Is the intent of API RP 1102 that the same design factor be used for checking both as shown in the examples?

In this response, we refer to ASME B31.4-2006, API RP 1102, 7th ed. and the current 49 CFR 195 pipeline safety regulations.

Paragraph 4.8.1.3 of ASME B31.4 (2006) states that the design factor shall not be greater than 0.72 and Section 402.3.1(f) of ASME B31.4 (2006) states that users may elect to use a design factor of less than 0.72.

49 CFR 195.106 also uses a design factor in the Barlow formula of 0.72 and stipulates the use of lower design factors in certain circumstances. CFR 195.106 does not specify any further design factors with regard to external loading or effective stress but 195.108 requires that external pressure must be accounted for and 195.110 refers to B31.4 section 419 to account for Expansion and Flexibility with regard to external loads.

API RP 1102 requires two (2) checks for allowable stress:
1. Paragraph 4.8.1.1 describes the check for circumferential stress due to internal pressurization using the Barlow formula. It states "F is the design factor chosen in accordance with 49 Code of Federal Regulations Part 192.111 or Part 195.108."
2. Paragraph 4.8.1.3 provides a formula for Total Effective Stress but does not define what the design factor, F, is. It states that "the Design Factor, F, be consistent with standard practice or code requirements."

The statement in RP 1102 Section 4.8.1.3 is accurate in its simple language and intent that "the Design Factor, F, be consistent with standard practice or code requirements."

The question correctly quotes B31.4 paragraph 402.3.2(b) which specifies a total combined stress as combined in the above paragraph of 1102 of 0.90SMYS.

The statement in RP 1102 Section 4.8.1.3 is accurate in its simple language and intent that "the Design Factor, F, be consistent with standard practice or code requirements."

There are different Fs to be applied in a single design, such as F=0.6 for highway crossing Barlow check, then F=0.8 or 0.9 for effective stress check? I am not assigning a separate circumferential stress check based on the appropriate standard?

API 1102 recognizes the use of a design factor as an industry best practice and in some cases a regulatory requirement of the pipeline operator. It is not the intent of API 1102 to provide a recommended numerical value for the design factor. The examples provided in Annex B provide the reader an example of the API 1102 process of evaluating the stresses on an uncased liquid pipeline crossing. It is recommended that the designer select the design factor based on known information concerning the pipeline and the crossing, the regulatory requirements of the operator, and/or references provided in API 1102 (i.e. ASME).

Is the deliberate or an error? How should the figure be used?

Yes. The reproduction of the Figure 3 is in error. The stiffness factor (i.e. Y-axis) is meant to be linear from 0 to 12000.

Why is the steel thermal expansion as specified in your RP as (1.6-1.9 x10-5 C°) where at ASME B31.8 specified as (1.17x10-5) which one is correct and which one I should use for API 1102 Road crossing calculation?

API 1102 has been corrected in the ERRATA 5, dated March 2014. The applicable except from the errata is:
Replace the conversion to Centigrade: (1.6 – 1.9 x 10-5) with (10.8 – 12.6 x 10-6)