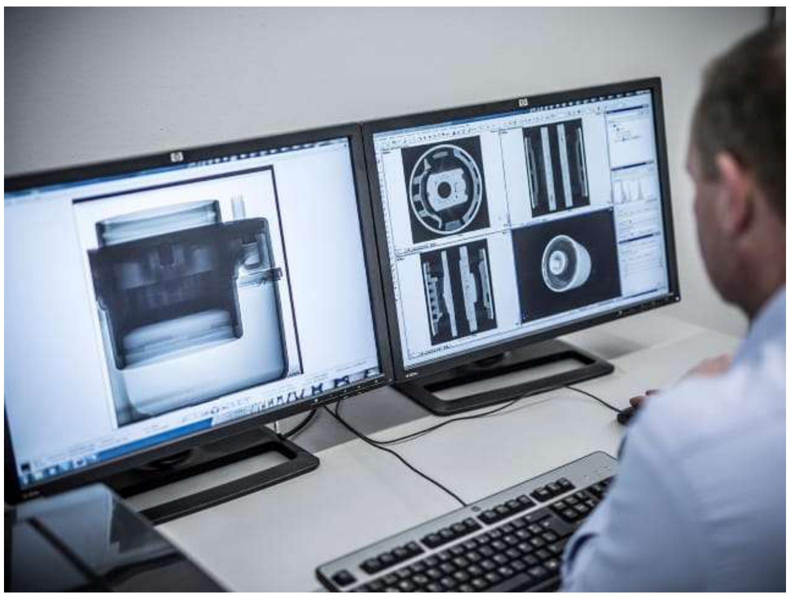
Non-Destructive Testing (NDT) of Steel Pipe Welds with Digital Radiography

From Conventional Film to Digital Evolution (CR & DR)

Perry Sheth P.E

Platform for NDT Oversight

Ooga makes NDT safer, faster, and more cost efficient



Ooga Technologies connects you with vetted NDT experts within minutes. We provide remote non-destructive testing expertise while supporting collaboration, project management, training, and mentorship.

Serving Oil & Gas, Aerospace, and Nuclear Industries

Platform for NDT Oversight

NDT Oversight / Audits

- Provide oversight to ensure your organization is in compliance with NDT standards
- Increase accuracy and develop consistent NDT standards for all contractors to use to improve safety

NDT Platform

- Centralize inspection data, certification records, and project documentation in a secure, cloud-based environment to comply with TVC regulations
- Improve accessibility, eliminate data silos, and ensure real-time availability to authorized stakeholders

NDT Training & Qualifications

- Access a wide variety of NDT training courses and qualify your personnel

Conversion of Film to Digital

- Transition conventional film to digital to archive your records for the life of the asset

Technologies

The Ooga Leadership Team

DR. AJAY PASUPULETI

CEO & Co-Founder

PhD in in Electrical and Microsystems Engineering from the Rochester Institute of Technology in 2006.
15+ years of experience in image processing, data management, and archival technologies

MIKE TURNBOW

Co-Founder & Chief Workforce Officer

Over 30 years of experience in Non- Destructive Testing (NDT) to the company. Former General Manager of the Tennessee Valley Authority's Testing and Services Group

DALE LYNN

Director & Co-Founder

ASNT Level III certified. Experience in NDT has been in Aerospace, Defense, Space, Commercial, Castings, and more. Dedication to integrating NDT 4.0 methodologies.

PERRY SHETH

Senior Utility & Materials Expert

35+ years in distribution and transmission utilities, specializing in materials testing and failure analysis. Licenses PE (NY, MA, RI) AWS CWI. Former AGA Plastic Materials Committee Chair, active member in ASTM F17, API 1104, GPTC, NGA committees.

PETER DAVIS

Business Development Manager

Breadth of experience in X-ray technology business development and sales roles to the Ooga team. He specializes in connecting organizations to the solutions they uniquely need to improve the accuracy and efficiency of NDT.

NIHARA VANKAYALA

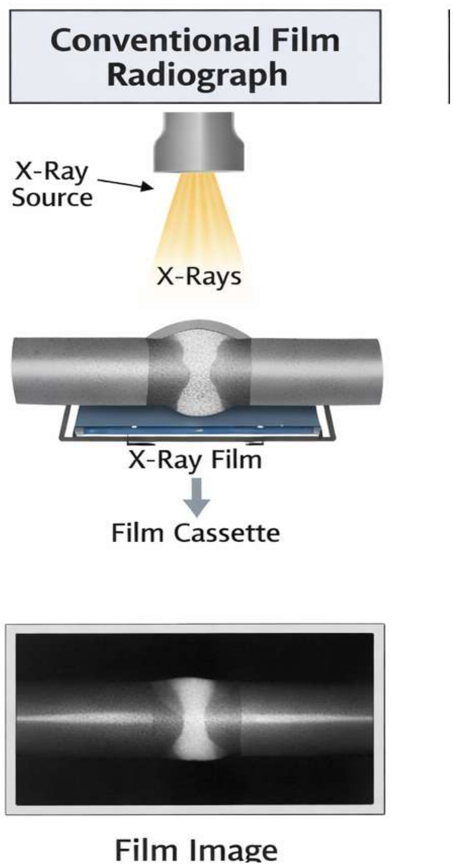
Director of Engineering

5 years of experience building scalable platforms and high-performing teams across the technology sector. Bachelor of Engineering in Electrical & Master of Science in Image/Signal Processing.

Comparison of Common NDT Inspection Methods

Method	Detects	Best Applications	Materials	Advantages	Limitations	Typical Use
VT	Surface defects	General inspection	All	Fast, low cost	Visible only	All projects
PT	Surface cracks	Weld caps	Non-porous metals	High sensitivity	Surface only	Crack detection
MT	Surface & near-surface	Steel welds	Ferromagnetic	Quick results	Steel only	Pipeline welds
UT	Internal flaws	Thickness & welds	Most metals	Deep penetration	Skill dependent	Corrosion
PAUT	Volumetric weld flaws	Critical welds	Metals	Accurate sizing	Higher cost	Transmission lines
RT (Film)	Volumetric defects	Code welds	Metals	Permanent record	Radiation	Regulated work
CR	Volumetric defects	Pipeline welds	Metals	Digital image	Plate handling	Transition tech
DR	Volumetric defects	Production welds	Metals & plastics	Fast, real-time	Image control	High productivity
ECT-Eddy Current	Surface flaws	Tubes	Conductive	No couplant	Shallow depth	Heat exchangers
LT	Leaks	Pressure systems	All	Direct confirmation	No flaw sizing	Final testing

Conventional Film Radiography (The Baseline)



The Medium: Industrial X-ray film

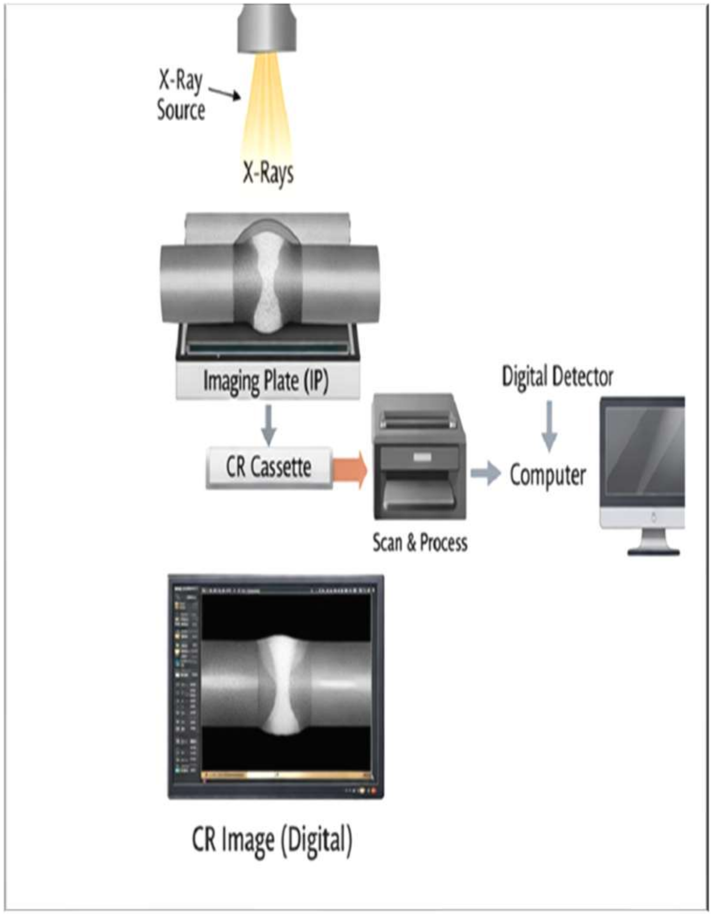
(Siver Halide emulsion on a polyester base)

The Process:

Setup:	Exposure:	Latent Image:
Film in a light-tight cassette is placed behind the weld	Radiation passes through the weld; denser areas (steel) absorb more, defects (voids) absorb less	A hidden chemical change occurs in silver halide crystals

Processing: Requires a darkroom and chemical "wet" processing (Developer, Stop Bath, Fixer, Wash, Dry)

Computed Radiography (CR)

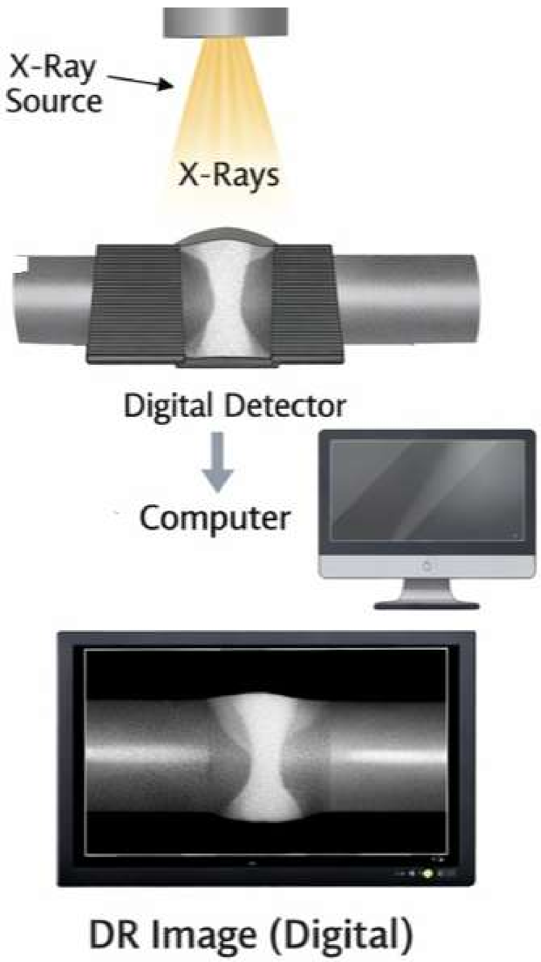


The Medium: Reusable Imaging Plates (IP) coated with Photostimulable Phosphors

How it Works:

- **Capture: The IP stores radiation energy in a "quasi-stable" electronic state**
- **Reading: The plate is fed into a laser scanner. The laser stimulates the phosphor to release blue light**
- **Digitization: A photomultiplier Tube (PMT) converts light into a digital signal**
- **Key Advantages – Plates are flexible (like film) and can be wrapped around small-diameter pipes**

Digital Radiography (DR)



The Medium: Flat Panel Detectors (FPD) or Digital Detector Arrays (DDA)

How it Works:

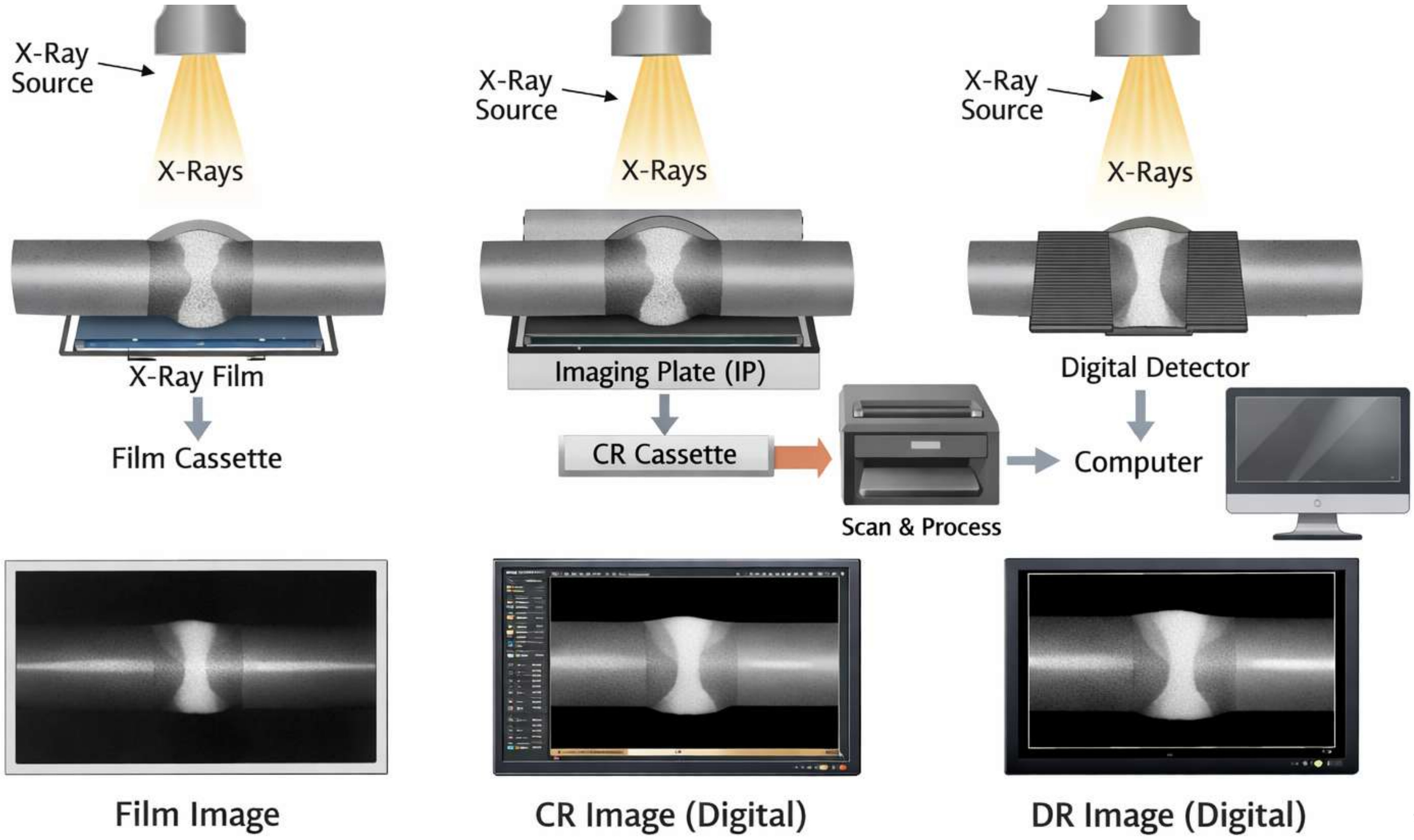
- **Direct Conversion:** X-rays are converted directly into electrical charges using Amorphous Selenium
- **Indirect Conversions:** A scintillator (Cesium Iodide) converts X-rays to light, then to electricity

Real-Time Result: The image appears on the monitor (within seconds of exposure)

Remote reading by ASNT Level III – Audit Function

Flexible Digital Detector can easily wrap around the weld joint

Schematic of Film, CR & DR



Technique Comparison – Steel Pipe Welds

Feature	Conventional Film	Computed Radiography (CR)	Digital Radiography (DR)
Processing Time	10–20 mins (Wet)	1–5 mins (Scan)	< 10 seconds (Instant)
Consumables	High (Film/Chemicals)	Low (Plates are reusable)	Minimal
Flexibility	Excellent (Wrappable)	Excellent (Wrappable)	Excellent (with Flexible Digital Detector)
Dynamic Range	Narrow (Limited Latitude)	Very High	Highest
Resolution	Very High (Spatial)	High	Variable (Pixel-limited)

Digitizing:
Save Time, Cut Costs, and Strengthen Compliance

The Problem with Analog Film

- Film degrades, gets lost, or damaged over time
- Limited shelf life
- Physical storage is expensive and space-consuming
- Difficult to search, retrieve, and share records
- Manual handling increases labor and error risk
- Limited image enhancement capabilities for accurate interpretation
- Potential for quality issues due to development errors

Why Go Digital Now?

Instant access to any image — anywhere

Secure cloud or local storage with backup

Fully compliant with ASME, ISO, and client audit demands

No risk of damage, loss, or misfiling

Remote NDT independent Oversight Audit

Savings in storage & labor cost

Quick turnaround time

Advantages of Digital Evolution (CR & DR)

Dose Reduction: Digital detectors are more sensitive, often requiring **30-50% less radiation** than film.

Image Enhancement: Tools like zoom, contrast adjustment, and noise filters allow for better defect identification.

Digital Archiving: No physical storage rooms needed; images are DICONDE (Digital Imaging and Commuinication in Nondestructive Evaluation) ASTM E2339 compliant for easy sharing and tamper proof. Leveraging digital twins and artificial intelligence for automated defect recognition

Environmental Impact: Elimination of hazardous chemicals (Developer/Fixer).

DR for Remote NDT Oversight

The "Hidden" Value of Digital

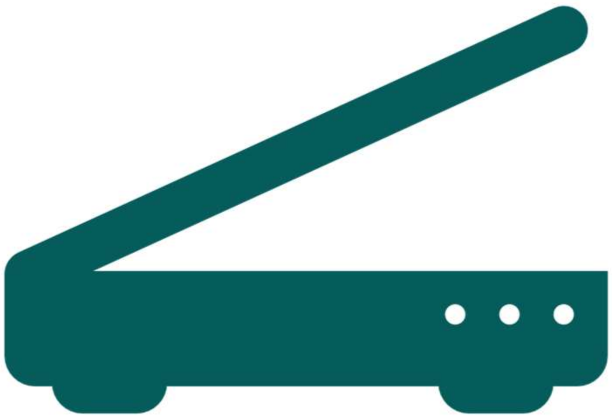
Production Speed: In a pipe shop, switching to DR can increase the number of welds inspected per shift by **up to 50%**.

Safety Gains: Shorter exposure times mean the "controlled area" is active for less time, allowing other trades (welding, coating) to resume work faster.

Client Confidence: Providing a client with a digital link to their weld images is more professional and accessible than a box of physical films.

Remote Reading & Auditing – ASNT III can remotely validate acceptance/rejection real time before backfilling

DICONDE (Digital Imaging Communication in Nondestructive Evaluation) – ASTM E2339



DICONDE (Digital Imaging and Communication in Nondestructive Evaluation) is the NDT version of the medical "DICOM" format. It ensures that the digital files contain "meta-data" like the pipe heat number, welder ID, and date, which cannot be tampered with, ensuring data integrity.

Challenges in Pipe Inspection

Geometry: Small-bore pipes require flexible detectors

Site Conditions: DR panels are expensive compared to robust film cassettes.

Standardization: Transitioning from "Density" (Film) to "Signal-to-Noise Ratio (SNR)" for digital code compliance (ASME Sec V, ISO 17636-2).

Conclusion

Film remains the "Gold Standard" for high-resolution requirements but is fading due to cost, storage issues and speed.

CR is the current industry workhorse for field pipe-work due to its flexibility. However, due to quality of scanning and additional regulatory demand for the remote NDT oversight by an independent ASNT Leve III, industry is seeing transitioning from CR to DR

DR is the future for compliance with TVC (Traceable, Verifiable & Complete) and allow remote NDT oversight

The Business Case – ROI of Digital Transition

Cost Factor	Conventional Film	Digital (CR/DR)
Consumables	High (Film, Developer, Fixer)	Near Zero (Reusable plates/panels)
Labor (Time)	High (Darkroom time, drying)	Low (Instant or rapid scan)
Waste Disposal	Expensive (Chemical/Silver hazard)	None
Storage	Physical archives/Climate control	Server/Cloud (Scalable)
Retakes	Costly (Must re-setup & re-expose)	Cheap (Instant feedback allows adjustment)

Radiation Safety & Calibration

Safety: "Radiation Area" and "Exclusion Zones"—remain largely the same regardless of the detector type.

Calibration: CR/DR systems require "Bad Pixel Mapping" and regular calibration to ensure the digital sensors haven't degraded over time.

Codes & Standards for Digital Radiography

1. ASME Section V, Article 2

ASME recognizes digital methods under specific "Mandatory Appendices.

- **Appendix VIII (CR):** Focuses on the use of photostimulable storage phosphor imaging.
- **Appendix IX (DR):** Focuses on the use of Digital Detector Arrays (DDA)
- **Key Requirement:** The Image Quality Indicator (IQI) or "penetrameter" must be visible. For digital, you must also use Duplex Wire IQIs to measure the Spatial Resolution (SRb).

Codes & Standards for Digital Radiography

ISO 17636-2 (International Standard)

This is the primary international standard for the digital radiography of welds.

Class A: Basic inspection techniques.

Class B: Improved inspection techniques (higher sensitivity, used for critical pipe welds).

Signal-to-Noise Ratio (SNR): Unlike film, where you measure "Optical Density," ISO 17636-2 requires a minimum **Normalized SNR** to ensure the image isn't too "grainy" or noisy to find small cracks.

Standards Alignment (ASNT / API)

Standard	Relevance
ASNT SNT-TC-1A	Qualification of RT Level I/II/III personnel
ASNT CP-189	Personnel certification requirements
ASTM E2445	Digital detector system qualification
API 1104	Radiographic standards for pipeline welds
ASTM E2597	Characterization of digital detectors
ISO 17636-2	Digital RT requirements for weld inspection

Summary of Technical Standards (ASME & ISO)

01

Spatial Resolution (SRb): In digital, "sharpness" is measured using a Duplex Wire IQI. The code specifies the maximum unsharpness allowed based on the material thickness.

02

Normalized SNR (SNRn): This is the digital equivalent of film contrast. ISO 17636-2 requires specific SNRn values (e.g., SNRn >= 130 for Class B) to ensure image clarity.

03

Grey Values: While film uses "Density" (typically 2.0 to 4.0), digital images must stay within the "Linear Range" of the detector to avoid saturation or "burn-out" of the image.

Need for Oversight

Fraud Detection: $21M Cost Avoidance

Ooga identified intentional weld fraud within the first 4 miles of a federally regulated pipeline project.

Impact:

$4M immediate savings in fines, $21M projected full-scope avoidance at $1M per mile repair cost.

"Had this not been caught, we were facing $1 million per mile in repair costs across 21 miles."

Invested $150k in Ooga

Quality Control: 4% Miss Rate

Ooga's second-level audits consistently find 4% of weld indications missed by primary inspection teams.

Impact:

Unburied: 100 hours saved per 1,000 welds = $120K+ avoidance.

Buried: 320-640 hours saved = $200K-$350K+ avoidance.

Legacy Risk Assessment: Film Digitization

Ooga digitizes archived radiograph records for compliance and safety analysis.

Value: Proactive failure prevention, regulatory support, targeted maintenance via secure LMS platform

The Ooga Platform Gives NDT Leaders Access to:

Qualified NDT expert & AI Tools Marketplace

Remote Digital Inspection System

Collaboration and Training Solution

Ooga's Services for Gas Industry

Services:

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- Provide oversight to ensure your organization is in compliance with NDT standards
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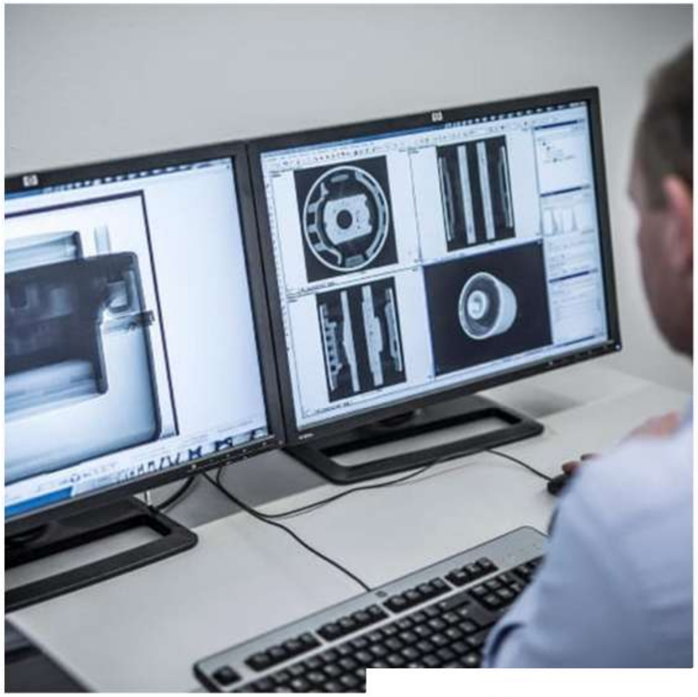

Ooga Technologies

Why Ooga?

Remote Expertise Without Fixed Costs

Ooga delivers Level III inspection oversight, fraud detection, and regulatory compliance support through a scalable, pay-as-you-go model. No standby pay, travel costs, or fixed salaries—just expert analysis when projects need it.

Proven Detection Capabilities

Remote second-level inspection of radiographic data (film & digital), real-time fraud identification, 4% miss rate recovery, and LMS-integrated training and audit tracking.

Built-In Training & Knowledge Transfer

Asset owners and vendor teams receive included awareness training to improve inspection reliability, code compliance, and safety accountability—preventing future issues at no additional cost.

Cost-Negative Investment

Client feedback: "Ooga's service cost is negligible compared to savings and risk avoided." Each identified weld defect prevents downtime, regulatory violations, and potential disasters.

Ooga transforms inspection overhead into profit protection—catching what others miss while building internal capabilities for long-term risk reduction.

Ooga Technologies

Technologies