# It all starts with design specifications.

### What is a design specification?

Virtually all major and many minor construction projects are engineered to meet established codes. Design specifications either meet or exceed these codes. There are simply too many organizations that specialize in codes to list them all, but I will give you some examples. Most large buildings are built to AWS (American Welding Society) code:D1.1. Steel bridge structures are built to AWS code D1.5. Gas and oil pipelines and storage tanks are are built to various API (American Petroleum Institute) codes. Power piping (pressurized piping), pressure vessels, nuclear and conventional power plants are built to various ASME (American Society of Mechanical Engineers) codes. Fire protection and sprinkler systems are built to NFPA (National Fire Protection Association) codes. Virtually all structural steel, piping, and alloys are produced to ASTM (American Society for Testing and Materials) specifications. There are other code organizations as well as state, local, and federal codes that govern all aspects of construction. Other codes would include plumbing, electrical, HVAC (Heating, Ventilation, and Air Conditioning) and military codes for a few more examples. These codes and the design specifications determine the method and extent of inspection required for a particular job or project. The first thing that an inspector has to do is establish the proper codes for the particular job at hand. Many complex construction projects fall under multiple codes.

### Inspectors

An inspector shoulders an incredible amount of responsibility. He/she must be knowledgable about welding processes and procedures. The ability to determine the proper code or codes when not known is also needed. Knowledge of blueprints, specifications, and welding and non-destructive test symbols is required. Knowledge of various test methods is also necessary. The ability to keep and maintain test records is also important. One of the most important requirements is a fair and impartial attitude while performing inspection duties. Find Out More About Becoming an Inspector

**What an Inspector looks for...** Other Non-Destructive Test **(NDT)** methods are used to find indications which have to be interpreted according to the inspection procedure for that particular job. Indications are inspection lingo for possible defects. These discontinuities (a fancier name for indications) have to be evaluated with reference to the acceptance criteria for that particular job. After comparison to the criteria are they considered acceptable or rejectable. These other Non-Destructive Inspection **(NDI)** methods require special training, written and practical examinations and accumulation of experience. It is important that a welder also understands the flaw terminology to effectively repair any possible defects.

## Visual Inspection (VT)

The importance of visual inspection is often over looked. A visual test (VT) will provide a wealth of information about a weld. Many weld defects such as porosity, cracks, incomplete fusion, inclusions, overlap, edge melt, and incomplete penetration can be observed with just a simple visual exam. A weld that passes a visual exam has a much higher probability of passing further Non-Destructive Evaluation (NDE) methods. Causes of welding defects by different welding processes.

## X-Rays (RT)

Radiographic weld inspection is performed by pointing a radiographic source (an x-ray tube or a radioactive isotope) to the part of the weld to be inspected and by exposing for a predetermined time a radiographic film to the radiation on the opposite side of the source tip or tube. The resulting film contains information on the internal features of the weld. Variations in film density allow the film interpreter to accept or reject the weld based on comparison to specific hole or wire sizes in or on a penetrameter. These hole or wire sizes represent the largest acceptable defect size in a weld. Any indication that is larger than the acceptable wire or hole size is cause for rejection. All the relevant parameters including accept or reject are then recorded on an X-Ray Technique Sheet. The technique sheet and the processed film are usually turned over to the customer at the completion of the job.

## Radiation Safety

I am including this section specifically to address a practice that I have seen at virtually every job site that I have worked at--people ducking under the radiation lines to take a short cut. Radiation lines are predetermined by the responsible radiographer based upon the strength of the radiation source, the direction of the shots, and available shielding, if any. Radiation is calculated using the inverse square law. Without getting into the actual math formulas involved, I will give you some examples of why these lines should never be crossed without the permission of the radiographer. First you need to know that ionizing radiation can cause measurable changes to the blood of anyone exposed. Example: The outer low radiation boundary is set to 2 mr (milli-rems) per hour and is 100 feet from the source. The radiographer only has one shot to take that will last for a minute. He calculates that the line he is aiming the shot at will read 30mr for that one minute. He is legal because the total exposure will not exceed 2mr per hour. Just as the shot is exposed, Mr. Curious decides to duck under the line to see how the shot was set up. He gets to 50 ft. and his exposure is now 120mr per hour. At 25 ft., it increases to 480mr per hour. At 12.5 ft it increases to 1920mr per hour. At 6 ft., the dose is 7680mr per hour. At 3 ft., the dose increases to 30720 mr per hour and as he stops at a foot and a half away, his exposure is a staggering 122880 mr per hour. One hour of exposure at that rate exceeds the whole body lethal dose of 1200 rems as currently set by the Nuclear Regulatory Commission (NRC). Radiation lines are set up to protect the general public, not the radiographers. They wear several types of dosimeter (radiation measuring devices) and carry a survey meter (Geiger counter) to measure their own exposure. They are also the only ones that know what direction the shot is pointed at. Stay safe-stay out!

## Ultrasonic (UT)

Ultrasonic weld inspection is based on the fact that high frequency sound waves out of the range of human hearing can propagate in different materials, and be reflected by internal interfaces and opposite wall surfaces. These waves are generated by piezoelectric transducers of different sizes and frequencies which transform electrical vibrations into mechanical vibrations and vice-versa. These transducers are selected to match the thickness, type, temperature, and configuration of the material to be tested. Signal reflections are evaluated on a computer screen, and by making reference to standard reflectors (normally flat bottom holes carefully machined on specimens of the same material) of given shape and size, the qualified inspector can conclude that if an echo is present where it should not be and if its reflection is larger than that of comparison, then there is an indication that must be evaluated. Additional techniques may be required to determine acceptance or rejection. Ultrasonic testing is capable of detecting thin interfaces normal to the line of propagation of the wave (that X-Rays cannot detect) so that both testing methods complement each other. Ultrasonic testing is becoming one of the most widely used methods of nondestructive testing. Its primary purpose is to detect and characterize internal discontinuities. UT can also measure thickness, detect surface discontinuities, and define bond characteristics.

## Liquid Penetrant (PT)

Liquid Penetrant weld inspection is a sensitive method of detecting and locating discontinuities that are clear and open to the surface. A penetrating liquid dye is applied to the cleaned surface. This dye will seep into surface discontinuities. After a certain amount of time(dwell time), the excess penetrant dye is removed. A developer is then applied that acts like a blotter and draws the remaining penetrant out of the discontinuity. Liquid Penetrant inspection is used for both magnetic and non magnetic materials like aluminum, stainless steel, magnesium, titanium, bronze etc. and will detect extremely small cracks. There are three different types of penetrant used with both visible and fluorescent methods. These are classified by how they are removed from the test surface: solvent removable, water washable, and post-emulsifiable. The solvent removable types are most common and highly portable making them ideal for "on site" inspections.

## Leak Testing

Leak testing for weld inspection is done on containers and piping systems built to hold a liquid or a gas. The tank or piping system is usually pressurized above its design operating pressure and held at that pressure for a specific amount of time. The usual test mediums are air, gas(usually nitrogen), or water. These tests are performed mostly on new construction and are part of the ASME code.