MANDATORY APPENDIX 5
GUIDELINES ON THE APPROVAL OF NEW MATERIALS UNDER
THE ASME BOILER AND PRESSURE VESSEL CODE

5-100 CODE POLICY

It is expected that requests for Code approval will normally be for materials for which there is a recognized national or international specification. It is the policy of the ASME Boiler and Pressure Vessel (BPV) Committee on Materials to approve, for inclusion in the Code Sections, only materials covered by specifications that have been issued by standards-developing organizations such as, but not limited to, American Petroleum Institute (API), American Society for Testing and Materials (ASTM), American Welding Society (AWS), Canadian Standards Association (CSA), European Committee for Standardization (CEN), Japan Industrial Standards (JIS), Standards Association of Australia (SAA), and China Standardization Committee (CSC).

Material specifications of other than national or international organizations, such as those of material producers/suppliers or equipment manufacturers, will not be considered for approval. The Committee will consider only official requests for specifications authorized by the originating standardization body and available in the English language and in U.S. Customary and/or SI/Metric units.

For materials made to a recognized national or international specification other than that of ASTM or AWS, the inquirer shall give notice to the standards-developing organization that a request has been made to ASME for approval of the specification under the ASME Code and should request that the issuing organization grant ASME permission to at least reproduce copies of the specification for Code Committee internal use and, if possible, reprint the specification. For other materials, a request shall be made to ASTM, AWS, or a recognized national or international standardization body to include the material in a specification that can be presented to the BPV Committee on Materials.

It is the policy of the ASME BPV Committee on Materials to consider requests to approve new materials only from boiler, pressure vessel, transport tank, nuclear facility component manufacturers, architect-engineers, or end users. Such requests should be for wrought, cast, or hot isostatically pressed powder materials for which there is a reasonable expectation of use in a boiler, pressure vessel, transport tank, or nuclear facility component constructed to the rules of one of the Sections of this Code. When a grade does exist in a defined wrought product form, a material producer/supplier may request the inclusion of additional wrought product forms or, provided all of the requirements of Table 5-100 of this Appendix are met, the inclusion of hot isostatically pressed (HIP) powder metallurgy components of this grade. When a grade does exist in a defined cast product form, a material producer/supplier may request the inclusion of additional cast product forms.

Any qualified organization requesting that an ASME BPV Committee approve a “new” material for use in their Code book should be aware that only the BPV Committee on Materials provides the appropriate design values for the construction Codes (Sections I, III, IV, VIII, and XII of the BPV Code and B31 Codes).

The design values are calculated in accordance with the appropriate mandatory Code rules. If the inquirer considers the material to be essentially identical to one that has been approved by the BPV Committee on Materials, the inquirer shall so state in its request, and the BPV Committee on Materials shall evaluate that judgment. If the material is not essentially identical to one that has been approved by the BPV Committee on Materials, the inquirer shall provide all of the data cited in this Mandatory Appendix. Based on those data, the BPV Committee on Materials will provide the appropriate design values.

Before approval of a new material for inclusion in one of the Sections of the Code, use of this material may be permitted in the form of a Code Case. This Case shall fix at least the conditions of use and the necessary requirements linked to these conditions. It is the policy of the ASME BPV Committee to admit, in this way, material for which full experience on all working parameters has not yet been acquired.

5-200 APPLICATION

The inquirer shall identify to the BPV Committee the following:
(a) the Section or Sections and Divisions of the Code in which the new material is to be approved
(b) the temperature range of intended application
(c) whether cyclic service is to be considered
(d) whether external pressure is to be considered

The inquirer shall identify all product forms, size ranges, and specifications or specification requirements for the material for which approval is desired. When
Table 5-100
Hot Isostatically Pressed Component Requirements for Austenitic Stainless Steels, Austenitic–Ferritic (Duplex) Stainless Steels, Martensitic Stainless Steels, Ferritic Steels, and Nickel Alloys

<table>
<thead>
<tr>
<th>Category</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>The chemistry requirements of the hot isostatically pressed components shall be identical to those of the corresponding wrought product form.</td>
</tr>
<tr>
<td>Mechanical properties</td>
<td>The room-temperature mechanical properties of hot isostatically pressed components shall be identical to those that apply to the corresponding wrought product form.</td>
</tr>
<tr>
<td>Heat treatment</td>
<td>The heat-treatment requirements that apply to the hot isostatically pressed components shall be identical to those that apply to the corresponding wrought product form.</td>
</tr>
<tr>
<td>Grain size</td>
<td>The grain size requirements that apply to the hot isostatically pressed components shall be identical to those that apply to the corresponding wrought product form.</td>
</tr>
<tr>
<td>Control of powder prior to hot isostatic pressing</td>
<td>The maximum allowable powder size shall be 5 mm and the powder shall be produced by the gas atomization process. Immediately following atomization, the powder shall remain shielded by an inert gas until the powder is below a temperature of 40°C, to ensure that the detrimental absorption of oxygen and other deleterious contaminants is no longer possible. For austenitic stainless steels, duplex stainless steels, martensitic stainless steels, and nickel alloys, powder should be protected during storage to prevent the detrimental pickup of oxygen and other contaminants. For ferritic steels, following atomization, powders shall be stored under a positive nitrogen or argon atmosphere or vacuum to minimize potential oxidation or contamination.</td>
</tr>
<tr>
<td>Mandatory testing of hot isostatically pressed components</td>
<td>The chemical composition of a sample from one part from each lot of parts shall be determined by the manufacturer. The composition of the sample shall conform to the chemistry requirements of the defined wrought product form. The microstructure shall be examined at 20–50X, 100–200X, and 1,000–2,000X. The microstructure shall be reasonably uniform and shall be free of voids, laps, cracks, and porosity. One sample from each production lot shall be examined. The sample shall be taken from the component, stem, protrusion, or test part made from a single powder blend consolidated in the same hot isostatic press, using the same pressure, temperature, and time parameters, and heat treated in the same final heat-treatment charge at the option of the producer, after hot isostatic pressing or after final heat treatment. Samples for mechanical testing shall be from the component, stem, protrusion, or test part made from a single powder blend consolidated in the same hot isostatic press, using the same pressure, temperature, and time parameters, and heat-treated in the same final heat-treatment charge.</td>
</tr>
<tr>
<td>Material certification requirements</td>
<td>A manufacturer’s certification shall be furnished to the purchaser stating that material has been manufactured, tested, and inspected in accordance with the applicable specification, and that the test results on representative samples meet specification requirements. A report of the test results shall be furnished.</td>
</tr>
</tbody>
</table>

GENERAL NOTES:
(a) When a grade does exist in a defined wrought product form for alloys other than those cited, an inquirer may request the inclusion of hot isostatically pressed (HIP) components of this grade. However, the Committee may have additional requirements placed on the grade to accept this request.
(b) If the material is to be used at temperatures where the time-dependent performance will determine the allowable stress values, the requirements of Mandatory Appendix 5 relative to the provision of data for new materials shall apply.
available, the inquirer shall furnish information describing service experience in the temperature range requested.

5-300 CHEMICAL COMPOSITION

The inquirer shall recommend to the BPV Committee on Materials whether the chemical composition specified in the reference specification applies or whether restrictions to this composition shall be imposed for the intended application. When coverage by a recognized national or international standardization body has been requested but not yet obtained, the inquirer shall indicate the detailed chemical composition in the inquiry. The inquirer shall explain the reasons for the chemistry and limits, and their relationship to the metallurgical structure (e.g., influence on precipitates and their morphology, grain size, and phases), heat treatment effect (e.g., strengthening mechanisms and their stability), and mechanical properties. Elements that significantly influence strength, ductility, toughness, weldability, and behavior under service conditions should be identified.

After review of the submitted data, the Committee reserves the right to modify the permitted compositional ranges for key elements so that they more accurately reflect the range of the elements of the submitted test heats.

5-400 METALLURGICAL STRUCTURE AND HEAT TREATMENT

When applicable for the proposed material, the inquirer shall indicate the intended metallurgical structure(s) to be achieved in order to comply with the mechanical properties requirements and, where applicable, fully describe the heat treatment (including cooling rates) to be applied to achieve this (or these) structure(s), the mechanical properties, and the expected behavior under service conditions.

An explanation for the proposed heat treatment temperature ranges shall be furnished. When such concepts apply, metallurgical transformation curves and information on the transformation points and conditions for appearance of the major phases in the microstructure (e.g., continuous cooling transformation diagram or time-temperature precipitation plots) would be beneficial for the Committee’s consideration.

5-500 MECHANICAL PROPERTIES

Test methods employed for the properties tested shall be those referenced in or by the material specifications, or shall be the appropriate ASTM test methods, recommended practices, or test methods described in accepted international standards. The test methods used shall be indicated in the data package.

It is desired that the data be obtained using material representative of the range of effects of the key variables of composition, thickness, mechanical working, and heat treatment. It is desirable that, when applicable, test data also be provided for the range of heat treatment exposures that may influence properties such as tensile strength, toughness, and stress rupture behavior. After consideration of the submitted data, the Committee reserves the right to modify the specification requirements.

5-600 DEFINITIONS FOR DATA COLLECTION PURPOSES

casting lot: single production pour from a master heat.

heat: quantity of metal with one chemical composition, produced by a recognized production process from a single primary melt of the metal. Remelted ingot material is not recognized as a separate heat unless it is produced from a melt having a different chemical composition than the other heats.

hot isostatically pressed component lot: a number of parts made from a single powder blend consolidated in the same hot isostatic press using the same pressure, temperature, and time parameters, and heat treated in the same final heat-treatment charge.

powder blend: a homogeneous mixture of powder from one or more heats of the same grade. The term “powder blend” shall be substituted for the term “heat” for hot isostatically pressed powder material in 5-300, 5-700, 5-900, 5-1200, 5-1400, and 5-1800.

wrought lot: quantity of metal made by melting followed by working or by working and heat treatment as a unique batch. Different lots may come from the same heat and may be made into different product forms. Lot definitions are expected to be found in the applicable material specifications.

5-700 REQUIRED SAMPLING

For all mechanical properties, data shall be provided over the required range of test temperatures from at least three heats of material meeting all of the requirements of the applicable specifications. Data submitted on three heats of one wrought product form for which coverage is requested may be considered to be applicable for all other wrought product forms having the same chemistry.

For wrought materials and especially for those materials whose mechanical properties are enhanced by heat treatment, forming practices, or a combination thereof, and for other materials for which the mechanical properties may be reasonably expected to be thickness dependent, data from one additional lot from material of at least 75% of the maximum thickness for which coverage
is requested shall be submitted. If no maximum thickness is given, information shall be provided to support the suitability of the thickness used for the tested samples.

When adoption of cast product forms is requested, data from at least three heats for one of the cast product forms shall be submitted. The cast material shall be considered as a separate material even if its nominal composition is the same or very similar to that of an approved wrought material.

If the hot isostatically pressed powder material meets all of the requirements of Table 5-100, it shall be considered the same material as that of the approved wrought material for temperatures approximately 25°C below the temperature where time-dependent properties, as defined by the Time-Dependent Properties Notes (T-Notes) in the applicable allowable stress table for the approved wrought material, govern.

If the hot isostatically pressed material is to be used at temperatures where the time-dependent properties, as defined by the Time-Dependent Properties Notes (T-Notes) in the applicable allowable stress table for the approved wrought material, govern, the requirements of this Appendix relative to the provision of data for new materials shall apply.

If the hot isostatically pressed powder material does not meet all of the requirements of Table 5-100, it shall be considered as a separate material to that of the approved wrought material. In this case, the requirements of this Appendix relative to the provision of data for new materials shall apply.

Additional data for other heats tested to a lesser degree than described herein would be beneficial to the Committee’s consideration.

5-800 TIME-INDEPENDENT PROPERTIES

For time-independent properties at and above room temperature, the required data include values of ultimate tensile strength, 0.2% offset yield strength, reduction of area (when specified in the material specification), and elongation. For steels, nickel alloys, cobalt alloys, and aluminum alloys, data shall be provided at room temperature and 50°C intervals, beginning at 100°C to 50°C above the maximum intended use temperature, unless the maximum intended use temperature does not exceed 40°C. For copper alloys, titanium alloys, and zirconium alloys, data shall be provided at room temperature, 65°C, and 100°C, and then at 50°C intervals, to 50°C above the maximum intended use temperature, unless the maximum intended use temperature does not exceed 40°C. The test methods shall be as given in ASTM A370, ASTM A1058, ASTM E8, ASTM E21, or other equivalent national or international test standards. In addition, when specified in the material specification, hardness values shall be provided at room temperature and shall be determined as specified in the material specification. Data provided shall be expressed in the units and to the number of significant figures shown in Table 5-800. When either the material specification or the applicable construction code (e.g., Section XII) permits or requires that yield strength be determined by other than the 0.2% offset method, those other yield strength values shall also be reported.

5-900 TIME-DEPENDENT PROPERTIES

If approval is desired for temperatures where time-dependent properties may be expected to control design, time-dependent data, as itemized below, shall be provided, starting at temperatures approximately 25°C below the temperature where time-dependent properties may govern and extending at least 50°C above the maximum intended use temperature. Exceptions to this rule are permitted, provided the inquirer provides suitable justification for the deviation. The creep–rupture test method shall be in accordance with ASTM E139 or other equivalent national or international test standard.

For time-dependent tests, the interval between successive temperatures shall be chosen such that it permits, in all cases, an accurate estimation of the slope of the stress–rupture curves. For normally stable materials (e.g., solid solution-strengthened materials), test temperatures shall be at intervals of 50°C or less. Where there is a possibility of degradation of strength related to metallurgical instability (e.g., for precipitation-strengthened materials), test temperatures shall be at intervals of 25°C or less. Data provided shall be expressed in the units and to the number of significant figures shown in Table 5-800.

In addition, for certain types of steels or alloys, it may be necessary to choose different temperature intervals in order to adequately reflect the evolution of the properties. In such cases, the interval between successive test temperatures shall be chosen such that rupture lives do not differ by more than a factor of 10 at any given stress for two adjacent temperatures. Data to be reported include stress, temperature, time to rupture, and, when available, either or both elongation and reduction of area. Additional comments regarding post-test specimen appearance (e.g., oxidation, necking, intergranular fracture, etc.), as well as photographs and photomicrographs, may be beneficial for the analysis.

Except as provided further below, the longest rupture time at each test temperature shall be in excess of 10 000 h for each required heat. At least three additional tests shall be conducted for each required heat at each test temperature, at stresses selected to provide shorter rupture times but at least 500 h (e.g., 500 h, 1 400 h, and 4 000 h).

Tests of shorter duration than about 500 h are not desired for long-term stress rupture prediction. Obviously, longer times and additional test data are beneficial. At successive temperatures, two or more test stresses should be selected to be preferably identical or in a close range.
<table>
<thead>
<tr>
<th>ASTM Designation</th>
<th>Title</th>
<th>Property</th>
<th>Metric Units</th>
<th>Significant Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>A370</td>
<td>Standard Test Methods and Definitions for Mechanical Testing of Steel Products</td>
<td>Tensile strength and yield strength</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>A1058</td>
<td>Standard Test Methods for Mechanical Testing of Steel Products—Metric</td>
<td>Tensile strength and yield strength</td>
<td>MPa</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thermal diffusivity</td>
<td>(m²/sec) × 10⁻⁶</td>
<td>4, except 3 for x &lt; 10</td>
</tr>
<tr>
<td>E8</td>
<td>Standard Test Methods for Tension Testing of Metallic Materials</td>
<td>Tensile strength and yield strength</td>
<td>MPa</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Density</td>
<td>kg/m³</td>
<td>4</td>
</tr>
<tr>
<td>E132</td>
<td>Standard Test Method for Poisson’s Ratio at Room Temperature</td>
<td>Poisson’s ratio</td>
<td>...</td>
<td>2</td>
</tr>
<tr>
<td>E228</td>
<td>Standard Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer</td>
<td>Instantaneous coefficient</td>
<td>(mm/mm/°C) × 10⁻⁶</td>
<td>3, except 2 for x &lt; 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean linear coefficient</td>
<td>(mm/mm/°C) × 10⁻⁶</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Linear coefficient</td>
<td>mm/m</td>
<td></td>
</tr>
<tr>
<td>E831</td>
<td>Standard Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis</td>
<td>Instantaneous coefficient</td>
<td>(mm/mm/°C) × 10⁻⁶</td>
<td>3, except 2 for x &lt; 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean linear coefficient</td>
<td>(mm/mm/°C) × 10⁻⁶</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Linear coefficient</td>
<td>mm/m</td>
<td></td>
</tr>
<tr>
<td>E1875</td>
<td>Standard Test Method for Dynamic Young’s Modulus, Shear Modulus, and Poisson’s Ratio by Sonic Resonance</td>
<td>Modulus of elasticity</td>
<td>MPa × 10³</td>
<td>3</td>
</tr>
</tbody>
</table>
Alternative test plans that deviate from the prior description but achieve the overall objective may be considered. This may, in particular, apply to solid solution alloys for which the stability of strength-controlling microstructures is certain.

For new materials for which the expectation of reasonable stability of strength-controlling microstructures is uncertain or suspect, and for extension of allowable stresses of more familiar classes of alloys into much higher temperature applications where such stability might come into question, either creep–rupture data with duration of more than 30 000 h or equivalent experience in service is required. A Code Case may be approved based on shorter duration test data, but inclusion of the material into one of the sections of the BPV Code may be deferred until longer-term creep–rupture data are available or until sufficient service experience is obtained to provide confidence that extrapolations from the existing database reasonably describe the long-term behavior of the material.

For at least two heats, strain–time plots or minimum creep rate (MCR) data shall be provided for at least two test stresses at each test temperature, including at least one stress for each material resulting in MCR values below 3×10\(^{-4}\) %/h. If it can be conclusively demonstrated that creep rate does not control the design stresses, the creep rate data may be sparse in relation to the above requirement. Creep rate data may be obtained in the course of stress–rupture testing or may be obtained on additional specimens.

### 5-1000 LOW-TEMPERATURE PROPERTIES

If use of the material below room temperature is contemplated, data should be provided at appropriate temperatures down to the lowest contemplated use temperature.

### 5-1100 TOUGHNESS DATA

Toughness data shall be provided for materials for which Construction Code toughness rules would be expected to apply. The test requirements shall be as required by the requested Construction Code(s). The data shall include test results for the intended lowest service metal temperature and for the range of material thicknesses desired.

### 5-1200 STRESS–STRAIN CURVES

If the material is to be used in components that operate under compressive loads (e.g., external pressure), stress–strain plots (tension or compression) shall be furnished for each of the three heats of material at 50°C intervals from room temperature up to 50°C above the maximum temperature desired. Engineering stress–strain data (stress versus strain) shall be provided in the form of stress–strain plots and digitized data, from which the plots were derived, in tabular form up to 1.2% strain. Digitized data shall be provided at intervals no greater than 0.01% strain. In addition, the minimum yield strength, modulus of elasticity, and proportional limit, for materials where a proportional limit can be identified, shall be reported for each temperature. The stress–strain plots (not load versus extension) shall be determined using a Class B-2 or better-accuracy extensometer as defined in ASTM E83. The plots shall include gridlines with the units marked on the gridlines: for strain, minor gridlines at intervals of 0.01% and major gridlines at 0.1%, up to 1.2% strain; and for stress, minor gridlines at 2 MPa and major gridlines at 20 MPa.

### 5-1300 FATIGUE DATA

If the material is to be used in cyclic service and the Construction Code in which adoption is desired requires explicit consideration of cyclic behavior, fatigue data for characterized samples shall also be furnished over the range of design temperatures desired, from 10\(^3\) to at least 10\(^6\) cycles.

### 5-1400 PHYSICAL PROPERTIES

For at least one heat meeting the requirements of the material specification, the inquirer shall furnish to the Boiler and Pressure Vessel Committee on Materials adequate data necessary to establish values for coefficient of thermal expansion, coefficients of thermal conductivity and diffusivity, modulus of elasticity, Poisson’s ratio, and density. Test methods shall be as follows:

- (a) ASTM E228 or ASTM E831 for thermal expansion coefficients
- (b) ASTM C177 for thermal conductivity and thermal diffusivity
- (c) ASTM E1875 for modulus of elasticity
- (d) ASTM E1875 or ASTM E132 for Poisson’s ratio

Data from other equivalent national or international test standards shall be acceptable in lieu of those listed above. Instantaneous, mean, and linear coefficients of thermal expansion shall be reported. Data for all physical properties shall be provided at least over the range of temperatures for which the material is to be used. It is recommended that data be collected at temperature intervals not greater than 50°C. If the material is intended to be used below room temperature, data should be provided for temperatures down to the minimum use temperature. Data provided shall be expressed in the units and to the number of significant figures shown in Table 5-800.
5-1500 DATA REQUIREMENTS FOR WELDS, WELDMENTS, AND WELDABILITY

The following three types of welding information are required for a new base metal for use in welded construction in an ASME BPV Construction Code: data on weldability, data on strength and toughness in the time-independent regime, and data on strength in the time-dependent regime.

The data requirements for weldability and for strength in the time-independent regime are the responsibility of the BPV IX Standards Committee and are to be found in Section II, Part C, Guideline on the Approval of New Welding and Brazing Material Classifications Under the ASME Boiler and Pressure Vessel Code; and in Section IX, Mandatory Appendix J, Guideline for Requesting P-Number Assignments for Base Metals Not Listed in Table QW/QB-422. The requirements for weld metal and weldment toughness data vary with the class of materials and their application, and are to be found in the Construction Codes that have toughness rules — Sections III, VIII, and XII.

Data for welds and weldments for a new base material for use in the time-dependent regime are the responsibility of the BPV II and BPV IX Standards Committees, and particularly of their joint Subgroup on Strength of Weldments. The following welding information shall be provided by the Inquirer, to support the request for a Code Case for, or incorporation of, a new base material for use in elevated temperature service:

(a) When there is one or more AWS, ASME, or equivalent consumable specification and classification suitable for use with the new base material, and when such consumable/process combinations can produce welds and weldments that have both good weldability and as high or higher strengths as the base metal over the range of expected service temperatures, no time-dependent test data is required. Rather, the inquirer shall submit a tabular or graphical comparison of time-dependent allowable stresses for base metals nominally matching the compositions of such welding consumables against the allowable stresses proposed for the new base metal. (Note that since neither ASME nor any other organization publishes allowable stresses for all-weld metal or for weldments, it is necessary to use, in this comparison, the allowable stresses for the base metals equivalent to the welding consumables as a reasonable first approximation.) An example of such a comparison appears in Table 5-1500.

(b) When there is no such suitable consumable having an AWS, ASME, or equivalent specification and classification, or when it is necessary or desirable to use a new, perhaps nominally matching, welding consumable, the following information shall be provided to the Committee:

(1) the chemistry ranges for each element specified for the consumable to be used. If the chemistry ranges vary for the consumables to be used for different processes, then the chemistry ranges of the consumables appropriate for each process shall be provided.

(2) creep–rupture data for weldments made with one lot of consumables for each process intended to be used with the new base material

(-a) at temperature intervals not greater than 100°C

(-b) over a temperature range spanning the range from the first rational temperature above the temperature at which time-dependent properties control the allowable stresses of the new base material to about 50°C above the maximum temperature for which allowable stresses for the base material are requested

(-c) at a minimum of four stresses calculated to produce rupture times of about 1,000, 2,500, and 4,500 h, and beyond 6,000 h

(-d) the test temperature; stress; rupture time; specimen size and configuration, including weld location; and failure location (base metal, weld metal, or heat affected zone), for each test condition

(-e) the creep–rupture data shall be compared to the scatter bands of data for the base metal

5-1600 LONG-TERM PROPERTIES STABILITY

For new materials, and particularly for those whose creep–rupture properties are affected by heat treatment or deformation processes or a combination of these, it is important to know the structural stability characteristics and the degree of retention of properties with long-term exposure at temperature. Where particular temperature ranges of service exposure or fabrication heat treatment, cooling rates, and combination of mechanical working and thermal treatments cause significant changes in the microstructure on which the creep–rupture properties depend, these shall be brought to the attention of the BPV Committee.

5-1700 REQUESTS FOR ADDITIONAL DATA

The Committee may request additional data, including data on properties or material behavior not explicitly treated in the Construction Code for which approval is desired.

5-1800 NEW MATERIALS CHECKLIST

To assist inquirers desiring Code coverage for new materials, or extending coverage of existing materials, the Committee has developed the following checklist of items that ought to be addressed in each inquiry. While taking into account the intended application of the product,
### Table 5-1500

#### Example of a Comparison of Allowable Stresses of Base Metals With Compositions Similar to Those of Selected Welding Consumables and the Proposed New Base Metal

**Comparison of Nominal Chemical Compositions, %, and Specified Mechanical Properties of Ni-Base Alloys in Section II, Part B**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Ni</th>
<th>Cr</th>
<th>Fe</th>
<th>Mn</th>
<th>Mo</th>
<th>Co</th>
<th>Al</th>
<th>C</th>
<th>Cu</th>
<th>B</th>
<th>Si</th>
<th>Ti</th>
<th>W</th>
<th>Cb + Ta</th>
<th>Ultimate Tensile Strength, MPa</th>
<th>Yield Strength, MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>N06230</td>
<td>Bal. ≈ 53</td>
<td>22</td>
<td>3</td>
<td>0.65</td>
<td>2</td>
<td>5</td>
<td>0.5</td>
<td>0.1</td>
<td>...</td>
<td>...</td>
<td>0.5</td>
<td>14</td>
<td>760</td>
<td>310</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N06600</td>
<td>72 min.</td>
<td>15.5</td>
<td>8</td>
<td>0.5</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0.1</td>
<td>0.25</td>
<td>0.25</td>
<td>0.5</td>
<td>0.4</td>
<td>550</td>
<td>240</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N06617</td>
<td>44</td>
<td>22</td>
<td>1.5</td>
<td>9</td>
<td>12</td>
<td>1.2</td>
<td>0.1</td>
<td>0.25</td>
<td>0.005</td>
<td>0.5</td>
<td>0.4</td>
<td>665</td>
<td>240</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N06625</td>
<td>58 min.</td>
<td>21.5</td>
<td>5</td>
<td>0.5</td>
<td>9</td>
<td>1</td>
<td>0.4</td>
<td>0.1</td>
<td>0.4</td>
<td>0.5</td>
<td>0.4</td>
<td>3.65</td>
<td>827</td>
<td>414</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N06696</td>
<td>Bal. ≈ 60</td>
<td>30</td>
<td>4</td>
<td>0.2</td>
<td>2</td>
<td>...</td>
<td>0.07</td>
<td>2</td>
<td>1.5</td>
<td>0.6</td>
<td>586</td>
<td>240</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Comparison of Allowable Stresses of Ni-Base Alloys in Section II, Part B (MPa at Temperature, °C, Estimated for N06696)**

<table>
<thead>
<tr>
<th>Grade</th>
<th>P-No.</th>
<th>500</th>
<th>550</th>
<th>600</th>
<th>650</th>
<th>700</th>
<th>750</th>
<th>800</th>
<th>850</th>
<th>900</th>
<th>950</th>
<th>1000</th>
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<tbody>
<tr>
<td>N06230</td>
<td>43</td>
<td>194</td>
<td>194</td>
<td>151</td>
<td>102</td>
<td>75.5</td>
<td>50.4</td>
<td>32.9</td>
<td>18.4</td>
<td>10.2</td>
<td>5.2</td>
<td>2.4</td>
</tr>
<tr>
<td>N06600</td>
<td>43</td>
<td>79.7</td>
<td>40.1</td>
<td>19.0</td>
<td>13.8</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>N06617</td>
<td>43</td>
<td>108</td>
<td>106</td>
<td>106</td>
<td>105</td>
<td>81.0</td>
<td>50.4</td>
<td>31.3</td>
<td>19.4</td>
<td>12.3</td>
<td>7.5</td>
<td>...</td>
</tr>
<tr>
<td>N06625</td>
<td>43</td>
<td>184</td>
<td>182</td>
<td>178</td>
<td>136</td>
<td>84.3</td>
<td>50.2</td>
<td>30.3</td>
<td>16.5</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>N06696</td>
<td>TBD</td>
<td>139</td>
<td>87.0</td>
<td>55.6</td>
<td>35.5</td>
<td>22.8</td>
<td>13.9</td>
<td>9.0</td>
<td>4.9</td>
<td>3.2</td>
<td>2.1</td>
<td>1.4</td>
</tr>
</tbody>
</table>

**GENERAL NOTE:** In this example, the proposed new base metal is N06696.
the Committee may require specific information from the inquirer, as shown above for certain material characteristics.

(a) Has a qualified inquirer request been provided?
(b) Has a request either for revision to existing Code requirements or for a Code Case been defined?
(c) Has a letter to ASTM or AWS been submitted requesting coverage of the new material in a specification? Alternatively, is this material already covered by a specification issued by a recognized national or international organization and has an English language version been provided?
(d) Has the Construction Code and, if applicable, a Division, Subsection, or Part been identified?
(e) Have product forms, size range, and the applicable specification(s) been defined?
(f) Has the range (maximum/minimum) of temperature application been defined?
(g) Has the chemistry been submitted and the related requirements been addressed?
(h) Have the metallurgical structure and heat treatment requirements been submitted?
(i) Have mechanical property data been submitted (ultimate tensile strength, yield strength, reduction of area, and elongation at 50°C intervals, from room temperature to 50°C above the maximum intended use temperature, for three heats of appropriate product forms and sizes?
(j) If requested temperatures of coverage are above those at which time-dependent properties begin to govern design values, have appropriate time-dependent property data for base metal and weldments been submitted?
(k) If higher allowable stresses for material to be used below room temperature are requested, have appropriate mechanical property data below room temperature been submitted?
(l) Have toughness considerations required by the Construction Code been defined and have appropriate data been submitted?
(m) Have stress-strain curves been submitted for the establishment of External Pressure Charts?
(n) If cyclic service considerations are required by the requested Construction Code application, have appropriate fatigue data been submitted?
(o) Have physical properties data (coefficient of thermal expansion, thermal conductivity and diffusivity, modulus of elasticity, Poisson’s ratio, and density) been submitted?
(p) Have welding requirements been defined, and weld metal and weldment data been submitted?
(q) Has the influence of fabrication practices on material properties been defined?

5-1900 REQUIREMENTS FOR RECOGNIZED NATIONAL OR INTERNATIONAL SPECIFICATIONS

Acceptable material specifications will be identified by date or edition. The latest approved edition(s) will be stated in the subtitle of the ASME specification. Eventually, acceptable previous editions will be listed in Section II, Parts A and B. Minimum requirements that shall be contained in a material specification for which acceptance is being requested include such items as the name of the national or international organization, scope, reference documents, process, manufacture, conditions for delivery, heat treatment, chemical and tensile requirements, forming properties, testing specifications and requirements, workmanship, finish, marking, inspection, and rejection.

5-2000 PUBLICATION OF RECOGNIZED NATIONAL OR INTERNATIONAL SPECIFICATIONS

Specifications for which ASME has been given publishing permission by the originating organization will be published in Section II, Parts A and B. Specifications for which ASME has not been given publishing permission by the originating organization will be referenced on a cover sheet in Section II, Parts A and B. Information on obtaining a copy of those referenced documents will be maintained in those Parts. Additions and exceptions to the material specification will be noted in the subtitle of the specification and in Table II-200-1 or II-200-2 in Section II, Parts A and B.

5-2100 CEN SPECIFICATIONS

European Standards are adopted by CEN in three official languages (English, French, and German) as an EN standard. After the CEN adoption, to become applicable in a member country of CEN, an EN standard shall be given the status of a national standard. During this process

(a) the text of the EN standard shall remain unaltered and shall be included as adopted by CEN
(b) national forewords and/or annexes may be added to cover specific national practices, but shall not be in contradiction with the EN standard
(c) a prefix XX (e.g., XX = BS for the United Kingdom, NF for France, and DIN for Germany) is added to the designation of the EN standard (e.g., BS EN 10028-1 or NF EN 10028-1)

(d) the date of adoption as a national standard will differ from the date of adoption as an EN standard, and may differ from one country to another

Written or electronic copies can only be obtained from European National Standardization Bodies as XX EN (CEN does not sell standards). Consequently, in order to
maintain coherence and homogeneity in the reference system, the mentions in the subtitle of the corresponding ASME specification will only refer to the EN standard number without any prefix and to the year of approval by CEN. It will also be mentioned in the cover sheet that the national parts do not apply for the ASME specification.
MANDATORY APPENDIX 5
GUIDELINES ON THE APPROVAL OF NEW MATERIALS UNDER
THE ASME BOILER AND PRESSURE VESSEL CODE

5-100 CODE POLICY

It is expected that requests for Code approval will normally be for materials for which there is a recognized national or international specification. It is the policy of the ASME Boiler and Pressure Vessel (BPV) Committee on Materials to approve, for inclusion in the Code Sections, only materials covered by specifications that have been issued by standards-developing organizations such as, but not limited to, American Petroleum Institute (API), American Society for Testing and Materials (ASTM), American Welding Society (AWS), Canadian Standards Association (CSA), European Committee for Standardization (CEN), Japan Industrial Standards (JIS), Standards Association of Australia (SAA), and China Standardization Committee (CSC).

Material specifications of other than national or international organizations, such as those of material producers/suppliers or equipment manufacturers, will not be considered for approval. The Committee will consider only official requests for specifications authorized by the originating standardization body and available in the English language and in U.S. Customary and/or SI/Metric units.

For materials made to a recognized national or international specification other than that of ASTM or AWS, the inquirer shall give notice to the standards-developing organization that a request has been made to ASME for approval of the specification under the ASME Code and should request that the issuing organization grant ASME permission to at least reproduce copies of the specification for Code Committee internal use and, if possible, reprint the specification. For other materials, a request shall be made to ASTM, AWS, or a recognized national or international standardization body to include the material in a specification that can be presented to the BPV Committee on Materials.

It is the policy of the ASME BPV Committee on Materials to consider requests to approve new materials only from boiler, pressure vessel, transport tank, nuclear facility component manufacturers, architect-engineers, or end users. Such requests should be for wrought, cast, or hot isostatically pressed powder materials for which there is a reasonable expectation of use in a boiler, pressure vessel, transport tank, or nuclear facility component constructed to the rules of one of the Sections of this Code. When a grade does exist in a defined wrought product form, a material producer/supplier may request the inclusion of additional wrought product forms or, provided all of the requirements of Table 5-100 of this Appendix are met, the inclusion of hot isostatically pressed (HIP) powder metallurgy components of this grade. When a grade does exist in a defined cast product form, a material producer/supplier may request the inclusion of additional cast product forms.

Any qualified organization requesting that an ASME BPV Committee approve a "new" material for use in their Code book should be aware that only the BPV Committee on Materials provides the appropriate design values for the Construction Codes (Sections I, III, IV, VIII, and XII of the BPV Code and B31 Codes).

The design values are calculated in accordance with the appropriate mandatory Code rules. If the inquirer considers the material to be essentially identical to one that has been approved by the BPV Committee on Materials, the inquirer shall so state in its request, and the BPV Committee on Materials shall evaluate that judgment. If the material is not essentially identical to one that has been approved by the BPV Committee on Materials, the inquirer shall provide all of the data cited in this Mandatory Appendix. Based on those data, the BPV Committee on Materials will provide the appropriate design values.

Before approval of a new material for inclusion in one of the Sections of the Code, use of this material may be permitted in the form of a Code Case. This Case shall fix at least the conditions of use and the necessary requirements linked to these conditions. It is the policy of the ASME BPV Committee to admit, in this way, material for which full experience on all working parameters has not yet been acquired.

5-200 APPLICATION

The inquirer shall identify to the BPV Committee the following:
(a) the Section or Sections and Divisions of the Code in which the new material is to be approved
(b) the temperature range of intended application
(c) whether cyclic service is to be considered
(d) whether external pressure is to be considered

The inquirer shall identify all product forms, size ranges, and specifications or specification requirements for the material for which approval is desired. When
<table>
<thead>
<tr>
<th>Category</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>The chemistry requirements of the hot isostatically pressed components shall be identical to those of the corresponding wrought product form.</td>
</tr>
<tr>
<td>Mechanical properties</td>
<td>The room-temperature mechanical properties of hot isostatically pressed components shall be identical to those that apply to the corresponding wrought product form.</td>
</tr>
<tr>
<td>Heat treatment</td>
<td>The heat-treatment requirements that apply to the hot isostatically pressed components shall be identical to those that apply to the corresponding wrought product form.</td>
</tr>
<tr>
<td>Grain size</td>
<td>The grain size requirements that apply to the hot isostatically pressed components shall be identical to those that apply to the corresponding wrought product form.</td>
</tr>
<tr>
<td>Control of powder prior to hot isostatic pressing</td>
<td>The maximum allowable powder size shall be 0.020 in. and the powder shall be produced by the gas atomization process. Immediately following atomization, the powder shall remain shielded by an inert gas until the powder is below a temperature of 105°F, to ensure that the detrimental absorption of oxygen and other deleterious contaminants is no longer possible. For austenitic stainless steels, duplex stainless steels, martensitic stainless steels, and nickel alloys, powder should be protected during storage to prevent the detrimental pickup of oxygen and other contaminants. For ferritic steels, following atomization, powders shall be stored under a positive nitrogen or argon atmosphere or vacuum to minimize potential oxidation or contamination.</td>
</tr>
<tr>
<td>Mandatory testing of hot isostatically pressed components</td>
<td>The chemical composition of a sample from one part from each lot of parts shall be determined by the manufacturer. The composition of the sample shall conform to the chemistry requirements of the defined wrought product form. The microstructure shall be examined at 20–50X, 100–200X, and 1,000–2,000X. The microstructure shall be reasonably uniform and shall be free of voids, laps, cracks, and porosity. One sample from each production lot shall be examined. The sample shall be taken from the component, stem, protrusion, or test part made from a single powder blend consolidated in the same hot isostatic press, using the same pressure, temperature, and time parameters, and heat treated in the same final heat-treatment charge at the option of the producer, after hot isostatic pressing or after final heat treatment. Samples for mechanical testing shall be from the component, stem, protrusion, or test part made from a single powder blend consolidated in the same hot isostatic press, using the same pressure, temperature, and time parameters, and heat-treated in the same final heat-treatment charge.</td>
</tr>
<tr>
<td>Material certification requirements</td>
<td>A manufacturer's certification shall be furnished to the purchaser stating that material has been manufactured, tested, and inspected in accordance with the applicable specification, and that the test results on representative samples meet specification requirements. A report of the test results shall be furnished.</td>
</tr>
</tbody>
</table>

GENERAL NOTES:
(a) When a grade does exist in a defined wrought product form for alloys other than those cited, an inquirer may request the inclusion of hot isostatically pressed (HIP) components of this grade. However, the Committee may have additional requirements placed on the grade to accept this request.
(b) If the material is to be used at temperatures where the time-dependent performance will determine the allowable stress values, the requirements of Mandatory Appendix 5 relative to the provision of data for new materials shall apply.
available, the inquirer shall furnish information describing service experience in the temperature range requested.

5-300 CHEMICAL COMPOSITION

The inquirer shall recommend to the BPV Committee on Materials whether the chemical composition specified in the reference specification applies or whether restrictions to this composition shall be imposed for the intended application. When coverage by a recognized national or international standardization body has been requested but not yet obtained, the inquirer shall indicate the detailed chemical composition in the inquiry. The inquirer shall explain the reasons for the chemistry and chemistry limits, and their relationship to the metallurgical structure (e.g., influence on precipitates and their morphology, grain size, and phases), heat treatment effect (e.g., strengthening mechanisms and their stability), and mechanical properties. Elements that significantly influence strength, ductility, toughness, weldability, and behavior under service conditions should be identified.

After review of the submitted data, the Committee reserves the right to modify the permitted compositional ranges for key elements so that they more accurately reflect the range of the elements of the submitted test heats.

5-400 METALLURGICAL STRUCTURE AND HEAT TREATMENT

When applicable for the proposed material, the inquirer shall indicate the intended metallurgical structure(s) to be achieved in order to comply with the mechanical properties requirements and, where applicable, fully describe the heat treatment (including cooling rates) to be applied to achieve this (or these) structure(s), the mechanical properties, and the expected behavior under service conditions.

An explanation for the proposed heat treatment temperature ranges shall be furnished. When such concepts apply, metallurgical transformation curves and information on the transformation points and conditions for appearance of the major phases in the microstructure (e.g., continuous cooling transformation diagram or time-temperature precipitation plots) would be beneficial for the Committee’s consideration.

5-500 MECHANICAL PROPERTIES

Test methods employed for the properties tested shall be those referenced in or by the material specifications, or shall be the appropriate ASTM test methods, recommended practices, or test methods described in accepted international standards. The test methods used shall be indicated in the data package.

It is desired that the data be obtained using material representative of the range of effects of the key variables of composition, thickness, mechanical working, and heat treatment. It is desirable that, when applicable, test data also be provided for the range of heat treatment exposures that may influence properties such as tensile strength, toughness, and stress rupture behavior. After consideration of the submitted data, the Committee reserves the right to modify the specification requirements.

5-600 DEFINITIONS FOR DATA COLLECTION PURPOSES

casting lot: single production pour from a master heat.
heat: quantity of metal with one chemical composition, produced by a recognized production process from a single primary melt of the metal. Remelted ingot material is not recognized as a separate heat unless it is produced from a melt having a different chemical composition than the other heats.
hot isostatically pressed component lot: a number of parts made from a single powder blend consolidated in the same hot isostatic press using the same pressure, temperature, and time parameters, and heat treated in the same final heat-treatment charge.
powder blend: a homogeneous mixture of powder from one or more heats of the same grade. The term "powder blend" shall be substituted for the term "heat" for hot isostatically pressed powder material in 5-300, 5-700, 5-900, 5-1200, 5-1400, and 5-1800.
wrought lot: quantity of metal made by melting followed by working or by working and heat treatment as a unique batch. Different lots may come from the same heat and may be made into different product forms. Lot definitions are expected to be found in the applicable material specifications.

5-700 REQUIRED SAMPLING

For all mechanical properties, data shall be provided over the required range of test temperatures from at least three heats of material meeting all of the requirements of the applicable specifications. Data submitted on three heats of one wrought product form for which coverage is requested may be considered to be applicable for all other wrought product forms having the same chemistry.

For wrought materials and especially for those materials whose mechanical properties are enhanced by heat treatment, forming practices, or a combination thereof, and for other materials for which the mechanical properties may be reasonably expected to be thickness dependent, data from one additional lot from material of at least 75% of the maximum thickness for which coverage...
is requested shall be submitted. If no maximum thickness is given, information shall be provided to support the suitability of the thickness used for the tested samples.

When adoption of cast product forms is requested, data from at least three heats for one of the cast product forms shall be submitted. The cast material shall be considered as a separate material even if its nominal composition is the same or very similar to that of an approved wrought material.

If the hot isostatically pressed powder material meets all of the requirements of Table 5-100, it shall be considered the same material as that of the approved wrought material for temperatures approximately 50°F below the temperature where time-dependent properties, as defined by the Time-Dependent Properties Notes (T-Notes) in the applicable allowable stress table for the approved wrought material, govern.

If the hot isostatically pressed material is to be used at temperatures where the time-dependent properties, as defined by the Time-Dependent Properties Notes (T-Notes) in the applicable allowable stress table for the approved wrought material, govern, the requirements of this Appendix relative to the provision of data for new materials shall apply.

If the hot isostatically pressed powder material does not meet all of the requirements of Table 5-100, it shall be considered as a separate material to that of the approved wrought material. In this case, the requirements of this Appendix relative to the provision of data for new materials shall apply.

Additional data for other heats tested to a lesser degree than described herein would be beneficial to the Committee’s consideration.

5–900 TIME-DEPENDENT PROPERTIES

If approval is desired for temperatures where time-dependent properties may be expected to control design, time-dependent data, as itemized below, shall be provided, starting at temperatures approximately 50°F below the temperature where time-dependent properties may govern and extending at least 100°F above the maximum intended use temperature. Exceptions to this rule are permitted, provided the inquirer provides suitable justification for the deviation. The creep–rupture test method shall be in accordance with ASTM E139 or other equivalent national or international test standard.

For time-dependent tests, the interval between successive temperatures shall be chosen such that they permit, in all cases, an accurate estimation of the slope of the stress-rupture curves. For normally stable materials (e.g., solid solution-strengthened materials), test temperatures shall be at intervals of 100°F or less. Where there is a possibility of degradation of strength related to metallurgical instability (e.g., for precipitation-strengthened materials), test temperatures shall be at intervals of 50°F or less. Data provided shall be expressed in the units and to the number of significant figures shown in Table 5-800. When either the material specification or the applicable construction code (e.g., Section XII) permits or requires that yield strength be determined by other than the 0.2% offset method, those other yield strength values shall also be reported.

5–800 TIME-INDEPENDENT PROPERTIES

For time-independent properties at and above room temperature, the required data include values of ultimate tensile strength, 0.2% offset yield strength, reduction of area (when specified in the material specification), and elongation. For steels, nickel alloys, cobalt alloys, and aluminum alloys, data shall be provided at room temperature and 100°F intervals, beginning at 200°F to 100°F above the maximum intended use temperature, unless the maximum intended use temperature does not exceed 100°F. For copper alloys, titanium alloys, and zirconium alloys, data shall be provided at room temperature, 150°F, and 200°F, and then at 100°F intervals, to 100°F above the maximum intended use temperature, unless the maximum intended use temperature does not exceed 100°F. The test methods shall be as given in ASTM A370, ASTM A1058, ASTM E8, ASTM E21, or other equivalent national or international test standards. In addition, when specified in the material specification, hardness values shall be provided at room temperature and shall be determined as specified in the material specification. Data provided shall be expressed in the units and to the number of significant figures shown in Table 5-800. When either the material specification or the applicable construction code (e.g., Section XII) permits or requires that yield strength be determined by other than the 0.2% offset method, those other yield strength values shall also be reported.
<table>
<thead>
<tr>
<th>ASTM Designation</th>
<th>Title</th>
<th>Property</th>
<th>U.S. Customary Units</th>
<th>U.S. Customary Significant Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>A370</td>
<td>Standard Test Methods and Definitions for Mechanical Testing of Steel Products</td>
<td>Tensile strength and yield strength</td>
<td>ksi</td>
<td>3</td>
</tr>
<tr>
<td>A1058</td>
<td>Standard Test Methods for Mechanical Testing of Steel Products—Metric</td>
<td>Tensile strength and yield strength</td>
<td>...</td>
<td>...</td>
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<tr>
<td></td>
<td></td>
<td>Thermal diffusivity</td>
<td>ft²/hr</td>
<td>3</td>
</tr>
<tr>
<td>E8</td>
<td>Standard Test Methods for Tension Testing of Metallic Materials</td>
<td>Tensile strength and yield strength</td>
<td>ksi</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Density</td>
<td>lb/in.³</td>
<td>3</td>
</tr>
<tr>
<td>E132</td>
<td>Standard Test Method for Poisson's Ratio at Room Temperature</td>
<td>Poisson's ratio</td>
<td>...</td>
<td>2</td>
</tr>
<tr>
<td>E228</td>
<td>Standard Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer</td>
<td>Instantaneous coefficient</td>
<td>(in./in./°F) $\times 10^{-6}$</td>
<td>3, except 2 for $x &lt; 10$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean linear coefficient</td>
<td>(in./in./°F) $\times 10^{-6}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Linear coefficient</td>
<td>in./100 ft</td>
<td></td>
</tr>
<tr>
<td>E831</td>
<td>Standard Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis</td>
<td>Instantaneous coefficient</td>
<td>(in./in./°F) $\times 10^{-6}$</td>
<td>3, except 2 for $x &lt; 10$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean linear coefficient</td>
<td>(in./in./°F) $\times 10^{-6}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Linear coefficient</td>
<td>in./100 ft</td>
<td></td>
</tr>
<tr>
<td>E1875</td>
<td>Standard Test Method for Dynamic Young's Modulus, Shear Modulus, and Poisson's Ratio by Sonic Resonance</td>
<td>Modulus of elasticity</td>
<td>psi $\times 10^{6}$</td>
<td>3</td>
</tr>
</tbody>
</table>
Alternative test plans that deviate from the prior description but achieve the overall objective may be considered. This may, in particular, apply to solid solution alloys for which the stability of strength-controlling microstructures is certain.

For new materials for which the expectation of reasonable stability of strength-controlling microstructures is uncertain or suspect, and for extension of allowable stresses of more familiar classes of alloys into much higher temperature applications where such stability might come into question, either creep–rupture data with duration of more than 30,000 hr or equivalent experience in service is required. A Code Case may be approved based on shorter duration test data, but inclusion of the material into one of the sections of the BPV Code may be deferred until longer-term creep–rupture data are available or until sufficient service experience is obtained to provide confidence that extrapolations from the existing database reasonably describe the long-term behavior of the material.

For at least two heats, strain–time plots or minimum creep rate (MCR) data shall be provided for at least two test stresses at each test temperature, including at least one stress for each material resulting in MCR values below 3×10⁻⁴ %/hr. If it can be conclusively demonstrated that creep rate does not control the design stresses, the creep rate data may be sparse in relation to the above requirement. Creep rate data may be obtained in the course of stress–rupture testing or may be obtained on additional specimens.

5-1000 LOW-TEMPERATURE PROPERTIES

If use of the material below room temperature is contemplated, data should be provided at appropriate temperatures down to the lowest contemplated use temperature.

5-1100 TOUGHNESS DATA

Toughness data shall be provided for materials for which Construction Code toughness rules would be expected to apply. The test requirements shall be as required by the requested Construction Code(s). The data shall include test results for the intended lowest service metal temperature and for the range of material thicknesses desired.

5-1200 STRESS–STRAIN CURVES

If the material is to be used in components that operate under compressive loads (e.g., external pressure), stress–strain plots (tension or compression) shall be furnished for each of the three heats of material at 100°F intervals from room temperature up to 100°F above the maximum temperature desired. Engineering stress–strain data (stress versus strain) shall be provided in the form of stress–strain plots and digitized data, from which the plots were derived, in tabular form up to 1.2% strain. Digitized data shall be provided at intervals no greater than 0.01% strain. In addition, the minimum yield strength, modulus of elasticity, and proportional limit, for materials where a proportional limit can be identified, shall be reported for each temperature. The stress–strain plots (not load versus extension) shall be determined using a Class B-2 or better-accuracy extensometer as defined in ASTM E83. The plots shall include gridlines with the units marked on the gridlines: for strain, minor gridlines at intervals of 0.01% and major gridlines at 0.1%, up to 1.2% strain; and for stress, minor gridlines at 0.2 ksi and major gridlines at 2.0 ksi.

5-1300 FATIGUE DATA

If the material is to be used in cyclic service and the Construction Code in which adoption is desired requires explicit consideration of cyclic behavior, fatigue data for characterized samples shall also be furnished over the range of design temperatures desired, from 10⁴ to at least 10⁶ cycles.

5-1400 PHYSICAL PROPERTIES

For at least one heat meeting the requirements of the material specification, the inquirer shall furnish to the Boiler and Pressure Vessel Committee on Materials adequate data necessary to establish values for coefficient of thermal expansion, coefficients of thermal conductivity and diffusivity, modulus of elasticity, Poisson’s ratio, and density. Test methods shall be as follows:

(a) ASTM E228 or ASTM E831 for thermal expansion coefficients

(b) ASTM C177 for thermal conductivity and thermal diffusivity

(c) ASTM E1875 for modulus of elasticity

(d) ASTM E1875 or ASTM E132 for Poisson’s ratio

Data from other equivalent national or international test standards shall be acceptable in lieu of those listed above. Instantaneous, mean, and linear coefficients of thermal expansion shall be reported. Data for all physical properties shall be provided at least over the range of temperatures for which the material is to be used. It is recommended that data be collected at temperature intervals not greater than 100°F. If the material is intended to be used below room temperature, data should be provided for temperatures down to the minimum use temperature. Data provided shall be expressed in the units and to the number of significant figures shown in Table 5-800.
5-1500 DATA REQUIREMENTS FOR WELDS, WELDMENTS, AND WELDABILITY

The following three types of welding information are required for a new base metal for use in welded construction in an ASME BPV Construction Code: data on weldability, data on strength and toughness in the time-independent regime, and data on strength in the time-dependent regime.

The data requirements for weldability and for strength in the time-independent regime are the responsibility of the BPV IX Standards Committee and are to be found in Section II, Part C, Guideline on the Approval of New Welding and Brazing Material Classifications Under the ASME Boiler and Pressure Vessel Code; and in Section IX, Mandatory Appendix J, Guideline for Requesting P-Number Assignments for Base Metals Not Listed in Table QW/QB-422. The requirements for weld metal and weldment toughness data vary with the class of materials and their application, and are to be found in the Construction Codes that have toughness rules — Sections III, VIII, and XII.

Data for welds and weldments for a new base material for use in the time-dependent regime are the responsibility of the BPV II and BPV IX Standards Committees, and particularly of their joint Subgroup on Strength of Weldments. The following welding information shall be provided by the Inquirer, to support the request for a Code Case for, or incorporation of, a new base material for use in elevated temperature service:

(a) When there is one or more AWS, ASME, or equivalent consumable specification and classification suitable for use with the new base material, and when such consumable/process combinations can produce welds and weldments that have both good weldability and as high or higher strengths as the base metal over the range of expected service temperatures, no time-dependent test data is required. Rather, the inquirer shall submit a tabular or graphical comparison of time-dependent allowable stresses for base metals nominally matching the compositions of such welding consumables against the allowable stresses proposed for the new base metal. (Note that since neither ASME nor any other organization publishes allowable stresses for all-weld metal or for weldments, it is necessary to use, in this comparison, the allowable stresses for the base metals equivalent to the welding consumables as a reasonable first approximation.) An example of such a comparison appears in Table 5-1500.

(b) When there is no such suitable consumable having an AWS, ASME, or equivalent specification and classification, or when it is necessary or desirable to use a new, perhaps nominally matching, welding consumable, the following information shall be provided to the Committee:

(1) the chemistry ranges for each element specified for the consumable to be used. If the chemistry ranges vary for the consumables to be used for different processes, then the chemistry ranges of the consumables appropriate for each process shall be provided.

(2) creep-rupture data for weldments made with one lot of consumables for each process intended to be used with the new base material

(-a) at temperature intervals not greater than 200°F

(-b) over a temperature range spanning the range from the first rational temperature above the temperature at which time-dependent properties control the allowable stresses of the new base material to about 100°F above the maximum temperature for which allowable stresses for the base material are requested

(-c) at a minimum of four stresses calculated to produce rupture times of about 1000, 2500, and 4500 hr, and beyond 6000 hr

(-d) the test temperature; stress; rupture time; specimen size and configuration, including weld location; and failure location (base metal, weld metal, or heat affected zone), for each test condition

(-e) the creep–rupture data shall be compared to the scatter bands of data for the base metal

5-1600 LONG-TERM PROPERTIES

STABILITY

For new materials, and particularly for those whose creep-rupture properties are affected by heat treatment or deformation processes or a combination of these, it is important to know the structural stability characteristics and the degree of retention of properties with long-term exposure at temperature. Where particular temperature ranges of service exposure or fabrication heat treatment, cooling rates, and combination of mechanical working and thermal treatments cause significant changes in the microstructure on which the creep-rupture properties depend, these shall be brought to the attention of the BPV Committee.

5-1700 REQUESTS FOR ADDITIONAL DATA

The Committee may request additional data, including data on properties or material behavior not explicitly treated in the Construction Code for which approval is desired.

5-1800 NEW MATERIALS CHECKLIST

To assist inquirers desiring Code coverage for new materials, or extending coverage of existing materials, the Committee has developed the following checklist of items that ought to be addressed in each inquiry. While taking into account the intended application of
### Table 5-1500
Example of a Comparison of Allowable Stresses of Base Metals With Compositions Similar to Those of Selected Welding Consumables and the Proposed New Base Metal

#### Comparison of Nominal Chemical Compositions, %, and Specified Mechanical Properties of Ni-Base Alloys in Section II, Part B

<table>
<thead>
<tr>
<th>Grade</th>
<th>Ni</th>
<th>Cr</th>
<th>Fe</th>
<th>Mn</th>
<th>Mo</th>
<th>Co</th>
<th>Al</th>
<th>Cu</th>
<th>B</th>
<th>Si</th>
<th>Ti</th>
<th>W</th>
<th>Cb + Ta</th>
<th>Ultimate Tensile Strength, ksi</th>
<th>Yield Strength, ksi</th>
</tr>
</thead>
<tbody>
<tr>
<td>N06230</td>
<td>Bal. ≈ 53</td>
<td>22</td>
<td>3</td>
<td>0.65</td>
<td>2</td>
<td>5</td>
<td>0.5</td>
<td>0.1</td>
<td>...</td>
<td>...</td>
<td>0.5</td>
<td>...</td>
<td>14</td>
<td>...</td>
<td>110</td>
</tr>
<tr>
<td>N06600</td>
<td>72 min.</td>
<td>15.5</td>
<td>8</td>
<td>0.5</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0.1</td>
<td>0.25</td>
<td>...</td>
<td>0.25</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>N06617</td>
<td>44</td>
<td>22</td>
<td>1.5</td>
<td>0.5</td>
<td>9</td>
<td>12</td>
<td>1.2</td>
<td>0.1</td>
<td>0.25</td>
<td>...</td>
<td>0.005</td>
<td>0.5</td>
<td>0.4</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>N06625</td>
<td>58 min.</td>
<td>21.5</td>
<td>5</td>
<td>0.5</td>
<td>9</td>
<td>1</td>
<td>0.4</td>
<td>0.1</td>
<td>0.4</td>
<td>...</td>
<td>0.5</td>
<td>0.4</td>
<td>...</td>
<td>3.65</td>
<td>120</td>
</tr>
<tr>
<td>N06696</td>
<td>Bal. ≈ 60</td>
<td>30</td>
<td>4</td>
<td>0.2</td>
<td>2</td>
<td>...</td>
<td>...</td>
<td>0.07</td>
<td>2</td>
<td>...</td>
<td>1.5</td>
<td>0.2</td>
<td>...</td>
<td>...</td>
<td>85</td>
</tr>
</tbody>
</table>

#### Comparison of Allowable Stresses of Ni-Base Alloys in Section II, Part B (ksi at Temperature, °F, Estimated for N06696)

| Grade | P-No. | 950 | 1,000 | 1,050 | 1,100 | 1,150 | 1,200 | 1,250 | 1,300 | 1,350 | 1,400 | 1,450 | 1,500 | 1,550 | 1,600 | 1,650 | 1,700 | 1,750 | 1,800 |
|-------|-------|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| N06230 | 43 | 20.9 | 20.9 | 20.9 | 20.9 | 19.0 | 15.6 | 12.9 | 10.6 | 9.5 | 8.7 | 6.6 | 5.1 | 3.9 | 3.0 | 2.3 | 1.8 | 1.4 | 1.1 |
| N06600 | 43 | 10.6 | 7.0 | 4.5 | 3.0 | 2.2 | 2.0 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| N06617 | 43 | 21.0 | 20.9 | 20.9 | 20.8 | 20.7 | 18.1 | 14.5 | 11.2 | 8.7 | 6.6 | 5.1 | 3.9 | 3.0 | 2.3 | 1.8 | 1.4 | 1.1 | 0.73 |
| N06625 | 43 | 26.6 | 26.4 | 26.2 | 26.1 | 26.0 | 15.0 | 11.6 | 8.5 | 6.7 | 4.9 | 3.8 | 2.6 | 1.9 | ... | ... | ... | ... | ... |
| N06696 | TBD | 17.9 | 14.1 | 11.0 | 8.6 | 6.7 | 5.2 | 4.1 | 3.2 | 2.4 | 1.8 | 1.4 | 1.1 | 0.76 | 0.59 | 0.47 | 0.37 | 0.29 | 0.23 |

**GENERAL NOTE:** In this example, the proposed new base metal is N06696.
the product, the Committee may require specific information from the inquirer, as shown above for certain material characteristics.

(a) Has a qualified inquirer request been provided?
(b) Has a request either for revision to existing Code requirements or for a Code Case been defined?
(c) Has a letter to ASTM or AWS been submitted requesting coverage of the new material in a specification? Alternatively, is this material already covered by a specification issued by a recognized national or international organization and has an English language version been provided?
(d) Has the Construction Code and, if applicable, a Division, Subsection, or Part been identified?
(e) Have product forms, size range, and the applicable specification(s) been defined?
(f) Has the range (maximum/minimum) of temperature application been defined?
(g) Has the chemistry been submitted and the related requirements been addressed?
(h) Have the metallurgical structure and heat treatment requirements been submitted?
(i) Have mechanical property data been submitted (ultimate tensile strength, yield strength, reduction of area, and elongation at 100°F intervals, from room temperature to 100°F above the maximum intended use temperature, for three heats of appropriate product forms and sizes?
(j) If requested temperatures of coverage are above those at which time-dependent properties begin to govern design values, have appropriate time-dependent property data for base metal and weldments been submitted?
(k) If higher allowable stresses for material to be used below room temperature are requested, have appropriate mechanical property data below room temperature been submitted?
(l) Have toughness considerations required by the Construction Code been defined and have appropriate data been submitted?
(m) Have stress-strain curves been submitted for the establishment of External Pressure Charts?
(n) If cyclic service considerations are required by the requested Construction Code application, have appropriate fatigue data been submitted?
(o) Have physical properties data (coefficient of thermal expansion, thermal conductivity and diffusivity, modulus of elasticity, Poisson’s ratio, and density) been submitted?
(p) Have welding requirements been defined, and weld metal and weldment data been submitted?
(q) Has the influence of fabrication practices on material properties been defined?

5-1900 REQUIREMENTS FOR RECOGNIZED NATIONAL OR INTERNATIONAL SPECIFICATIONS

Acceptable material specifications will be identified by date or edition. The latest approved edition(s) will be stated in the subtitle of the ASME specification. Eventually, acceptable previous editions will be listed in Section II, Parts A and B. Minimum requirements that shall be contained in a material specification for which acceptance is being requested include such items as the name of the national or international organization, scope, reference documents, process, manufacture, conditions for delivery, heat treatment, chemical and tensile requirements, forming properties, testing specifications and requirements, workmanship, finish, marking, inspection, and rejection.

5-2000 PUBLICATION OF RECOGNIZED NATIONAL OR INTERNATIONAL SPECIFICATIONS

Specifications for which ASME has been given publishing permission by the originating organization will be published in Section II, Parts A and B. Specifications for which ASME has not been given publishing permission by the originating organization will be referenced on a cover sheet in Section II, Parts A and B. Information on obtaining a copy of those referenced documents will be maintained in those Parts. Additions and exceptions to the material specification will be noted in the subtitle of the specification and in Table II-200-1 or II-200-2 in Section II, Parts A and B.

5-2100 CEN SPECIFICATIONS

European Standards are adopted by CEN in three official languages (English, French, and German) as an EN standard. After the CEN adoption, to become applicable in a member country of CEN, an EN standard shall be given the status of a national standard. During this process
(a) the text of the EN standard shall remain unaltered and shall be included as adopted by CEN
(b) national forewords and/or annexes may be added to cover specific national practices, but shall not be in contradiction with the EN standard
(c) a prefix XX (e.g., XX = BS for the United Kingdom, NF for France, and DIN for Germany) is added to the designation of the EN standard (e.g., BS EN 10028-1 or NF EN 10028-1)
(d) the date of adoption as a national standard will differ from the date of adoption as an EN standard, and may differ from one country to another

Written or electronic copies can only be obtained from European National Standardization Bodies as XX EN (CEN does not sell standards). Consequently, in order to
maintain coherence and homogeneity in the reference system, the mentions in the subtitle of the corresponding ASME specification will only refer to the EN standard number without any prefix and to the year of approval by CEN. It will also be mentioned in the cover sheet that the national parts do not apply for the ASME specification.