(b) Cases to Which Rules Are Applicable. These rules apply only to cases where the axis of the outlet intersects and is perpendicular to the axis of the run.

(c) Nomenclature. The notation used herein is illustrated in Figure NC-3643.4(a)-1. All dimensions are in inches.

\[

d = \text{outside diameter of branch pipe} \\
D_c = \text{corroded internal diameter of run (DN 150)} \\
D_o = \text{corroded internal diameter of run (0.10 + tmh mm) measured at the level of the outside surface of the run} \\
h_o = \text{height of the extruded lip, in. (mm): this must be equal to or greater than } r_o \text{ except as permitted in (d)(4).} \\
L = \text{height of reinforcement zone } \\
r_1 = \frac{h_o}{2} \\
r_o = \text{radius of curvature of external contoured portion of outlet measured in the place containing the axes of the run and branch; this is subject to the limitations given in (d) below} \\
T_b = \text{actual thickness of branch wall not including corrosion allowance} \\
t_b = \text{required thickness of branch pipe according to wall thickness eq. NC-3641.1(3) or eq. NC-3641.1[5], but not including any thickness for corrosion} \\
T_o = \text{corroded finished thickness of extruded outlet measured at a height equal to } r_o \text{ above the outside surface of the run} \\
T_r = \text{actual thickness of run wall, not including the corrosion allowance} \\
t_r = \text{required thickness of the run according to eq. NC-3641.1(3) or eq. NC-3641.1(4), but not including any allowance for corrosion} \\
K = 0.6 + 2d/D \\
D = \text{outside diameter of run} \\
d = \text{outside diameter of branch pipe} \\
d_c = \text{corroded internal diameter of run} \\
d_o = \text{corroded internal diameter of extruded outlet measured at the level of the outside surface of the run} \\
K = 0.6 + 2d/D
\]

(d) Radii

(1) The minimum radius shall not be less than 0.05d, except that on branch diameters larger than 30 in. (750 mm) it need not exceed 1 1/2 in. (38 mm).

(2) The maximum radius for outlet pipe sizes NPS 6 (DN 150) and larger shall not exceed 0.10d + 0.50 in. (0.10d + 13 mm). For outlet pipe sizes less than NPS 6 (DN 150), this dimension shall be not greater than 1 1/4 in. (32 mm).

(3) When the external contour contains more than one radius, the radius of any arc sector of approximately 45 deg shall meet the requirements of (1) and (2) above.

(4) Machining shall not be employed in order to meet the above requirements.

(e) Required Area. The required area is defined as

\[
A = K(t_r \times D_o) \\
K = 0.6 + 2d/D
\]

where K shall be taken as follows:

(1) for \(d/D\) greater than 0.60, \(K = 1.00\) for \(d/D\) greater than 0.15 and not exceeding 0.60, \(K = 0.6 + 2d/D\) for \(d/D\) equal to or less than 0.15, \(K = 0.70\)

(f) Reinforcement Area. The reinforcement area shall be the sum of areas \(A_1 + A_2 + A_3\) as defined in (1), (2), and (3) below.

(1) Area \(A_1\) is the area lying within the reinforcement zone resulting from any excess thickness available in the run wall:

\[
A_1 = D_o(T_r - t_r)
\]

(2) Area \(A_2\) is the area lying within the reinforcement zone resulting from any excess thickness available in the branch pipe wall:

\[
A_2 = 2L(T_b - t_b)
\]

(3) Area \(A_3\) is the area lying within the reinforcement zone resulting from excess thickness available in the extruded outlet lip:

\[
A_3 = 2t_o(T_o - t_o)
\]

(g) Reinforcement of Multiple Openings. When any two or more adjacent openings are so closely spaced that the reinforcement zones overlap, the two or more openings shall be reinforced in accordance with NC-3643.4, with a combined reinforcement that has a strength equal to the combined strength of the reinforcement that would be required for separate openings. No portion of the cross section shall be considered as applying to more than one opening or be evaluated more than once in a combined area.

(h) Marking. In addition to the above, the Certificate Holder shall be responsible for establishing and marking on the section containing extruded outlets, the Design Pressure and Temperature, and the Certificate Holder’s name or trademark.

NC-3643.5 Branch Connections Subject to External Pressure.

(a) The reinforcement area required for branch connections subject to external pressure shall be \(0.54 \times (t_m h) \times (d_1) \times (2 - \sin \alpha)\). All terms as defined in NC-3643.3(c)[1], except \(t_m h\), is the minimum required wall thickness as determined by NC-3641.2.

(b) Procedures established for connections subject to internal pressure shall apply for connections subject to external pressure.

NC-3643.6 Reinforcement of Other Designs. The adequacy of designs to which the reinforcement requirements of NC-3643 cannot be applied shall be proved by burst or proof tests (NC-3649) on scale models or on full size structures, or by calculations previously substantiated by successful service of similar design.
Figure ND-3643.3(c)(1)-1
Reinforcement of Branch Connections

Required reinforcement = \( t_{mh} \) \( (d_1) (2 - \sin \alpha) \)
Reinforcement areas = \( A_1, A_2, A_3, A_4 \)

Explanation of areas:
- Required reinforcement area
- \( A_1 \) – Excess wall in header
- \( A_2 \) – Excess wall in branch
- \( A_3 \) – Fillet weld metal
- \( A_4 \) – Metal in reinforcement

GENERAL NOTES:
(a) When metal is added as reinforcement (Example B), the value of reinforcing area may be taken in the same manner in which excess header metal is considered. Typical acceptable methods of meeting the above requirement are shown in Figure ND-4244.3(d)-1.
(b) Width to height of reinforcement shall be reasonably proportioned, preferably on a ratio as close as 4 to 1 as the available horizontal space within the limits of the reinforcing zone along the run and the outside diameter of the branch will permit, but in no case may the ratio be less than 1.
(c) This Figure is to be used only for definitions of terms, not for fabrication details.
(d) Use of reinforcing saddles and pads is limited as stated in ND-3643.3(c)(7).