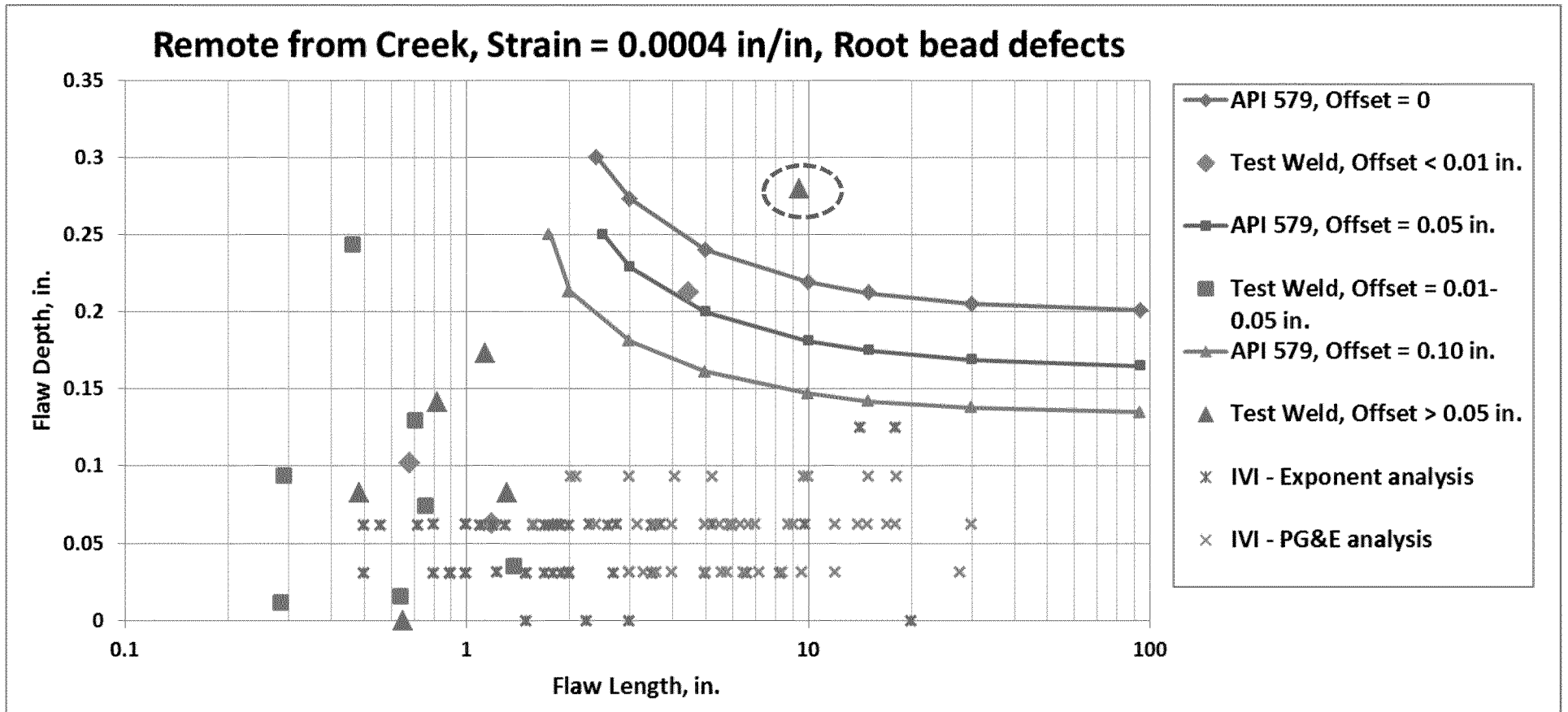
Adjacent to

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Embedded flaws



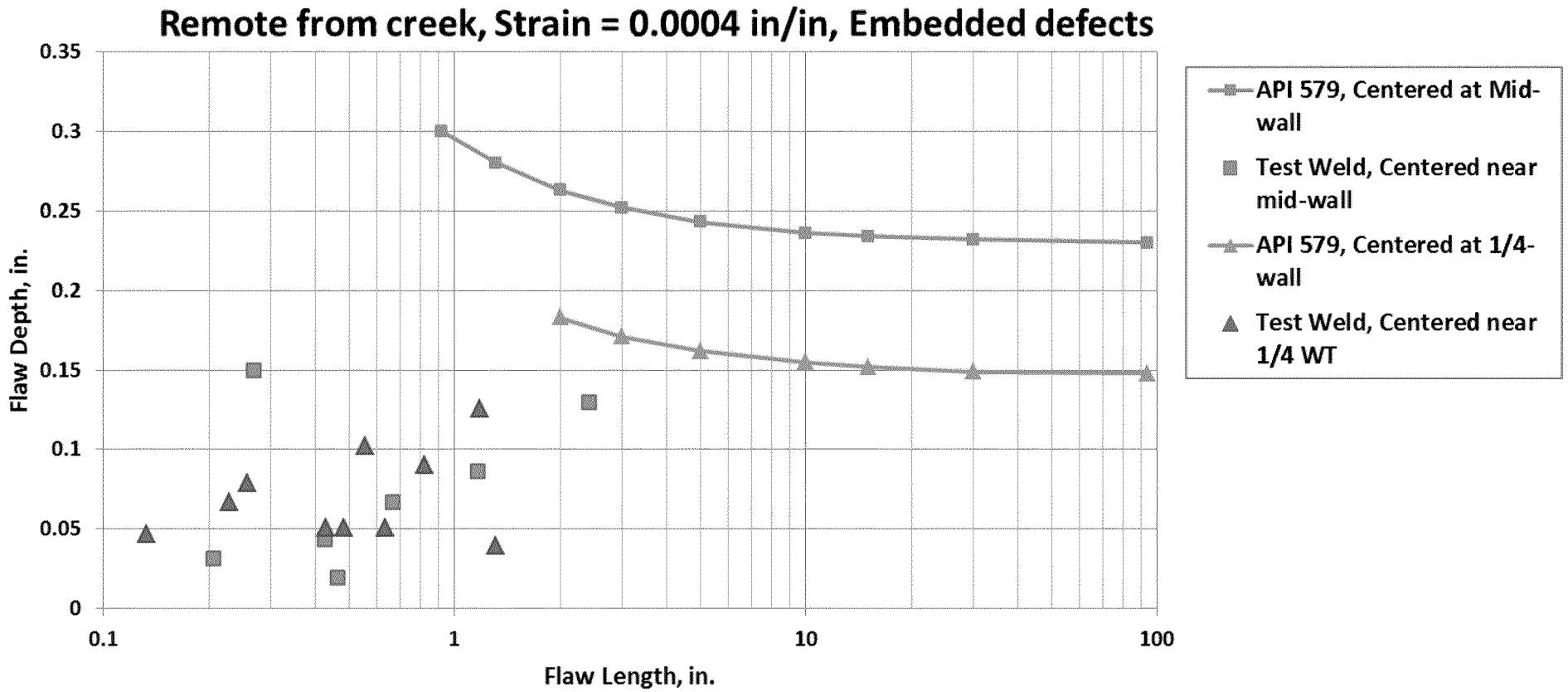
Remote from Redacted Root bead IP and burn-through



Remote from

Redacted

Embedded flaws



Results

- Analysis showed that critical defect sizes are governed by weld metal strength, not toughness properties.
- Results considered lowest weld strength.
- Embedded flaws are not governing, so IVI can be used to detect potentially critical flaws.

Results

- Two outliers discovered in L132 might not perform as required during an event.
- Outliers were removed and confirmation that no similar conditions remain in welds near creek can be obtained by IVI.
- Welds with flaws similar to the rest of those discovered would be expected to perform as required during an event.
- No weld concern exists if no seismic event occurs.