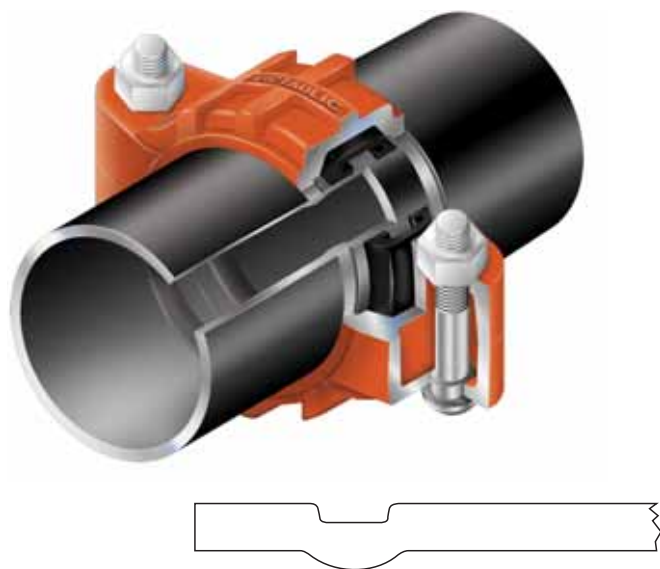


Roll Grooved Pipe Technical Data



Exaggerated for clarity

Victaulic® has been recognized as the industry leader in grooved product development and enhancement since 1925. One of the most innovative developments in the grooved piping industry has been the introduction of the roll grooving process. The roll grooving technique was developed and introduced by Victaulic in the mid-1950's. Since its inception, roll grooving has been recognized as an efficient way to groove pipe. Roll grooving also helped to promote the use of light wall steel and aluminum pipe. Later developments allowed for the expansion of the grooving method into other materials such as copper tubing, which had previously been unsuitable for cut grooving due to its thinner wall. Today, roll grooving is applicable to many pipe materials, including steel, copper, aluminum, stainless steel, PVC and copper nickel. The benefits of roll grooved pipe are verified by independent approval agencies such as Underwriters Laboratories, Inc. (UL), Factory Mutual Research Corporation (FM), Loss Prevention Council (LPC), Verband der Schadenverhütung GmbH (VdS), and many others (request publication 02.02 for a complete listing) who have supported the integrity and reliability of roll grooved pipe since the 1970's through their Listing/ Approval of it for use in fire protection systems. The acceptance of roll grooving has grown to where the percentage of standard wall pipe that gets roll grooved versus cut grooved currently exceeds 90%, based on Victaulic field observations.

ROLL GROOVING TOOLS

Victaulic designs, manufactures and sells its own roll grooving equipment, which helps to maintain strict quality standards and ample product inventory. Victaulic supplies its first grooving tools in 1945. Continued research and development has resulted in roll grooving equipment designed to optimize pipe joint performance. Victaulic Vic-Easy® roll grooving tools produce grooves to Victaulic standard dimensions, which have subsequently become industry standard dimensions, providing the optimum groove profile for superior pipe joint

performance and longevity. Victaulic is continuously working to expand the range of our roll grooving tools to handle wall thickness above the current capability of 0.375"/9.5mm and large diameter pipe above the current capability of 48"/1200mm. In addition, the Victaulic Company works with our customers to develop tools with special capabilities for unique requirements such as different piping materials, heavier walls, larger diameters and other applications.



Recent advances in roll grooving technology include Victaulic Company's exclusive introduction of patented Enhanced Tracking Roll (ETR) sets, and the Advanced Groove System (AGS). The patented features of ETR technology allow the pipe to be roll grooved without requiring the operator to "track" the pipe to prevent the pipe from "walking out" of the tool. With our patented ETR roll sets, the grooving process becomes a "hands-free" operation to allow for safer and less strenuous effort than competitive roll grooving tools. The Advanced Groove System, for 14 – 24"/350 – 600 mm pipe, is a deeper, wider wedge-shaped groove increasing coupling-to-pipe engagement. There is a single groove profile for all sizes, 14 – 24"/350 – 600 mm, created by AGS roll sets (request publication 25.09). Another exclusive innovation from Victaulic is the RX roll set series for light wall stainless steel pipe. RX roll sets are designed to increase the performance capabilities of grooved couplings on light wall stainless steel by enhancing the groove profile.

The basic principle behind the roll grooving process is that pipe can be cold formed quickly to generate a grooved end. Roll grooving is well suited to materials such as carbon steel, stainless steel, aluminum, PVC, copper and copper nickel, all of which have excellent formability characteristics. It also allows light wall pipe to be used with grooved mechanical couplings. In the roll grooving process, an internal cylindrical roll supports the pipe from the inside as an external roll applies force to the pipe O.D.

JOB OWNER

System No. _____
Location _____

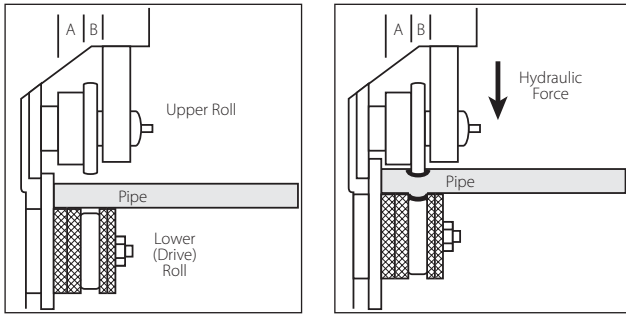
CONTRACTOR

Submitted By _____
Date _____

ENGINEER

Spec Sect _____ Para _____
Approved _____
Date _____

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No metal is removed during the roll grooving process. Instead, the pipe material at the groove is displaced inward by the cold forming operation. As a result, the roll groove operation is performed much faster than the machining operation required for cut grooving or threading. The use of messy cutting fluids and the generation of metal shavings are also eliminated. In fact, one of roll grooving's most recognized benefits is time savings. Less time to prepare the pipe for installation translates to shorter production schedules and fewer chances for construction delays. The following table shows typical times required to roll groove versus cut groove or weld a schedule 40 carbon steel pipe end.

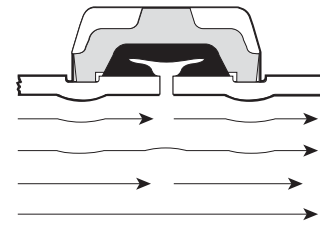
| Pipe Size | | Roll Groove | Cut Groove | Weld |
|------------------------|-------------------------------|-------------|------------|----------|
| Nominal Size Inches/mm | Actual Outside Dia. Inches/mm | Time | Time | Time * |
| 4 100 | 4.500 114.3 | 0.5 min. | 2 min. | 135 min. |
| 8 200 | 8.625 219.1 | 2 min. | 5 min. | 200 min. |
| 12 300 | 12.750 323.9 | 3 min. | 10 min. | 240 min. |
| 16 400 | 16.000 406.4 | 4 min. | 16 min. | 600 min. |

*Welding times are based on values found in Mechanical Contractors Association of America Labor Estimating Manual (Rev. 2/98); grooving times are based on typical field observations.

The rapid grooving time, inherent cleanliness and ease of grooved coupling assembly help to make Victaulic Company's roll grooved pipe joining method the ideal choice for many piping applications.

FLOW CHARACTERISTICS

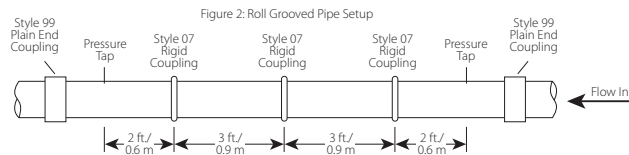
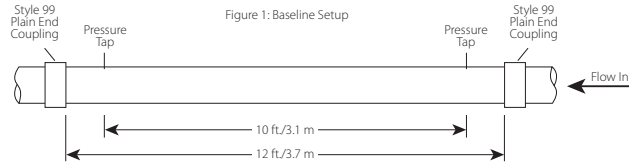
System designers typically incorporate no additional losses in the flow calculations for pipe joints in traditional joining methods. However, the slight indentation on the interior of roll grooved pipe is frequently perceived to generate flow losses. Recent flow testing conducted on pipe joints grooved with Vic-Easy roll grooving tools confirmed that roll grooved joints have excellent flow characteristics. The flow tests clearly showed that roll grooved pipe contributes insignificantly to system pressure loss. The losses are so small that they are typically negligible when compared to other pressure losses, such as those from pipe friction, valves, bends and branches.



Exaggerated for clarity

Our in-house flow tests were conducted on grooved and plain end pipe using 4"/104.8mm Type "K" copper tubing and 2 – 8"/50 – 200mm Schedules 10 and 40 carbon steel pipe. Pressure drops were measured over flow velocities of 4, 8, 12 and 16/1.2, 2.4, 3.7 and 4.9 ft./meters per second at ambient water temperature. For all tests, pressure taps were located 10/3m apart on a straight section of pipe/tube to establish a baseline measurement. A 4"/100mm Controlotron ultrasonic digital readout flow meter with calibration certified traceable to NIST (National Institute of Standards and Technology) was used to determine flow rate through the pipe/tube. Pressure readings were measured with standard U-tube mercury-over-water manometers. After pressure losses were recorded, the pipe/tube was removed and cut into four segments to allow for three roll grooved pipe joints between the pressure taps.

FLOW LOSS TEST SETUP (CARBON STEEL)



Flow velocities and the 10/3m pressure tap spacing were maintained for both carbon steel and copper. After the pressure losses were recorded, the baseline loss across plain end pipe/tubing was subtracted out. The remainder was divided by three (the number of roll grooved pipe joints). The following table provides the average loss of each grooved coupling joint in equivalent feet of pipe for each size tested.

| Pipe Size | | Friction Loss in Equivalent Feet/m of Pipe | | |
|------------------------|-------------------------------|--|--------------------------|-----------------|
| Nominal Size Inches/mm | Actual Outside Dia. Inches/mm | Schedule 10 Carbon Steel | Schedule 40 Carbon Steel | Type "K" Copper |
| 2 50 | 2.375 60.3 | 0.55 0.17 | 0.48 0.15 | — |
| 4 100 | 4.500 114.3 | 0.51 0.16 | 0.49 0.15 | 0.32 0.10 |
| 6 150 | 6.625 168.3 | 0.35 0.11 | 0.31 0.09 | — |
| 8 200 | 8.625 219.1 | 0.31 0.09 | 0.50 0.15 | — |

In addition to Victaulic Company's own flow tests, other outside agencies have verified the negligible flow losses attributed to roll grooved pipe joints. Factory Mutual Research Corporation, an independent approval agency that has Approved roll grooved pipe for fire protection

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systems since 1976, has established values to be used in hydraulic calculations which reflect the excellent flow characteristics of roll grooved pipe. Section 6-4.3.1 of Factory Mutual's Loss Prevention Data Technical Advisory Bulletin 2-8N (Rev. 2/97) stipulates one equivalent foot of pipe to be added for each roll grooved joint on any pipe size. This is conservatively higher than our actual test values, yet still relatively low compared to the values established for components such as valves and fittings. These values further attest to the low loss characteristics of roll grooved joints.

STRENGTH OF ROLL GROOVED PIPE

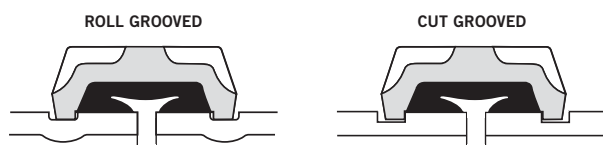
With regard to pipe end preparation, roll grooving does not compromise the integrity of the pipe joint. The inward radial displacement which occurs at the groove during the roll grooving process causes pipe material property changes comparable to similar cold forming manufacturing operations. Any potential increase in pipe hardness, reduction in tensile strength or reduction in elongation due to the roll grooving process has no effect on the pressure capability of the joint. **Most importantly, the published maximum rated pressures for Victaulic couplings on roll grooved pipe are based on actual test data and extensive field experience. Any effect that roll grooving has on the pipe material has been accounted for in our pressure ratings.**

Component performance requirements for many piping applications are dictated by standard codes relevant to the service. In order to comply with the code requirements, the piping materials must be able to maintain their published performance capabilities while in service. Victaulic couplings on roll grooved pipe have consistently met the requirements of various industry codes based on their proven performance capabilities. Such codes include ASME B31.1, Power Piping Code, ASME B31.3, Chemical Plant and Petroleum Refinery Piping Code, ASME B31.9, Building Services Code, NFPA 13, ASME A17.1, Safety Code for Elevators and Escalators, MIL standards and other industry codes.

The suitability of grooved pipe for use in piping systems is recognized in such standards as ASTM F 1476, Performance of Gasketed Mechanical Couplings for Use in Piping Applications, and ANSI/AWWA C606, Grooved and Shouldered Joints. These pipe standards have been established in recognition of the widespread use of grooved piping in air and water conveying systems, and the subsequent need for sufficient clarity in the performance and dimensional requirements of grooved joints. ANSI/AWWA C606-97 provides a definition of roll grooving in Section 4.3.3.2 and roll grooving dimensions in Table 5. ASTM F-1476 requires that grooves be provided in accordance with the grooved mechanical coupling manufacturer's published specifications.

PRESSURE PERFORMANCE CAPABILITIES

The use of roll grooved standard wall pipe maintains the coupling's full pressure handling capability. Pressure ratings are identical for both roll and cut grooved standard wall pipe joints. In-house testing to ASTM F-1476, independent laboratory tests (UL, FM, VdS, LPC, etc.) and extensive field use have verified the pressure capabilities of our grooved couplings on roll and cut grooved pipe. The independent agency Listed/Approved pressure ratings are established after extensive performance barometers which include ultimate pressure, bending moment and cyclic loading tests. The ratings have been verified by more than 40 years of successful use on roll grooved pipe.



Exaggerated for clarity

As the leader in the grooved piping product industry, Victaulic recognizes its responsibility to continuously ensure that the performance capabilities of our product line exceed their requirements. Every new coupling design and modification is performance tested to confirm the design integrity. We have performed thousands of hydrostatic and bending moment tests on our couplings installed on both cut and roll grooved pipe, with results that substantiate the performance capabilities of our products with either of the two grooving methods. While the actual test results are proprietary, ultimate hydrostatic pressures for any given size coupling on roll or cut grooved standard wall pipe typically differ by less than 5%. The similar performance of our products on cut or roll grooved standard wall pipe can most easily be explained as a balance between removing pipe material but maintaining a "square" groove (cut grooving) and maintaining the full pipe material but producing a groove with radiused corners and slight tapers on the side walls (roll grooving). Consequently, Victaulic publishes identical pressure ratings for any given coupling on standard wall grooved pipe, regardless of whether the pipe is roll grooved or cut grooved.

The only performance difference between roll and cut grooved pipe is the amount of angular deflection and linear movement available when joining with a Victaulic flexible coupling. Flexible couplings installed on roll grooved pipe provide half the angular deflection and linear movement of identical couplings installed on cut grooved pipe. This is due to the roll groove profile which incorporates radii at the base of the groove to minimize stresses imparted during the cold forming operation. When more flexibility is required in a roll grooved pipe system beyond what can be provided by a flexible coupling on roll grooved pipe, then alternate means to provide the flexibility should be considered (request 26.02).

CONCLUSION

The Victaulic roll grooving method offers a clean, fast method for grooving standard wall and light wall carbon steel, stainless steel, aluminum, PVC, copper and copper nickel tubing and pipe. This has helped roll grooving to become the standard method for pipe end preparation in grooved pipe systems, with more than 90% of standard wall pipe being roll grooved instead of cut grooved. The construction scheduling time-saving benefits and inherent cleanliness are complemented by excellent pressure handling performance once installed. Moreover, decades of field-proven success on millions of roll grooved pipe joints around the world fully demonstrate its integrity for use in grooved piping systems.

All products to be installed in accordance with current Victaulic installation/assembly instructions. Victaulic reserves the right to change product specifications, designs and standard equipment without notice and without incurring obligations.

Roll Grooved Pipe Technical Data

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