(a) interaction loads on the run pipe when more than one valve releases, and
(b) the transient impacting of the valve mechanism opening and closing, if applicable

O-1300 STRESS EVALUATION OPEN SYSTEM

Evaluation of stresses due to the design mechanical loads may be made by using the rules for Class 1 piping, O-1310 and for Class 2 or Class 3 piping, O-1320.

O-1310 CLASS 1 PIPING

(a) Whenever any of the equations of NB-3650 are used in the analysis of Class 1 piping systems, the value of \( M_i \) shall include the reaction force moment. The contribution from the reaction force \( F \) to the branch moment \( M_b \), as defined in NB-3683.1, shall be no less than the product \( F \times \text{nominal discharge pipe size} \times \text{DLF} \).

(b) Note that the use of the equations of NB-3650 for branch connections requires a nozzle spacing as defined by NB-3683.8(a)(2).

(c) When NB-3650 eq. (9) is used in the analysis, the value of \( M_i \) shall be defined as:

\[ M_i = \text{resultant moment due to a combination of primary loads. Loads to be considered include: weight; earthquake, considering only one-half the range of the earthquake and excluding the effects of anchor displacement due to earthquake; thrusts from relief and safety valve loads from pressure and flow transients; and other sustained mechanical loads.} \]

(d) The combination of loads shall be specified in the Design Specification. In the combination of loads, all directional moment components in the same direction shall be combined before determining the resultant moment; i.e., resultant moments of loads shall not be combined.

(e) When NB-3650 eq. (10) is used in the analysis, the value of \( M_i \) shall be defined as:

\[ M_i = \text{resultant range of moment due to a combination of primary plus secondary loads. Loads to be considered include: thermal expansion; anchor movement from any cause; earthquake effects; thrusts from relief and safety valve loads from pressure and flow transients; and other mechanical loads.} \]

(f) The combination of loads shall be specified in the Design Specification. The earthquake loading shall be considered in conjunction with the operating conditions. Weight effects need not be considered in the range loading because they are noncyclic in character. In the combination of loads, all directional moment components in the same direction shall be combined before determining the resultant moment; i.e., resultant moments of loads shall not be combined. If a combination includes earthquake effects, \( M_i \) shall be the greater of the resultant range of moment due to the combination of all loads considering one-half the range of the earthquake or the resultant range of moment due to the full range of the earthquake.

O-1320 CLASS 2 OR CLASS 3 PIPING

(a) For Class 2 or Class 3 piping, \( \text{NC-3653.1(a) eq. (9a)} \) or \( \text{ND-3653.1(a) eq. (9a)} \) is to be used with \( M_b \) to include the reaction force moment. The contribution from the reaction force \( F \) to the branch moment, as defined in \( \text{NC-3653.3 or ND-3653.3} \), shall be no less than the product, \( F \times \text{nominal discharge pipe size} \times \text{DLF} \).

(b) Note that the use of \( \text{NC-3653.1(a) eqs. (9a) and (9b)} \) or \( \text{ND-3653.1(a) eqs. (9a) and (9b)} \) for branch connections requires a nozzle spacing, as defined by \( \text{NC-3643.3 (c)(6) or ND-3643.3(c)(6)} \).

O-1400 CLOSED DISCHARGE SYSTEMS — OPEN DISCHARGE SYSTEMS WITH LONG DISCHARGE PIPES — SYSTEMS WITH SLUG FLOW

(a) For closed discharge systems, open discharge systems with long discharge pipes, and systems with slug flow, the state of the art does not lend itself to a well-defined method of load computation. For these systems the dynamic interaction forces of the total system including the attached discharge piping must be considered.

(b) When a safety valve discharge is connected to a relatively long run of pipe and is suddenly opened, there is a period of transient flow until the steady-state discharge condition is reached. During this transient period, the pressure and flow will not be uniform. When the safety valve is initially opened, the discharge pipe may be filled with air. If the safety valve is on a steam system, the steam discharge from the valve must purge the air from the pipe before steady state steam flow is established and, as the pressure builds up at the valve outlet flange and waves start to travel down the discharge pipe, the pressure wave initially emanating from the valve will steepen as it propagates, and it may steepen into a shock wave before it reaches the exit.

(c) Relief valves discharging into an enclosed piping system create momentary unbalanced forces which act on the piping system during the first few milliseconds following relief valve lift. The pressure waves traveling through the piping system following the rapid opening of the safety valve will cause bending moments in the safety valve discharge piping and throughout the remainder of the piping system. In such a case, the designer must compute the magnitude of the loads and perform appropriate evaluation of their effects.

(d) Particular attention should be given to the large forcing functions acting on the pipe if it contains water seals, two phase flow, or if there is a water column in the discharge piping.
The reaction force effects are dynamic in nature. A time history dynamic solution, incorporating a multi-degree-of-freedom model solved for the transient hydraulic forces is considered to be a preferred method of analysis.

O-1500 DESIGN CONSIDERATIONS

Reference should be made to NB/NC/ND-7000.

It is recommended that the following be included as part of the total design consideration.

(a) Where not required by the Code, it is recommended that the header penetrations for relief valves be in accordance with the nozzle spacing recommendation of NB-3683.8(a)(2).

(b) No more than one penetration should be made around the circumference of the run pipe (i.e., no two penetrations in the same transverse plane), the spacing to be in accordance with the preceding (a).

(c) The stress analysis of the pipe could require additional thickness for membrane protection above that required by the thickness equation for pressure load only.

(d) Detail design should preclude sharp notches that may be generated by the use of saddles, gussets, ribs, etc.

(e) Contoured outlets are often advantageous.

(f) The direction of discharge of several pressure relief valves on the same run pipe should be such as to tend to balance one another for all modes of operation specified in the piping design specification.

(g) Supports may require a detailed analysis to determine their role in restraint as well as support. Considerations should be given to the possibility that, under load, snubbing devices may permit significant deflections.

(h) The reaction force moment arm on the outlet piping should be minimized in accordance with the valve manufacturer’s recommendation.

(i) The relief valve outlet piping stack clearance should be checked for interference from thermal expansion, earthquake displacements, etc. The vent stack and valve discharge piping system should be arranged such that pull out of the valve discharge pipe does not occur.

(j) Thermal expansion effects are to be considered as they presently are defined in the Code.

(k) The force due to venting should be included in the evaluation of the stack forces. The effects of back pressure in the discharge stack can be significant.

(l) The station should be arranged such that the discharge piping is void of collected water. The discharge piping from each valve or device should be at least of the same size as the valve outlet.

(m) Drains shall be provided so that condensed leakage, rain, or other water sources will not collect on the discharge side of the valve and adversely affect the reaction force. Safety valves are generally provided with drain plugs that can be used for a drain connection. Discharge piping shall be sloped and provided with adequate drains if low points are unavoidable in the layout.

(n) Where water seals are used ahead of the safety valve, the total water volume in the seals should be minimized. To minimize forces due to slug flow or water seal excursion, the number of changes of direction and the lengths of straight runs of piping should be limited.

(o) Often safety valves are full lift, pop-type valves and are essentially full flow devices with no capability for flow modulation. In actual pressure transients, the steam flow required to prevent overpressure is a varying quantity, from zero to the full rated capacity of the safety valves. As a result, the valves may be required to open and close a number of times during the transient. Since each opening and closing produces a reaction force, consideration should be given to the effects of multiple valve operations on the piping system, including supports.