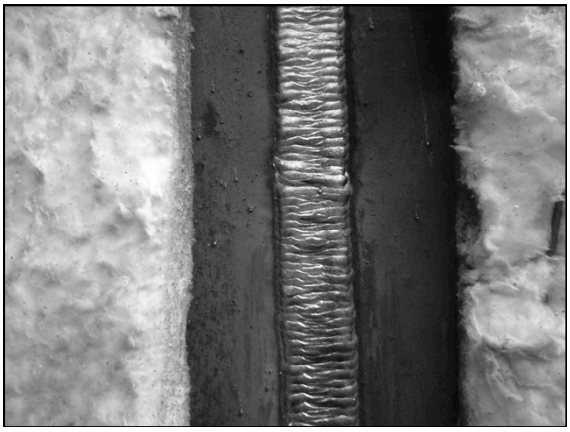
Process Safety Management of Highly Hazardous & Explosive Chemicals

NC OSHA PSM Training
Welding & NDT Basics

What is Welding?



Subpart Q

- ✓ 1910.251 – Definitions
- ✓ 1910.252 - General Requirements
- ✓ 1910.253 - Oxygen-fuel gas welding & cutting
- ✓ 1910.254 - Arc welding and cutting
- ✓ 1910.255 - Resistance welding

Subpart J

- ✓ 1926.350 – Gas Welding & Cutting
- ✓ 1926.351 – Arc Welding & Cutting
- ✓ 1926.352 – Fire Prevention
- ✓ 1926.353 – Ventilation & Protection in Welding, Cutting & Heating
- ✓ 1926.354 – Welding, Cutting & Heating in Preserved Coatings

Incorporate by reference

- ✓ ANSI Standards
- ✓ Compressed Gas Association Standards

Other Related OSHA Standards

- ✓ 1910.102 - Acetylene
- ✓ 1910.104 - Oxygen
- ✓ 1926.350 - Gas welding and cutting
- ✓ 1926.351 - Arc welding and cutting
- ✓ 1926.352 - Fire prevention
- ✓ 1926.353 - Ventilation and protection in welding, cutting, and heating
- ✓ 1926.354 - Welding, cutting, and heating in way of preservative coatings

Welding Terminology

Arc welding

- Carbon Arc Welding **CAW**
- **Gas Metal Arc Welding** **GMAW**
- Gas Tungsten Arc Welding **GTAW**
- **Plasma Arc Welding** **PAW**
- Shielded Metal Arc Welding **SMAW**
- **Stud Arc Welding** **SW**
- Submerged Arc Welding **SAW**

Welding Terminology

Oxyfuel Gas Welding

- Oxyacetylene Welding **OAW**
- Oxyhydrogen Welding **OHW**
- Pressure Gas Welding **PGW**

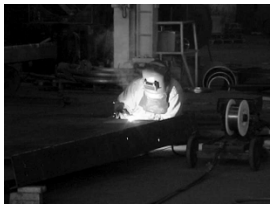
Welding Terminology

Brazing

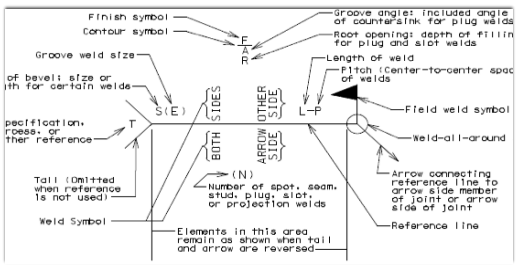
- Diffusion Brazing **DFB**
- Dip Brazing **DB**
- Furnace Brazing **FB**
- Induction Brazing **IB**
- Infrared Brazing **IRB**
- Resistance Brazing **RB**
- Torch Brazing **TB**

Welding Terminology Slang

- Stick
- MIG
- TIG
- Sub Arc
- Gouging
- Plasma Cutting
- Torch Cutting



Welding Call Outs



Welding – Types & Typical Symbols

- **FILLET** Type of weld, approximately triangular cross section joining two surfaces at approximately exact angles to each other.

- **SEAM** A type of welding, continuous weld made between or upon overlapping metal parts.

Welding – Types & Typical Symbols

- **BEVEL** A type of groove weld in which one member has a joint edge beveled from one side

- **V-Groove** A groove weld in which the joint edge of each member is beveled from the similar side.

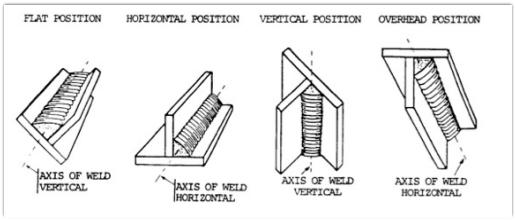
AISC Welding – Best Practices

- Certified Welders (Weld Certs)
- Welding Procedures (WPS)
- Setting up the Welding Machine Properly
- Use of Amp Meter
- Weld Electrode (Rod) Storage in Rod Oven
- Weld Gauges (to visually Inspect the Weld)
- Weld Inspetions by Qualified Persons

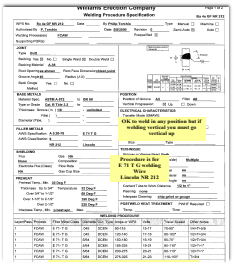
Weld Certification Basics

- **The goal of getting certified, then, is to perform the most difficult welder qualification tests you can handle. For example, if you can weld an acceptable groove joint in the vertical and overhead positions, you'll receive 3G and 4G certs for the welding process (and thickness), and not have to take any test below those levels. In addition, if you're certified in welding groove joints, you're automatically certified to weld fillets (but not vice versa).**
- **On the other hand, if your test involves a less ambitious weld, such as a fillet weld in the vertical position, you would be certified for 3F welding and lower, but not 4F, 1G, 2G, 3G, or 4G.**
- **Of course, veteran pipe welders can do much better than a 4G certification. The highest level for them is usually 6G, which means they can weld 360 degrees around a pipe that doesn't move. Producing this weld to the satisfaction of a certified welding inspector is tough sledding for a beginner. =**

Welding Certification Basics



AISC Weld Procedures



Welding Codes
Short List

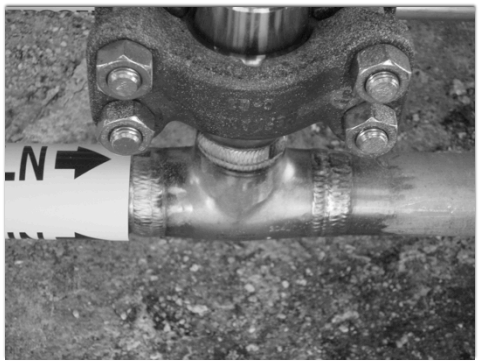
- AWS A02.4 Standard symbols for welding, brazing, and non-destructive examination
- AWS A03.0 Standard welding terms and definitions
- AWS A05.1 Specification for carbon steel electrodes for shielded metal arc welding
- AWS A05.18 Specification for carbon steel electrodes and rots for gas shielded arc welding
- AWS B01.10 Guide for the nondestructive examination of welds
- AWS B02.1 Specification for Welding Procedure and Performance Qualification
- AWS D10.18 Pipe welding (stainless steel)

Welding Codes
Related Codes

ASME BPVC Section II	Part C: Specifications for Welding Rods, Electrodes, and Filler Metals.[1]
ASME BPVC Section V	Nondestructive Examination
ASME BPVC Section IX	Welding and Brazing Qualifications
ASME B16.25	Buttwelding ends
ASME Section VIII Div I	Boiler & Pressure Vessel Code
API 620	Design and Construction of Large, Welded, Low-pressure Storage Tanks
API 650	Welded Tanks for Oil Storage
API 1104	Standard for Welded Pipelines
API 510	Pressure Vessel Inspector Program
API 570	Piping Inspector Program

Design Codes & Mechanical Integrity

- Design Codes Drive Many Times Drive Mechanical Integrity / Inspection & Testing & Quality Assurance

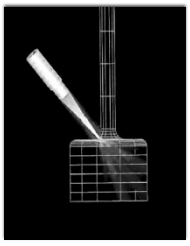


Introduction to Nondestructive Testing

Prepared by the Collaboration for NDT Education.
Partial support for this work was provided by the National Science Foundation's Advanced Technological Education program through grant number DUE-0101709. The opinions expressed are those of the authors and not necessarily those of the National Science Foundation.

Definition of NDT

The use of noninvasive techniques to determine the integrity of a material, component or structure
or
quantitatively measure some characteristic of an object.



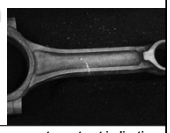
i.e. Inspect or measure without doing harm.

Methods of NDT

Visual
Phased Array
Thermography
Microwave
Tap Testing
Magnetic Particle
X-ray
Acoustic Microscopy
Acoustic Emission
Magnetic Measurements
Liquid Penetrant
Ultrasonic
Replication
Laser Interferometry
Eddy Current
Flux Leakage

What are Some Uses of NDE Methods?

- Flaw Detection and Evaluation
- Leak Detection
- Location Determination
- Dimensional Measurements
- Structure and Microstructure Characterization
- Estimation of Mechanical and Physical Properties
- Stress (Strain) and Dynamic Response



Fluorescent penetrant indication

When are NDE Methods Used?

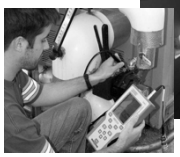
There are NDE application at almost any stage in the production or life cycle of a component.

- To assist in product development
- To screen or sort incoming materials
- To monitor, improve or control manufacturing processes
- To verify proper processing such as heat treating
- To verify proper assembly
- To inspect for in-service damage

Six Most Common NDT Methods

- **Visual**
- **Liquid Penetrant**
- **Magnetic**
- **Ultrasonic**
- **Eddy Current**
- **X-ray**





Visual Inspection

Most basic and common inspection method.

Tools include fiberscopes, borescopes, magnifying glasses and mirrors.

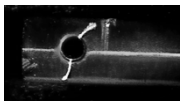
Portable video inspection unit with zoom allows inspection of large tanks and vessels, railroad tank cars, sewer lines.

Robotic crawlers permit observation in hazardous or tight areas, such as air ducts, reactors, pipelines.

Liquid Penetrant Inspection

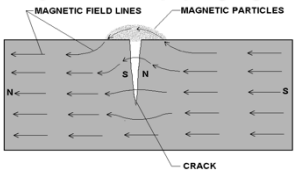
- A liquid with high surface wetting characteristics is applied to the surface of the part and allowed time to seep into surface breaking defects.
- The excess liquid is removed from the surface of the part.
- A developer (powder) is applied to pull the trapped penetrant out the defect and spread it on the surface where it can be seen.
- Visual inspection is the final step in the process. The penetrant used is often loaded with a fluorescent dye and the inspection is done under UV light to increase test sensitivity.






Magnetic Particle Inspection

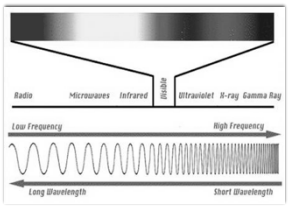
The part is magnetized. Finely milled iron particles coated with a dye pigment are then applied to the specimen. These particles are attracted to magnetic flux leakage fields and will cluster to form an indication directly over the discontinuity. This indication can be visually detected under proper lighting conditions.

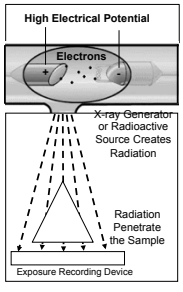


Magnetic Particle Crack Indications

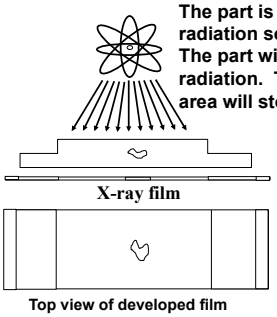
Radiography

The radiation used in radiography testing is a higher energy (shorter wavelength) version of the electromagnetic waves that we see as visible light. The radiation can come from an X-ray generator or a radioactive source.





Film Radiography



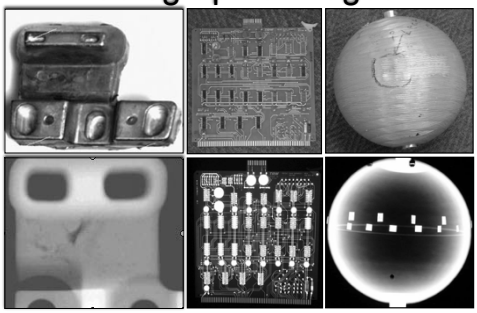
The part is placed between the radiation source and a piece of film. The part will stop some of the radiation. Thicker and more dense area will stop more of the radiation.

The film darkness (density) will vary with the amount of radiation reaching the film through the test object.

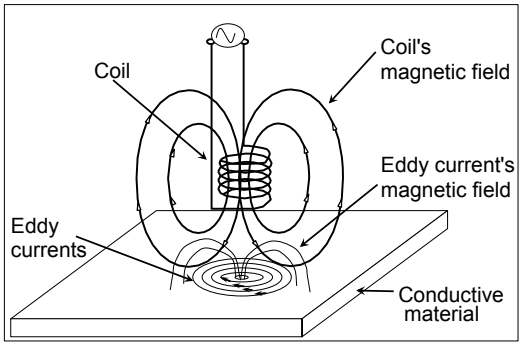
= less exposure

= more exposure

Radiographic Images



Eddy Current Testing



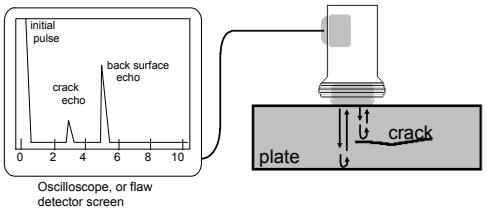
Eddy Current Testing

Eddy current testing is particularly well suited for detecting surface cracks but can also be used to make electrical conductivity and coating thickness measurements. Here a small surface probe is scanned over the part surface in an attempt to detect a crack.

Ultrasonic Inspection (Pulse-Echo)

High frequency sound waves are introduced into a material and they are reflected back from surfaces or flaws.

Reflected sound energy is displayed versus time, and inspector can visualize a cross section of the specimen showing the depth of features that reflect sound.

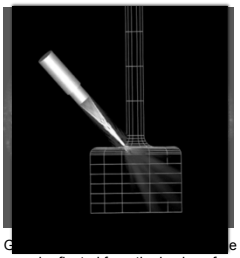


Oscilloscope, or flaw detector screen

Ultrasonic (Phased Array) Imaging

High resolution images can be produced by plotting signal strength or time-of-flight using a computer-controlled scanning system.

Gray scale image produced using the sound reflected from the front surface of the coin



G e sound reflected from the back surface of the coin (inspected from heads side)

Common Application of NDT

- Inspection of Welded Vessels & Pipes
- Inspection Following Maintenance / Construction
- In-Services Damage Inspection
- QA/ QC Activities in Construction / Fabrication / Erection

Inspection of Raw Products

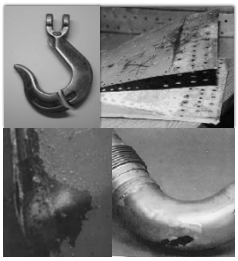
- Forgings,
- Castings,
- Extrusions,
- etc.

Inspection Following Secondary Processing

- Machining
- Welding
- Grinding
- Heat treating
- Plating
- etc.

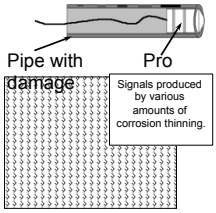
Inspection For In-Service Damage

- Cracking
- Corrosion
- Erosion/Wear
- Heat Damage
- etc.



Power Plant Inspection

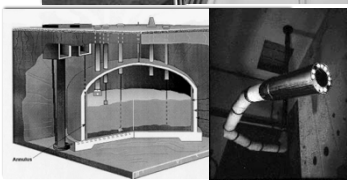
Periodically, power plants are shutdown for inspection. Inspectors feed eddy current probes into heat exchanger tubes to check for corrosion damage.



Storage Tank Inspection

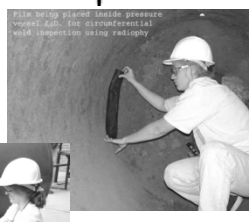
Robotic crawlers use ultrasound to inspect the walls of large above ground tanks for signs of thinning due to corrosion.

Cameras on long articulating arms are used to inspect underground storage tanks for damage.



Pressure Vessel Inspection

The failure of a pressure vessel can result in the rapid release of a large amount of energy. To protect against this dangerous event, the tanks are inspected using radiography and ultrasonic testing.



Pipeline Inspection

NDT is used to inspect pipelines to prevent leaks that could damage the environment. Visual inspection, radiography and electromagnetic testing are some of the NDT methods used.

Magnetic flux leakage inspection. This device, known as a pig, is placed in the pipeline and collects data on the condition of the pipe as it is pushed along by whatever is being transported.

Remote visual inspection using a robotic crawler.

Radiography of weld joints.

For More Information on NDT

The Collaboration for NDT Education

www.ndt-ed.org

The American Society for Nondestructive Testing

www.asnt.org

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