where

$$\ln\left(\frac{R}{Q}\right)_m = \text{the mean value of } \ln\left(\frac{R}{Q}\right)$$

$$\sigma_{\ln(R/Q)} = \text{standard deviation of } \ln\left(\frac{R}{Q}\right)$$

This transformation converts the abscissa U to multiples of standard deviations and places the mean of U at $U = 0$. The probability of failure can then be written as

$$P_F = P\left[\ln\left(\frac{R}{Q}\right) < 0\right] = P\left[U\sigma_{\ln(R/Q)} + \ln\left(\frac{R}{Q}\right)_m < 0\right]$$

$$= P\left[U < \frac{\ln\left(\frac{R}{Q}\right)_m}{\sigma_{\ln(R/Q)}}\right] = F_u\left[\frac{\ln\left(\frac{R}{Q}\right)_m}{\sigma_{\ln(R/Q)}}\right]$$

where F_u is the *cumulative distribution function* of U, or the probability that U will not exceed the argument of the function. If we let

$$= \frac{\ln\left(\frac{R}{Q}\right)_m}{\sigma_{\ln(R/Q)}}$$

then

$$\ln\left(\frac{R}{Q}\right)_m = \beta\sigma_{\ln(R/Q)}$$

The variable β can be interpreted as the number of standard deviations from the origin that the mean value of $\ln(R/Q)$ is. For safety, the mean value *must* be more than zero, and as a consequence, β is called the *safety index* or *reliability index*. The larger this value, the larger will be the margin of safety. This means that the probability of failure, represented by the shaded area in Figure 2.3 labeled P_F, will be smaller. The reliability index is a function of both the load effect Q and the resistance R. Use of the same reliability index for all types of members subjected to the same type of loading gives the members relatively uniform strength. The •targetŽvalues of β shown in Table 2.1, selected and used in computing both load and resistance factors for the AISC Specification, were based on the recommendations of Ravindra and Galambos (1978), who also showed that

$$\phi = \frac{R_m}{R_n} e^{-0.55\,\beta V_R}$$

TABLE 2.1 Target Values of β

Type of Component	Loading Condition		
	D + (L or S)	*D + L + W*	*D + L + E*
Members	3.0	2.5	1.75
Connections	4.5	4.5	4.5

where

R_m = mean value of the resistance R
R_n = nominal or theoretical resistance
V_R = coefficient of variation of R

2.6 STEEL CONSTRUCTION MANUAL

Anyone engaged in structural steel design in the United States must have access to AISC•s *Steel Construction Manual* (AISC, 2011a). This publication contains the AISC Specification and numerous design aids in the form of tables and graphs, as well as a •catalogŽof the most widely available structural shapes.

The first nine editions of the *Manual* and the accompanying specifications were based on ASD. The ninth edition was followed by editions one through three of the LRFD-based manuals. The edition that followed, which for the first time incorporated both ASD and LRFD, was named the thirteenth edition, because it was the thirteenth manual that had been published. The current version, the fourteenth edition, also covers both ASD and LRFD.

This textbook was written under the assumption that you would have access to the *Manual* at all times. To encourage use of the *Manual,* we did not reproduce its tables and graphs in this book. The *Manual* is divided into 17 parts as follows:

Part 1. Dimensions and Properties. This part contains details on standard hot-rolled shapes, pipe, and hollow structural sections, including all necessary cross-sectional dimensions and properties such as area and moment of inertia.

Part 2. General Design Considerations. This part includes a brief overview of various specifications (including a detailed discussion of the AISC Specification), codes and standards, some fundamental design and fabrication principles, and a discussion of the proper selection of materials. Part 2 also lists the load combinations we discussed in Sections 2.3 and 2.4.

Part 3. Design of Flexural Members. This part contains a discussion of Specification requirements and design aids for beams, including composite beams (in which a steel shape acts in combination with a reinforced concrete floor or roof slab) and plate girders. Composite beams are covered in Chapter 9 of this textbook, •Composite Construction,Ž and plate girders are covered in Chapter 10, •Plate Girders.Ž

Part 4. Design of Compression Members. Part 4 includes a discussion of the Specification requirements for compression members and numerous design aids.