12. Allowable Joint Deflections.

a. General.

 When it is necessary to deflect pipe from a straight line in either the horizontal or vertical plane, the amount of joint deflection shall not exceed the allowable joint deflections as shown in Tables "3", "3.1", "4", "5.0", "5.1", "5.2", "5.3" and "5.4". Figure "A" illustrates the joint deflections shown in the tables. The deflections listed in the tables are the maximum deflections allowable for WSSC pipeline designs and should not be exceeded. Assume twenty (20) foot lengths of pipe for design purposes.

b. DIP and PVC with Push-on Type Joints.

- For maximum joint deflections for full-length DIP with push-on type joints, see Table "3". The maximum deflection angles shown in Table "3" are used for design purposes and are based on eighty (80%) percent of the maximum recommended deflection for standard pipe joints that all DIP manufacturers can produce. The eighty (80%) percent value is based on AWWA C600 recommendations.
- 2) DIP manufacturers can produce pipe with larger joint deflections or special pipe joints with larger deflections. If the design requires larger deflections then those shown in Table "3", submit information for approval.

Nominal Pipe Size	Maximum Offset Based on	Design Maximum	Minimum Allowable	
Diameter	20 Foot Lengths of Pipe	Deflection Angle	Radius	
(D)	(S)	(θ)	(R)	
12-inch and under	1.39 feet	04°-00' (4.0°)	290 feet	
14-inch and over	0.83 feet	02°-24' (2.4°)	480 feet	

 TABLE ''3''

 Deflection Table - DIP Push-on Type Joints

- 3) For maximum joint deflections for full-length PVC pipe with push-on type joints on pipelines which are 12-inches and smaller in diameter, see Table "3.1". The maximum deflection angle in Table "3.1" is used for design and is based on seventy (70%) percent of the recommended deflection for standard pipe joints that most PVC manufacturers can produce.
- 4) No deflection at connection to DIP or at fittings.
- 5) Only pipe joint deflections are allowed at joint, no bending of the pipe.

Deflection Table - PVC Pipe with Push-on Joints				
Nominal Pipe Size	Maximum Offset Based on	Design Maximum	Minimum Allowable	
Diameter	20 Foot Lengths of Pipe	Deflection Angle	Radius	
(D)	(S)	(Θ)	(R)	
12-inch and under	0.48 feet	01°-24' (1.4°)	820 feet	

 TABLE ''3.1''

 Deflection Table - PVC Pipe with Push-on Join



c. DIP Mechanical Joints.

- For maximum joint deflections on full-length DIP mechanical joint pipe, see Table "4". The maximum deflection angle in Table "4" is used for design purposes and is based on eighty (80%) percent of the maximum recommended deflection set by WSSC for pipe sizes 20-inch and smaller and on AWWA C600 for 24-inch pipe. The eighty (80%) percent value is based on AWWA C600 recommendations.
- 2) Mechanical joint pipe may not be available, therefore verify the availability of Mechanical Joint Pipe with the pipe manufacturers before specifying this type of pipe in the design.

Deflection Table - DIP Mechanical Joint Pipe				
Nominal Pipe Size	Maximum Offset Based on	Design Maximum	Minimum Allowable	
Diameter	20 Foot Lengths of Pipe	Deflection Angle	Radius	
(D)	(S)	(0)	(R)	
12-inch and under	1.39 feet	04°-00' (4.0°)	290 feet	
14-inch to 20-inch	0.83 feet	02°-24' (2.4°)	480 feet	
24-inch	0.56 feet	01°-36' (1.6°)	720 feet	

TABLE "4"	
eflection Table - DIP Mechanical	loint l

d. Restrained Joint Pipe.

- 1) <u>For maximum joint deflections</u> on full length restrained joint DIP or PVC pipe, see Tables "5.0", "5.1", "5.2", "5.3", "5.4" and "5.5".
- 2) <u>The types of restrained joint pipe and fittings</u> in the tables below are the WSSC approved restrained joints (pipe or fittings) which are included in the Standard Details and the Specifications. First consider using concrete thrust blocking before specifying restrained joints, see Part Three, Section 27 (Thrust Restraint Design for Buried Piping).
- 3) Indicate on the drawings the limits of restrained joints in the Blocking Notes and on the profile.
- 4) <u>Type of restrained joints</u>:
 - a) <u>Wedge action-restraining glands</u> on DIP mechanical joint pipe.
 - (1) For maximum joint deflections for full length restrained mechanical joint pipe with wedge action restraining glands, see Table "5.0". The maximum deflection angle in Table "5.0" is used for design purposes, and is based on eighty percent (80%) of the maximum recommended deflection set by WSSC for pipe sizes 20-inch and smaller and on AWWA C-600 for 24-inch diameter pipe.
 - (2) Maximum size of wedge action restraining glands for fittings is 48-inch diameter. Mechanical joint pipe is only available in pipe sizes 24-inch and smaller diameter, therefore verify the availability of 14-inch to 24-inch Mechanical Joint Pipe with the mechanical joint pipe manufacturers before specifying in the design.
 - (3) Only use wedge action restraining glands when the total pressure (operating pressure plus surge pressure) is below the pressures in Table "5.0a".

(4) Wedge action restraining glands can only be used for DIP, see Standard Detail B/2.7.

Deflection Table - Wedge Action Restraining Glands - Mechanical Joint DIP				
Nominal Pipe Size	Maximum Offset Based on	Design Maximum	Minimum Allowable	
Diameter	20 Foot Lengths of Pipe	Deflection Angle	Radius	
(D)	(S)	(Θ)	(R)	
12-inch and under	1.39 feet	04°-00' (4.0°)	290 feet	
14-inch to 20-inch	0.83 feet	02°-24' (2.4°)	480 feet	
24-inch	0.56 feet	01°-36' (1.6°)	720 feet	

TABLE ''5.0''

TABLE "5.0a"

Maximum Total Pressure for Wedge Action Restraining Glands for DIP			
Nominal Pipe Size Diameter Total Pressure			
(D)	(Operating Pressure plus Surge Pressure)		
16-inch and smaller	350 psi		
Larger than 16-inch	250 psi		

- b) Push-on restrained joint gaskets for DIP, 24-inch and smaller diameter.
 - (1) Maximum joint deflections for full-length manufacturer's proprietary restrained joint DIP, see Table "5.1". Maximum deflection angle for design is based on eighty (80%) percent of the maximum recommended deflection angle set by WSSC for pipe sizes 24-inch and smaller in diameter.

TABLE "5.1"

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Deflection Table - Manufacturer's Proprietary Restrained Joint DIP - Push-on Restrained Joint Gaskets
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Nominal Pipe Size	Maximum Offset Based on	Design Maximum	Minimum Allowable
Diameter	20 Foot Lengths of Pipe	Deflection Angle	Radius
(D)	(S)	(θ)	(R)
12-inch and under	1.39 feet	04°-00' (4.0°)	290 feet
14-inch to 24-inch	0.83 feet	02°-24' (2.4°)	480 feet

- c) <u>Manufacturer's proprietary restrained joints for DIP</u>, 14-inch and larger diameter.
 - (1) For maximum joint deflections for full-length manufacturer's proprietary restrained joint DIP, see Table "5.2". The maximum deflection angle in Table "5.2" is used for design purposes and is based on eighty (80%) percent of the manufacturer's recommended deflection angle.
 - (2) Manufacturers produce other types of restrained pipe and fittings, which are not included in the Specifications and Standard Details. These restrained joints may be specified if approved.



Denection rable - Manufacturer's Proprietary Restrained Joint Dir			
Nominal Pipe Size	Maximum Offset Based on 20	Design Maximum	Minimum Allowable
Diameter	ameter Foot Lengths of Pipe		Radius
(D)	(S)	(Θ)	(R)
14-inch to 16-inch	0.83 feet	02°-24' (2.4°)	480 feet
18-inch to 30-inch	0.48 feet	01°-24' (1.4°)	820 feet
36-inch to 54-inch	0.14 feet	00°-24' (0.4°)	2860 feet

 TABLE ''5.2''

 Deflection Table - Manufacturer's Proprietary Restrained Joint DIP

- d) <u>Wedge action-restraining glands</u> for DIP push-on joints.
 - (1) For maximum joint deflections for full-length DIP push-on joint pipe with wedge action restraining glands, see Table "5.3". The maximum deflection angle in table "5.3" is used for design purposes and is based on eighty (80%) percent of the manufacturer's maximum recommended deflection. Check with the manufacturer for availability of this type of restrained joint system.
 - (2) Only use this restrained joint system when the total working pressure (operating pressure plus surge pressure) is below the pressures in Table "5.3a" and use only on DIP. This restrained joint system must be approved.

Deflection Table - Wedge Action Restraining Gland – DIP Push-on Joints			
Nominal Pipe Size	Maximum Offset Based on 20	Design Maximum	Minimum Allowable
Diameter	Diameter Foot Lengths of Pipe		Radius
(D)	(S)	(θ)	(R)
12-inch and under	1.39 feet	04°-00' (4.0°)	290 feet
14-inch to 48-inch	0.83 feet	02°-24' (2.4°)	480 feet

TABLE ''5.3''

TABLE "5.3a"

Maximum Total Pressure for Wedge Action Restraining Gland – DIP Push-on Joints

Nominal Pipe Size Diameter	Total Pressure	
(D)	(Operating Pressure plus Surge Pressure)	
4-inch to 16-inch	350 psi	
18-inch to 48-inch	250 psi	



- e) <u>Wedge action-restraining glands</u> on PVC Push-on pipe.
 - (1) For maximum joint deflections for full length restrained PVC push-on pipe with wedge action restraining glands, see Table "5.4". The maximum deflection angle in Table "5.4" is used for design purposes, and is based on seventy (70%) percent of the recommended deflection set by WSSC for PVC pipe sizes 12-inch and smaller diameter.

Deflection Table - Wedge Action Restraining Glands - Fusi-on FVC Fipe				
Nominal Pipe Size	Maximum Offset Based on	Design Maximum	Minimum Allowable	
Diameter	20 Foot Lengths of Pipe	Deflection Angle	Radius	
(D)	(S)	(θ)	(R)	
12-inch and under	0.48 feet	01°-24' (1.4°)	820 feet	

 TABLE
 "5.4"

 Deflection Table
 Wedge Action Postspining Glands
 Push on PVC Pina

e. D	etermining	Joint I	Deflections	and	Offset Distances.
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1) Figure "A" illustrates Formula "A" and shows the variables for determining pipeline joint deflections and offset "S" distances.



FORMULA "A"

$$R = \frac{L}{2 \tan (\Theta/2)}$$

FORMULA "B"

 $S = \sin \Theta x L$

Where:

θ	=	deflection angle	S	=	joint deflection offset (ft)
L	=	laying length (ft)	R	=	radius of curve (ft)

Note: For design purposes, the laying length (L) should be assumed as twenty (20) feet for determining the minimum allowable radius (R).

