



REMR TECHNICAL NOTE CS-ES-1.6

UNDERWATER NONDESTRUCTIVE TESTING OF METAL STRUCTURES (TRAINING FOR DIVERS)

PURPOSE: To provide information about underwater, nondestructive testing (NDT) of metal structures and the qualifications of and training required by personnel performing these tests.

APPLICATION: Divers normally are required to perform a visual inspection of underwater structures. A diver with training in NDT can detect defects that would be missed by visual inspection alone.

ADVANTAGES: The diver with training in NDT of metal structures can detect defective welds, cracks, and corrosion by using magnetic particle or ultrasonic inspection. The thickness of lock gates and metal structures can be measured with ultrasonics.

If NDT equipment is not available to the Corps (owned or rented), underwater NDT can be contracted to a company that provides this service. The Corps diver with NDT training can more effectively oversee and monitor the contracted diver-inspector work.

LIMITATIONS: Underwater NDT methods for metal structures are limited to visual, ultrasonic, magnetic particle, and in some cases eddy current. Because of the reduced visibility, the inspection speed is much slower than that of inspections done above water. The inspection procedure usually involves the inspector-diver who moves the transducer along the area to be inspected and an inspector who is above water interpreting the inspection instrument indications.

PERSONNEL QUALIFICATIONS: Personnel who perform NDT must attend formalized training courses and must have performed the tests a specific length of time to be qualified to a certain level of competency. The American Welding Society Structural Welding Code D1.1 (Ref a) states: "Personnel that perform nondestructive testing shall be qualified in accordance with the current edition of the American Society for Nondestructive Testing (ASNT) Recommended Practice SNT-TC-LA (Ref b). Only individuals qualified for NDT Level I and working under an NDT Level 2 or individuals qualified for NDT Level 2 may perform nondestructive testing."

To gain a qualification of Level I in ultrasonic inspection, the inspector should satisfy any one of the following requirements:

- a. Completion with passing grades of at least 2 years of engineering or science study at an accredited university, college, or technical institute, plus 3 months of experience in ultrasonic testing, plus 40 hr of training in accordance with an approved training course.

- b. High school graduation plus 6 months of experience in ultrasonic testing plus 40 hr of training in accordance with an approved training course.
- c. Grammar school (8th grade) education plus 1 year of experience in ultrasonic testing plus 40 hr of training in accordance with an approved training course.
- d. The above requirements may be reduced in recognition of satisfactory completion of additional applicable training or demonstrated proficiency in conducting ultrasonic tests. For NDT Level I in ultrasonic testing, the required experience shall not be less than 3 months.

TRAINING: Training in NDT is available in almost all large cities located throughout the country. A directory of organizations, schools, or companies that conduct these NDT courses is published in the journal Materials Evaluation, published by ASNT, Columbus, OH. Manufacturers of NDT equipment conduct NDT courses to various levels of proficiency to meet ASNT-TC-IA criteria for Levels 1, 2, or 3.

Training is conducted in the classroom or laboratory. This theory and practical experience, which is applicable to above-water inspection, can be adapted, with minor modification, to underwater inspection.

The College of Oceanering, a Los Angeles harbor-based commercial diving school, conducts a 6-week underwater inspection course recognized by the ASNT. An applicant to this course must be a graduate of an accredited commercial or military diving school or must be a commercial diver from the field. The course is divided into two, 3-week segments. The first segment covers visual weld inspection, underwater photography, and video recording. The second segment covers ultrasonic and magnetic particle inspection techniques. Theory is taught in the classroom and practiced underwater.

UNDERWATER INSPECTION: Performing NDT underwater can cause a decrease in reliability as compared with above-water testing. There are factors that influence the results, such as environmental and working conditions, qualification of personnel, inspection procedures, and capacity and performance of the equipment. If all these factors are resolved, it is possible to achieve a reliable test. The most common underwater tests are the following:

- a. Visual inspection: Used for detecting mechanical damage, corrosion, coating damage, obvious cracks, scouring, or cathodic protection anode condition.
- b. Magnetic particle: Used with good results on steel structures for detecting surface cracks if the water is not laden with silt. The surface to be inspected must be cleaned of marine growth, heavy contamination, and rust, a time-consuming process. The normal procedure involves using AC current. In most cases, fluorescent magnetic particles are used and are visible only with an ultraviolet light. Colored visible particles can be used, but their use requires an even more perfectly cleaned surface.

- c. Ultrasonics: Ultrasonic thickness measurements are easily performed underwater; however, the surface of the object being tested must be clean and relatively smooth for good transducer contact. A few available ultrasonic units are encased in waterproof plastic boxes for use underwater. However, the most common practice is to have the inspection unit above water and the cables and transducer underwater. One operator moves the transducer along the metal surface while another operator above water with the inspection unit interprets the readings and records the location. Communication between the two operators is by phone or radio.
- d. Eddy current: Eddy current inspection has been used for locating cracks, measuring thickness of electroplated materials and paint, sorting metals, or detecting heat damage. Recently, eddy current equipment has been designed to be used underwater. Inspectors who perform underwater inspection on oil-drilling platforms are, in many instances, replacing magnetic particle inspection with eddy current inspection to detect cracks in welds.

REFERENCES:

- a. American Welding Society. 1986. "American Welding Structural Code," AWS DI.1, Miami, FL.
- b. American Society for Nondestructive Testing. 1985. "Recommended Practice SNT-TC-IA," Columbus, OH.
- c. _____. 1987. "Directory of Educational Institutions Offering Courses in Nondestructive Testing," Redi Reference Guide, Columbus, OH, p 128.
- d. American Welding Society. 1983. "Specifications for Underwater Welding," AWS D3.6, Miami, FL.