WLD 204
Non Destructive Testing I
Visual Testing

Welding Technology

Portland Community College

NSF-ATE Project

Advanced Materials Joining for Tomorrow's Manufacturing Workforce

INDEX

This project was supported, in part,
by the
National Science Foundation
Opinions expressed are those of the authors
And not necessarily those of the Foundation

VISUAL INSPECTION (VT)

With practice and experience you will learn to uncover a vast amount of information about a weld by visually examining the surface. Such discontinuities as undercut, cracks, surface porosity, inadequate root penetration, and improper dimensions, improper joint prep, improper fit-up or profiles can easily be seen with the eye. Even such things as improper technique by the welder can be detected by studying the weld with a trained eye. We will talk more about the trained eye after showing some advantages and limitations of visual inspection.

The Trained Eye (See Article The Case for Eye Test Standardization by William H. Bailey)

A person with a trained eye is someone who has really learned to see detail. At first, most of us assume that is an easily acquired skill and say, "I can see all right. Nobody needs to tell me how to see." But as you work with a skillful inspector, you might find yourself saying, "I really didn't see that before. I didn't know that you could tell so much about a weld just by looking at it."

A prerequisite to visual inspection is an eye examination and correction of vision (glasses) if necessary. You might call this examination the calibration of your eye. It merely verifies that you can see with a given sensitivity.

The next step in visual examination is learning what discontinuities are possible to detect visually, and learning where these will normally show up. For example, undercut occurs along the toe of the bead. It is seen as a groove alongside the weld that may be caused by the amperage being too high or other improper welding techniques.

The third aspect of visual inspection is realizing that you cannot see everything with the naked eye, let alone find the smaller discontinuities. There are many devices you can use to help see them. The other methods of nondestructive testing we will talk about are extensions of the eyes. They help in locating and seeing smaller and less distinct discontinuities

Once the weld is completed, the acceptance inspection for discontinuities, dimensional accuracy (including distortion), conformity to drawings, and weld appearance (roughness, spatter, etc.) should take place. The thoroughness of this review should be aided by using the other nondestructive inspection methods, as dictated by your judgment or as called for in the specification documents.

Improper fit-up undercut, surface porosity, cracks open to the surface, bead contour, and overlap are some typical discontinuities that can be seen with the naked eye.

Note that visual inspection, besides being the least expensive of the nondestructive methods, may result in the greatest cost savings. Visual inspection before and during deposition of any weld metal may substantially reduce the overall cost of fabrication. For instance, ultrasonic testing of a weld joint with a borderline indication due to lack of back gouging is very slow and expensive. This ability to eliminate many discontinuities before the weld is completed is perhaps the most important feature of visual inspection.

Advantages

1. Visual inspection is used before, during, and after fabrication of any weldment.
2. Visual inspection will show most large discontinuities and will generally point to other discontinuities that must be detected by another method.
3. Visual inspection can detect and aid in eliminating discontinuities that might become defects in the completed weldment.
4. Visual inspection costs less than any other nondestructive inspection method.

Limitations

1. The value of visual inspection depends largely on the experience and welding knowledge of the inspector. The inspector should be familiar with design and weld requirements.
2. Visual inspection is limited to detection of surface discontinuities.
3. Visual inspection started too late in the sequence of welding operations cannot detect improper joint fit-up or other costly deviations from best welding practice.

Have you ever seen someone radiographing a weld that you can practically see through? Have you ever watched UT being performed on an obviously defective specimen? Seems as though no one wants to stop, look, and listen anymore. Just seeing a defect isn't grounds for rejection anymore! Good old common sense is being traded for sophistication and a few thousand dollars of equipment. Wonder how much time, effort, and money could be saved if we would just stop and look at what we are doing. Anyway, thanks for stopping here and looking. Hope you look further into Visual Testing here in this "Back to Basics," and continue to look at this page in the coming months.

FRANK A. IDDINGS

Visual Inspection

by Calvin E. Pepper

Normally, a person's tools are an easy indication of his profession. This is true of all NDT inspectors except Visual Inspectors. Since Visual Inspection is so much an optical medium, most inspectors fail to develop much in the way of visual aids. It is not unusual to see an inspector complete an "inspection" of a piece of equipment, or pipe assembly, without once complementing his vision with some form of measuring or illuminating device. This is not to imply that Visual Inspection must be performed at all times with a sophisticated array of instruments, or that inspectors should develop some form of equipment or tools simply to make themselves easily recognizable. Rather, Visual Inspectors should develop an inspection "kit" containing a number of simple, readily available, and inexpensive visual aids which will help make inspections easier, quicker, and more accurate.

Since a large portion of Visual Inspection is done on welded fabrication, the inspector should have some type of weld gauge capable of determining misalignment, root opening, groove angle, root face, and material thickness of a weld fit-up. The weld reinforcement height and width should be measured. Exact measurements of fillet welds can be determined using either of two types of "fillet sets" which are available at a reasonable price.

The importance of measuring these features, rather than simply "looking" at the dimensions, cannot be overemphasized. Remember that the Design Engineer had specific design criteria in his calculations, based on the sketch of the weldment which is part of the Welding Procedure Specification (WPS). The inspector must also consider that joint preparations not within the tolerances given on the WPS sketch may result in rejectable defects causing lost time and money for the project.

Several types of illumination should be a part of the "kit" to be used for interrogating the internals of pipe and equipment. Remember that an excess penetration or incomplete penetration can often be "seen" if good lighting is available, saving the cost of radiographic, ultrasonic, or other expensive testing.

Useful measuring tapes come in many lengths and types. Since one of the responsibilities of the inspector is to insure that the specimen is dimensionally correct, he should have one or more of these in his possession. Straight metal rules, 6 inches normally, are useful for determining thicknesses, spacings, or diameters of openings, while a common 6-foot long carpenter's folding rule is extremely handy for taking measurements alone. When working alone, incidentally, the inspector will find it useful to include one or more magnets in his kit to be used to secure the free end of tape measures, to secure plumb bobs, or to serve as an extra hand when working off the ground.

Another carpenter's tool, the combination square, serves very well to check both dimensional correctness and alignment of equipment nozzles. This is another extremely important area where precision is essential. A misaligned nozzle will invariably result in a leaking flange connection, and, in the case of thin-walled or nonmetallic equipment, could result in a failure of the nozzle joint itself.

Carpenter's levels, torpedo levels, and plumb bobs all complement the combination square for nozzle inspections, and for a very small cost!

There are a number of tools which the inspector should consider in addition to those common ones already mentioned. A set of temperature-sensitive crayons is always helpful, rather than relying on the intuition of the welder to maintain preheat and interpass temperatures. It is common practice in shops and in the field to hand a welder a single temperature crayon with which to monitor preheat or interpass temperature. This is obviously not a good idea, as it simply tells the mechanic that he is either above (melted) or below (not melted) the desired temperature—not how much above or below. The proper method is to issue two crayons representing one temperature below that desired and one above. The instructions would be simply obtain a temperature so that one crayon (lower temperature) melts but the other one (upper temperature) does not. This technique allows a suitable temperature to be reached and maintained.

A radiographic density strip is one of those less common items well worth making a part of the "kit." Often the radiographer will have no densitometer or will have no calibration for it. Since proper radiographic density is essential, the density strip can help the inspector determine the approximate density until the proper density can be measured when a calibrated densitometer is available.

Each inspector's "kit" will contain those items most helpful to his particular type of inspection responsibility, as some assignments require rather specialized equipment. What is of greatest importance is that each inspector investigate, experiment, and develop tools or techniques which will help him do his job better.

Since the Visual Inspector is given enormous responsibility—and power—by his company and often is the only representative of his company at the vendor's site, one other important tool he should have is the proper *attitude*. This is an extremely important point for the inspector. He must not compromise his integrity by doing less than adequate inspections, nor allow questionable products to reach the field, yet he must not delay completion of the product without good cause.

The inspector should remember that he is there with his expertise to help the vendor provide the required quality

Pepper is with Salmon and Assoc. Consulting Engineers, Baton Rouge, LA.

product. An inspector who rejects weldments without the benefit of counseling the vendor in the possible cause for repetitive defects is of minimal value to the project. A well-trained inspector will know the causes of weld defects and should call these points to the attention of the proper management person (Quality Control, Welding Engineer, Welding Supervisor, etc.).

The inspector can assure himself of success by presenting, at all times, a sober, mature, knowledgeable, and responsible attitude. By being observant and technically current, he can provide an invaluable service to the project team. His practical experience in matters of construction and fabrication can temper technical assessments and judgments and ultimately result in cost savings.

Because of the extreme diversity of the Visual Inspector's responsibilities, the inspector must be more closely screened and evaluated by his employer than any other Nondestructive Testing personnel. This diversity, in fact, places the inspector in a unique position—often more a professional than other NDT inspectors. Also, because of the great amount of responsibility placed upon the inspector, it is unfortunate that so little has been done to attempt to control, qualify, and certify Visual Inspectors, so as to provide industry with an individual better able to perform this vital function.

The reason no two of us may see things exactly the same way includes many factors. One factor is our eyes. The other parts of this problem need to be considered. The following article by W. H. Bailey gives an excellent background to begin understanding our vision. Take a "look!"

FRANK A. IDDINGS

The Case for Eye Test Standardization

by William H. Bailey*

To more completely understand the use of the eyes, shown in Figure 1, a series of vision-related fields of study is required. These fields are optometry, psychology, neurology, physiology, nutrition and, in some instances, child development. Stresses, emotional situations, and posture are conditions which may affect an individual's vision.

This paper presents a series of facts from various sources. No one field will be completely discussed. It is hoped that questions may be planted in your mind, while some points of interest proposed may answer some questions you already have.

In our basic schooling, the eye has always been compared to a camera. This may have been somewhat misleading and much too simple. As seen in Figure 2, the eye is a visual receptor. A camera converts light entering a lens into a projected image located at a distance behind on a recording film. But it must be remembered that a film shows only a single plane view.

Figure 3 shows the various parts of the eye. The *cornea*, which is the outer protective covering; the *iris* which controls the amount of light being admitted; and the *lens* which focuses the light on the *retina*. The layer of *rods* and *cones* receive the light rays and convert them to electrical impulses which are transmitted to the brain by the *optic nerve*. The *eye muscles* are used to move the eye in the direction the brain directs the individual's attention.

In the human eye, we have depth perception. This is because two receptors are used. Two views of an object are received, and depth of field results. The "standard eye," wherein every light ray is handled perfectly, is really theoretical. As in Figure 4, there is no single point of focus. Light rays are bent only above or below the center of the pupil.

The eye is not corrected for color distortion. As different color light waves travel at different speeds, they also focus differently. Blue color travels faster than red waves, which results in blue waves being the first to be focused. The yellow-green is the range of colors that focus on the retina with more ease. Although physics substantiates this, the vision receptors send the signal to the brain so that an integrated or composite color or image is visualized. Experiments have shown that the elimination of chromatic aberration, or color distortion, causes individuals to lose the ability to focus. An inspector, such as a film interpreter, who spends too many continuous hours performing monotonous inspections can, unbeknown to himself, suffer temporary loss of visual acuity and evaluate the work incorrectly. Color aberration, therefore, may have an effect on inspectors who perform chores where color perception is not normally considered a problem.

Fluorescent magnetic particle and fluorescent penetrant inspection, as normally performed, does not fall into this category to as great an extent. The yellow-green color has been noted as the range of colors that most readily focus on the retina, while the remaining spectrum tends to blur. When an individual has a vision deficiency, the problem can be magnified greatly. Figure 5 indicates the basic vision problems.

It may be noted the eyes are usually in motion. This allows the various colors to be registered at different locations on the retina to form the image in the entire color spectrum. If the axiom of the eye being a camera were true, the camera would have to oscillate, or move, to record a true picture. An experiment has shown that when a lens was used to counteract the minute eye movement, a loss of vision occurred. Long distance drivers may suffer from the lack of eye movement due to excessive searching strain. Figure 6 shows the electromagnetic spectrum. From the range covered, the human eye sees less than 1 percent. This does not mean that the individual or his eyes are not affected by any of the remaining 99 percent.

There is more to good vision than the

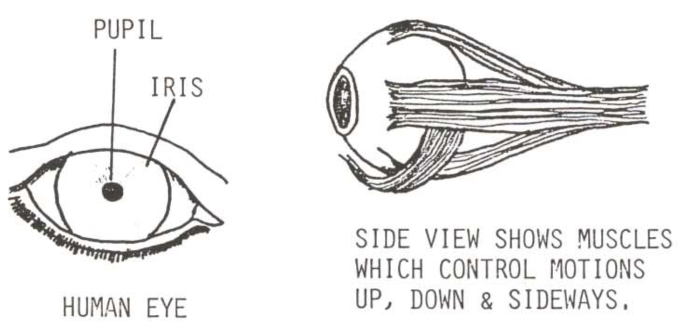


Figure 1.

*Cleveland Pneumatic Co., Cleveland, OH

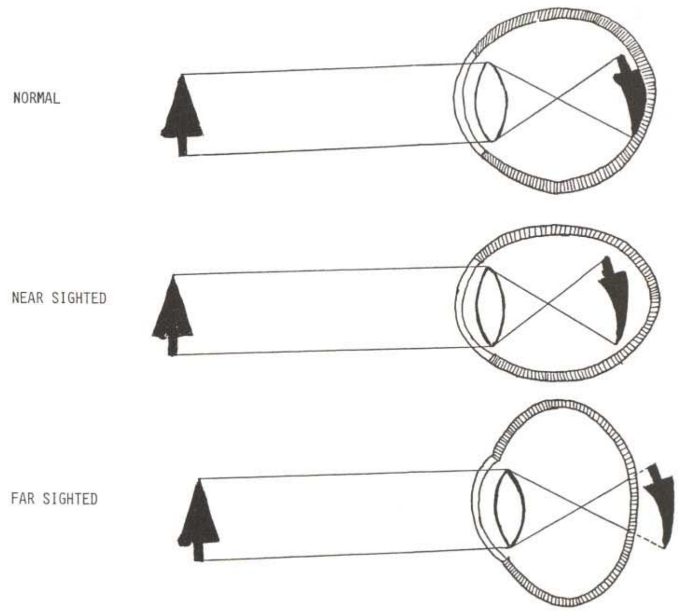
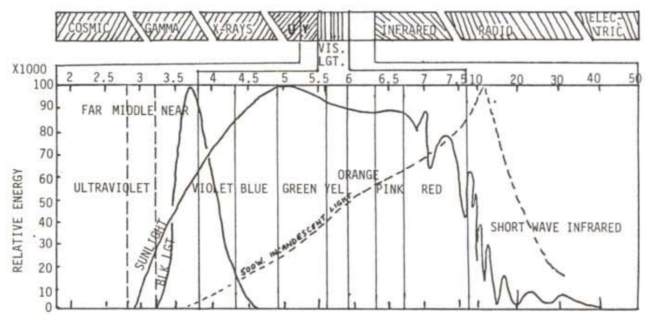


Figure 5—Basic vision problems.



THE HUMAN EYE SEES LESS THAN 1% OF THE TOTAL ELECTROMAGNETIC SPECTRUM

Figure 6—Electromagnetic spectrum.

lighting engineers have selected various lights for "special effects." Designers have colored walls to set a mood.

Brightness, too, has an effect. Newborn infants with a jaundice condition have been known to respond satisfactorily without medication, by being exposed to a shining blue light. An ordinary incandescent light bulb has been known to correct women's menstrual cycles. During specific days, sleeping with the light on has caused more uniform cycles. Animal experiments have also shown the effect of light pertaining to conception. Changing from the incandescent bulbs to fluorescent "daylight" bulbs, ratios of 60/75 percent males born reversed to the females' favor. Closing one's eyes is not sufficient to counteract some of the effects of lighting. Experiments with blind persons and seeing persons who were hoodwinked showed outstretched arms of both groups would move toward red light and away from blue. A study at Georgia State University concluded that dark-eyed persons let less shortwave light into the eye, resulting in less gland activation. Several studies have shown that darkness decreases the red blood cell count.

Recently on television a demonstration was performed. A weight lifter was seen lifting a weight within his physical limits. Prior to his second lift, he was required to stare at a pink-to-red card for twenty seconds. He was unable to complete the second lift. After a brief rest of several minutes, he was successful on the third attempt. A police department found that rowdy prisoners confined to a pink-colored area for a short period of time became more manageable.

It has been noted that light-eyed individuals tend to be better at analytical tasks. Dark-eyed individuals have more emotional reactions. This was a point noted as a newspaper filler that indicated that the most successful professional quarterbacks were light-eyed and the best linemen. dark-eyed. A Pennsylvania State University study showed that normal reaction time to a stimulus is 150 to 200 milliseconds. The dark-eyed persons were 12 to 22 milliseconds faster than the light-eyed folks. Cornell University has performed similar tests with similar results.

One point of interest reported by the American Optometric Association is a person's age. A sixty-year-old person requires about seven times more light than a twenty year old. They recommend using more light for reading and other projects requiring good concentration. Use incandescent lighting rather than fluorescent, as the yellowish light is easier on the eyes than the blue of the fluorescent light.

Not to overlook gender, it has been claimed, men have better eyesight than women. A 1971-72 survey by the National Center for Health Statistics which examined over 10,000 people between the ages of 1 and 74, showed 60.9 percent of the women had trouble seeing, including some who had received glasses or contact lenses. Fewer black persons had eye problems. More persons between 6 and 74 in the Northeast and Midwest wear glasses than those in the South and West.

In conclusion, it may be noted that eyesight is not a camera but receptors that signal the brain to decide what there is to behold. The eyes may be trained to be more perceptive, and standardization of eye tests may not be possible, utilizing the usual eye charts found in medical offices. These charts have been in use for over one hundred years. In this period of time, not many, if any, of the conditions or facts mentioned, have been considered when selecting an individual for visual tasks. Perhaps, the bringing to light of these peculiarities shall inspire others to produce data and direction in the formulation of methods of eye standardization. Hopefully, it will result in better quality and more meaningful inspections.

References

1. Richard S. Kavner, O.D., and Lorraine Dusky, *Total Vision*, 1978, Addison-Wesley Jacob Way, Reading, MA.
2. John N. Ott, *Health & Light, The Effects of Natural and Artificial Light on Man and Other Living Things*, 1973, Devin-Adair Co., Old Greenwich, CT.

Inspector examines weld surface through a magnifying lens to make sure that appearance complies with code requirements.

Know your welding NDT - Visual Inspection

Inspect by eye before, during, and after welding to cut down on post-construction repair and testing

Visual inspection (VT) of welds sounds simple—the term suggests that one simply studies the weld surface carefully to evaluate weld quality. Properly performed though, VT is a detailed exercise that does much more. Visual inspection starts when the material comes in the door, continues throughout welding, and finishes when the inspector examines the complete structure, marks and reinspects repair areas, and completes his report. Conscientiously done by knowledgeable personnel, visual inspection weeds out out-of-spec material, catches and corrects substandard work in process, and cuts down on the need for after-the-fact NDT.

Starting out

Knowledge and good eyesight, lens-correctible to at least 20/40 vision in one eye, preferably both, constitute the most important attributes of a visual inspector. He should be familiar with the applicable codes and blueprints, workmanship standards, and all phases of good shop practice. Good vision is essential, so that the inspector can see surface details clearly and distinctly. The AWS Structural Welding Code (AWS D1.1), for example, states categorically that stress-bearing welds should be free of cracks, implying that the inspector must have eyes sharp enough to spot hairline defects.

Get an early start

The VT inspector begins by examining incoming material. Referring to plans and specs, he makes sure that the stock is correct in grade and dimensions for the job. Then he eyeballs all plates, shapes, and welding set ups, on both sides and along edges, looking for scabs, seams, scale, laminations, substandard flamecuts, and other defects that would interfere with welding.

After workers set up parts to be welded, the inspector checks joint preparations and fitup, measuring root openings and other joint dimensions to make sure that they conform with specs. He also assesses quality of finish, edge preparation, alignment, and cleanliness. Another responsibility is filler metal, so the inspector checks electrodes and wire to make sure that they conform with specs. He also verifies that electrodes used for structures being welded by low-hydrogen practices come either from sealed containers or from ovens held at specified holding temperatures.

Looking around

Regarding the welding itself, the inspector reviews the weld area for correct procedure and establishes that welders qualify to applicable codes. Then he oversees a few runs, paying extra attention to root passes, which are more likely to crack than succeeding passes. He also makes sure that welders use the right filler metal, equipment settings, and shielding gas, and checks preheat and interpass temperatures with temperature-sensitive crayons. Examining multipass welds, inspectors often use workmanship standards, samples built up of similar base and filler metals to show each pass of the weld as it should appear in longitudinal and cross sections. After each pass, the inspector compares its appearance to the sample pass.

When the welder finishes a joint, the inspector examines the completed weld to make sure that it meets appearance and quality standards. He looks for surface imperfections such as undercut, spatter, cracks, roughness, and underfill. He uses gages to measure weld dimensions, including weld throats, leg lengths, and reinforcements.

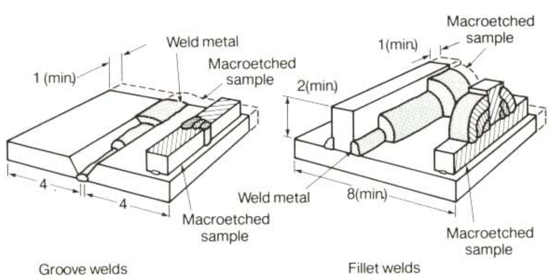
What he looks for

The inspector can determine much about weld quality from its appearance. First he looks at the weld assembly, ascertaining whether it is warped or distorted. Then he studies weld surfaces to judge workmanship. When run at correct speed with the proper current settings, a weld displays even contour, regular ripples, and specified penetration, determined by viewing from the opposite side.

Too low an amperage produces a narrow weld with a high crown and uneven ripples. Undercut also appears, and the weld may not penetrate to the root. Excessively high currents elongate ripples, generate spatter, cause undercut, and penetrate enough to force weld metal beyond the root on the underside, a condition called melt-thru by the AWS. Welding too slowly builds the crown to produce a high contour, indicating that penetration may be poor. High welding speeds create narrow, uneven ripples, undercut, and poor penetration.

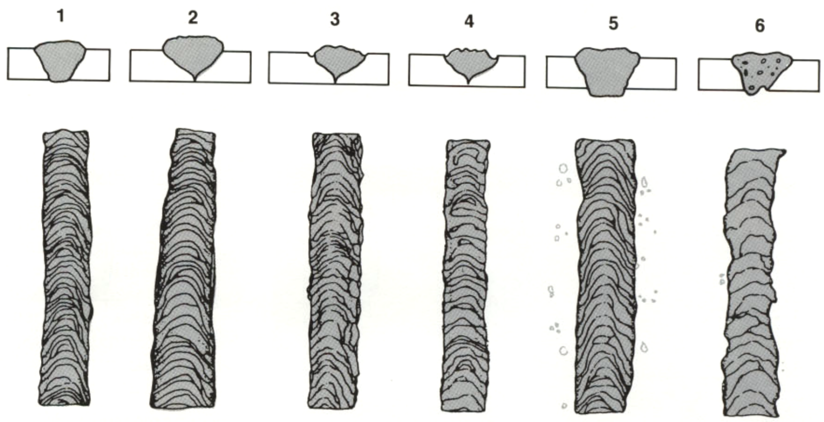
The inspector should know that variations in arc length also affect weld appearance. Long arcs, even given proper current

WORKMANSHIP STANDARDS



Inspectors use workmanship standards, longitudinal and cross-section mock-ups of production welds, to compare with shop-made welds. Source: "Nondestructive Inspection and Quality Control," Vol. 11, *Metals Handbook*, 8th Edition, American Society for Metals, 1976.

SURFACES REVEAL WELD CHARACTERISTICS



Surface contours indicate substandard weld techniques.

1. Normal, amperage, speed, and arc — uniform contour, good penetration.
2. Normal amperage, slow welding speed — high weld bead, poor penetration.
3. Low amperage, correct welding speed — narrow weld, uneven ripples, high crown, undercut.
4. Normal amperage, too fast welding speed — uneven ripples, undercut, poor penetration.
5. High amperage, correct welding speed — elongated ripples, spatter, excessive penetration, undercut.
6. Normal amperage, long arc — uneven penetration, porosity, trapped inclusions.

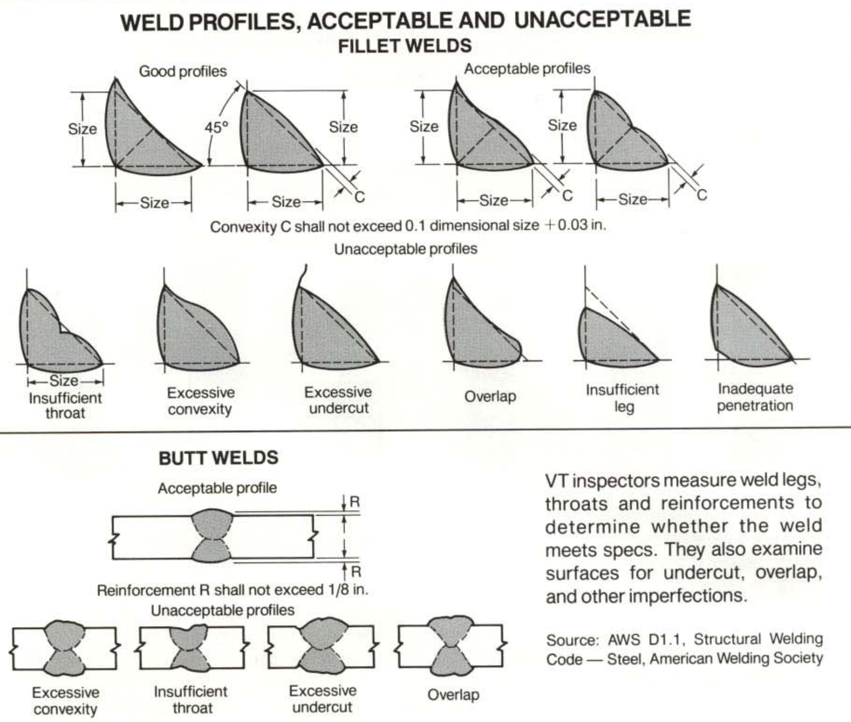
Source: *Visual Examination*, American Society for Metals, 1983

and speed, produce porosity, inclusions, and irregular penetration. Low and high voltages act much like low and high currents.

Visual inspection reveals several types of defects, some lying below the surface. When **incomplete fusion** occurs, depressions can appear between the bead and base metal. **Inadequate joint penetration**, which develops when the root does not fuse into the wall, produces a depression along the underside. To detect this condition, the VT inspector must examine the root, if it is accessible; this can be difficult to view when inspecting welds joining small tubes. **Undercut**, easily identified by VT, shows up as base-metal depressions along one or both sides of beads. **Underfill** appears when the welder fails to fill the groove completely. **Slag, oxides, and scale** trapped in weld metal can be detected only when at the surface; ultrasonic testing and radiography pick up subsurface slag. UT and RT also locate **subsurface porosity**, which results from entrapped gas; surface pores, detectable by VT, suggest subsurface porosity.

Cracks come in several forms. **Hot tearing** develops along the centerline of the weld surface as the last of the weld metal solidifies and contracts in restrained welds. **Heat-affected-zone cracking** occurs along the edge of the weld bead, which can be hard and brittle. Because HAZ cracks are often very tight, inspectors may need magnifying lenses to discern them. **Crater cracks** appear in craters at ends of welds, usually radiating from the center.

Arc strikes, arc drag, and spatter are visible defects that detract from appearance. **Arc strikes**, hard spots that result when the hot arc strikes base metal outside the weld area, can start cracks. **Arc drag**, essentially a long arc strike, appears when the welder drags the electrode along base metal away from the weld joint. **Spatter**, small droplets of weld metal flying outside the weld



VT inspectors measure weld legs, throats and reinforcements to determine whether the weld meets specs. They also examine surfaces for undercut, overlap, and other imperfections.

Source: AWS D1.1, Structural Welding Code — Steel, American Welding Society

area, also produces hard spots on base metal, but they are usually too small to cause cracking.

The VT inspector studies visible defects and discontinuities, judging their character according to applicable codes and specs. Codes generally ban cracks of any type. Other types of defects also need repair when the code so dictates. When appearance is a deciding factor, as for welds visible to potential customers buying consumer products, too much spatter, usually considered innocuous, may call for cosmetic finishing, by grinding perhaps.

On the job

Visual inspectors usually stay at the job site from start to finish. In the field, he does his work during construction. Appointed by the owner and working as the independent overseer of construction activities, he accepts the responsibility for assuring that the contractor sticks to code-approved building materials and practices. Inspection contract organizations, such as Herron Testing Laboratories, take on test jobs, bidding for them much as construction firms bid for building contracts.

Edward M. Kudlaty, inspector for the Cleveland-based lab, starts a job by reviewing the building plans from basement to roof. Following the company-developed five-page VT checklist, he examines the material to be fabricated, measuring dimensions and looking for defects. After workmen set up sections for welding, he examines root openings, edge preparation, joint dimensions, finish, cleanliness, and other code requirements.

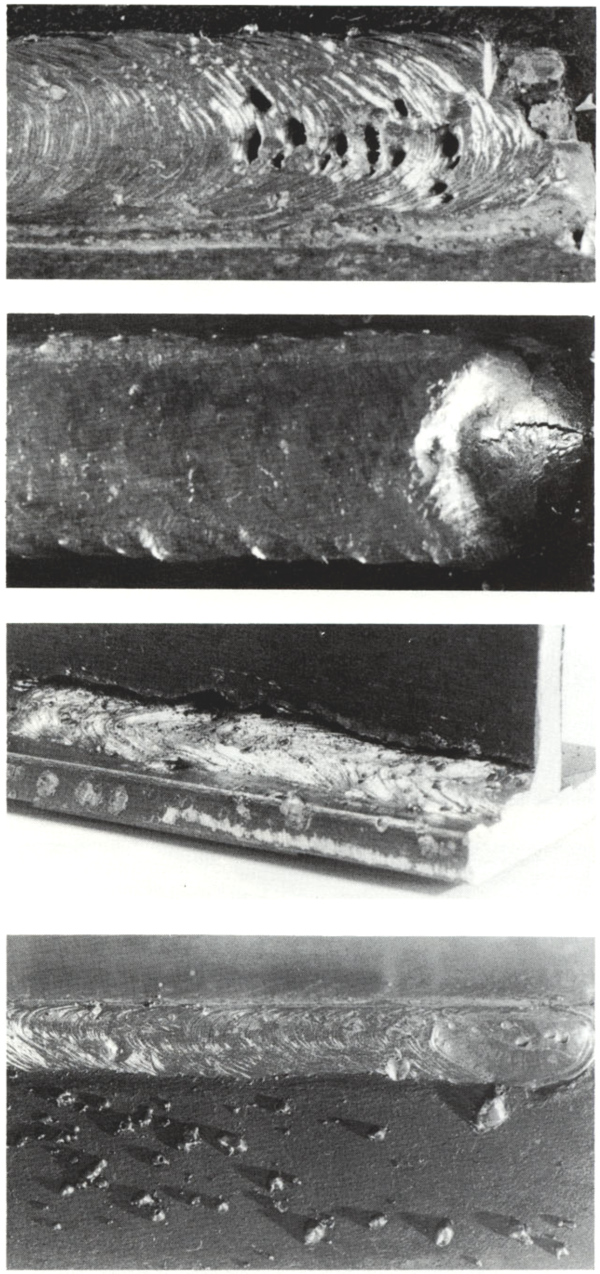
During welding, Kudlaty monitors the process, checking filler metal, preheat and interpass temperatures, and other details that might affect weld quality. Substandard welding practices, he says, should be discussed with welding foremen, rather than welders, so that the foremen can work with welders to correct the troubles.

After welding, Herron inspectors examine structures for conformity to design requirements, and for weld appearance, structural discontinuities, and evidence of punch marks, excessive grinding, and other signs of poor workmanship. At this point, warns Kudlaty, inspectors must be careful to mark repair areas clearly with a durable medium, such as a paint stick. This is important, he adds, because marks can wear off or be covered up by subsequent construction. Herron directives specify that marks must be clear enough to be easily understood by other inspectors and repair personnel, distinctly colored to avoid confusion with other markings, and durable enough to last until the repair has been made and inspected. Besides marking repair areas, Herron inspectors prepare written reports giving inspection dates, locations, and results.

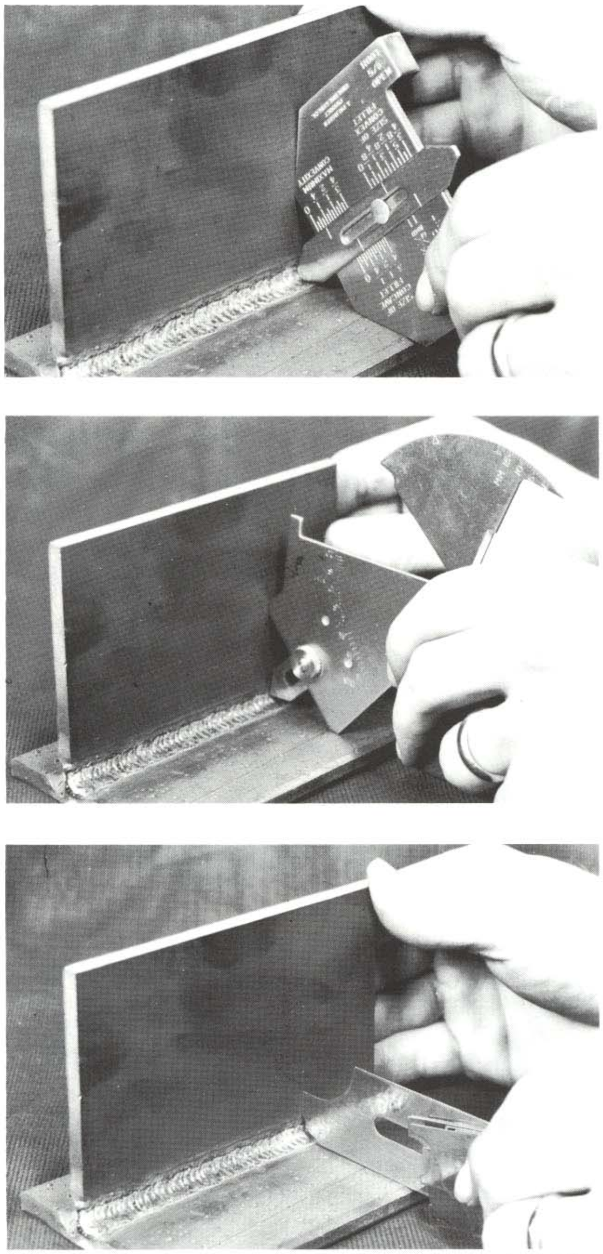
Tools for VT

Visual inspection calls for a few simple tools, such as rules, mirrors, gages, magnifying lenses, flashlights, and borescopes, for examining interiors of tube welds, and other out-of-the-way joints. Pocket scales satisfy for short measurements, as for determining lengths of cracks and other defects. Measuring tapes and folding rulers, 6 feet long and more, come in handy for determining stock lengths and widths. In his article, "Visual Inspection" (*Materials Evaluation*, November 1979), Calvin E. Pepper recommends a combination square, such as carpenters use, to check stock angles and nozzle alignment. Other useful tools are levels and plumb bobs, also used by carpenters. Dental mirrors, bent at angles, may be employed to examine surfaces of hard-to-reach welds.

Inspectors use several types of weld gages to measure sizes of fillet and groove welds. The Welding Institute, in England, offers a convenient gage that measures angles, misalignment, fillet legs and throats, reinforcements, undercut, and underfill. U.S. Navy engineers devised an-



VT inspectors look for visible defects. Top to bottom: porosity, crater cracks, undercut, spatter. Photos courtesy Alloy Rods, Inc.



Weld gages in common use include types from the U.S. Navy, top; the Welding Institute (England), middle; and the standard fillet gage. Photos courtesy Hobart Brothers Company.

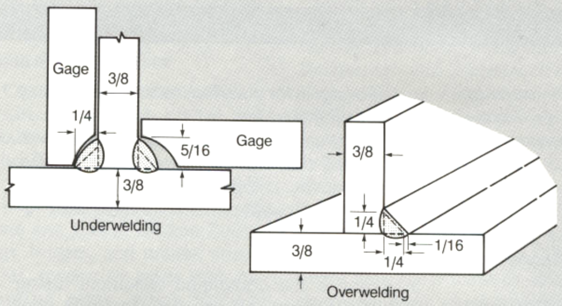
other type of gage for measuring fillets. Gage manufacturers include Chicago Tool & Engineering Company, Dimensions Division of Radiation Equipment Company, G.A.L. Gage Company, Dearman International, and Intratec Division, British Aerospace, Inc.

Hand lenses, ×5 to ×10 magnifying power, can be useful for spotting hairline cracks in weld metal and HAZs. Be careful, however, when interpreting magnified views, because small grinding marks can loom like canyons. Herron inspectors generally depend on good eyesight, which the lab verifies by eye tests once a year for those to 35, every 6 months for older workers.

Borescopes, probably the most complex instruments used by visual inspectors, get the call for examining hard-to-reach welds. Made by such companies as Lenox Instrument Company and Machida America, borescopes resemble microscopes — they have objectives for weld closeups at one end and eyepieces for viewing at the other. Borescopes can be rigid, with eyepieces and objectives lying in a straight line, or flexible, with glass fibers linking objective to eyepiece. For those who want to inspect long distances away, perhaps to examine welds of pipe lying along an ocean bed, Dainichi-Nippon Cables, Ltd. offers Diaguide Scopes, fiberscopes that run 300 feet long. Most borescopes illuminate areas to be examined, using glass-fiber light guides running from a convenient source of illumination to the objective.

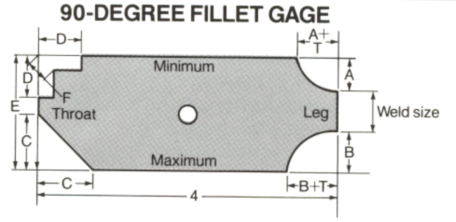
VT inspectors also employ temperature-sensitive crayons to estimate preheat, interpass, and post-weld heat treating temperatures. It's best to carry a set of these crayons to cover the ranges of temperatures expected on the job. Marking critical zones, the inspector should use two crayons, rated at temperatures that strad-

GAGES REVEAL OUT-OF-SPEC WELDS



Underwelding, making welds smaller than specified, produces welds that will not meet specified strengths. Overwelding wastes filler metal—the 5/16-inch-leg weld contains 56 percent more metal than the 1/4-inch-leg weld specified by design. Source: Lincoln Electric Company

90-DEGREE FILLET GAGE



Using this pattern, shops can make gages for measuring legs and throats, maximums and minimums, of 90-degree fillet welds.

A = Minimum allowable length of leg.
B = Maximum allowable length of leg.
C = 1.414 times maximum allowable throat size (maximum allowable convexity).
D = Maximum allowable length of leg when maximum allowable concavity is present.
E = *A* plus *B* plus nominal weld size (nominal length of leg).
F = Minimum allowable throat size (maximum allowable concavity).
T = Additional tolerance for clearance of gage when placed in the fillet.

Source: "Nondestructive Inspection and Quality Control," Vol. 11, *Metals Handbook*, 8th Edition, American Society for Metals.

dle the specified temperature. One mark melts while the other remains dry to indicate that the weld area is at the right temperature.

To record visual examinations of critical areas, inspectors may use cameras, employing film, color or black-and-white, or video tape. It is also possible to record views through borescopes, though the photographer must be careful to line up the camera lens with the borescope eyepiece, using a clear focusing screen on the camera. More information on borescope photography can be found in "Borescope Photography Made Easy," by Frank G. Becher, *Materials Evaluation*, December 1983, pages 1430 to 1432.

Other joining processes

Visual inspection applies to resistance welding and brazing as well as to arc welding. For spot and seam welds, surfaces must be free of paint, oil, scale, and other contaminants, so that electrodes make firm contact. Examining spot welds, inspectors look for smooth, round (sometimes oval) welds with uniform appearance.

Spot-weld defects include indentations (reductions in metal thickness due to electrode shape, too much force, and excessive heat); misshapen welds (caused by inadequate electrode dressing, poor part alignment and fitup, movement, and contamination); surface fusing and electrode deposit (surface and electrode melting due to excessive heat); and cracks and gas holes in welds, due to high heat, poor fitup, and insufficient cycle time for electrode pressure. These defects reduce strength and promote corrosion, shortening weldment life.

VT inspectors examine brazements for cleanliness and good fitup before brazing. Improperly cleaned parts develop voids owing to incomplete fusion. Tight fits keep braze metal from penetrating throughout the joint, and wide gaps leave voids, because metal cannot fill seams. After brazing, inspectors make sure that braze metal fills joints completely, displaying sound, well-fused material. Gas pockets indicate unsound braze metal; excessive heat causes base-metal erosion; and flux residues corrode brazements.

Using codes and specs

Construction codes spell out requirements for visual inspection just as they do those for other NDT methods. The *Structural Welding Code—Steel* (AWS D1.1) covers visual inspection of plate and tubing used in buildings, bridges, and tubular structures. Inspection starts with incoming plate, when the VT inspector examines sheared and flame-cut edges for inclusions and blow holes. Small discontinuities (less than 1 inch) need not be explored, but longer ones, especially those more than 1/8 inch deep, require investigation, sometimes repair.

Strict VT rules apply to qualify pipe and tube welds and their welders. Welds should be crack-free, and craters filled to blend into cross sections. Weld faces must lie flush with pipe exteriors and blend smoothly into base metal. Other requirements are small reinforements and sound roots, smooth and free of discontinuities.

On the job, VT inspectors measure sizes and contours of welds with gages, examine welds for cracks and other discontinuities, using flashlights and lenses as required to reveal details, and mark areas that need to be repaired. Examining welds in bridges, buildings, and tubular structures, especially those that bear tensional stresses, VT inspectors must watch out for undercut, porosity, and complete penetration. Though inspectors can examine welds in most steels after the welds cool to ambient temperature, they wait at least 48 hours before examining welds in ASTM A 514 and A 517 grades. Welds in these quenched-and-tempered high-strength grades can suffer delayed cracking due to hydrogen, if welders have not followed low-hydrogen practices properly.

Other codes also recognize visual inspection. The *API Recommended Practices for Planning, Designing, and Constructing Fixed Offshore Platforms* (API RP 2A), for example, notes, "All fit-ups (joint preparation prior to welding) and completed welds shall be subject to visual inspection." Also falling to the VT inspector's responsibility is another RP 2A stipulation, "The plans and specifications shall clearly delineate which materials and fabricated items are to be further inspected by nondestructive testing, the acceptance criteria, and the extent of testing and the methods to be used in such inspections." Checking welds in simple tubular joints, the VT inspector makes sure that profiles merge smoothly with base metal of brace and chord, and that undercut does not exceed 0.01 inch.

The *API Specification for High-Test Line Pipe*, API Spec 5LX, details VT criteria carefully. All finished pipe, the code stipulates, must be free of the following defects: Cracks, leaks, laminations wider than 1/4 inch, arc burns, undercut greater than 1/32 inch long, and other discontinuities, such as dents, which reduce wall thickness by more than 12-1/2 percent.

In conclusion

The visual inspector oversees quality control throughout a job, from the time that stock arrives to be readied for welding and fabrication, through construction, to inspection of the final product. He is in a position to catch and correct substandard practices and scrap out-of-spec material and weldments before they are built into the structure. Given the authority to call the QC shots and backed up when disputes arise, he can save time and money wasted by poor workmanship and testing of rewelded parts and structures.■

welding engineer data sheet

Checklist for visual inspection (VT)

Visual inspection takes place before welding, during welding, and after welding. This checklist spells out points to consider during each phase.

BEFORE WELDING

1. Examine mill records of incoming plates and shapes, and determine whether stocked items correspond to those listed in construction plans and blueprints.
2. Measure stock to make sure that diameters, lengths, widths, and thicknesses conform to specifications.
3. Inspect stock surfaces for scabs, seams, and other harmful defects; examine plate edges for laminations and rough flame-cut surfaces which might interfere with welding.
4. Check sections fitted up for welding to verify that root openings, joint designs, and weld preparation meet specifications. Inspect these conditions:
   - Edge preparation, dimensions, and finish of components.
   - Clearance dimensions of backing strips, rings, and filler metal.
   - Alignment and fitup of components.
   - Cleanliness of surfaces, especially in weld areas.
5. Review specs pertaining to welding processes, procedures, and consumables, then make sure that welders know them. Pay special attention to filler metal storage and handling when specs call for low-hydrogen procedures.

DURING WELDING

1. Make sure that the welder adheres to welding parameters and that he uses the right consumables (filler metal, flux,and shielding gas), preheat temperatures, and interpass temperatures. Inspect joint cleanliness, bead cleaning method, joint preparation for welding the second side, welding sequence, and distortion control. Measure postheat temperatures and times.
2. Examine the root pass for cracks, because it freezes quickly and may crack or trap slag. If possible, check for penetration. At that time, check again for plate laminations, which may open when heated.
3. Inspect undersides of double-groove joints after the first side is welded to verify slag removal, by chipping or gouging, before welding proceeds; otherwise, slag may remain in the weld.

AFTER WELDING

1. Examine the completed weldment, using rules, gages, and squares, to verify conformance to blueprint dimensions. Check fillet welds with gages that measure legs and throats to determine whether leg length, convexity, and concavity conform to specifications. Check groove welds for width and reinforcement height.
2. Judge welds for appearance — roughness, spatter, and slag detract from appearance of welds and surrounding areas.
3. Look for discontinuities which may reduce fatigue life, such as craters at weld ends, cracks, incomplete penetration, undercut, and overlap, referring to applicable codes and specifications. Clean carefully before inspecting, using a stiff wire brush; chipping hammers and blasting, with shot or grit, can hide hairline cracks.
4. Mark repair areas clearly, using a paint stick or other means of permanent marking. Make sure to mark areas distinctively, using colored markers if necessary, so that repair crews will know what needs to be done.
5. Inspect repaired areas, and mark their disposition, again using permanent marking to avoid erasures and survive rough handling.
6. Prepare a written report, list job number and descriptive title, date of inspection, site of inspection, results of inspection, and inspector's name.

Note: These are general guidelines. Visual inspection need not be restricted to these items, but the scope of inspection should be designated in the purchase order and other governing documents of the contract.

Source: Herron Testing Laboratories

1. What is the most extensively used Nondestructive Testing Method (NDT)?

   A. Radiographic Testing (RT)
   B. Ultrasonic Testing (UT)
   C. Visual Testing (VT)
   D. General Testing

2. Which of the following is not a feature of Visual Inspection?

   A. requires no special equipment
   B. very time consuming
   C. inexpensive
   D. requires good eyesight

3. Because visual inspection is the simplest of the NDT methods definite procedures are not required only common sense and the possession of the proper code book are necessary

   A. True
   B. False

4. Using Visual examination how can plate laminations be observed?

   A. using Ultrasonic Inspection
   B. using a lamination gauge
   C. by inspecting a cut edge
   D. A and B

5. After a part has been fit up and is in position to be welded, the visual inspector should inspect the following to assure the quality of the welded joint. (select more than one)

   A. root opening
   B. edge preparation
   C. weld metal tensile strength
   D. density of the base metal

6. Because of the large number of variables that can cause defects, which weld layer or pass is considered the most important?

   A. root pass
   B. hot pass
   C. fill pass
   D. cap pass

7. From the list below which is (are) weld defects that cannot be detected by visual inspection?

   A. undercut
   B. cracks
   C. overlap
   D. slag inclusions

8. Which weld cleaning operation from the list below, may harm the surface of the weld and mask surface defects?

   A. chipping hammer
   B. shot blasting
   C. power wire brushing
   D. all of the above

9. Select from the list below, the feature that is not desirable, when marking a weld for repair.

   A. a distinctive color should be used
   B. easy to apply
   C. marking material that will not damage material
   D. Permanent enough so that repair and reinspection can take place

10. For visual inspection to be a valuable welding tool, it should take place?

   A. prior to welding
   B. during welding
   C. after welding
   D. all of the above

11. Select those items from the list below that are considered limitations of visual inspection (VT).

   A. requires little training
   B. economical
   C. defects must be on surface
   D. many applications

12. Which type of weld does a visual welding inspector determine the weld size by measuring its leg?

   A. Butt weld
   B. Spot weld
   C. Pipe weld
   D. Fillet

13. When acceptance of welds with regard to appearance is a major factor the visual inspector may use.

    A. a workmanship standard
    B. another NDT method
    C. an appearance gage
    D. none of the above

14. When detailed written visual procedures are not available, the inspector maybe required to work directly with:

    A. his own insight and ideas of what is acceptable
    B. codes
    C. specifications
    D. B and C

15. Any conscientious quality control program consisting of visual inspection, which includes a continual sequence of examinations performed during all phases of fabrication will:

    A. add cost to a project and should be avoided
    B. will allow visual inspection of the exposed surfaces as they occur in the fabrication sequence
    C. assure a 100 % defect free project
    D. none of the above

16. What is a hold point as applied to visual examination?

    A. the fabrication will hold up a project until additional payments are made
    B. a welder must hold the electrode at a set angle or hold point
    C. a point in time where an examination is to occur prior to any further work
    D. the end of a job

17. Visual examination of joint fit-up, prior to welding is of the highest priority. Which items from the list below should be inspected by the visual inspector? (select more than one)

    A. groove angle
    B. root pass
    C. joint alignment
    D. convexity
    E. joint cleanliness
    F. maximum weld reinforcement

18. From the list below select the items that a visual welding inspector would perform during welding that require the aid of a special tool.

    A. quality of root
    B. sequence of weld passes
    C. cleaning between passes
    D. interpass temperature

19. What type of weld defect can be avoided with adequate cleaning between weld passes?

    A. slag inclusions
    B. overlap
    C. incomplete joint penetration
    D. cracks

20. The type of weld discontinuities, which can be detected by visual examination and are almost never allowable when the structure is subject to cyclic or fatigue loading are?

    A. overlaps
    B. cracks
    C. slag inclusions
    D. porosity

VT QUIZ 1 **Name: ___________________**

1. Visual inspection is a method of ____________________________________.

2. Nondestructive testing does not destroy or impair the usefulness of the materials being tested.

   A. True B. False

3. Inherent discontinuities occur during _________________________________.

4. Lamination occur in bar stock.

   A. True B. False

5. Welding pipe and tubing is formed by drawing a flat strip of metal through a __________ __________ or sets of ______________.

6. Weld metal in excess of the quantity require to fill the joint is called the __________ ______________.

7. The heat affected zone is the area of the base metal which has been melted.

   A. True B. False

8. Dirt or moisture on the surface of the base metal or contaminated welding consumables can cause ______________.

9. Undercut, under fill and overlap are easily detected by ____________ inspection.

10. Arc strikes may require removal by grinding and inspection by ___________ ____________ _______________.

11. Arc welding requires a protective atmosphere to protect the weld from ___________ ___________.

12. Inclusions are classed as ___________ and _______________.

13. Rule or scale accuracy is limited to

    a. .015
    b. .001
    c. .0015
    d. .005

14. Protractors are used to measure
    a. thickness of steel plate
    b. thread pitch
    c. depth of holes and recesses
    d. angular relationships

15. Weld inspection gages measure
    a. weld preparation angles
    b. height of weld metal
    c. length of weld
    d. a and b above

16. The accuracy of a venire micrometer is

    a. .001
    b. .0001
    c. .005
    d. .010

17. Consistent accuracy is dependent on the

    a. strength of the inspector
    b. sense of sight
    c. sense of feel
    d. both b and c

18. The numbered lines on the micrometer barrel or sleeve represents

    a. .100, .200, .300
    b. .001, .002, .003
    c. .01, .02, .03
    d. 1000, 2000, 3000

19. Telescoping gages measure

    a. outside diameter
    b. surface finish
    c. inside diameters
    d. fillets and radii

20. The weld gage will measure
    a. Undercut
    b. Filler metal type
    c. Weld metal temperature
    d. Area of heat affected zone

21. A visual inspector's most valuable asset is ___________ ___________.

22. Illumination intensity is measured in ____________ _______________.

23. Flashlights and extension-drop lights provide _____________ ____________.

24. Power of a magnifier is designated by the letter _________________.

25. The flexible bore scope operates entirely with ____________ ____________.

WELDING DEFECTS

A listing and description of defects important to weld quality is presented, with notes on appearance, cause, and effect, emphasizing radiographic appearance and interpretation from radiographic film.

Although radiography is emphasized, the appearance of defects and the quality evaluation inspectors understanding of appearance and causes is important for all methods of nondestructive examination

Various illustrations of weld defects are included.

A – WELDING DEFECTS

Condition	Probable Cause	Radiographic Image
Cracks		(1)A crack is a rupture of solidified metal(2) Very often other small cracks of hair line width branch off from the main crack. (3) Dangerous small cracks often appear in the first pass, particularly in the inside reinforcement of pipe welds made without a cover pass on the back side of weld. They appear as a straight narrow line exactly centered in a zone of lower image density, corresponding to the inside of the reinforcement.
1. Transverse Crack	A rupture in the weld perpendicular to the axis of the weld	A darkened line relatively straight, but may be curved or irregular, assuming the position and direction indicated.
2. Longitudinal Crack	A rupture in the weld metal predominately in the center and parallel to the weld.	A darkened line relatively straight, but may be curved or irregular, assuming the position and direction indicated.
3. Base Metal Crack	A rupture in the base metal, normally in the heat affected zone	As the plane of the crack deviates from the direction of the radiation beam, the appearance becomes an increasingly broad and poorly defined line. May appear intermittent.
4. Fusion Zone Crack	A rupture in the base metal which originated in the fusion zone.	Crack image particularly if coarse-grained films are used, may not appear very clear

5. Crater Crack	Occurs occasionally when the welding is interrupted improperly.	A fine irregular or star shaped darkened area cracks criss-cross and proceed only to the edge of the crater.
6. Incomplete Penetration (lack of)	Occurs at the root of welds designed for through penetration where full penetration has not been achieved - weld metal failing to fuse to the base metal.	That may be either continuous or intermittent in center of weld (butt) edge of weld (fillet) The indication may be thin and sharp, broad and diffused or two parallel lines, depending upon the specific geometry of the joint and the width of the discontinuity.
7. Incomplete Fusion (lack of)	Caused by molten weld metal, which has failed to bond to the base metal or to a previously deposited weld bead.	Dark indications usually elongated and varying in length and width. May be intermittent or continuous.
8. Porosity (Gas Pockets)	Occurs as voids caused by gas trapped in the weld deposit. Gas pockets are not peculiar to any one spot in the weld and may be fairly well scattered.	Spherical voids have the appearance of a rounded dark area while the non-spherical voids have an elongated dark area with smooth outline. Can be scattered fine or coarse, clustered, elongated, linear or worm hole(pipe).

9. Slag Inclusions	Particles of slag entrapped in the weld metal or along the fusion planes. Due to their low specific gravity, these compounds tend to seek the upper surface of the molten metal. The distance of the slag line from the center of the weld can indicate the probable depth of the slag area if the angle of the bevel is known.	Isolated slag deposits usually form an irregular body and are most frequently found at the edge or fusion line of the particular bead. The most frequent type of slag deposits are found between the first or root pass and the second pass. Such slag deposits may be quite long and appear as lines of some width. Where such lines are found on both sides of the root bead, they are commonly referred to as ”wagon tracks”. These frequently have considerable length but seldom are of excessive width. Isolated slag pockets on the other hand frequently have decided width as well as length. Generally the density of a slag inclusion is rather uniform throughout.
10. Burn through	Melting of the metal from the root of the weld or through the backing strip. This discontinuity occurs in seams welded from one side only.	Darkened area of elongated or rounded contour, which may be surrounded by a lighter ring. Where such an area is indicated merely by a circle, the second pass has filled the original defect. Frequently, an area will appear only slightly darker than the weld density, but will contain a very black line in the center. This indicates that the second pass filled the original hole in the root pass, but that a shrinkage crack has developed at this point. Such shrinkage cracks may extend entirely through the second pass.

11. Undercut	Longitudinal groove melted into the base metal adjacent to the toe of the weld. Another type of undercut may occur in backing strip joints where the backing strip is left in place. It is caused by melting away of the base metal at the root. This type is generally termed root undercut.	Dark linear indication of indistinct outline adjacent to the edge of the weld. Root undercut - appears as a relatively straight and narrow dark line and can be located on either one or both sides of the root opening location.
12. Icicles (Teardrops)	Fused droplets of weld metal extending beyond the root of the weld, occurring in seams welded from one side only.	Rounded lighter indications with an occasional small dark spot in the center of the drop.
13. Tungsten Inclusions	Tungsten particles entrapped in the weld deposits considered local stress risers.	Lighter than surrounding areas and may be rounded or irregular. Can be in clusters or rectangles.

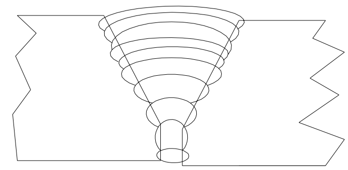
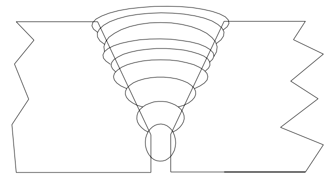
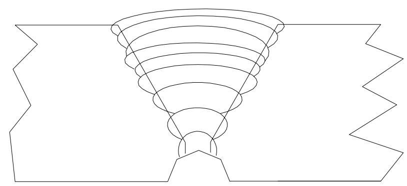
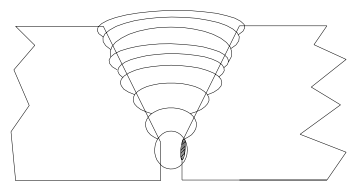
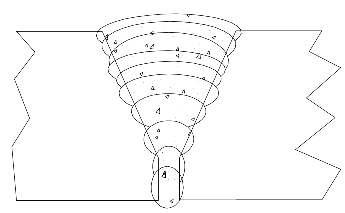
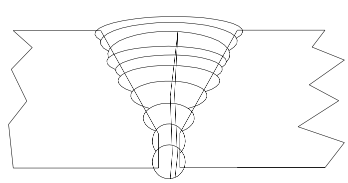
WELDING DEFECTS
(Surface)

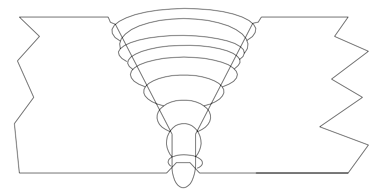
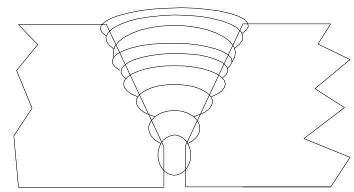
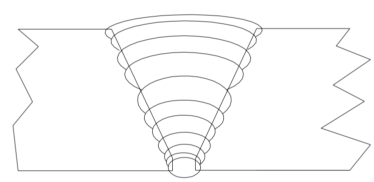
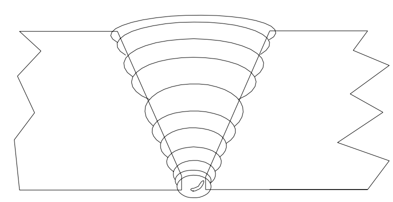
Condition	Probable Cause	Radiographic Image
1. Incompletely Filled Weld Grooves	Insufficient deposit of weld metal to fill groove to edge of base metal.	This lack of material is imaged by increased density in the corresponding areas.
2. Concavity at the Weld Root	A concave surface at the root of the weld; occurs particularly in pipe welding without cover pass on the root side.	Consists of a dark line in the center of the weld. It cannot be mistaken for lack of penetration, since the line is broader and lacks sharp boundaries.
3. Excessive Reinforcement	If a weld is made with an excessive number of passes or with inadequate arc current or the speed of travel in submerged arc welding is too slow, the weld reinforcement will be too convex and too high.	Because of the abrupt change in thickness at the boundary between the base metal and the reinforcement, the image will show lowered density at the edge of the reinforcement adjacent to the base metal.
4. Overlap	If an excess of metal is deposited in the final pass, or if inadequate current or speed of travel is used in submerged arc welds, the deposited metal may overlap the base metal, causing lack of fusion at the edges of the reinforcement.	This peculiar profile is indicated by an abrupt change in density between the parent metal and the reinforcement. The edge of the reinforcement characteristically shows an irregular waviness often containing gas inclusions.

5. Excessive Penetration	Molten metal runs through the root of the weld groove, producing an excessive reinforcement at the backside of the weld. In general, this condition is not continuous but has an irregular shape with characteristic hanging drops of excessive metal (teardrops)	A line of lowered density in the center of the weld; irregularities in the shape are accompanied by corresponding irregularities in density. Round white spots in the center of the weld corresponds to hanging drops of metal. These often contain blow holes
6. Longitudinal grooves	In horizontal, multiple pass welds, the last pass may fail to form a smooth top surface. Instead, longitudinal grooves may appear in the surface of the deposited metal, paralleling the weld bead.	These thickness variations produce dark lines corresponding to the reduced metal thickness at the grooves. Their diffused edges cannot be mistaken for images of slag lines, which are sharper and thinner. In addition, the dark lines corresponding to the grooves are rarely exactly straight.
7. Undercutting	The exposed upper edges of the beveled weld preparation tend to melt and run down into the deposited metal, resulting in a groove, which may be either with more or less sharp edges paralleling the weld reinforcement.	A dark line of varying width and extent, readily seen between the lower image density zones corresponding to the reinforced base metal.

8. Out of Line weld Beads	Insufficient care in positioning automatic welding machines, or careless chipping out of the backside of single-vee welds so that the groove is displaced from the root of the weld, this leads to misalignment of the two weld beads.	Because of the added thickness of the reinforcements, misalignment is evident by the displacements from the centerline of the images of the two weld reinforcements. In the case of the single-vee weld preparations, misalignment is clearly seen. The width of the root reinforcement is much less than that of the cover pass reinforcement, so its image appears clearly and can be discriminated from the image of the front surface reinforcement.
9. Irregularities at Start and Stops	A reduction in reinforcement thickness can result at the end of the bead laid by the first electrode, followed by an increase thickness at the point where the new electrode was started.	Shows a crescent shaped indication with lower density followed by higher image density as the reinforcement returns to normal thickness in the direction of travel. Sometimes, small slag inclusions occur at the point of electrode change.
10. Grinding Marks	When weld reinforcements are not ground out smoothly, the resultant thickness varies above and below that of the base metal.	Show variously shaped areas of uneven image densities usually with sharp contours. Such indications from the grinding wheel are recorded just like surface tool marks of any kind.
11. Spatter of Weld Metal	Droplets of molten metal splattered about the weld region. These drops stick to the surface of the metal near the weld seam.	Since they correspond to local areas of increased thickness, their radiographic images consist of light round spots.

12. Arc Strikes Arc-Starting Marks (Spitting)	When the welding arc is started or displaced during welding out onto the base metal surface beside the weld groove, an irregular deposit of filler metal occurs on the base metal near the weld seam. In some cases this deposit is accompanied by an indentation due to melting of the base metal where the arc was struck.	Consists of a lowered density spot corresponding to the irregular shape of the deposited metal, often accompanied by an irregular dark spot where the arc has melted into the base metal.

High-low is defined as a condition where the pipe and /or fitting surfaces are misaligned.	
Inadequate penetration is defined as the incomplete filling of the weld groove with weld metal	
A burn-through area is that portion in the root bead where excessive penetration has caused the weld puddle to be blown into the pipe	
A slag inclusion is a non-metallic solid entrapped in the weld metal, or between the weld metal and the pipe metal. Elongated slag inclusions are usually found at the fusion zone. Isolated slag inclusions are irregularly shaped inclusions and may be located anywhere in the weld.	
Porosity or gas pockets are voids occurring in the weld metal. Maximum distribution of gas pockets is usually determined by code or standard.	
Welds containing cracks, regardless of size or position are not normally acceptable	

Undercutting is the burning away of the side walls of the welding groove at the edge of a layer of weld metal, or the reduction in the thickness of the pipe wall adjacent to the weld and where it is fused to the surface of the pipe.	
The term "internal concavity" as used in the paper shall mean a bead which is properly fused to and completely penetrated the wall thickness along both sides of the bevel, but the center of the bead is somewhat below the inside surface of the pipe wall. The magnitude of the concavity shall be defined as the perpendicular distance between an axial extension of the pipe wall surface and the lowest weld bead surface point.	
Incomplete fusion is defined as the lack of bond at the root of the joint or at the top of the joint between base metal and weld metal.	
Hollow bead is elongated linear porosity occurring in the root pass.	

CRACKING

The result of localized stress, which at some point exceeds the ultimate strength of the metal.

TYPES OF CRACKING FOUND – Longitudinal, Transverse, Crater, Underbead

CAUSES	**PREVENTION**
A. Releasing lineup equipment to soon.	A. Complete stringer or root pass before releasing lineup equipment. (In some cases two passes may be required.
B. Cold weather.	B. Preheat when necessary. Use required number of welders on large pipe. Once welding is started don't stop on a stringer bead. Clean stringer beads at once. Run hot pass as soon as possible. Protect weld from rapid cooling.
C. High carbon pipe.	C. Change welding procedure and rod type
D. Excessive preheat.	D. Use correct heats.
E. Tack welds not reworked.	E. Use proper procedure for reworking tack welds.
F. Rapid cooling.	F. Follow a proper welding procedure.
G. Insufficient preheating.	G. Follow a proper welding procedure.
H. Initial bead to small.	H. Follow a proper welding procedure

Note: As bead size increases, cracking possibilities also increase, therefore, small or medium size beads laid in correct sequence and position result in the best type pipeline joint. Where large beads are necessary the joint must be protected from rapid cooling, in some cases stress relieving may be necessary.

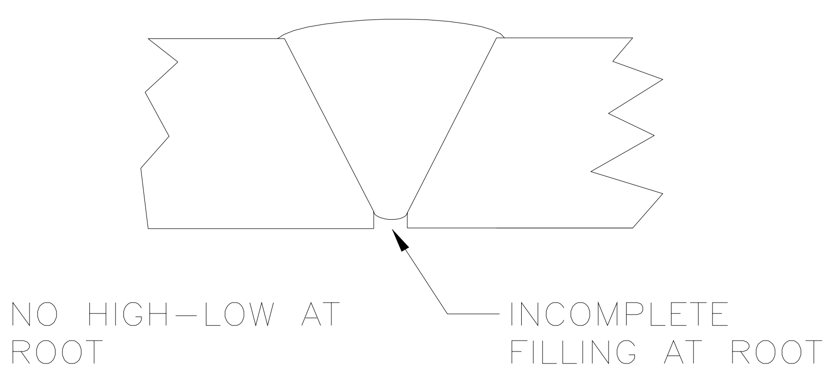
INADEQUATE PENETRATION

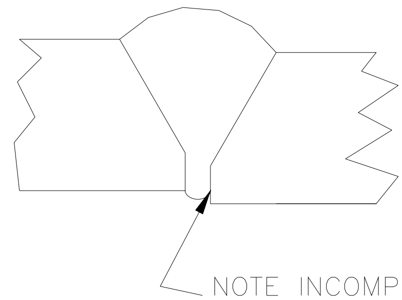
A condition existing in groove welds when the deposited metal and base metal are not fused at the root of the weld (inside the pipe wall).

CAUSES	PREVENTION
A. Areas of base metal above the root of the weld reaching the molten condition before proper temperature is obtained at the root such as would occur with no bevel or with improperly beveled pipe ends.	A. Utilize proper welding current for electrode size and type being used.
B. Use of too large an electrode in the root pass; e.g. A 3/16” rod is too large, and will not penetrate far enough into the space between abutting ends of the pipe.	B. Use proper size electrode.
C. Not enough space provided between pipe ends in the lineup (root opening).	C. Space root opening properly during lineup.

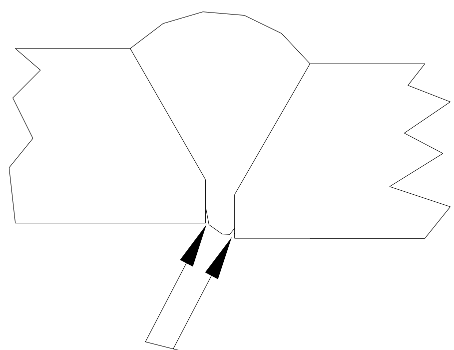
Note: Some welders will try to overcome © by using 1/8” rod. This is normally not allowed since 1/8” rod is not considered adequate for vertical down field welding conditions.

ONE OR BOTH BEVELS MAY BE INADEQUATELY FILLED AT THE INSIDE SURFACE.

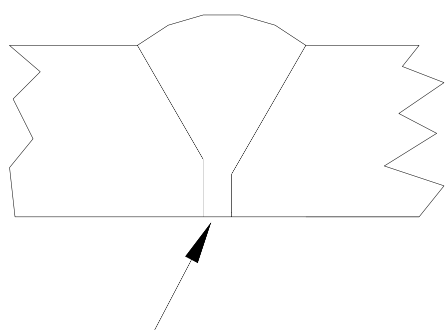




INADEQUATE PENETRATION DUE TO HIGH LOW



INADEQUATE PENETRATION DUE TO HIGH LOW

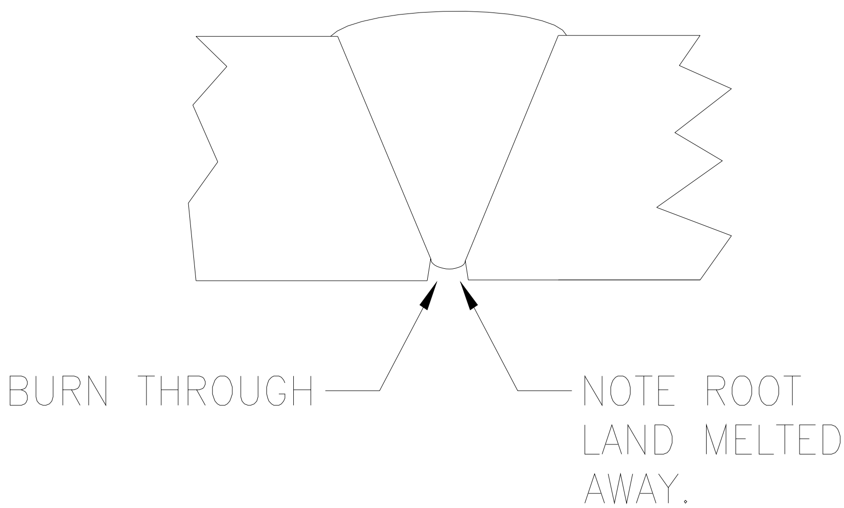


INADEQUATE PENETRATION DUE TO INTERNAL CONCAVITY

BURN THROUGH

Excessive penetration causes weld puddle to be blown into the pipe.

CAUSE	PREVENTION
A. Excessive welding heat.	A. Correct current rates.
B. Poor electrode manipulation.	B. Correct technique.
C. Thin stringer bead.	C. Correct size rod
D. Excessive space in lineup.	D. Proper lineup.
E. Lamination of pipe wall	E. Correction is at the steel mill. 1. Field method for correction- begin cutting at the pipe end, cut longitudinally back until lamination disappears. Make several cuts around periphery of pipe to be certain that metal is good. Rebevel pipe before welding.



INCOMPLETE FUSION

Failure to fuse together adjacent layers of weld metals or adjacent weld metal and base metal.

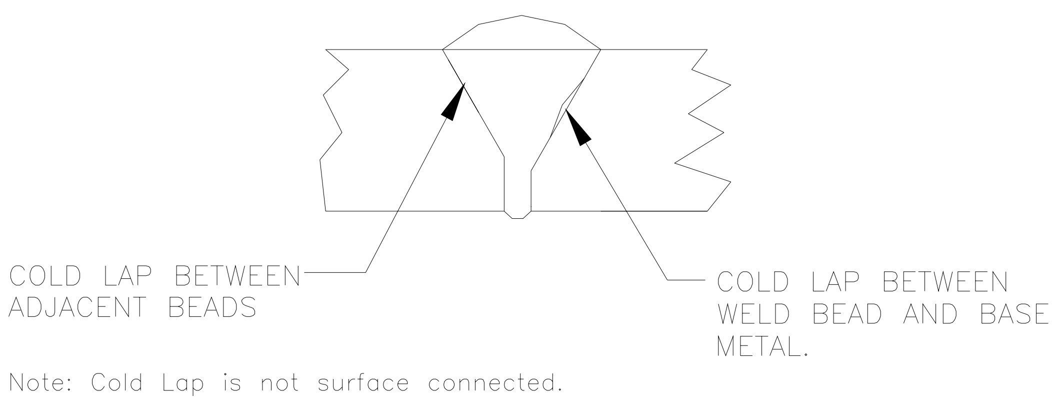
CAUSE

Failure to raise the temperature of the base metal (Or previously deposited weld metal) to the melting point, or to dissolve, by means of flushing. The oxides or other foreign material present on the surface to which the deposited metal must fuse.

PREVENTION

1. Maintain surfaces free from foreign matter.
2. Use proper heat and electrode manipulation.
3. Once a welding pass is started it should be completed with a minimum of interruption. When starting with a new rod, manipulate arc back into previously deposited weld to insure complete fusion.

INCOMPLETE FUSION AT ROOT OF BEAD OR TOP OF THE JOINT



INCOMPLETE FUSION DUE TO COLD LAP

SLAG

Oxide and other solids found as elongated and globular inclusions – sometimes called wagon tracks when it continues on both sides of a pass. (This normally occurs on the stringer or initial pass).

CAUSE

A. Use of too large a size electrode particularly on the stringer pass.

B. Failure to remove all slags between weld beads or between welds beads parent metal before welding another pass.

C. Improper welding technique and cleaning procedures.

D. Gap too narrow and/or land too large.

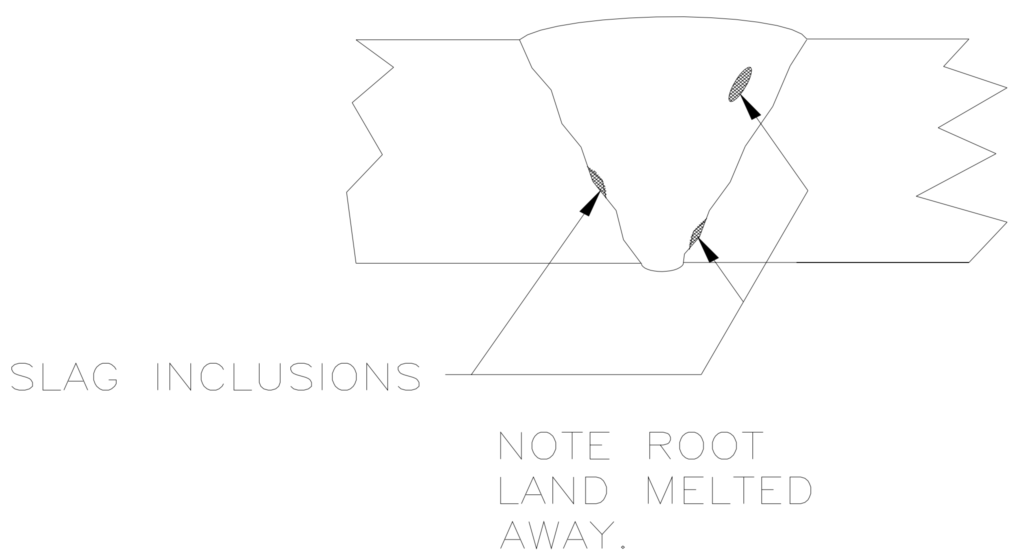
PREVENTION

A. Use a size electrode that will penetrate to the bottom of the bevel.

B. Clean, Clean ,Clean Use higher current and arc length on second pass.

C. Clean the weld joint. Use proper rod size and current. Angle of electrode is very important especially in downhill welding. Each pass must be cleaned thoroughly as made, do not depend on arc force to wash or float all oxides to surface.

D. Use a qualified welding procedure. Making sure that you use a approve root opening and land width.

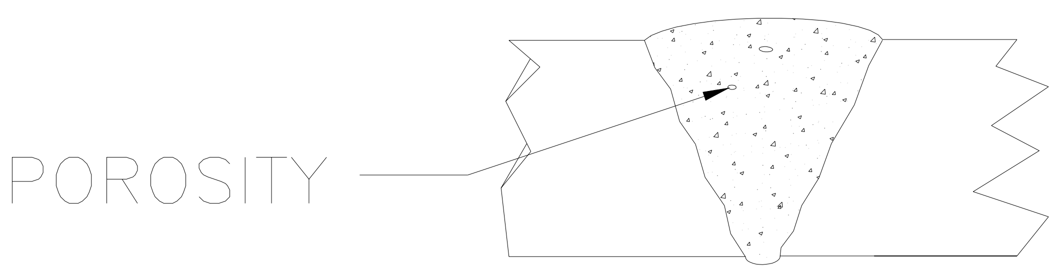


SLAG LINES
(WAGON TRACKS)

POROSITY

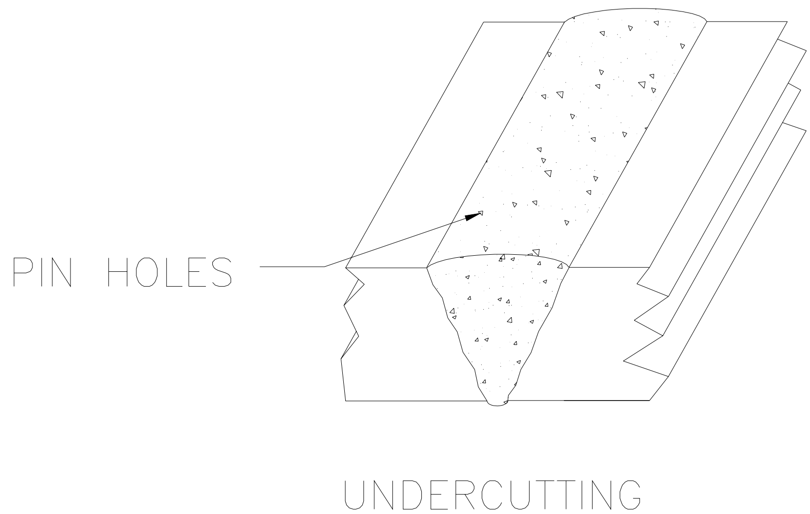
A type of globular void free of any solid material also referred to as gas pockets.

CAUSES	PREVENTION
A. Excessive welding heat	A. Use recommended amperage for rod being used. Various coatings require different current rates.
B. Incorrect electrode manipulation.	B. Work area must be large enough to permit welder to obtain correct angle between welding rod and the work. Also permitting free movement of the rod.
C. Damp electrodes or high winds.	C. Keep rods dry. Do not take out an excessive supply of rods. Use windscreens when necessary. Store electrode at recommended temperature and conditions.
D. Improperly maintained welder.	D. Maintain welder and cables according to manufactures recommendations.
E. Excessive travel speed.	E. Maintain recommended welding speed.



Porosity (PIN HOLES) on Cover Pass

CAUSES	**PREVENTION**
A. Electrode too dry or wet.	A. Proper electrode storage.
B. Poor technique (excessive speed etc.)	B. Proper technique
C. Cover pass too wide.	C. Proper width cover pass
D. Rusty or Dirty Material.	D. Properly clean material.



UNDERCUTTING

The melting or burning away of base metal.

CAUSES	**PREVENTION**
A. Excessive welding heat.	A. Properly maintain equipment to insure proper welding parameters.
B. Poor technique (arc length too long etc.)	B. Proper technique
C. Cover pass too wide.	C. Proper width cover pass
D. Rusty or Dirty Material.	D. Properly clean material.

VISUAL EXAMINATION

TABLE OF CONTENTS

1.0 SCOPE

1.1 Requirements

This procedure covers the general requirements for direct and remote examination of materials as may be required by the client's specifications and by various codes under which a component or system is being designed and manufactured.

1.1.1 This procedure is not intended to cover the visual examination involved in interpretation of other non-destructive examination methods such as radiography, ultrasonic, magnetic particle, liquid penetration, hydrostatic testing, leak testing, or eddy current.

1.1.2 This document meets the minimum requirements of the ASME Code, Section V, Article 9, and any other code or specification referencing the methods for visual examination as defined by ASME, Section V, Article 9.

1.1.3 This document meets the minimum requirements of API- 1104, Sixteenth Edition, May 1983, Section 5.0.

2.0 GENERAL

2.1 Visual examination as performed to this procedure is direct visual examination or remote visual examination (using such visual aids as mirrors, bore scopes, cameras, magnifiers, etc.). The effectiveness of the examination primarily depends on the resolution of the examination technique, the expertise of the technician, the visual acuity of the technician, and the acceptance standards.

2.2 In order to perform visual examination of materials to this procedure, it may be necessary for the client to provide the following information in writing:

a) Identify the material to be examined. This information should include the project or contract designation, the component or piece, mark the area(s) to be examined with respect to location on the component or piece, and the site.
b) How visual examination is to be performed.
c) Type of surface condition available.
d) Method or tool for surface preparation, if any.
e) Whether direct or remote viewing is used.
f) Special illumination, instruments, or equipment to be used, if any.
g) Sequence of performing examination, when applicable.
h) Date to be tabulated, if any.
i) Report forms or general statement to be completed.
j) The acceptance standards to be used.
k) When applicable, the marking system required.

3.0 REFERENCES

3.1 The following documents, of the issue in effect as called out on the purchase order or contract, have been referenced in the preparation of this procedure and are considered a part of this procedure as applicable:

- **American Society of Mechanical Engineers (ASME)**

  I Power Boilers
  V Nondestructive Examination
  VIII Div. 1 Pressure Vessels
  VIII Div. 2 Alternate Rules, Pressure Vessels

- **American Petroleum Institute (API)**

  API-1104 Standard for welding pipelines and related facilities.
  API-650 Welded steel tanks for oil storage.
  API-653 Tank inspection, repair, alternation, and reconstruction.
  API-1107 Recommended pipeline maintenance welding practices.

- **American Welding Society (AWS)**

  ANSI/AWS D1.1 Structural Welding Code

- **American Society for Nondestructive Testing (ASNT)**

  SNT-TC-1A Nondestructive testing personnel Qualification and Certification.

- **PCC Procedures**

  QC-OO1 Procedures for the qualification and certification of nondestructive examination personnel to SNT-TC-1A and alternative 1.

4.0 PERSONNEL

4.1 Personnel performing visual examination to this procedure shall be qualified and certified in accordance with PCC "Procedures for the Qualification and Certification of Nondestructive Examination Personnel to SNT-TC-1A and alternative 1". (Note: SNT-TC-1A has been used as a guide in the preparation of this procedure.)

4.2 Only certified Level II, Level III, or AWS QC-1 personnel shall interpret examination results to determine acceptability.

4.3 Visual Inspection Personnel - All personnel responsible for conducting in-process and final visual inspections must be familiar with the acceptance standards specified.

4.4 Annual Visual Tests - All personnel responsible for performing visual inspections must take an annual vision test. If glasses are required for use on the job (Corrected/uncorrected), they must be worn during the vision test. PCC will maintain on file a record of the individual's vision test results.

5.0 EQUIPMENT

5.1 Lighting - For direct visual examination, the lighting shall be sufficient to provide for the required examination resolution. Lighting shall be considered sufficient when it is measured by a light meter and is found to be more than 32.5 foot candles at the surfaces to be examined or when a black line 1/32" wide on an 18% neutral gray card can be resolved under the worst conditions of lighting, angles of vision, etc., to be encountered in the examination. (See paragraph 6.2)

5.2 Visual Aids, including mirrors, bore scopes, cameras, remote controls, etc., when used as an integral part of the examination technique, shall be approved for use by the client and their use shall be noted on the Visual Examination Technique Record. Visual aids not used as an integral part of the examination (such as for verifying interpretation of an indication) need not be approved by the client.

5.3 Weld gages must be used during visual weld inspection. The size and shape of fillet welds and the amount of reinforcement of butt welds shall be checked by suitable gages.

6.0 PROCESS

6.1 Applications

Visual examination is generally used to determine such things as the surface condition of the part, alignment of mating surfaces, shape, or evidence of leaking. In addition, visual examination is used to determine a composite material's (translucent laminate) subsurface conditions.

6.2 Direct Visual Examination

Direct visual examination may usually be made when access is sufficient to place the eye within 24 inches of the surface to be examined and at an angle not less than 30 degrees to the surface to be examined. Mirrors may be used to improve the angle of vision, and aids such as a magnifying lens may be used to assist examinations. The specific part, component, vessel, or election thereof, under immediate examination, shall be illuminated, if necessary with flashlight or other auxiliary lighting, to attain a minimum of 15 fc for general examination and a minimum of 50 fc for the detection or study of small anomalies. Visual examination to assure natural or corrected near distance acuity such that they are capable of reading standard J- 1 letters on standard Jaeger test type charts for near vision or equivalent methods.

6.3 Remote Visual Examination

In some cases, remote visual examination may have to be substituted for direct examination. Remote visual examination may use visual aids such as mirrors, telescopes, bore scopes, fiber optics, cameras, or other suitable instruments. Such systems shall have a resolution capability at least equivalent to that obtainable by direct visual observation.

6.4 Translucent Visual Examination

Translucent visual examination is a supplement of direct visual examination. The method of translucent visual examination uses the aid of artificial lighting, which can be contained in an illuminator that produces directional lighting. The illuminator shall provide light of an intensity that will illuminate and diffuse the light evenly through the area or region under examination. The ambient lighting must be so arranged that there are no surface glares or reflections from the surface applied through the area or region under examination. The artificial light source shall have sufficient intensity to permit "candling" any translucent laminate thickness variation. Classification of the visual imperfections shall be made as recommended in SD-2563, Article 28.

7.0 PROCEDURE

7.1 Time of Examination

The areas to be examined and the time of examination shall be specified by the client.

7.2 Surface Condition

The areas to be examined shall be free of oil, grease, dirt, lint, and other contaminants that might mask a discontinuity.

7.3 Technique

For a specific examination, the technique variables shall be recorded on a Visual Examination Technique Record. This technique record will be used to identify and repeat examination variables. A copy of the Visual Examination Technique Record shall be furnished with reports.

7.3.1 The following information shall appear on the Visual Examination Technique Record:

a) Identification of materials under examination and specification and acceptance standards to which the examination is to be made.
b) Whether the examination is to be made by direct visual examination or by remote visual examination.
c) Equipment to be used during the examination such as additional lighting, mirrors, bore scope, cameras, magnifiers, etc.
d) Instructions for showing location of unacceptable discontinuities on the report.
e) A checklist of indications, dimensions, or conditions to be recorded.
f) When direct examination is used, the maximum distance from the eye to the examination surface shall be 24 inches and the minimum angle between the eye and the examination surface shall be 30º, unless otherwise approved by the client.
g) Adequacy of the examination resolution.

7.4 Lighting

Lighting shall meet the requirements of Paragraphs 5.1 and 6.2.

7.5 Resolution of Examination

The resolution of the examinations shall be considered adequate when a black line 1/32" wide on an 18% neutral gray card can be resolved under the worst conditions of lighting, angles of visions, etc., to be encountered in the examination. The resolution may be proven at the time of the examination or may have been proven at a previous time for an examination having the same technique variables. Adequacy of resolution shall be documented on the technique record.

7.6 Examination

The required examinations shall be made in accordance with the Visual Examination Technique Record and a checklist for each specific examination. The checklist should be approved by the client.

7.6.1 Workmanship - Workmanship shall be in accordance with good commercial practices.

7.6.2 Dimensions and Tolerances - Parts shall be inspected for conformance with dimensions and tolerances specified on the drawings. Any dimensions falling outside the specified limits shall be cause for rejection.

7.7 Record able Data

Indications, dimensions, or conditions as listed in the checklist shall be recorded.

7.8 Examination of Repairs

Shall be done using the same procedure and technique used to detect and evaluate the discontinuities.

8.0 REPORTS

8.1 Checklist

An examination checklist shall be used to plan visual examination and to verify that the required visual observations were performed. This checklist establishes minimum examination and inspection requirements and does not indicate the maximum examination, which the Manufacturer may perform in process.

8.2 Visual Examination Report

A visual examination report shall be prepared and furnished to the client. A standard visual examination report form will be used unless otherwise requested by the client.

8.2.1 The report shall contain the following:

- Name of the company and the visual examination, procedure number, technician, level of certification, the contract number, job number, and date of the visual examination.

- The illuminators, instruments, equipment, tools, etc., shall be identified in the report to the extent that they or their equivalents can be obtained for future examination. This may be accomplished by referencing the visual examination procedure number.

- At the option of the Manufacturer, he may maintain one certification for each product, or several separate signed records based on the area or type of work, or both combined. Where impractical to use specialized visual examination personnel, knowledgeable production workmen may be used to perform the examination and to sign the report forms.

- Even though dimensions, etc., were recorded in the process of visual examination to aid in the evaluation, there need not be documentation of each viewing or each dimensional check. Documentation shall include all observation dimensional checks specified by the referencing Code Section.

- A drawing or sketch identifying and showing the location of the area examined and the item or piece number.

- Examination variables to permit repetition of the examination at a later date.

8.2.2 The required number of report copies will be furnished to the client.

- A minimum of one report copy will be kept on file at the PCC

9.0 ACCEPTANCE STANDARDS

9.1 Acceptance standards shall be as stated in the applicable specification (Code Section) or as specified by the client and shall be established prior to examination.

9.2 Weld Discontinuities - Weld and weld repairs must meet acceptance standards contained in the referenced specification code or standard.

a. Cracks
b. Undercut
c. Underfill
d. Fillet Weld Size
e. Concave or Convex Fillet Welds
f. Weld Reinforcement
g. Arc Strikes and Other Fabrication Scars
h. Porosity
i. Spatter
j. Slag
k. Offset
1. Overlap
m. Roughness
n. Burn Through and Melt Through
o. Incomplete Fusions and Incomplete Penetration

Contour Grinding - Welds shall be contour ground, when specified by the drawing and/or referenced specification, code or standard.

9.3 API-1104, Sixteenth Edition, May 1983, Section 6.0

10.0 FORMS and ILLUSTRATIONS

- Visual Inspection Report
- Weld Inspection Report
- Visual Inspection Report (Detail)
- Non-Conformance Report
- Weld Fillet Gauge
- Typical Wire Gage

	VISUAL INSPECTION REPORT	In Reply: Refer to: Date Page of

OWNER/CLIENT ______________________ ADDRESS ______________________

CONTRACTOR ______________________ SITE: ______________________

QC/QA INSP. ______________________ SPEC: ______________________
OWNER CONTRACTOR

DWG. NO. ______________________ OPER. PROC.: ______________________

ACTIVITY
SURVEYED ____

____

DETAILS AND COMMENTS
OF INSPECTION: ____

____

____

____

____

____

____

____

____

____

____

____

SATISFACTORY ☐ UNSATISFACTORY ☐ RE-SURVEILLANCE REQUIRED ☐

SIGNATURE
INSPECTOR ______________________ SIGNATURE
CONTRACTOR ______________________

INSPECTOR ______________________ CONTRACTOR ______________________

DATE ____________

Confidence Through Inspection

WELD INSPECTION REPORT

VISUAL INSPECTION REPORT

CUSTOMER				DATE
ADDRESS				REPORT NO.
JOB OR PROJECT		P. O. NO.		PLAN OR DWG. NO.
SURFACE CONDITION	HEAT NO.	HEAT TREAT BEFORE ☐ AFTER ☐	TYPE OF MATERIAL	TEMP. OF MAT'L.
NCR NO.	EXAMINATION STANDARD	ACCEPTANCE STANDARD	VISUAL PORCEDURE NO.	
PART NO.	TOTAL LENGTH EXAMINED FEET / INCHES	TYPE OF WORK NEW ☐ REPAIR ☐	NO. OF ITEMS ACCEPTED	NO. OF ITEMS REJECTED

WELD. PC NO. OR SN	ACC	REJ	DEFECT CODE	REMARKS	WELD. PC NO. OR SN	ACC	REJ	DEFECT CODE	REMARKS

DEFECT CODE
C – Cracks P – Porosity NF – Non-Fusion LI – Linear Indication S – Slag LA – Lamination OTHER – Sp

_______ IN _______ A.M. OUT _______ A.M. Technician _______ SNT-TC-1A Level/QC-I _______

_______ _______ P.M. _______ P.M. Asst. Technician _______ SNT-TC-1A Level/QC-I _______

_______ Total Hours at Jobsite Customer _______

_______ Lunch _______ Standby _______ Travel Witnessed by _______
Signature

_______ Total Hours _______ Total Mileage Page _______ of _______

Confidence Through Inspection

FORM N.D.E.1-3 Assumes no responsibility for losses of any kind due to interpretation.

		In Reply:
		Refer to:
	VISUAL INSPECTION REPORT	Date
		Page of

DETAILS AND COMMENTS (CONTINUED)

SATISFACTORY ☐ UNSATISFACTORY ☐ RE-SURVEILLANCE REQUIRED ☐

SIGNATURE INSPECTOR ______ SIGNATURE CONTRACTOR ______

INSPECTOR ______ CONTRACTOR ______

DATE ______

Confidence Through Inspection

NONCONFORMANCE REPORT

PAGE ____ OF ______

DATE ______

ISSUED TO ______ REPORT NO. ______

RECEIVED BY ______ DATE ______ TIME ______

DATE ______ TIME ______ ISSUED BY ______

PART NUMBER	PART NOMENCLATURE	PART IDENTIFICATION

RELATED DOCUMENT(S)

P.O. ______ SPECIFICATION ______

DWG. ______ PROCEDURE ______

OTHER ______

DESCRIPTION OF THE NONCONFORMANCE ______

CORRECTIVE ACTION IMPLIMENTED

DISPOSITION

ALTERNATE DISPOSITION

1. ☐ ACCEPT-AS-IS ______
2. ☐ REWORK ______
3. ☐ REPAIR ______
4. ☐ REJECT ______

SUBMITTED BY ______ ORGANIZATION ______ DATE ______

CORRECTIVE ACTION RESULTS:

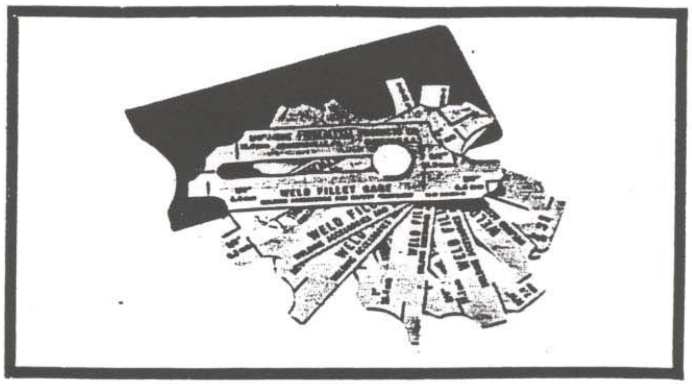
APPROVED BY ______ ENGINEERING ______ DATE ______

CONCURRENCE ______ QUALITY CONTROL ______ DATE ______

FORM 1280

Confidence Through Inspection

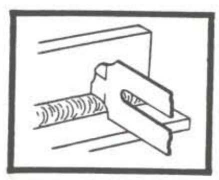
WELD FILLET GAGE

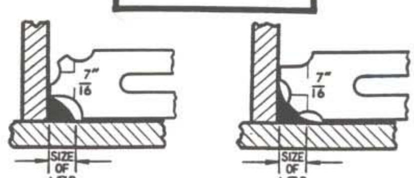


A PRECISION WELD INSPECTION INSTRUMENT

HOW TO USE:

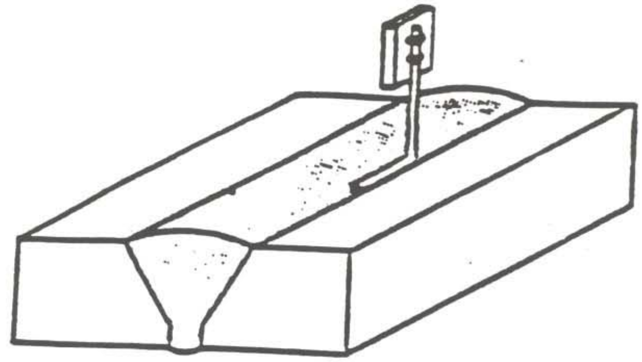
Measure convex or concave welds, (see below). Be certain blade edge is square with welded parts. For convex welds: use blade with single arc at appropriate size. For concave welds: use blade with double arc at appropriate size.

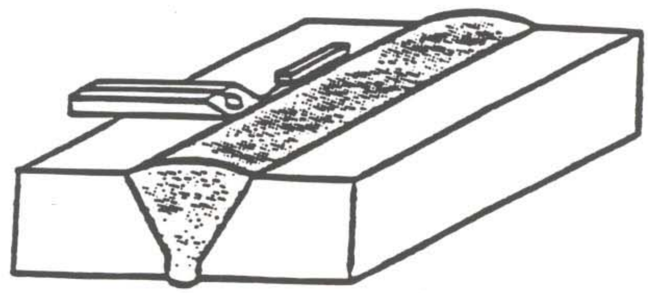




CONVEX WELDS CONCAVE WELDS

TYPICAL WIRE GAGES USED TO MEASURE UNDERCUT





11.0 DEFINITIONS

Any weld deposited in accordance with a structural, pressure vessel and pipe welding procedure written to meet specified requirements. Structural welds include the following:

a. Tack welds
b. Attachment welds
c. Miscellaneous outfitting welds
d. Surfacing welds
e. Welds and weld repairs to structural base materials (including castings)
f. Completed structural welds

Structural welds do not include welds deposited in accordance with piping, machinery, or pressure vessel welding procedures.

Surfacing Welds - A type of weld deposited on a surface to enlarge it or provide desired properties (e.g., build-up, buttering, cladding, corrosion resistant overlays, and hard facing).

Competed Weld - A weld that is competed and is ready for final visual inspection.

Finished Weld - A weld that has received final inspection and has been accepted.

Discontinuity - Any imperfection in the normal structure or configuration of a weld or the base metal. Some discontinuities are not harmful and do not need to be repaired.

Defect - Any discontinuity that must be repaired to be acceptable.

Sound Metal - Metal that contains no discontinuities, except as allowed in the referenced specification, code or standard.

Back Gouging - Gouging to sound metal of the back side of a partially welded joint to assure complete penetration. When a weld is back gouged, the gouged out surface is know as a back gouged root surface.

Repair Excavation - Gouging to sound metal in an area to remove a defect.

Welder - Anyone who is currently qualified to weld.

Face of Weld - The surface of a weld on the side from which the welding was done.

Toe of Weld - The points where the face of a weld joins the base metal.

Root of Weld - The points where the back of the weld joins the base metal.

Leg of Fillet Weld - The distance from the root of the joint to the toe of the fillet weld.

Throat of Weld - The shortest distance from the root of the weld to its face.

PCC
Visual Inspection
LAB 1

OBJECTIVE:

To familiarize the student, with the procedures and application of Visual inspection using the information and data learned in class. Normal industry accepted inspection equipment will be used.

PROCDURES:

1. The instructor will provide a sample of a unwelded joint to be inspected. Along with a qualified joint design and welding procedure. The student will conduct and document the proper pre-weld inspections according to specifications.

2. Students may work in groups of two or as individuals.

3. Joint may or may not include irregularities.

4. Each student must write up a complete report containing lab 1. Using provided form Student should use one of the discussed methods to preserve indications if applicable.

5. Each student should be able to use any and all equipment as discussed or demonstrated in class.

PCC
Visual Inspection
LAB 2

OBJECTIVE:

To familiarize the student, with the procedures and application of Visual inspection using the information and data learned in class. Normal industry accepted inspection equipment will be used.

PROCDURES:

1. The instructor will provide a sample of a unwelded joint to be inspected. Along with a qualified joint design and welding procedure. The students document the proper observations and inspections according to specifications that would be necessary during the actual welding of the Joint.

2. Students may work in groups of two or as individuals.

3. Joint will be completed under an industry standard or code.

4. Each student must write up a complete report, containing lab 2. Using provided form. Student should use one of the discussed methods to preserve indications if applicable.

5. Each student should be able to use any and all equipment as discussed or demonstrated in class.

PCC
Visual Inspection
LAB 3

OBJECTIVE:

To familiarize the student, with the procedures and application of Visual inspection using the information and data learned in class. Normal industry accepted inspection equipment will be used.

PROCDURES:

1. The instructor will provide a sample of a welded joint to be inspected. Along with a qualified joint design and welding procedure. The student will conduct and document the proper post-weld inspections according to specifications.

2. Students may work in groups of two or as individuals.

3. Joint may or may not include irregularities.

4. Each student must write up a complete report, containing lab 3. Using provided form Student should use one of the discussed methods to preserve indications if applicable.

5. Each student should be able to use any and all equipment as discussed or demonstrated in class.

NONDESTRUCTIVE EXAMINATION REPORT

Job No. and Project Location		Date
Surface Condition	Time of Examination Before PWHT ☐ After PHWT ☐	Iso/Dwg Number
Type of Examination PT ☐ MT ☐ UT ☐ Other ☐	Type and Temp. of Material	NDE Procedure No.
Specification Standard	Acceptance Standard	

Defect Code

C-Cracks P-Porosity NF-Nonfusion S-Slag R-Rounded L-Linear Other Specity

Part or Weld Number	ACC	REJ	Defect Code	Remarks

Notes: ______________________

Enclosure Added: Yes ☐ No ☐

Examiner, Level II

Witnessed by

Form 104 8/76