piping and vessel nozzle. There are momentum effects and pressure effects at steady state flow as well as transient dynamic loads caused by opening.

(b) *External Loads.* Mechanical forces may be applied to the pressure relief device by discharge piping as a result of thermal expansion, movement away from anchors, and weight of any unsupported piping. The resultant bending moments on a closed pressure relief device may cause device leakage, device damage, and excessive stress in inlet piping. The design of the installation should consider these possibilities.

**M-13 SIZING OF PRESSURE RELIEF DEVICES FOR FIRE CONDITIONS**

(a) Excessive pressure may develop in pressure vessels by vaporization of the liquid contents and/or expansion of vapor content due to heat influx from the surroundings, particularly from a fire. Pressure relief systems for fire conditions are usually intended to release only the quantity of product necessary to lower the pressure to a predetermined safe level, without releasing an excessive quantity. This control is especially important in situations where release of the contents generates a hazard because of flammability or toxicity. Under fire conditions, consideration must also be given to the possibility that the safe pressure level for the vessel will be reduced due to heating of the vessel material, with a corresponding loss of strength. For some fire situations, there may be an insufficient rise in pressure to activate a pressure relief device. The user should consult other references, which provide guidelines for protecting vessels from the effects of fire.

(b) Several formulas have evolved over the years for calculating the pressure relief capacity required under fire conditions. The major differences involve heat flux rates. There is no single formula yet developed which takes into account all of the many factors which could be considered in making this determination. When fire conditions are a consideration in the design of a pressure vessel, the following references which provide recommendations for specific installations may be used:

- Safety Relief Device Standards: S-1.1, Cylinders for Compressed Gases; S-1.2, Cargo and Portable Tanks; and S-1.3, Compressed Gas Storage Containers, Compressed Gas Association, Arlington, VA
- NFPA Code Nos. 30, 58, 59, and 59A, National Fire Protection Association, 1 Battery March Park, Quincy, MA 02169-7471
- Pressure-Relieving Systems for Marine Cargo Bulk Liquid Containers, 1973, National Academy of Sciences, Washington, DC
- Bulletin E-2, How to Size Safety Relief Devices, Phillips Petroleum Company, Bartlesville, OK

**M-14 PRESSURE-INDICATING DEVICE**

If a pressure-indicating device is provided to determine the vessel pressure at or near the set pressure of the relief device, one should be selected that spans the set pressure of the relief device and is graduated with an upper limit that is neither less than 1.25 times the set pressure of the relief device nor more than twice the maximum allowable working pressure of the vessel. Additional devices may be installed if desired.