d) When two or more required pressure relief devices are placed on the connection, the inlet cross-sectional area of this connection shall be sized either to avoid restricting flow to the pressure relief devices or made at least equal to the combined inlet areas of the pressure relief devices connected to it. The flow characteristics of the upstream system shall satisfy the requirements of NBIC Part 1, 5.3.6 a).

e) There shall be no intervening stop valves between the piping system and its pressure relief device(s), or between the pressure relief device(s) and the point of discharge except under the following conditions:

   1) These stop valves shall be so constructed or positively controlled that the closing of the maximum number of block valves at one time will not reduce the pressure relieving capacity below the required relieving capacity;

   2) Upon specific acceptance of the Jurisdiction, when necessary for the continuous operation of processing equipment of such a complex nature that shutdown of any part is not feasible, a full area stop valve between a piping system and its pressure relief device may be provided for inspection and repair purposes only. This stop valve shall be arranged so that it can be locked or sealed open and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station;

   3) A full area stop valve may be placed on the discharge side of a pressure relief device when its discharge is connected to a common header for pressure relief devices to prevent discharges from these other devices from flowing back to the first device during inspection and repair. This stop valve shall be arranged so that it can be locked or sealed open, and it shall not be closed except by an authorized person who shall remain stationed there during that period of operation while the valve remains closed. The valve shall be locked or sealed in the open position before the authorized person leaves the station. This valve shall only be used when a stop valve on the inlet side of the pressure relief device is first closed; or

   4) A piping system where the pressure originates from an outside source may have a stop valve between the system and the pressure relief device, and this valve need not be sealed open, provided it also closes off that vessel from the source of pressure.

f) Pressure relief device discharges shall be arranged such that they are not a hazard to personnel or other equipment and, when necessary, lead to a safe location for disposal of fluids being relieved.

g) Discharge lines from pressure relief devices shall be designed to facilitate drainage or be fitted with drains to prevent liquid from collecting in the discharge side of a pressure relief device. The size of discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the pressure relief device or adversely affect the operation of the pressure relief device. It shall be as short and straight as possible and arranged to avoid undue stress on the pressure relief device.

h) The reaction forces due to discharge of pressure relief devices shall be considered in the design of the inlet and discharge piping.

i) Pressure relief devices shall be installed so they are accessible for inspection, repair, or replacement. These stop valves shall be so constructed or positively controlled that the closing of the maximum number of block valves at one time will not reduce the pressure relieving capacity below the required relieving capacity.

5.4 EXAMINATION, INSPECTION, AND TESTING

The owner shall ensure that all examinations, inspections, and tests required by the code of construction have been performed prior to operation.

PART 1, SECTION 6
INSTALLATION SUPPLEMENTS

SUPPLEMENT 1
INSTALLATION OF YANKEE DRYERS (ROTATING PRESSURE VESSELS) WITH FINISHED SHELL OUTER SURFACES

S1.1 SCOPE (21)

This supplement provides guidelines for the installation of a yankee dryer. A yankee dryer has the following characteristics:

a) It is a rotating steam-pressurized cylindrical vessel commonly used in the paper industry, and is typically made of cast iron, finished to a high surface quality, and characterized by a center shaft connecting the heads. While traditionally made of cast iron, bolted or welded steel vessels are in use.

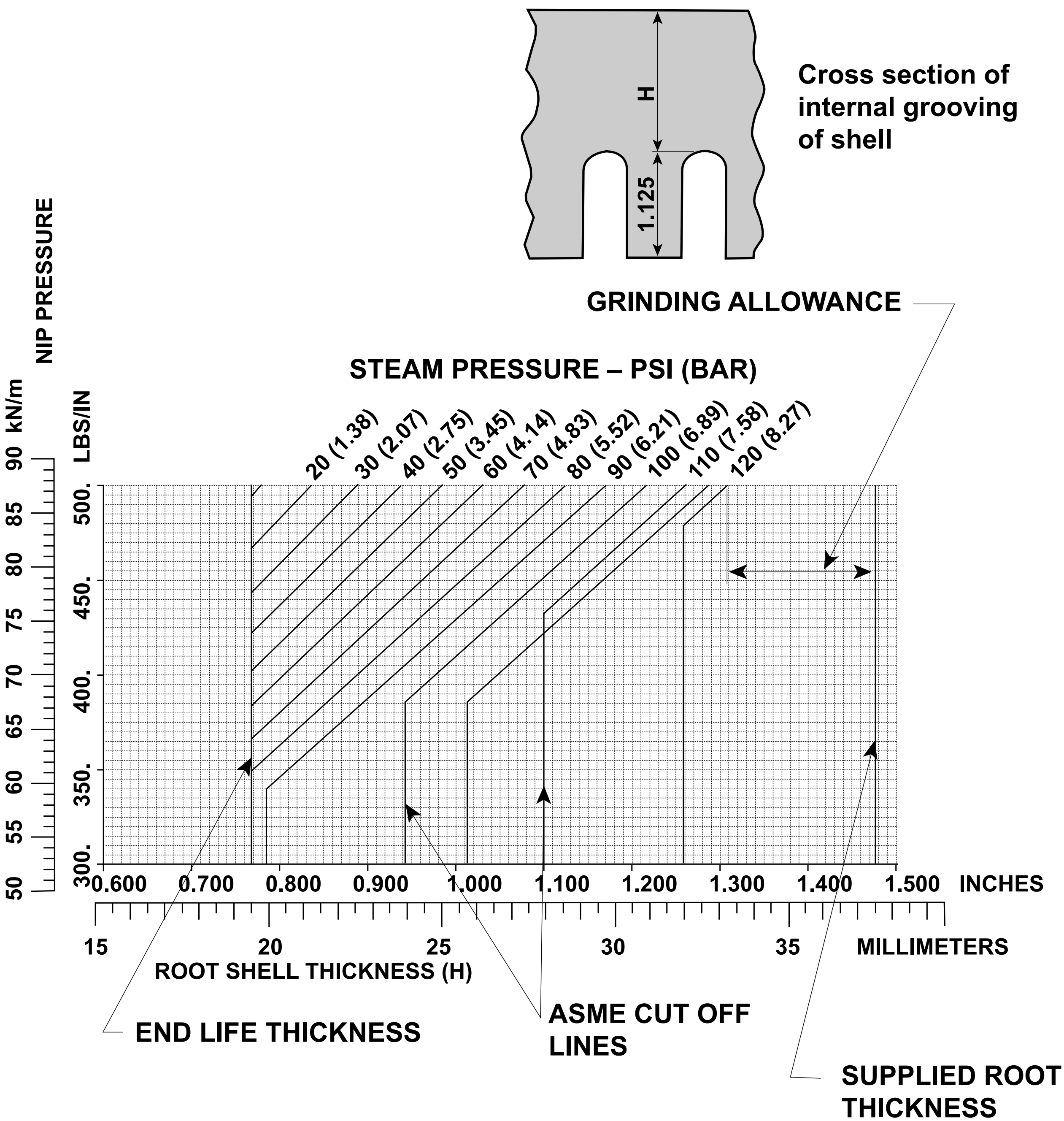
b) Yankee dryers are primarily used in the production of tissue-type paper products. When used to produce machine-glazed (MG) paper, the dryer is termed an MG cylinder. A wet paper web is pressed onto the finished dryer surface using one or two pressure (pressing) rolls. Paper is dried through a combination of mechanical dewatering by the pressure roll(s), thermal drying by the pressurized Yankee dryer, and a steam-heated or fuel-fired hood. After drying, the paper web is removed from the dryer.

c) A yankee dryer is typically manufactured in a range of outside diameters from 8 to 23 ft. (2.4 to 7 m), widths from 8 to 28 ft. (2.4 to 8.5 m), pressurized and heated with steam up to 160 psi (1,100 kPa), and rotated at speeds up to 7,000 ft/min (2,135 m/min). Typical pressure roll loads against the Yankee dryer are up to 600 pounds per linear inch (105 kN/m). A thermal load results from the drying process due to difference in temperature between internal and external shell surfaces. The dryer has an internal system to remove steam and condensate. These vessels can weigh up to 220 tons (200 tonnes).

d) The typical yankee dryer is an assembly of several large components. The cylindrical shell is commonly ASME SA-278 gray cast iron, or SA-516 steel. Shells internally may be smooth bore or ribbed. Heads, center shafts, and journals may be gray cast iron, ductile cast iron, or steel.

FIGURE S1.1
A TYPICAL MANUFACTURER'S "DE-RATE CURVE"

NOTE: There are several safe operating pressures for a given shell thickness.



S1.2 ASSESSMENT OF INSTALLATION

a) The Inspector verifies that the owner or user is properly controlling the operating conditions of the dryer. The Inspector does this by reviewing the owner's comprehensive assessments of the complete installation.

b) The dryer is subjected to a variety of loads over its life. Some of the loads exist individually, while others are combined. Considerations of all the loads that can exist on a Yankee dryer are required to determine the maximum allowable operating parameters. There are four loads that combine during normal operation to create the maximum operating stresses, usually on the outside surface of the shell at the axial center line. These loads and the associated protection devices provided to limit these loads are:

   1) Pressure load due to internal steam pressure. Overpressure protection is provided by a safety relief valve;

   2) Inertial load due to dryer rotation. Over-speed protection is usually provided by an alarm that indicates higher-than-allowable machine speed;

   3) Thermal gradient load due to the drying of the web. Protection against unusual drying loads is usually provided by logic controls on the machine, primarily to detect a “sheet-off” condition that changes the thermal load on the shell exterior from being cooled by the tissue sheet to being heated by the hot air from the hood; and

   4) Pressure roll load (line or nip load) due to pressing the wet web onto the dryer. Overload protection is usually provided by a control valve that limits the pneumatic or hydraulic forces on the roll loading arms such that the resultant nip load does not exceed the allowable operating nip load.

c) Steam pressure, inertial, and thermal gradient loads impose steady-state stresses. These stresses typically change when the dryer shell thickness (effective thickness for ribbed dryers) is reduced to restore a paper-making surface, the grade of tissue is changed or speed of the dryer is changed.

d) The pressure roll(s) load imposes an alternating stress on the shell face. The resulting maximum stress is dependent on the magnitude of the alternating and steady-state stresses.

e) Section VIII, Division 1, of the ASME Code only provides specific requirements for the analysis of pressure loads. Although the Code requires analysis of other loads, no specific guidance for thermal, inertial, or pressure roll loads is provided. Hence, additional criteria must be applied by the manufacturer to account for all the steady-state and alternating stresses.

f) To maintain product quality, the dryer surface is periodically refurbished by grinding. This results in shell thickness reduction. Therefore, the manufacturer does not provide a single set of maximum allowable operating parameters relating steam pressure, rotational speed, and pressure roll load for a single design shell thickness. The manufacturer, or another qualified source acceptable to the Inspector, instead provides a series of curves that graphically defines these maximum allowable operating parameters across a range of shell thicknesses. This document is known as the “De-rate Curve.” (See NBIC Part 1, Figure S1.1).

g) In addition to the loads on the Yankee dryer due to operation, other nonstandard load events can occur during shipment and installation into the paper machine. These nonstandard load events should be recorded in an incident log. Examples of nonstandard load events include:

   1) Damage to the protective packaging of the Yankee dryer during transport;

   2) Scratches, gouges, dents in the Yankee dryer shell during packaging removal or installation into the paper machine;

   3) Excessive heating of the Yankee dryer shell during the installation and testing of the hot air hood. If the hot air hood will be generating air that is hotter than the Yankee dryer shell material’s maximum allowable working temperature (MAWT), then temperature sensors should be installed to monitor and record the Yankee dryer shell temperature during the hood testing; and

   4) Impact load from improperly installed rolls, wires, nuts, dropped wrenches, etc., that may travel through the pressure roll nip causing external impact loads on the Yankee dryer shell.

h) If nonstandard load events (incidents) have occurred during installation, then the Inspector should ensure that an appropriate assessment of the structural integrity of the Yankee dryer has been performed. For additional details see Yankee dryer supplements in NBIC Part 2 and Part 3.

S1.3 DETERMINATION OF ALLOWABLE OPERATING PARAMETERS

a) A Yankee dryer is designed and intended to have its shell thickness reduced over the life of the vessel through routine grinding and machining. The Yankee dryer shell is ground or machined on the outside surface to restore the quality or shape of the papermaking surface essential to the manufacturing of tissue or other paper products.

b) Design documentation, called the “De-rate Curve,” is required and dictates the maximum allowable operating parameters as shell thickness is reduced (see NBIC Part 1, Figure S1.1). Calculations, used to determine those parameters, are in accordance with ASME Code requirements for primary membrane stress by the vessel manufacturer or design criteria based on relevant stress categories, e.g., fatigue and maximum principal stress. Calculation of these parameters requires that the respective stresses, resulting from the imposed loads, be compared to the appropriate material strength properties. Hence, knowledge of the applied stresses in the shell and the tensile and fatigue properties of the material are essential.

c) Yankee dryers are subjected to a variety of loads that create several categories of stress. Yankee dryers are designed such that the stress of greatest concern occurs at the centerline of the shell.

1) Steam Pressure Load — The internal steam pressure is one of the principal design loads applied to the Yankee dryer. The steam pressure expands the shell radially, causing a predominately circumferential membrane tensile stress. Because the shell is constrained radially by the heads at either end of the shell, the steam pressure also causes a primary bending stress in the vicinity of the head-to-shell joint. The ends of the shell are in tension on the inside and compression on the outside due to the steam pressure. The steam pressure also causes a bending stress in the heads.

2) Inertia Load — The rotation of the Yankee dryer causes a circumferential membrane stress in the shell similar to that caused by the pressure load. This stress is included in the design of the shell and increases with dryer diameter and speed.

3) Thermal Load — The wet sheet, applied to the shell, causes the outside surface to cool and creates a thermal gradient through the shell wall. This thermal gradient results in the outside surface being in tension and the inside surface in compression. With this cooling, the average shell temperature is less than the head temperature, which creates bending stresses on the ends of the shell and in the heads. The ends of the shell are in tension on the outside and compression on the inside.

a. Other thermal loadings also occur on a Yankee dryer. The use of full-width showers for a variety of papermaking purposes affects the shell similar to a wet sheet. The use of edge sprays produce high bending stress in the ends of the shell due to the mechanical restraint of the heads.

b. Warm-up, cool-down, hot air impingement from the hood, moisture profiling devices, fire fighting, and wash-up can all produce non-uniform thermal stresses in the pressure-retaining parts of the Yankee dryer. Heating or cooling different portions of the Yankee dryer at different rates causes these non-uniform stresses.

4) Nip Load — The nip load from the contacting pressure roll(s) results in an alternating, high cycle, bending stress in the shell. This stress is greatest at the centerline of the shell. The load of the pressure roll deflects the shell radially inward causing a circumferential compressive stress on the outside surface and a tensile stress on the inside. Because the shell has been deflected inward at the pressure roll nip, it bulges outward about 30 degrees on each side of the nip. The outward bulge causes a tensile stress on the outside shell surface at that location and a corresponding

compressive stress on the inside. Since the shell is passing under the pressure roll, its surface is subjected to an alternating load every revolution.

S1.4 ASME CODE PRIMARY MEMBRANE STRESS CRITERIA

a) Yankee dryers are typically designed and fabricated in accordance with ASME Section VIII, Division 1, The maximum allowable stress for cast iron is specified in UCI-23 and UG-22 of the ASME Code.

b) ASME Section VIII, Division 1, requires design stresses to be calculated such that any combination of loading expected to occur simultaneously during normal operation of the Yankee dryer will not result in a general primary stress exceeding the maximum allowable stress value of the material. In the ASME Code, the combination of loading resulting in the primary membrane stress in the shell is interpreted to be only composed of the circumferential stress from steam pressure. Sometimes, the stress from the inertial loading is included in this consideration.

c) In ASME Section VIII, Division 1, it is very important to note that no formulas are given for determining the stresses from thermal operating loads and pressure roll nip load(s). Hence, additional criteria need to be incorporated to establish the maximum allowable operating parameters of the Yankee dryer. Two such additional criteria are based upon the maximum principal and fatigue stress.

   1) Maximum Principal Stress Criteria

      The maximum principal stress in a Yankee dryer shell is the sum of the stresses that are simultaneously applied to the shell and is always aligned in the circumferential direction. The purpose of these criteria is to recognize the paper making application of the Yankee dryer and to prevent catastrophic failure by including all stresses. The ASME Code does not provide specific formulas for the full array of Yankee dryer shell stresses encountered in tissue making.

   2) Fatigue Stress Criteria

      Under normal operation, the stresses due to the steam pressure, inertial and thermal operating loads are considered to be steady-state stresses. When acting simultaneously, the sum of these stresses must be judged against the cyclic, or alternating, stress due to the pressure roll nip load. Fatigue stress criteria limit the alternating stress at a given mean stress using fatigue failure criteria described by the Goodman or Smith Diagram. The purpose of this limitation is to prevent crack initiation in the outside wall due to the combination of stresses. As the thickness of the shell is reduced, one or more of these criteria will control the various operating parameters.

S1.5 PRESSURE TESTING

a) Water pressure testing in the field is not recommended because of the large size of Yankee dryers and the resulting combined weight of the Yankee dryer and the water used in the testing. This combined weight can lead to support structure overload. Several failures of Yankee dryers have occurred during field pressure testing using water. If this test must occur, the following review is recommended:

   1) The testing area should be evaluated for maximum allowable loading, assuming the weight of the Yankee dryer, the weight of the water filling the Yankee dryer, and the weight of the support structure used to hold the Yankee dryer during the test; and

   2) The manufacturer should be contacted to provide information on building the Yankee dryer support structure for the water pressure test. Typically, the Yankee dryer is supported on saddles that contact the Yankee dryer shell at each end near the head-to-shell joint. The manufacturer can provide information on saddle sizing and location so that the Yankee dryer is properly supported for the test.

b) When pressure testing is desired to evaluate the Yankee dryer for fitness for service, an alternative to water pressure testing is acoustic emission testing using steam or air pressure. Typically, the test pressure used is the operating pressure. Caution needs to be exercised to ensure personnel safety. Entry to the test area needs to be controlled and all personnel need to maintain a safe distance from the Yankee dryer during the test. The steam or air test pressure should never exceed the maximum allowable working pressure (MAWP) of the Yankee dryer.

S1.6 NONDESTRUCTIVE EXAMINATION

a) Nondestructive examination (NDE) methods should be implemented by individuals qualified and experienced with the material to be tested using written NDE procedures. For Yankee dryers, cast iron knowledge and experience are essential.

b) Typical nondestructive examination methods should be employed to determine indication length, depth, and orientation (sizing) of discontinuities in Yankee dryers. Magnetic Particle, specifically the wet fluorescent method, and Dye Penetrant methods are applicable in the evaluation of surface-breaking indications. Ultrasound testing is the standard method for evaluation of surface-breaking and embedded indications. Radiographic methods are useful in the evaluation of embedded indications. Acoustic Emmission Testing can be used to locate and determine if a linear indication is active, e.g., propagating crack. Metallographic Analysis is useful in differentiating between original casting discontinuities and cracks.

c) When nondestructive testing produces an indication, the indication is subject to interpretation as false, relevant, or nonrelevant. If it has been interpreted as relevant, the necessary subsequent evaluation will result in a decision to accept, repair, replace, monitor, or adjust the maximum allowable operating parameters.

SUPPLEMENT 2
PRESSURE RELIEF VALVES ON THE LOW-PRESSURE SIDE OF STEAM PRESSURE REDUCING VALVES

S2.1 SCOPE

This supplement provides requirements and guidelines for the installation of safety valves on the low-pressure side of steam pressure reducing valves.

a) The subject of protection of vessels in steam service connected to the low-pressure side of a steam-pressure reducing valve is of considerable importance to proper operation of auxiliary equipment such as pressure cookers, hot-water heating systems, etc., operating at pressures below that which the primary boiler generating unit is operating.

b) To automatically reduce the primary boiler pressure for such processing equipment, pressure reducing valves are used. The manufacturers of such equipment have data available listing the volume of flow through reducing valves manufactured by them, but such data are not compiled in a form that the results can be deduced readily. To protect the equipment operating on the low-pressure side of a pressure reducing valve, pressure relief valves of a relieving capacity sufficient to prevent an unsafe pressure rise in case of failure of the pressure reducing valve, should be installed.

c) The pressure reducing valve is a throttling device, the design of which is based on certain diaphragm pressures opposed by spring pressure which, in turn, controls the opening through the valve. If the spring, the diaphragm, or any part of the pressure reducing valve fails, steam will flow directly through the valve and the low pressure equipment will be subjected to the boiler pressure. To protect the equipment operating on the low pressure side of the pressure reducing valve, pressure relief valve(s) should be installed on the low pressure side of the pressure reducing valve, which will provide a relieving capacity sufficient to prevent the pressure from rising above the system design pressure.

d) In most cases pressure reducing valves used for the reduction of steam pressures have the same pipe size on the inlet and outlet. In case of failure of a pressure reducing valve, the pressure relief valve on the low-pressure side must have a capacity to take care of the volume of steam determined by the high pressure side and the area of the pipe.

S2.2 PRESSURE RELIEF VALVE CAPACITY

a) The capacity of the pressure relief valve(s) on the low-pressure side of the pressure reducing valve should be based on the capacity of the pressure reducing valve when wide open or under maximum flow conditions or the flow capacity through the bypass valve.

b) By using the formula in NBIC Part 1, S2.3, Inspectors may calculate the required relieving capacities of the pressure relief valve(s) installed on the low-pressure side of the pressure reducing valve.

c) Usually a pressure reducing valve has a bypass arrangement so that in case of failure of the pressure reducing valve the boiler pressure may be short circuited into the low-pressure line without passing through the pressure reducing valve. When determining the required relieving capacity of pressure relief valves for the low-pressure side of the pressure reducing valve, the steam flow through the bypass must be taken into consideration.

S2.3 CALCULATION OF PRESSURE RELIEF VALVE RELIEVING CAPACITY

a) When a pressure reducing valve is installed, there are two possibilities of introducing boiler pressure into the low-pressure system:

1) The failure of the pressure reducing valve so that it remains wide open; and

2) The possibility of the bypass valve being open.

b) It is necessary therefore, to determine the flow under both circumstances in paragraph a) above and check that the size of the pressure relief valve under either condition will be adequate. The following formulas should be used:

1) W = steam flow in lbs/hr (kg/hr) through the pressure reducing valve

$W = AKC$

where,

A = internal area in sq. in. (sq. mm) of the inlet pipe size of the pressure reducing valve (see NBIC Part 1, Table S2.5)

K = flow coefficient for the pressure reducing valve (see NBIC Part 1, S2.4)

C = flow capacity of saturated steam through a pipe in lbs/hr/in^2 (kg/hr/mm^2) at various pressure differentials from NBIC Part 1, Tables S2.3-a, S2.3-b, or S2.3-c (for U.S. Customary units) or NBIC Part 1, Tables S2.3M-a, S2.3M-b, or S2.3M-c (for metric units).

2) W = steam flow in lbs/hr (kg/hr) through the by-pass valve

$W = A_1 K_1 C_1$

where,

A_1 = internal area in sq. in. (sq. mm) of the pipe size of the bypass around the pressure reducing valve

K_1 = flow coefficient for the bypass valves (see NBIC Part 1, S2.4)

C_1 = flow capacity of saturated steam through a pipe in lbs/hr/in^2 (kg/hr/mm^2) at various pressure differentials from Tables S2.3-a, S2.3-b, or S2.3-c (for U.S. Customary units) or Tables NBIC Part 1, S2.3M-a, S2.3M-b, or S2.3M-c (for metric units).

TABLE S2.3-a

CAPACITY OF SATURATED STEAM, IN LBS/HR, PER IN.[2] OF PIPE AREA

Outlet Pressure, psi	pressure reducing valve inlet pressure, psi												
	1,500	1,450	1,400	1,350	1,300	1,250	1,200	1,150	1,100	1,050	1,000	950	900
1,000	76,560	72,970	69,170	64,950	60,540	55,570	49,930	43,930	35,230	25,500	……	……	……
950	77,430	74,180	70,760	63,100	63,100	58,770	53,920	48,610	42,380	34,890	24,910	……	……
900	77,750	74,810	71,720	68,340	64,870	61,040	56,820	52,260	47,050	41,050	33,490	23,960	……
850	77,830	74,950	72,160	69,130	66,020	62,610	58,900	54,930	50,480	45,470	39,660	29,080	23,190
800	……	75,070	72,330	69,490	66,700	63,680	60,390	56,910	53,060	48,800	43,980	38,340	31,610
750	……	……	……	69,610	66,880	64,270	61,260	58,200	54,840	51,170	47,080	42,420	37,110
700	……	……	……	……	66,900	64,270	61,520	58,820	55,870	52,670	49,170	45,230	40,860
650	……	……	……	……	……	……	61,550	58,860	56,260	53,480	50,440	47,070	43,400
600	……	……	……	……	……	……	……	58,980	56,270	53,660	51,020	48,470	45,010
550	……	……	……	……	……	……	……	……	……	53,810	51,040	48,470	45,800
500	……	……	……	……	……	……	……	……	……	……	……	……	45,850
450	……	……	……	……	……	……	……	……	……	……	……	……	45,870
400	……	……	……	……	……	……	……	……	……	……	……	……	……
350	……	……	……	……	……	……	……	……	……	……	……	……	……
300	……	……	……	……	……	……	……	……	……	……	……	……	……
250	……	……	……	……	……	……	……	……	……	……	……	……	……
200	……	……	……	……	……	……	……	……	……	……	……	……	……
175	……	……	……	……	……	……	……	……	……	……	……	……	……
150	……	……	……	……	……	……	……	……	……	……	……	……	……
110	……	……	……	……	……	……	……	……	……	……	……	……	……
100	……	……	……	……	……	……	……	……	……	……	……	……	……
85	……	……	……	……	……	……	……	……	……	……	……	……	……
75	……	……	……	……	……	……	……	……	……	……	……	……	……
60	……	……	……	……	……	……	……	……	……	……	……	……	……
50	……	……	……	……	……	……	……	……	……	……	……	……	……
40	……	……	……	……	……	……	……	……	……	……	……	……	……
30	……	……	……	……	……	……	……	……	……	……	……	……	……
25	……	……	……	……	……	……	……	……	……	……	……	……	……
15	……	……	……	……	……	……	……	……	……	……	……	……	……
10	……	……	……	……	……	……	……	……	……	……	……	……	……
5	……	……	……	……	……	……	……	……	……	……	……	……	……

Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.

TABLE S2.3M-a

CAPACITY OF SATURATED STEAM, IN KG/HR, PER MM^2 OF PIPE AREA

Outlet Pressure, MPa	pressure reducing valve inlet pressure, MPa																
	10.25	10.00	9.75	9.5	9.25	9.00	8.75	8.5	8.25	8.00	7.75	7.50	7.25	7.00	6.75	6.50	6.25
6.75	53.44	51.68	49.82	47.85	45.77	43.63	41.28	38.73	36.01	33.09	29.47	25.37	20.89	......	......	......	......
6.50	53.87	52.23	50.52	48.69	46.79	44.83	42.69	40.40	37.95	35.30	32.33	29.02	25.31	20.46	......	......	......
6.25	54.07	52.55	50.96	49.27	47.51	45.71	43.75	41.67	39.46	37.08	34.46	31.59	28.43	24.45	19.36	......	......
6.00	54.15	52.67	51.19	49.62	47.99	46.33	44.53	42.63	40.62	38.74	36.12	33.59	30.83	27.53	23.13	17.64	......
5.75	54.19	52.74	51.32	49.85	48.33	45.80	45.14	43.40	41.56	39.62	37.51	35.25	32.82	30.04	26.20	21.90	18.76
5.50	54.20	52.78	49.97	69610	48.53	47.11	45.60	44.00	42.32	40.55	38.56	36.63	34.48	32.05	29.37	26.41	23.01
5.25	......	......	......	50.00	48.60	47.20	45.82	44.35	42.78	41.17	39.44	37.62	35.68	33.52	31.16	28.59	25.72
5.00	......	......	......	50.01	48.62	47.23	45.89	44.49	43.02	41.55	39.98	38.33	36.57	34.64	32.56	30.01	27.84
4.75	......	......	......	......	......	47.24	......	44.52	43.13	41.75	40.31	38.81	37.22	35.50	33.64	31.66	29.51
4.50	......	......	......	......	......	......	......	44.53	43.14	41.77	40.43	39.08	37.63	36.07	34.41	32.65	30.76
4.25	......	......	......	......	......	......	......	......	43.15	41.82	40.46	39.10	37.74	36.33	34.90	33.39	31.60
4.00	......	......	......	......	......	......	......	......	......	41.84	40.48	39.12	37.82	36.45	35.12	33.76	32.15
3.75	......	......	......	......	......	......	......	......	......	......	......	39.14	37.88	36.48	35.13	33.81	32.45
3.50	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	32.47
3.25	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	32.48
3.00	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......

Where capacities are not shown for inlet and outlet conditions, use the highest capacity shown under the applicable inlet pressure column.

SUPPL. 2