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FYI

Angle of View

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Direct visual testing is a technique of the visual testing method of nondestructive testing. Direct visual testing differs from indirect techniques, sometimes called *remote* visual testing, because the direct inspector is in the presence of the test object and has an unmediated view of the test surface, even if he looks through a device such as a magnifier or camera. In indirect techniques, the inspector uses a borescope or remotely controlled camera to view surfaces otherwise inaccessible.

Viewing Angle

The eye muscles can manipulate the eye to align the image on the lens axis. The angle may change the quality and quantity of the light energy reaching the retina. Even variations in color and contrast affect depth perception.

The angle of view is very important during visual testing. The viewer should try to observe the target "dead on," along the center axis of the eye. Figure 1 shows how the eye perceives an object from several angles and how the object appears to change size or to move with a change in viewing angle.

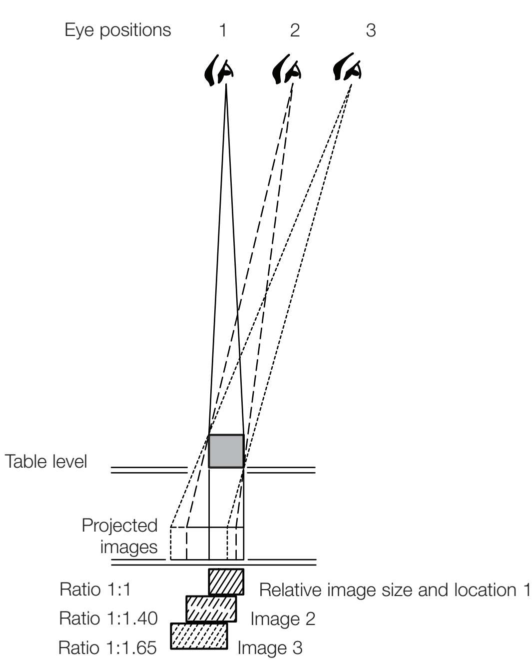

Figure 1. Eye position affects apparent size and location of object.

The angle of view should vary ideally not more than 45 degrees from normal, and a recommended viewing distance and angle for visual testing is to have the eye within 600 mm (24 in.) of the object and positioned at an angle not less than 30 degrees to the inspection surface, as shown in Fig. 2.

The same principle applies to objects viewed through accessories such as mirrors or borescopes. The field of view should be maintained much as it is when viewed directly. If the test surface is immovable and situated so that the eye cannot be placed within this region, suitable visual aids, such as mirrors, must be used.

In peripheral vision, you may notice something "from the corner of your eye" without focusing on it. The angle of peripheral vision is not critical when performing detailed visual tests. It is of value under certain inspection conditions such as when surveying large areas for a discontinuity indication that has high contrast with the background and is observed to one side. The inspector's attention is drawn to this area, and it can then be scrutinized by focusing the eyes on it.

Mirrors

Mirrors are common inspection aids. Easy to use, mirrors make inspection possible inside pipes and apertures and inside or behind objects obstructing the inspector's view. Mirrors can also give the inspector a good angle of view (Fig. 3).

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Several precautions must be remembered in interpreting mirror images. Curved mirrors can distort the apparent shape and size of an object. A mirror image is reversed, so an object on the right appears on the left and one on the left appears right. The inspection distance is equal to the distance from the area being inspected to the mirror plus the distance from the mirror to the inspector's eye. These factors can mislead the inspector.

Illumination Angle

It is important to weigh the effects of illuminance on the detection and assessment of significant indications. Discontinuity detectability is greatly affected by the angle of incidence of the illumination.

When light strikes the test surface from an oblique angle, small variations in surface roughness and contour cast tiny shadows that can help in the detection of depth and form. Local lighting increases illuminance so that shadows enhance contrast and reveal indications. In some cases, the inspector can move a lamp or test object to make indication shadows appear and disappear (Fig. 4).

Local general lighting provides uniform illumination to the test surface, and lamps can be directed to provide optimum illumination if inspection is performed in a single area. During visual inspection in the field, however, it can be difficult to get enough light. Digital cameras adjust automatically to dim illumination, and subsequent image processing may salvage a dark photograph. For direct viewing in the shop or field, however, the inspector may need an artificial light source, even one as simple as a flashlight.

A portable flood lamp or camera flash may remedy dim lighting for a test, but if lights are too bright, they may cause eye strain. Light from incandescent lamps can reflect into the inspector's eyes and cause eye fatigue or create artifacts — glints and glare that mask or distract from indications. Indirect lighting and overhead illumination from fluorescent lamps help minimize this problem.

Angles of View with Borescopes

In optical systems such as borescopes, the angle of view is constrained by the instrument's field of view. The field of view is the entire area that can be seen through an optical system as light is received from the

FYI continued on p 8

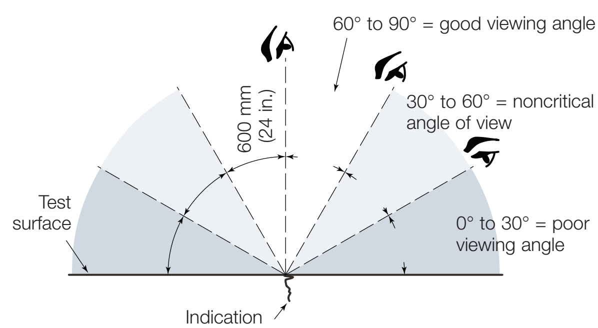

Figure 2. Good and poor angles of view.

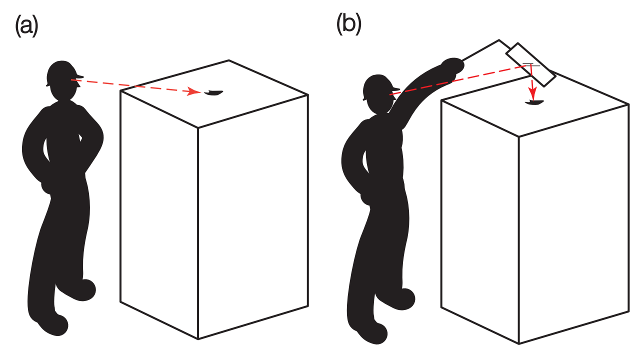

Figure 3. Angle of view: (a) poor; (b) good with mirror.

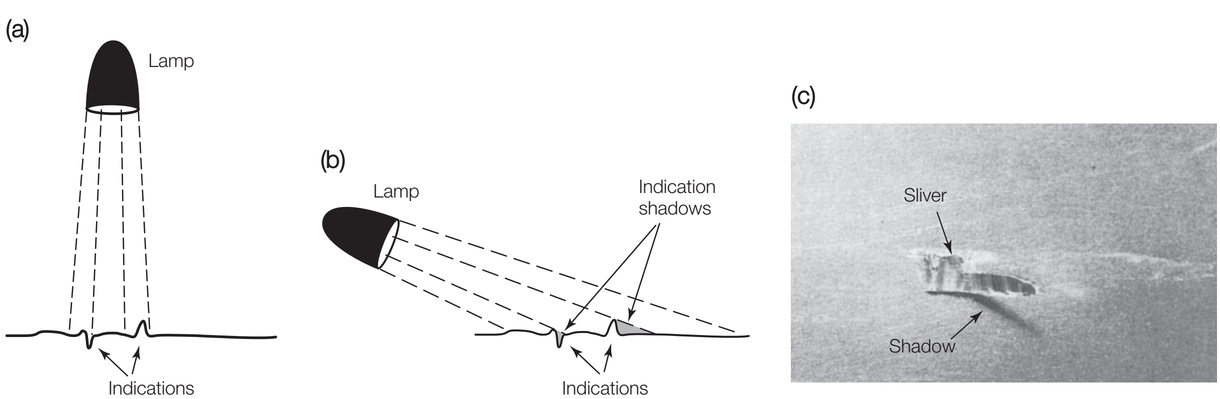

Figure 4. Angle of illumination: (a) no indication shadows; (b) indication shadows (c) photo of sliver with shadow.

FYI continued from p 7

conical angle covered by the system's optics. An astronomical telescope's field of view is the area of the sky that can be seen with a given eyepiece. Theoretically, a field of view is three-dimensional, like a room, and not two-dimensional, like a wall. The area of interest in a field of view, however, is often a flat surface.

Different lenses can be attached to an instrument to achieve different fields of view. Figure 5 shows the field of view of an ordinary rigid borescope. This instrument has a field of view with a range of 60 degrees.

For different lenses, the shape of each side results in desired features: closeup, close focus and high magnification; or short focus, wide angle views and high magnification.

Factors affecting visual tests with borescopes may be in conflict, and compromise is often needed. For example, a wide field of view reduces magnification (Fig. 6). With zoom, a narrow field of view produces higher magnification but surveys a smaller area.

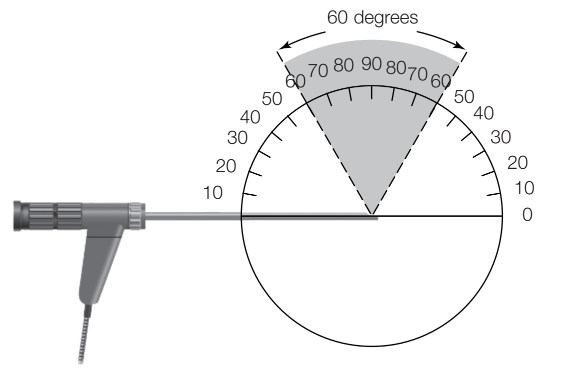

Figure 5. Field of view of rigid borescope.

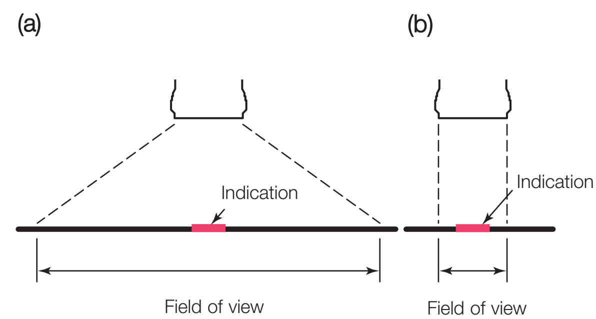

Figure 6. Effect of field of view on magnification at 90 degree angle: (a) with wide field of view, indication is one tenth as wide as image; (b) with zoom, indication is half as wide as image.

Interaction of these effects must be considered in determining the optimum setup for detection and evaluation of discontinuities in the test object.

Object depth affects focusing. If portions of the test surface are in different planes, then the borescope must have sufficient focus adjustment or depth of field to visualize these different planes sharply. Direction of view determines positioning of borescopes.

The need for focus in getting a sharp image is critical for optical instruments such as borescopes and cameras, but is not covered by the present discussions. In most visual tests, the inspector will move his or her body, head, lamp, mirror, optical instrument, or the test object itself to get a good look at the test surface. A good-quality, qualitative assessment takes advantage of the inspector's experience and conscientious judgment.

Content for "Angle of View" has been adapted from the *Nondestructive Testing Handbook,* third edition: Vol. 9, *Visual Testing.* Columbus, OH: American Society for Nondestructive Testing (2010).