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XI. APPENDIX

1. P. F. Packman, "Status of Nondestructive Inspection Techniques with Special Reference to Welding Defects", Japan-U.S. Seminar of Tokyo. Press, 1974.

Discussion of the interface of fracture mechanics and nondestructive testing. The need for greater reliability in detection and flaw characterization as typified by size, orientation, shape and location is stressed. Presents summaries of data on minimum size abilities for the major NDT methods. (Revised.)

2. D. O. Sproule, "Ultrasonic Testing of Welds", British Welding Journal, October, 1959.

The paper reviews the general procedures for the ultrasonic interrogation of weldments and adjacent parent material. The need for both single and double probe techniques are presented; emphasis is on the single probe technique. The influence of surface condition, beam characteristics, attenuation, mode conversion of the reflection from the flaw and instrumentation characteristics such as pulse length, resolution and linearity are presented. (Revised.)

3. P. Bastien, "The Possibilities and Limitations of Ultrasonics In The Nondestructive Testing of Steel", NDT International, 10, 6, 297, 1977.

This paper describes the role of ultrasonics in NDT with reference to steel. The ability of ultrasonic testing to determine the presence, size, shape and orientation of single defects and clusters of porosity is appraised, and its relationship to fracture mechanics is discussed. It is concluded that, although ultrasonic NDT has many limitations it is satisfactory for the detection and location of defects but less adequate in determining their dimensions. An extensive bibliography is given.

4. Robert T. Irving, "High Technology Erupts on the NDT Scene". ID No. E1780751548 851548. Iron Age v 221 n 20 May 15, 1978; p 39-42. CODEN: IRAGAN.

Inspection is not only becoming more widely used in metalworking but the arsenal of nondestructive testing (NDT) is overflowing with new and ingenious developments. Many of these were invented by engineers in aerospace and nuclear companies. This article highlights some of the NDT techniques that are now ready for broader markets. Particular reference is made to the developments in acoustic emission, radiography, ultrasonics, as well as those in the eddy current field. Advances in dye penetrants are also covered.
DESCRIPTORS: (*METALS and ALLOYS, *Nondestructive Examination), (WELDS, Nondestructive Examination), ACOUSTIC EMISSION TESTING, RADIOGRAPHY, IDENTIFIERS: NONDESTRUCTIVE TESTING, NDT
CARD ALERT: 531, 421, 422, 538.

5. I. N. Ermolov; A. Z. Rikhman, "Ultrasonic Inspection of Tube and Pipe Welds in the Soviet Power Industry". ID No. E1721213851 291850. CNIITMASH, Moscow, USSR. Nondestr. Test (London v 5 n 4 August, 1972, p 235-238. CODEN: NDETA5.

Modern power plant contains a great number of welds in systems of piping and tubing. These welds must be inspected during construction and operation of power stations. In the Soviet Union this inspection is now chiefly carried out by ultrasonics. The authors outline the inspection system employed. 7 refs. DESCRIPTORS: (*STEAM POWER PLANTS, *Piping Systems), PIPING SYSTEMS, (PIPE, STEEL, Welding), WELDS, Testing), IDENTIFIERS: NONDESTRUCTIVE TESTING OF WELDS, CARD ALERT: 421, 538, 545, 614, 619.

6. Henry J. Ridder, "New Nondestructive Technology as Applied to the Testing of Pipe Welds". ID No. E1721109917 287916. Magnaflux Corp., Los Angeles, CAlif. ASME Pap n 72-Pet-57 for Meet Sep 17-21, 1972, 11 p.

Describes new developments in nondestructive test equipment and techniques for inspecting welded pipes in either process control or final inspection. The author demonstrates the use of ultrasonics as a reliable high speed test method for both electric resistance and submerged arc welds in either straight or spiral seams and describes improvements in ultrasonic instruments, as well as development of a new variable angle transducer suitable for production testing. To show relative advantages and limitations, the author compares the ultrasonic technique with radiography with real-time enhancement, electromagnetic inspection, and automatic magnetic particle testing. In view of computerized operations, recording interpretation, storage, and retrieval of the inspection data are discussed.
DESCRIPTORS: ("WELDS, *Testing), (MATERIALS TESTING, Nondestructive Testing), (PIPE, Welding), CARD ALERT: 421, 422, 538.

7. D. Ensminger, "Applying Fundamentals to Weld Inspection by Ultrasonic Means". Battelle Memorial Inst., Columbus, Ohio. Proc 1968 Symp on NDT of Welds & Mater Joining, Mar 11-13, 1968, Los Angeles, Calif. p 413-39.

Considerable time and money can be saved by a thorough analysis of the effects of material variables on the propagation of ultrasonic energy prior to the application of ultrasonics to weld inspection. These variables include the material to be inspected, the types and sizes of defects of interest, the type of weld, the grain size and other metallurgical factors, the location of the defects, and the geometry and dimensions of the specimen. Considering the results of such an analysis in relation to the test specifications of speed and resolution can more readily lead to a satisfactory inspection procedure. Formulas dealing with specific conditions

are presented. 14 refs.
DESCRIPTORS: (*WELDS, *Inspection), (MATERIALS TESTING, Nondestructive), CARD ALERT: 000.

8. D. Hagemaier, "Fundamentals of Ultrasonic Weld Inspection". ID NO. E171X052758 152758. North American Rockwell Corp, Canoga Park, Calif. Proc 1968 Symp on NDT of Welds & Mater Joining, Mar 11-13, 1968. Los Angeles, Calif, p 440-81.

Reliable ultrasonic testing of weldments can be accomplished if the variables affecting the test method are adequately controlled. To establish this reliability, the inspector must be thoroughly familiar with test parameters. In this report methods to determine and control test parameters for ultrasonic inspection of weldments are discussed in detail, instrument and transducer calibration standards are described, and defect evaluation standard are discussed and illustrated. Methods to locate and identify internal defects are presented tegether with those for reporting test results, and techniques for inspecting different joint configurations are illustrated. 7 refs.
DESCRIPTORS: (*WELDS, *Inspection), (METALS TESTING, Nondestructive), CARD ALERT: 000.

9. H. J. Riddler, "Ultrasonic Weld Inspection. Limitations and Possibilities". ID No. E171X052752 152752. Magnaflux Corp., Los Angeles, Calif. Proc 1968 Symp on NDT of Welds & Mater Joining. Mar 11-13, 1968, Los Angeles, Calif, p 587-604.

The advantage of ultrasonic weld inspection is not only in the amount of information obtained but also in the speed with which the inspection can be carried out, even in difficult to reach places. In this respect the development of miniature transistorized instruments is one of the major advances in the last few years.
DESCRIPTORS: (*WELDS, *Inspection), (MATERIALS TESTING, Nondestructive), CARD ALERT: 000.

10. A. DeSterke, "Weld Inspection by Ultrasonic Waves", Materials Evaluation, 22, 1, 18, 1964.

Attention is drawn to the increasing importance of ultrasonic examination as an extention of X-ray inspection; in particular, where the examination of greater weld lengths, the examination of welds in plates over 2 in. thickness, and the inspection of welds in T-joints or other similar shapes of welds difficult to examine by radiography, are concerned. It is emphasized that preference should be given to ultrasonic examination for the detection of two-dimensional defects like cracks, lack of fusion, etc.

Careful calibration of ultrasonic equipment and probes is advised to enable identification of defects. In this respect, the possibilities of the IIW calibration block as a useful auxiliary are mentioned. It is explained that standard reference blocks have only limited value for the determination of the size of weld defects.

Probe guiding devices to facilitate the scanning of welds in T-joints and normal butt welds are described. An appeal is made to design engineers to adopt types of joints which improve the possibilities for an efficient ultrasonic examination and to make proposals with respect to the drawing up of acceptance criteria for discontinuities, so that - eventually - a practical and realistic basis for ultrasonic acceptance standards can be obtained.

11. G. J. Posakony, "Flaw Characterization: How Good is Ultrasound", ASM, Prevention of Structural Failure Conference, 1975.

Characterizing flaws into type, shape, size and location provides data to engineering mechanics, materials engineering, or fracture mechanics for determination of material serviceability. Nondestructive testing has the responsibility for providing the measurement tools which can accurately portray flaws. The probing energy from an ultrasonic beam can develop a comprehensive picture of a flaw but the understanding of the physical principles and operating capabilities of ultrasound are essential to quantify data in terms of actual flaw size and orientation.

12. I. N. Ermolov, "Current Trends in the Development of Acoustical Testing Methods," DEFEKTOSCOPIYA, *4*, 7, July-Aug 1977.

Papers and exhibits presented at the Eighth World Conference on Nondestructive Testing are reviewed; the main trends are discussed in the development of acoustical testing methods and equipment.

13. B. Ostrofsky, "Ultrasonic Inspection of Welds", Welding Journal Research Supplement, March 1965.

At the present tine ultrasonic weld inspection requires highly trained and experienced operators. The ultrasonic flaw detectors currently in use only indicate the flaw location, the approximate size of the flaw with respect to a reference standard, and the behavior of the oscilloscope traces as the transducer is rotated. The operator must correlate all other information such as weld geometry, material and type of weld with his observations of the oscilloscope traces. In addition, he must select the correct transducer angle and wave frequency and be certain that the standardizations and calibrations are valid. An experienced operator can inspect welds by means of ultrasonics and probably obtain more rapidly and economically the same and sometimes more information than is available by means of radiographic methods.

In the future, the results of work now in progress will permit correlation of weld defects with type of service, which in turn will lead to more reliable acceptance and rejection standards. A standard for certification of ultrasonic operators has yet to be agreed upon. Likewise, a universal sensitivity reference must be chosen for adjusting ultrasonic pulse-echo flaw detection systems.

14. D. E. Center and R. J. Roehrs, "Ultrasonic/Radiographic Examination of Heavy-Wall Pressure Vessel Weldments", Materials Evaluation, 27, 5, 107, 1969.

Since the early 1900's when the National Board of Boiler and Pressure Vessel Inspectors was organized, increased operating temperatures and pressures have caused greater emphasis on the safe construction of chemical and petroleum processing equipment. Though many nondestructive testing methods are presently used to prove the integrity of the welds, this paper presents an analysis of ultrasonic and radiographic examinations of heavy wall pressure vessel weldments. Similarities and differences in the two methods are discussed.

There has been some reluctance to utilize ultrasonics for the examination of welds; however, this inspection method has continually proven to be valuable for detecting planar type defects such as cracks, lack of fusion and lack of penetration. Since ultrasonic inspection of welds is not mentioned in Section VIII of the ASME Code, controlled studies have been made to determine the feasibility of using this method as a supplement to present ASME acceptable radiographic procedures and some results are discussed along with the findings of actual production weld testing.

15. A. deSterke, "Some Aspects of Radiography and Ultrasonic Testing of Welds in Steel with Thicknesses from 100-300 mm". 9. 4, 94, 1967.

The initial portion of the paper is concerned with the use of radiography for the evaluation of welds in the subject range of thickness. The detection of laminar flaws and mobility of necessary equipment are perhaps the most motivating reasons to consider the ultrasonic method. The author illustrates the difficulty involved in detecting laminar flaws oriented normal to the inspection surface - e.g., regions where lack of fusion occurs. Such detecting ability is enhanced when the tandem system of transducers are used. However, the consideration of such a system should not exclude single probe interrogations. Multiple probe assemblies with a switching arrangement to provide both single and double probe interrogations is suggested.

The author indicates that the two basic problems with weld inspection are (1) designing of scanning procedures and (2) the interpretation of the data obtained. The influence of the characteristics of the parent material are discussed - i.e., surface roughness, internal stress, and attenuation. (Revised.)

16. J. F. Lovelace and L. A. Luini, "A Correlation Study Between Ultrasonic, Radiographic and Visual Examination of Heavy Steel Plate Weldments", 26, 1, 1, 1968.

Data is presented from the radiographic and ultrasonic (both manual and automatic) inspection of 16 HY-80 steel plate butt welds. The results of visual examination of 95 sections cut from eight of the welds are compared to radiographic and ultrasonic inspection data at these locations. The validity of the ultrasonic inspection process was found to be almost twice as great as the validity of the radiographic inspection process. Results of the visual examination of weld sections are discussed in relation to theory.

17. N. A. Sinclair and M. N. Nanda, "Ultrasonic Inspection of Submarine Steel Weldments", Materials Evaluation, 19, 1, 58, 1961.

The paper discusses the results of a laboratory investigation to develop ultrasonic inspection techniques and standards for butt weldments in ship plates. The material was HY-80 and 1" thick plates were used. The program consisted of generating and interrogating 24 specimens with a variety of flaws. The results indicate ultrasound detects the cracks while radiography was superior for the detection of globular anomalies typified by inclusions, It was found to be quite impossible to establish ultrasonic standards based on oscilloscope patterns.

18. Yoshiaki Futamura; Takeniko Kinoshita; Kinichi Torikai, "Piping Cracks in JPDP $EM Dash$ 2. In Service Inspection of Weld Joints in Reactor Coolant Pressure Boundary". ID No. E1790536039 936039. Jpn At Energy Res Inst., Tokai, Ibaraki J Nucl Sci Techno1 v 15 n 11 Nov 1978 p 856-862 CODEN: JNSTAX.

Ultrasonic and radiographic examinations of weldments in the primary piping of the Japan Power Demonstration Reactor (JPDR) revealed crack indications in two reactor vessel nozzle safe-end to pipe joins CS-1 and UL-1, while on the joint FW-132 a crack-like indication was given only on the ultrasonic record. These three parts of the reactor piping were removed from the reactor, and subjected to thorough nondestructive and destructive examination in the laboratory. The indications obtained in the field by ultrasonic and radiographic means agreed with each other, and were further confirmed by the laboratory tests. Crack indications given by one nondestructive method and not concurred by another method may safely be taken as inconsequential or spurious. 1 ref. DESCRIPTORS: (*NUCLEAR REACTORS, *Piping Systems), (PIPES, Defects), INSPECTION, IDENTIFIERS: INSERVICE INSPECTION, REACTOR COOLANT PRESSURE BOUNDARY, PIPE CRACKS, NONDESTRUCTIVE EXAMINATION, ULTRASONIC TESTING. CARD ALERT: 621, 619.

19. A. Z. Raikhman, S. N. Christyakov, "Ultrasonic and Radiographic Inspection of Welded Joints in Boiler Tubes". ID No. E1740423945. Orgres, Ural Div., USSR. Weld Prod v 20 n 5 May 1973 p 69-74. CODEN: WEPRAO.

Comparative investigations of the detectability of defects were carried out on circumferential butt-welded seams in tubes of the heating surfaces of modern high-power boilers. Ultrasonic and radiographic detection methods were tested and differences in the weld quality assessments between these methods were observed. A probability-statistical method of comparing the two methods of flaw detection is proposed. It is demonstrated that the consumer risk is higher in all cases in radiographic inspection than in ultrasonic testing. 4 refs.
DESCRIPTORS: (*WELDS, "Testing), (BOILERS, Fire Tube), CARD ALERT: 421, 538, 614.

20. F. Karlsen, "Radiography Versus Ultrasonic Testing". ID No. E1730421645 321645. Det Norske Veritas' Engineering Service Div, Nondestr. Test (London) v 5 n 6 Dec 1972 p 340-343. CODEN: NDETA5.

Radiography and ultrasonics are both widely used in the inspection of weldments and other structures. Thechoiceof method depends on the economics and technical considerations based on the end use. The author gives his personal views on the applicability of the methods and advocates a greater use of ultrasonics for weldment inspection.
DESCRIPTORS: (*WELDS, *Testing), (METALS TESTING, Nondestructive Testing), CARD ALERT: 421, 423, 538.

21. Y. LePenven, "Application of Nondestructive Methods to the Inspection of Stress-Corrosion Crack Affected Welded Structures". ID No. E1721320591 298588. French Welding Inst., Paris, Fr. Nondestr. Test (London) v 5 n 1 Feb 1972 p 22-27, CODEN: NDETA5.

This paper reports on investigations conducted with a view to solving industrial problems involving the detection of stress $EM DASH$ corrosion cracking. Comparisons are drawn of the relative effectiveness of dye penetrant, magnetic particle, radiography and ultrasonic tests in the examination of butt welds, inside fillet welds and lap welds. The developments of a method combining ultrasonic and magnetic particle tests is discussed.
DESCRIPTORS: (*WELDS, *Corrosion), (WELDS, Inspection), (CORROSION, Stress Corrosion Cracking), (WELDING, Steel), CARD ALERT: 538, 539, 545, 913.

22. B. Kato; K. Morita; H. Furuzawa, "Estimation of Weld Defects Through Ultrasonic Testing". 057249. Welding Journal - Vol 55, No. 11, Nov. 1976. pp 946-953. 12 Fig., 6 Tables, 14 Refs. Languages: ENGLISH.

The sizes of various artificial defects present in test specimens were assessed by a number of ultrasonic inspection techniques. Weld root and weld interior cracks and slag inclusions were considered, in addition to lack of penetration. The results are discussed in terms of the accuracy of the different methods with respect to defect height and length. The accuracy in some cases was found to be comparable with radiographic inspection. Test welds were made in SM50 steel *MY* MMA, FCA and C02 welding.
DESCRIPTORS: ARC WELDING; CALIBRATION; C02 WELDING; CRACKING; DEFECTS; DIMENSIONS; FCA WELDING; GMA WELDING; INCLUSIONS; MEASUREMENT; MICROALLOYED STEELS; MMA WELDING; NONDESTRUCTIVE TESTING; PENETRATION DEFECTS; PRECISION; REFERENCE LISTS; SIZE; STEELS; ULTRASONIC TESTING; WELDED JOINTS.

23. W. D. Rummel; R. A. Rathke; P. H. Todd; S. J. Mullen, "The Detection of Tightly Closed Flaws by Nondestructive Testing (NDT) Methods". 057590. Report NASA-CR-144639 (N76-14475). Denver, Colo. 80201; Martin Marietta Aerospace; Oct. 1975. 188 pp. 42 Fig., 17 Tables, 24 Refs. Languages: ENGLISH, MICROFICHE.

Liquid penetrant, ultrasonic, eddy current, and X-radiographic techniques were optimized and applied to the evaluation of 2219-T87 aluminum alloy test specimens. Fatigue cracks in integrally stiffened panels, lack-of-fusion (lack of penetration) in TIG welded panels, and fatigue cracks in welded panels were evaluated. Specimen thickness were nominally 3.17 mm (0.125 inch) and 12.7 mm (0.500 inch) for welded specimens and 7.10 mm (0.280 inch) for the integrally stiffened panels. NDT detection reliability enhancement was evaluated during separate inspection sequences in the specimens in the as-machined or as-welded, post etched and post proof loaded conditions. Results of the NDT evaluations were compared to actual flaw sizes measured on fracture specimens. Inspection data were then analysed to provide a statistical basis for determining the flaw detection reliability.
DESCRIPTORS: AL CU ALLOYS; ALUMINIUM ALLOYS; ARC WELDING; CRACKING; DEFECTS; DYE PENETRANT TESTING; EVALUATION; FATIGUE LOADING: GTA WELDING; LOADING; NONDESTRUCTIVE TESTING; PRECISION; RADIATION; RADIOGRAPHY; REPORTS; SENSITIVITY; SHEET; STATISTICAL METHODS; ULTRASONIC TESTING; WELDED JOINTS; X-RAYS.

24. Yoshihiro Nishida; Tohachiro Tanaka; Yutaka Ogura; Masaaki Kawai; Toshio Shiraiwa; Yoshinori Ito; Hisao Yamaguchi; Masahikok Ikeda; Shigeaki Matsumoto, "Automatic Site Welding Method and Automatic Nondestructive Inspection Method for Steel Constructed Buildings". ID No. E1780107577 807577. Sumitomo Met. Jpn. Sumitomo Search n 17 May 1977 p 104-121. CODEN: SUSEAY.

The use of steel in the construction of ever-bigger buildings in Japan has been on the increase, and components used have also gained both in size and thickness. Consequently, the problem of

welding extra-heavy components, such as wide flange beam columns has arisen. This article describes an automatic gas-shielded pulse arc welding method, developed by Sumitomo Metal Industries Ltd., which is highly effective and produces high-quality welds with a narrow gap joint. Also described is another development; an automatic ultrasonic inspection device that can print out the results of on-site welds.
DESCRIPTORS: (*WELDING, ELECTRIC ARC, *Steel), (BUILDINGS, Welded Steel), (WELDED STEEL STRUCTURES, Nondestructive Examination), (WELDS, Testing), CARD ALERT: 538, 545, 402, 405, 422, 421.

25. 052137, "Shortened-Term Construction of High-Rise Building". Steel Today and Tomorrow - No. 9. Mar.-Apr. 1975. pp 8-9, 5 Fig., Languages: ENGLISH.

Methods of reducing the time required for the construction of the substructure of a steel framed building are described briefly. Semi-automatic welding and narrow gap automatic welding are increasingly employed; on site ultrasonic inspection is widely applied.
DESCRIPTORS: ARC WELDING; BUILDINGS; CONSTRUCTING; CONTROLS; EFFICIENCY; NARROW GAP WELDING; NONDESTRUCTIVE TESTING; SEMI-AUTOMATIC CONTROL; SITE OPERATIONS; STEELS; STRUCTURAL STEELS; STRUCTURES; TIME; ULTRASONIC TESTING.

26. B. Glidden, "New Ideas in Skyscrapers". 027349. WDG. DES. FAB (Vol. 43, No. 10, Oct. 1970, pp 75-78, 11 Pot., Languages: ENGLISH.

Construction in Pittsburgh, USA, of a 64 story building, the United States Steel Building. The six grades of high strength structural steels (ASTM A36, A572 Grades 42, 50 and 60, ASTM A514 Type F (T-I), and ASTM A588 Grade A (COR-TEN) are welded by the C02 submerged arc, electroslag with consumable wire guide processes, by arc welding with stick electrodes and by the mig process with solid or flux-cored wire. Magnetic particle and ultrasonic inspection.
DESCRIPTORS: ARC WELDING; CARBON STEELS; CONSUMABLE GUIDE WELDING; CORED ELECTROD; CO2 WELDING; ELECTROSLAG WELDING; FILLER MATERIALS; FILLER WIRE; GMA WELDING; LOW ALLOY STEELS; MAGNETIC INSPE; MAGNETIC PARTICLE TESTING; MANUAL METAL A; MIG WELDING; MMA WELDING; NON-DESTRUCTIVE TESTING; STEELS; STRUCTURAL STEELS; SUBMERGED ARC WELDING; ULTRASONIC TESTING; UNALLOYED STEELS; USA.

27. 024082, "Welding and Inspecting the World Trade Center - Giant Among Giants". Weld. Des. Fabr. - Feb. 1970, *43*, (2), 53-56, Languages: ENGLISH.

The 110-story World Trade Center in New York is being built with load-bearing outside walls which will support the towers, bear the full brunt of wind and free the towers of interior columns. The walls are box columns fabricated from plates as thick as 5 in.

and tied together with 60 in wide spandrel beams. Welds are generally made with E7018 Low-H electrodes but occasionally semi-automatic C02 welding is employed. Inspection relies on an ultrasonic flaw detector that is fast, easy to calibrate, and switches quickly from one thickness range to another.
DESCRIPTORS: ARC WELDING; BASIC ELECTRODES; BEAMS; BUILDINGS; COLUMNS; COVERED ELECTRODES; C02 WELDING; DIMENSIONS; FILLER MATERIALS; GIRDERS; GMA WELDING; INSPECTION; MANUAL METAL A; MMA WELDING; NONDESTRUCTIVE TESTING; PLATE; QUALITY CONTROL; SIZE; STEELS; STRUCTURAL MEMBERS; STRUCTURAL STEELS; STRUCTURES; THICKNESS; ULTRASONIC TESTING; USA; VISUAL INSPECTION.

28. C. L. Hunt; J. Jaso, "Erection of a Skyscraper with 100 Per Cent Semi-Automatic Field Welding". 021031. Weld. J. - May 1969, *48*, (5), 402-409. Languages: ENGLISH.

Substantially increased efficiency in field welding has been achieved by using an all-position self-shielded electrode for 100 per cent semi-automatic open-arc process welding in the erection of a new skyscraper. Established and approved procedures are given for web-to-column groove welds, flange-to-column groove welds and column splices. Ultrasonic inspection of all the welds has shown less than 1 per cent defects, about one-sixth the normal expectancy. These defects are primarily easily repairable surface types or have been traceable to improper tacking techniques on backing strips.
DESCRIPTORS: ARC WELDING; BACKING TECHNIQUES; BUILDINGS: CONTROLS; NONDESTRUCTIVE TESTING; NONSHIELDED WELDING; SEMI-AUTOMATIC CONTROL; SITE OPERATIONS; SITE WELDING; STRUCTURES; ULTRASONIC TESTING; WELDED JOINTS.

29. H. J. Meyer, "Aspects of In Service Inspections on Reactor Pressure Vessels in Germany", Materials Evaluation, **26**, 8, 171, 1971.

Describes a multiple angle beam probe interrogating system where the probes operate primarily in the tandem mode and the number of such pairs are determined by the thickness of the material being interrogated. Additional probes (2) are operated in the pulse-echo mode to examine the top and bottom of the particular perpendicular cross section of the material being examined, Moreover, each probe has longitudinal transducers incorporated into its assembly to note any variation in coupling conditions. Data acquisition, recording and readout techniques are presented for data evaluation as to defect location, orientation and size determinations. Many methods of translating such probe assemblies on a variety of surfaces are described. There is no indication of preliminary evaluation of the system with either artificial or natural flaws. (Revised.)

30. J. F. Krakovyak; I. L. Grebennik, "Feasibility Study of Ultrasonic Inspection of the Welded Joints of Tube Headers". ID No. E1790430174 930174. Cent Sci-Res Inst. of Technol. & Mech. Eng., USSR. Sov J Nondestr. Test v 14 n 2 Feb 1978, p 110-115. CODEN: SUNTAB.

The results of ultrasonic inspection of welded joints in a tube-tube header system are presented. The ultrasonic inspection procedures, arrangements, and equipment are described. 7 refs.
DESCRIPTORS: (*WELDS, *Defects), (NONDESTRUCTIVE EXAMINATION, Ultrasonic Applications), CARD ALERT: 421, 422, 538, 753.

31. J. C. Spanner, "Preliminary Development of Inservice Inspection Methods for LMFBR's". ID No. E1770859073 759073. Hanford Eng Dev Lab, Richland, Wash. NDT Int v 10 n 2 Apr 1977, p 73-79, CODEN: NDITDS.

Investigations have been carried out on four NDT techniques to determine their suitability for inservice inspection of liquid metal fast breeder reactors. The methods studied were ultrasonic examination of austenitic stainless steel welds, electro-thermal inspection of stainless steel components, eddy-current in situ examination of heat exchange tubes, and a prototype under-sodium viewing and ranging system. Although the development work was of a preliminary nature, each of the four techniques showed promise. An outline of future work is also suggested. 5 refs.
DESCRIPTORS: (*NUCLEAR REACTORS, BREEDER, *Nondestructive Examination), (NONDESTRUCTIVE EXAMINATION, Ultrasonic Applications), (WELDED STEEL STRUCTURES, Inspection), IDENTIFIERS: EDDY CURRENT TESTING, CARD ALERT: 621, 421, 422, 538, 545.

32. Soji Sasaki; Kimio Kanda: Masaharu Tadauchi; Tsutomu Hayashi, Hirotsugu Fujimoto; Hajime Ito, "Ultrasonic B-Scan Inspection System for Nuclear Reactor Pressure Vessels Using Compound Scanning". ID No. E1760533089 633089. Hitachi Res Lab, Ibaraki-Ken, Jpn. Period Insp of Pressurized Components, Conf. Proc. London, Engl, June 4-6 1974, Pap C74/74 p 1-7, Publ by Inst. of Mech Eng (CPB 1974), London, Engl, 1974.

The remote ultrasonic inspection system for nuclear reactor pressure vessels described here employs B-scan representation method by compound scanning technique and makes it possible to display the acoustic sectional image of inspected portion. The compound scanning consists of 'sector scan' and 'traversal scan' of ultrasonic beam performed using variable angle probe. Several types of numerically controlled manipulators are developed to inspect the following portions of vessels from outside: shell weld, nozzle to safe end weld, nozzle to shell weld and nozzle inner radius. Some experimental results obtained by operating the above system are also described in this paper. 2 refs.
DESCRIPTORS: (*NUCLEAR REACTORS, *Pressure Vessels), (INSPECTION, Ultrasonic Applications), (PRESSURE VESSELS, Welding), (MATERIALS TESTING, Nondestructive Testing), IDENTIFIERS: COMPOUND SCANNING METHOD, INSERVICE INSPECTION, CARD ALERT: 619, 621, 913.

33. H. Jackson; H. Tickle, D. C. B. Walker, "Nondestructive Testing Tube-to-Tubeplate welds". ID No. E1760214249 614249. UK at Energy Auth. Engl. Int Conf on Qual Control and Nondestr. Test in Weld, Pap and Discuss, London, Engl. Nov. 19-21 1974, v 1 p 159-166. Publ by Weld Inst. Abington, Cambs, Engl. 1975.

The various techniques developed at Risley Engineering Materials Laboratory (REML) for tube-to-tubeplate inspection of the sodium/water heat exchangers (HEs) for sodium-cooled fast reactors are reviewed. The methods include sophisticated γ - and microfocus X-ray techniques, magnetography, and complex visual systems. Particular attention is given to the development of ultrasonic techniques for periodic in-service HE inspection. 3 refs.
DESCRIPTORS: (*WELDS, *Testing), (TUBES, Welding), HEAT EXCHANGERS, CARD ALERT: 421, 538, 632, 616.

34. R. Nakamura, "Inservice Inspection of No. 2 Reactor in Fukushima Nuclear Power Plant". ID No. E1750532478 532478. Tokyo Electr Power Co., Jpn. Karyoku Genshiryoku Hatsuden v 25 n 3 Mar 1975, p 219-234.

Preservice inspection of the Fukushima-2 reactor is described. The preservice inspection employed a remotely controlled automatic ultrasonic testing system in regions of high radiation level such as the reactor core and employed a manual ultrasonic testing system or other nondestructive inspection methods in the other regions. The methods of inspection employed for the reactor were visual testing, surface testing, and volume testing as prescribed in ASME CODE. The preservice inspection was satisfactorily performed. Some problems were pointed out. In the ultrasonic inspection of welded joints, relatively high echo was generated from the back side, so that it was difficult to distinguish defect echo and back echo. Therefore, the back surface of welded parts must be finished. It was not possible to perform ultrasonic tests in welded parts of austenite stainless steel, for the decay of the ultrasonic wave was very pronounced. In Japanese.
DESCRIPTORS: (*NUCLEAR REACTORS, *Inspection), (MATERIALS TESTING, Nondestructive Testing), CARD ALERT: 421, 613, 621, 913.

35. B. Kuhlow; E. Neumann; H. Wustenberg; E. Nabel; E. Mundry, "Ultrasonic Testing of Austenitic Steel Weld Joints". 066767. 'Reliability of Nuclear Power Plants' - Proceedings, Symposium, Innsbruck, 14-18 April 1975. Publ. 1011 Vienna, Austria; International Atomic Energy Agency; 1975. Paper IAEA-SM-195/24. PP 569-575. 6 Fig., 13 Ref, Language: ENGLISH.

To improve the reliability of inspection results, an ultrasonic probe system operating as a transmitter-receiver with obliquely incident waves has been developed. The beams of the two probes cross in a limited 'focal area' in a distance corresponding to the near-field length of the probes. The natural bundling of the sound

field at this point leads to a constriction of the focal area, resulting in a substantial improvement of the signal-to-noise ratio. It was found that longitudinal as well as shear waves are suitable with the exception of the uppermost layer of the weld specimen. The disturbance of the results of measurements by surface waves can be avoided in this case only by use of longitudinal waves. The transceiver angle probes have been tested in an actual inspection of austenitic welds in reactor components.
DESCRIPTORS: ACOUSTICS; AUSTENITIC STAINLESS STEELS; AUSTRIA; NONDESTRUCTIVE TESTING; NUCLEAR ENGINEERING; PRECISION; REFERENCE LISTS; SENSITIVITY; STAINLESS STEELS; STEELS; SYMPOSIA; TEST EQUIPMENT; TRANSDUCERS; ULTRASONIC TESTING; WELD METAL; WELDED JOINTS.

36. E. R. Reinhart, "Nuclear Reactor Piping Welds". Proceedings - ASNT 37th National Fall Conference, Detroit, Michigan, 3-6 October 1977. Publ. Columbus, Ohio 43221; American Society for Nondestructive Testing; 1977. PP 323-328. Languages: English.

The results of a study of current in--service inspection practice for nuclear reactor piping welds are presented. Five industry teams examined a variety of welds for intergranular stress corrosion cracking using the procedure defined by section XI of the ASME Code. The ultrasonic inspection was repeated using a reference procedure defined by EPRI. The fundamental problem in using the technique is in correctly recognizing only signals from flaws. Results show that the final outcome of testing depends very much on the inspector.
DESCRIPTORS: CODES OF PRACTICE; CORROSION; CRACKING; DEFECTS; ERRORS; HUMAN FACTORS; IN SERVICE OPERATIONS; INTERGRANULAR CORROSION; NONDESTRUCTIVE TESTING; NUCLEAR ENGINEERING; PRECISION; RULES; SENSITIVITY; STRESS CORROSION; SYMPOSIA; TUBES AND PIPES: ULTRASONIC TESTING; USA; WELD METAL.

37. P. Butler, "Ultrasonic Inspection by Multi-Crystal Probes and Records by Computerized Datal'. 062645. Engineer - Vol 244, No. 6306. 3 Feb. 1977. PP 22-23, 25, 28. Languages: ENGLISH.

A world lead is claimed for ultrasonic inspection technology employing multi-crystal probes and on-line computer analysis of data. The method should supersede X-ray examinations for internal and surface defects. Instead of moving a single probe over a weld, a multi-crystal probe, shaped to the surface profile, is used. All details of sample, procedure and results can be recorded and stored. The conditions of the new ASME-XI code are described. An underwater magnetic particle inspection system is described with closed-circuit TV relayed to a screen at the surface.
DESCRIPTORS: COMPARISONS; COMPUTERS; DEFECTS; DESIGN; DRILLING RIGS; ENVIRONMENT; MAGNETIC PARTICLE TESTING; NONDESTRUCTIVE TESTING; PRESSURE VESSELS; RADIATION; SHAPE; STRUCTURES; TELEVISION; TEST EQUIPMENT; TRANSDUCERS; ULTRASONIC TESTING; UNDERWATER ENVIRONMENTS; UTILIZATION; WELD METAL; X-RAYS.

38. V. A. Peters; D. M. Davies; B. G. Hughes, "Role of Nondestructive Testing in the Offshore Oil and Gas Industry". ID No. E1760107085 607085. Unit Inspection Co., South Wales Area. Weld in Offshore Constr. Int Conf, Proc, Pap and Discuss, Newcastle-upon-tyne, Northumberl, Engl, Feb 26-28 1974, v 1 p 187-194. Publ. by Weld Inst. Abington, Cambs, Engl., 1974.

Paper describes applications of non-destructive testing (NDT) in the development of the North Sea oil and gas fields and reports upon the extent to which testing requirements have been met up to the end of 1973. Nondestructive testing of welds in platform structures during construction and in service is discussed, and a description of the application of ultrasonics to the rapid examination of circumferential butt welds in undersea oil lines during lay barge operation is given. Mention is also made of the problems which have faced the NDT industry in meeting the staffing requirements for the North Sea.
DESCRIPTORS: ("WELDS, *Testing), MARINE PLATFORMS, CARD ALERT: 538, 422, 421, 674.

39. G. A. Alpsten; B. I. B. Hallberg, "Some Aspects of the Welding Quality Control in Two North Sea Offshore Drilling Platforms". ID No. E1760107025 607025. Industrikontroll, Enskede, Swed. Weld in Offshore Constr., Int Conf, Proc, Pap and Discuss, Newcastle-upon-tyne, Northumberl, Engl, Feb 26-28 1974, v 1 p 205-213. Publ by Weld Inst., Abington, Cambs, Engl, 1974.

Paper describes some points experienced from the nondestructive testing of the structures of two North Sea Offshore drilling platforms, each comprising about 7000 metric tons of steel. For each platform some 6000m of weld were examined by ultrasonic testing and some 8000 X-ray films were obtained, together representing roughly 60% of the actual welding costs. Of the total examined weld length, less than 6% was repaired as a result of the quality control efforts. Because of the enormous risks and costs involved in a failure of the structure during drilling operations, it appears rational to resort to a massive effort of quality control and inspection services on offshore constructions.
DESCRIPTORS: (*WELDING, *Quality Control), (WELDED STEEL STRUCTURES, Testing), MARINE PLATFORMS, (OIL WELL DRILLING, Offshore), CARD ALERT: 538, 911, 545, 511, 674.

40. V. A. Bobrov; N. V. Khimchenko; V. A. Simonov, "Position and Prospects of Development of Mechanization and Automation of Ultrasonic Inspection of Manufactured Articles at Plants". ID No. E1721109789 287788. Chem Petrol Eng v 7 n 9-10 Sep-Oct 1971, p 887-891.

It has been found that the most urgent problem is that of mechanizing and automating the process of ultrasonic quality control of welds in blanks, shells, and apparatus made of carbon and low-alloy steels. It is suggested that in the design of an apparatus for automated ultrasonic inspection, attention should be paid to the development of standard mechanical units as this will enable a design to be made of a standard series of automatic apparatus. 15 refs.

DESCRIPTORS: (*MATERIALS TESTING, *Nondestructive Testing), ULTRASONIC DEVICES, MATERIALS TESTING APPARATUS, (MATERIALS TESTING, Inspection), INSPECTION, CARD ALERT: 421, 422, 423, 753.

41. C. J. Abrahams, "Design Engineers' Guide to Inspection Problems". ID No. E171X040079 140079. Metal Constr. Brit Weld J v 2 n 9 Sept 1970, p 365-8, CODEN: MCBWA.

Increasingly a complete ultrasonic inspection of fillet welds is being specified by purchasers, yet most of the current designs for welded connections for pressure vessels data from a time before ultrasonic examination was considered necessary. The designer should appreciate the need for a weld which can economically and critically examined so that defects can be differentiated accurately. With cooperation from the welding engineer only minor modifications are required to produce suitable designs for inspection. A good design is one which can be examined with one or, at the most, two robes. The tracking distance and the beam path is relatively short and the slope of the fillet face such that a minimum of grinding is required.
DESCRIPTORS: (*WELDS, *Inspection), CARD ALERT: 538, 913.

42. K. F. Bainton; M. G. Silk; N. R. Williams; D. M. Davies; I. R. Lyon; V. Peters, "The Underwater Inspection of Fixed Offshore Platforms - A Review and Assessment of Techniques". Report AERE-R8067. Harwell-Oxon.; AERE: July 1975. ISBN 0-70-580385-6. 64 PP, 3 Fig., 3 Tab., 3 Ref. Languages: English.

Present techniques and their limitations, especially those caused by the underwater environment in the North Sea, and possible ways of overcoming them are reviewed. Approaches discussed include modification of platform design, use of techniques such as ultrasonic testing and acoustic emission to detect and evaluate defects, and use of remote inspection systems such as automatic sensors left in position, remote controlled TV, and sonar. Other topics covered include training of divers, reporting methods, underwater welding techniques and associated nondestructive testing, and diving methods and equipment.
DESCRIPTORS: ACOUSTIC EMISSION; CONTROLS; DRILLING RIGS; ENVIRONMENT; HUMAN FACTORS; NONDESTRUCTIVE TESTING; OTHER NDT METHODS; REMOTE CONTROL; REPORTS; REVIEWS; STRUCTURES; TELEVISION; ULTRASONIC TESTING; UNDERWATER ENVIRONMENTS; UNDERWATER WELDING.

43. R. C. Ewing, "Alaska Line Welds Pass Supercritical Inspection". 057903. Oil and Gas Journal - Vol 74, No. 45, 8 Nov 1976. PP 186-190. 4 Fig.. Languages: ENGLISH.

Material tests carried out in advance of construction on welding materials for the Alaska pipeline are described. Welding procedures adopted for the construction were semi-automatic CO_2 welding, MMA

welding and, for welds carried out off-site, automatic submerged arc welding. Ultrasonic and radiographic tests were carried out on joints before the pipe sections left the factories. Radiographic on-site inspection and necessary repair procedures are described. The remedial program carried out after falsification of some radiographs was discovered is outlined.
DESCRIPTORS: ARC WELDING; CONSTRUCTING; C02 WELDING; DIMENSIONS; GMA WELDING; MMA WELDING; NONDESTRUCTIVE TESTING; PIPELINES; QUALITY CONTROL; RADIOGRAPHY; SITE OPERATIONS; SIZE; STEELS; SUBMERGED ARC WELDING; TUBES AND PIPES; ULTRASONIC TESTING; USA; WIDTH.

44. P. Tenge; O. Solli; O. Forli, "Acceptance Criteria for Weld Defects and Nondestructive Inspection Procedures for LNG Tanks in Ships". Det norske Veritas, Oslo, Norw. Int Conf on Qual Control and Nondestr. Test in Weld, Pap and Discuss, London, Engl, Nov 19-21 1974, v 1 p 149-158. Publ by Weld Inst. Abington, Cambs, Engl. 1975.

The establishment of acceptance criteria and nondestructive testing (NDT) procedures for weldments in liquified natural gas (LNG) tanks in ships is described. The significance of welding defects is analyzed in the light of safety against fatigue and unstable fracture. Fracture toughness and fatigue crack propagation test results from laboratory and production testing are used in the evaluation of acceptance criteria. Size and type of a number of microscopically examined production weld defects have been compared with ultrasonic test results. Special consideration has been given to the detection of lack of fusion. Experience in the use of ultrasonic testing for large LNG tanks of 9%Ni steel and aluminum alloy 5083-0 is presented, and the advantages and disadvantages of the currently used NDT methods are discussed. 20 refs.
DESCRIPTORS: (*WELDS, *Testing), (NATURAL GAS, LIQUIFIED, Storage), (TANKS, Welding), CARD ALERT: 421, 538, 512, 522, 415.

45. T. Suzuchi; S. Kikuchi, "Application of Mechanized Ultrasonic Testing in Shipbuilding". ID No. E1750748839 548839. Mitsubishi Heavy Ind., Yokohama Shipyard, Jpn. Br J Nondestr. Test, v 17 n 3 May 1975, p 65-70, CODEN: BJNTAS.

An ultrasonic system for mechanized examination of submerged arc butt-welds in the storage tanks of LP-gas tankers is described. The method uses a pair of 70 $degrees$, 5 MHz angle probes and a gate divided into ten, with a pen-record from each division. Comparison of the results with radiographic inspection has shown that it is possible to determine both defect type and defect size from the ultrasonic record. The cost of inspection is one-third of that of radiography.
DESCRIPTORS: (*TANKERS, *Testing), (WELDS, Defects), ULTRASONIC EQUIPMENT, IDENTIFIERS: LPG TANKERS, ULTRASONIC TESTING, CARD ALERT: 538, 671, 753.

46. N. Kurata; H. Ohshima; T. Nomura: M. Yamano; C. Maekawa; M. Ohmori, "Construction Procedure of Tanks of a Hitachi Zosen-CBI Spherical Tank LNG Carrier". 066483. Hitachi Zosen Technical Review - Vol 39. No. 2, June 1978. PP 132-139, 22 Fig., 1 Tab.. Languages: ENGLISH.

The report explains the construction procedure of the spherical tanks of a Hitachi Zosen-CBI Spherical Tank LNG Carrier. The tanks are of 9% Ni steel with a diameter of about 38 meters. Numerical-control machines flame cut the spherically curved shell plates, which were then submerged arc welded, two at a time, on a tilt table. Keys, horizontal girders and vertical stiffeners were welded by pulsed semi-automatic MIG welding, the inside joints of the plates being TIG welded. Butt joints were radiographically checked and full penetration joints ultrasonically inspected. Penetrant examination was given to backgouged joints.
DESCRIPTORS: ARC WELDING; AUTOMATIC CONTROL; COMPUTERS; CONSTRUCTING; CONTAINERS; CONTROLS; FLAME CUTTING; FUEL CASES; GASES; GMA WELDING; GTA WELDING; HIGH ALLOY STEELS; LIQUIFIED GASES: METHANE; MIG WELDING; NICKEL STEELS; NONDESTRUCTIVE TESTING; PLATE; PROCESS CONDITIONS; PROCESS PROCEDURES; RADIOGRAPHY; SEMI-AUTOMATIC CONTROL; SHIPS; STEELS; STORAGE TANKS; TANKERS; THERMAL CUTTING; ULTRASONIC TESTING; WELDED JOINTS.

47. 064132, "Guide for Repair, Welding, Cladding and Straightening of Tail Shafts". American Eureau of Shipping Booklet, Published: New York, NY 10004-USA; American Bureau of Shipping; 1975, 26 PP, 8 Fig., Languages: ENGLISH.

Procedures are recommended for the repair of cracks, eroded and corroded areas, etc., in ships' tail shafts, for welding of flanges to tail shafts, flame straightening, weld cladding, repair of clad areas, etc. Materials covered are carbon and alloy steel forgings. Preparation, welding procedures and inspection are dealt with for MMA and submerged arc welding. Procedure qualification and ultrasonic test methods are included.
DESCRIPTORS: ARC WELDING; CARBON STEELS: CODES OF PRACTICE; FLAME STRAIGHTENING; FLANGES; FORGINGS; JOINT PREPARATION; LOW ALLOY STEELS; MAINTENANCE; MMA WELDING; NONDESTRUCTIVE TESTING; PROCESS CONDITIONS; PROCESS PROCEDURES; PROCESS QUALIFICATION; PROPELLERS; QUALITY CONTROL; RULES; SHAFTS; SHIPS; STEELS; STRAIGHTENING; SUBMERGED ARC WELDING; SURFACE PREPARATION; SURFACING; ULTRASONTC TESTING; UNALLOYED STEELS; USA.

48. M. Kaneda, "An Automatic Ultrasonic Testing Method for Butt Welds in Ships' Hulls". 041195. Journal of the Japan Society for Nondestructive Inspection - Vol. 22, No. 3, 1973. PP 154-160. Languages: ENGLISH, JAPANESE.

Equipment in use for the ultrasonic testing of welds is reviewed. The device used for ultrasonic testing of one-sided automatic welds in naval construction is described. Defect size can be determined. See Also: Ishikawa - Harima Engineering Review,

Vol. 13, No. 4, 1973. PP. 443-450. (In Japanese.)
DESCRIPTORS: NONDESTRUCTIVE TESTING; ONE SIDED WELDING; SHIPS; TEST EQUIPMENT; ULTRASONIC TESTING: WELDED JOINTS,

49. Nezihi Ozden, "Construction of the Bosphorus Suspension Bridge from the NDT Point of View". ID No. E1740739227 439227. Cleveland Bridge and Eng Co., London and Hochtief, Engl. Br J Nondestr. Test, v 16 n 3, May 1974, p 80-83, CODEN: BJNTAS.

NDT, as applied to the welding of the deck of the new Bosphorus suspension bridge is described. By using very extensive visual inspection, the amount of radiographic inspection, on site, has been limited to between 11.5% and 44% of the total weld length. Magnetic crack detection and ultrasonic inspection have been used to only a very limited extent.
DESCRIPTORS: (*BRIDGES, SUSPENSION, *Welding), (WELDS, Testing), (MATERIALS TESTING, Nondestructive Testing), RADIOGRAPHY,
IDENTIFIERS: RADIOGRAPHIC INSPECTION, CARD ALERT: 401, 421, 422, 538.

50. J. Banks, "Magnetic Particle and Dye Penetrant Techniques as Aids to The NDT of Rails". ID No. E1740315375 415375. Br J Nondestr. Test v 15 n 6 Nov 1973, p 176-178, CODEN: BJNTAS.

A description of the methods of magnetic particle testing, magnetic ink inspection and dye penetrant tests in revealing accurately the extent of thermal cracking in the head of a severely wheelburnt rail, whether of the continuous or isolated type of burn and the examination of the running face of Thermit welded rails for surface cracking. A description is given of the use of ultrasonic methods of rail testing with these visual picture methods as a supporting aid.
DESCRIPTORS: (*RAILS, *Testing), (MATERIALS TESTING, Nondestructive Testing), CARD ALERT: 681.

51. 067674, "Rail Welds Checked Ultrasonically". Railway Engineer - Vol 3, No. 2, Mar-Apr, 1978, p 45, Languages: ENGLISH.

A description is given of a multi probe assembly for the nondestructive inspection of Thermite welds. Brief details are given of its development in Guinea and its present use in Canada.
DESCRIPTORS: NONDESTRUCTIVE TESTING; RAILS; SITE OPERATIONS; TEST EQUIPMENT; THERMIT WELDING; ULTRASONIC TESTING; WELD METAL; WELDED JOINTS.

52. J. R. Anderson; P. Wells, "Nondestructive Testing of Welding for the Bridge Over the Murrunbidgee River at Gundagai". 066865. Nondestructive Testing Australia - Vol. 14, No. 10, Oct. 1977, PP 9-16, 2 Fig., 1 Ref., Languages: ENGLISH.

The use of ultrasonic and radiographic methods for testing and quality control on 12 to 22 mm thick steel plate box girders welded by submerged arc and MMA welding is discussed as an illustration of the requirements to be considered for nondestructive testing during design. Radiography was used as the primary method and as a means of checking defect levels for quality control. Ultrasonics were used for the thinner sections to augment radiography. Acceptance criteria, visual inspection and repair of butt corner and fillet welds are also considered.
DESCRIPTORS: ACCEPTANCE; ARC WELDING; BRIDGES; BUTT WELDS; CORNER JOINTS; DESIGN; FILLET WELDS; GIRDERS; MMA WELDING; NONDESTRUCTIVE TESTING; PLATE; QUALITY CONTROL; RADIOGRAPHY: RULES; SPECIFICATIONS; STEELS; STRUCTURAL MEMBERS; STRUCTURAL STEELS; STRUCTURES; SUBMERGED ARC WELDING; THICK; ULTRASONIC TESTING; VISUAL INSPECTION; WELDED JOINTS.

53. 060573, "Bridge Over Troubled Water". Welding and Metal Fabrication - Vol. 45, No. 4, May 1977, PP 201, 203, 205-206, 11 Fig., 1 Tab., Languages: ENGLISH.

The design and construction of the Oshima Bridge in Japan are described. It consists of two spans of 200 m and a center span of 325 m. The spans had to be prefabricated using manual metal arc and submerged arc welding and flame cutting. Inspection of joints was by radiographic testing backed up by ultrasonic and visual inspection. Of the total 5400 tonnes of steel used, 70 per cent was 30-50 mm high strength steel plate.
DESCRIPTORS: ARC WELDING; BRIDGES; CONSTRUCTING; DESIGN; DIMENSIONS; FLAME CUTTING; JAPAN; MILD STEEL; MMA WELDING; NONDESTRUCTIVE TESTING; PLATE; QUALITY CONTROL; RADIOGRAPHY; SIZE; STEELS; STRUCTURAL STEELS; STRUCTURES; SUBMERGED ARC WELDING; THERMAL CUTTING; ULTRASONIC TESTING; UNALLOYED STEELS; VISUAL INSPECTION.

54. 055155, "How Perfect Must an 1800-Foot Tower Be?" Welding Design and Fabrication - Vol. 49, No. 2, Feb. 1976. PP 41-48. 11 Fig. Languages: ENGLISH.

The construction of the Canadian National Railway Tower in Toronto is described. A structure 1815 ft. (553 m) tall. Welding was used extensively, and joint testing was very important: the test procedures for antenna mast, bracket-to-tower wall plate and sky pod welds, presented in detail, involved mainly magnetic particle, ultrasonic and visual inspection. The antenna mast was welded by the CO_2 process, and manual welding was necessary on the sky pod.
DESCRIFTORS: ARC WELDING; CANADA: COMPONENTS; CONSTRUCTING; CO_2 WELDING; DIMENSIONS; GAM WELDING; MAGNETIC PARTICLE

TESTING; MMA WELDING; NONDESTRUCTIVE TESTING; PLATE; QUALITY CONTROL; SIZE; STEELS: STRUCTURAL STEELS; STRUCTURES: TOWERS; ULTRASONIC TESTING; VISUAL INSPECTION: WELDED JOINTS.

55. W. Fotheringham; R. Barry, "The Batman Bridge Tasmania...Orthotropic Deck Highlights Shop Fabrication". 010211. Wdg. Fabr. Des. - Vol. 9, No. 6, July 1966, PP 27-32, 10 Fig., Languages: ENGLISH.

Description of the fabrication of a bridge with an overall length of 1,417 ft. 6 in. and a main span of 675 ft. Welding processes used: manual arc, semi-automatic and automatic submerged arc, automatic C02, X-ray and ultrasonic inspection of the welds.
DESCRIPTORS: ARC WELDING; ARC WELDING; AUSTRALASIA; AUTOMATIC CONTROL; BRIDGES; BRIDGES; CONTROLS; C02 WELDING; FLOORS; FLOORS; GMA WELDING; INSPECTION; MANUAL METAL A; MANUAL METAL A; MMA WELDING; MMA WELDING; NONDESTRUCTIVE TESTING; QUALITY CONTROL; RADIATION; SEMIAUTOMATIC CONTROL; STRUCTURAL MEMBERS; STRUCTURAL MEMBERS; STRUCTURES; STRUCTURES; SUBMERGED ARC WELDING; ULTRASONIC TESTING; VISUAL INSPECTION; WELDED JOINTS; X-RAYS.

56. G. Boulanger; J. P. Dufayet; A. Samoel; B. Spriet; A. Stossel, "Automatic Nondestructive Testing System for Thin Tubes''. Cent d'Etud Nucl de Cadarache, St. Paul-Lez Mater Eval v 32 n 1 January 1974, p 18-24, CODEN: MAEVAD.

Paper reports extensive inspections of the cladding tubes for the fuel elements of the different reactor types. A number of various nondestructive tests have been made on thousands of smooth tubes, seamless or welded, drawn or rolled, in stainless steel or zirconium alloy. Three testing methods have been used (multi-frequency eddy currents, ultrasonics, metrology), spread out over two operating plants: 1) an eddy current bench for a preliminary soundness test combined with a metrology system permitting continuous measurement of the average diameter and of ovality, and 2) an ultrasonic testing bench for additional detection of defects coupled with a simultaneous thickness measurement system. 4 refs.
DESCRIPTORS: ("NUCLEAR REACTORS, *Fuel Elements), (METALS TESTING, Nondestructive Testing), ULTRASONICS, CARD ALERT: 422, 545, 549, 621, 622, 753.

57. A. DeSterke; T. DeBlieck, "Nondestructive Examination of Tube to Tube Plate Connections". ID No. E172X002746 202746. 6th Int Conf on Nondestructive Testing, June 1-5, 1970, Hanover, West Germany, v 2 Sess F Rep 6, p 65-76.

Several inspection methods have been studied in order to establish one which would secure the most adequate results for brazed and welded joints. The methods studied include ultrasonic, gamma ray and X-ray radiography and helium leak test techniques. Both advantages and disadvantages of each method are outlined. 3 refs. DESCRIPTORS: (*WELDS, *Testing), BRAZING, (MATERIALS TESTING Nondestructive), CARD ALERT: 421, 422, 538.

58. R. Lewis; A. R. Cornforth, "Automatic Rotary Probe System for the Ultrasonic Inspection of Steel Tube". ID No. E171X042937 142937. British Steel Corp. Corby, England. Nondestruct Test (London) v 3 n 2 Apr 1970, p 128-31, CODEN: MDETA.

Manual systems for tube inspection are unable to keep pace with high-speed tube manufacturing processes, and only provide an imprecise test. A range of high speed rotating ultrasonic probe systems and static probe assemblies has been developed for automatic quality control and acceptance testing of tubes. These systems afford automatic inspection of tubes in the diameter range 0. 5 to 44 in. seamless or welded tubes, at inspection speeds up to 200 fpm. The systems incorporate several novel features in the ultrasonic and electronic designs. One of these systems is described in detail.
DESCRIPTORS: (*TUBES, *Steel), (TUBES, Inspection), (STEEL TESTING, Nondestructive), CARD ALERT: 415, 421, 422, 619.

59. D. H. Turner; B. L. Elliot; K. James; P. Thompson, "Ultrasonic Bracelet Probe Device for the Inspection of Tube Butt Welds". ID No. E171X025574 125574. CEGB, London, England. Ultrasonics for Industry 1969, Conference Papers. Proc of Conf Oct 7-8, 1969, London, Engl, by Journal Ultrasonics, p 51-5, CODEN: ULIQA.

Tube butt welds in boilers were not subject to 100% inspection, and leakages at them were confirmed as a significant cause of boiler outage. Consequently, it was concluded that it would be feasible to inspect a complete weld with a circumferential array of angle probes - the bracelet probe device. Three regional laboratories had particular requirements and a full description of the devices developed to meet these is given. Also the extensive advantages offered by the bracelet probe device are listed.
DESCRIPTORS: (*WELDS, *Inspection), ULTRASONICS, CARD ALERT: 753, 913.

60. R. Lewis; A. R. Cornforth, "Automatic Ultrasonic Inspection of Steel Tubes". ID No. E171X025431 125431. British Steel Corp, Corby, Northhamptonshire, England. Ultrasonics for Industry 1969, Conference Papers. Proc of Conf October 7-8 1969, London, Engl, by Journal Ultrasonics, p 63-6, CODEN: ULIQA.

Manual systems for tube inspection are unable to keep pace with high-speed tube manufacturing processes, and only provide an imprecise test. A range of high speed rotating ultrasonic probe systems and static probe assemblies has been developed for automatic quality control and acceptance testing of tubes. These systems

afford automatic inspection of tubes in the diameter range 1/2 to 44 in., seamless or welded tubes, at inspection speeds up to 200 fpm. The systems have incorporated several novel features in the ultrasonic and electronic design. One of the systems is described in detail.
DESCRIPTORS: (*TUBES, *Inspection), ULTRASONICS, CARD ALERT: 422, 753.

61. 063928, "Ultrasonics for Undersea Pipeline NDT". Metal Construction - Vol. 10, No. 4, Apr 1978, PP 170-171. 4 Figs., Languages: ENGLISH. (See also: Engineering Materials and Design, Vol. 22, No. 4, Apr 1978, PP 43-45.)

A nuclear vessel inspection system has been developed for use in pipe weld examination on lay barges, where radiography is still the predominant technique. The system comprises a control unit, a pair of ultrasonic probes, a manipulator which is mounted on the pipe, and a 20-channel recorder, scanning of a 914 mm pipe takes 54 seconds, and only flaws above a preset size threshold are recorded.
DESCRIPTORS: AUTOMATIC CONTROL; BUTT WELDS; CIRCUMFERENTIAL; CONTROLS; DEFECTS; DIMENSIONS; MANIPULATORS: NONDESTRUCTIVE TESTING; SIZE; SPEED; STEELS; STRUCTURAL STEELS; TEST EQUIPMENT; TUBES AND PIPES; ULTRASONIC TESTING: WELDING ACCESSORIES; WIDTH.

62. I. Sejima; T. Okada; T. Watanabe; T. Hidaka, "Welding and Inspection of Tube to Tubeplate Joints". 057670. Preprints. International Conference on Fabrication and Reliability of Welded Process Plant - London, 16-18 November 1976. Abington Hall, Abington, Cambridge CB1 6AL, The Welding Institute, 1976. Paper 2. (Separate.) 15 PP, 12 Fig., 1 Table., Languages: ENGLISH.

The relationship between heat input and grain size in tube to tube plate welds in 2.25 CR-1 MO steel was evaluated with a view to eliminating such faults as brittleness. Increased crack sensitivity and decreased corrosion resistance which arise as a result of excessive heat input. An automatic TIG welding method with heat input control was developed and ultrasonic examination techniques were studied.
DESCRIPTORS: ARC WELDING; AUTOMATIC CONTROL; CONTROLS; CORROSION: CRACKING; CREEP RESISTING MATERIALS; DEFECTS; DUCTILITY; ENERGY INPUT; GRAIN SIZE; GTA WELDING; LOW ALLOY STEELS; MECHANICAL PROPERTIES; NONDESTRUCTIVE TESTING; STEELS; SYMPOSIA; TUBE PLATES; TUBES AND PIPES; UK; ULTRASONIC TESTING; WELDED JOINTS.

63. A. R. Cornforth, "Development of Nondestructive Testing Systems for the Inspection of Steel Tubes". 041768. Iron and Steel International - Vol. 46, No, 6. Dec. 1973. PP 527-530, 4 Figs. Languages: ENGLISH.

The corby works of the British Steel Corporation operates a non-destructive testing research center for the BSC Tubes Division. The article concerns the function of the center and its developments in NDT equipment for tubes. Equipment is described for testing spiral welded pipes ultrasonically and for testing hot, continuously welded tubes using an eddy current method. Testing of rotary forged seamless pipes and high quality electric resistance welded and cold drawn tubes is also described.
DESCRIPTORS: ARC WELDING; EDDY CURRENT TESTING; HOT; HOT PRESSURE WELDING; LONGITUDINAL; NONDESTRUCTIVE TESTING: PRESSURE WELDING; RESISTANCE WELDING; STEELS; SUBMERGED ARC WELDING; TEST EQUIPMENT; TUBES AND PIPES; ULTRASONIC TESTING.

64. M. Akebi; T. Hiramatsu; Y. Yoshida, "Development of Automatic ISI (In-Service Inspection) Tool for the (Japanese) 'Fugen' Prototype Advanced Thermal Reactor''. 065305. Proceedings - 3rd Conference on 'Periodic' Inspection of Pressurized Components; London, September 1976. Publ. London SWlH 9JJ; Institution of Mechanical Engineers; 1976. PP 133-140. Languages: ENGLISH.

The development of an in-service flaw-detection system capable of the volumetric examination of welds in the components of the primary cooling system of the advanced thermal reactor is described. The system consists of six remote-controlled manipulators, a minicomputer, and an ultrasonic flaw detector. Tests to simulate various flaws using stainless steel 304 demonstrate the capabilities of the system.
DESCRIPTORS: AUSTENITIC STAINLESS STEELS; COMPUTERS; CONTROLS; HEAT EXCHANGERS; IN SERVICE OPERATIONS; NONDESTRUCTIVE TESTING; NUCLEAR ENGINEERING; PRESSURE VESSELS; REMOTE CONTROL; SIMULATING; STAINLESS STEELS; STEELS; SYMPOSIA; UK; ULTRASONIC TESTING; WELD METAL.

65. R. D. Sachs; J. D. Elkins; J. H. Smith, "Ultrasonic Data Analysis Using a Computer''. ID No. E1721315989 293988. Union Carbide Corp, Oak Ridge, Tenn. Mater Eval v 30 n 6, June 1972, p 121-125, 135, CODEN: MAEVAD.

A digital computer is used to analyze the data obtained from the ultrasonic inspection of a weld. The computer is interfaced to a standard ultrasonic flaw detector and to the scanning mechanism. The computer can automatically determine the size of a flaw and its location on the test part as the test is being conducted semiautomatically. 1 ref.
DESCRIPTORS: (*WELDS, *Inspection), ULTRASONIC EQUIPMENT, CARD ALERT: 442, 538, 753.

66. L. B. Gross and C. R. Johnson, "In-Service Inspection of Nuclear Reactor Vessels Using an Automated Ultrasonic Method", Materials Evaluation, 162-167, July, 1970.

A dual probe operating in pitch-catch mode is described for in-service inspection of a nuclear reactor. The transducers were mounted in liquid filled wheels and translated on the outside surface of the reactor by a programmed mechanical system attached to the reactor. The data was gathered and viewed from the standpoint of amplitude reduction (due to the presence of a flaw) and the location of the transducer assembly. The paper describes the initial feasibility work performed where only one set of transducers were used. It was envisioned that another set of transducers would be needed at right angles to the first as well as a single transducer operating in the pulse-echo mode to aid in more meaningful flaw orientation, location and size determinations.

67. C. R. Honeycutt; F. J. Sattler; L. P. Williams; E. G. Griffith; "Computerized Ultrasonic Inspection of Reactor Vessels", Materials Evaluation, 181-186, September 1974.

A fully automated ultrasonic inspection system for reactor vessels is described. The inspection is performed internally to take advantage of the greater degrees of freedom in the manipulation of the transducer assembly. In those areas where indications are noted, the automatic scanning may be eliminated in preference to operator control to facilitate the acquisition of auxiliary data necessary for the ensuing evaluation process. The paper describes the intricate manipulator structure and movements. The transducer assembly contains sufficient transducers to provide angle beam longitudinal and shear wave interrogations in the pulse-echo, tandem and delta modes of operations. Such interrogations are carried out at 2.25 MHz when the thicknesses are less than 6 inches and at 1.0 MHz when the thickness exceeds 6 inches. No mention is made of the capabilities of the system in terms of the results obtained in service.

i8. V. V. Zalesskii et al, "An Automated System of Ultrasonic Inspection with Digital Recording", DEFEKTOSCOPIYA, 2, 122, March-April 1975.

Consideration is given to some specific features of an automated system of ultrasonic inspection. Block circuits are given, and the operation of the primary units of the SARD-1 system of automatic observation and recording of defects is described. It is designed for the ultrasonic inspection of weld joints up to 250 mm thick. The SARD-1 system is distinguished by its high accuracy and makes it possible to record in digital form on paper forms the depth of the defect, the amplitude and length of the impulses reflected from the defect, and *two* coordinates of the probe head.

69. B. G. Yee et al, "Computer Automated Ultrasonic Inspection System for Aircraft Forgings", Report TR-75-82, AF Materials Laboratory, AF Systems Command, Wright-Patterson AFB, Ohio, May 1975.

This report describes the work conducted on a program to design, fabricate and evaluate a prototype Computer Automated Ultrasonic Inspection System for inspecting complex aircraft forgings. This report documents the modification required to off-the-shelf ultrasonic equipment to provide all the ultrasonic flaw data for the computer and provide computer control of receiver gain and flaw-gate width. Also the design and fabrication of a multiple flaw gate system is described and evaluated. The development of the computer controlled five axes (S, Y, Z, θ, and ϕ) with contour following is described. The computer hardware configuration and the software to acquire and process the ultrasonic and position data, control the scanner in closed loop mode, and display the data is documented. The effects of complex contours on the ultrasonic contour following system are discussed. The development of two software contour following schemes (peaking and vector drive) are described. The capability of the system to inspect simple slopes, aluminum forgings, and engine disks are documented in detail.

70. V. V. Grebennikov et al, "Unit for Automation Ultrasonic Inspection of Weld Joints of Complex Configuration Using Tangential Ultrasonic Beam Method", DEFEKTOSCOPIYA, *6*, **63**, Nov-Dec 1974.

A description is given of a unit for automated ultrasonic inspection of weld joints of thick walled 600 x 76 mm diameter connecting pieces of complex configuration and also of the design of a probe for inspection using a tangential ultrasonic beam method. Data is given characterizing the capacity for revealing artificial and natural defects of various sizes.

71. J. F. Lovelace and L. A. Luini, "Ultrasonic Theory Applied to the Automatic Inspection of Welds", Materials Evaluation, 26, 10, *204*, 1968.

Theoretical studies were made on the beam pattern of the transducer, the scattering pattern of the defect and the transmission properties of the probe-to-weldment interface. The results of this study are discussed in terms of the design of an automatic ultrasonic inspection system. The system, consisting of a flaw detector, control unit, scanning mechanism and data recorder, is described.

72. J. A. deRaad, "Automatic Ultrasonic Examination of Welds", Röntgen Technische Dienst bv, Seventh International Conference on Nondestructive Testing, Warszana, Poland, 1973.

Presents the argument for the necessity for the use of multiple angle beam probes for the evaluation of weldments. The multiple probes by sequential operation should include both the single and tandem interrogation schemes. The latter is illustrated by use of experimental examples. The tandem scheme is warranted by the existence of the large planar flaws that are oriented nearly perpendicular to the inspection surface. The single probe scheme must also be included to detect those flaws that are oriented closer to being parallel to the inspection surface. The number of probes necessary are dictated primarily by the thickness of the weldment. The paper presents a fair discussion on recording methods and the interpretation of the resulting data. A number of systems are shown and discussed.

73. B. T. Cross and W. M. Tooley, "Advancement of Ultrasonic Techniques Using Reradiated Sound Energies for Nondestructive Evaluation of Weldments", TR 67-53, Automation Industries, Boulder, CO, 1967.

The Delta Ultrasonic Inspection Technique is applied to steel weldments under a U.S. Navy Contract. A variety of parameters involving test frequencies, incident angles and sound beam configurations are evaluated. Several scanning techniques are compared. Resultant C-Scans and a destructive analysis of weld sections are illustrated in the report.

74. W. R. Turner, "Experiments in Ultrasonic Imaging for Weld Inspection". 062307. Journal of the Acoustical Society of America - Vol. 62, No. 2, Aug. 1977, PP 361-369. 11 Fig., 2 Tab., 27 ref., Languages: ENGLISH.

Defects in butt welds were visualized against a dark field by obliquely insonifying the weldment and focusing the scattered ultrasonic energy onto an electronic sensor for conversion into a nonholographic visual display. Also shown are comparative images obtained by radiographic and ultrasonic delta techniques. The artefacts encountered as a result of source side lobes, cylindrical collimation, multipath distortion, and wave interference are described together with the techniques for analyzing and suppressing them. The system appears adaptable to automatic object movement and computerized interpretation of data at rates approaching 10,000 resolvable image points per second.
DESCRIPTORS: AUTOMATIC CONTROL; COMPARISONS; COMPUTERS; CONTROLS; DATA; ERRORS; FOCUSSING; MOVEMENT; NONDESTRUCTIVE TESTING; OPTICS; RADIOGRAPHY; SPEED; ULTRASONIC TESTING; UTILIZATION; WELD METAL.

75. B. T. Cross; K. J. Hannah; W. M. Tooley; A. S. Birks, "Delta Technique Extends the Capabilities of Weld Quality Assurance". 023535. The British Journal of Nondestructive Testing. December 1969- 11, 4, 62-77, 25 Figs., 1 Table, 7 refs., Languages: ENGLISH.

The delta ultrasonic! inspection technique, based on sensing the redirected sound energy which originates when a scanning sound beam strikes internal discontinuities, is explained. The three basic test methods, utilizing the delta effect (contact, immersion, shttle), and the equipment requirements are described. Inspection results are discussed for steel butt weldments, aluminum butt weldments, narrow gap welds, and an electron beam weld. DESCRIPTORS: ALUMINUM; ARC WELDING; BUTT WELDS; CARBON STEELS; DIMENSIONS; EB WELDING; GMA WELDING; INSPECTION; MIG WELDING; NONDESTRUCTIVE TESTING; PRESSURE WELDING; QUALITY CONTROL; RADIOGRAPHY; SIZE; STEELS; ULTRASONIC TESTING; UNALLOYED STEELS; VISUAL INSPECTION; WELDED JOINTS; WIDTH.

76. U. Schlengermann and R. Frielinghus, "Remarks on the Practice of Determining the Size of Reflectors by Scanning''. Eight World Conference on Nondestructive Testing; Cannes, France, 1976.

This paper is concerned with the flaw sizing technique that utilizes the width of the amplitude response envelope as determined by the 6, 12, and 20 db amplitude points. Actual fracture surfaces were scanned in water; ideal smooth reflectors were also considered. It was observed that the rough surface flaws produced what appeared to be a collection of small flaws. From this point, it was determined that the 6 db amplitude points gave the best results. The authors mention that for small beams the results for the ideal flaws were very good.

77. A. Wustenburg and E. Mundry, "Study Concerning the Half-Value Depth of Reflecting Zones in Ultrasonic Testing", Material prof., 13, 10, 329, 1971.

The half-value depths are often used for classifying echo indications although there generally does not exist a monotonous relation between the half-value depth and the true dimensions of the flaw independent of the special shape of this flaw. In the case of cylindrical bores e.g., the half-value depth essentially depends on the directional characteristic of the probe. In the case of flaws with plain reflecting surfaces, three types of the half-value behaviour can be distinguished: - The half-value depth of small flaws only depends on the directional characteristic of the probe. - For somewhat larger flaws, the half-value depth decreases with increasing size of the flaw. - When the flaw size is equal to the diameter of the sound beam or larger, the half-value depth can be used to describe the extension of the flaw.

78. E. Mundry, "Defect Evaluation by Ultrasonics", Welding and Metal Fabrication, 40, 4, 135, 1972.

Presents the major ultrasonic techniques used for flaw characterization. These include the utilization of DGS-Diagrams, using the distance between specific amplitude decay points and the use of artificial reflectors such as side drilled holes, flat bottom holes, and notches. These methods are analyzed and limitations, errors and misinterpretation problems are indicated. It is concluded that none of these methods can reliably provide a quantative assessment of the flaw. (Revised.)

79. A. McNab and G. Muir, "Flaw Sizing of Real Defects", British J. of NDT, 20, 3, 130, 1978.

This paper reviews flaw sizing techniques and their relation to the defects being sought. Consideration is also given to the practical aspects of manual testing and to the individual factors affecting accurate defect assessment.

80. B. Jackson, "The Use of Edge-of-Beam Methods for the Assessment of Defect Size", British Journal of NDT, July 1974.

The paper discusses the use of the edge-of-the-beam method for defect size determinations by shear wave interrogation. The method is applicable for large defect and nssentially consists of noting the points on the part surface where the amplitude drops to a specified portion of the maximum amplitude - say 20 db. This information on a flaw distance basis along with an accurate determination of the entry angle of the ultrasound will present, according to the author, a good approximation of the flaw size. The procedure is to lay out the information to scale and to pick out the extremes or edge of the flaw. The paper stresses the need for accurate determinations on the part of the operator.

81. J. Davies, "An Alternative Approach to Flaw Size Measurement, Nondestructive Testing.

The paper deals with the determination of flaw size of laminar flaws by longitudinal wave probes where the size is taken as the probe distance between the 6 db down points. The contribution of the paper is in the form of calibration curves involving such determinations on an array of flat bottom holes ranging from diameters of 0.030 to 0.5 inches. Both focused (immersion) and flat probes are included. There appears to be excellent functional agreement between actual and ultrasonic determinations. A threshold in the defectable size was noted which is probably due to the relative size of the flaw and beam. This observation is substantiated in part, by the fact that the focused probes have a smaller threshold sensitivity in detectable flaw size. One can criticize the paper for lack of taking flaw depth into consideration.

82. I. N. Ermolov and V. G. Shcherbinskii, "Measurement of Defect Size in Ultrasonic Flaw Detection, DEFEDTOSKOPIYA, 1, 17-23, Jan-Feb 1967.

An analytical study of predicting the size of flaws oriented parallel to the inspection surface by noting those points where the amplitude of ultrasound from the flaw is eliminated. The distance between the probe positions for this condition is taken as the length of the flaw in the particular material cross section involved. The analysis consists of formulating the magnitude of the ultrasound received in terms of the directivity functions involved. The authors show the results of flat bottom hole artificial flaws. The results indicated best results when the flaw diameter is small. As the flaw size is increased the reliability of the procedure is reduced.

83. S. E. Iversen, "Improved P-Scan Techniques for Ultrasonic Weld Inspection," Eighth World Conference on Nondestructive Testing, Cannes, France, 1976.

The P-scan or projection-scan principal was developed by the Danish Welding Institute in 1970. Use is made of an electrode ruler which contains an array of electrodes in electrical contact with a strip of electrosensitive paper mounted on the weld to be interrogated. An on line computer marks the position on the recording paper as well as lighting the point on the electrode ruler for the benefit of the operator. In effect, one obtains a projection of the flaw on the plane of the interrogating transducer. It is also possible to obtain a projection of the flaw on any other plane - usually taken perpendicular to the interrogating surface.

84. S. A. Lund; P. R. Jensen, "Projection Scan. A New Method for Recording and Visualizing Data from Ultrasonic Weld Inspection". ID No. E1740316962 416952. Dan Weld Cent, Glostrup Nondestr. Test (Lond) v 6 n 6 Dec 1973, p 307-313, CODEN: NDETAS.

A new scanning and flaw-location method $EM DASH$ the P-scan $EM DASH$ is described. A lightweight ruler carrying either an array of light-emitting diodes or an array of electrodes is mounted on the front of an angle probe parallel to the projection of the ultrasound path in the material. When an echo from a defect is received, the diode directly above the defect is lighted. in this way the A-presentation of an oscilloscope is virtually displayed on the diode or electrode array and the flaw position and depth can be read directly from the diode array or recorded on electro-sensitive paper beneath the electrodes. The method offers the possibility of recording wel' defects as projection images on a plane parallel to the surface of the inspected part and/or on planes perpendicular to this surface. The records give to a certain extend a direct visual presentation of the shape, orientation, position and size of defects and can be considered as an ultrasonic equivalent to radiography. The image quality which can be expected has been analyzed and is illustrated by examples.

DESCRIPTORS: (*WELDS, *Testing), (METALS TESTING, Nondestructive Testing), ULTRASONIC APPLICATIONS, CARD ALERT: 421, 423, 538, 753.

85. D. Sproule, "Ultrasonic Imaging System for Flaw Detection". ID No. E171X025572 125572. Videoson Ltd., London, England. Ultrasonics for Industry 1969, Conference Papers. Proc of Conf Oct 7-8 1969, London, Engl., by Journal Ultrasonics, p 56-9, CODEN: ULIQA.

The system comprises a small hand - held immersion tank in which a variable - angle probe scans the object under examination. A B-scan or Plan-Position-Indicator system displays the angle of refraction of the ultrasound which is computed by a mechanism using a mechanical linkage attached to a protractor. The slanting time-base on the display shows flaws in the body of the scanned object. Examples are given of flaws detected in the welds. DESCRIPTORS: *ULTRASONICS (WELDS, Inspection), CARD ALERT: 753, 913.

86. J. Krautkramer, "Determination of the Size of Defects by the Ultrasonic Impulse Echo Method", British Journal of Applied Physics, 10, 6, 240, 1959.

Much to the detriment of ultrasonic testing and all attempts at standardization, it is not yet possible to compare the results from different kinds of equipment regarding the echo of a back wall or a small defect. In order to facilitate this, the relations between echo height, distance and size of circular disk defect are brought into simple and universally applicable forms. It is shown that the first echo of a simple plate is the most convenient reference echo. With the help of a calibrated gain control as accessory to a usual flaw detector and a graphical representation of the formulae, an equivalent circular disk defect can be attributed to the actual defect.

The influence of curved contact and back wall surfaces, and the application of the method for determining ultrasonic attenuation in thick specimens, is discussed.

87. P. Opel and G. Ivens, "Determination of Flaw Size with Ultrasonics in Forgings", Report 1320, Cooperative Committee for Ultrasonic Testing of Heavy Forgings, Dusseldorf, September 1961.

A discussion of determining flaw size in large cylindrical forgings. The sizing is accomplished by the use of DGS diagrams that are generated for cylindrical specimens. Due to the large size of such forgings, the authors offer a means of correcting for the influence of the attenuation involved.

88. J. L. Rose and H. Schlemn, "Equivalent Flaw Size Measurements and Characterization Analysis", Materials Evaluation, *34*, 1, 1, 1976.

The subject of flaw characterization has received considerable attention recently. Programs are being established to determine such flaw characteristics as flaw type, location, shape, size, and orientation in a structure. These data allow us to study the effects of specific flaws on material performance as well as to provide valuable design information with respect to fracture mechanics and design optimization for materials with reasonably high impact resistance, degradation resistance and fatigue life.

The problem of flaw characterization is one with no immediate solution. An infinite variety and combination of flaws and ultrasonic characterization techniques could possibly be used to solve a few specific problems provided certain process control or in-service degradation features of the flaw were known. An ultrasonic approach is presented in this paper that represents a first step toward solving this formidable flaw-characterization problem. The concepts of an equivalent flaw size and DGS (distance gain size approach) are discussed in detail. The equivalent flat-bottom hole, sidedrilled hole, cylindrical porosity cluster density, porosity size, or crack length, delamination size, etc. can be used to provide useful quality control data or defect growth characteristics in materials undergoing impace, fatigue or in-service environmental degradation. The experimental techniques presented here allow us to select appropriate reference standards and suitable ultrasonic transducers for reliable signal analysis and processing.

89. I. N. Ermolov and V. G. Shcherbinskii, "Use of Amplitude-Distance-Diameter Diagrams When Inspecting with Inclined Probes:' DEFEKTOSCOPIYA, *6*, 41, Nov-Dec 1970.

An approximate calculation of the radiation field of an inclined probe and method of interpreting the dimensionless parameters of amplitude-distance-diameter (DGS) diagrams for measuring the size of defects are examined.

90. B. Watkins, "Periodic Inspection of Light Water Reactor Pressure Vessels", British Journal of NDT, Nov 1973.

Author describes an ultrasonic interrogation system which utilizes the B-scan presentation on an oscilloscope. A fully automated single probe in the pulse/echo mode is used. The probe angle is varied from 70° on one side of the weld to 70° on the other side. The received signals are processed to eliminate the variations in amplitude due to the incident angle involved. In this manner a constant interrogation sensitivity is maintained. During the initial scanning procedure a discrete number of scan angles (2 or 3) are used. Whenever a signal above a prescribed threshold valve is noted, the sranning procedure is expanded to include a continuous change of scan angles in order to optimize the detection process.

DESCRIPTORS: BOILERS; CAVITIES; DEFECTS; DIMENSIONS; FREQUENCIES; INCLUSIONS; MEASUREMENT; NONDESTRUCTIVE TESTING; POROSITY; SIZE; TEST EQUIPMENT; TUBES AND PIPES; ULTRASONIC TESTING; WELD METAL.

95. J. M. Coffey; G. Oates, "Problems in Interpreting Ultrasonic Echoes from Weld Defects". 063989. Paper presented at Commission V Colloquium on 'Nondestructive Determination of Type-Position, Orientation and Size of Defects', at the 11 W Annual Assembly, Copenhagen, July 1977. Paper No. 10. 14 PP., 5 Fig., 5 Ref., Languages: ENGLISH.

Problems, both practical and fundamental, attending ultrasonic methods for weld inspection are reviewed. Conditions necessary for effective inspection and the consequences when these are not met are discussed. The work needed to improve and assess inspection performance quantitatively as illustrated by projects on surface finish requirements, austenitic weld inspection, probe performance specifications, B-scan display and ultrasonic holography. A comprehensive program of research into the basic problems surrounding test sensitivity, resolution and defect sizing techniques is outlined.
DESCRIFTORS: AUSTENITE; DENMARK; DIMENSIONS; HOLOGRAPHY; 11 W; MEASUREMENT; NONDESTRUCTIVE TESTING; PRECISION; RESEARCH AND DEVELOPMENT; RULES; SPECIFICATIONS; SURFACE CONDITIONS; SYMPOSIA; TEST EQUIPMENT; ULTRASONIC TESTING; WELD METAL.

96. Karl Schroeder, "Technology of Ultrasonic Inspection of Welds in Special Weldments for Flaw Size Determination by Means of the AVG Method". ID No. E1750856570 556570. Zentralinst fuer Schweisstech, Halle, E. Ger. Conf on Dimens and Strength Calc, 5th, and Congr. on Mater Test, 6th, Proc, Budapest, Hung, Oct 28-Nov 1 1974, v 1, p 447-458. Publ by Akad Kiado, Budapest, Hung, 1974.

The present paper, which is concerned with a special technology of ultrasonic weld inspection, shows, by reference to a practical example of weld examination, how AVG diagrams and supplementary scales may be used for reliably assessing the quality of special weldments. Six different inspection techniques of determining the size of root imperfections were developed and tested for their usefulness by comparing several variants.
DESCRIPTORS: (*WELDS, *Testing), CARD ALERT: 421, 538.

97. V. G. Shcherbinskii and V. E. Belyi, "Observing Weld Joint Defects Using 'Tandem' System Ultrasonic Inspection", 4, 23, DEFEKTOSKOPIYA, Sept-Oct 1974.

The results of examining 131 natural defects are displayed in terms of the ability of a single probe with an entry angle of 40 to determine true defect size. There is reasonable accuracy for 3 dimensional defects (slag inclusions), however, there is a drastic departure in ability for planar defects. The latter is more dramatic for the larger defect spectrum. The authors examine two tandem probe systems for the detection of vertical planar defects. The technique is to note the reflection from such a defect as it is bounced from the side opposite the probe assembly. In the first system the probe separation is fixed and the location of the probe assembly is dictated by the thickness of the weld and the entry angle. Under this condition scanning perpendicular to the weld axis produces a constant location of the indication on the sweep axis. The authors mention that this is more conducive to automatic inspection. The other system varies the location of the receiving probe to note maximum magnitude; a manual operating system. Both of these systems are examined from a theoretical standpoint. For the fixed probe separation system calculations show that one can expect an amplitude within 6 db as the defect is rotated from the vertical approximately + 15 and 10 degrees for entry angles of 38° and 50°. Using an experimentally derived defect-orientation distribution the authors associate detection probability for each of the latter entry angles. (Revised.)

98. V. A. Chegorinskii, "Analysis of the Error of Defect Coordinate Measurements in the Oblique-Entry Inspection of Welds". ID No. E1771078761 778761. All-Union Sci-Res Inst of Nondestr Testing, Kishinev, Mold SSR. Sov J Nondestr Test v 11, n 5, Sep-Oct 1975, p 608-612, CODEN: SJNTAB.

The article presents a statistical analysis of the error of measurements of the depth of defects by standard ultrasonic flaw detectors and by a comparison method. The expressions obtained for the error probability density functions make it possible to estimate the error of the measurement technique and to select the optimum probe parameters as a function of the inspection conditions. 5 refs.
DESCRIPTORS: (*WELDS, *Nondestructive Examination), (NONDESTRUCTIVE EXAMINATION, Ultrasonic Applications), IDENTIFIERS: FLAW DETECTORS, CARD ALERT: 538, 421, 422, 753.

99. Goetz Herberg; Walter Mueller; Otto Ganglbauer, "Preliminary Results for Practical Ultrasonic Testing of Austenitic Steel Welds". Interatom, Bensberg, Ger NDT Int v 9, n 5, Oct 1976, p 239-241, CODEN: NDITDS.

The welds of the austenitic reactor vessel of the liquid-metal fast-breeder reactor (lmfbr) SNR 300 were inspected by an ultrasonic method using transmitter-receiver angle-beam probes with longitudinal-wave ultrasound. The inspections showed that it is generally possible to find longitudinal defects, but not transverse defects. Furthermore, interpretation of the results for the type and size of defects is difficult, and phantom signals may lead to misinterpretation. Further developments and improvements are necessary. 1 ref.
DESCRIPTORS: (*NUCLEAR REACTORS, *Nondestructive Examination), (STEEL, Welding), ULTRASONIC DEVICES, WELDS, Inspection, IDENTIFIERS: HAZ INSPECTION, CARD ALERT: 545, 621, 753, 538.

100. A. E. Wehrmeister (Magnaflux Corp., Chicago, ILL), "Use of Ultrasonic Testing in Structural Steel Industry". AM Inst Steel Construction - Eng J v 6 n 2, Apr 1969, p 55-9, Languages: ENGLISH.

Application of ultrasonic weld inspection methods to test parent metal in area of weld zone; cathode ray tube presentation illustrates time/distance relationship using straight beam transducer; T-joint weld penetration and I-beam integrity are inspected using straight beam ultrasonic transducer; determination of location of discontinuity within weld zone with use of calculator card.
DESCRIPTORS: DEFECTS; HEAT AFFECTED ZONE; NONDESTRUCTIVE TESTING; PENETRATION DEFECTS; STEELS; STRUCTURAL STEELS; ULTRASONIC TESTING; WELD ZONE.

101. H. Wustenberg and J. Kutzner, "Dependence of Echo Amplitude on Defect Orientation in Ultrasonic Examinations", Eighth World Conference on Nondestructive Testing; Cannes, France, 1976.

A theoretical assessment for the orientation dependence of an ultrasonic defect indication is described. Although other characteristics specific to the examination object, e.g., the sensitivity variations due to different surfaces or materials, too, have to be considered, the quantitative estimation of the crack detectability and the reliability of the examination methods for thick walled nuclear components can be estimated by means of the relations described in this contribution.

102. A. K. Gurvich, "Investigation of the Accuracy Attainable in Measuring the Coordinates of a Defect in Scanning with an Angle Search Unit", DEFEKTOSCOPIYA, 4, 1, July-August 1967.

The paper considers the influence of systematic and random errors that are possible in determining the location of a flaw noted during interrogation by an angle search unit. The author examines the systematic errors due to the uncertainties associated with the entry angle, velocity of ultrasound, the transit time of the ultrasound within the shoe of the search unit, attenuation and the point of entry of the ultrasound. His analysis of the random error is based upon amplitude considerations consistent with the ability of the operator to read a screen. The analysis must necessarily be considered an elementary one in terms of weld inspection because of the factors which the weldment introduces. (Revised.)

103. G. A. Krug, "Use of a Comparison Method for Measuring Coordinates in Automated Ultrasonic Testing with an Inclined Search Head", DEFEKTOSCOPIYA, 6, 87, Nov-Dec 1970.

The underlying principles of a comparative method designed to increase accuracy in measuring the coordinates of defects in ultrasonic defectoscopy are explained. A method of calculating (designing) the search heads is presented, together with graphs for determining the operating parameters of the heads, and also some experimental results by way of verification.

104. A. K. Gurvich and M. S. Desyatnik, "Method of Increasing the Accuracy of the Measurement of Defect Coordinates Using an Inclined Searcher", DEFEKTOSCOPIYA, 35, Jan-Feb 1971.

The paper indicates a statistical analysis of the uncertainty involved in defect location as determined by a single probe interrogating system. The source of the latter is due to the error associated with the ability of an operator to read the magnitude and position of the maximum amplitude from the flaw on the time/distance axis of the CRT. Using experimentally derived operator error probability density functions, the location error is modeled methematically. It is shown that the defect depth measurement error increases with depth and is inversely dependent upon the entry angle of the ultrasound. A comparison method which uses two identical probes at two different entry angles is mentioned along with the fact that the significant reduction in error is attained. (Revised.)

105. H. L. Carson, "Errors in Calibration Introduced by the Geometry of the IIW Block", Ultrasonics, 6, 1, 97, 1967.

The geometry of the IIW (International Institute of Welding) calibration block introduces errors into the determination of the probe index and the beam angle of a shear-wave probe. In this paper equations are derived which enable these errors to be calculated. The accuracy of a probe-index determination is shown to depend on the crystal diameter and the beam angle, as well as on the material of the block. The accuracy of a beam-angle determination is shown to be inversely related to the size of a narrow pencil of rays which is asymmetric around the beam axis. The author has calculated the values between which a particular beam-angle determination is likely to lie for reading errors of $\pm$ 1 mm.

106. V. P. Savchenko, "Certain Factors Affecting the Point of Entry for Ultrasound in the Inspection of Needed Joints", DEFEKTOSCOPIYA, 2, 40, March-April 1966.

Results are presented from the ultrasonic inspection of butt welds in AMg alloy structures. The influence of AMg alloys on the input site of the ultrasonic vibrations is characterized; graphs are given, showing the dependence of the displacement of the point of entry of ultrasound on the angle of inclination of the prism.

107. A. K. Gurvich, "Analysis of Random Error of Defect Coordinate Measurements in Oblique Entry Ultrasonic Inspection", DEFEKTOSCOPIYA, 5, 68, Sept-Oct 1975.

The random error in measurements of the coordinates of reflectors is analyzed with allowance for ultrasonic attenuation. It is shown that the error value decreases as the attenuation is increased.

108. O. F. Hedden, "On Developing New Rules for Ultrasonic Examination of Welds in Nuclear Vessels", Instn. Mech. Engrs. Conference Publication 8, 1974.

The Summer 1973 addenda to section XI of the ASME Boiler & Pressure Vessel Code requires that all flaws above a minimum acceptable size must be evaluated for location, orientation and size. The paper points out that there are factors which deter from this requirement - i.e., influence of cladding, reproducability of inspection results are highly dependent upon the inspection team involved. The author, who is reporting the results of an ASME task group, suggests an approach to obtaining meaningful reproducability of ultrasonic data. They propose that the scope of the inspection be limited to low alloy ferritic steels which would eliminate austenitic materials and bi-metallic welds. Also, they suggest that multiple scans must be employed and that they are limited to the half node technique. Furthermore, they believe that calibration and sizing techniques and procedures should be precisely defined. The calibration block should be of the same material as the vessel material. They suggest that the adoption of such a program will result in greater product integrity. (Revised.)

109. H. Wustenberg and E. Schultz, "Investigations Concerning the Influence of Austenitic Claddings on the Sound Fields of Ultrasonic Probes", Seventh International Conference on Nondestructive Testing, Warszana, Poland, 1973.

For the safety and availability of nuclear power systems reliable ultrasonic test methods for production and periodic in-service inspection methods of nuclear pressure vessels are needed. As all watercooled nuclear pressure vessels are cladded with austenitic steel at their inner surfaces, one has especially for in-service inspections the problem of about how the cladding influences the practicability and reliability of ultrasonic test methods.

First experiences on in-service inspection systems in the German Federal Republic and other countries showed that with all ultrasonic test methods a fluctuation of the so-called transfer correction is to be expected which depends on the special test methods and sort of cladding and can reach more than 25 db.

By the experiments described in this paper the sources for strong transfer fluctuations within cladded components should be found by measuring sensitivity distributions for the applied ultrasonic probe arrangements.

The most important cladding parameters which means surface, micro structure and austenitic-ferritic interface, which causes transfer fluctuations, should be separated.

110. B. L. Baikie; A. R. Wagg; M. J. Whittle; D. Yapp, "Ultrasonic Inspection of Austenitic Welds". ID No. E1761285876 685876. Cent Electr Generating Board, Engl J Br Nucl Energy Soc v 15, n 3, July 1976, p 257-261, CODEN: JBNSAN.

Austenitic steels with welded or cast structures are notorious for the high and variable scatter they produce, with the result that satisfactory ultrasonic inspection is difficult to achieve. A research program is described, undertaken to understand considerable variations of attenuation in welds. The experimental techniques involved the use of optical and X-ray metallography, combined with ultrasonic testing by compression waves. It is shown that ultrasonic attenuation is a strong function of the orientation of the ultrasonic beam relative to the fiber axis. The orientation of the fiber axis in an austenitic stainless steel weld is a function of the welding procedure and can be varied over a wide range by simple modifications to the welding procedure, to improve ultrasonic transmission. The ultrasonic inspection sensitivity to small defects is unlikely to be as high for austenitic welds as it is for ferritic, even when the weld structure is optimized.
DESCRIPTORS: (*WELDS, *Testing), (ULTRASONIC WAVES, Scattering), (IRON AND STEEL METALLOGRAPHY, Austenite), CARD ALERT: 538, 421, 753, 531, 545, 613.

111. M. Macecek, "Metallurgical Causes of Difficulties with Ultrasonic Inspection of Austenitic Welds". ID No. E1780971027 871027. Can Weld Dev Inst, Toronto, Ont. ASME Pap n 78-PVP-8 for Meet Jun 25-30 1978, 11 p, CODEN: ASMSA4.

Structural causes leading to the difficulties with the ultrasonic inspection of austenitic stainless steel weldments are studied. The influence of welding method and procedure upon the structure of the solidified weld metal are discussed. Interactions of the weld structure with the ultrasonic beam and possible causes of existence of structural reflectors are analyzed. Considerations are given to the two inspection methods capable of inspecting butt welds. Some changes in the inspection philosophy of austenitic welds are recommended. 17 refs.
DESCRIPTORS: (*WELDS, "Inspection), (NONDESTRUCTIVE EXAMINATION, Ultrasonic Applications), CARD ALERT: 421, 538.

112. David S. Kupperman; K. J. Reimann; Nicholas F. Fiore, "Role of Microstructure in Ultrasonic Inspectability of Austenitic Stainless Steel Welds". ID No. E1780754786 854786. Argonne Nat'l Lab, ILL. Mater Eval v 36, n 5, Apr 1978, p 70-74, CODEN: MAEVAD.

The behavior of ultrasonic waves in welded austenitic stainless steel plates with various base-metal microstructures was characterized. The tests were conducted in 15 and 80 mu m grain-diameter annealed plates. In sensitized plates, and in cast plates with elongated grains. In the plates of preferred orientations, longitudinal sonic velocity provided an indication of crystalline anisotropy. For

The data is recorded on video tape and assembled to provide a cross sectional view of the particular weld position involved. (Revised.)

91. J. M. Coffey, "Quantitative Assessment of the Reliability of Ultrasonics for Detecting and Measuring Defects in Thick-Section Welds". Paper C85/78; Inst. Mech. Eng. Proceedings, 1978.

It is proposed that the performance of an ultrasonic test cannot exceed a limit set by the equipment's resolution, and by the physics of reflection from metallurgical defects. By means of a specific numerical example the paper illustrates how we can use simplified models of ultrasonic reflection to give a quantitative upper bound to the probability of detecting planar defects. Unless the appropriate ultrasonic beam angles and test sensitivity are chosen, this probability can be very low. The paper also estimates the highest accuracy to be expected of defect size measurements, and indicates the benefits of B-scan display and ultrasonic holography in defect diagnosis.

92. S. Serabian and W. E. Lawrie, "An Amplitude-Independent Ultrasonic Flaw Detection Method", to be offered for publication.

A method for determining both flaw size and orientation is proposed. Unlike conventional pulse-echo ultrasonic flaw detection, the method is not dependent upon the magnitude of the detected amplitude response from the flaw and is frequency independent as well. The method utilizes the location of the maximum amplitude and requires two such determinations with different transducer sizes.

93. L. H. Boyd, "The Influence of Flaw and Transducer Radiation Patterns on the Ultrasonic Detection Process''. M.S. Thesis, University of Lowell, June 1977.

Experimental study on the influence of flaw and transducer sizes upon the location of the maximum of the resulting amplitude response envelope. It was shown that the location is a function of the ratio of the flaw to transducer sizes and is independent of frequencv.

94. N. P. Aleshin; V. N. Volchenko; I. Yu Mogil'ner, "The Ultrasonic Inspection of Welded Joints in Boiler Tubes". Welding Production - Vol. 24, No. 2, February 1977, PP 38-40. 3 Fig., 1 Tab., 6 Ref., Languages: ENGLISH. (Translation of Svarochnoe Proizvodstvo).

A method for ultrasonic inspection of welds in boiler piper of diameter 28-65 mm and wall-thickness 3.5-7 mm using a special angled probe was developed. The frequency used was 5 MHz and the angle of incidence of the beam was 50-53 DEG. This showed up defects of inadmissible size in the welds, including pores, slag inclusions, and flaws. A correlation dependence of the echo-signal amplitude with the size of single spherical pores is presented.

all microstructural conditions, ultrasonic attenuation measurements and spectral analysis indicated that maximum signal strength and flow detectability was obtained at test frequencies below 3 MHz. 14 refs.
DESCRIPTORS: (*WELDS, *Testing), (WELDING, Stainless Steel), (IRON AND STEEL METALLOGRAPHY, Microstructures), (PLATES, STEEL), CARD ALERT: 538, 545, 753, 421, 531, 408.

113. V. N. Prikhod'ko, "Acoustic Properties of Stainless Steels with Intergranular Defects'', DEFEKTOSCOPIYA, 2, 12, Feb 1978.

A finely stratified medium and a two-layer model of stainless steels with intergranular corrosion are considered, on :he basis of which the changes in the velocity and in the damp ng of longitudinal and transverse waves within the defective layer as well as in the metal region of a specimen whose surface has been affected by intergranular corrosion are calculated. Results of theoretical and experimental studies are compared, whereupon recommendations are made on how to improve ultrasonic inspection for intergranular corrosion.

114. D. S. Kupperman and K. J. Reimann", Effect of Shear-Wave Polarization on Defect Detection in Stainless Steel Weld Metal", Ultrasonics, 16, 1, 21, Jan 1978.

Ultrasonic inspections of austenitic stainless steel weld metal are particularly difficult because of the dendritic structure and anisotropy of the material. The acoustic properties of stainless steel weld metal are discussed. Data on frequency spectra and variations in longitudinal and shear velocities with wave propagation direction are presented. Differences in shear velocities as great as 25% have been observed as the polarization direction is changed. The difference in detectability of artificial reflectors using shear waves of varying polarization is presented, and it is demonstrated in some cases that horizontally polarized shear waves can 'detect' a reflector in the weld metal where the traditional vertically polarized shear waves cannot.

115. H. Yoneyama, S. Shibata and M. Kishigami, "Ultrasonic Testing of Austenitic Stainless Steel Welds – False Indications and the Cause of the Occurrence", NDT International, 11, 1, 3, 1978.

A study has been made into the causes of the false indications sometimes observed upon ultrasonic inspection of austenitic stainless steel welds. The path taken by transverse ultrasonic waves through an austenitic stainless steel specimen embodying a butt-weld was traced by repeatedly shaving the surface of the specimen and scanning at each stage the newly uncovered surface with a dynamic sensor to obtain a C-scan of the through-transmission pattern of the beam penetrating through the surface. This showed that the false indications are back reflections, from the metal surface, of waves that have propagated along dendritic crystal formations developed in the weld metal. The present work provides evidence that certain indications obtained on austenitic stainless steel welds are in fact spurious, and should not be ascribed to defects in the weld.

116. V. V. Grebennikov and V. V. Maisov, "The Choice of Frequency and Angle of Incidence of the Ultrasonic Beam When Testing Austenitic Welds in Pearlitic Steels", DEFEKTOSCOPIYA, 1, 86, Jan-Feb 1977.

A relationship is established between the level of structural noise, on the one hand, and the frequency and the angle of incidence of the ultrasonic beam, on the other, during the testing of welds in steels of types 15 KhN, 09G2S(M), and 17SN2(M)D of 25-40 mm gauge made by the use of austenitic fillers. It is shown that the possibility of ultrasonic testing of these welds by the usual method is determined in the main, by the presence of long crystallites in the molten metal. The useful signal-to-noise ratio of the structural noise increases as the angle of incidence of the ultrasonic vibrations is increased.

117. J. P. Pelseneer and G. Louis, "Ultrasonic Testing of Austenitic Steel Castings and Welds", 16, 4, 107, 1974.

With the aim of testing austenitic steel castings and welds, single probes emitting short-pulse focused longitudinal waves have been built. The theoretical and experimental basis of this work is explained. The performance of these probes is compared with that of standard commercially available probes, in tests on thick austenitic castings and welds.

118. S. J. Mech; T. E. Michaels, "Development of Ultrasonic Examination Methods for Austenitic Stainless Steel Weld Inspection". 061492. Materials Evaluation - Vol. 35, No. 7, July 1977, PP 81-86, 9 Fig., 13 Ref., Languages: ENGLISH.

Signal acquisition and analysis techniques were developed to permit locating notches placed in an austenitic stainless steel pipe weld. This ultrasonic technique used a refracted longitudinal inspection beam with a dual element, pitch-catch transducer. Data were analyzed in both time and frequency domains, and a simple frequency moment algorithm was developed which is sensitive to defect signal and somewhat insensitive to grain noise. Sources of grain noise and the metallurgical implications of inspecting austenitic stainless steel welds are reviewed.
DESCRIPTORS: AUSTENITIC STAINLESS STEELS; COMPUTATION; DEFECTS; FREQUENCIES; LONGITUDINAL; METALLURGY; NONDESTRUCTIVE TESTING; REFERENCE LISTS; SENSITIVITY; STAINLESS STEELS; STEELS; TRANSDUCERS; TUBES AND PIPES; ULTRASONIC TESTING; WELD METAL; WELDED JOINTS.

119. E. Neumann; H. Wuestenberg; E. Nabel; W. Leisner, "Ultrasonic Testing of Welds in Austenitic Steels". ID No. E1760214247 614247. Bundesanst fuer Materialpruef, Berlin, Ger Int Conf on Qual Control and Nondestr. Test in Weld, Pap and Discuss, London, Engl, Nov 19-21 1974, v 1, p 115-120. Publ by Weld Inst., Abington, Cambs, Engl, 1975.

A special ultrasonic technique which, contrary to conventional ultrasonic angle-beam methods, makes it possible to inspect welds in austenitic steels without difficulties owing to the high ultrasonic scatter which occurs in this type of structure is described. 8 refs.
DESCRIPTORS: (*WELDS, *Testing), (MATERIALS TESTING, Ultrasonic Applications), CARD ALERT: 538, 422, 423, 753.

120. D. S. Kupperman; K. J. Reimann, "Microstructural Effects and Signal - Enhancement Techniques in Ultrasonic Examination of Stainless Steel". 067046 Report ANL-76-115. Publ. Argonne ILL 60439; Argonne National Laboratory; Sept. 1976, 29 pp, 25 Fig., 3 Tab., 9 Ref., Languages: ENGLISH.

Welded coupons, 25 and 50 mm thick, were made from type 304 steel, with type 308 as the weld metal. Metallographic techniques were used to determine the differences in microstructure between the two metals, which affect the behaviour of ultrasonic waves. These differences can produce spurious reflections and reduce the effectiveness of shear-wave inspections improvements can be made by proper selection of frequency, polarization and type of round wave and effects can be used to characterize materials, e.g., preferred crystal orientation and grain size determination computer-aided techniques for increasing signal-to-noise ratios of ultrasonic signals in stainless steel are presented and discussed.
DESCRIPTORS: AUSTENITIC STAINLESS STEELS; COMPUTERS; CRYSTAL STRUCTURE; DIRECTIONALITY; ERRORS: FREQUENCIES; GRAIN SIZE; METALLOGRAPHY; MICROSTRUCTURE; NONDESTRUCTIVE TESTING; PLATE; REPORTS; SENSITIVITY; STAINLESS STEELS; STEELS; ULTRASONIC TESTING; WELD METAL.

121. S. Serabian, "Influence of Attenuation Upon the Weld Interrogation Distance - Amplitude Curve", Materials Evaluation, 34, 12, 265, 1976.

The influence of the distance-amplitude curve (DAC) used to establish quantitative information for indications noted during an ultrasonic angle beam weld interrogation is examined. The resulting implications to flaw detection are explored and suitable corrective methods are presented.

122. W. T. Flach, "Effects of Construction Practices on the Ultrasonic Inspectability of Piping Welds". ID No. E1771292139 792139. Southwest Res Inst., San Antonio, Tex ASME Pap n 77-PVP-15 for Meet, Sep 18-22 1977, 14 p, CODEN: ASMSA4.

The ultrasonic examination of piping welds can be accomplished effectively; however, the construction practices employed create several conditions which have significant adverse effects on the ultrasonic examination of these welds. The identification of the mechanisms of ultrasound reflection resulting from the weld configurations can be helpful in identifying the existence of flaws. Unless due consideration of the effects of piping weld configuration is given when the ultrasonic data are analyzed, erroneous determinations of the integrity of the piping welds can result.
DESCRIPTORS: (*PIPE, *Welding), (WELDS, Nondestructive Examination), (METALS TESTING, Ultrasonic Applications), (STAINLESS STEEL, Stress Corrosion Cracking), CARD ALERT: 538, 619, 421, 753, 545.

123. "Proceedings of NDE Experts Workshop on Austenitic Pipe Inspection", EPRI Report SR-30; Editor – G. J. Dau, Feb 1976.

The result of a day long meeting of some fifty persons concerned with the inspection of austenitic pipe by ultrasonic interrogation. Problems were presented, reviewed and appropriate steps of action were developed.

124. G. J. Dau, "A Status Report on Austenitic Pipe Inspection". 065306. Proceedings – 3rd Conference on 'Periodic Inspection of Pressurized Components', London, Sept. 1976. Publ. London SWlH 9JJ; Institution of Mechanical Engineers; 1976. PP 141-145. 21 ref., Languages: ENGLISH.

A discussion of the performance of in-service inspections on austenitic steel pipe joints shows that the inspection is hampered by several conditions that are generated before the plant becomes operational. These can be reduced by considering inspection requirements in the design, procedure, and construction phases. Inspectability could be improved in existing plants by removing the weld crown. However, significant grains will result from developments of concepts to distinguish between flaws and geometrical reflectors. These include non-linear adaptive signal processing techniques, tomography, and interferometric ultrasonic holography.
DESCRIPTORS: AUSTENITIC STAINLESS STEELS; CONSTRUCTING; DEFECTS; DESIGN; DRESSING; HOLOGRAPHY; IN SERVICE OPERATIONS; NONDESTRUCTIVE TESTING: PRESSURE; REFERENCE LISTS; REVIEWS; SENSITIVITY; SHAPE; STAINLESS STEELS; STATISTICAL METHODS; STEELS; SYMPOSIA; TUBES AND PIPES; UK; ULTRASONIC TESTING; WELD METAL.

125. R. W. Andrews, "Ultrasonic Testing of Electron-Beam Closure Weld on Pressure Vessel". 058249. British Journal of Nondestructive Testing - Vol. 19, No. 2. March 1977. PP 85-89. 7 Fig., 1 Table., Languages: ENGLISH.

The use of ultrasonic testing for the inspection of end-plugs in pressure vessels is described. The plugs are screwed in place and sealed by electron beam welding. X-ray inspection had failed to reveal defects, particularly where the electron beam was not precisely aligned. Ultrasonic testing was successful detecting regions where the thread was not completely fused. An automatic helical method of scanning was used.
DESCRIPTORS: CAPS; EB WELDING: NONDESTRUCTIVE TESTING; PRESSURE VESSELS; ULTRASONIC TESTING; WELDED JOINTS.

126. V. S. Yamshchikow and V. N. Nosov, "Theoretical Foundation of the Correlation of the Ultrasonic Flaw Detection Method for Coarse-Structured Materials", DEFEKTOSCOPIYA, 3, 39, May-June 1972.

The possibilities of using one of the derivatives of the classical spectral methods of ultrasonic flaw detection based en the measurement and application of the cross-correlation function are explored. Theoretical aspects of the method are given, along with a theoretical analysis and selection of information-bearing criteria for correlation flaw detection in coarse-structured materials (ores and concretes). The relationship of these criteria to defects contained in the investigated medium is indicated. A block diagram is given for an instrument to implement the correlation ultrasonic method of flaw detection.

127. S. Serabian and R. S. Williams, "Experimental Determination of Ultrasonic Attenuation Characteristics Using the Roney Generalized Theory", Mat. Eval., 36, 8, 55, 1978.

To date, little use has been made of the generalized theory of ultrasonic attenuation in polycrystalline materials proposed by Roney. It is the only generalized theory which appears to run the gamut of grain size and frequency dependency of attenuation from the hysteresis loss mechanism through the complete scattering losses, i.e., Rayleigh, phase and diffusion. The theory requires only two constants - a hysteresis constant for the hysteresis losses and a scattering coefficient to describe those losses due to scattering. In the frequency range normally associated with the ultrasonic interrogation method the hysteresis losses are essentially negligible, thus, the scattering coefficient can fully describe the ability of a given material to propagate ultrasound. Moreover, this assessment of the material can be made without necessitating direct inferences to the grain size or frequenrv involved.

128. V. V. Orebennikov et al, "Multifrequency Method of Ultrasonic Testing for Austenitic Welds", DEFEKTOSCOPIYA, 1, 81, Feb. 1973.

A multifrequency method of ultrasonic testing is described. Experimental data are presented, showing that the interference-resistance of the ultrasonic method of testing austenitic welds increases by a factor of many times on using the search head here described, which has annular converters operating at different frequencies.

129. V. S. Grebennik, "Estimating the Efficiency of Ultrasonic Amplitude Inspection of Coarse-Grained Materials", DEFEKTOSCOPIYA, 1, 20, Jan-Feb 1976.

The scattering of ultrasound during echo flaw detection in pipe with a diameter of 560 x 32 mm made of Kh18N9T steel is investigated experimentally. The a priori probabilities of erroneous estimates of equivalent defect sizes are analyzed for the generalized Rayleigh law. The possibilities of improving the reliability of the detection and size assessment of defects on the basis of statistical processing of the signals are discussed. The mean and mean-square values of the amplitudes of asymmetrically fluctuating signals are plotted as a function of the equivalent defect area. The contribution of amplitude fluctuations to the potential error of measurement of the signal arrival time at a fixed reference level is estimated; this error determines the error of measurement of the distance to a defect or the wall thickness of a testpiece in echo inspection.

130. V. A. Feoktistov; V. I. Gorbachev, "Inspecting Stress Corrosion of Welded Joints". 023154. Svar. Proizv. - Sept. 1969, (9), 36-37., Languages: ENGLISH.

Stress corrosion was studied by ultrasonic X-Radiographic, and Xero-Radiographic methods on welded joints in tubes of 1KH18N9T steel made by manual AR arc welding. Metallographic analysis showed that the base metal had a fine grain structure. The weld dendrites were non-directional. Specimens were tested after welding and heat treatment (650 deg. C and hold for 2H, cool in water). The specimens were immersed in boiling 65 per cent HNO_3 for 1270-300 H. Various depths of stress corrosion (0.4-2.7 mm) were produced. The accuracy of determination of stress corrosion by the ultrasonic method was 0.01 mm. Checks were made by X-Radiographic and Xero-Radiographic methods. The Xero-Radiographic method has several advantages in comparison with the X-Radiographic method. The initial stages of stress corrosion are best checked by the Xero-Radiographic method but where the range of signals is sufficiently high, the ultrasonic method can be used to determine the depth of stress corrosion.
DESCRIPTORS: ARC WELDING; CORROSION; GTA WELDING; INSPECTION; NONDESTRUCTIVE TESTING; QUALITY CONTROL; RADIOGRAPHY; STAINLESS STEELS; STEELS; STRESS; TIG WELDING; TUBES AND PIPES; ULTRASONIC TESTING; VISUAL INSPECTION; WELDED JOINTS.

131. J. C. Kennedy; W. E. Woodmansee, "Signal Processing in Nondestructive Testing". 05773. Journal of Testing and Evaluation - Vol. 3, No. 1, Jan. 1975. PP 26-45, 47 Fig., 6 Ref., Languages: ENGLISH.

Signal averaging has been used to improve the clarity of flaw indications in ultrasonic testing of an electron beam weld. The delay of an electronic gate has been synchronized to the transducer motion to improve the detectability of a tight interface crack in a tensile specimen. Cross-correlation techniques and multiple transducer arrays have been used to improve the signal-to-noise ratio of artificial flaws in welded panels. Signal averaging has been used to reduce random noise in the through-transmission ultrasonic inspection of a honeycomb composite. Other achievements reported include tape recording of ultrasonic flaw data, use of a lock-in amplifier to give quantitative data in eddy current testing, and reduction of surface noise in such testing by cross-correlation techniques and a multiple-coil probe.
DESCRIPTORS: DATA; EB WELDING; EDDY ,CURRENT TESTING; HONEYCOMB CONSTRUCTIONS; NONDESTRUCTIVE TESTING; SENSITIVITY; STATISTICAL METHODS; ULTRASONIC TESTING.

132. H. R. Chin Quan and I. G. Scott, "Operator Effects in NDT", Nondestructive Testing.

In the past, the part played by the human operator has been largely ignored in assessing the performance of NDT equipment and techniques. Readily discernible differences in performance between operators have been found in tests, using either eddy current or ultrasonic equipment to detect milled slots in laboratory specimens. The authors describe and discuss test design and procedure, along with the interpretation of test results.

133. C. J. Abrahams, "Methods Used in Ultrasonic Testing of Welds". 012511. WDG Met. Fabr. - Vol 35, No. 11, Nov 1967, PP 458-63, 9 Diagr., Languages: ENGLISH.

Importance of operators' training for the ultrasonic testing of welds, essential points which they must know. Applications; preparation of the parts to be inspected; geometrical and material appreciations; factors affecting the determination of the size of defects. Inspection of fillet welds and of welds on pipe lines.
DESCRIPTORS: DEFECTS; EDUCATION; FILLET WELDS; INSPECTION; NON-DESTRUCTIVE TESTING; PERSONNEL; PIPELINES; QUALITY CONTROL; ULTRASONIC TESTING; UTILIZATION; VISUAL INSPECTION; WELD METAL.

134. R. S. M. Moffatt, "Examining Pressure Vessels". ID No. E1760747724 647724. Whessoe Ltd., Met Constr, v 8 n 4 Apr 1976, p i61-163, CODEN: MECODD.

The changes in NDT requirements and techniques (as applied to pressure vessels) over recent years are outlined. Codes of practice for safe design and manufacture of pressure vessels have been developed by ASME and BSI. A survey is made of NDT methods from visual inspection to ultrasonic testing. Some available personnel qualification schemes and approval schemes for pressure vessel fabrication are described. Some problems of nondestructive testing are discussed.
DESCRIPTORS: (*PRESSURE VESSELS, *Testing), (WELDING, Steel),
CARD ALERT: 619, 422, 538, 545.

135. J. G. Sessler, "The Effect of Stress Fields on Ultrasonic Energy Reflected from Discontinuities in Solids", International Advances in Nondestructive Testing; Editor O W. J. McGonnagle, Gordon and Breach; Vol 5, 1977.

A program of analytical and experimental research has been performed to investigate the effect of stress fields on the ultrasonic energy reflected from discontinuities in solids. The research is based on the principle that discontinuities contained within solid bodies undergo geometric change when stress is applied to the body. The change in geometry effected by stress can result in corresponding changes in ultrasonic energy reflected from the discontinuity, and the response should be relatable to specific features of the discontinuity. This principle, when used in conjunction with conventional ultrasonic pulse-echo techniques, can provide improvement in the detection and characterization of flaws in engineering materials and structures.

In the case of thin flat cracks, the studies have demonstrated that the amount of ultrasonic energy reflected from such cracks in steel, aluminum and glass is very sensitive to small changes in stress intensity at the crack tips. Hence the detection of thin flat cracks with ultrasonic pulse-echo is enhanced by providing tensile stress in the crack region. It also has been shown that this effect can be useful for providing better accuracy in determining true crack size with pulse-echo methods.

The potential of the information acquired in these studies for use in NDT practice is discussed, and some examples of possible benefits are presented.

136. D. M. Corbly, "The Accuracy and Precision of Ultrasonic Shear Wave Flaw Measurements as a Function of Stress on the Flaw", Materials Evaluation, **28**, 5, 103, 1970.

Quantitative estimates of crack length and crack depth obtained from ultrasonic shear wave reflected peak intensities were correlated with the actual values of crack length and depth as measured on the fracture surface. Part through-surface fatigue cracks were initiated in ¼ in. sheet 7075-T6511 aluminum and grown by fatigue cycling to various sizes ranging from 0.1 in. to 0.45 in. in length and 0.02 in. to 0.125 in. in depth. The precision of the flaw indications (scatter in estimate of flaw size) was determined for specimens in the stress-free condition and under several applied loads.

It was found that artificial flaws, made using a jeweler's saw, cannot be used for calibration with a high degree of accuracy. The most accurate estimates of flaw size were obtained using natural fatigue cracks as calibration samples. The accuracy of flaw measurement using natural cracks for calibration decreases with increasing load, while the accuracy of flaw measurement using artificial flaws increases with increasing load. In both cases, the precision, measured by standard deviation from the mean, increases with increasing load.

Ultrasonic shear wave measurements do not measure the true depth of the flaw, but only the depth for which the crack opening displacement is greater than some critical amount, hence upon stressing the flaw, the apparent indicated crack depth increases. This increase in apparent crack depth indication appears to be a linear function of the stress.

137. M. G. Silk and Bill Lidington, "A Preliminary Study of the Effect of Defect Shape and Roughness on Ultrasonic Size Estimation", Nondestructive Testing, 2, 27, 1975,

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The authors studied the accuracy of decibel-drop techniques with particular reference to the effects of defect shape and defect surface roughness as part of a wider reappraisal of ultrasonic defect sizing techniques. The variations found are consistent with qualitative explanations but the magnitudes of the variations may be larger than commonly expected. It should be mentioned that the study is primarily concerned with the distribution of radiation due to defect shape and roughness rather than actual amplitudes (Revised.)

138. R. Werneyer and U. Schlengermann, "Reflection of Ultrasonic Waves from Surface Cracks and Notch Shaped Reference Defects", Materialprufung 31, 7, 213, 1971.

Theoretical and practical investigations into the reflection of ultrasonic waves from surface defects, assuming search head and defect to constitute an ideal rectangular piston generator.

Effect of depth and slope of defect upon detectability and defect evaluation. Monotonic relationship between defect echo and defect depth valid only within a limited range for defects normal to sound beam and specimen surface. Directional characteristics of a rectangular defect and of a search probe with rectangular generator are also given.

Model for reflections from rectangular notches and cracks perpendicular to the surface being tested directional characteristics vs. defect depth and angle of incidence. Reflections from defects with perpendicular flanks and from rectangular notches and natural defects. Resulting sound pressure. Experimental confirmation is given.

139. N. F. Haines, "Reliability of Ultrasonic Inspection", International Symposium on Applications of Reliability Technology to Nuclear Power Plants, Vienna; October 1977.

Ultrasonic techniques have become the preferred method of volumetric examination of the walls of thick section reactor pressure vessels. Different countries have devised methods of calibrating ultrasonic systems and establishing acceptance criteria; in general, these are based upon the amplitude of the reflected signal. Two particular examples are the American ASME XI code and the German Reactor Safety Commission guidelines. In order to assess the limitations of amplitude threshold criteria, work at Berkeley Nuclear Laboratories has been aimed at providing a theoretical model of pulse reflection from surfaces. Crack size, shape, orientation and surface roughness as well as the ultrasonic pulse shape are taken into account in the model. Particular geometries which have been included are elliptic, planar (rough and smooth), cylindrical and spherical.

The results have been interpreted to demonstrate the limited range of orientation over which a crack of any size may be detected by applying either the American or German criteria using a common transmit and receive system. A discussion is given of two approaches to overcome the problems of detecting a crack growing directly into the wall of a vessel, either by the German Tandem system or by use of a B-scan presentation of data.

The model presented only considers the physical limitations set by the geometry of the crack. No consideration has been given to attenuation caused by the surface condition of the wall of the vessel, presence of cladding, etc. The model, therefore, presents the optimum results that can be obtained with a simple pulse echo system.

140. S. Serabian and W. E. Lawrie, "A Detection Model for Pulse-Echo Ultrasonics", to be offered for publication.

In this paper, flaw detectability by the pulse-echo straight and angle beam ultrasonic interrogation methods from a flat surface is examined. Flaw detection is modeled in terms of the spatial interplay of the radiation fields of the interrogating transducer and of the flaw. The model is used to select and investigate characteristics descriptive of the amplitude response envelope obtained during a conventional scan of a flaw that can be used to quantitatively define the detected flaw content.

141. J. M. Coffey, "Quantitative Assessment of the Reliability of Ultrasonics for Detecting and Measuring Defects in Thick-Section Welds". Paper C85/78; Inst. Mech. Eng. Proceedings, 1978.

It is proposed that the performance of an ultrasonic test cannot exceed a limit set by the equipment's resolution, and by the physics of reflection from metallurgical defects. By means of a specific numerical example the paper illustrates how we can use simplified models of ultrasonic reflection to give a quantitative upper bound to the probability of detecting planar defects. Unless the appropriate ultrasonic beam angles and test sensitivity are chosen, this probability can be very low. The paper also estimates the highest accuracy to be expected of defect size measurements, and indicates the benefits of B-scan display and ultrasonic holography in defect diagnosis.

142. R. Saglio, "Better Detection of Large, Poorly Oriented Plane Defects'', by Ultrasonics, NDT International, August 1976.

Contrary to expectations, the most difficult defects to detect by ultrasonic inspection are large plane defects. This account is far more descriptive than theoretical; it demonstrates that the probability of detecting a poorly oriented plane defect can be increased by using a highly focused ultrasonic transducer at the lowest possibly frequency.

143. S. Serabian, "Influence of Geometry Upon an Ultrasonic Defect Size Determination in Large Rotor Forgings", Society for Nondestructive Testing, 14, 5, 18, 1956.

The shape of a test object, the test standards used, and the surface condition of the test object are among the factors that affect ultrasonic flaw detection in its ability to indicate the true size of a defect or flaw. In the testing of large steam-turbine rotor and generator field forgings, two such factors that somewhat dominate attempts to correlate the magnitude of ultrasonic indications and the defect sizes involved are defect orientation and the geometric configuration of the test forging, i.e., the outside and bore diameters

Methods are presented to measure the angle at which the defect is lodged, along with the correction factors that must be applied to an indication to eliminate this effect.

Also presented is a study of the forging geometry and its influence upon the testing sensitivity, with its subsequent effects upon defect-size determination.

144. N. F. Haines and D. B. Langston, "The Reflection of Ultrasonic Pulses from Surfaces", Research Division, Berkeley Nuclear Laboratories, Central Electric Generating Board, Report RD/B/N4115, England.

A model is developed which successfully accounts for the experimentally observed reflection of ultrasonic pulses from a variety of surfaces. An existing frequency domain approach for arbitrarily shaped rigid surfaces of known geometry (Johnson, 1976) is extended to include the effects of a statistical surface roughness and a variable reflection coefficient. The equations describing the reflection in the frequency domain essentially predict the complex frequency spectra of pulses reflected from surfaces of various geometries; by Fourier transforming these equations expressions describing the actual pulse waveforms reflected from the surfaces have been obtained.

The predicted effects of surface roughness, size, shape and orientation on both the reflected pulse and its frequency spectrum are confirmed by experiment. The converse problem of using the reflected pulse to infer information about the reflecting surface using a deconvolution technique is also demonstrated.

145. G. K. Kramarenko, "Effect of Surface Finish on Ultrasonic Inspection Results", DEFEKTOSCOPIYA, 6, 68, Nov-Dec 1972.

The author examines the experimentally obtained relations describing the dependence of the amplitude characteristics of pulses reflected from the front and bottom of rough-machined parts during inspection by the immersion method and also the duration of pulses and their moduli of spectral density as functions of the height and pitch of surface irregularities of various materials. He makes some suggestions on the inspection of parts with rough-machined surfaces.

146. V. Ya Ostrenko; M. I. Chepurko; A. M. Buinovskii; N. S. Yakimenko; P. I. Shperlin; Ya. A. Sosnitskii; Yu. M. Egorov, "Pressing and Rolling Bimetallic Tubes". ID No. E175016686 506686. Nikopol South Tube Metall Plant, USSR, Metallurgist (USSR), v 17, n 9-10, Sep-Oct 1973, p 747-749, CODEN: MTLUAB.

A detailed report is given of an investigation aimed at developing the technology of producing hot pressed and cold rolled bimetallic corrosion resisting tubes of carbon plus stainless steel. The

production process included the manufacture of the initial sleeves of both metals, chemical treatment of the contact surfaces, manufacture of bilayer billets, pressing, cold rolling, finishing, ultrasonic inspection of the metal quality, and welding the layers. The process developed is applicable to the production of tubes measuring (34 to 95) $\times$ (2.5 to 6.0) mm in a wide range of thickness of the cladding layer.
DESCRIPTORS: (*TUBES, *Manufacture), (STAINLESS STEEL, Cladding), (STEEL, Bimetals), CARD ALERT: 535, 545, 632.

147. G. Nardoni; A. Berzolla, "L'Efficienza Dei Controlli Non Distruttivi Delle Saldature in Relazione Allo Stato Superficiale Dei Cordoni". (Efficiency of Nondestructive Testing of Welds Related to Surface Conditions.) ID No. E1740852770 452770. Acciaieria e Tubificio di Brescia, Italy, Riv Ital Saldatura, v 26, n 1 Jan-Feb 1974, p 3-11, CODEN: RISAAT.

The paper considers the problem of the preparation of weld surfaces for the performance of NDT's (ultrasonic, radiographic and magnetic particles inspections). Some examples show how the results of the different inspections can be negatively affected by the conditions of the above surfaces. In the appendix, the author outlines a proposal for minimum requirements of surface preparation for the ultrasonic inspection of welds in pressure vessels, as this inspection is the one most affected by a wrong preparation. 8 refs, In Italian with English abstract.
DESCRIPTORS: (*WELDS, *Testing), CARD ALERT: 538.

148. P. F. Packman and J. K. Malpani, "The Reliability of Production Nondestructive Testing for Defects"; Eighth World Conference on Nondestructive Testing; Cannes, France; 1976.

Indicates the results of an experimental study on the detection of surface cracks by the penetrant and magnetic particle NDT methods. The results are viewed by statistical methods and indicate that more probable detection exists at the larger flaws. The detection probability is also viewed in terms of operator false calls or the indication of a defect when one does not exist. (Revised.)

149. P. F. Packman et al, "Reliability of Defect Detection in Weld Structures", Air Force Office of Scientific Research, Contract Number F44620-73-0073, 1975.

An analysis has been made of the ability of several nondestructive inspection procedures to reliably detect surface fatigue cracks. It is shown that the ability cf penetrant systems of aluminum and titanium are over 90% for cracks whose surface length is greater than 0.939 mm (0.037 inches) in length and decreases for cracks less than this value. The probability of detection of these cracks, given that the crack is present has been determined at

90, 93, and 99% confidence factors. The conditional probabilities associated with an error call have also been developed.

150. F. H. Chang et al, "Methods for the Determination of the Sensitivity of NDE Techniques", General Dynamics - Air Force Contract F33615-76-C-5066; Air Force Systems Command; Wright Patterson AFB, Ohio.

This report describes the work accomplished under a 12-month program conducted for the purpose of developing a model to translate the nondestructive evaluation (NDE) capabilities assessed from aluminum and steel specimens with simple geometries to equivalent detection sensitivity for specimens with complex geometries. The NDE methods include ultrasonic, eddy current, magnetic particle, penetrant and radiography. NDE reliability data base compiled under a previous NASA program was enlarged. An adaptive learning technique and a linear regression analysis were developed to establish the parametric relationships between inspection sensitivity and NDE parameters. Translation models were developed on the basis of the parametric study to translate inspection results obtained on flat plate specimens to equivalent results on specimens with more complex geometries. Results obtained in this program were limited to aluminum and the NDE techniques of ultrasonic, penetrant and eddy currents due to the inadequacy of the existing data. Data deficiencies were identified during the model development process. Based on the parametric study results and the translation models developed in the program, an optimum demonstration program was designed to evaluate the NDE CAPABILITY OF INDUSTRIAL FACILITIES.

151. D. P. Johnson, T. L. Toomay and C. S. Davis, "Estimation of the Defect Detection Probability for Ultrasonic Tests on Thick Section Steel Weldments", Electric Power Research Institute, NP-991, February 1979.

This paper reports an inspection uncertainty analysis of published PVRC Specimen 201 data. One purpose of this analysis is to obtain an estimate of the probability of recording an indication as a function of imperfection height for ASME Section XI Code ultrasonic inspections of the nuclear reactor vessel plate seams. A second purpose of this analysis is to demonstrate the advantages of inspection uncertainty analysis over conventional detection/nondetection counting analysis.

The analysis found the probability of recording a significant defect with an ASMR Section XI Code ultrasonic inspection to be very high, if such a defect should exist in the plate seams of a nuclear reactor vessel. For a one-inch high crack, for example, this analysis gives a best estimate recording probability of .985 and a 90% lower confidence bound recording probability of .937. It is also shown that inspection uncertainty analysis gives more accurate estimates and gives estimates over a much greater flaw size range than is possible with conventional analysis.

It should be emphasized that while there is reason to believe that the estimation procedure used is conservative, the estimation is based on data generated several years ago, on very small defects, in an environment that is different from the actual in-service inspection environment.

152. O. R. Gericke, "Determination of Hidden Defects by Ultrasonic Pulse Analysis Testing", J. Acoust. Soc. Amer., 35, 3, 364, 1963.

Current methods for ultrasonic inspection of metals and other solid materials are limited by their inability to determine the geometry of concealed defects if these defects are comparable in size, or smaller than the width of the ultrasonic search beam. Whenever such relatively small flaws are involved, ultrasonic pulse echo testing, if conducted at a single frequency, will yield the flaw location only, but no information on the flaw geometry. It is therefore very difficult to interpret the test results. The difficulty can be overcome by introducing the novel ultrasonic test method described in this paper. In this procedure, ultrasonic signals are utilized which contain a broad band of frequencies, and in analogy to optics, can therefore be considered as "white" ultrasonic pulses. The form and spectral energy distribution, or "color," of such ultrasonic pulses is influenced by the geometry of a defect from which they are reflected. Hence, an analysis of the defect echo yields information on the defect configuration. The successful application of the ultrasonic pulse analysis method for differentiating between flaws of various configurations is illustrated by a number of test examples.

153. W. L. Whaley and L. Adler, "Flaw Characterization by Ultrasonic Frequency Analysis", Materials Evaluation, 24, 8, 182, 1971.

A new method was developed for the characterization (determination of the size and orientation) of a reflector by ultrasonic spectral analysis. This technique can be used to determine nondestructively the nature of flaws detected in a material by means of ultrasonic examination. It is shown that it is feasible to characterize a flaw by this technique in spite of its composition (i.e., crack, void, or inclusion) or shape and without the need for a calibration standard. This technique is free of several limitations inherent in techniques based on amplitude. The results presented here are based on a series of reflection experiments in which the ends of solid rods immersed in water and machined discontinuities in metal samples were used as reflectors. Broadband ultrasonic pulses were analyzed after reflection from the interface of interest. A physical and analytical model was developed based on an interference mechanism that results from the superposition of spherical wavelets emitted from opposing extremes of the reflector. This model explains very well the experimentally observed spectra' variations in terms of size and three-dimensional angular orientation of the reflector, distance between the transducer and reflector, and displacement of the reflector from the axis of the transducer for a flat reflector of any composition. Based on this technique, a detailed procedure can be outlined for characterizing a randomly oriented natural flaw in a plate. The feasibility and practicality of using this technique to test various materials and in automated testing systems were considered.

154. L. Adler and D. K. Lewis, "Diffraction Model for Ultrasonic Frequency Analysis and Flaw Characterization", Materials Evaluation, 30, 1, 51, 1977.

Ultrasonic frequency analysis is developing into a powerful tool in nondestructive evaluation. In this technique an incident broadband pulse hits the target (flaw) and the scattered pulse is spectrum analyzed. The interpretation of the spectrum from various targets and identifying the target is the problem to solve. In our earlier work the frequency distribution of the scattered wave was related to the size and orientation of the target by an approximate theory. This theory assumed that the wavelets originating from the edge of the target will interfere. By realizing that any flaw will diffract sound waves like an aperture diffracts light, we have adopted a geometrical theory of diffraction of flaw characterization problems. An exact expression was derived which relates the amplitude and the frequency of the scattered wave to the size and orientation of a flaw. Computer calculations of this diffraction theory agree very well with the experimentally obtained spectra from frequency analysis measurements. This approach is applied to the characterization of flaws in metals.

155. H. L. Whaley and K. V. Cook, "Ultrasonic Frequency Analysis", Materials Evaluation, 29, 3, 61, 1970.

In order to increase our understanding of frequency effects in ultrasonic testing, we have developed a system which can analyze the frequency content of reflected or transmitted ultrasonic pulses. The system is composed of commercially available electronic equipment and can be used with conventional ultrasonic instruments operating in either a contact or immersion mode. We have applied the system to examine the frequency effects of the following ultrasonic test variables: transducer type, ultrasonic instrument type, transducer positioning, tuning devices and collimation.

156. L. Adler et al, "Flaw Size Measurements in a Weld Sample by Ultrasonic Frequency Analysis", Materials Evaluation, 30, 3, 44, 1977.

An ultrasonic frequency-analysis technique has been developed and applied to characterize flaws in an 8 in. (203 mm) thick heavy-section steel weld specimen. The technique applies a multitransducer system. The spectrum of the received broad-band signal is frequency analyzed at two different receivers for each of the flaws. From the two spectra, the size and orientation of the flaw are determined by the use of an analytic model proposed earlier.

157. A. K. Vopilkin et al, "A Theoretical Study of Ultrasonic Spectral Analysis of Flaws", DEFEKTOSCOPIYA, 6, 667, Nov-Dec 1977.

The amplitude-frequency characteristics of flaws of different shapes and sizes have been studied theoretically. Expressions were derived for calculating such characteristics. It has been shown that each type of flaw has specific amplitude-frequency characteristic, most information being provided by planar flaws inclined with respect to the ultrasonic beam axis. Its amplitude-frequency characteristics have an oscillatory nature with periodically recurring peaks. It is shown that with the aid of the specific amplitude-frequency characteristics of different flaws it is possible to differentiate between planar and three-dimensional flaws.

158. R. S. Gilmore and G. J. Czerw, "The Use of Radiation Field Theory to Determine the Size and Shape of Unknown Reflectors by Ultrasonic Spectroscopy", Materials Evaluation, **35**, 1, **37**, 1977.

This paper deals with the application of field theory to explain ultrasonic spectroscopy measurements. Calculations similar to those used to describe radar antenna or ultrasonic transducer radiation patterns can be applied to the evaluation of reflectors in metal. Seven reflector shapes are treated specifically; a dipole, an n tupple pole, a continuous line, a rectangle, a square, a ring source, and a circular disk, and it is shown how the calculations can be applied to evaluate reflectors whose geometry may not approximate any of these specific shapes. The results include the effects of the uniformity of both the illuminating wave and the reflector target strength.

159. **A. K.** Gurvich, "Basic Numerical Characteristics of Echo Train Envelopes", **DEFEKTOSKOPIYA**, 1, 141, Jan-Feb 1975.

A study to indicate the possible uses of the A-scan amplitude and time response envelopes for flaw characterization. Flaw characterization in terms of flaw size and orientation are presented in theory and some experimental work. (Revised.)

160. *S.* Serabian and W. **E.** Lawrie, "Experimental Verification for a Pulse-Echo Ultrasonic Detection Model", to be offered for publication.

In a previous paper a computer model for the pulse-echo ultrasonics method was presented. The model is based upon the spatial interplay of the radiation fields from the transducer and flaw. It was found that the model is valid for both straight and angle beams as well as for the tandem technique. With the model, it is possible to examine selected characteristics descriptive of the amplitude response envelope obtained during a conventional scan of a flaw and to note their usefulness to quantitatively define the detected flaw content.

In this paper experimental evidence is presented which supports the proposed model. The experimental work is confined to the straight beam interrogation and involves a number of combinations of transducer and flaw sizes, frequencies and flaw orientations. Angle beam experimentation is in progress. However, the success of the model to date indicates that the model can probably be used to describe the angle beam mode of interrogation as well.

161. F. V. Ammirato, "The Influence of Reference Defect Geometry Beam Angle and Frequency on Shear Wave Ultrasonic Test Sensitivity", Materials Evaluation, 34, 2, 44, 1976.

The sensitivity of an ultrasonic shear wave inspection is adjusted by setting the instrument gain control to obtain a specified echo amplitude from a reference defect placed in the part to be tested or in an equivalent calibration block. The size and shape of the reference defect are governed by the applicable material specification. Side-drilled holes, V-notches, and rectangular notches are commonly used for this purpose. The test sensitivity is strongly affected by the reference defect geometry, incident shear wave angle and the frequency. Usually, these parameters are not rigidly specified but are only required to be inside a range of values. This report demonstrates the wide variation in test sensitivity that can be obtained by varying these parameters within the range permitted by material specifications.

162. A. K. Gurvich, "Directivity Patterns of Angled Probes", DEFEKTOSCOPIYA, 6, 3, Nov-Dec 1966.

The results of a calculation of the directivity patterns of angled probes in steel, aluminum, and copper are discussed for various prism angles and ratios of the emitter diameter to the wavelength. The possibility of approximating the directivity patterns by a cosine curve is demonstrated. A technique is presented for experimentally determining the directivity patterns of angled probes.

163. B. D. Simmons and R. J. Urick, "The Plane Wave Reciprocity Parameter and Its Application to the Calibration of Electroacoustic Transducers at Close Distances", J. Acous. Soc. *Am.* 21, 6, 633, 1949.

The reciprocity parameter for a plane wave sound field is shown to be equal to $2A/\rho c$, where A is the area of the plane piston source and ρc the characteristic acoustic resistance of the medium. It is shown experimentally that the sound field in front of a plane piston source is effectively plane over a distance approximately equal to A/λ, and that in such a region the plane wave parameter may be used to obtain a free field calibration of the transducer by the reciprocity method.

164. J. L. Rose and P. A. Meyer, "Model for Ultrasonic Field Analysis in Solids", J. Acous. Soc. Am. 57, 3, 598, 1975.

In this paper a theoretical model is presented that can be used to evaluate analytically ultrasonic transducer longitudinal wave-generation characteristics in homogeneous isotropic solids. Comparisons with fluid-type solutions are also outlined. A continuous wave solution is determined first, from which particle displacement, particle velocity, and stress solutions for arbitrary pulse shapes are obtained. The ultrasonic field distributions resulting from several basic pulse shapes are presented along with the results of an experimentally obtained distribution. Nearfield and beam angle of divergence for pulse output transducers are also discussed. In addition to developing data for ultrasonic field analysis in solids, the equations developed can be used for obtaining solutions to many other ultrasonics problems. For example, it now becomes possible to develop equations that can analyze the resulting stress and particle velocity distribution in a multilayer structure for materials subjected to either normal beam incidence or angle beam incidence. The work may also be extended to include many aspects of ultrasonic field measurement analysis for flaw characterization work.

165. B. T. Cross, "Sound Beam Directivity: A Frequency Dependent Variable", Nondestructive Testing, 119, April 1971.

This report is part of a study of high frequency sound beam propagation and the information concerns the frequency-dependence observed in ultrasonic test results. The author has mathematically predicted and empirically verified that ultrasonic response curves from area-amplitude references are influenced by frequency. The frequency influence is identified as the beam directivity associated with the d/λ ratio. Schlieren photography provides supporting data by showing the reflected sound beam patterns for various reflector sizes. These findings are significant; accurate prediction may be made for a given ultrasonic inspection by considering the frequency range of its operation. Also insight is given into the reasons why two different instruments can yield non-correlating test data at the same apparent frequency.

166. J. Zamanek, "Beam Behavior Within the Nearfield of a Vibrating Piston", J. Acous. Soc. Am., 49, 1, 181, 1971.

A numerical investigation of the nearfield region of a vibrating piston was conducted. While existing literature is not exactly clear about how close to a transducer a regular beam pattern is formed, the results of this investigation show the limits of operation one can expect. From one interpretation of literature, a - 3 db beam with a minimum spot size equal to the transducer diameter would be expected to form beyond an axial distance $z = 3.89\ a^2/\lambda$. This investigation shows that such a beam forms at $z = 0.75\ a^2/\lambda$ and has a minimum spot size equal to one-quarter the transducer radius. These results are verified for transducers with a/λ's ranging from 1 to 20 and can be extended with confidence to higher a/λ's. Similar results are also obtained for −1.5, −4.5, −6.0, −7.5, −9.0, −10.5, and −12 db beams.

167. E. A. Vasil'tsov, "Shaping the Directivity of Radiation Fields from Small Acoustic Transducers", DEFEKTOSCOPIYA, 5, 76, Sept–Oct 1973.

Using the difference effect, consideration is given to the possibility of shaping the directivity of radiation fields from acoustic transducers that are small compared to the wavelength (less than 0.5). Expressions are derived for linear and circular systems that describe the directional characteristics of the fields, and an evaluation is provided for the radiation efficiency (relative pressure gain) as a function of the ratio between a linear dimension and the wavelength. Recommendations are made regarding the practical use of small transducers that provide a constant directional characteristic over a broad frequency band.

168. U. Schlengermann, "Focused Sound Fields and Their Applicability to the Nondestructive Testing of Materials", British Journal of NDT, **298,** Nov 1977.

For the detection of very small reflectors, at greater distances, sound fields with very high intensity are required; for an exact determination of the shape of the reflectors however, highly concentrated sound fields are necessary. Both requirements can be fulfilled by focusing the sound field. It is shown that, independent of the type of focusing, the narrowing of the sound field is always due to the same interference effects. By means of characteristic examples of focused sound fields, the important effects to be considered when choosing appropriate probes can be detailed.

169. R. Saglio, "Better Detection of Large, Poorly Oriented Plane Defects by Ultrasonics", NDT International, **193,** August 1976.

Contrary to expectations, the most difficult defects to detect by ultrasonic inspection are large plane defects. This account is far more descriptive than theoretical; it demonstrates that the probability of detecting a poorly oriented plane defect can be increased by using a highly focused ultrasonic transducer at the lowest possible frequency.

170. S. Lees, "Useful Criteria in Describing the Field Pattern of Focusing Transducers", Ultrasonics, 16, 5, 229, 1978.

The sonic beam of a weakly focused transducer can be represented by a cone with apex on the transducer. The focal spot diameter and the beam divergence are calculated from O'Neil's expression for the pressure distribution at the focus and the appropriate criterion defining the edge of the beam. Confirmation with experimental results is given.

171. I. N. Kanevskii and M. N. Nisnevich, "Enhancement of Ultrasonic Flaw Detection Sensitivity by Means of Focusing Systems; Part II - Experiment".

The characteristics of ultrasonic inspection aided by focusing systems are investigated experimentally. The advantage of focused ultrasound in immersion inspection is demonstrated. A typical practical application of the results in the inspection of forged niobium ingots is given as an example.

172. J. Szilard and M. Kidger, "A New Ultrasonic Lens", Ultrasonics, 268, November 1976.

There is an increasing need for good ultrasonic lenses in nondestructive testing, medical diagnostics and short range underwater applications. The difficulties encountered are material problems in nature; optical design techniques are well developed.

A symmetrical doublet has been designed with an aperture of F1 and with aberrations much less than $\lambda/4$ at 2 MHz. The calculated resolution is 4λ per line pair. Details of the construction and the first test results, which agree well with predictions, are reported.

173. J. T. Walker and J. D. Meindle, "A Digitally Controlled CCD Dynamically Focused Phased Array", IEEE, Ultrasonics Symposium Proceedings, 1975.

This paper presents an electronically focussed and scanned linear ultrasonic array using individual CCD delay line chips separatelv controlled by a common digital controller. Use of separate control provides system versatility and accuracy in near field focusing. The system discussed here uses a 3.1 cm linear array of 31 ultrasonic transducers at 1.5 MHz. Each transducer is provided with a separate transmitter, receiver, and CCD delay line. Outputs from the 31 CCD delay lines are added onto an RF summing buss to form the final scanned array beam. A digital control unit controls the CCDs to cause sector scanning $\pm$ 30 degrees relative to the array normal and chirped clock generators produce dynamic focusing on echoes received from ranges of 2 to 40 cm. Automatic channel control circuits maintain the array gain and phase variations due to component variaticns within acceptable limits.

174. W. L. Beaver, "A Method of Three-Dimensional Electronic Focusing and Beam Steering Using Electronic Delay Lines", IEEE, Ultrasonics Symposium Proceeding, 1975.

Delay line networks to steer the two-dimensional ultrasonic beam of a linear array of transducer elements can be thought of as modules that are useful in three-dimensional beam steering. The beam may be focused at a particular range by sweeping the steering angle or focused by an auxiliary set of delay lines. These networks are realizable as integrated circuits, and it is shown that N+1 of them may be used to steer and focus the beam of an NxN rectangular transducer array.

175. J. M. Smith, "Advanced Acoustic Imaging with Linear Transducer Arrays", AMMRC TR 77-26, Army Materials and Mechanics Research Center, Watertown, Mass., Dec 1977.

A prototype ultrasonic inspection system, using a sequentially fired transducer array, has been built that is much faster than conventional single-element transducer systems. This system was assembled with off-the-shelf components and would appear to be an attractive solution to nondestructive testing problems that require fast inspection rates and have resolution and sensitivity requirements that are consistent with the use of unfocused transducer elements. The fast inspection of a number of Army components, such as artillery projectile rotating bands and tank track pads, has been demonstrated with this system.

176. K. E. Simmonds and S. D. Hart, "A Circular Transducer Array for Ultrasonic Inspection of Plates and Sheets", British J of NDT, 21, 1, 1979.

Several years ago, in an effort to increase the reliability of detection of randomly oriented cracks, a rotating transducer head was needed to rotate this device made it impractical, but the principle was sound. Recent developments in the miniaturization of electronic circuitry have made possible a substitute for rotation, namely, sequential operation of a ring of transducers. An experimental model has been build. This report describes its performance.

177. A. Smallman and M. J. Whittle, "The Assessment and Specification of Ultrasonic Probes", British Journal of NDT, 20, 6, 296, 1978.

A comprehensive range of equipment for assessing ultrasonic probes has been assembled at the NDT Applications Center of the C.E.G.B., and large numbers of commercial transducers have been examined. About one-third of these proved to be defective, pointing to the need for improved quality control by manufacturers. Accordingly, we are drafting a number of standards for probes which define the performance required by the C.E.G.B. In contrast with previous probe

standards, these define acceptable ranges for the various probe parameters. The first standard, which applies to single and twin crystal miniature angle probes, has been circulated for comment within the U.K., and will be issued very shortly.

178. B. H. Lidington and M. G. Silk, "The Variability of Ultrasonic Transducers", British J. of NDT, *14*, **6**, 173, 1972.

A statistical analysis of the variation in some of the important properties of ultrasonic probes is described. The probes evaluated by the NDT Center's probe-beam plotter have been used as a sample. An attempt has been made to define acceptable limits to the variations in probe parameters, although these may not be of wide application since every application of ultrasonic testing defines slightly different limits of acceptability. It appears that 45% of low frequency probes and 81% of high frequency probes may lie outside these limits.

179. B. H. Lidington and M. G. Silk, "A Reappraisal of the Variability of Ultrasonic Transducers", Nondestructive Testing, *204*, Aug *1974*.

The authors describe a second statistical analysis of the variations in the properties of ultrasonic probes. The probes evaluated for customers on the NDT Center's probe-beam plotter provided the sample. Defining, as before, limits of acceptability in those parameters subject to changes in particular applications, it appears that the probability of a probe giving a malfunction is 53% for lower frequency probes compared with 76% for higher frequency probes. These figures compare with earlier estimates, based on the same limits of acceptability, of 45% and 81% respectively.

180. J. T. McElroy, "Identification and Measurement of Ultrasonic Search Unit Characteristics", Materials Evaluation *25*, 6, *129*, 1967.

The most important single component of any ultrasonic testing system is the search unit. The sound beam emitted from the search unit determines what can be detected and visualized by the ultrasonic equipment. Any standards programs for ultrasonic testing must logically start with an accurate knowledge and understanding of the beam characteristics.

To provide a basis for understanding and acceptance of measured data, sound beam analysis must be basic and consistent with fundamental theory. The methods used to analyze the sound beam must provide a high degree of signal "purity." The crystal excitation and the amplification of the information must be accomplished without distortion. With a pure system of analysis, such factors as frequency, sensitivity, damping factor, beam profile, and distance amplitude characteristics can be expressed in basic units of measurement.

This paper discusses approaches to the evaluation of ultrasonic search units.

181. N. G. Neubauer, "A Summation Formula for Use in Determining the Reflection From Irregular Bodies", J. Acous. Soc. Am., 35, 3, 279, 1963.

The solution to the approximate integral form of the reflection in the "far field" has been developed, as well as a graphical, or numerical, method for the case of a rigid, finite plane rotated about an edge, and for a wedge shape. The Kirchhoff approximation is used. The reflection may be conveniently presented in diagrams in the complex plane. Extension of the method has been made to the case for the magnitude of the reflection at any orientation of a reflector. Physically measurable quantities are required in the evaluation of this sum. Although the evaluation is not exact, rapid, or inclusive of all reflection mechanisms, it does make possible the derivation from shapes which are not analytically describable.

182. D. M. Johnson, "Model for Predicting the Reflection of Ultrasonic Pulses From a Body of Known Shape", J. Acous. Soc. Am.; 59, 6, 1319, 1976.

An approximate model for determining the response functions of reflectors of known shape has been used to provide theoretical support for experimental investigations of flaw characterization. The reflection of broad-band ultrasonic pulses from an object can result in modifications to both the frequency spectrum and phase information in the pulses. These changes are largely controlled by the parameters of the reflector, and relating these factors has been the subject of many experimental investigations. Within the fundamental approximations, the model can readily be applied to any reflector of known shape and provides a simple interpretation of what is physically occurring. It has the advantage that additional experimental factors can be included to determine their effect on the results.

183. G. A. Budenkov and L. I. Khakimova, "Reflection From a Cylindrical Defect", DEFEKTOSCOPIYA, 1, 34, Jan-Feb 1976.

The displacement amplitudes of transverse waves reflected from cylindrical defects of various radii are calculated, along with the initial phases due to interaction of the incident waves with the surface of a defect. The displacement amplitude of the reflected waves increases monotonically with the ratio of the defect radius to the incident wavelength.

184. I. N. Ermolov, "Reflection of Ultrasound from Various Types of Defects", DEFEKTOSCOPIYA, 4, 77, July-Aug 1970.

On the basis of using the method of similarity and approximation of ray acoustics, formulas are derived for calculating the reflection of ultrasound from defects of the disk, sphere, cylinder, band and plane types.

185. I. N. Ermolov, "The Reflection of Ultrasonic Waves From Targets of Simple Geometry", Nondestructive Testing, April 1972.

This paper discusses the problem of estimating the size of flaws using ultrasound. A solution to the problem, for various targets, is suggested that uses Krautkramer's method of similarity for a disc reflector. Examples are worked out for different conditions. The targets considered are the flat-disc, sphere, cylinder and infinite plate. (Revised.)

186. M. G. Silk and B. H. Lidington, "The Potential of Scattered or Diffracted Ultrasound in the Determination of Crack Depth", 8, 6, 146, 1975.

This article reports an investigation which was a part of a wider study of defect sizing techniques. The authors have examined the method of crack depth determination using scattered ultrasound developed by Bottcher et al with special reference to contact probe studies with normal grade structural steels. They conclude that the use of amplitude of the scattered signal as a measure of crack depth, as proposed, suffers from a number of serious drawbacks in these contexts. However, the alternative of using the change of time delay between the transmitted and the first received signal has been investigated here and appears to provide a very attractive alternative.

187. R. J. Hudgell et al, "Nondestructive Measurement of the Depth of Surface Breaking Cracks Using Ultrasonic Rayleigh Cracks", 16, 5, 144, 1974.

In ultrasonic testing, defect size has traditionally been estimated from the measurement of echo amplitude and/or shadowing such as the 20 db drop method. Certain techniques utilizing ultrasonic Rayleigh waves give the possibility of estimation of crack depth by observing change in the time domain. Three Rayleigh wave techniques are considered - transmission around the defect, mode conversion at the defect, and spectroscopy. This paper describes the techniques, outlines some of the experimental work which has been done, and discusses the present state of the art and possible routes for future development.

188. P. A. Doyle and C. M. Scala, "Crack Depth Measurement by Ultrasonics: A Review", Ultrasonics, 16, 3, 164, 1978.

A review is given of both bulk and surface wave ultrasonic methods for the measurement of the depth of surface-breaking cracks. Research is considered which relates to techniques for measuring crack depth by studying the scattered pulse amplitude, by using time-of-flight methods, or by carrying out ultrasonic spectroscopic analysis. Measurement of the transit time of bulk waves appears most likely to provide simple and reliable depth measurement in the near future. Further work in the other two areas should also prove valuable. Some suggestions are made of promising directions for future research.

189. M. V. Grigor'ev; V. V. Grebennikov and A. K. Gurvich, "Ultrasonic Determination of Crack Dimensions", DEFEKTOSCOPIYA, 2, 8, Feb 1978.

The paper deals with the detection of surface cracks. The methods in use today can be subdivided into amplitude methods, time based methods, and spectral methods. It is fact that the spectral method is in its early developmental stages and much more research is needed on real cracks before any estimate can be made of its accuracy and the practical usefulness. The amplitude methods have not showed an impressive abilities to date due to flaw orientation, shape, width and the quality of the acoustic contact. It is concluded that the time based measurements have the most promise. (Revised.)

190. H. Wustenberg and E. Mundry, "Consideration of the Ultrasonic Testing Method as an Information Transfer System", British Journal of NDT, 15, 2, 36, 1973.

If progress is to be made in defect evaluation by ultrasonics, pulse spectrometry and "echo dynamics" are important techniques which must be developed. An information transfer system approach to both techniques has been used to demonstrate where further work may be successful, and where limitations may be expected, for example by a restriction to simple geometric conditions in both cases. These limitations must be clarified by experiment. Some additional results are:

(a) Due to the required reproducibility of echo amplitude in normal routine inspection, a narrow-banded system is needed. Up to now, this has often been neglected.

(b) For successful use of echo dynamics, one must have only one wavelength, i.e., a narrow-banded system.

(c) Broad-band systems are necessary for pulse spectrometry and perhaps for the inspection of strongly scattering materials.

191. B. L. Lack, "Ultrasonic Examination of Welds in Thick Plates Using a Double Probe in Line Technique", British Welding Journal, February 1962.

Discussion of a double probe interrogation method - known as the tandem method today. This paper is the first to mention such a notion. The author points out the need for such a method to cater to those weld flaws that are oriented essentially perpendicular to the interrogation surface. However, this system must also be augmented by the single probe interrogation to assure detection of those flaws that are located parallel to the plate surfaces. Considering the data of this paper, the author presents an excellent analysis of the many factors that affect the notion of determining flaw size from amplitude considerations. (Revised.)

192. P. B. whitford, "Ultrasonic Test Sensitivity in the Examination of Weldments", British Journal of NDT, 16, 3, 84, 1974.

Presents the difficulties associated with the establishment of an inspection sensitivity. The discussion includes a summary of the methods available for doing this - i.e., reference blocks, noise level, back reflections, etc. It is pointed out that with even a bonified method the numerous variables in materials, equipment and personnel render the establishment of sensitivity a difficult chore.

193. "Use of Reference Blocks for Checking Ultrasonic Inspection Apparatus", International Institute of Welding, Commission V - Testing, Measurement and Control of Welds", British Journal of NDT, April 1960.

Reports on the investigations dealing with the adoption of a reference block to measure the response of equipment and transducers, establishment of inspection sensitivity and to calibrate the combination of equipment and transducers.

194. M. J. Pinondel, "Setting of Sensitivity of Ultrasonic Equipment for Weld Inspection", Nondestructive Testing, 88, April 1973.

The author points out the disadvantages of current methods of setting sensitivity and reports her work on a method which could overcome them. The work was done on commonly used ultrasonic equipment and a variety of grease-coupled probes. An llW calibration block was used as a standard. The author's work leads her to put forward a general formula for sensitivity in terms of the amplitude from a reference hole on the llW block and the attenuation. She gives worked examples and makes practical advice to operators.

195. A. K. Gurvich and L. I. Kuz'mina, "Basic Parameters of Ultrasonic Control of Welded Joints and the Principles of Their Standardization and Standardizing (Survey)", DEFEKTOSCOPIYA, 6, 4, Nov-Dec 1970.

The basic parameters of the echo and mirror-shadow methods of ultrasonic defectoscopy of welded joints are examined. The principles of standardizing them and of their standardization are substantiated, and the standards and the All-Union State standard 14782-69 "Seams of Welded Junctions - Ultrasonic Defectoscopy Methods" are also described.

196. . G. Walther, "Realistic Ultrasonic Test Specifications Based on Measurab .e Data", Metal Construction and British Welding Journal, 389, August 1969.

Presents the need for close cooperation between the material engineer, designer, fracture mechanics specialist and the NDT engineer in the formulation of an inspection specification. The requirements generated may readily be translated into a working ultrasonic procedure.

197. I. N. Ermolov and D. F. Karlov, "Investigation of the Frontal Resolution of an Echo Type Flaw Detector", DEFEKTOSCOPIYA, 4, 57, July-Aug 1976.

An analysis is made of the resolution for an echo-type flaw detector when inspecting with straight, combination probes. A formula is derived for the variation of the echo-signal amplitudes from two flaws located at the same depth which have different reflection areas. A program was written for the MIR digital computer, and the variation of the echo signal was calculated and confirmed experimentally for a wide range of dimensionless parameters both along a line connecting the two flaws and at an angle to it.

198. R. J. Botsco, "High Resolution Ultrasonics", Material Evaluation, 25, 4, 76, 1967.

The dimensions and exotic configurations for many of today's aerospace structures present a spectrum of challenges to nondestructive testing. The use of ultrasonic, high-resolution (range) techniques offers a potential solution to many of these testing challenges. The fundamental electronic and ultrasonic principles which define pulse-echo high resolution are presented in this paper. To apply these principles, however, requires the development of specialized electronic and electroacoustic circuitry, such as the SPIDER (Sonic Pulse-echo Instrument Designed for Extreme Resolution). The characteristics, performance, and several generalized areas of application for the SPIDER are discussed.

199. H. Bosselaar and E. VanBokhorst, "Determination of the Resolving Power and Ultrasonic Frequency of Angle Beam Transducers", Nondestructive Testing, 382, December 1971.

The test block employed has two divergently placed grooves on the side opposite the transducer. By moving in a direction that is essentially perpendicular to the two grooves, it is possible to obtain two reflectors with a continuous separation. The resolution may be studied as a function of transducer characteristics and operating frequencies.

200. H. Wustenberg and E. Mundry, "Notches and Edges as Reference Defects in Ultrasonic Testing", Materialprufung, Vol *14*, 2, 58–61, 1972.

Examination of the suitability of notches and edges as reference defects for the establishment of equipment sensitivity for an ultrasonic interrogation for subsurface defects. The study includes the reliability in using the reflections from notches and edges as a function of the angle of incident of the ultrasound. (Revised.)

201. I. N. Ermolov and I. A. Vyat-Skov, "Reflection from a Cylindrical Side Hole in Pulsed Echo Nondestructive Testing". DEFEKTOSCOPIYA, 2, 66, March-April 1973.

Experimental studies were conducted on reflections of pulses of transverse waves emitted and picked up by inclined probes off a cylindrical side hole. The findings were that the energy theory is valid when the ratio of cylinder diameter to transverse wavelength is greater than two. When this ratio is between 0.8 and 2, the nonmonotonic behavior of the echo signal amplitude predicted by diffraction theory is not observed; the experimental curve runs below the curve plotted in conformity with the energy theory.

202. A. Juva and M. Haarvisto, "On the Effects of Microstructure on the Attenuation of Ultrasonic Waves in Austenitic Stainless Steels", British Journal of NDT, 19, *6*, 293, 1977.

This paper describes the effects of microstructure on the behavior of ultrasonic waves in austenitic stainless steels. The grain size and the carbide content of the same materials were varied by heat treatment. The effect of delta-ferrite was studied using cast materials having different delta-ferrite contents and distributions. The effects of solidification texture were studied with continuously cast materials and multilayer welded specimens. In both of these the grains had grown very long in the solidification direction, having a partly <100> and partly <111> fibre texture. An ultrasonic immersion technique was used €or the attenuation measurements.

203. "Effect of Reflector Shape on Response from Calibration Notches", Technical Data 50-707, Automation Industries, 1966.

Experimental comparison of the amplitude-distance response of a number of calibration reflectors such as milled slots (end, ball, and vee), segment slots and drilled holes. All data was taken by an angle beam transducer. The results indicate that the amplitude from the milled slots were the most sensitive to distance variations. The rest of the reflectors exhibit much less distance sensitivity and appear to have essentially the same amplitude-distance characteristics.

204. H. D. Tietz, "Determining the Size of Defects in Standardizing Sensitivity Using a Spherical Reflector", 1, 32, Jan-Feb 1972.

The author claims that using a reference standard with a planar simulated flaw such as a flat bottom hole results in size determinations that are always undersized. It is suggested that using a sphere as a reference standard will produce the maximum or upper limit in the flaw size determination. The reasoning for this is that the sphere is such a poor reflector that it will require increased interrogation sensitivities. It is proposed that by using both a planar and spherical reference standard, one will obtain a minimum and maximum assessment of flaw size, respectively. Appropriate DGS diagrams are generated to implement this notion. (Revised.)

205. A. R. Wilson; B. Rowe; S. A. Ambrose, "Full-Scale Testing of a Pressure Vessel $EM DASH$ Implications For Code Requirements". ID No. E1770968343 768343. Electr Comm of NSW, Aust IIW (Int Inst of Weld) Public Sess & Met Technol Conf., Sydney, Aust, Aug 21-28 1976; Sponsored by Int Inst of Weld, London, Engl, 1976, v B Sess 10, Pap 5, 13 p.

This paper refers to experimental and theoretical work carried out on a full-scale pressure vessel withdrawn from service due to cracked nozzles. Testing included strain gaging, acoustic emission, ultrasonic testing and magnetic particle inspection at various stages during pressurizing of the vessel over 1000 cycles, with general membrane stress approaching the proof stress of the parent material, and with 2 final cycles above proof stress. Preliminary comparisons are made with finite element analysis and fracture mechanics analysis in order to provide experimental data in the elastic/plastic region for typical full-scale welded nozzles with compensating rings. Material properties are yet to be determined to provide full comparison between theoretical and experimental work. Comments are given on the implications of this work on code requirements for nozzle welds. 4 refs.
DESCRIPTORS: (*PRESSURE VESSELS, *Testing), (NOZZLES, Welding),
CARD ALERT: 619, 902, 631, 538.

206. N. Sinclair, "Considerations for Establishing Ultrasonic Test Acceptance Standards", *25, 5,* 118, 1967.

Weld-defect characteristics which govern the failure of a pressure vessel are examined and ultrasonic methods for determining these characteristics are discussed. Assuming that data on slow crack growth rate and critical crack size for the inception of catastrophic failure are available, a method for establishing ultrasonic acceptance standards is presented, Ultrasonic weld-inspection acceptance standards presently in use are presented for comparison.

207. W. C. McGaughey, "Ultrasonic Examination of Welds: Comparison of ASME and AWS Procedures", *30, 2, 44,* 1972.

The ASME and AWS Ultrasonic Weld Examination procedures are compared in their requirements for personnel, instruments, calibration, technique selection and evaluation of reflectors detected in the weldment.

The ASME method requires: 1) preparation of a detailed written procedure which has been proven by actual demonstration; 2) distance amplitude calibration on a side drilled hole in material, thickness and curvature similar totheweldment, and 3) evaluation of reflectors which exceed 20% of the reference reflector amplitude. It specifies that cracks, lack of fusion and lack of penetration are unacceptable, as are other linear type reflectors exceeding the reference reflector amplitude and having a length of 3/4 in.

The AWS procedure details requirements: 1) for personnel; 2) instrument performance; 3) procedure changes with thickness; 4) acceptance level changes with thickness and 5) distance amplitude correction at a constant of 2 db per inch of beam path. The allowance of transducer size variation from 1/2 by 1/2 in. up to 13/16 by 1 in. can produce amplitude variations of 6 to 1 (16 db) from the same reflector at the same beam path.

In order safely to accommodate this variable, the AWS acceptance levels have a large safety factor which may result in excessive repairs.

208. C. J. Abrahams, "A Design Engineers' Guide to Inspection Problems", Metal Construction and British Welding Journal, 2, 9, *365,* 1970.

Increasingly a complete ultrasonic inspection of fillet welds is being specified by purchasers, yet most of the current designs for welded connections for pressure vessels date from a time before ultrasonic examination was considered necessary. Today, The author argues, the designer should appreciate the need for a weld which can be economically and critically examined so that defects can be differentiated accurately. He shows that with cooperation from the welding engineer only minor modifications are required to produce suitable designs for inspection.

209. I. Masuyama, M. Kisigami and T. Irisawa, "Ultrasonic Testing of Aluminium Alloy Weldments and Proposed Defect Acceptance Criteria Determined with Their Effect on Strength Taken into Consideration", British Journal of NDT, 19, 4, 185, 1977.

Conditions for assuring reliable detection of defects in weldments of 5083-0 aluminum-magnesium alloy are presented together with proposed acceptance criteria for defects determined in reference to their effect on the strength of the weldment.

210. P. Tenge; O. Solli and O. Forli, "Acceptance Criteria for Weld Defects and Nondestructive Inspection Procedures for LNG Tanks in Ships", Metal Construction, 7, 1, 29, 1975.

Acceptance criteria and nondestructive testing (NDT) procedures for weldments in liquified natural gas (LNG) tanks in ships have been established.

The significance of welding defects is analyzed in the light of safety against fatigue and unstable fracture. Fracture toughness and fatigue crack propagation test results from laboratory and production testing are used in the evaluation of acceptance criteria. Size and type of a number of microscopically examined production weld defects have been compared with ultrasonic test results.

This investigation forms a basis for the specification of ultrasonic inspection criteria, and special consideration has been given to the detection of lack of fusion. The choice of type and extent of nondestructive inspection is discussed. Experience in the use of uitrasonic testing for large LNG tanks of 9% Ni steel and aluminum-magnesium alloy 5083-0 is presented, with the advantages and disadvantages of the currently used NDT methods noted.

211. R. J. Roehrs, "An Analysis of the ASME Code", Proceedings of the 1968 Symposium on The NDT of Welds and Materials Joining, American Society for Nondestructive Testing, Los Angeles, CA, March 1968.

A critique of the ASME Code (sections III and VIII) and the procedures for the detection, location and evaluation of defects. It includes a technical discussion and explanation of the advantages and disadvantages of using various calibration reflectors. In addition, other areas include the calibration procedures, the reasoning behind the calibration transfer technique, as well as some of the thinking that prompted the ASME Sub Group on Ultrasonics to add many other concepts not incorporated in other documents.

212. "Recommendations for Ultrasonic Testing of Butt Welds", British Welding Journal, 12, 8, 394, 1965.

These recommendations are concerned with the manual fusion welding process in ferritic steels. It is the objective of the program which produce this document to provide an ultrasonic procedure which would optimize the detectionlcharacterization process. Of particular importance are the methods of beam width calibration, flaw size estimation and flaw type recognition. This document represents the first time that such details have been incorporated into a working weld inspection procedure.

213 G. A. Shenefelt, "Ultrasonic Testing Requirements of the AWS 1969 Building Code and Bridge Specifications", Welding Journal, 342, May 1971.

An assessment of the detectionlcharacterization procedures of the code dealing with groove welds in the 5/16 - 8 in. thickness range. The configuration of the welds may be either butt, tee or corner and may be either full or partial penetration welds. Electroslag and electrogas welds are included. It is the opinion of the writer that the procedures cited are very workable both from its implementation by operator and characterization of the observed data by engineering people.

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