(b) The Certificate Holder shall provide the organization performing the testing with the information listed below, as applicable.

(1) welding process;
(2) SFA Specification and classification;
(3) other identification if no SFA Specification applies;
(4) minimum tensile strength [NB-2431.1(e)] in the as-welded or heat-treated condition or both [NB-2431.1(c)];
(5) drop weight test for material as-welded or heat treated, or both (NB-2332);
(6) Charpy V-notch test for material as-welded or heat treated, or both (NB-2331); the test temperature and the lateral expansion or the absorbed energy shall be provided;
(7) the preheat and interpass temperatures to be used during welding of the test coupon [NB-2431.1(c)];
(8) postweld heat treatment time, temperature range, and maximum cooling rate, if the production weld will be heat treated [NB-2431.1(c)];
(9) elements for which chemical analysis is required per the SFA Specification or Welding Procedure Specification and NB-432;
(10) minimum delta ferrite (NB-2433).

**NB-2420 REQUIRED TESTS**

The required tests shall be conducted for each lot of covered, flux cored, or fabricated electrodes; for each heat of bare electrodes, rod, or wire for use with the OFW, GMAW, GTAW, PAW, and EGW (electrogas welding) processes (Section IX, Annex A); for each heat of consumable inserts; for each combination of heat of bare electrodes and lot of submerged arc flux; for each combination of lot of fabricated electrodes and lot of submerged arc flux; for each combination of heat of bare electrodes or lot of fabricated electrodes, and dry blend of supplementary powdered filler metal, and lot of submerged arc flux; or for each combination of heat of bare electrodes and lot of electroslag flux. Tests performed on welding material in the qualification of weld procedures will satisfy the testing requirements for the lot, or combination of heat or batch of welding material used, provided the tests required by NB-4000 and this Subarticle are made and the results conform to the requirements of this Article. The definitions in (a) through (h) below apply.

(a) A dry batch of covering mixture is defined as the quantity of dry covering ingredients mixed at one time in one mixing vessel; a dry batch may be used singly or may be subsequently subdivided into quantities to which the liquid binders may be added to produce a number of wet mixes [c] below.

(b) A dry blend is defined as one or more dry batches mixed in a mixing vessel and combined proportionately to produce a uniformity of mixed ingredients equal to that obtained by mixing the same total amount of dry ingredients at one time in one mixing vessel.

(c) A wet mix is defined as the combination of a dry batch or dry blend [(a) and (b) above, respectively], and liquid binder ingredients at one time in one mixing vessel.

(d) A lot of covered, flux-cored, or fabricated electrodes is defined as the quantity of electrodes produced from the same combination of heat of metal and dry batch, dry blend, or chemically controlled mixes of flux or core materials. Alternatively, a lot of covered, flux-cored, or fabricated electrodes may be considered one type and size of electrode, produced in a continuous period, not to exceed 24 hr and not to exceed 100,000 lb (45,000 kg), from chemically controlled tube, wire, or strip and a dry batch, a dry blend, or chemically controlled mixture of flux provided each container of welding material is coded for identification and traceable to the production period, the shift, line, and the analysis range of both the mix and the rod, tube, or strip used to make the electrode.

1. **Chemically controlled tube, wire, or strip** is defined as consumable tube, wire, or strip material supplied on coils with a maximum of one splice per coil that has been chemically analyzed to ensure that the material conforms to the electrode manufacturer’s chemical control limits for the specific type of electrode. Both ends of each coil shall be chemically analyzed, except that those coils which are splice free need only be analyzed on one end of the coil.

2. **Chemically controlled mixes of flux** are defined as flux material that has been chemically analyzed to ensure that it conforms to the percent allowable variation from the electrode manufacturer’s standard for each chemical element for that type electrode. A chemical analysis shall be made on each mix made in an individual mixing vessel after blending.

(e) A heat of bare electrode, rod, wire, or consumable insert is defined as the material produced from the same heat of metal.

(f) Alternatively, for carbon and low alloy steel bare electrode, rod, wire, or consumable inserts for use with SAW, OFW, GMAW, GTAW, PAW, and EGW processes, a heat may be defined as either the material produced from the same melt of metal or the material produced from one type and size of wire when produced in a continuous period [not to exceed 24 hr and not to exceed 100,000 lb (45,000 kg)] from chemically controlled wire, subject to requirements of (1), (2), and (3) below.

1. For the chemical control of the product of the rod mill, coils shall be limited to a maximum of one splice prior to processing the wire. Chemical analysis shall be made from a sample taken from both ends of each coil of mill-coiled rod furnished by mills permitting spliced coil practice of one splice maximum per coil. A chemical analysis need be taken from only one end of all coils furnished by mills prohibiting spliced coil practice.

2. Carbon, manganese, silicon, and other intentionally added elements shall be identified to ensure that the material conforms to the SFA or user’s material specification.
(4) Forgings and rolled bars which are to be bored and/or turned to form tubular parts or fittings shall be examined after boring and/or turning, except for threading. Fittings shall be examined after final forming.

**NB-2558 Elimination of Surface Defects**

Surface defects shall be removed by grinding or machining, provided the requirements of (a) through (c) below are met.

(a) The depression, after defect elimination, is blended uniformly into the surrounding surface.

(b) After defect elimination, the area is examined by the method which originally disclosed the defect to assure that the defect has been removed or reduced to an imperfection of acceptable size.

(c) If the elimination of the defect reduces the thickness of the section below the minimum required to satisfy the rules of **NB-3000**, the product shall be repaired in accordance with **NB-2559**.

**NB-2559 Repair by Welding**

Repair of defects shall be in accordance with **NB-2539**, except repair by welding is not permitted on copper-nickel alloy and nickel alloy heat exchanger tubes.

**NB-2560 EXAMINATION AND REPAIR OF TUBULAR PRODUCTS AND FITTINGS WELDED WITH FILLER METAL**

**NB-2561 Required Examinations**

(a) Welded tubular products (with filler metal) such as pipe made in accordance with SA-358, SA-409, SA-671, SA-672, and SA-691, and fittings made in accordance with the WPW grades of SA-234, SA-403, and SA-420, which are made by welding with filler metal, shall be treated as material; however, inspection by an Inspector and stamping with a Certification Mark with NPT Designator shall be in accordance with Section III requirements. In addition to the Certification Mark with NPT Designator, a number 1 shall be stamped below and outside the official Certification Mark.

(b) In addition to the requirements of the material specification and of the Article, pipe and fittings shall comply with the following:

1. The plate shall be examined in accordance with **NB-2530** prior to forming, or alternatively, the finished product shall be examined by the ultrasonic method in accordance with **NB-2562**.

2. All welds shall be examined 100% by radiography in accordance with the method and acceptance requirements of the base material specification, and by either the magnetic particle method in accordance with **NB-2564** or the liquid penetrant method in accordance with **NB-2565**. If radiographic examination of welds is not specified in the basic material specification, the welds shall be examined by the radiographic method in accordance with **NB-2563**. The radiographs and a radiographic report showing exposure locations shall be provided with the Certified Material Test Report.

**NB-2562 Ultrasonic Examination**

The ultrasonic examination shall be performed in accordance with the requirements of **NB-2552**.

**NB-2563 Radiographic Examination**

The radiographic examination shall be performed in accordance with the requirements of **NB-2553**.

**NB-2565 Magnetic Particle Examination**

The magnetic particle examination shall be performed in accordance with the requirements of **NB-2545**.

**NB-2566 Liquid Penetrant Examination**

The liquid penetrant examination shall be performed in accordance with the requirements of **NB-2546**.

**NB-2567 Time of Examination**

The time of examination shall be in accordance with the requirements of **NB-2557**, except that for magnetic particle or liquid penetrant examination of welds, including repair welds, for P-No. 1 (Section IX of the Code), examination may be performed prior to postweld heat treatment.

**NB-2568 Elimination of Surface Defects**

Unacceptable surface defects shall be removed in accordance with the requirements of **NB-2558**.

**NB-2569 Repair by Welding**

When permitted by the basic material specification, base material defects shall be repair welded in accordance with the requirements of **NB-2559**. Repair welding of weld seam defects shall be in accordance with **NB-4450**.

**NB-2570 EXAMINATION AND REPAIR OF STATICALLY AND CENTRIFUGALLY CAST PRODUCTS**

In addition to the requirements of the material specification and of this Article, statically and centrifugally cast products shall comply with the following subparagraphs.

**NB-2571 Required Examination**

Cast products shall be examined by the radiographic method, except cast ferritic steels which shall be examined by either the radiographic or ultrasonic method, or a combination of both methods, as required for the product form by Table **NB-2571-1**.

In addition, all cast products shall be examined on all external surfaces and all accessible internal surfaces by either the magnetic particle or liquid penetrant method.
NB-4323  Welding Prior to Qualifications

No welding shall be undertaken until after the welding procedures which are to be used have been qualified. Only welders and welding operators who are qualified in accordance with NB-4320 and Section IX shall be used.

NB-4324  Transferring Qualifications

The welding procedure qualifications and the performance qualification tests for welders and welding operators conducted by one Certificate Holder shall not qualify welding procedures and shall not qualify welders or welding operators to weld for any other Certificate Holder, except as provided in Section IX, QW-201 and QW-300.2.

NB-4330  GENERAL REQUIREMENTS FOR WELDING PROCEDURE QUALIFICATION TESTS

NB-4331  Conformance to Section IX Requirements

All welding procedure qualification tests shall be in accordance with the requirements of Section IX as supplemented or modified by the requirements of this Article.

NB-4333  Heat Treatment of Qualification Welds for Ferritic Materials

Postweld heat treatment of procedure qualification welds shall conform to the applicable requirements of NB-4620 and Section IX. The postweld heat treatment time at temperature shall be at least 80% of the maximum time to be applied to the component weld material. The postweld heat treatment total time may be applied in one heating cycle.

NB-4334  Preparation of Test Coupons and Specimens

(a) Removal of test coupons from the test weld and the dimensions of specimens made from them shall conform to the requirements of Section IX, except that the removal of impact test coupons and the dimensions of impact test specimens shall be in accordance with (b) below.

(b) Weld deposit of each process in a multiple process weld shall, where possible, be included in the impact test specimen. When each process cannot be included in the full-size impact test specimen at the 1/2t location required by this Section, additional full-size specimens shall be obtained from locations in the test weld that will ensure that at least a portion of each process has been included in full-size test specimens. As an alternative, additional test welds can be made with each process so that full-size specimens can be tested for each process.

NB-4334.1  Coupons Representing the Weld Deposit.

Impact test specimens and testing methods shall conform to NB-2321. The impact specimen shall be located so that the longitudinal axis of the specimen is at least 0.25t and, where the thickness of the test assembly permits, not less than 7/8 in. (10 mm) from the weld surface of the test assembly. In addition, when the postweld heat treatment temperature exceeds the maximum temperature specified in NB-4620 and the test assembly is cooled at an accelerated rate, the longitudinal axis of the specimen shall be a minimum of t from the edge of the test assembly. The specimen shall be transverse to the longitudinal axis of the weld with the area of the notch located in the weld. The length of the notch of the Charpy V-notch specimen shall be normal to the surface of the weld. Where drop weight specimens are required, the tension surface of the specimen shall be oriented parallel to the surface of the test weld assembly.

NB-4334.2  Coupons Representing the Heat Affected Zone. Where impact tests of the heat affected zone are required by NB-4335.2, specimens shall be taken from the welding procedure qualification test assemblies in accordance with (a) through (c) below.

(a) If the qualification test material is in the form of a plate or a forging, the axis of the weld shall be oriented in the direction parallel to the principal direction of rolling or forging.

(b) The heat affected zone impact test specimens and testing methods shall conform to the requirements of NB-2321.2. The specimens shall be removed from a location as near as practical to a depth midway between the surface and center thickness. The coupons for heat affected zone impact specimens shall be taken transverse to the axis of the weld and etched to define the heat affected zone. The notch of the Charpy V-notch specimen shall be cut approximately normal to the material surface in such a manner as to include as much heat affected zone as possible in the resulting fracture. Where the material thickness permits, the axis of a specimen may be inclined to allow the root of the notch to align parallel to the fusion line. When a grain refining heat treatment is not performed on welds made by the electroslag or electrogas welding process, the notch for the impact specimens shall be located in the grain coarsened region.

(c) For the comparison of heat affected zone values with base material values [NB-4335.2(b)], Charpy V-notch specimens shall be removed from the unaffected base material at approximately the same distance from the base material surface as the heat affected zone specimens. The axis of the unaffected base material specimens shall be parallel to the axis of the heat affected zone specimens, and the axis of the notch shall be normal to the surface of the base material. When required by NB-4335.2(b)(1), drop-weight specimens shall be removed from a depth as near as practical to midway between the surface and center thickness of the unaffected base material and shall be tested in accordance with the requirements of NB-2321.1.
NB-5273  **Hard Surfacing**

Hard surfacing weld metal shall be examined by the liquid penetrant method in accordance with NB-2546, and the acceptance standards applicable to materials less than \( \frac{3}{8} \) in. (16 mm) thick shall apply. Penetrant examination is not required for hard surfacing on valves with inlet connections NPS 4 (DN 100) or less.

NB-5274  **Tube-to-Tubesheet Welded Joints**

Tube-to-tubesheet welded joints shall be examined by the liquid penetrant method.

NB-5275  **Brazed Joints**

Flux and flux residue shall be removed from all surfaces prior to examination. Joints shall be visually examined on all accessible surfaces to determine whether there has been adequate flow of brazing metal through the joint. Optical aids may be employed for indirect visual examination of joints which cannot be directly examined.

NB-5276  **Inertia and Continuous Drive Friction Welds**

(a) When radiographic examination is required by this Article, inertia and continuous drive friction welds shall also be examined by the ultrasonic method to verify bonding over the entire area.

(b) The materials used shall be those assigned a P-Number by Section IX, but shall not include rimmed or semikilled steel.

(c) One of the two parts to be joined must be held in a fixed position and the other part rotated. The two faces to be joined must be symmetrical with respect to the axis of rotation.

(d) The weld between the two members shall be a full penetration weld.

NB-5277  **Electron Beam Welds**

In addition to the requirements for the type of weld being examined, all complete penetration welds made by the electron beam welding process shall be ultrasonically examined.

NB-5278  **Electroslag Welds**

In addition to the requirements for the type of weld being examined, all complete penetration welds made by the electroslag welding process in ferritic materials shall be ultrasonically examined.

NB-5279  **Special Exceptions**

When the joint detail does not permit radiographic examination to be performed in accordance with this article, ultrasonic examination plus liquid penetrant or magnetic particle examination of the completed weld may be substituted for the radiographic examination. The absence of suitable radiographic equipment shall not be justification for such substitution. The substitution of ultrasonic examination can be made provided the examination is performed using a detailed written procedure which has been proven by actual demonstration to the satisfaction of the Inspector as capable of detecting and locating defects described in this Subsection. The nondestructive examinations shall be in accordance with NB-5110 and meet the acceptance standards of NB-5300.

NB-5280  **PRESERVICE EXAMINATION**

NB-5281  **General Requirements**

(a) Examinations required by NCA-3252(c) shall be completed prior to completion of the N-5 Data Report.

(b) All volumetric and surface examinations shall be documented with results and identified in a form consistent with those required in NCA-4134.17 for transfer to the Owner.

NB-5282  **Examination Requirements**

(a) Components shall be examined as specified in Section XI, Table IWB-2500-1. The method of examination for the components and parts of the pressure-retaining boundaries shall comply with those tabulated in Table IWB-2500-1. Only the volumetric and surface examinations are required to be performed.

(b) For Control Rod housings, Examination Category B-O, the examination shall be extended to include essentially 100% of the welds in the installed peripheral control rod drive housing only.

NB-5283  **Components Exempt From Preservice Examination**

The following components or parts of components are exempted from the volumetric and surface examination requirements of this Subarticle:

(a) piping of NPS 1 (DN 25) and smaller, except for steam generator tubing;

(b) reactor vessel head connections and associated piping, NPS 2 (DN 50) and smaller, made inaccessible by control rod drive penetrations; and

(c) integral attachments of supports and restraints that are inaccessible due to being encased in concrete, buried underground, or encapsulated by guard pipe.

NB-5300  **ACCEPTANCE STANDARDS**

NB-5320  **RADIOGRAPHIC ACCEPTANCE STANDARDS**

Indications shown on the radiographs of welds and characterized as imperfections are unacceptable under the following conditions:

(a) any indication characterized as a crack or zone of incomplete fusion or penetration;

(b) any other elongated indication which has a length greater than:

1. \( \frac{1}{4} \) in. (6 mm) for \( t \) up to \( \frac{3}{8} \) in. (19 mm), inclusive