# TOFD Inspection of ERW in thin walled piping

A specialised inspection technique presented by Tim Poudrier





#### What we cover

- 1. Identify the concerns regarding Lack of Fusion (LoF) and cracks in ERW longseams.
- 2. Define the requirements of inspecting ERW longseams in thin walled pipe.
- 3. Define the limitations of various inspection methods.
- 4. Show how a specialized TOFD inspection answers the requirements to properly inspect ERW longseams in thin walled pipe.
- 5. Answer questions.

 OD surface-breaking LoF or cracklike anomalies in Electronic Resistance Welds(ERW) cause great concern for catastrophic failure. Direction of hoop stress



Direction of stress from internal pressure

 Buried (midwall) anomalies are less likely to cause failure. Direction of hoop stress



 Many LoF anomalies in the ERW develop into hook cracks after cyclic loading. Direction of hoop stress



Direction of stress from internal pressure

 Buried anomalies of sufficient thru-wall height can pose a dangerous risk of failure. Direction of hoop stress



 ID connected anomalies located beneath OD connected anomalies pose a serious danger of failure during OD crack removal. Direction of hoop stress



Direction of stress from internal pressure

Complete removal of crack-like anomalies by grinding may still require a compression sleeve if the material removed is too deep and/or too long.



If calculated BP<MAOP x SF, still requires compression sleeve

#### Recap the concerns

- 1. OD connected LoF or cracklike defects pose the highest risk of failure.
- 2. Midwall anomalies are less likely to cause failure, unless they are of a dangerous height
- 3. Repairing the pipe by grinding out the LoF or crack may pose a danger to connecting with a buried defect.
- 4. After repair by grinding, it's possible a steel compression sleeve will still need to be installed, due to low BP.
- 5. Cyclic loading can cause relatively small buried defects to develop into potentially hazardous hook cracks.

#### What we need

- 1. A method with a high probability of detection (POD) of anomalies which pose a threat and interact with the OD.
- 2. A *VERY HIGH POD* of anomalies that have a threatening through-wall height, even if they don't break the OD surface.
- 3. To know that removing a surface anomaly will not endanger the people or environment due to an ID connected flaw.
- 4. To make this inspection in a timely manner, in order to *reduce the total overall cost of defect mitigation*.

#### What we need

# The proposed specialized TOFD inspection technique will do what we need.

### **TOFD** has advantages

- Intuitive
- NOT angle dependent
- NOT amplitude dependent
- Relatively small file sizes from scanning
- BEST at avoiding false positives
- In ERW can clearly show misalignment

#### **TOFD** has advantages



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#### **TOFD** has advantages



#### **TOFD** has limits

- Cannot tell which side of the weld the defect is on. ①
  - In thick material, this matters for a repair location.
- Some indications are difficult to characterize. ②
  - Often cannot be done with TOFD data alone.
- TOFD display magnifies small indications. ③
  - Distracting, may cause unnecessary repairs.
- > Lateral Wave and Backwall Reflector have "dead zones". ④
  - If they're truly dead, there's no way to inspect these areas.

#### These limitations are usually addressed in a regular butt weld by combining TOFD with Phased Array UT (PAUT)

#### **TOFD** has limits



#### Lateral Wave dead zone = 4.5mm Backwall dead zone = 0.7mm TOFD inspection covers 79% of volume outside dead zones

# Butt welds use TOFD + PAUT



## Butt welds use TOFD + PAUT

- D By using both techniques, it's easy to measure a reflector's location in relation to the centerline of the weld
- ② The "A" Scan data of a PAUT scan aids in characterization of a reflector
- ③ Data from the angles of a Sectorial scan or the beams of a Linear scan help in sizing reflectors
- A Scan Plan will make sure any dead zones in TOFD are completely covered by the PAUT setup(s).

#### Butt welds use TOFD + PAUT

ERW longseams present a different set of variables, and are not subject to the same limitations.

#### ERW welds are different

- ① ERW has no width. The two faces are pressed together, current is applied, heat is generated, and they melt.
- ② The indications that will be found in an ERW are limited to LoF, cracking, and inclusions. There may be a lamination or "stringer" so close to the ERW that TOFD will detect it.
- ③ Qualified TOFD technicians have been taught to recognize indications that are superficial, and those that are relevant.
- ④ Because the ERW has a specific shape, we are able to change our setup and inspect the weld with TOFD.



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#### ID Connected

**OD** Connected



OD with indications below



Laminations/stringers, hook cracks, and LoF



Alignment and misalignment

#### Results

- Because we normally inspect 100% of bare pipe with MT and/or ET Arrays, we will detect surface anomalies.
  - Shallow anomalies <10 15% WT easily removed by grinding.
- TOFD setup will detect and measure the length, depth, and VH of surface-breaking (ID/OD) AND midwall anomalies.
  - Prevent leaks during grinding by being able to see other indications.
  - Detects defects with a threatening height that don't break the "skin".
- Encoded and recorded data allows for auditing, training, review, etc.

#### Results

- Small file size allows for sharing and remote interpretation of scan data.
  - Files are small enough to send via email.
  - No delay for decisions to be made.
- Easy to avoid misinterpretation of Hi-Low as a LoF defect.
- Full length of ERW can be scanned and analyzed in a short time.
- Shows if a compression sleeve would be required after defect removal, saving time – and money – for the owner.
- Confirmation of hook crack shape/depth is easily done with 0° UT, as necessary.

# **TOFD for ERW – Yes or No?**

- When combined with MT, or ET arrays, the probability of detection of surface anomalies is very high.
- Subsurface anomalies which could pose an immediate risk of failure are detected and measured.
- False positives from misalignment are avoided.
- Files are shareable, auditable, and can be used for review and training.
- TOFD limitations are managed by the specialized setup.
- Training is straightforward, and regular technicians get excellent repeatable results.

#### **TOFD for ERW – Yes or No?**

#### What say you?

#### **Questions?**