COMPONENT & INDUSTRIAL INNOVATION

BRYANT Products, Inc.

MEASURING ROLLER RUNOUT WHEN BUILT FROM WELDED TUBING

There are various methods and descriptions used in measuring roller run-out. Many of these "slang" methods are incorrect.

The measurement and drafting techniques that Bryant incorporates are based on the **ANSI Y14.5** standard for Geometric Dimensioning and Tolerancing - GD&T.

In order to correctly dimension and measure a mild steel or stainless steel roller, the following material descriptions and options must be understood that are derived from the **ASTM A513** Tubing Standards:

- 8.5 Straightness
  - The straightness tolerance for round tubing is .030/3ft lengths to 8.000 in. outside diameter.

- 8.6 Ovality (Hot and cold rolled steel)
  - The ovality shall be within tolerances (Table 4) except when wall thickness is *less than 3% of outside diameter*.

- 8.6.1 Ovality: Tubing types 1 and 2
  - In such cases for Type 1 and 2 the ovality *may be 50% greater than the outside tolerances* but the mean outside diameter shall be within the specified tolerance.

- 8.6.2 Ovality: Tubing types 3, 4, 5, and 6
  - For types 3, 4, 5, and 6 the additional ovality shall be per Table 5, but the mean outside diameter shall be within specified tolerance.

- 12.1 Condition:
  - The types and conditions of tubing covered by this specification are:

Type 1	AWHR	"as-welded" from hot rolled steel
Type 2	AWCR	"as-welded" from cold-rolled steel
Type 3	SDHR	"sink-drawn" hot-rolled steel
Type 4	SDCR	"sink-drawn" cold-rolled steel
Type 5	MD	mandrel drawn (DOM)
Type 6	SSID	special smooth inside diameter

TABLE 4 Diameter Tolerances for Type I (A.W.H.R.) Round Tubing

NOTE 1—Measurements for diameter are to be taken at least 2 in.[I] from the ends of the tubes.

Outside Diameter Range, in.[A]	Wall Thickness		Flash-in-Tubing[B,C]	Flash Controlled to 0.010 in. max Tubing[C,D]	Flash Controlled to 0.005 in. max Tubing[E,D]	
	Bwg[F]	in.[A]	Outside Diameter, ±	Outside Diameter, ±	Outside Diameter, ±	Inside Diameter, ±
			Tolerances, in.[A,G]			
½ to 1⅛, incl	16 to 10	0.065 to 0.134	0.0035	0.0035	0.0035	0.020
Over 1⅛ to 2, incl	16 to 14	0.065 to 0.083	0.005	0.005	0.005	0.021
Over 1⅛ to 2, incl	13 to 7	0.095 to 0.180	0.005	0.005	0.005	0.025
Over 1⅛ to 2, incl	6 to 5	0.203 to 0.220	0.005	0.005	0.005	0.029
Over 1⅛ to 2, incl	4 to 3	0.238 to 0.259	0.005	0.005	0.005	0.039
Over 2 to 2½, incl	16 to 14	0.065 to 0.083	0.006	0.006	0.006	0.022
Over 2 to 2½, incl	13 to 5	0.095 to 0.220	0.006	0.006	0.006	0.024
Over 2 to 2½, incl	4 to 3	0.238 to 0.259	0.006	0.006	0.006	0.040
Over 2½ to 3, incl	16 to 14	0.065 to 0.083	0.008	0.008	0.008	0.024
Over 2½ to 3, incl	13 to 5	0.095 to 0.220	0.008	0.008	0.008	0.026
Over 2½ to 3, incl	4 to 3	0.238 to 0.259	0.008	0.008	0.008	0.040
Over 2½ to 3, incl	2 to 0.320	0.284 to 0.320	0.010	0.010	0.010	0.048
Over 3 to 3½, incl	16 to 14	0.065 to 0.083	0.009	0.009	0.009	0.025
Over 3 to 3½, incl	13 to 5	0.095 to 0.220	0.009	0.009	0.009	0.027
Over 3 to 3½, incl	4 to 3	0.238 to 0.259	0.009	0.009	0.009	0.043
Over 3 to 3½, incl	2 to 0.360	0.284 to 0.360	0.012	0.012	0.012	0.050
Over 3½ to 4, incl	16 to 14	0.065 to 0.083	0.010	0.010	0.010	0.026
Over 3½ to 4, incl	13 to 5	0.095 to 0.220	0.010	0.010	0.010	0.028
Over 3½ to 4, incl	4 to 3	0.238 to 0.259	0.010	0.010	0.010	0.044
Over 3½ to 4, incl	2 to 0.500	0.284 to 0.500	0.015	0.015	0.015	0.053
Over 4 to 5, incl	16 to 14	0.065 to 0.083	0.020	0.020	0.020	0.036
Over 4 to 5, incl	13 to 5	0.095 to 0.220	0.020	0.020	0.020	0.045
Over 4 to 5, incl	4 to 3	0.238 to 0.259	0.020	0.020	0.020	0.054
Over 4 to 5, incl	2 to 0.500	0.284 to 0.500	0.020	0.020	0.020	0.058
Over 5 to 6, incl	16 to 10	0.065 to 0.134	0.020	0.020	0.020	0.036
Over 5 to 6, incl	9 to 5	0.148 to 0.220	0.020	0.020	0.020	0.040
Over 5 to 6 incl	4 to 3	0.238 to 0.259	0.020	0.020	0.020	0.054
Over 5 to 6, incl	2 to 0.500	0.284 to 0.500	0.020	0.020	0.020	0.058
Over 6 to 8, incl	11 to 10	0.120 to 0.134	0.025	0.025	0.025	0.043
Over 6 to 8, incl	9 to 5	0.148 to 0.220	0.025	0.025	0.025	0.045
Over 6 to 8, incl	4 to 3	0.238 to 0.259	0.025	0.025	0.025	0.059
Over 6 to 8, incl	2 to 0.500	0.284 to 0.500	0.025	0.025	0.025	0.063
Over 8 to 10, incl	14 to 12	0.083 to 0.109	0.030	0.030	0.030	0.041
Over 8 to 10, incl	11 to 10	0.120 to 0.134	0.030	0.030	0.030	0.043
Over 8 to 10, incl	9 to 5	0.148 to 0.220	0.030	0.030	0.030	0.045
Over 8 to 10, incl	4 to 3	0.238 to 0.259	0.030	0.030	0.030	0.059
Over 8 to 10, incl	2 to 0.500	0.248 to 0.500	0.030	0.030	0.030	0.063
Over 10 to 12, incl	14 to 12	0.083 to 0.109	0.035	0.035	0.035	0.041
Over 10 to 12, incl	11 to 10	0.120 to 0.134	0.035	0.035	0.035	0.043
Over 10 to 12, incl	9 to 5	0.148 to 0.220	0.035	0.035	0.035	0.045
Over 10 to 12, incl	4 to 3	0.238 to 0.259	0.035	0.035	0.035	0.059
Over 10 to 12, incl	2 to 0.500	0.284 to 0.500	0.035	0.035	0.035	0.063

[A] 1 in. = 25.4 mm.

[B] Flash-in-Tubing is produced only to outside diameter tolerances and wall thickness tolerances and the inside diameter welding flash does not exceed the wall thickness or ⅛ in., whichever is less.

[C] Flash Controlled to 0.010 in. maximum tubing consists of tubing which is commonly produced only to outside diameter tolerances and wall thickness tolerances, in which the height of the remaining welding flash is controlled not to exceed 0.010 in.

[D] No Flash tubing is further processed for closer tolerances with mandrel-tubing produced to outside diameter and wall, inside diameter and wall, or outside diameter and inside diameter to tolerances with no dimensional indication of inside diameter flash. This condition is available in Types 5 and 6.

[E] Flash Controlled to 0.005 in. maximum tubing is produced to outside diameters and wall thickness tolerance, inside diameter and wall thickness tolerances, or outside diameters and inside diameter tolerances, in which the height of the remaining flash is controlled not to exceed 0.005 in. Any remaining flash is considered to be part of the applicable inside diameter tolerances.

[F] Birmingham Wire Gage.

[G] The ovality shall be within the above tolerances except when the wall thickness is less than 3 % of the outside diameter, in such cases see 8.6.1.

TABLE 5 Diameter Tolerances for Types 3, 4, 5, and 6 (S.D.H.R, S.D.C.R., M.D., and S.S.I.D) Round Tubing

NOTE 1 - Measurements for diameter are to be taken at least 2 in. from the ends of the tubes.

OD Size Range[A]	Wall % of OD	Types 3, 4, (Sink Drawn)[A,B] and 5, 6, (Mandrel Drawn)[B,C] OD, In.		Types 5 and 6 (Mandrel Drawn)[B,C,D] ID in.	
		Over	Under	Over	Under
Up to 0.499	all	0.004	0.000	. . .	. . .
0.500 to 1.699	all	0.005	0.000	0.000	0.005
1.700 to 2.099	all	0.006	0.000	0.000	0.006
2.100 to 2.499	all	0.007	0.000	0.000	0.007
2.500 to 2.899	all	0.008	0.000	0.000	0.008
2.900 to 3.299	all	0.009	0.000	0.000	0.009
3.300 to 3.699	all	0.010	0.000	0.000	0.010
3.700 to 4.099	all	0.011	0.000	0.000	0.011
4.100 to 4.499	all	0.012	0.000	0.000	0.012
4.500 to 4.899	all	0.013	0.000	0.000	0.013
4.900 to 5.299	all	0.014	0.000	0.000	0.014
5.300 to 5.549	all	0.015	0.000	0.000	0.015
5.550 to 5.999	under 6	0.010	0.010	0.010	0.010
	6 and over	0.009	0.009	0.009	0.009
6.000 to 6.499	under 6	0.013	0.013	0.013	0.013
	6 and over	0.010	0.010	0.010	0.010
6.500 to 6.999	under 6	0.015	0.015	0.015	0.015
	6 and over	0.012	0.012	0.012	0.012
7.000 to 7.499	under 6	0.018	0.018	0.018	0.018
	6 and over	0.013	0.013	0.013	0.013
7.500 to 7.999	under 6	0.020	0.020	0.020	0.020
	6 and over	0.015	0.015	0.015	0.015
8.000 to 8.499	under 6	0.023	0.023	0.023	0.023
	6 and over	0.016	0.016	0.016	0.016
8.500 to 8.999	under 6	0.025	0.025	0.025	0.025
	6 and over	0.017	0.017	0.017	0.017
9.000 to 9.499	under 6	0.028	0.028	0.028	0.028
	6 and over	0.019	0.019	0.019	0.019
9.500 to 9.999	under 6	0.030	0.030	0.030	0.030
	6 and over	0.020	0.020	0.020	0.020
10.000 to 10.999	all	0.034	0.034	0.034	0.034
11.000 to 11.999	all	0.035	0.035	0.035	0.035
12.000 to 12.999	all	0.036	0.036	0.036	0.036
13.000 to 13.999	all	0.037	0.037	0.037	0.037
14.000 to 14.999	all	0.038	0.038	0.038	0.038

[A] Tubing, flash in or flash controlled which is further processed without mandrel to obtain tolerances closer than those shown in Tables 4 and 8.

[B] The ovality shall be within the above toleranes except when the wall thickness is less than 3% of the outside diameter. In such cases see 8.6.2.

[C] Tubing produced to outside diameter and wall thickness, or inside diameter and wall thickness, or outside diameter and inside diameter, with mandrel to obtain tolerances closer than those shown in Tables 4 and 8 and no dimensional indication of inside diameter flash.

[D] Where the ellipsis (. . .) appears in this table, the tolerance is not addressed.

Outside Diameter, in. (mm)	Additional Ovality Tolerance, in. (mm)
UP to 2 (50.8), Incl	0.010 (0.25)
Over 2 to 3 (50.8 to 76.2), incl	0.015 (0.38)
Over 3 to 4 (76.2 to 101.6), incl	0.020 (0.51)
Over 4 to 5 (101.6 to 127.0), incl	0.025 (0.64)
Over 5 to 6 (127.0 to 152.4), incl	0.030 (0.76)
Over 6 to 7 (152.4 to 177.8), incl	0.035 (0.89)
Over 7 to 8 (177.8 to 203.2), incl	0.040 (1.02)
Over 8 to 9 (203.2 to 228.6), incl	0.045 (1.14)
Over 9 to 10 (228.6 to 254.0), incl	0.050 (1.27)
Over 10 to 11 (254.0 to 279.4), incl	0.055 (1.40)
Over 11 to 12 (279.4 to 304.8), incl	0.060 (1.52)
Over 12 to 12.500 (304.8 to 317.5), incl	0.065 (1.65)

With the above standards listed, the following simplified roller and tubing assembly will be described and how it is measured:

- **What is Straightness of tubing**?
  Lay a 3 foot piece of tubing on a surface plate and rotate - the gap under the center of the tube is the "out of straightness"

- **What is Ovality?** Ovality is commonly referred to as "out of round". Measure over the OD with a vernier caliper or micrometer in 2 spots, 90 degrees from each other. The difference will be ovality or "out of round".

- **What is Runout?** Runout is a term that includes two characteristics:
  - Circular Runout - this runout typically occurs at only specified locations at the ends of the rollers
  - Total Runout - total runout is measured across the entire tube surface and includes all tube imperfection. See diagrams 1 and 2 for illustration.

  A common slang for both runouts is TIR (total Indicator Reading). When correctly measured using diagram 1 and 2, runout incorporates ovality and straightness.

The typical commercially available tubing types that rollers are built from are:

- Type 5 - drawn over mandrel ID (DOM)
- Types 1 and 2 (hot rolled (HR) and cold rolled (CR) only)

The DOM (CR/HR) tubing is sized on the ID and typically offers the straightest tubing and most consistent wall thickness. CR is more expensive than HR due to extra processing. The HR tubing is least expensive and has a wide range of wall thickness variation and higher straightness. It is used for cost.

When using an unmachined OD tube blank to make a roller use the incorporated spreadsheet labeled Bryant Gypsum Roll SpecificatoinsStandard to calculate and understand the interrelationships for determining runout/TIR.

Diagram 1

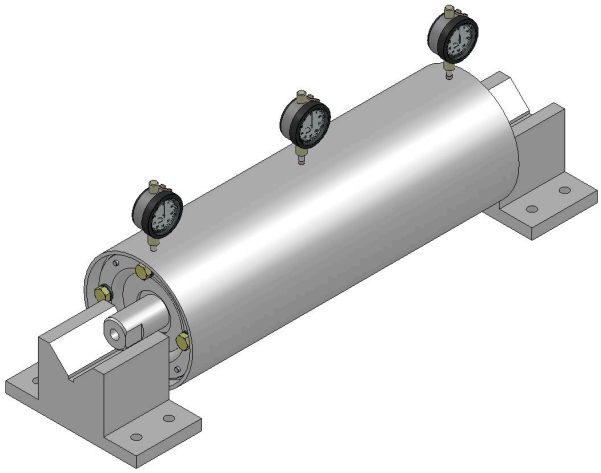
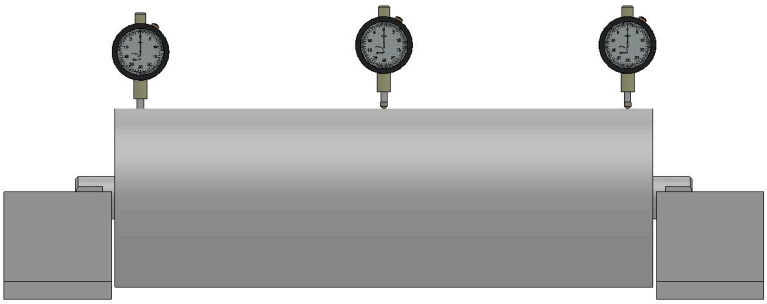


Diagram 2



Gypsum Roll Specifications:Bryant Standards
(Typical wall thickness of .095 to .220)

ASTM A513(DOM)				Length of Part in Inches	Straightness for Part
	Section 8.5 Straightness	Specification	Spec/Foot		
Less Than 8 Inch		.030/3 feet	0.010	114	0.095
	Bryant bores both ends-1/2 tolerance			**Bryant Spec**	0.048
ASTM A513(DOM)					
Type 5	**Section 8.6 Ovality**	Specification			
3.500 OD		0.010			
4.500 OD		0.013			
6.000 OD		0.026			
DOM total tolerance (Bryant)				**3.5 OD**	**0.058**
				4.5 OD	**0.061**
				6.0 OD	**0.074**
DOM total tolerance ASTM A513				**3.5 OD**	**0.105**
				4.5 OD	**0.108**
				6.0 OD	**0.121**

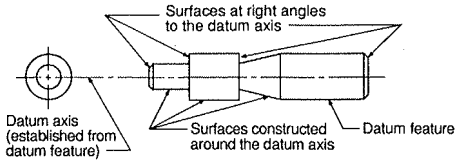
ASTM A513(Hot Rolled)				Length of Part in Inches	Straightness for Part
	Section 8.5 Straightness	Specification	Spec/Foot		
Less Than 8 Inch		.030/3 feet	0.010	114	0.095
	Bryant bores both ends-1/2 tolerance			**Bryant Spec**	0.048
ASTM A513(Hot Rolled)					
Type1&2	**Section 8.6 Ovality**	Specification			
3.500 OD		0.020			
4.500 OD		0.040			
6.000 OD		0.050			
HR A513 total tolerance (Bryant)				**3.5 OD**	**0.068**
				4.5 OD	**0.088**
				6.0 OD	**0.098**
HR A513 total tolerance ASTM A513				**3.5 OD**	**0.115**
				4.5 OD	**0.135**
				4.5 OD	**0.145**

Geometric Dimensioning and Tolerancing Symbols and Definitions

RUNOUT

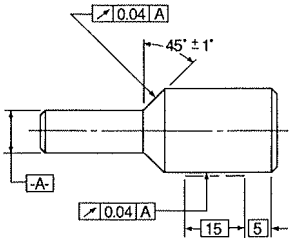
CIRCULAR RUNOUT

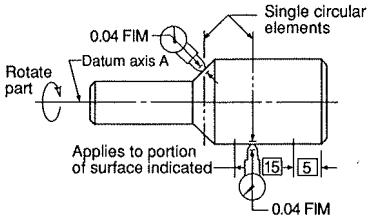
Runout is a composite tolerance used to control the relationship of one or more features to a datum axis. The illustration shows the types of features that can be controlled by runout tolerances.



Circular runout provides control of circular elements of a surface. It can be used to control the cumulative variations of circularity (roundness) and coaxiality.

In the example shown, each circular element of the surfaces toleranced must fall within 0.04mm (Full Indicator Movement) when the part is rotated 360° about the datum axis.

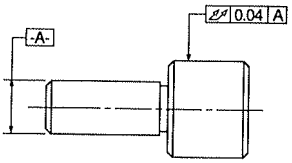




TOTAL RUNOUT

Total runout provides composite control of all surface elements. For surfaces around a datum axis this includes:

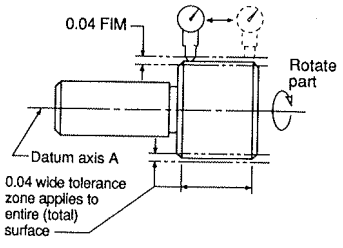
- Circularity (Roundness)
- Straightness
- Coaxiality
- Angularity
- Taper
- Profile of a Surface



For surfaces perpendicular to a datum axis it includes:

- Perpendicularity
- Flatness

In the example shown, the entire surface must lie within the 0.04mm wide (Full Indicator Movement) tolerance zone when the part is rotated 360° about the datum axis.

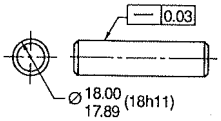


GEOMETRIC CHARACTERISTIC SYMBOLS

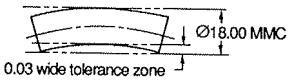
	TYPE OF TOLERANCE	CHARACTERISTIC	SYMBOL (ANSI)	MMIV
FOR INDIVIDUAL FEATURES	FORM	STRAIGHTNESS	—	
		FLATNESS	▱	
		CIRCULARITY (ROUNDNESS)	○	
		CYLINDRICITY	⌭	
FOR INDIV. OR RELATED FEATURES	PROFILE	PROFILE OF A LINE	⌒	
		PROFILE OF A SURFACE	⌓	
FOR RELATED FEATURES	ORIENTATION	ANGULARITY	∠	
		PERPENDICULARITY	⊥	
		PARALLELISM	//	
	LOCATION	POSITION	⌖	
		CONCENTRICITY	◎	
	RUNOUT	CIRCULAR RUNOUT	↗	
		TOTAL RUNOUT	⌰	

STRAIGHTNESS

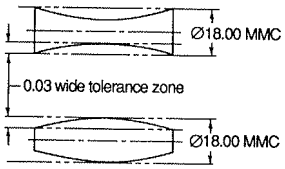
Straightness is the condition where all the points on a surface or an axis are in a straight line. A straightness tolerance specifies a zone within which the surface or axis must lie. In the example the zone is bounded by two parallel lines 0.03mm apart.



⌀0.03 When a diameter symbol is added to the tolerance the derived axis of the feature must lie within a cylindrical tolerance zone of 0.03mm diameter.



⌀0.03 Ⓜ When a modifier Ⓜ is added, the tolerance zone is 0.03 diameter at 18mm diameter and the zone increases as the feature decreases from MMC.



ROUNDNESS

Roundness or Circularity is the condition where all the points on a surface are in a circle. Roundness tolerance specifies a zone bounded by 2 concentric circles within which the measured surface must lie.

In the example shown each circular element must lie between 2 concentric circles, one having a radius 0.05mm larger than the other. Each circular element of the surface must also be within the specified limits of size.