Asset Lifecycle – Guidance Note

Spot facing of flanges

Purpose

This Guidance Note aims to provide clarity on the requirement for spot facing of cast flanges.

Section 13.4: Flanges of Watercare's *Material Supply Standard (M.S.S.)* currently specifies that "*spot facing is required on the back of all cast flanges to allow correct seating of the washers*".

This is also documented in the procurement schedules for various valves, however Section 13.2.1 of M.S.S.: *Gate valves 50mm diameter and greater*, the procurement schedule indicates that spot facing may be optional and allows for design / supplier input.

***Table 1**: Extract from procurement schedule in Section 13.2.1 of Watercare's Material Supply Standard*

Minimum standard required	Design specific requirements	Supplier submission
Flange spot facing required (y/n)		

The requirement for spot facing has subsequently been queried by many suppliers and designers, questioning whether or not this is applicable and required for all flanges, i.e. flanges welded to pipes and flanges on cast valves. It also raises further concerns:

- Potential inconsistency enforcing this on projects, i.e. is this specified by designers, procured correctly and checked by project engineers during construction.
- Is there a distinction between critical and non-critical assets?

It is understood that currently valves procured from suppliers do NOT include spot facing and therefore rely on casting quality and tolerances. Most notably, network sized valves (Figure 1) are generally not spot faced and are stocked and readily available.

***Figure 1**: Network gate valve without spot facing.*

References

Watercare

- **MS:** Material Supply Standard

Other

- **AS 2129**: Flanges for pipes, valves and fittings
- **AS 4331.1 / ISO 7005**: Metallic Flanges Part 1: Steel Flanges
- **AS 4795.2**: Butterfly valves for waterworks purposes – Double flanged
- **ASME B16.5**: Pipe Flanges and Flanged Fittings
- **ASME PCC-1**: Pressure boundary bolted flange joint assembly.
- **AS/NZS 4087**: Metallic flanges for waterworks purposes
- **EN1092-1**: Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part1: Steel flanges Panels.
- Manufacturers Standardization Society (MSS). 2013. Spot facing for bronze, iron, and steel flanges (MSS SP-9-2013).
- Rapid Axis. 2023. Understanding back spot facing: A comprehensive guide. https://rapidaxis.com/understanding-back-spot-facing-a-comprehensive-guide/
- Val-Matic White Paper: Valve Flanges for Waterworks Service Part 2: Construction and Installation. VM-VFWSP2/WP

Suppliers suggest this is justified by improved casting and manufacturing processes which has significantly increased the accuracy of castings. Val-Matic's White Paper: *Valve Flanges for Waterworks Service Part 2: Construction and Installation* notes the following regarding spot facing:

"The back of the flange can be back-faced (machined) or back spot-faced so that the nut and washer have a flat surface to rest against. Some utilities specify back spot-facing as a regular practice because of previous bad experiences with sloped flanges."

Note: Steel flanges are generally cut from a plate and machined and wouldn't require any spot facing.

Background

Spot facing is effectively recessing the area around a bolt hole where the washer is positioned before the bolt head is tightened against it. This is generally carried out to:

1) Account for sloped back flange surfaces and ensures the bolt bearing face (and washer) is parallel with the flange face and gasket surface, and within the allowable tolerance – this is in addition to the requirements for the flange to be flat.
2) Seat the washer into the flange limiting movement and aiding positional alignment.

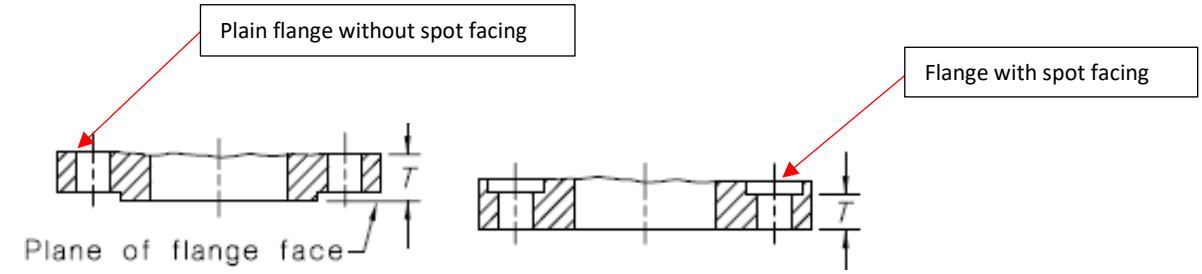

***Figure 2**: Example illustrations of flanges with and without spot facing.*

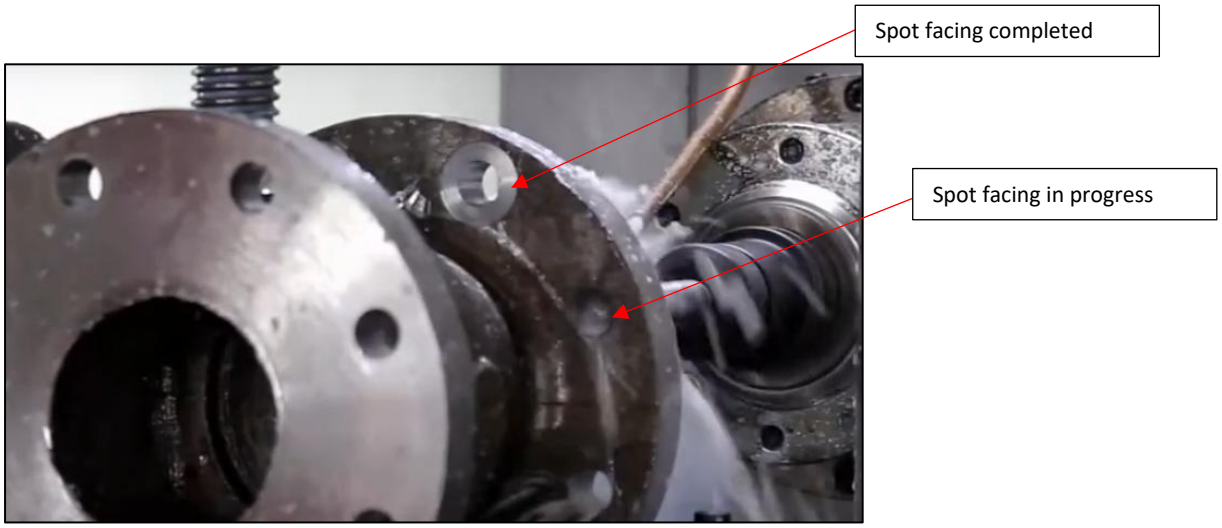

***Figure 3**: Example where spot facing is carried out on the back face of valve flanges.*

Spot facing of flanges may not be necessary where the flange surface is sufficiently flat and smooth to provide proper seating for bolt heads or nuts (whether the entire face is machined or not).

Bolt holes must be perpendicular to the flange face, allowing proper alignment and seating without additional machining.

Investigation

Most flange standards reference spot facing as well as the tolerances required when carrying out this machining process. The standards listed below are familiar to Watercare and specifies the minimum accuracy when spot facing is required. It generally stipulates that after spot facing the back and front flange surfaces should be continuously parallel within 1° - 2° depending on material.

The following section provides interpretation of each standard and the tolerance, where spot facing is required.

EN1092-1: Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part1: Steel flanges (European Standard)

5.8.2 Spot facing or back facing of flanges

"Any spot facing or back facing shall not reduce the flange thickness to less than the flange thickness specified.

When spot facing is used, the diameter shall be large enough to accommodate the outside diameter of the equivalent normal series of washers in accordance with EN ISO 887 for the bolt size being fitted. The bearing surfaces for the bolting shall be parallel to the flange face within the limits given in Table 22. When a flange is back faced a minimum fillet radius, R2 (see Figure 17) in accordance with Table 23 shall be maintained."

Table 22 *(5 of 5)*

Dimension	Flange Type	Size	Tolerance mm
Parallelism between bolting bearing surface and flange jointing faces	All types (machined bearing surface)	All DN	1°
	All types (un-machined bearing surface)		2°
a Tolerance in % from the outside diameter or respectively from the wall thickness.			
b Bore tolerance not applicable.			
c Preparation of ends see Annex A.			
d Between bolt circle and facing also as between bore diameter and facing.			

***Figure 4**: Table 22 of EN 1092-1 (Reference EN 1092-1)*

AS/NZS 4087: Metallic flanges for waterworks purposes (Australasian Standard)

"4.3 SPOT-FACING AND BACK-FACING OF FLANGES

4.3.1 Parallelism of bearing surfaces

The bearing surfaces on the flange for nuts and bolt heads shall be parallel to the flange face, with tolerances as follows:

(a) Copper alloy and steel flanges .....maximum of 1°.

(b) Grey cast iron and ductile cast iron flanges .....maximum of 2°."

AS 4331.1 / ISO 7005: Metallic Flanges Part 1: Steel Flanges (Australian Standard)

Table 20 (*concluded*)

Dimensions in millimetres

Dimension	PN	Flange type	Tolerance	Size range
Centre-to-centre of adjacent bolt holes	All	All	± 0,5	bolt sizes M14 to M24
			± 0,625	bolt sizes M27 to M33
			± 0,75	bolt sizes M36 to M52
			± 1	bolt sizes M56 to M95
			± 1,25	bolt sizes M100
Eccentricity of machined facing diameters	All	All	0,5	⩽ DN 65
			1	DN 80 up to and including DN 150
			2	DN 200 up to and including DN 500
			3	⩾ DN 600
Bolting bearing faces shall be parallel with the flange gasket surface within 1°.				
1) Small bore only.				

***Figure 5**: Table 20 of AS 4331.1 (Reference AS 4331.1)*

AS 2129: Flanges for pipes, valves and fittings (Australian Standard)

"4.6 Spot-facing and back-facing of flanges

***4.6.1 Parallelism of bearing surfaces**. The bearing surfaces on the flange for the heads of bolts and for nuts shall be parallel to the flange face with a tolerance of 1.2°.*

ASME B16.5: Pipe Flanges and Flanged Fittings (American Standard)

"6.6 Bolting Bearing Surfaces

Flanges and flanged fittings shall have bearing surfaces for bolting that are parallel to the flange face within 1 deg. Any back facing or spot facing shall not reduce the flange thickness, tf, below the dimensions given in Tables 8, 9, 11, 12, 14, 16, 18, 20, and 22 (Tables II-8, II-9, II-11, II-12, II-14, II-16, II-18, II-20, and II-22 of Mandatory Appendix II). Spot facing or back facing shall be in accordance with MSS SP-9."

Interpreting the standards above, they all suggest that when spot facing is carried out the bolt bearing surface (washer area) should be parallel to the flange face to within 1°.

Figure 6 shows where spot facing would be required on sloped flanges to rectify casting inaccuracies and provide parallel surfaces when assembling flanged components.

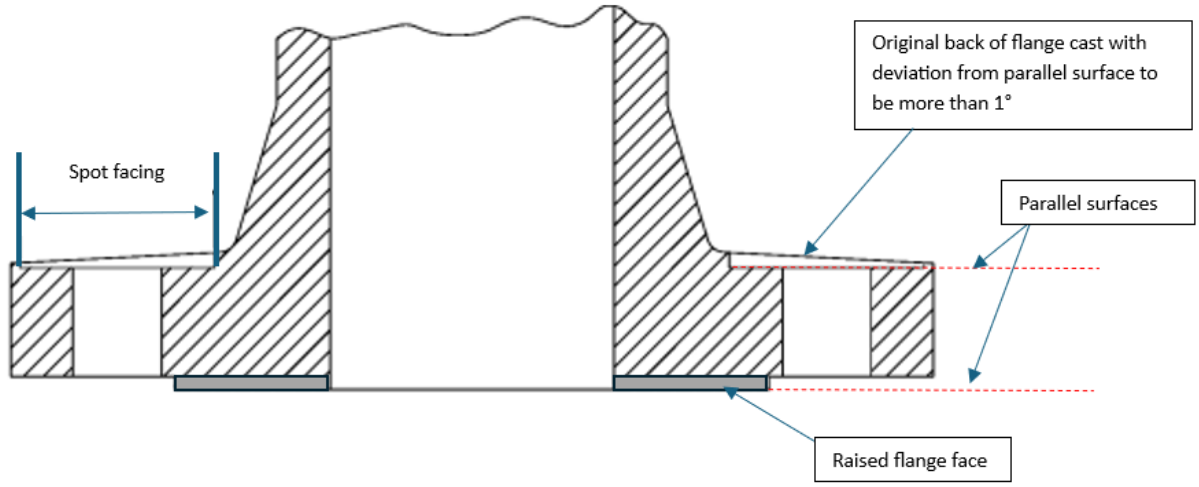

***Figure 6**: Illustration of spot facing required on non-parallel back surface. (Reference: adapted from MSS SP-9-2013)*

Several reputable international water utility providers have also been consulted to confirm their position on spot facing. From the analysis, it is evident that some utilities require spot facing regardless of flange accuracy, where others only require spot facing where the back of the flange slopes more than 2° (this would assume a ductile iron cast valve or fitting, as steel requires a more stringent 1° accuracy). This requirement aligns with AS 4795.2: Butterfly valves for waterworks purposes – Double flanged, which states:

> *"The backs of all flanges of valves rated greater than PN16 shall be machined or spot-faced if the rake angle is greater than 2°, to provide a satisfactory bearing for bolt heads and nuts."*

Conclusion

The overarching objective of spot facing on valve flanges is to ensure a flat, smooth surface for the bolt heads or nuts and washers to seat properly and achieve a secure and leak-proof connection. It also helps improve positional alignment between mating components and fitting of the washers and bolts which can reduce the risks associated with vibration (e.g. bolt shearing or loosening).

As outlined in this investigation and interpretation of the standards listed above, spot facing is generally required where the slope of the back flange falls outside of the tolerances specified, however some utilities are still insistent on spot facing regardless.

Recommended approach

Watercare requires that manufacturers demonstrate that their casting / machining process achieves the required accuracy and parallelism (≤ 1°), in which case spot facing should not be required, although a final determination is at Watercare's discretion. The necessary quality assurance testing shall be submitted to Watercare for confirmation. This can be done through an appropriate and calibrated measurement or scanning device. It is recommended that type / batch testing shall suffice to demonstrate the accuracy of the casting method used for each valve type.

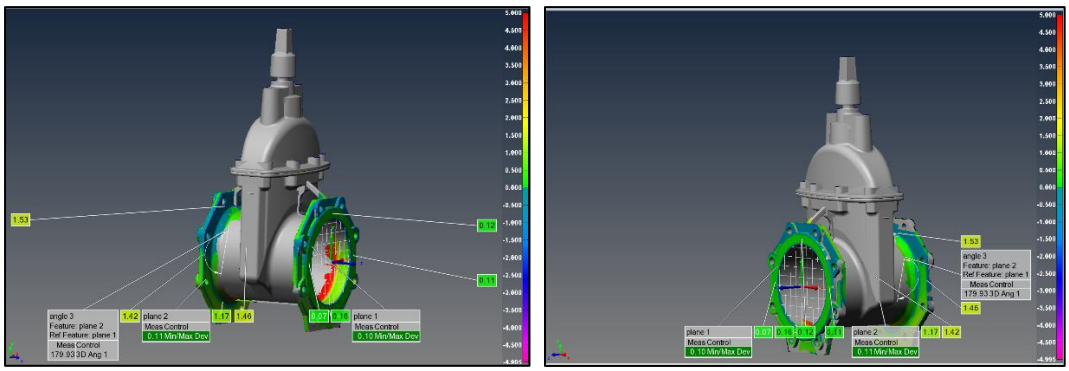

***Figure 7**: Example of scanned valve to confirm parallelism of flanges*

Alternatively, if this testing cannot be supplied, spot facing shall be carried out on all flanges to reduce any risks associated with inaccurate flange casting.

In addition, valves should be inspected on site to confirm no irregularities are present prior to preparing for the assembly.