Case N-898
Use of Alloy 617 (UNS N06617) for Class A Elevated Temperature Service Construction
Section III, Division 5

Inquiry: May 52Ni–22Cr–13Co–9Mo, Alloy 617 (UNS N06617) be used at elevated temperatures in the construction of components conforming to the requirements of Section III, Division 5, Subsection HB, Subpart B “Elevated Temperature Service”?

Reply: It is the opinion of the Committee that 52Ni–22Cr–13Co–9Mo, Alloy 617 (UNS N06617) may be used in the construction of components conforming to the requirements of Section III, Division 5, Subsection HB, Subpart B “Elevated Temperature Service,” provided the following requirements are met:

(a) The modifications and additions to the rules provided in Subsection HB, Subpart B defined in this Code Case shall be met.
(b) The service temperature shall be limited to 1,750°F (954°C) and below.
(c) Service time shall be limited to 100,000 hr.
(d) All other applicable requirements of Section III, Division 5, Subsection HB, Subpart B shall be met.
(e) This Case number shall be listed on the Data Report Form for the component.

This Code Case was written to be used in conjunction with Section III, Division 5, Subsection HB, Subpart B. All requirements of Subsection HB, Subpart B shall be met except when these requirements are modified by the corresponding numbered paragraphs of this Code Case.

References within Section III, Division 5 to figures and tables in Mandatory Appendix HBB-I-14, design fatigue curves or isochronous stress–strain curves should be extended to include corresponding figures and tables for Alloy 617 within this Code Case.

Thermal expansion, thermal diffusivity, and thermal conductivity are not currently contained in Section II for Alloy 617 (UNS N06617). Values for these properties are shown in Tables TE-4 and TCD of Nonmandatory Appendices A and B, respectively, of this Code Case. Elastic modulus values for Alloy 617 are currently included in Section II, Part D (Table TM-4) in U.S. Customary units for temperatures up to 1,500°F and in SI units for temperatures up to 850°C, but the temperature range must be increased to 1,750°F (954°C) to cover the maximum service temperature of Nonmandatory Appendix C of this Code Case. Elastic modulus values are shown in Table TM-4 of this Code Case.

ARTICLE HBB-2000 MATERIAL

HBB-2100

HBB-2160 Deterioration of Material in Service

(d) Long-time, elevated temperature service may result in the reduction of the subsequent yield and ultimate tensile strengths.

(3) When the yield and ultimate tensile strengths are reduced by the elevated temperature service, it is necessary to appropriately reduce the values of \( S_{mt} \) and \( S_m \). To reflect the effects of long-time elevated temperature service, the \( S_{mt} \) values of Tables HBB-I-14.3A through HBB-I-14.3F shall be redefined as the lower of (-a) through (-g) below, and the values of \( S_m \) shall be defined as the lower of (-b) through (-g) below:

\[-(g)\] for Alloy 617, the product of the yield strength at temperature...”

Subsection HB, Subpart B, it is important that the Code Case and Subsection HB, Subpart B be used together to ensure that all the elevated temperature service requirements for Alloy 617 are satisfied. All general notes contained in Section III, Division 5 shall apply to the corresponding figures and tables in this Code Case.

Change to:

1 For those Alloy 617 tables presented herein that list material properties or allowable stresses in SI units only to 950°C, a conversion from the U.S. Customary unit values at 1,750°F may be used to obtain 954°C values.
time duration, \( T_d \), based on parent material stress-to-rupture to Table HBB-I-14.6G of this Code Case and the reference for weld strength reduction factor to Table HBB-I-14.10F-1 of this Code Case. The factor \( K' \) is from Table HBB-T-1411-1 of this Code Case.

HBB-T-1800 ISOCRONOUS STRESS–STRAIN RELATIONS

HBB-T-1810 OBJECTIVE

HBB-T-1820 MATERIALS AND TEMPERATURE LIMITS

Data for Alloy 617 is added in Table HBB-T-1820-1 of this Code Case as indicated below.

HBB-T-1830 EQUATIONS FOR THE ISOCRONOUS CURVES

The equations for determining the elastic strain, plastic strain, and creep strain are expressed in terms of temperature and stress in SI units. When working in U.S. Customary units or other local customary units, the temperature and stress values should first be converted to °C and MPa units, respectively, and then be entered into the equations to obtain the appropriate strain values.

HBB-T-1836 Alloy 617

(a) Elastic Strain
\[
\varepsilon_e = \frac{\sigma}{E}
\]
with \( E \) the temperature-dependent value of Young’s modulus found in Table TM-4M of this Code Case

(b) Plastic Strain
(1) \( T \leq 750°C \)
\[
\begin{align*}
(-a) & \text{ for } \sigma \leq \sigma_0, \varepsilon_p = 0 \\
(-b) & \text{ for } \sigma > \sigma_0, \varepsilon_p = K \left( \frac{\sigma - \sigma_0}{\sigma} \right)^n
\end{align*}
\]
(2) \( T > 750°C \)
\[
\begin{align*}
(-a) & \text{ for } \sigma \leq \sigma_1, \varepsilon_p = 0 \\
(-b) & \text{ for } \sigma > \sigma_1, \varepsilon_p = \frac{1}{\delta} \ln \left( 1 - \frac{\sigma - \sigma_1}{\sigma_p - \sigma_1} \right)
\end{align*}
\]
where Table HBB-T-1836-1 gives the temperature-dependent values of the parameters \( \sigma_0, K, n \), and Table HBB-T-1836-2 gives the temperature-dependent values of \( \sigma_1, \delta, \sigma_p \). The parameters may be linearly interpolated between temperature values in Tables HBB-T-1836-1 and HBB-T-1836-2.

(c) Creep Strain
(1) for \( T \leq 775°C \)
\[
\varepsilon_c = \left[ \varepsilon_0 e^{B_2 \mu b^3/(A K T_k)} \left( \frac{\sigma}{\mu} \right)^{-b/3/(A K T_k)} \right] \times t
\]
(2) for \( T > 775°C \)
\[
\varepsilon_c = \left[ \varepsilon_0 e^{B_2 \mu b^3/(A K T_k)} \left( \frac{\sigma}{\mu} \right)^{-b/3/(A K T_k)} \right] \times t
\]
where Table HBB-T-1836-3 gives the values of the parameters \( \varepsilon_0, A, B_1, B_2, b, \) and \( k \);
\[
T_k = T + 273.15
\]
and
\[
\mu = \frac{E}{2(1 + \nu)}
\]
where
\( E \) = temperature-dependent value of Young’s modulus found in Table TM-4M of this Code Case
\( \nu \) = temperature-dependent value of Poisson’s ratio found in Section II, Part D (Metric), Table PRD for Alloy 617

<table>
<thead>
<tr>
<th>Material</th>
<th>Maximum Temp., °F</th>
<th>Temperature Increment, °F (°C)</th>
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<tbody>
<tr>
<td>Alloy 617</td>
<td>1,750 (954)</td>
<td>50 (28)</td>
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<table>
<thead>
<tr>
<th>Table HBB-T-1836-1</th>
</tr>
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<tbody>
<tr>
<td>( T, ^\circ C )</td>
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<tr>
<td>427</td>
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<tr>
<td>700</td>
</tr>
<tr>
<td>750</td>
</tr>
</tbody>
</table>

Add a negative sign to this equation so it becomes
\[
\varepsilon_p = -\frac{1}{\delta} \ln \left( 1 - \frac{\sigma - \sigma_1}{\sigma_p - \sigma_1} \right)
\]