ROTARY SHOULDERED CONNECTIONS

API 23	2-3/8 IF	2-3/8 Reg	3-1/2 H90	2-7/8 XH
API 26	2-7/8 IF	2-7/8 Reg	4 H90	3-1/2 XH
API 31	3-1/2 IF	3-1/2 Reg	4-1/2 H90	4-1/2 XH
API 35	4 IF	4-1/2 Reg	5 H90	5 XH
API 38	4-1/2 IF	5-1/2 Reg	5-1/2 H90	
API 40	5-1/2 IF	6-5/8 Reg	6-5/8 H90	3-1/2 Db SL
API 44	6-5/8 IF	7-5/8 Reg	7 H90 *1	4 Db SL
API 46		8-5/8 Reg	7 H90 *2	4-1/2 Db SL
API 50	3-1/2 FH	7-5/8 Reg LT	7-5/8 H90 *1	5-1/2 Db SL
API 56	4 FH	8-5/8 Reg LT	7-5/8 H90 *2	
API 61	4-1/2 FH		8-5/8 H90 *1	
API 70	5-1/2 FH	2-3/8 SH	8-5/8 H90 *2	
API 77	6-5/8 FH	2-7/8 SH	H90 THRD	
		3-1/2 SH	2-3/8 SL H90	
2-3/8 PAC	2-3/8 OH	4 SH	2-7/8 SL H90	
2-7/8 PAC	2-7/8 OH	4-1/2 SH	3-1/2 SL H90	

CLICK ON CONNECTION TO VIEW. CLICK ON CONNECTION LABEL IN UPPER LEFT CORNER TO RETURN TO THIS MENU

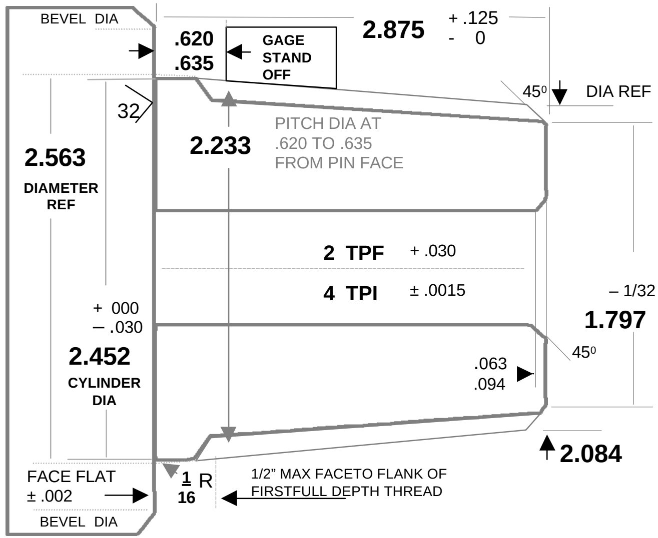
CONNECTION DIMENSIONS

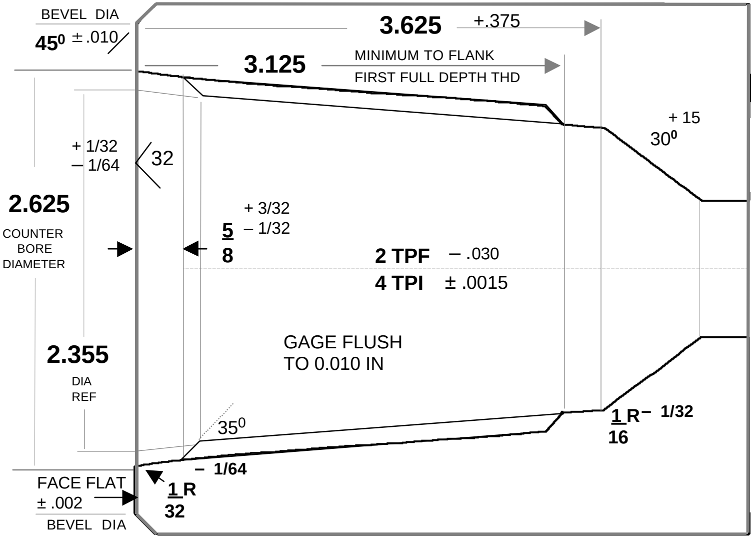
API 23

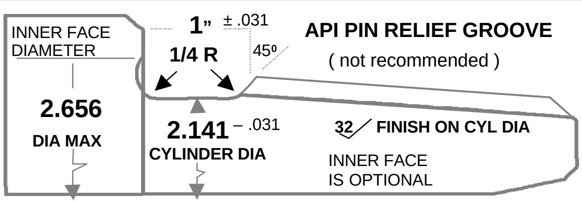
COMMON O.D AND BEVELS (± 1/64)

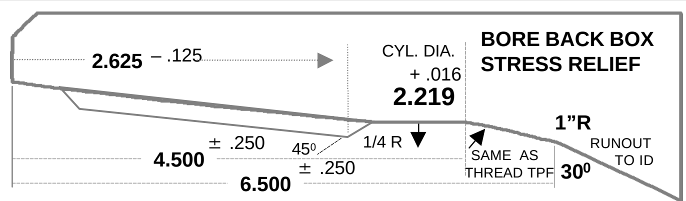
OD BEV	3-1/8 3								

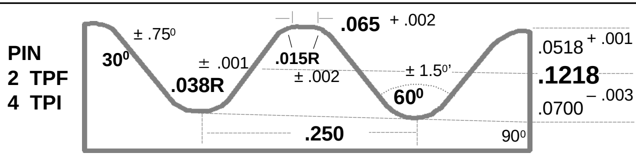
INTERCHANGES WITH:

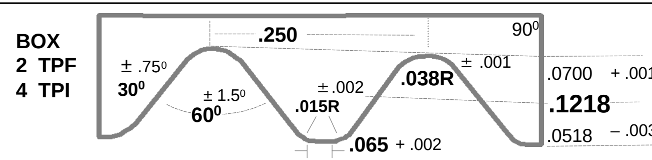












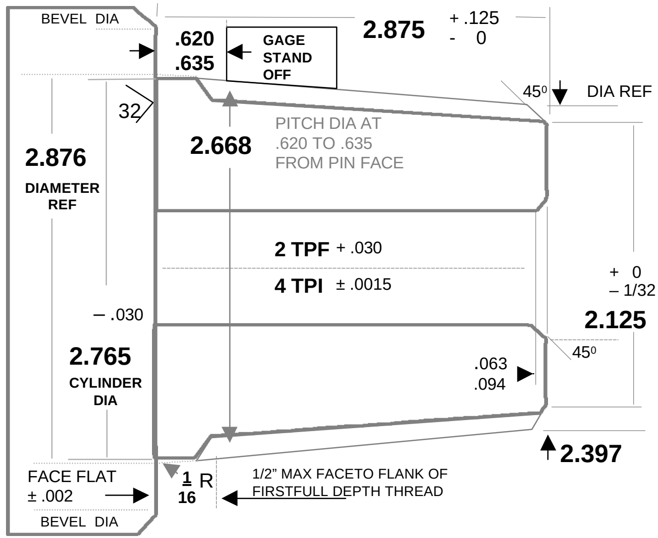
CONNECTION DIMENSIONS

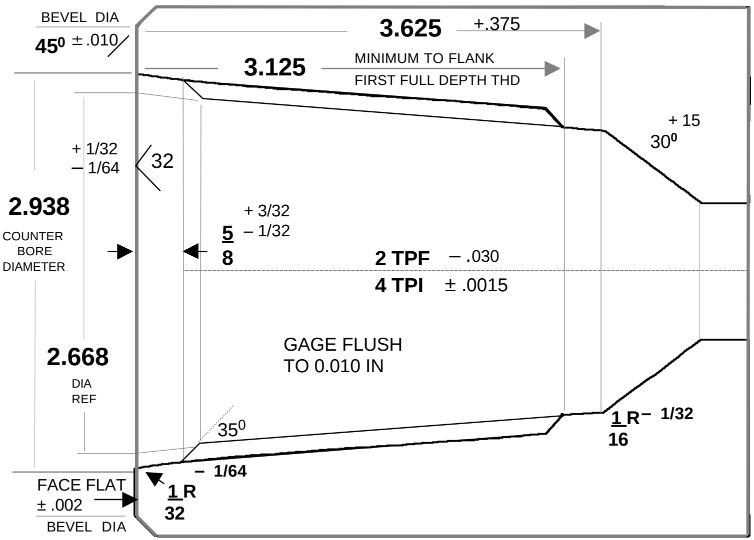
API 26

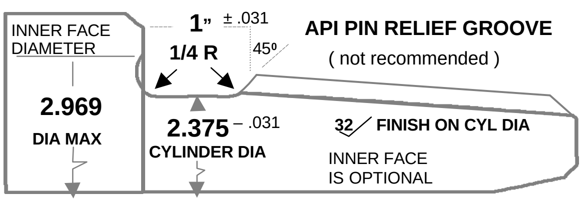
COMMON O.D AND BEVELS (± 1/64)

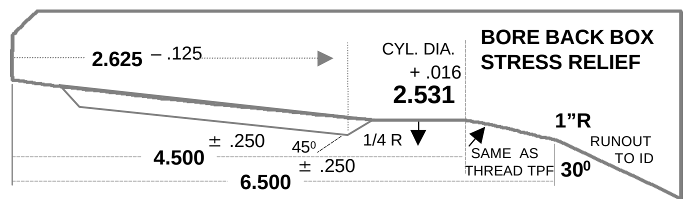
OD BEV	3-3/8 3-17/64	3-1/2 3-17/64	3-5/8 3-29/64	3-3/4 3-29/64	3-7/8 3-41/64				

INTERCHANGES WITH: 2-3/8 IF, 2-7/8 SLIM HOLE

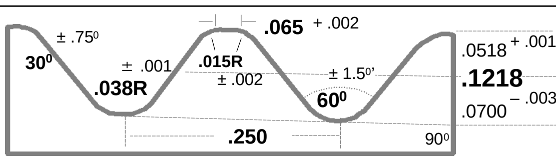




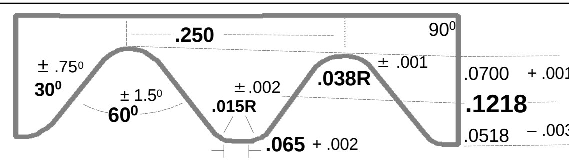




PIN
2 TPF
4 TPI



BOX
2 TPF
4 TPI



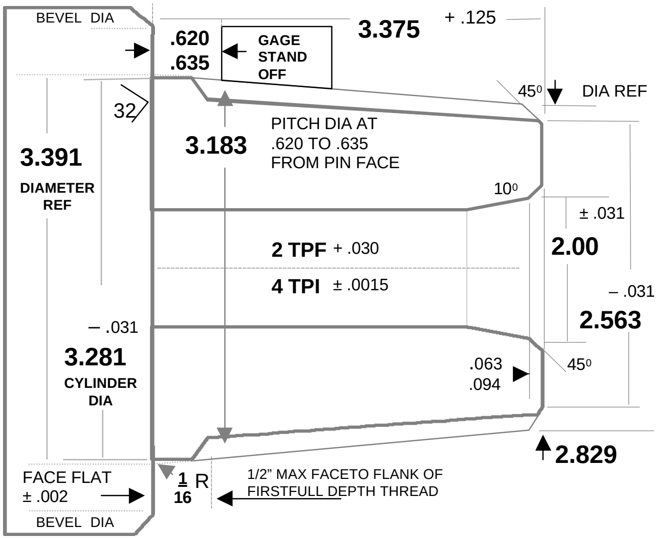
CONNECTION DIMENSIONS

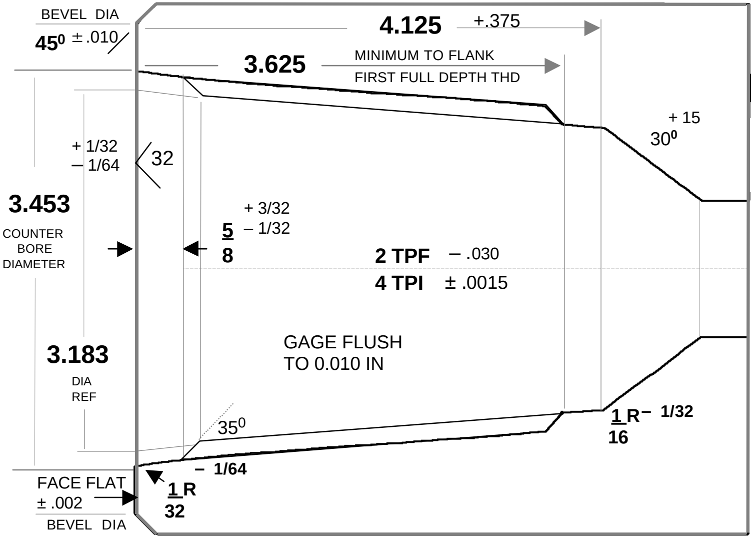
API 31

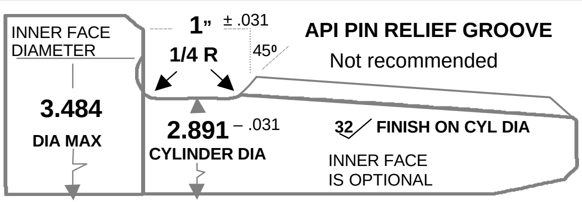
COMMON O.D AND BEVELS (± 1/64)

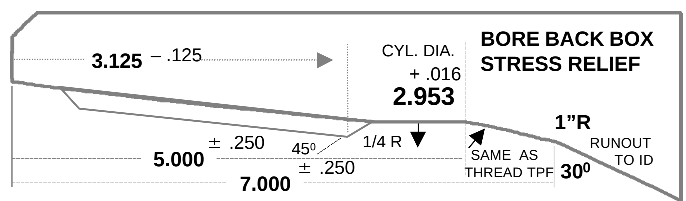
OD	**4-1/8**	**4-1/4**	**4-3/8**						
BEV	**3-61/64**	**3-61/64**	**4-9/64**						

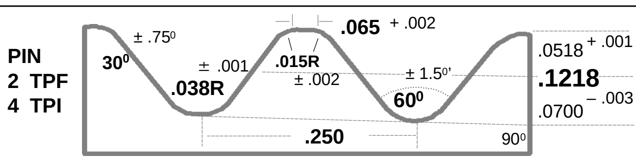
INTERCHANGES WITH: 2-7/8 IF, 3-1/2 SLIM HOLE

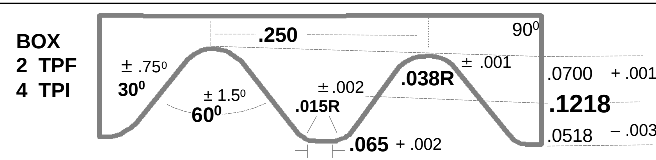












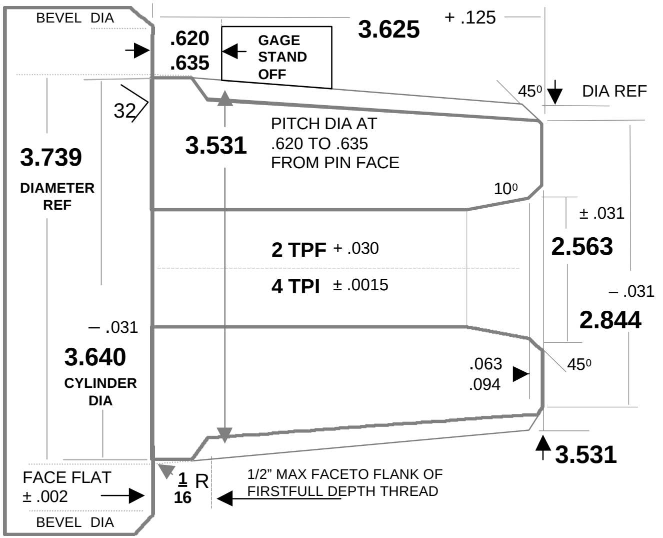
CONNECTION DIMENSIONS

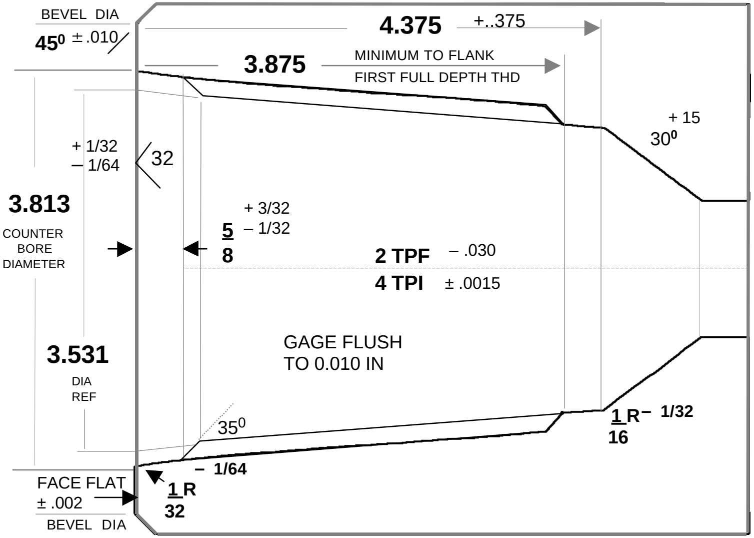
API 35

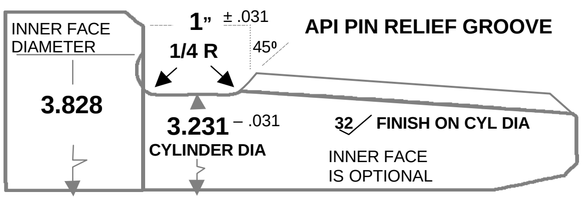
COMMON O.D AND BEVELS (± 1/64)

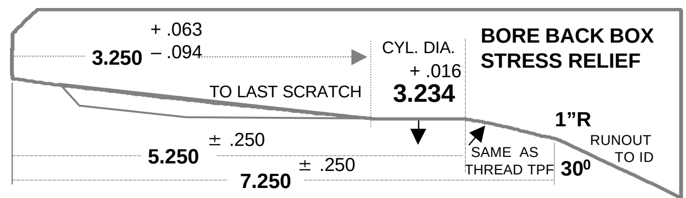
OD **BEV**	**4-3/4** **4-33/64**								

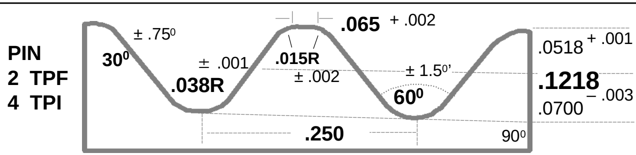
INTERCHANGES WITH:

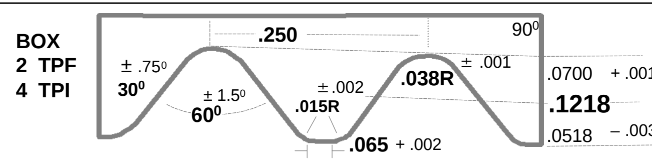












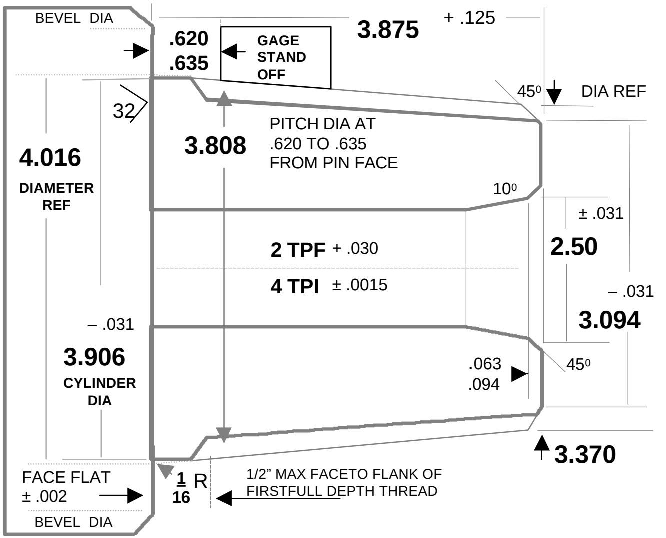
CONNECTION DIMENSIONS

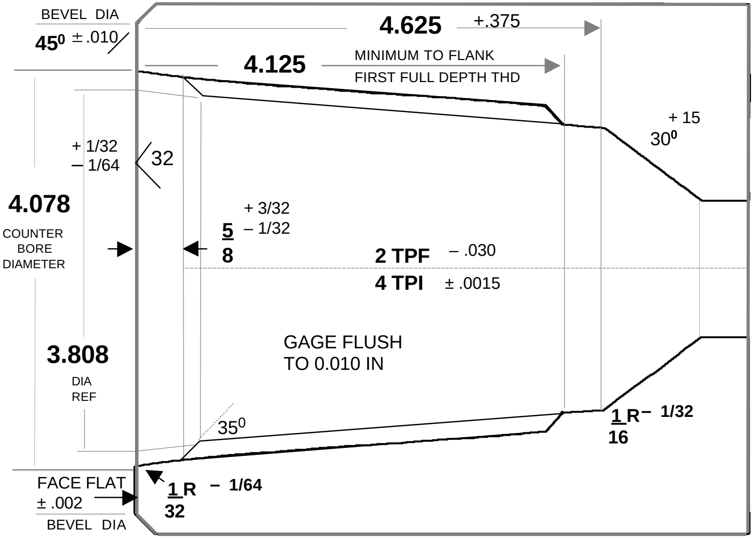
API 38

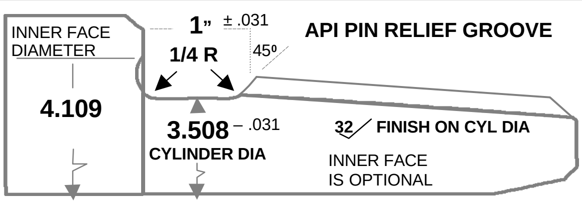
COMMON O.D AND BEVELS (± 1/64)

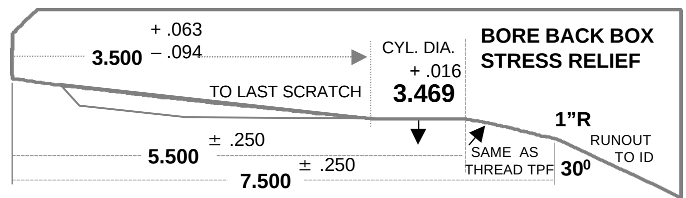
OD BEV	4-3/4 4-37/64	4-7/8 4-37/64	5 4-49/64	5-1/8 4-49/64	5-1/4 4-61/64				

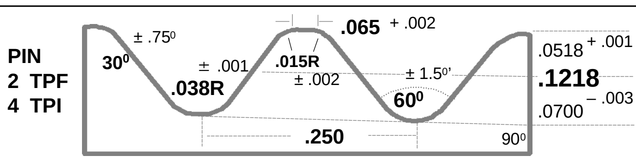
INTERCHANGES WITH: 3-1/2 IF, 4-1/2 SLIM HOLE

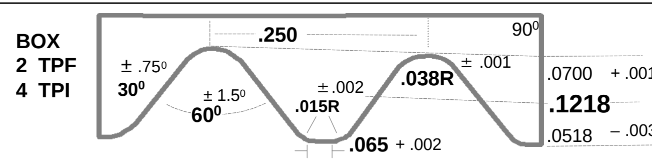












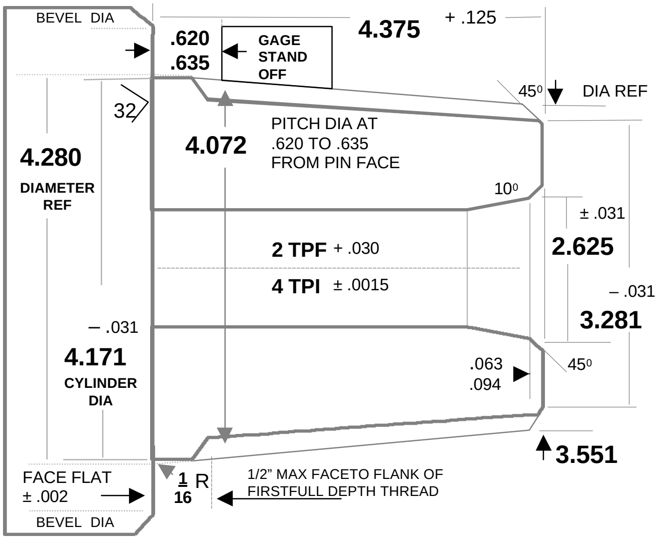
CONNECTION DIMENSIONS

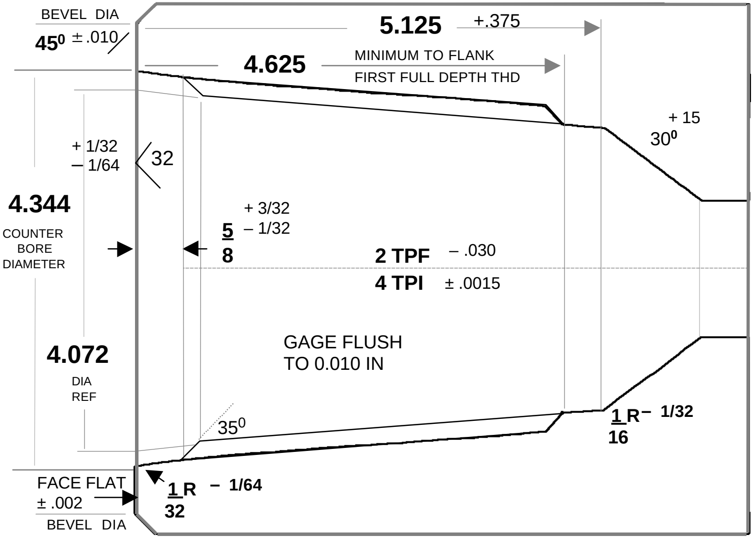
API 40

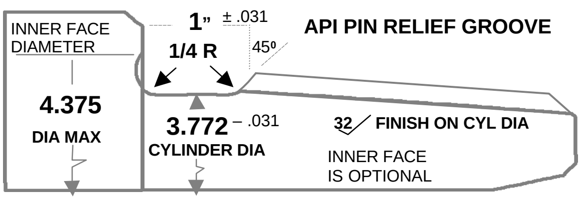
COMMON O.D AND BEVELS (± 1/64)

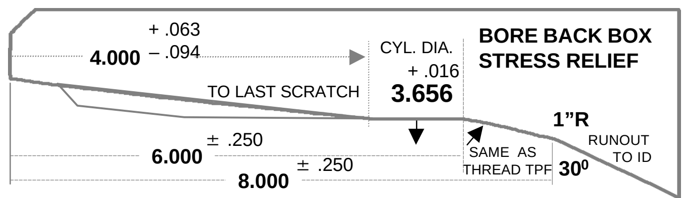
OD BEV	5-1/4	5-3/8	5-1/2	5-5/8	5-3/4				
	5-1/64	5-1/64	5-13/64	5-13/64	5-25/64				

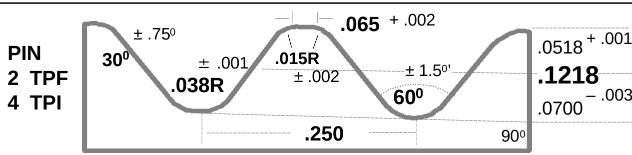
INTERCHANGES WITH: 4” FH, 4-1/2 DBL STREAMLINE

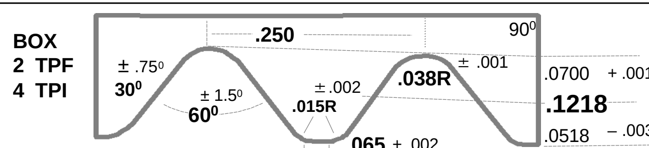












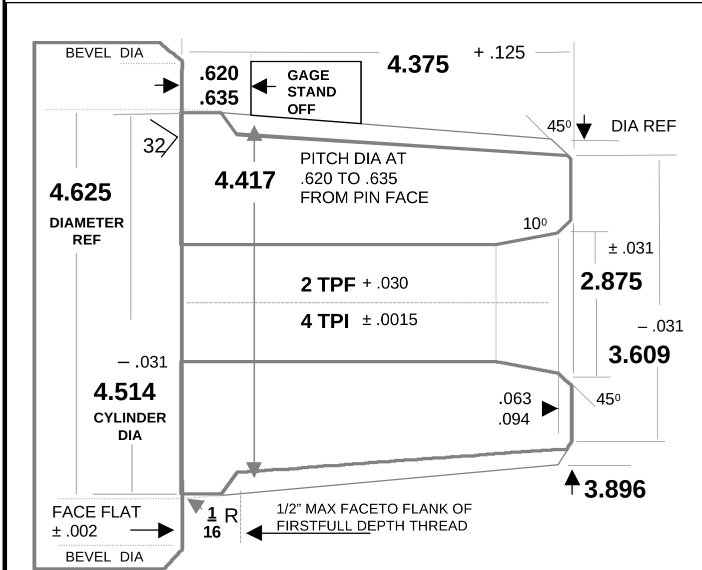
CONNECTION DIMENSIONS

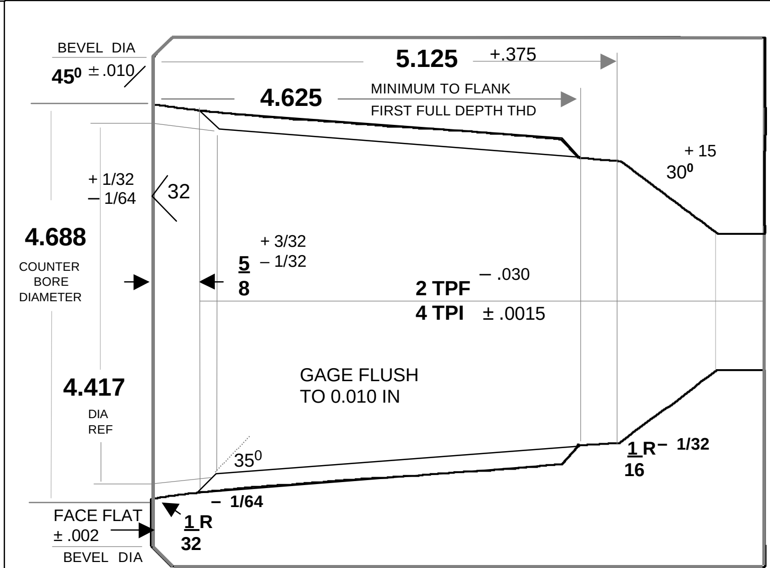
API 44

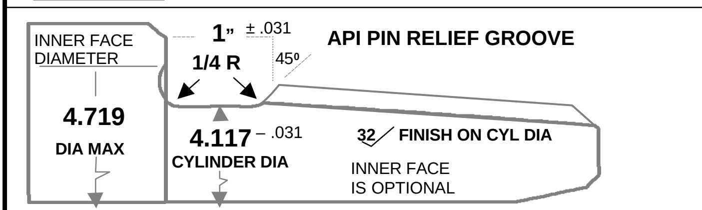
COMMON O.D AND BEVELS (± 1/64)

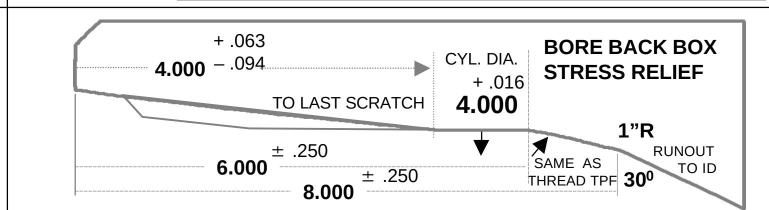
OD BEV	5-3/4 5-1/2	5-7/8 5-1/2	6 5-11/64	6-1/8 5-11/64	6-1/4 5-7/8				

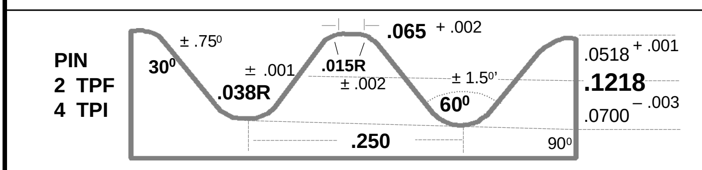
INTERCHANGES WITH:

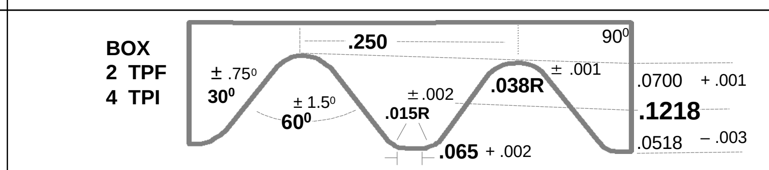












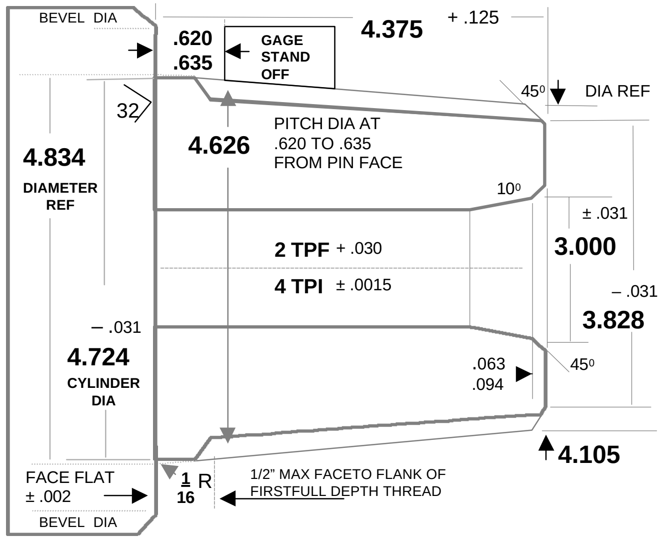
CONNECTION DIMENSIONS

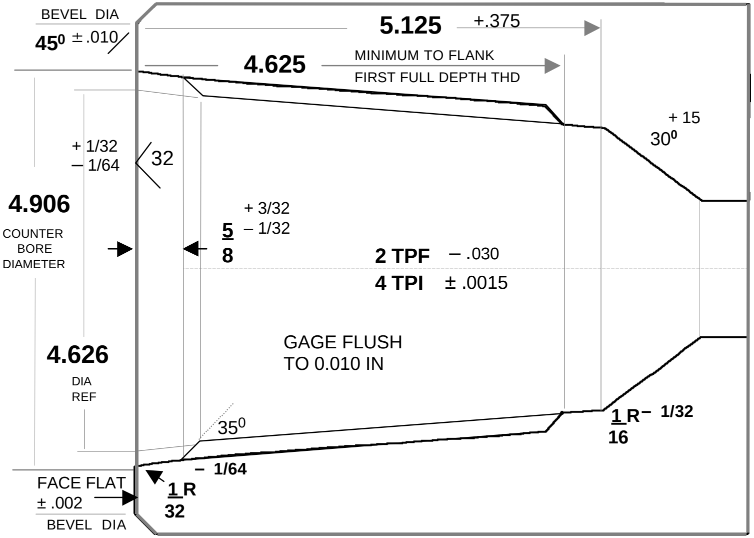
API 46

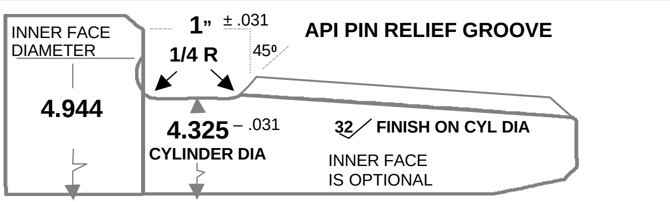
COMMON O.D AND BEVELS (± 1/64)

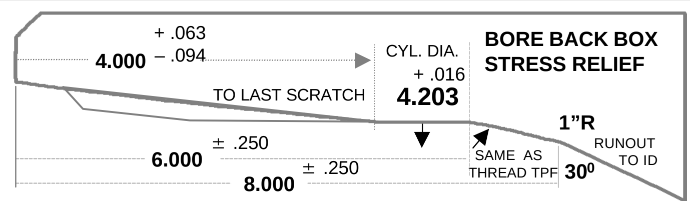
OD BEV	6 5-23/32	6-1/8 5-23/32	6-1/4 5-29/32	6-3/8 5-29/32	6-1/2 6-3/32	6-5/8 6-3/32	6-3/4 6-9/32		

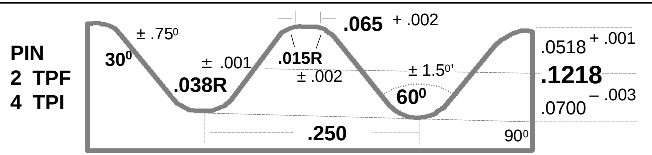
INTERCHANGES WITH: 4 IF, 4-1/2 XH

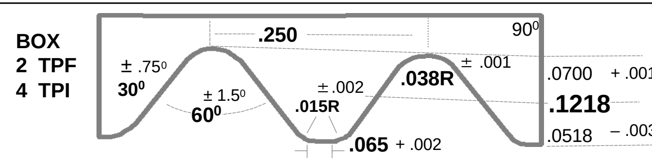












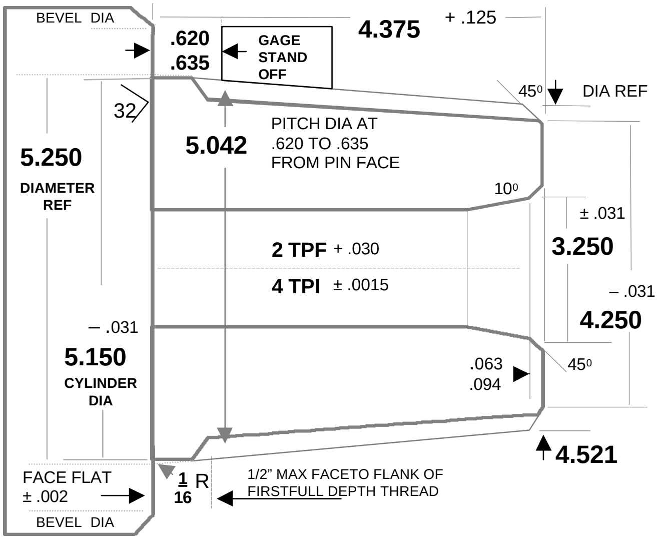
CONNECTION DIMENSIONS

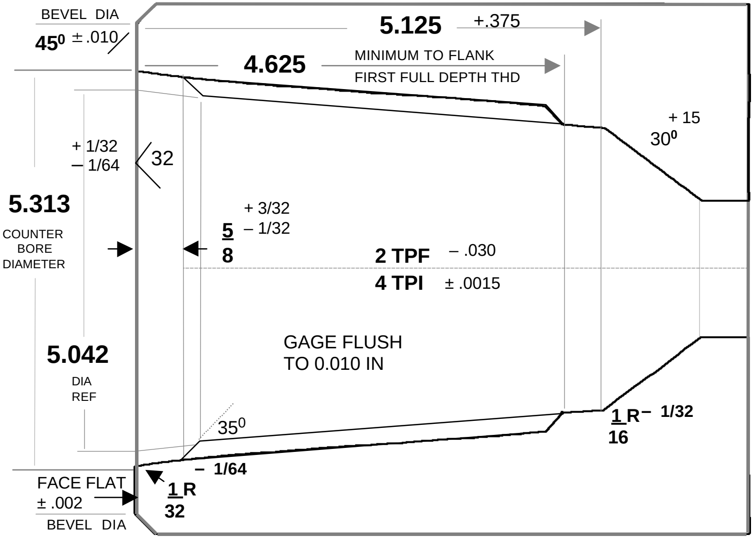
API 50

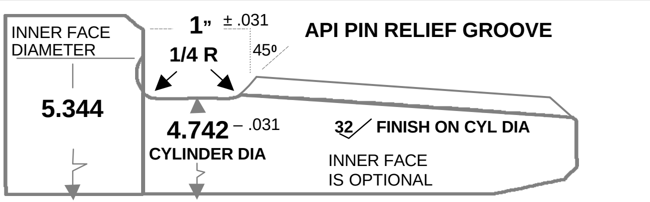
COMMON O.D AND BEVELS (± 1/64)

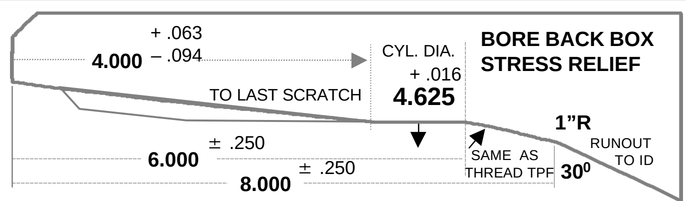
OD	6-1/4	6-3/8	6-1/2	6-5/8	6-3/4	6-7/8	7	7-1/8	7-1/4
BEV	6-1/16	6-7/64	6-7/64	6-19/64	6-19/64	6-31/64	6-31/64	6-43/64	6-43/64

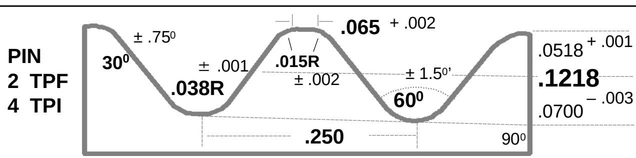
INTERCHANGES WITH: 4-1/2 IF, 5 XH, & 5-1/2 Dbl. STEAMLINE

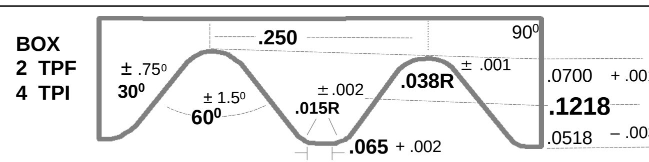












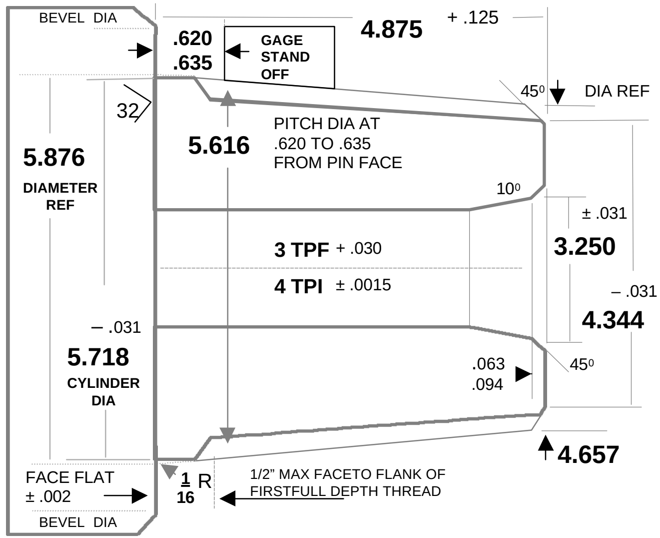
CONNECTION DIMENSIONS

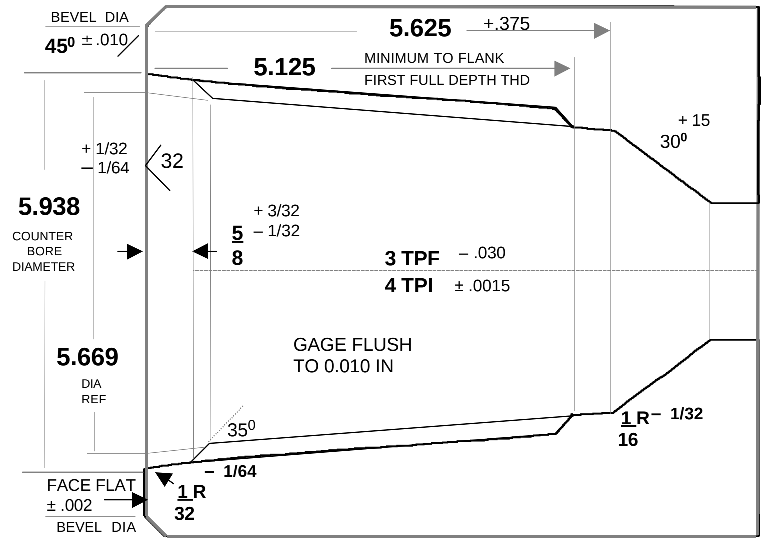
API 56

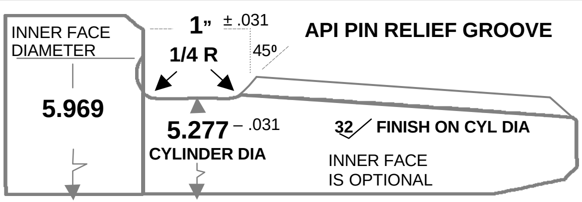
COMMON O.D AND BEVELS (± 1/64)

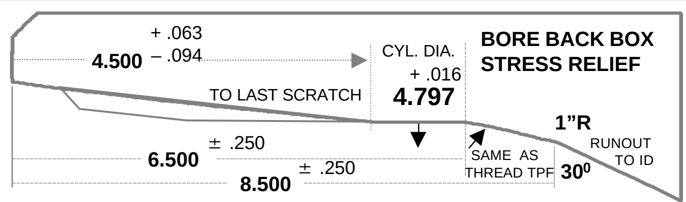
OD BEV	7-1/2 7-7/64	7-5/8 7-7/64	7-3/4 7-19/64	7-7/8 7-1964	8 7-31/64				

INTERCHANGES WITH: N/A

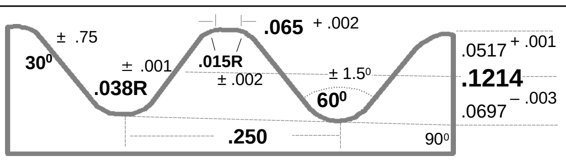




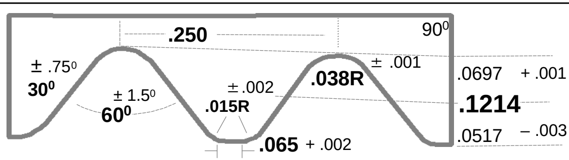




PIN
3 TPF
4 TPI



BOX
3 TPF
4 TPI



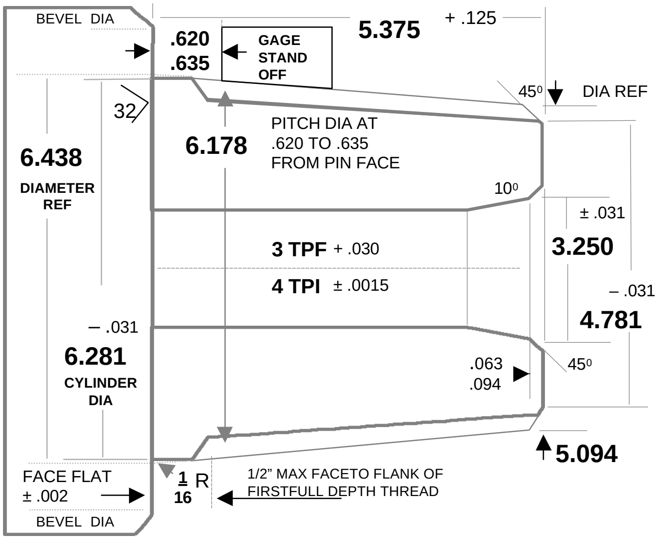
CONNECTION DIMENSIONS

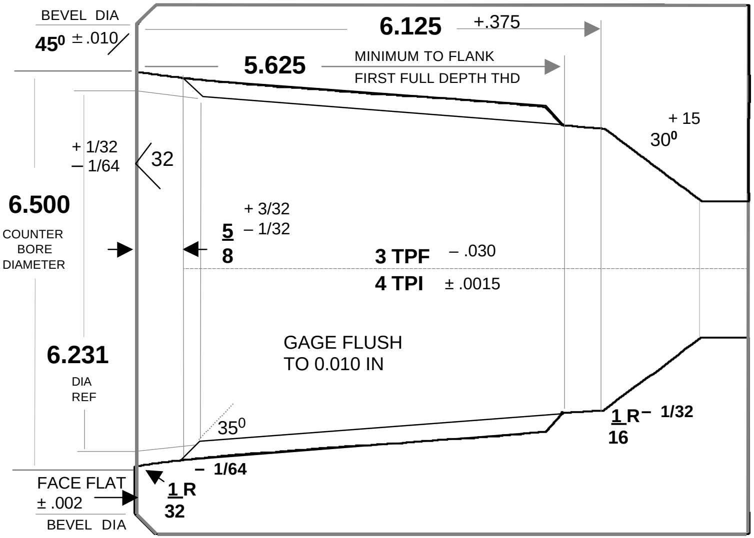
API 61

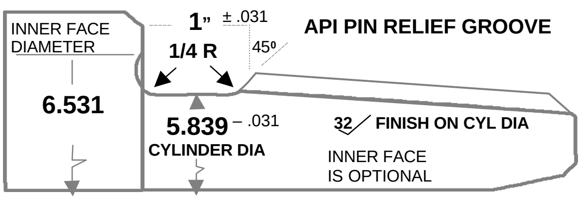
COMMON O.D AND BEVELS (± 1/64)

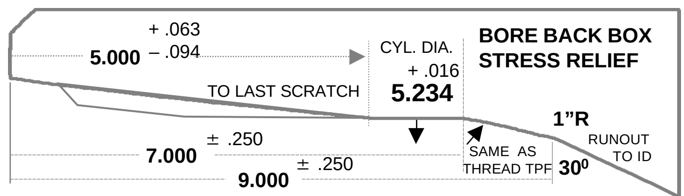
OD BEV	8-1/4 7-13/16	8-3/8 7-13/16	8-1/2 8	8-5/8 8	8-3/4 8-3/16	8-7/8 8-3/16	9 8-3/8		

INTERCHANGES WITH: N/A

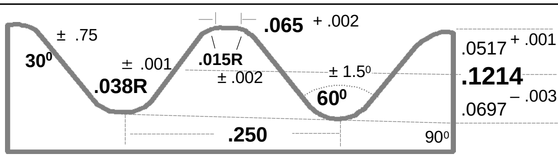




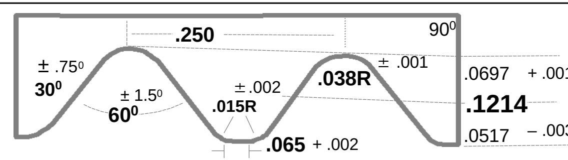




PIN
3 TPF
4 TPI



BOX
3 TPF
4 TPI



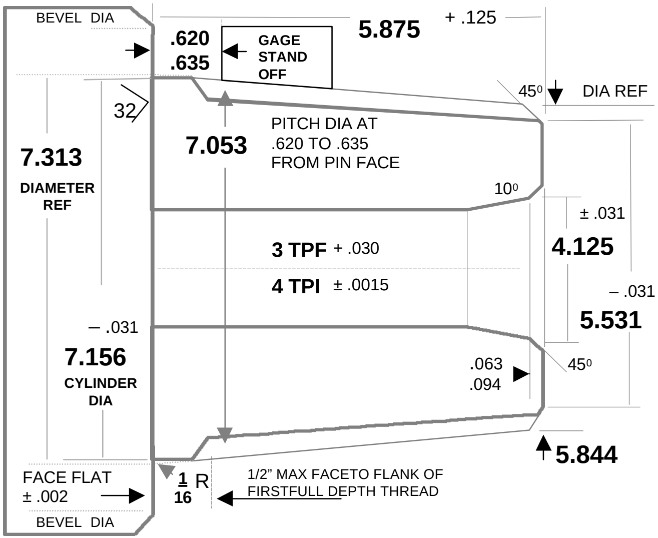
CONNECTION DIMENSIONS

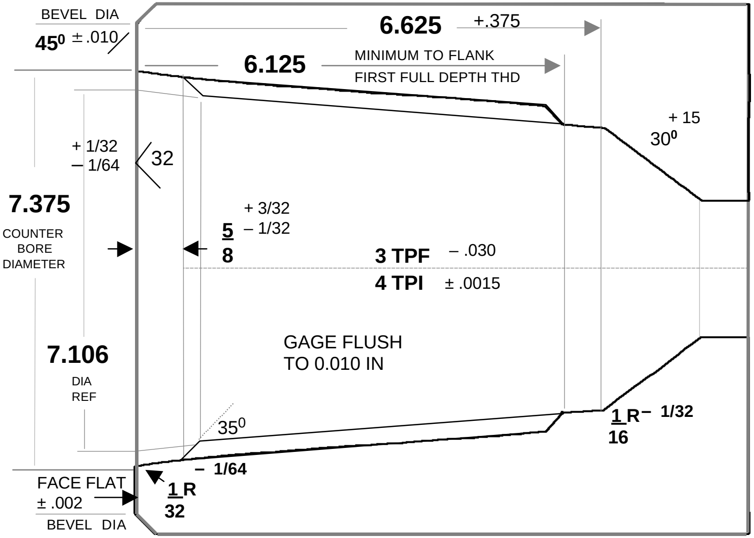
API 70

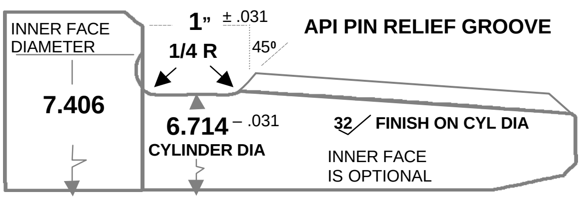
COMMON O.D AND BEVELS (± 1/64)

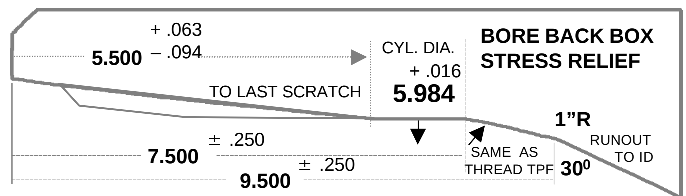
OD BEV	9-1/2 8-31/32	9-3/4 9-5/32	10 9-11/32						

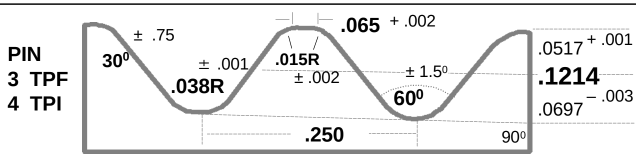
INTERCHANGES WITH: N/A

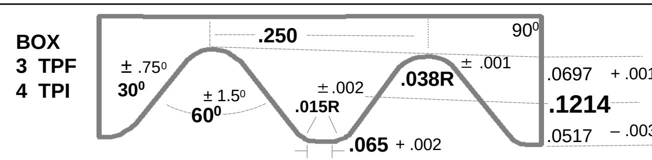












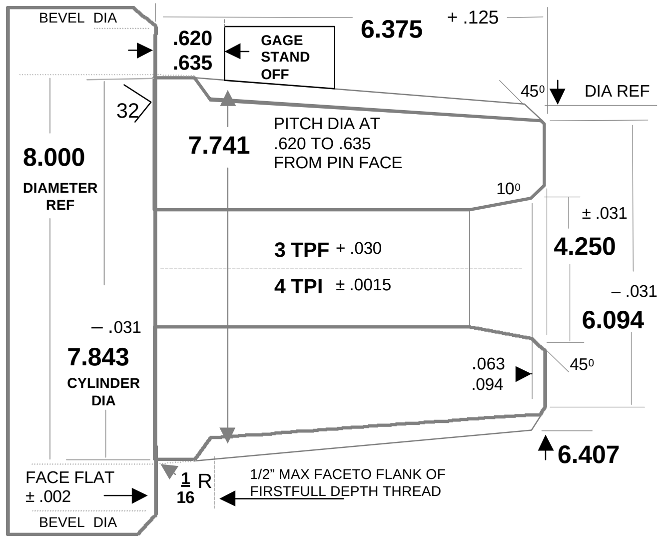
CONNECTION DIMENSIONS

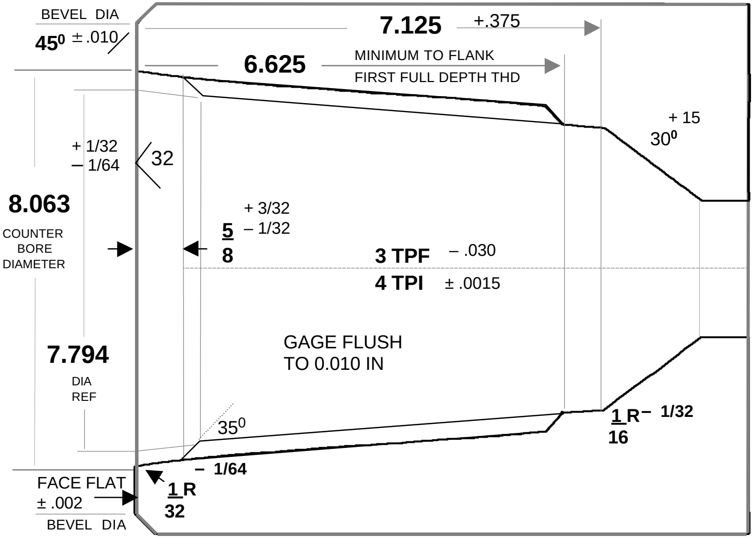
API 77

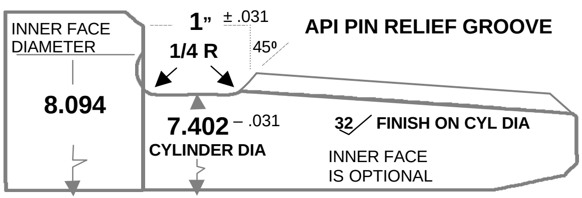
COMMON O.D AND BEVELS (± 1/64)

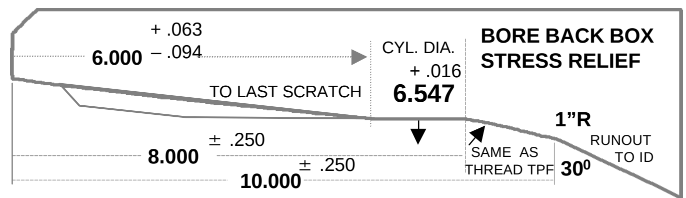
OD	**11**								
BEV	**10-17/64**								

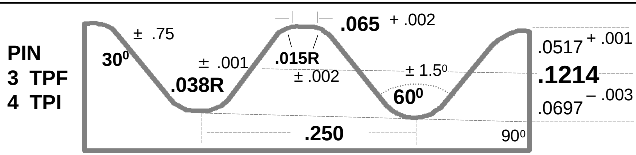
INTERCHANGES WITH: N/A

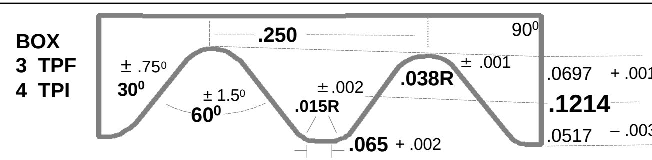












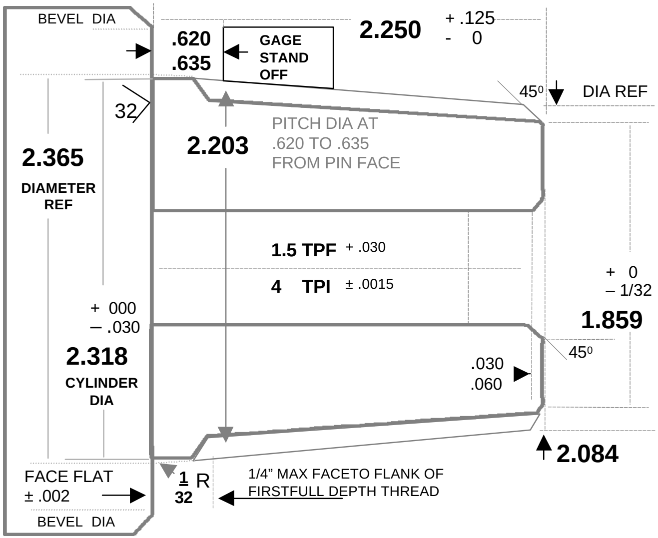
CONNECTION DIMENSIONS

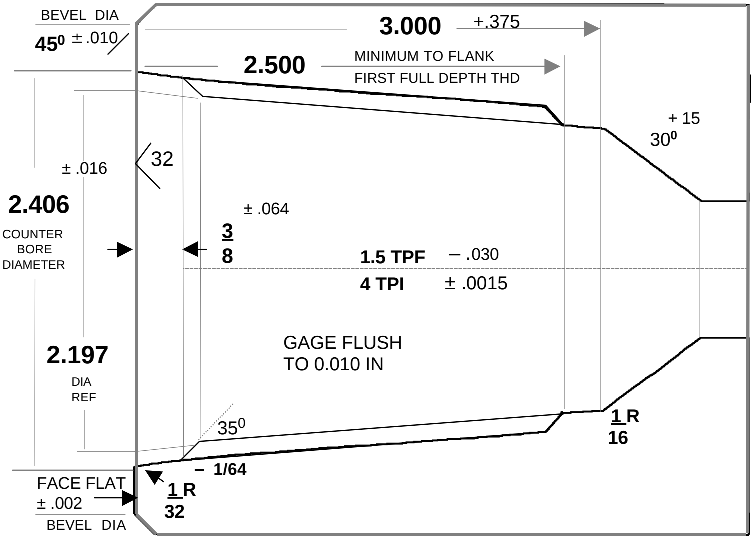
2-3/8 PAC

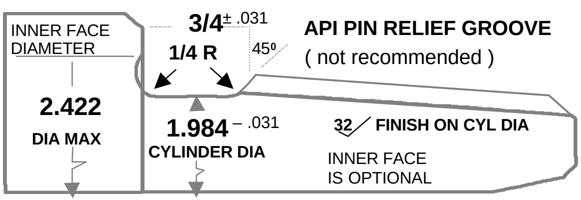
COMMON O.D AND BEVELS (± 1/64)

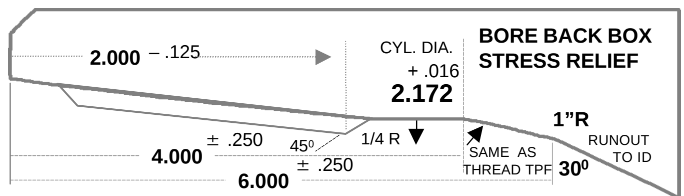
OD BEV	2-3/4 2-45/64	2-7/8 2-45/64	3 2-3/4						

INTERCHANGES WITH:

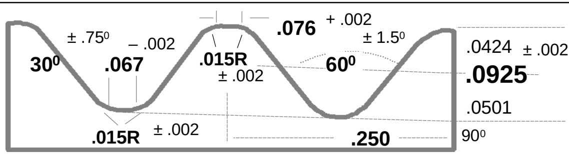




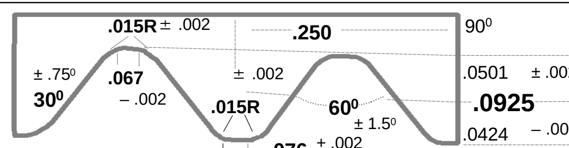




PIN
1.5" TPF
4 TPI



BOX
1.5" TPF
4 TPI



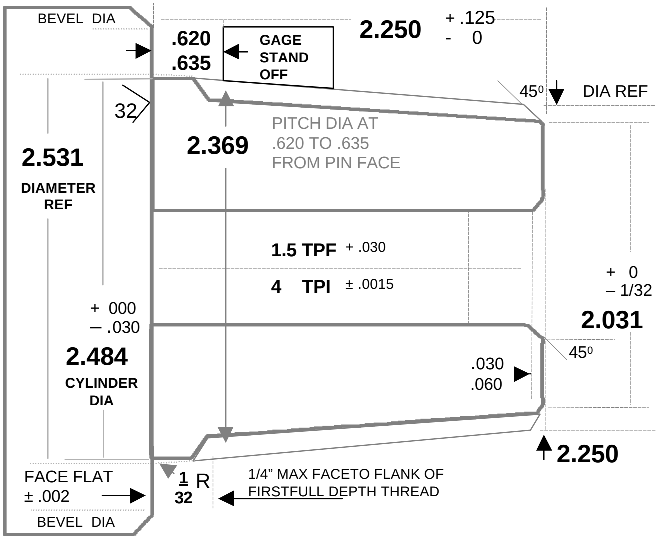
CONNECTION DIMENSIONS

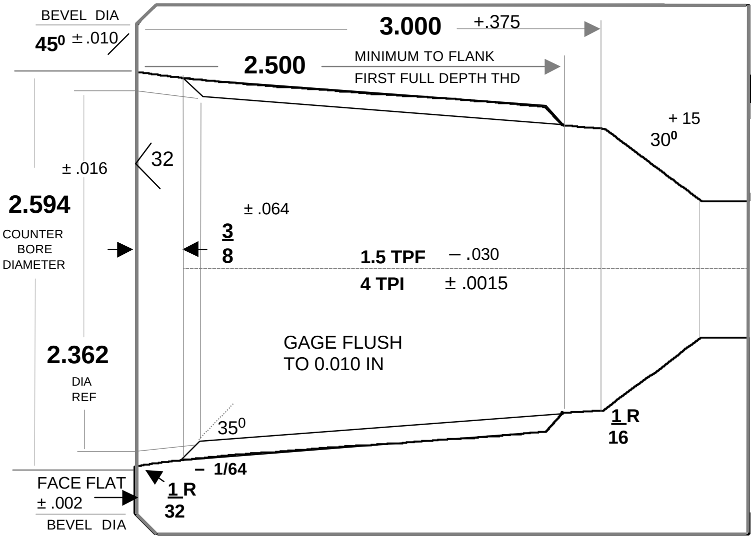
2-7/8 PAC

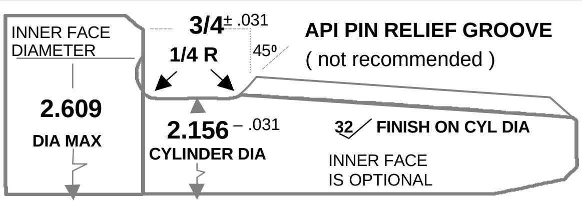
COMMON O.D AND BEVELS (± 1/64)

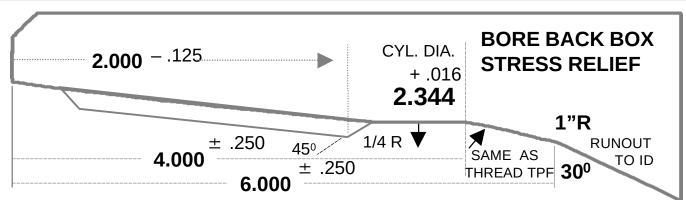
OD **BEV**	**3-1/8** **3**								

INTERCHANGES WITH:









PIN
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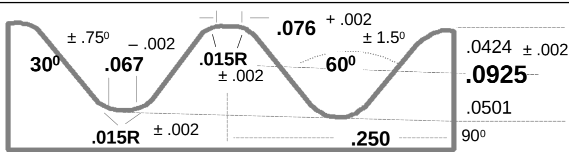
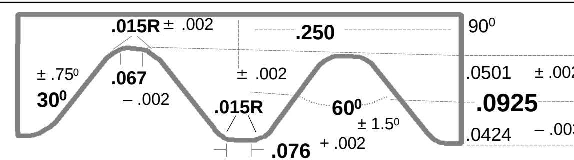
4 TPI



BOX
1.5" TPF
4 TPI



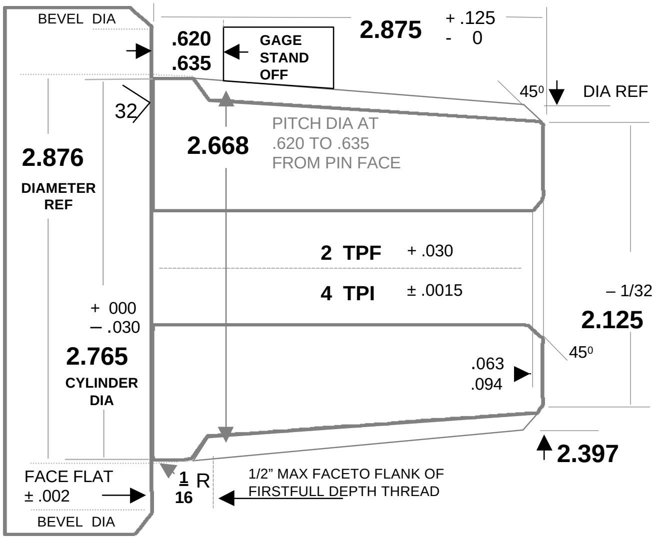
CONNECTION DIMENSIONS

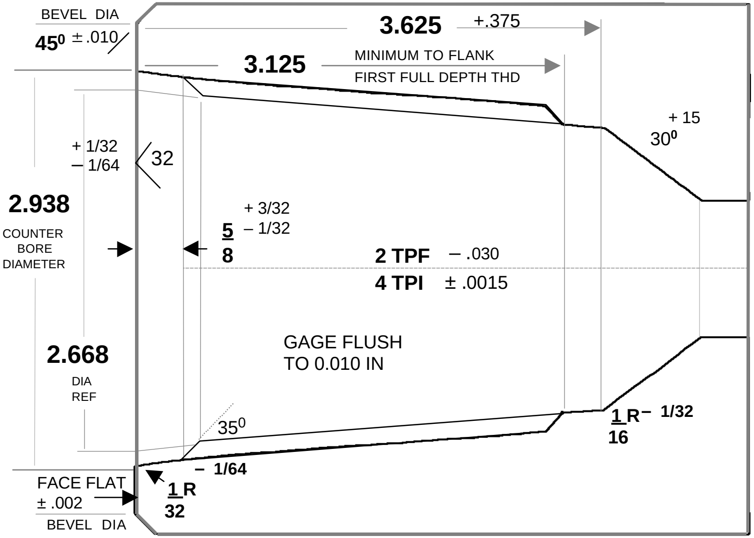
2-3/8 INTERNAL FLUSH

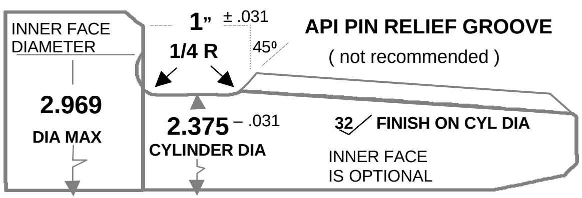
COMMON O.D AND BEVELS (± 1/64)

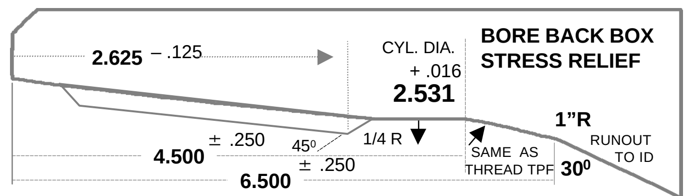
OD	**3-3/8**	**3-1/2**	**3-5/8**	**3-3/4**	**3-7/8**			
BEV	**3-17/64**	**3-17/64**	**3-29/64**	**3-29/64**	**3-41/64**			

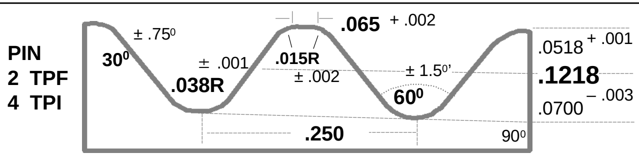
INTERCHANGES WITH: 2-7/8 SLIM HOLE, API 26

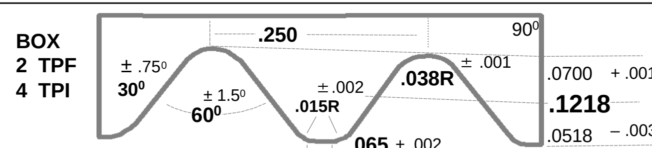












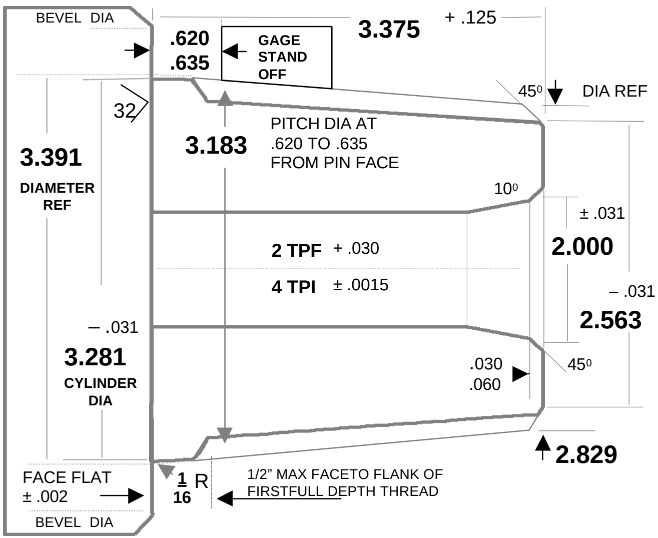
CONNECTION DIMENSIONS

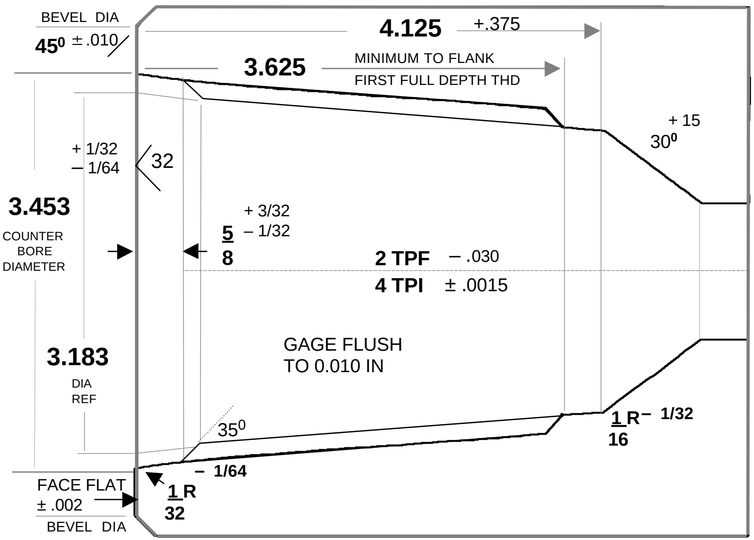
2-7/8 Internal Flush

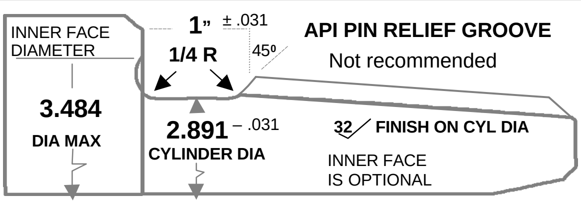
COMMON O.D AND BEVELS (± 1/64)

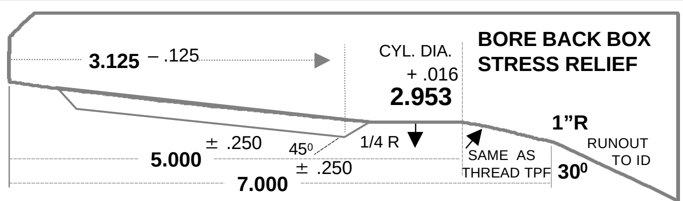
OD BEV	4-1/8 3-61/64	4-1/4 3-61/64	4-3/8 4-9/64						

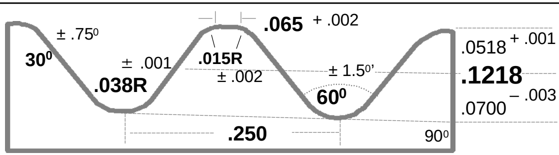
INTERCHANGES WITH: 3-1/2 SLIM HOLE, API 31

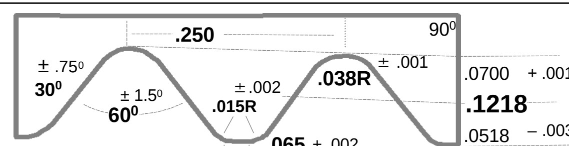












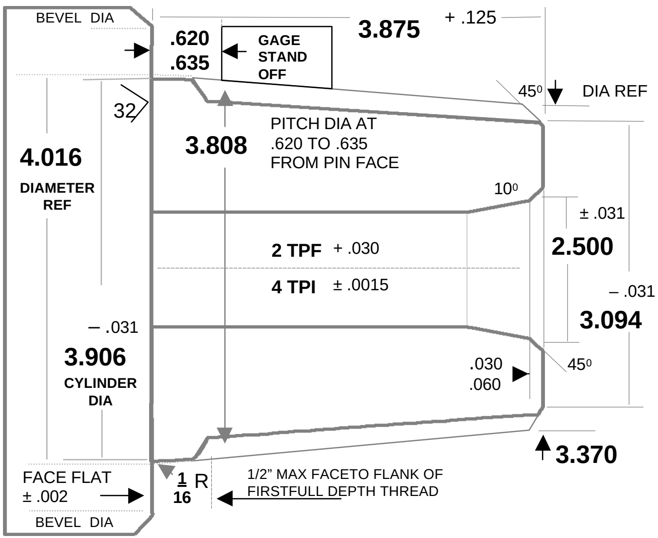
CONNECTION DIMENSIONS

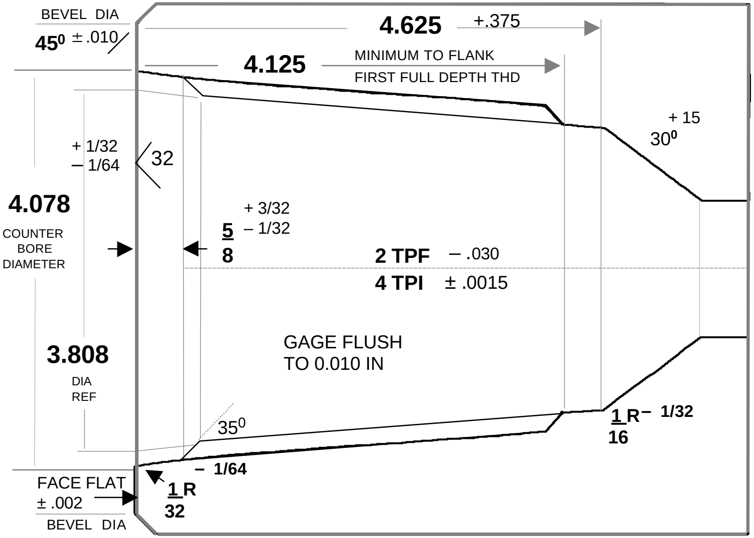
3-1/2 Internal Flush

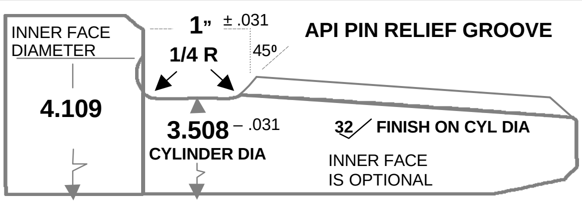
COMMON O.D AND BEVELS (± 1/64)

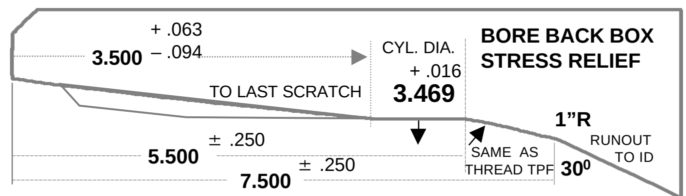
OD BEV	4-3/4 4-37/64	4-7/8 4-37/64	5 4-49/64	5-1/8 4-49/64	5-1/4 4-61/64				

INTERCHANGES WITH: 4-1/2 SLIM HOLE, API 38

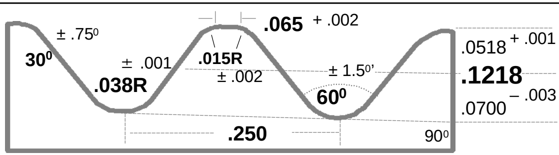




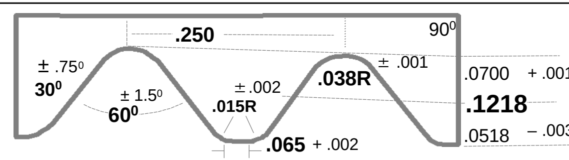




PIN
2 TPF
4 TPI



BOX
2 TPF
4 TPI



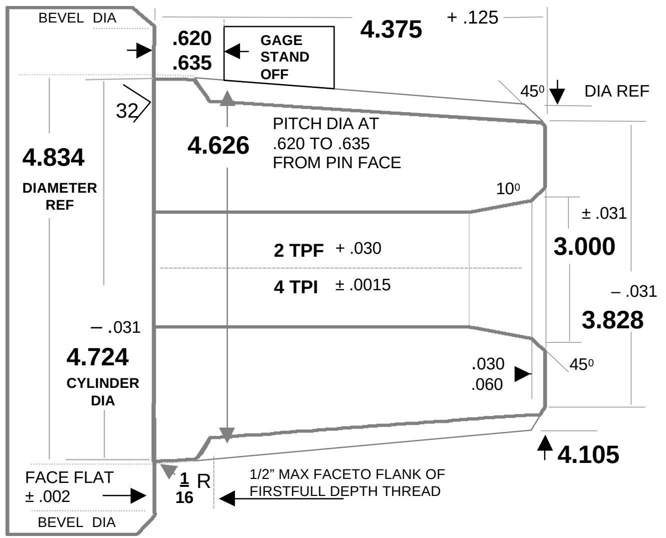
CONNECTION DIMENSIONS

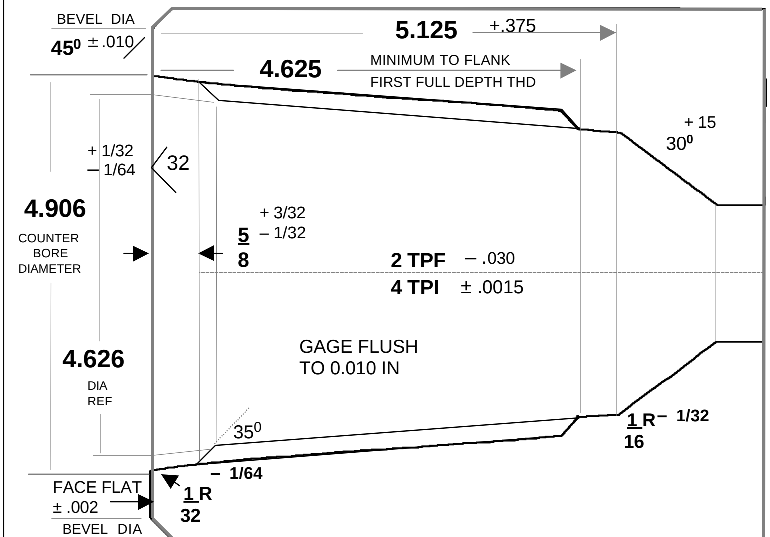
4 Internal Flush

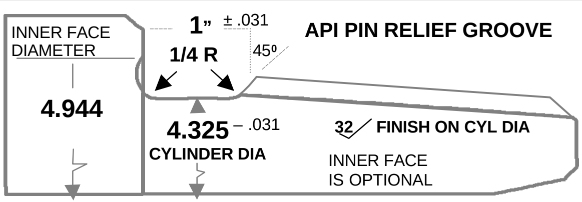
COMMON O.D AND BEVELS (± 1/64)

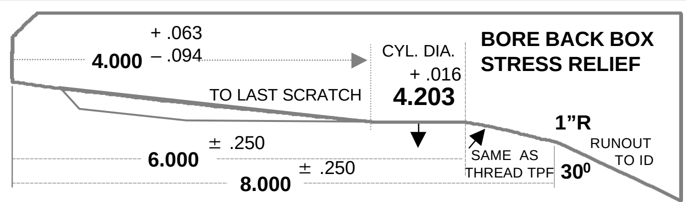
OD BEV	6 5-23/32	6-1/8 5-23/32	6-1/4 5-29/32	6-3/8 5-29/32	6-1/2 6-3/32	6-5/8 6-3/32	6-3/4 6-9/32		

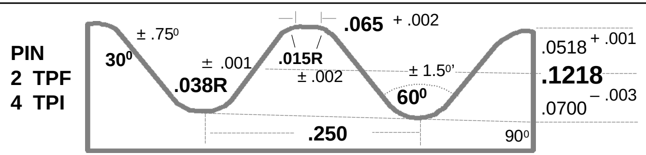
INTERCHANGES WITH: 4-1/2 XH, API 46

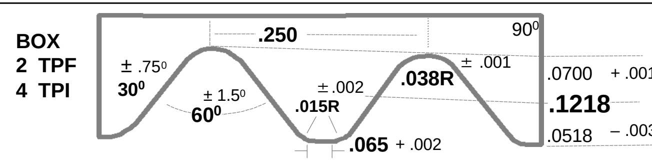












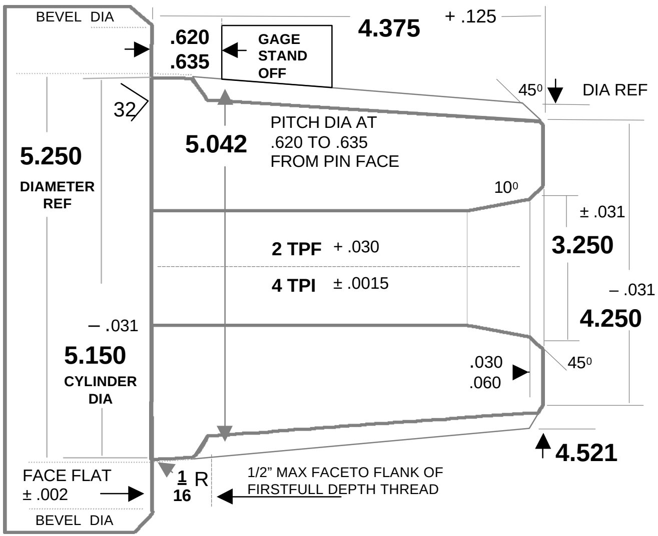
CONNECTION DIMENSIONS

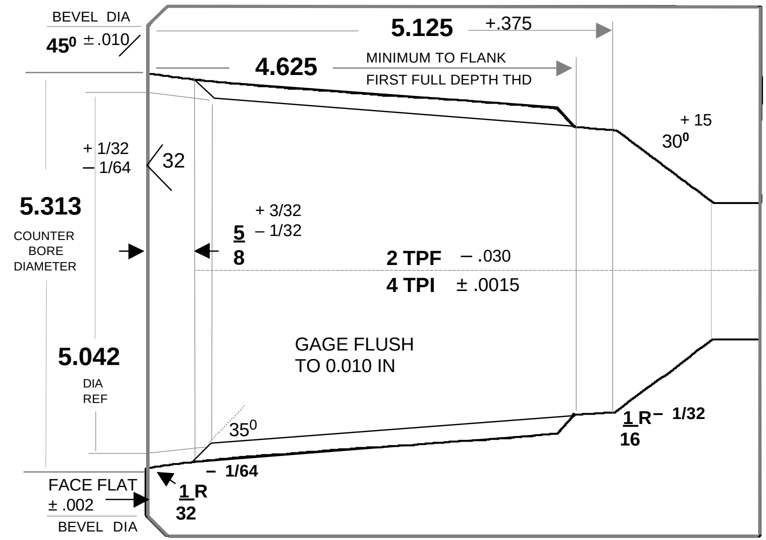
4-1/2 Internal Flush

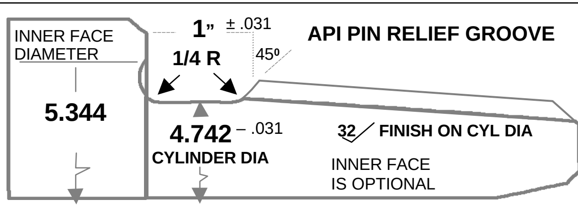
COMMON O.D AND BEVELS (± 1/64)

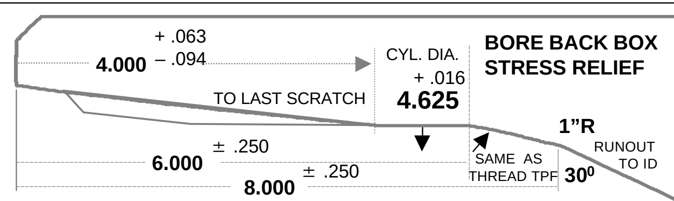
OD	6-1/4	6-3/8	6-1/2	6-5/8	6-3/4	6-7/8	7	7-1/8	7-1/4
BEV	6-1/16	6-7/64	6-7/64	6-19/64	6-19/64	6-31/64	6-31/64	6-43/64	6-43/64

INTERCHANGES WITH: 5 XH, API 50, & 5-1/2 Dbl. STEAMLINE

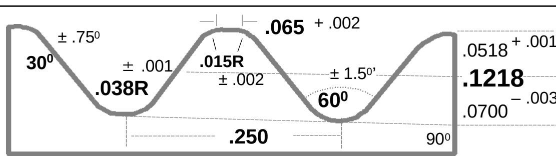




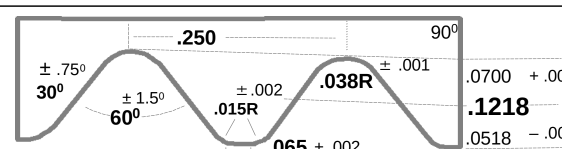




PIN
2 TPF
4 TPI



BOX
2 TPF
4 TPI



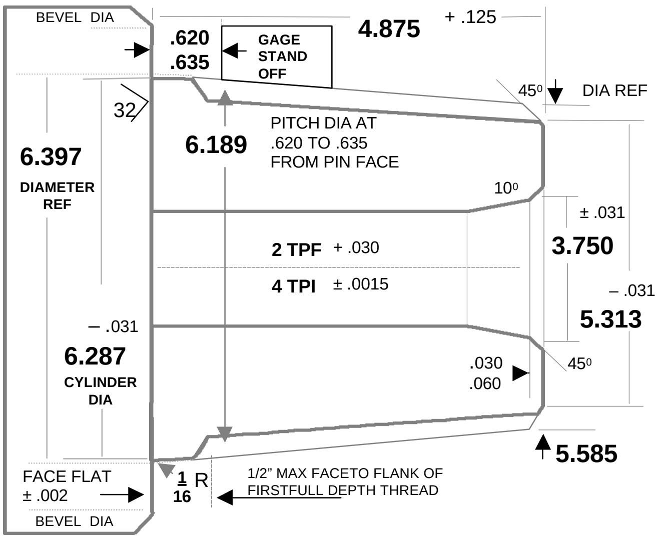
CONNECTION DIMENSIONS

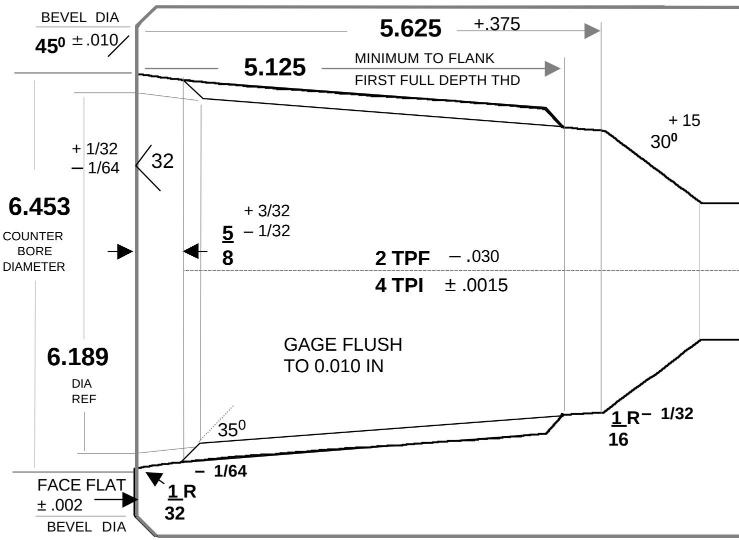
5-1/2 Internal Flush

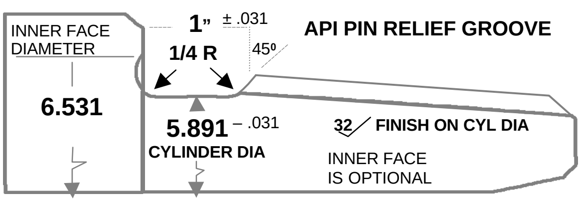
COMMON O.D AND BEVELS (± 1/64)

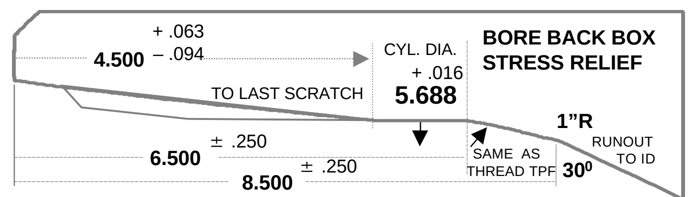
OD BEV	7-1/2	7-5/8	7-3/4	7-7/8	8	8-1/4	8-1/2	8-3/4	9
	7-9/64	7-21/64	7-21/64	7-33/64	7-33/64	7-45/64	7-57/64	8-5/64	8-17/64

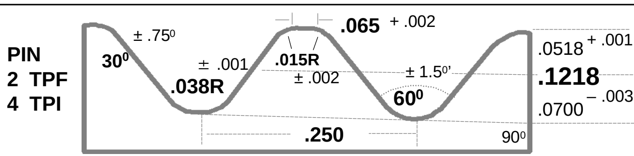
INTERCHANGES WITH: N/A

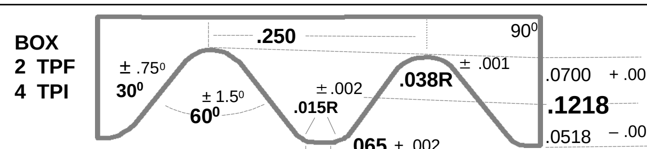












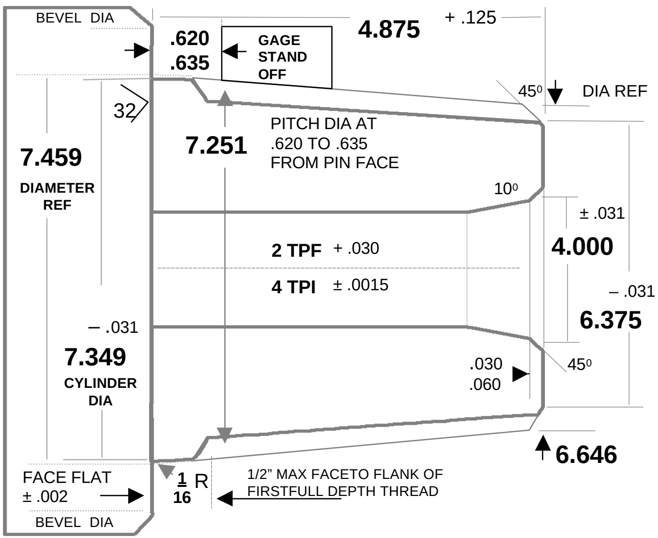
CONNECTION DIMENSIONS

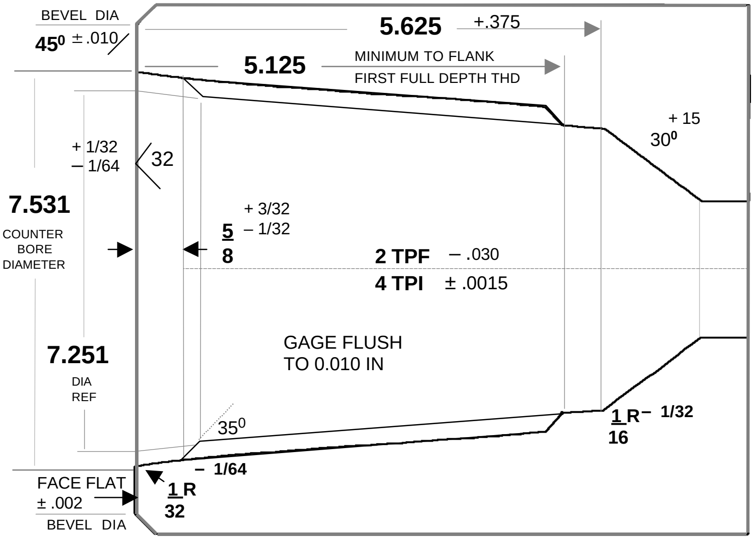
6-5/8 Internal Flush

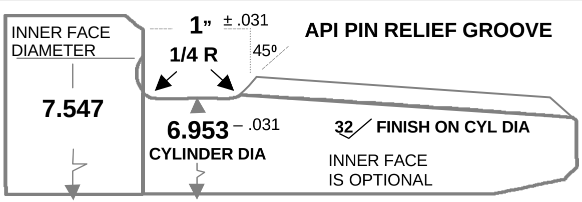
COMMON O.D AND BEVELS (± 1/64)

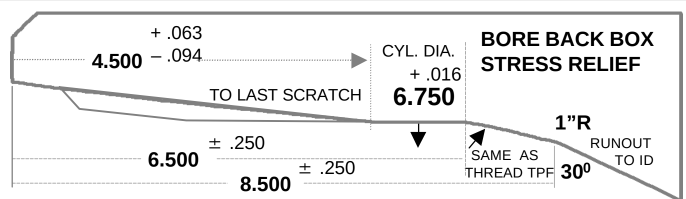
OD	9	9-1/8	9-1/4	9-3/8	9-1/2	9-5/8	9-3/4	9-7/8	10
BEV	8-5/8	8-5/8	8-13/16	8-13/16	9	9	9-3/16	9-3/16	9-3/8

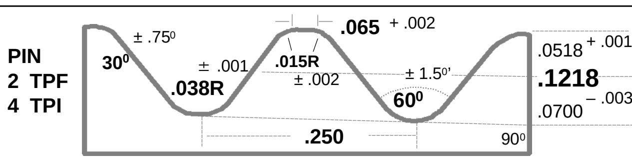
INTERCHANGES WITH: N/A

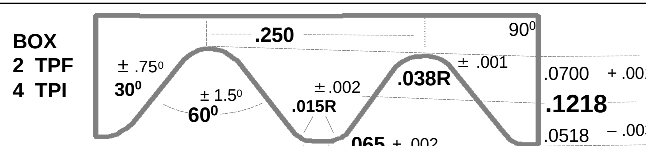












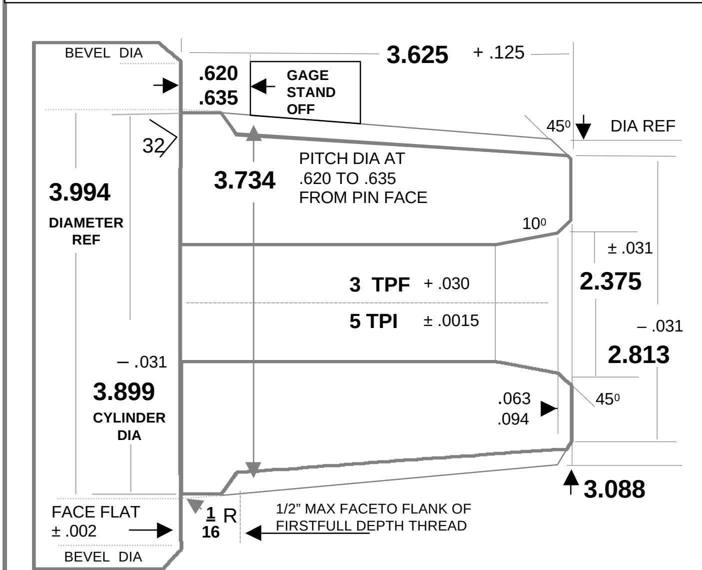
CONNECTION DIMENSIONS

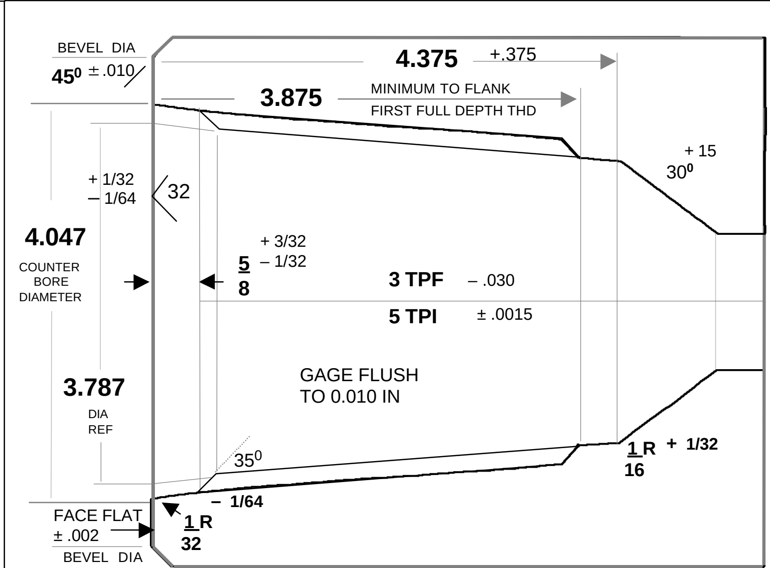
3-1/2 FULL HOLE

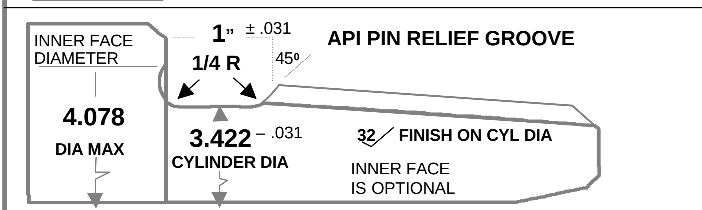
COMMON O.D AND BEVELS (± 1/64)

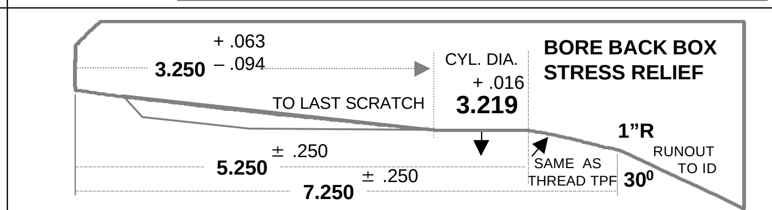
OD BEV	4-7/8 4-43/64	5 4-43/64	5-1/8 4-55/64	5-1/4 4-55/64					

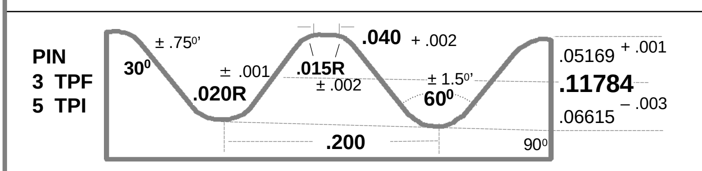
INTERCHANGES WITH:

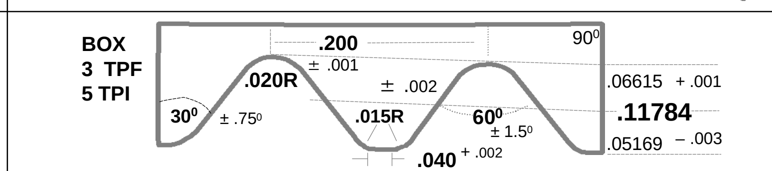












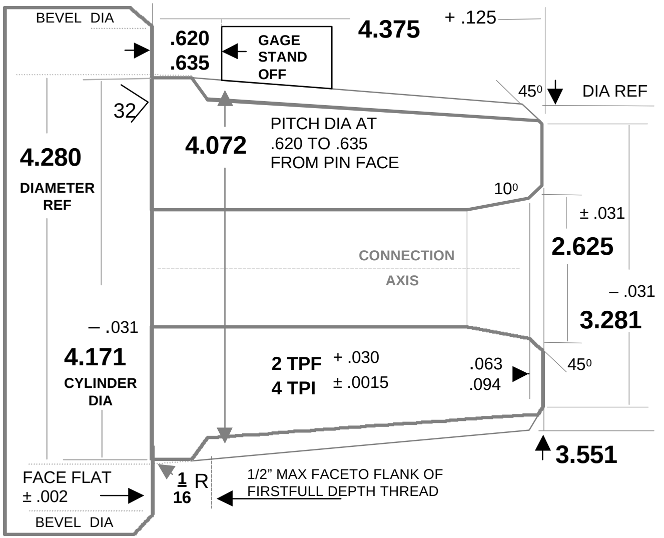
CONNECTION DIMENSIONS

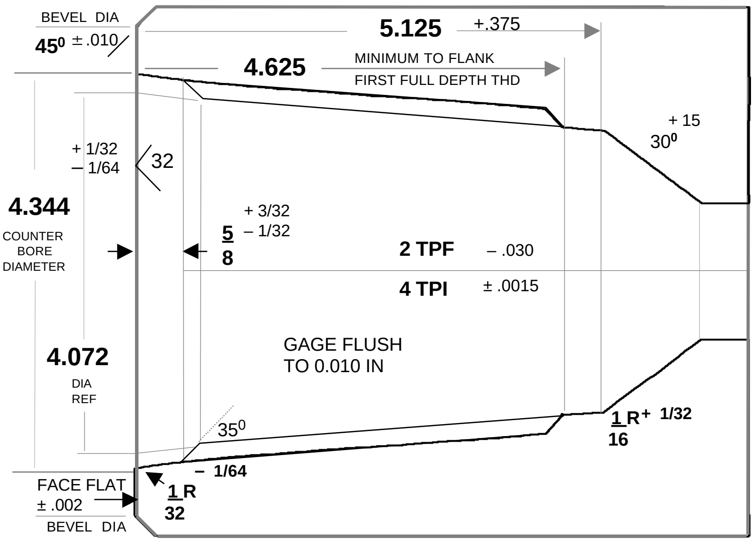
4 FULL HOLE

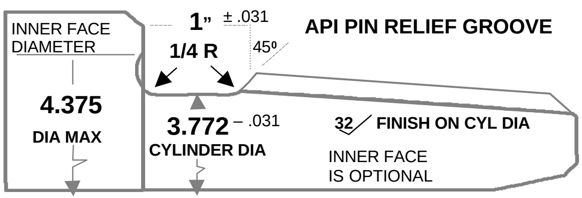
COMMON O.D AND BEVELS (± 1/64)

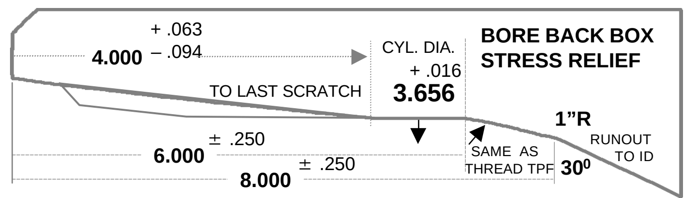
OD / BEV	5-1/4	5-3/8	5-1/2	5-5/8	5-3/4				
	5-1/64	5-1/64	5-13/64	5-13/64	5-25/64				

INTERCHANGES WITH: 4-1/2 DBL STREAMLINE, API 40

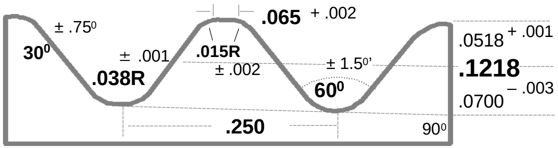




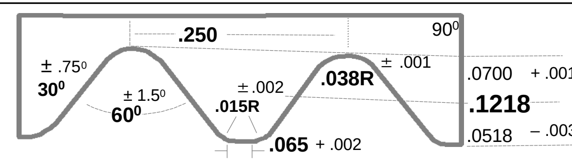




PIN
2 TPF
4 TPI



BOX
2 TPF
4 TPI



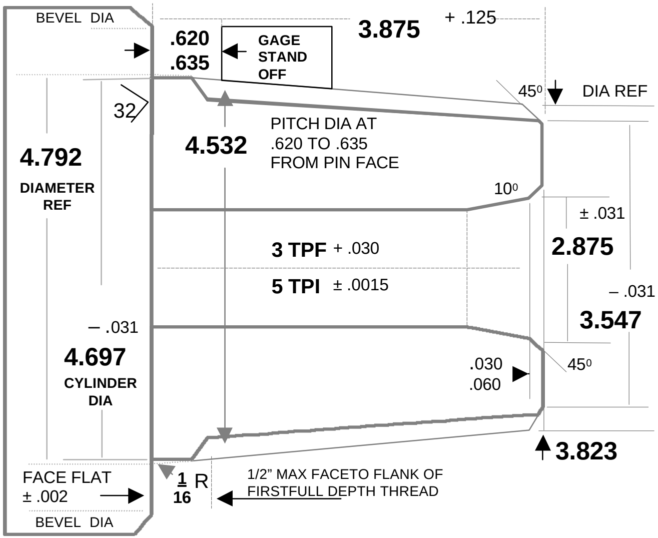
CONNECTION DIMENSIONS

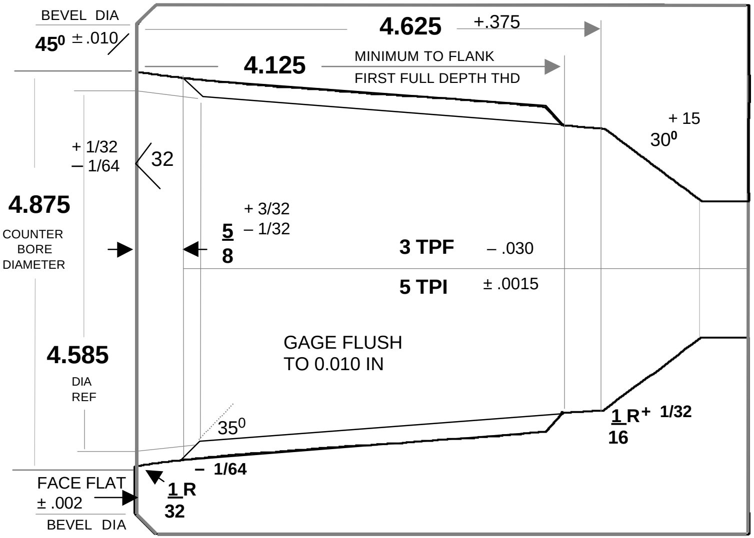
4-1/2 FULL HOLE

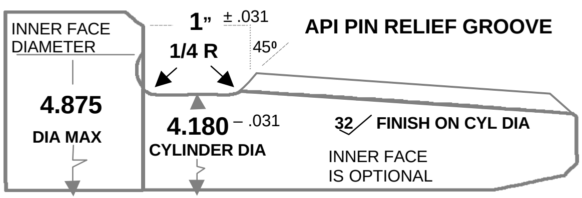
COMMON O.D AND BEVELS (± 1/64)

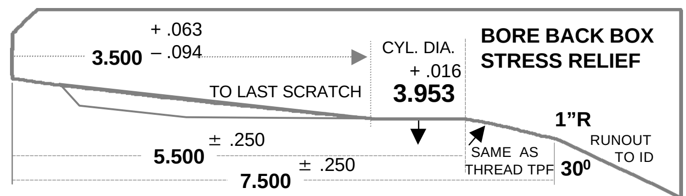
OD	5-3/4	5-7/8	6	6-1/8	6-1/4				
BEV	5-17/32	5-17/32	5-23/32	5-23/32	5-29/32				

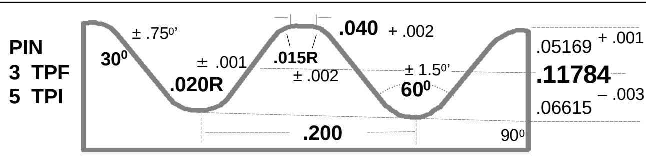
INTERCHANGES WITH:

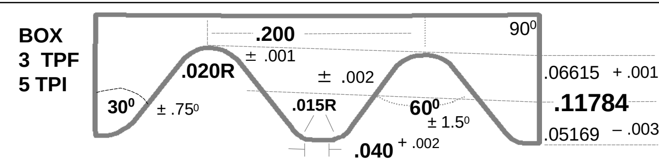












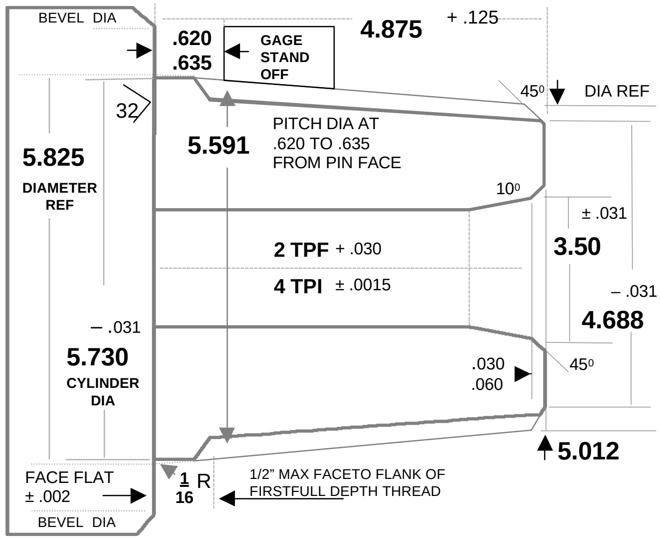
CONNECTION DIMENSIONS

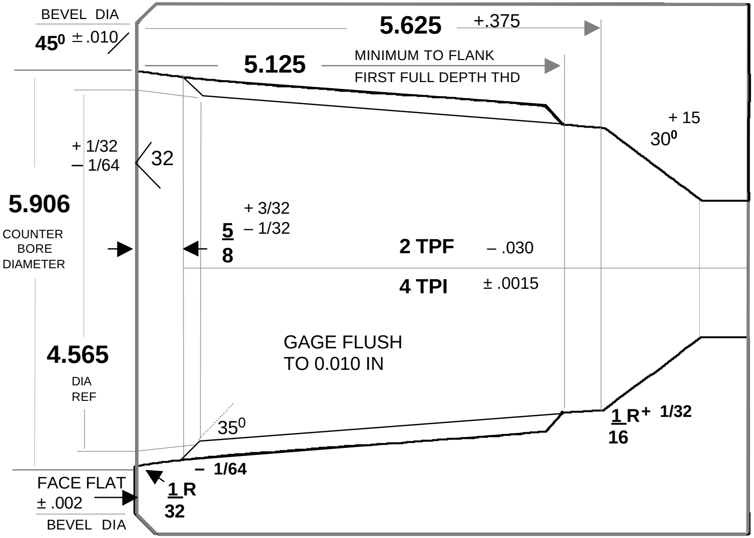
5-1/2 FULL HOLE

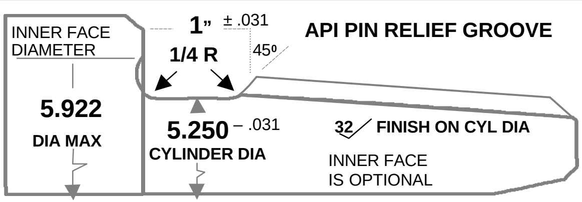
COMMON O.D AND BEVELS (± 1/64)

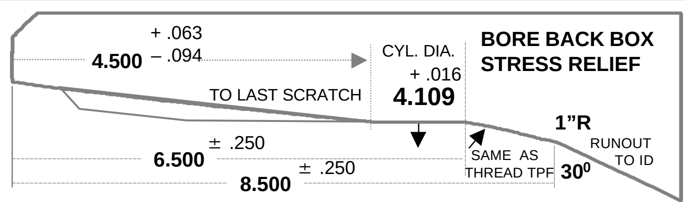
OD	6-7/8	7	7-1/8	7-1/4	7-3/8	7-1/2	7-5/8	7-3/4	8
BEV	6-17/64	6-23/32	6-23/32	6-29/32	6-29/32	7-3/32	7-3/32	7-9/32	7-15/32

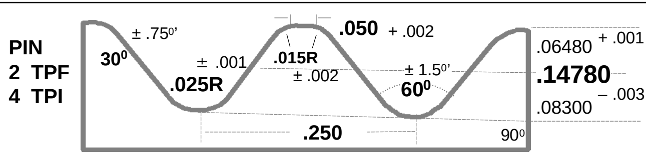
INTERCHANGES WITH:

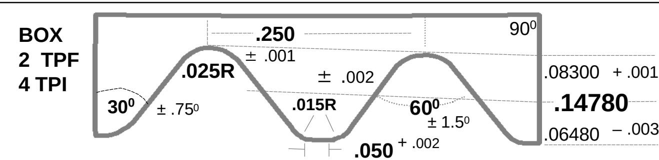












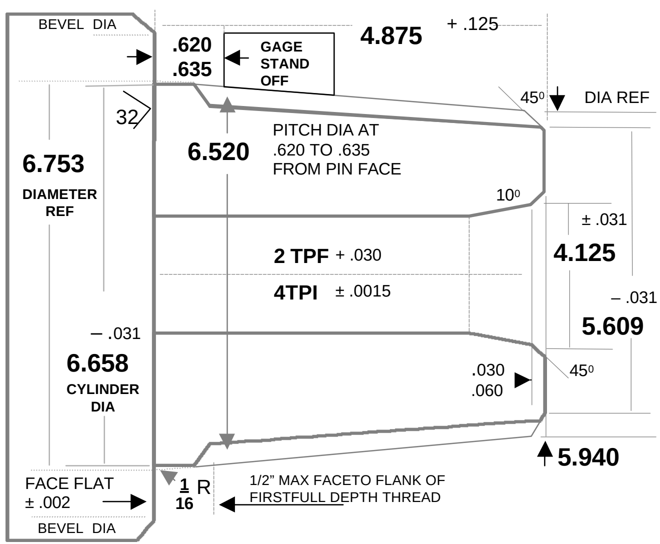
CONNECTION DIMENSIONS

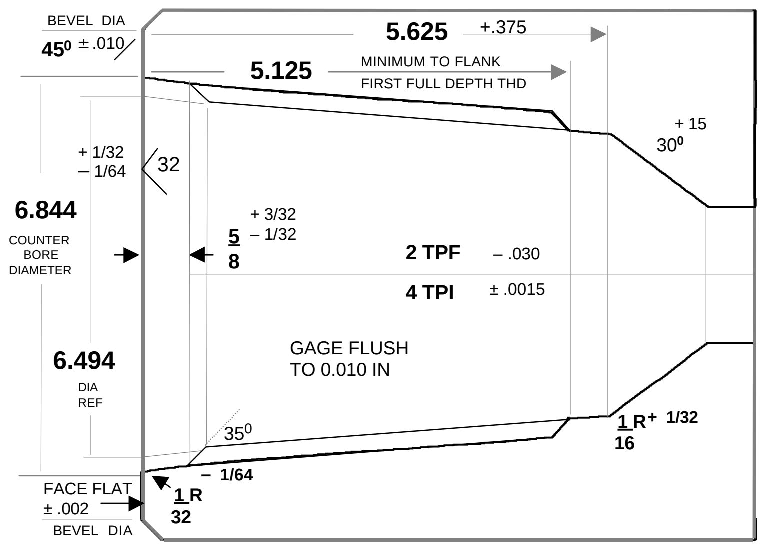
6-5/8 FULL HOLE

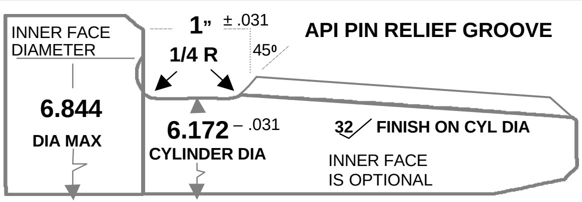
COMMON O.D AND BEVELS (± 1/64)

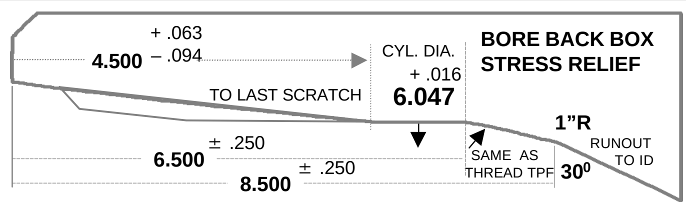
OD	8	8-1/8	8-1/4	8-3/8	8-1/2	8-5/8	8-3/4	9	9-1/4
BEV	7-45/64	7-45/64	7-57/64	7-57/64	8-5/64	8-5/64	8-17/64	8-29/64	8-41/64

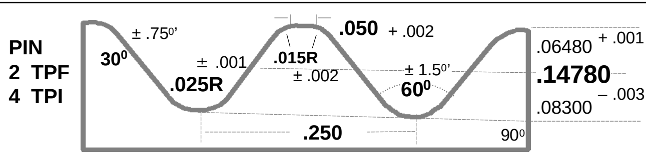
INTERCHANGES WITH:

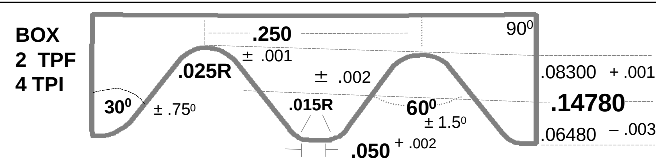












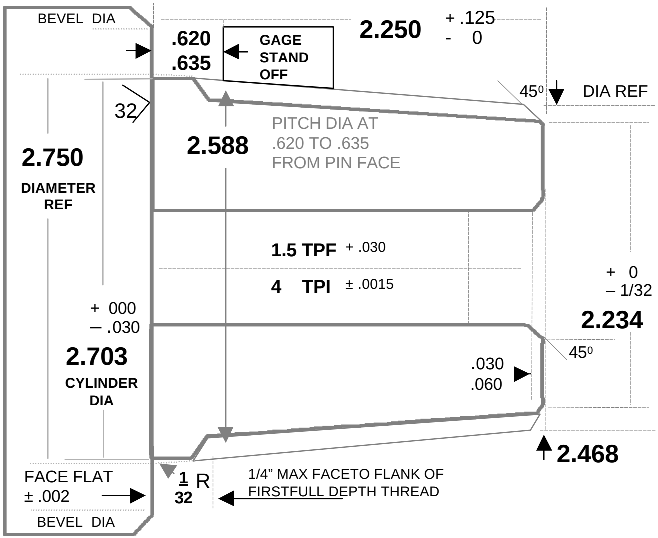
CONNECTION DIMENSIONS

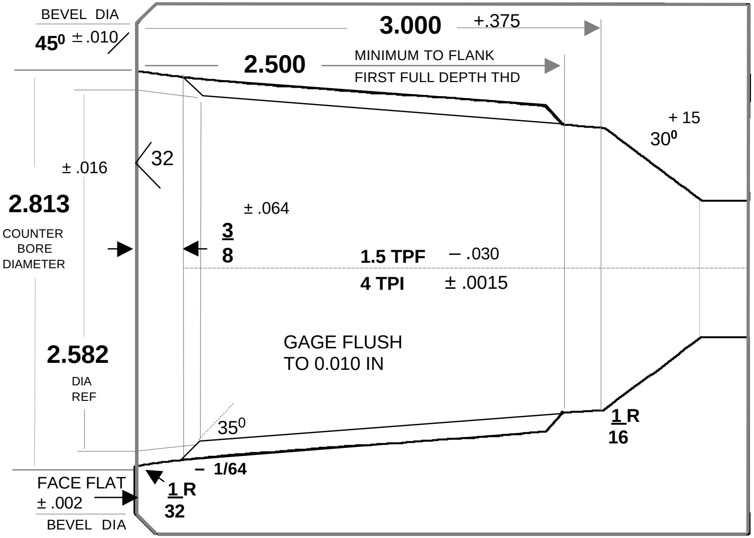
2-3/8 AMERICAN OPEN HOLE

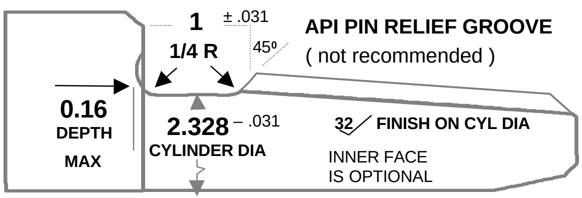
COMMON O.D AND BEVELS (± 1/64)

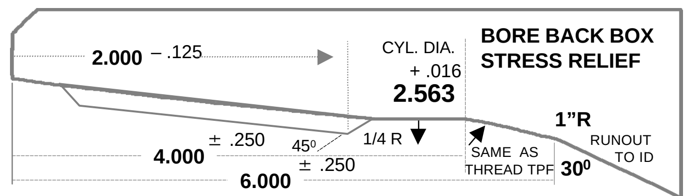
OD **BEV**	**3-1/8** **3**								

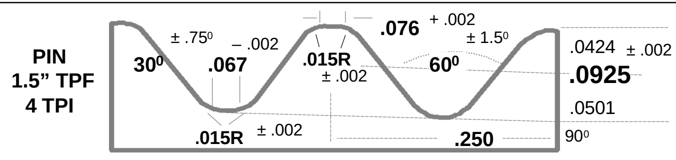
INTERCHANGES WITH:

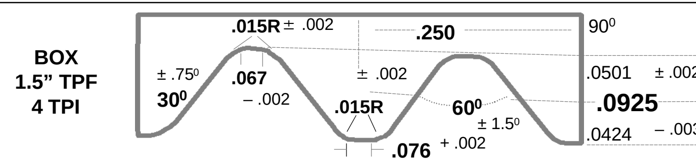












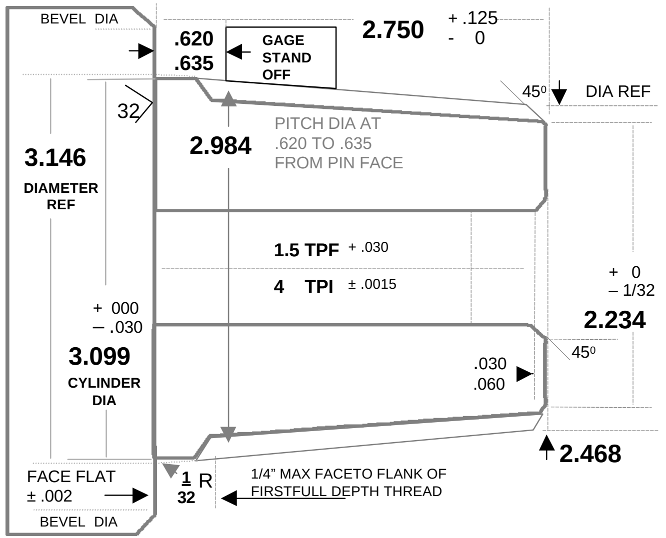
CONNECTION DIMENSIONS

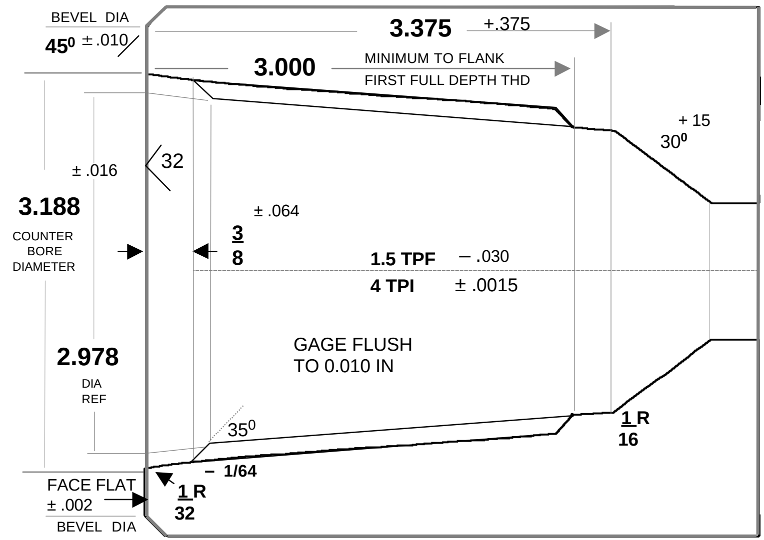
2-7/8 AMERICAN OPEN HOLE

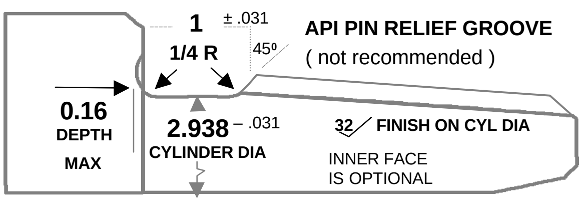
COMMON O.D AND BEVELS (± 1/64)

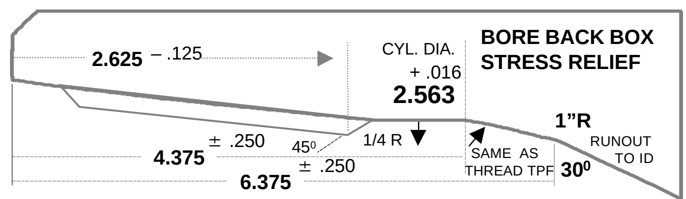
OD BEV	3-3/4 3-39/64	3-7/8 3-39/64	4 3-3/4	4-1/4 3-3/4					

INTERCHANGES WITH:

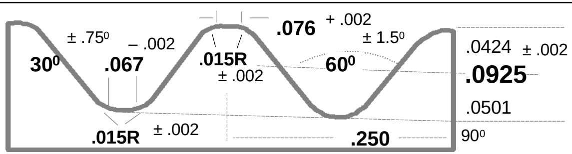




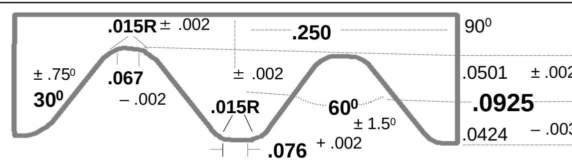




PIN
1.5” TPF
4 TPI



BOX
1.5” TPF
4 TPI



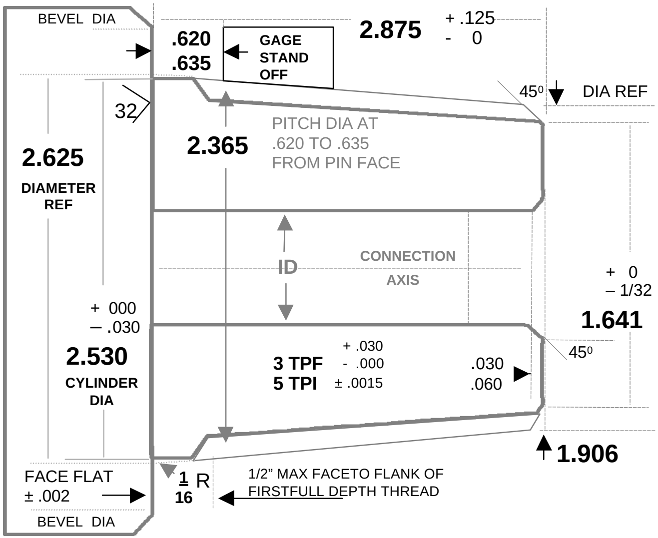
CONNECTION DIMENSIONS

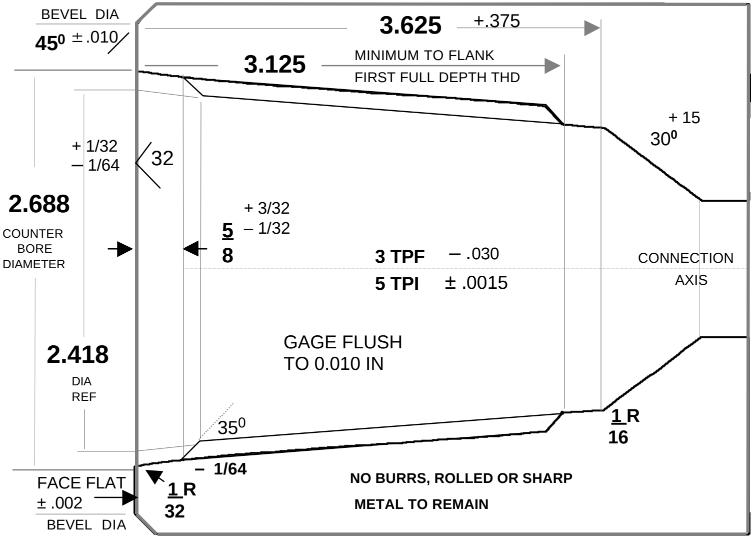
2-3/8 Regular

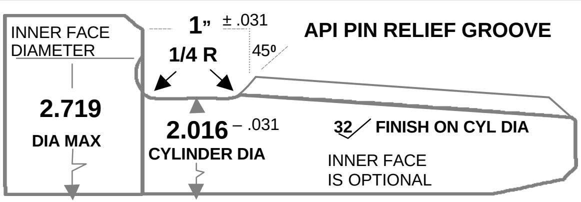
COMMON O.D AND BEVELS (± 1/64)

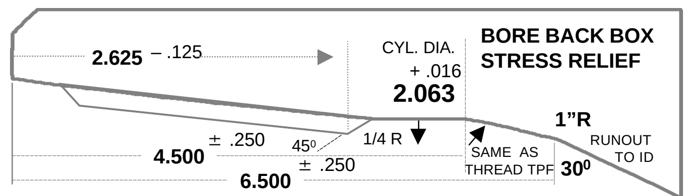
OD BEV	3-1/4 3-1/64	<u>3-3/8</u> 3-13/64	3-1/2 3-13/64						

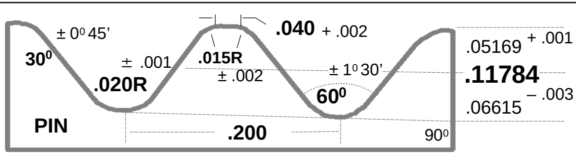
INTERCHANGES WITH:

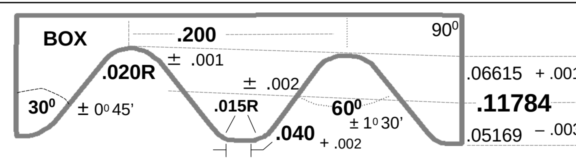












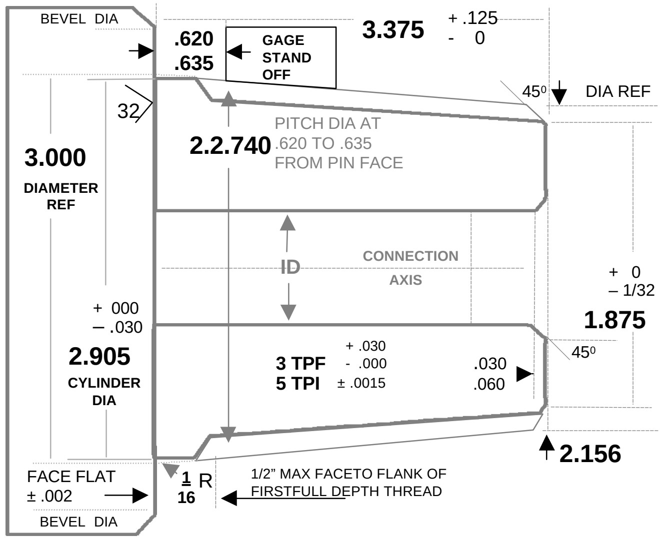
CONNECTION DIMENSIONS

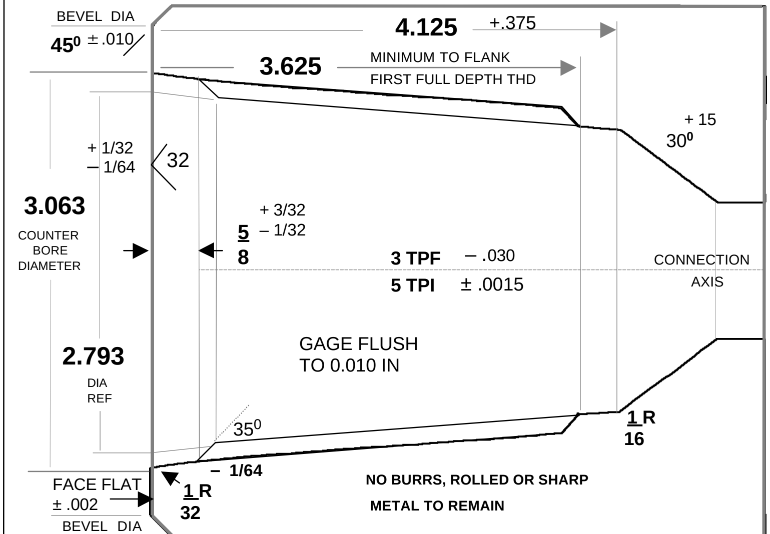
2-7/8 Regular

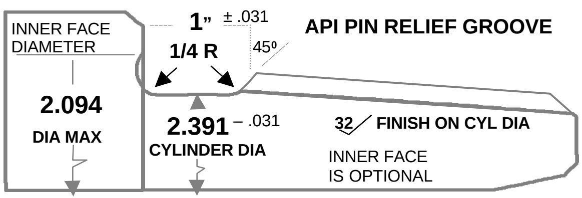
COMMON O.D AND BEVELS (± 1/64)

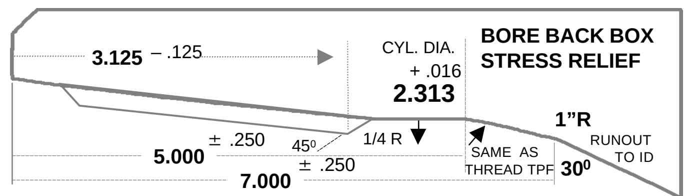
OD BEV	3-7/8 3-37/64								

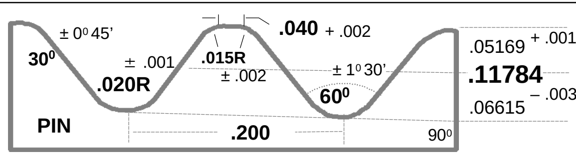
INTERCHANGES WITH:

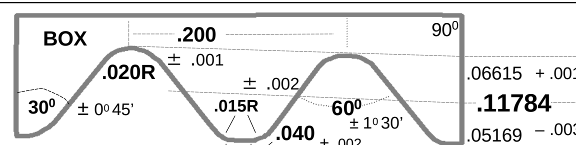












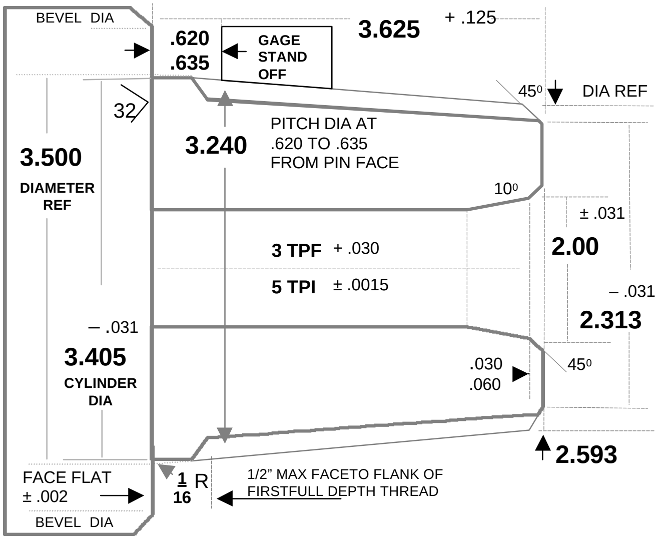
CONNECTION DIMENSIONS

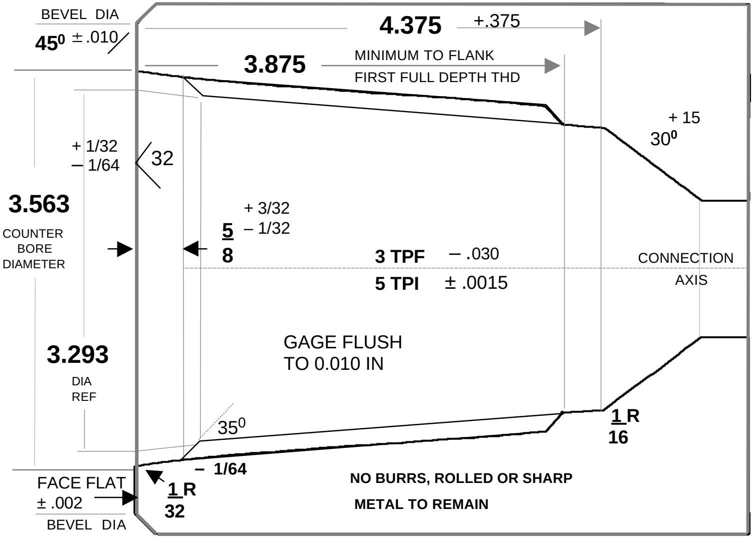
3-1/2 Regular

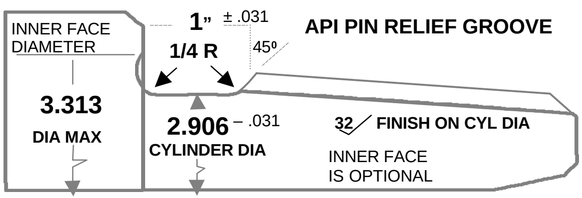
COMMON O.D AND BEVELS (± 1/64)

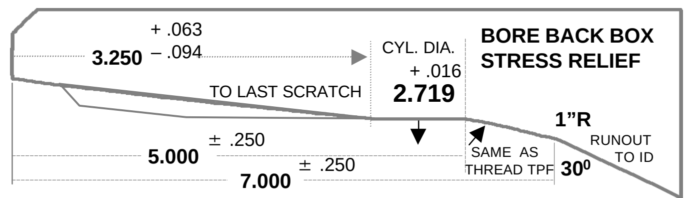
OD	**4-3/8**	**4-1/2**							
BEV	**4-5/64**	**4-17/64**							

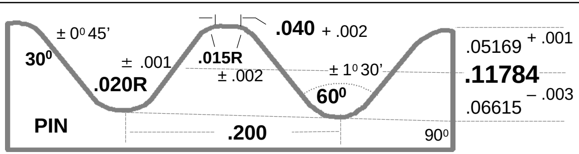
INTERCHANGES WITH:

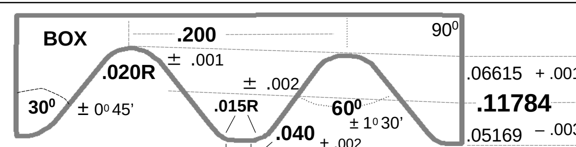












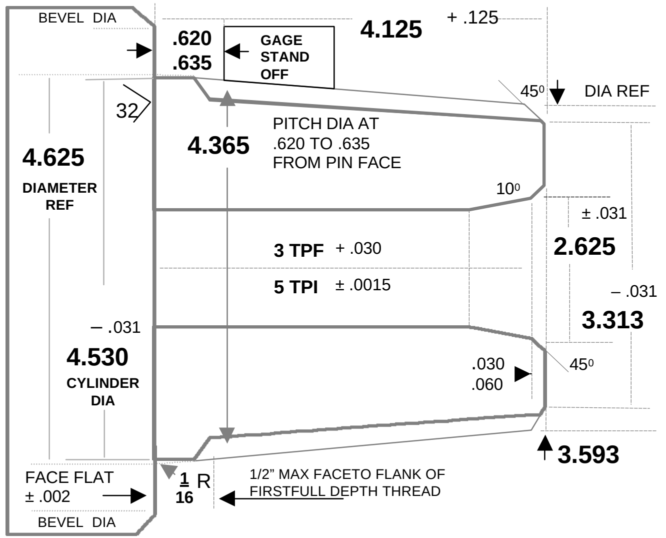
CONNECTION DIMENSIONS

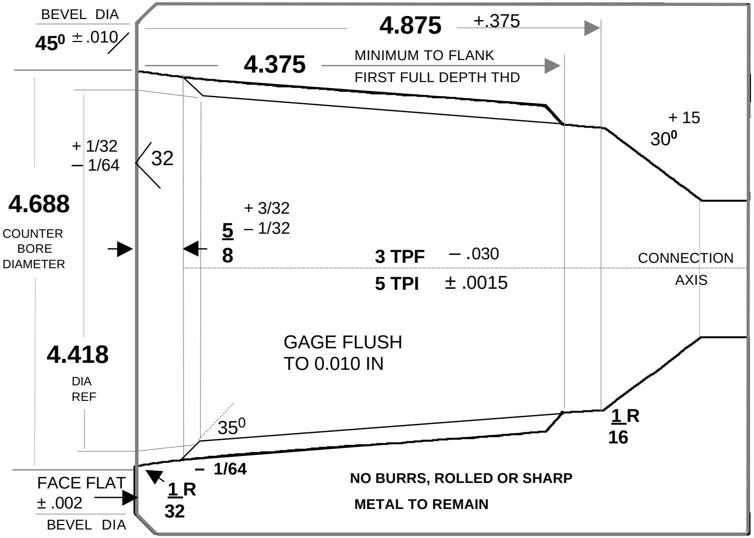
4-1/2 Regular

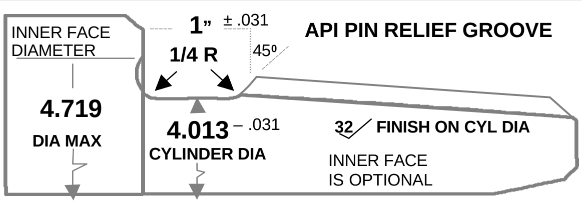
COMMON O.D AND BEVELS (± 1/64)

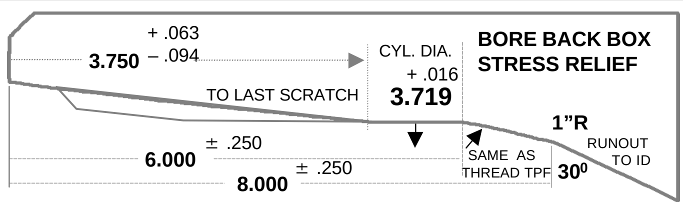
OD / BEV									
OD	5-5/8	5-3/4	5-7/8	6					
BEV	5-19/64	5-31/64	5-31/64	5-43/64					

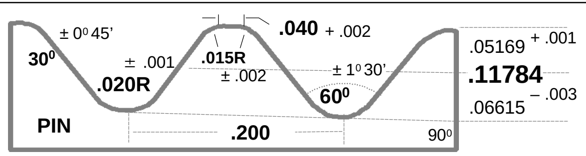
INTERCHANGES WITH:

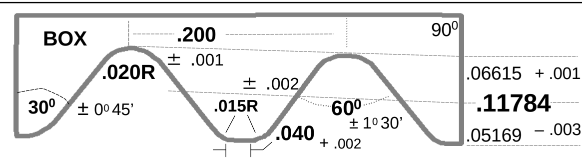












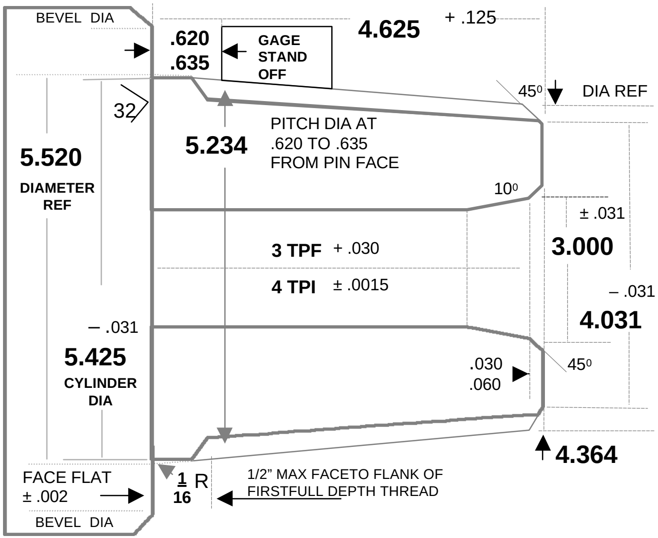
CONNECTION DIMENSIONS

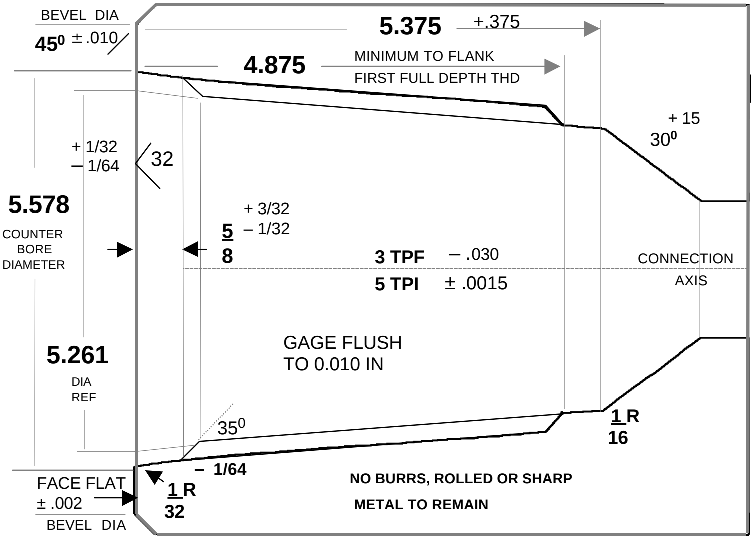
5-1/2 Regular

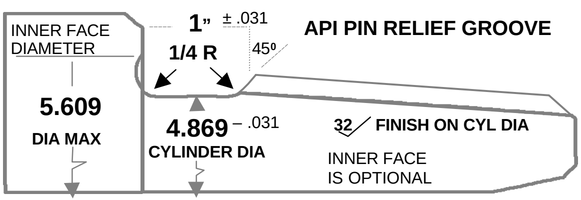
COMMON O.D AND BEVELS (± 1/64)

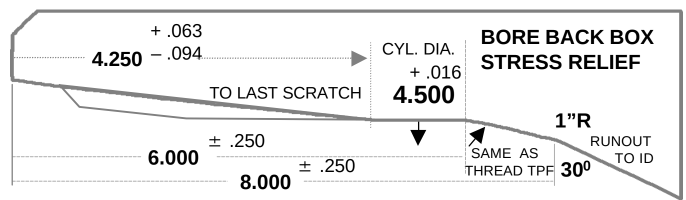
OD BEV	6-5/8 6-9/32	6-3/4 6-15/32	6-7/8 6-15/32	7 6-21/32	7-1/8 6-21/32	7-1/4 6-27/32	7-3/8 6-27/32	7-1/2 7-1/32	

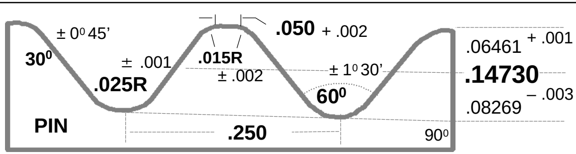
INTERCHANGES WITH:

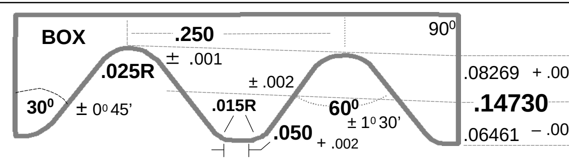












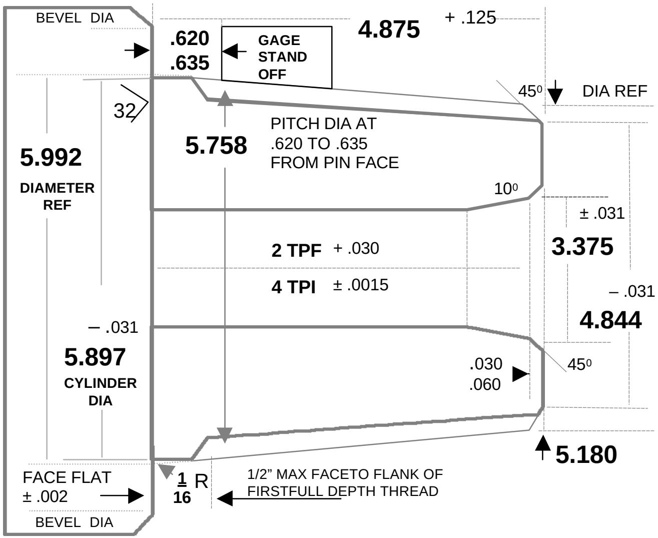
CONNECTION DIMENSIONS

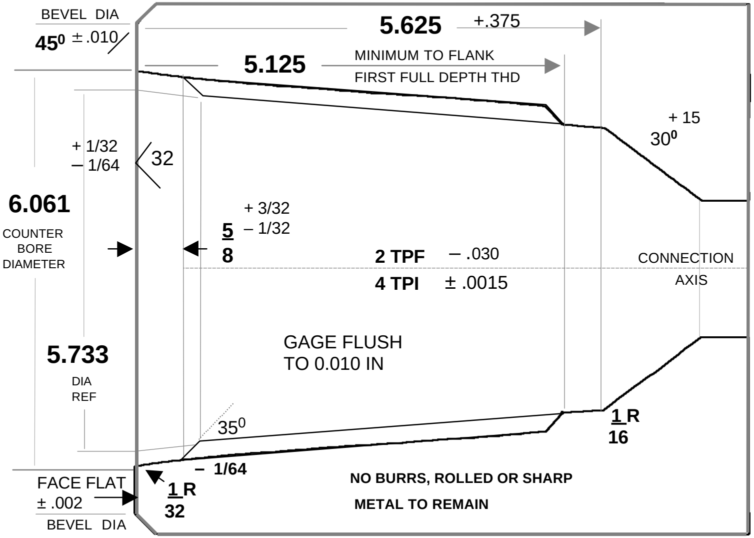
6-5/8 Regular

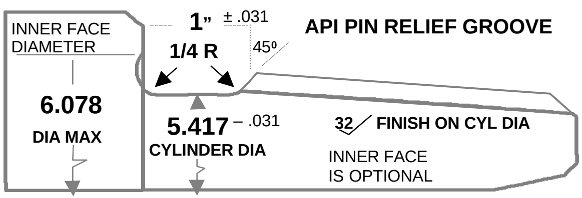
COMMON O.D AND BEVELS (± 1/64)

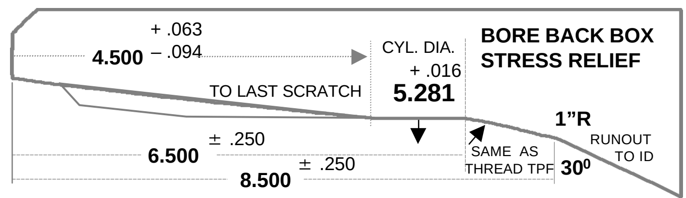
OD BEV	7-1/2 7-9/64	7-5/8 7-9/64	7-3/4 7-21/64	7-7/8 7-21/64	8 7-33/64	8-1/8 7-33/64	8-1/4 7-45/64		

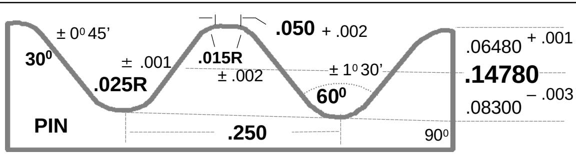
INTERCHANGES WITH:

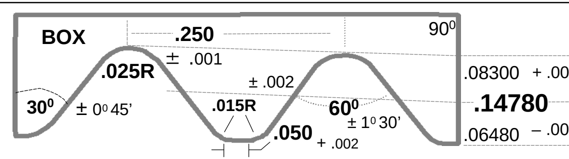












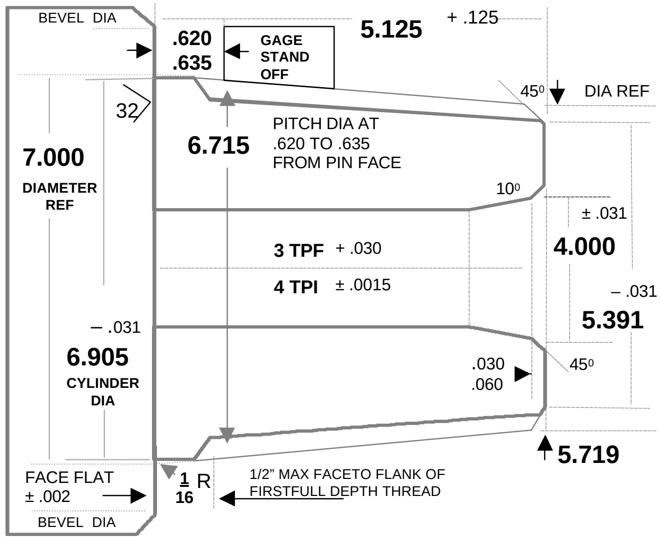
CONNECTION DIMENSIONS

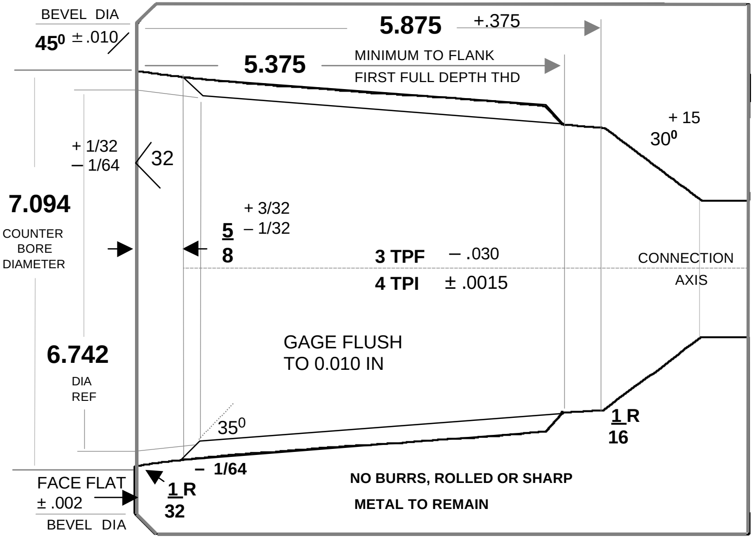
7-5/8 Regular

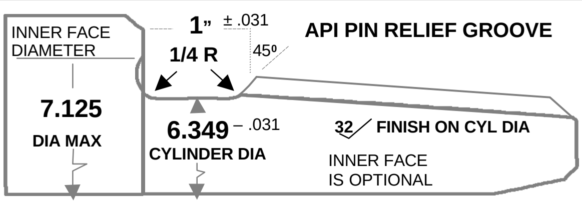
COMMON O.D AND BEVELS (± 1/64)

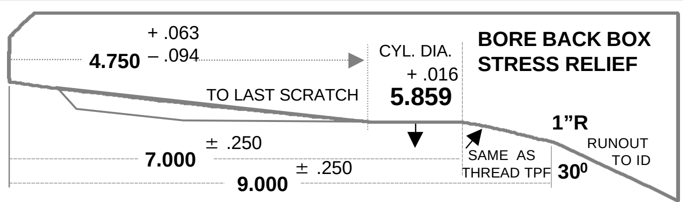
OD BEV	8-5/8 8-1/4	8-3/4 8-1/4	8-7/8 8-7/16	9 8-7/16	9-1/8 8-5/8	9-1/4 8-5/8	9-3/8 8-13/16	9-1/2 8-13/16	REC L..T.

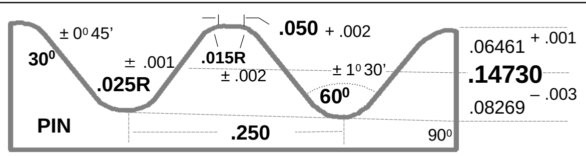
Note: For drill collars over 9-1/2" od - Low Torque Feature should be considered.

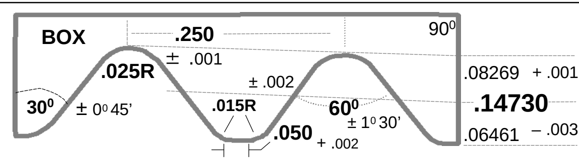












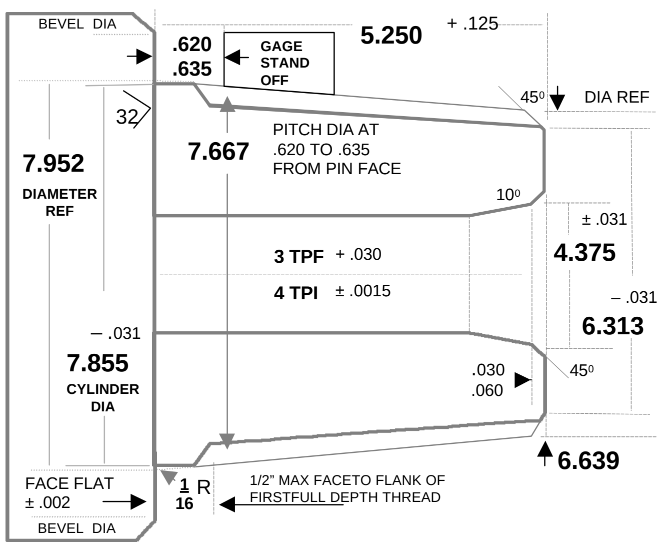
CONNECTION DIMENSIONS

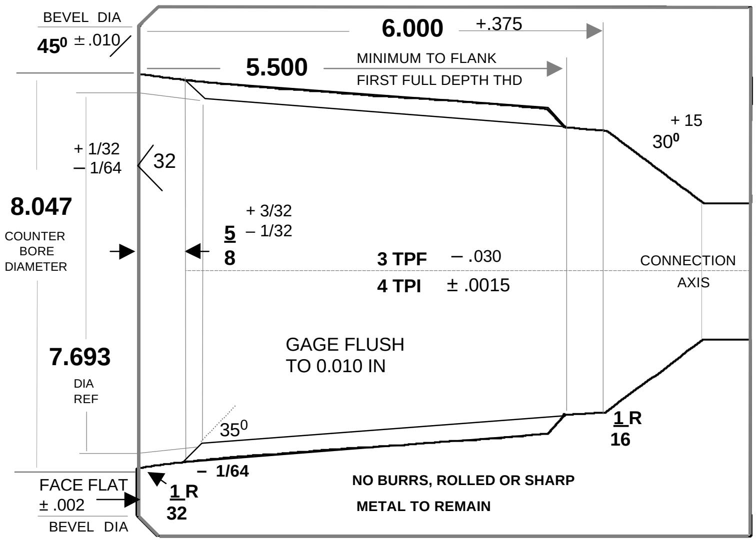
8-5/8 Regular

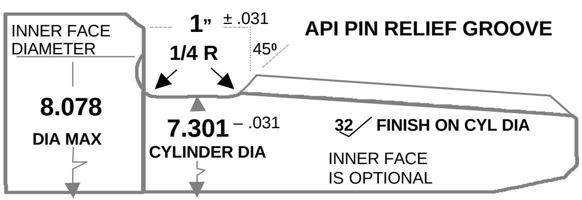
COMMON O.D AND BEVELS (± 1/64)

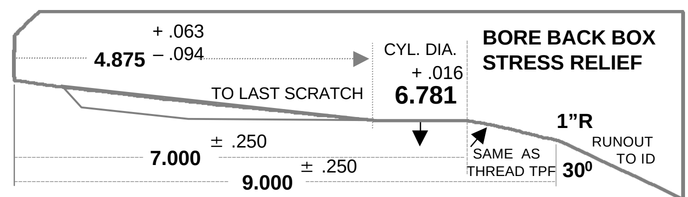
OD BEV	9-5/8 9-9/64	9-3/4 9-21/64	9-7/8 9-21/64	10 9-33/64	10-1/4 9-45/64	10-1/2 9-57/64	Over 10-1/2 USE LOW TORQUE

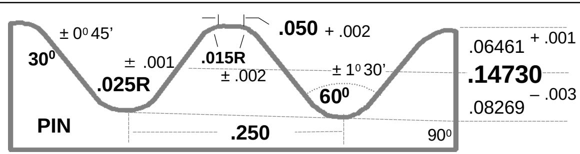
Note: For drill collars over 10-1/2” od - Low Torque Feature should be considered.

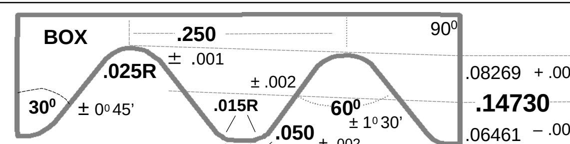




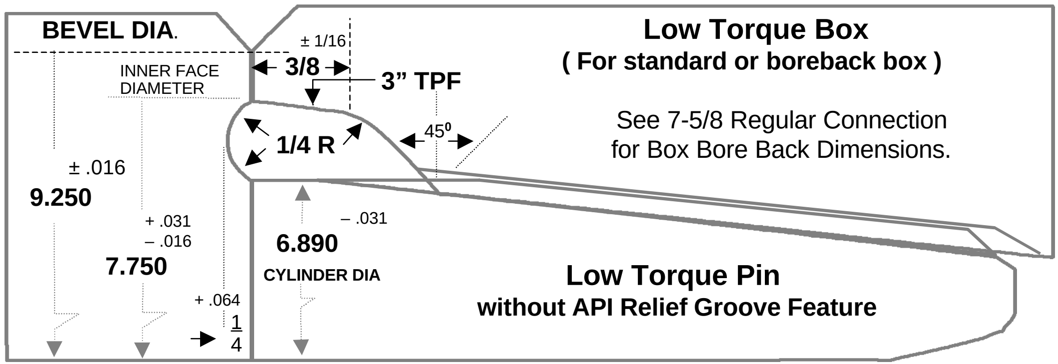


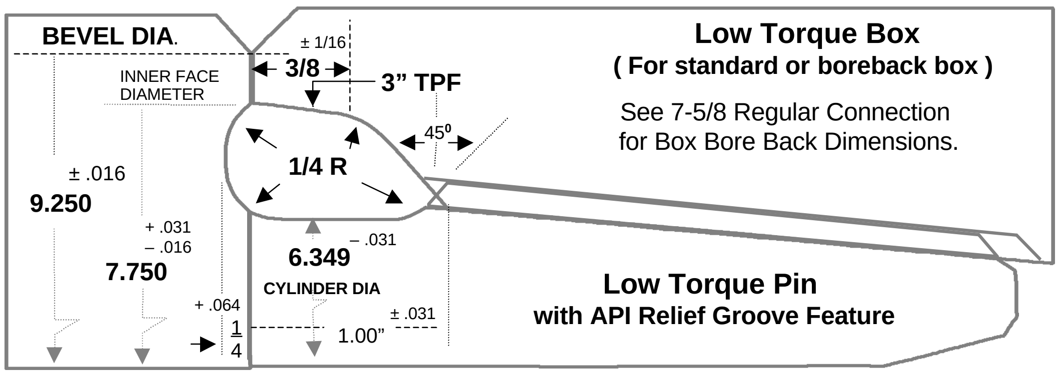




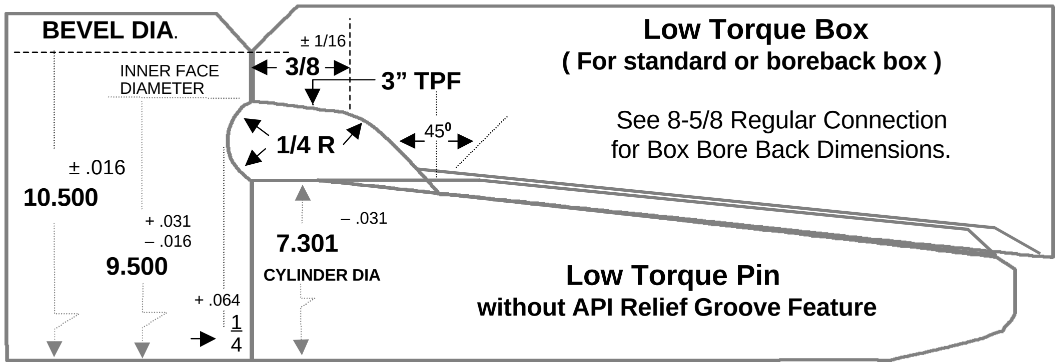


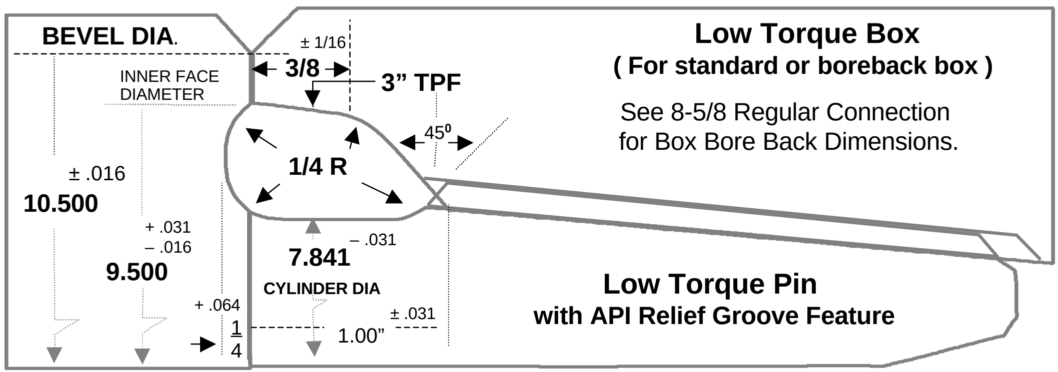
CONNECTION DIMENSIONS **7-5/8 Regular Low Torque Face**	See 7-5/8 Regular Connection for Pin and Box Dimensions not shown.





CONNECTION DIMENSIONS 8-5/8 Regular Low Torque Face	See 8-5/8 Regular Connection for Pin and Box Dimensions not shown.





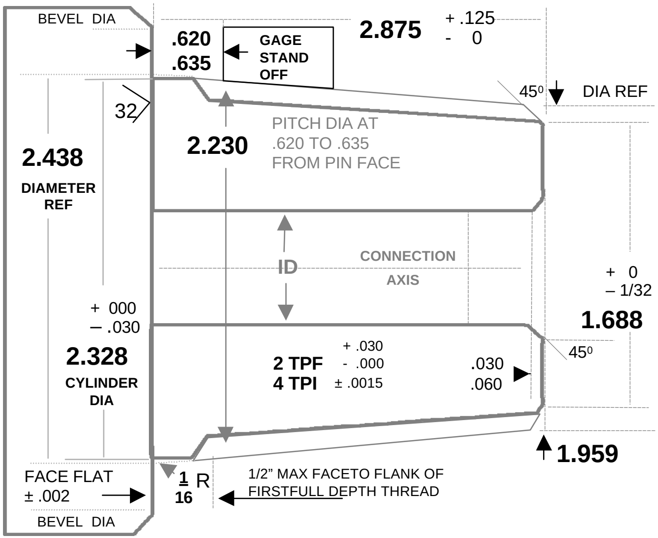
CONNECTION DIMENSIONS

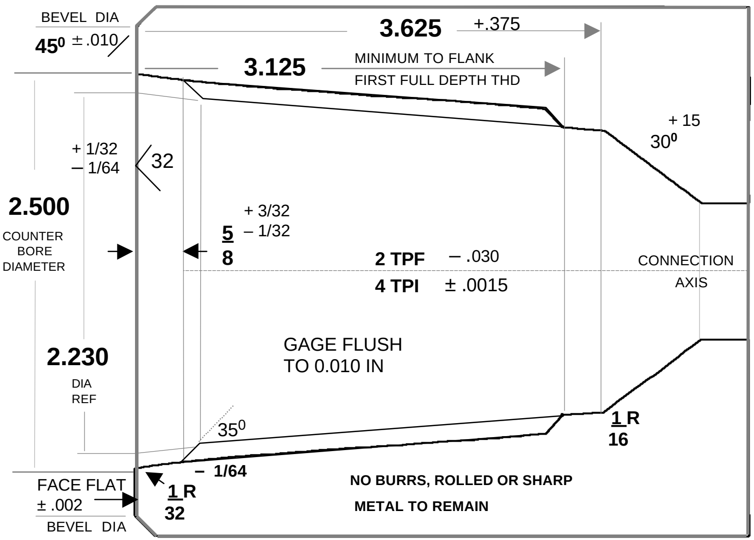
2-3/8 SLIM HOLE (Hughes)

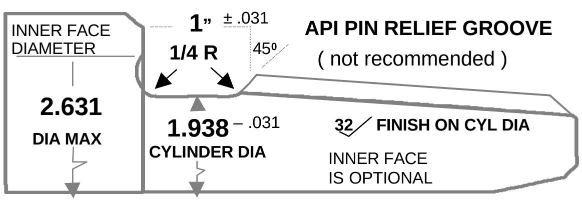
COMMON O.D AND BEVELS (± 1/64)

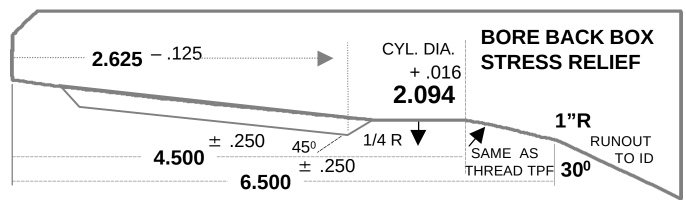
OD **BEV**	**3-1/8** **2-31/32**								

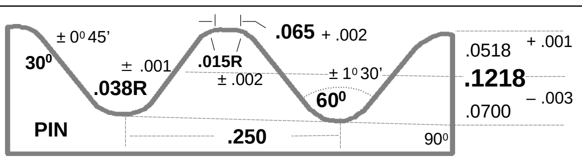
INTERCHANGES WITH:

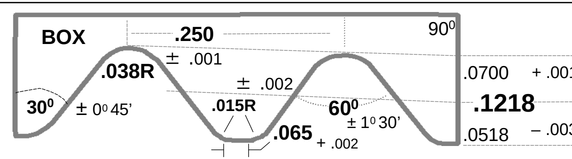












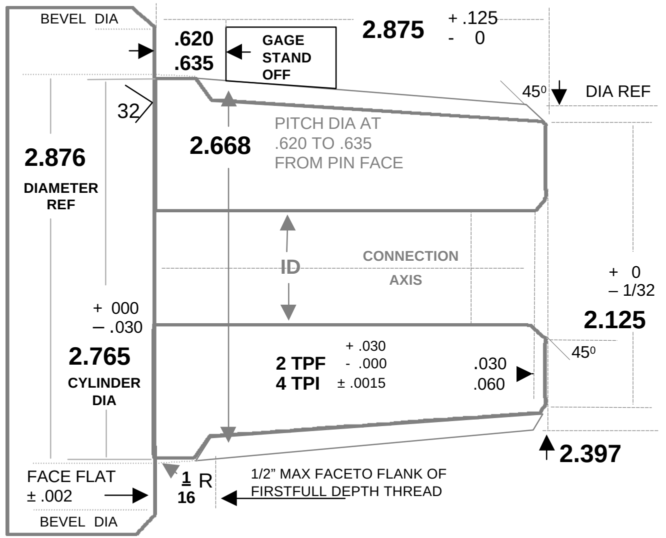
CONNECTION DIMENSIONS

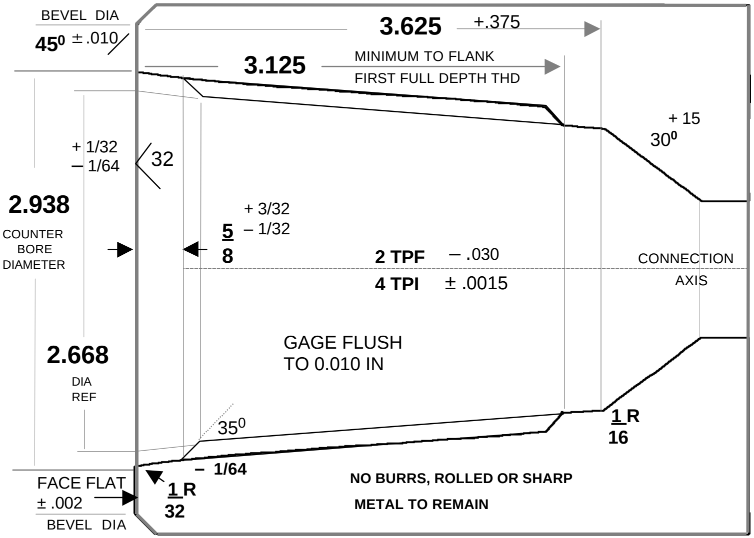
2-7/8 SLIM HOLE (Hughes)

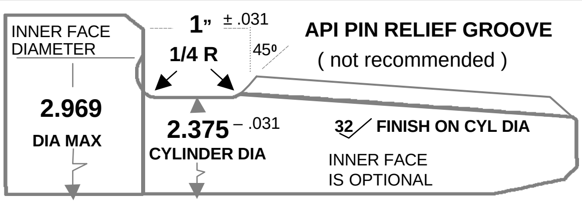
COMMON O.D AND BEVELS (± 1/64)

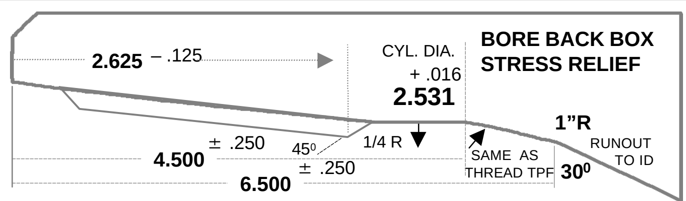
OD BEV	3-3/8 3-17/64	3-1/2 3-17/64	3-5/8 3-29/64	3-3/4 3-29/64	3-7/8 3-41/64				

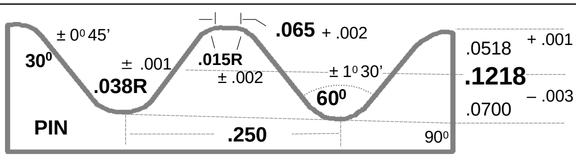
INTERCHANGES WITH: 2-3/8 IF, API 26

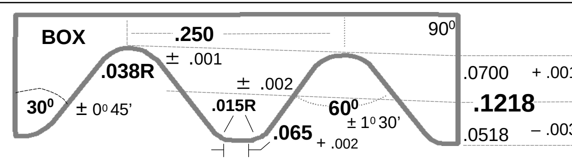












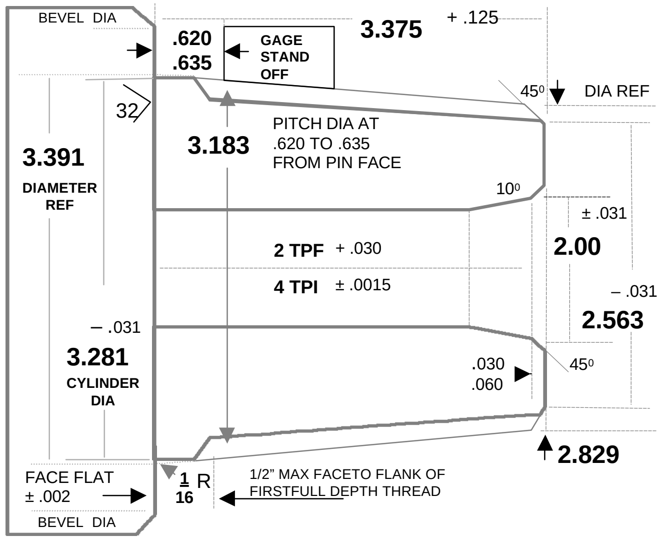
CONNECTION DIMENSIONS

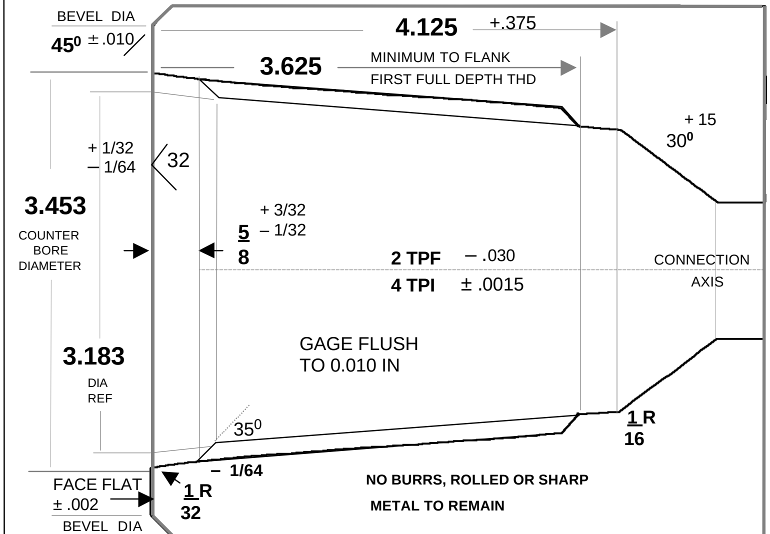
3-1/2 SLIM HOLE (Hughes)

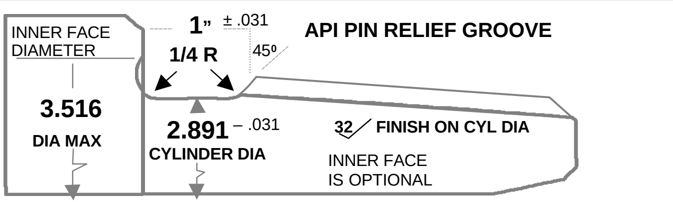
COMMON O.D AND BEVELS (± 1/64)

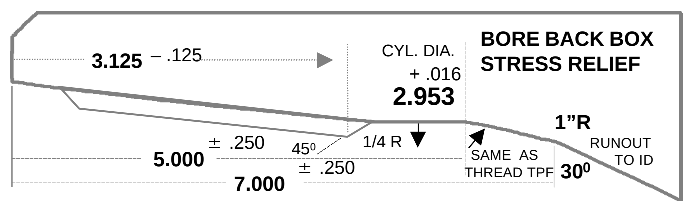
OD BEV	4-1/8 3-61/64	4-1/4 3-61/64	4-3/8 4-9/64						

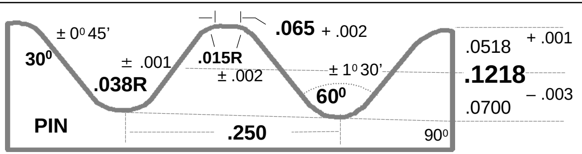
INTERCHANGES WITH: 2-7/8 IF, API 31

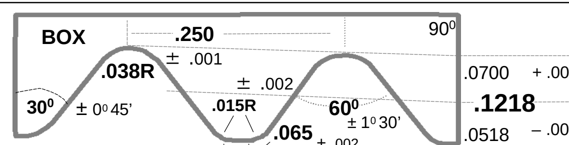












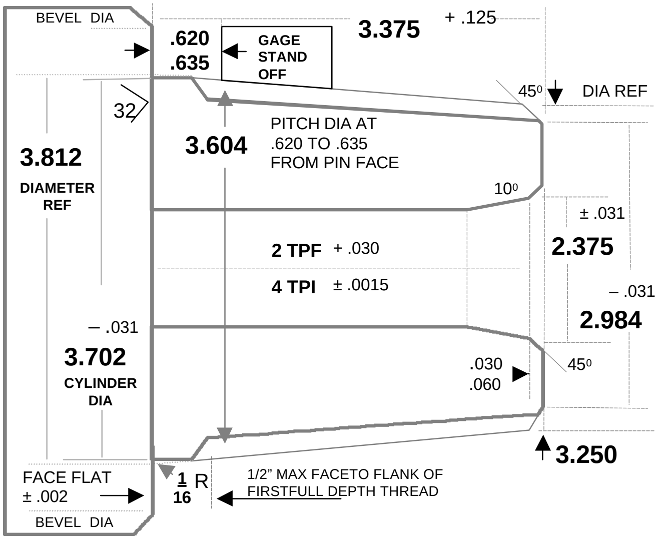
CONNECTION DIMENSIONS

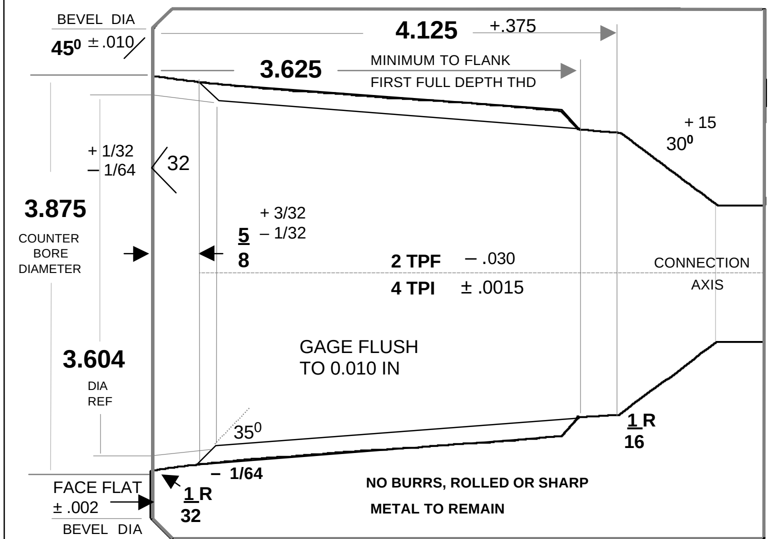
4 SLIM HOLE (Hughes)

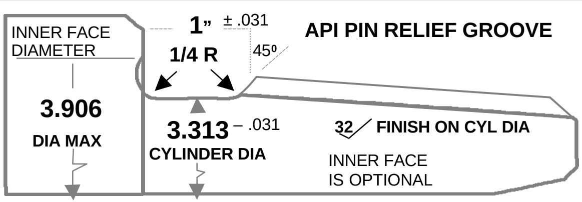
COMMON O.D AND BEVELS (± 1/64)

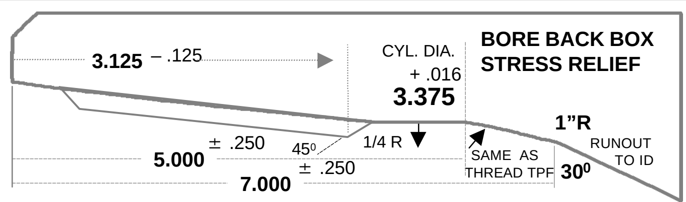
OD BEV	4-3/4 4-17/32	4-7/8 4-17/32	5 4-23/32						

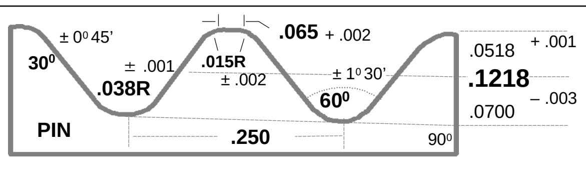
INTERCHANGES WITH: 3-1/2 XH

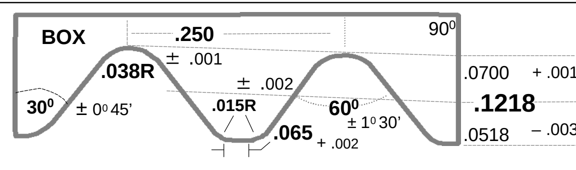












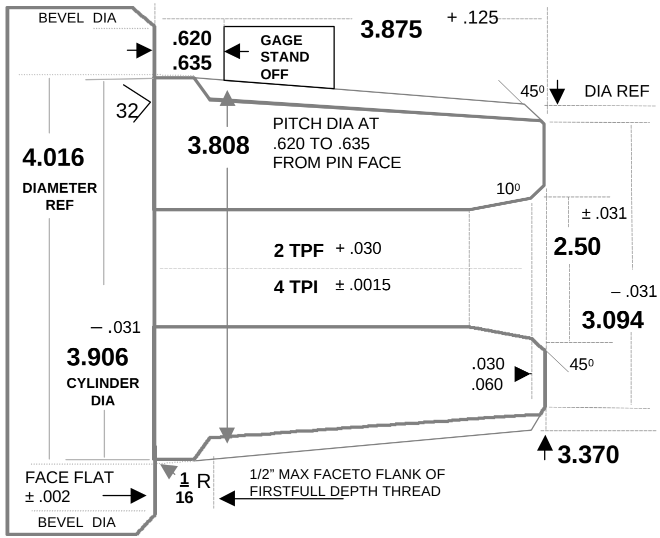
CONNECTION DIMENSIONS

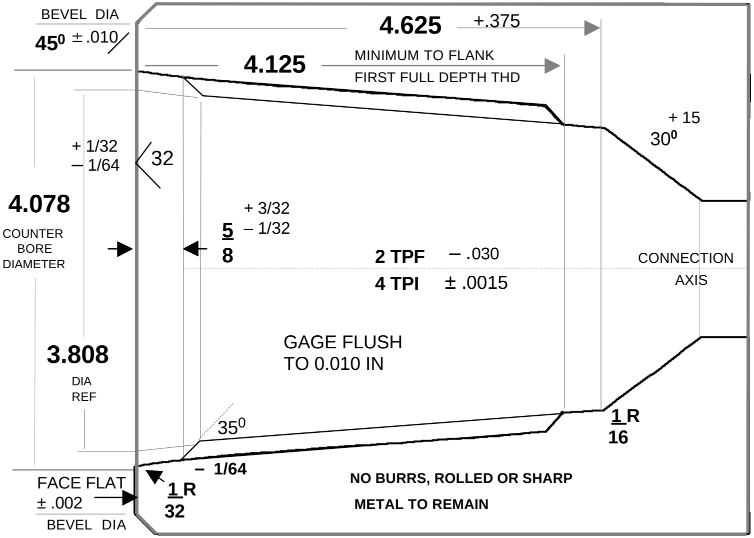
4-1/2 SLIM HOLE (Hughes)

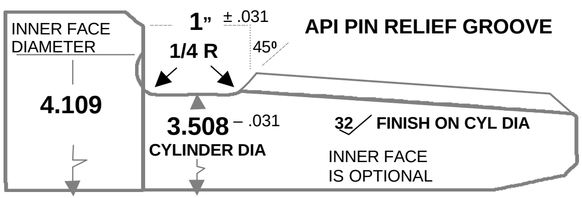
COMMON O.D AND BEVELS (± 1/64)

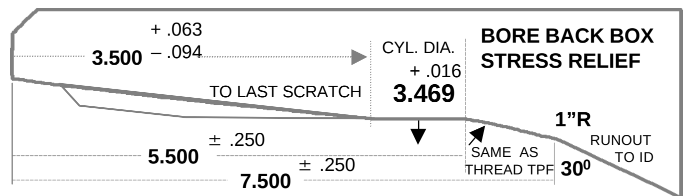
OD / BEV	4-3/4	4-7/8	5	5-1/8	5-1/4				
OD	4-3/4	4-7/8	5	5-1/8	5-1/4				
BEV	4-37/64	4-37/64	4-49/64	4-49/64	4-61/64				

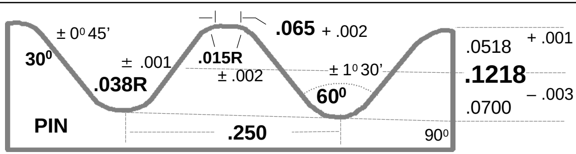
INTERCHANGES WITH: 3-1/2 IF, API 38

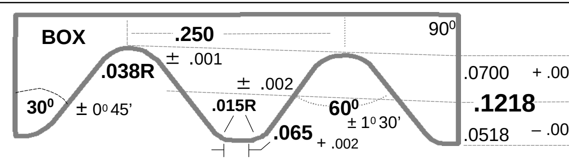












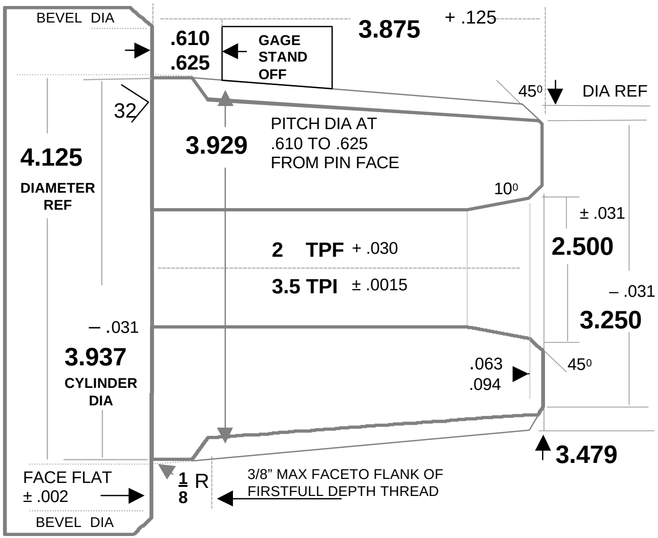
CONNECTION DIMENSIONS

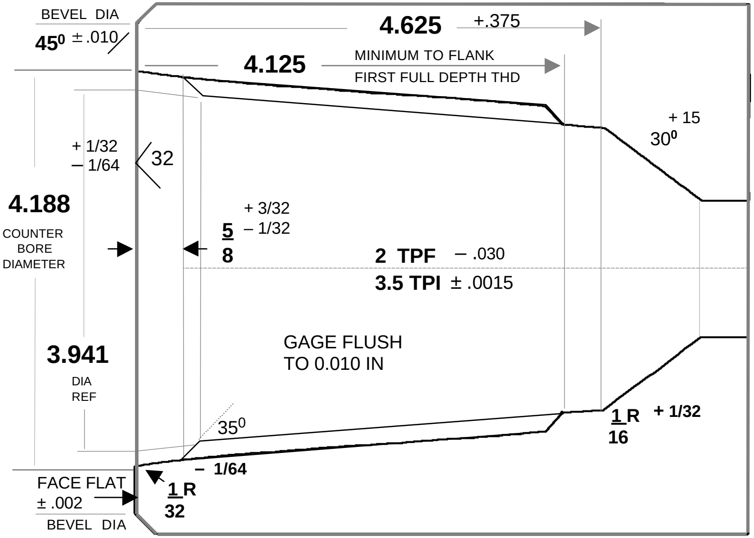
3-1/2 H90

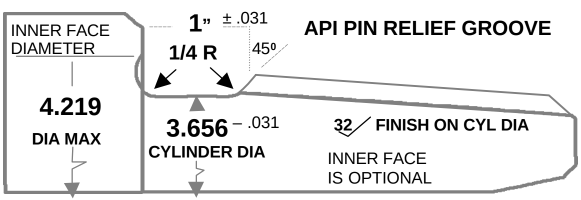
COMMON O.D AND BEVELS (± 1/64)

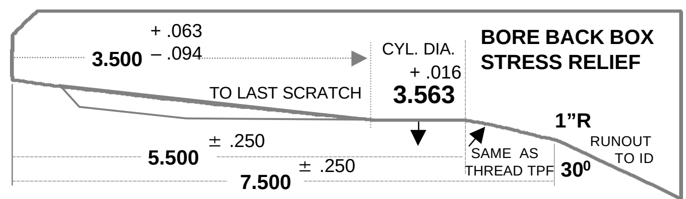
OD BEV	5 4-13/16	5-1/8 4-13/16	5-1/4 5	5-3/8 5	5-1/2 5				

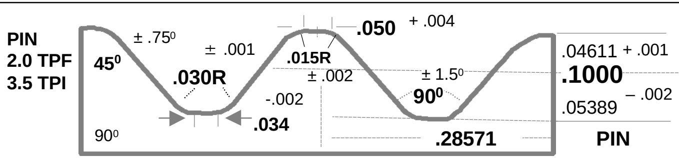
INTERCHANGES WITH:

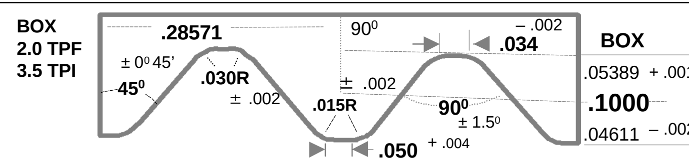












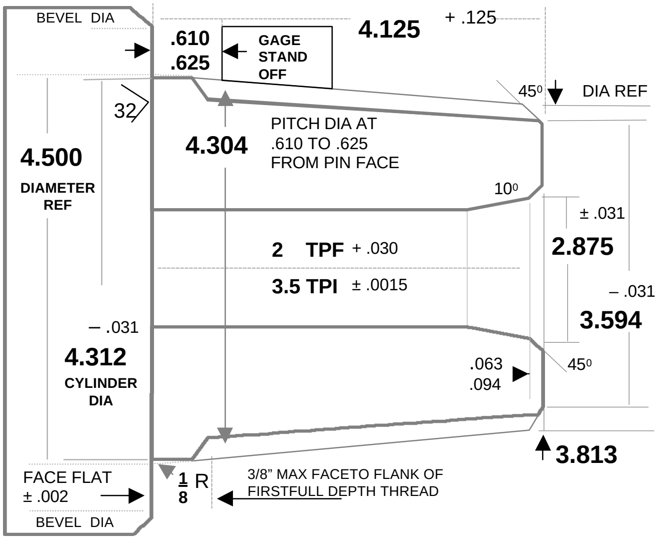
CONNECTION DIMENSIONS

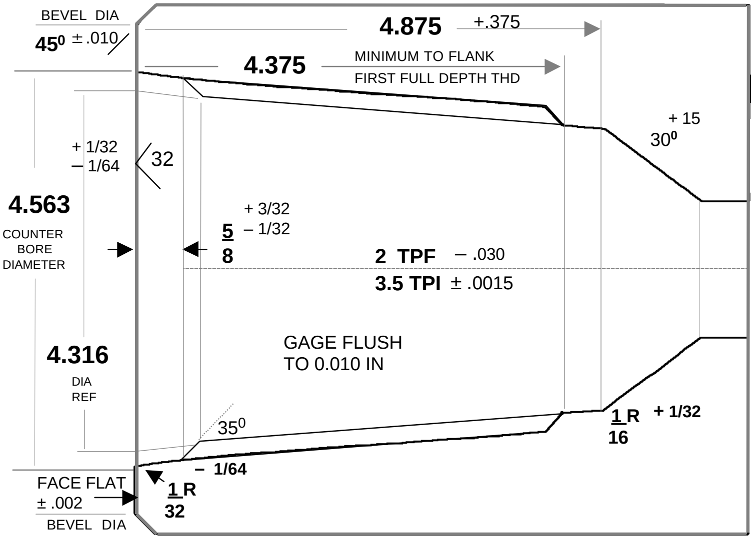
4 H90

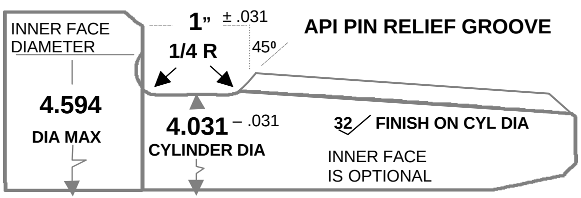
COMMON O.D AND BEVELS (± 1/64)

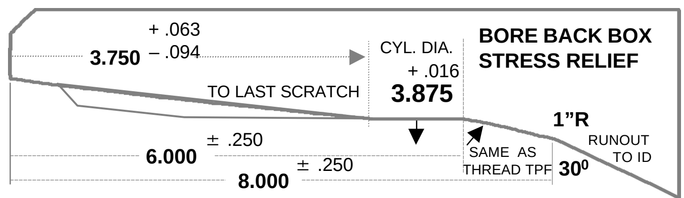
OD	**5-1/2**	**5-5/8**	**5-3/4**	**5-7/8**	**6**	**6-1/4**			
BEV	5-5/16	5-5/16	5-1/2	5-1/2	5-1/2	5-3/4			

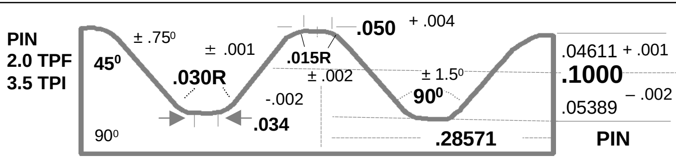
INTERCHANGES WITH:

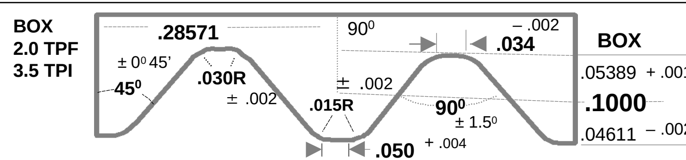












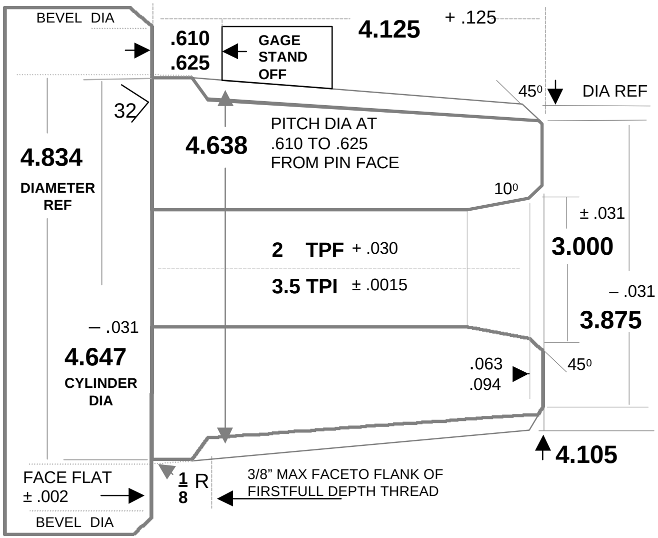
CONNECTION DIMENSIONS

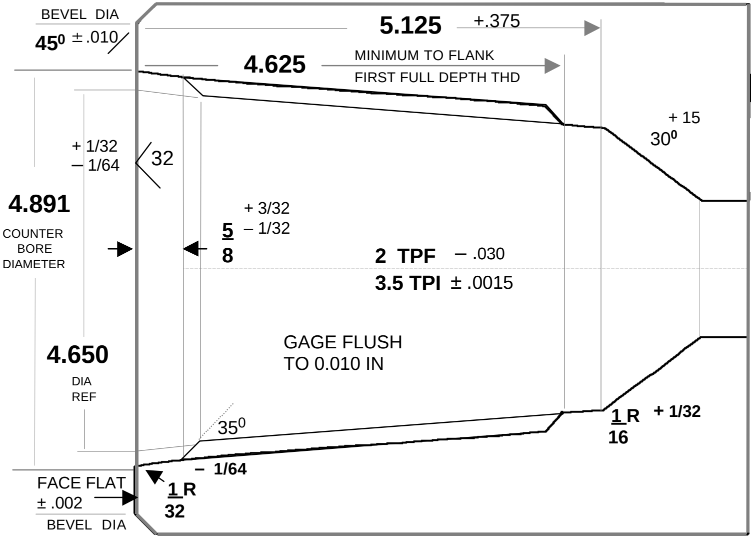
4-1/2 H90

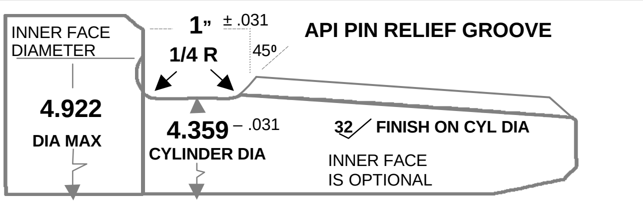
COMMON O.D AND BEVELS (± 1/64)

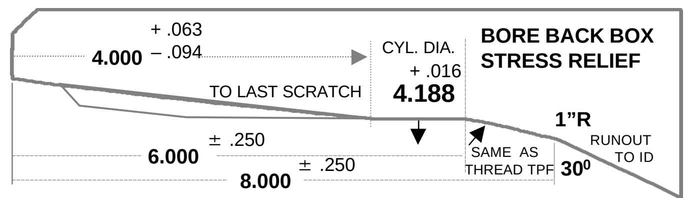
OD / BEV									
OD	6	6-1/8	6-1/4	6-3/8	6-1/2	6-3/4			
BEV	5-3/4	5-3/4	6	6	6	6-1/4			

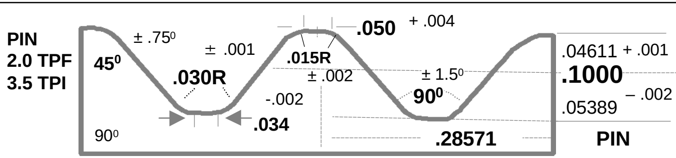
INTERCHANGES WITH:

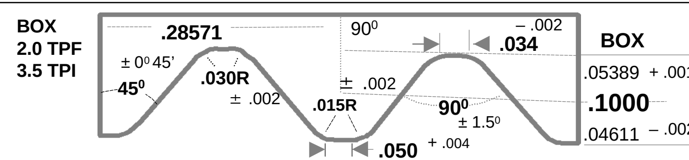












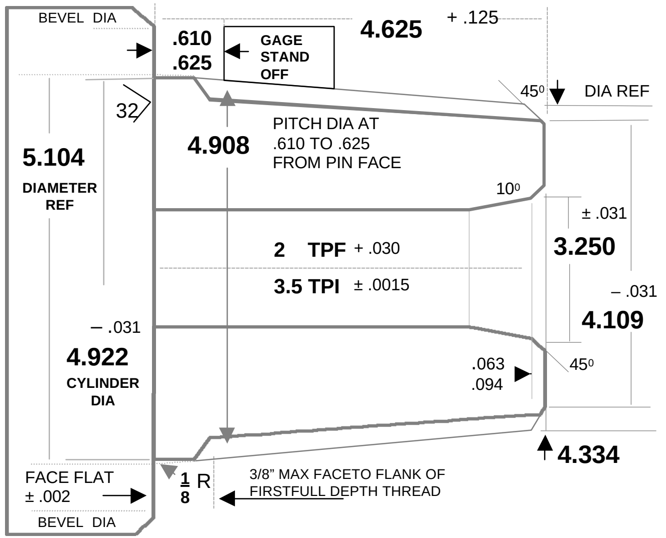
CONNECTION DIMENSIONS

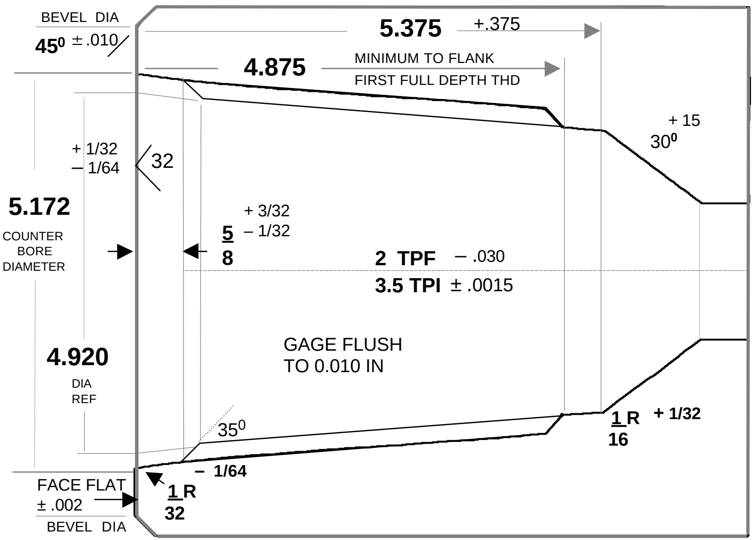
5 H90

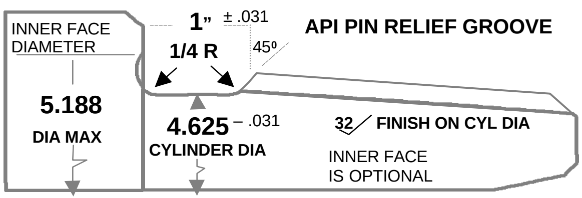
COMMON O.D AND BEVELS (± 1/64)

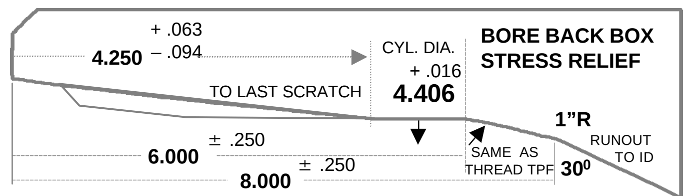
OD BEV	6-1/2 6-1/8	6-5/8 6-1/8	6-3/4 6-3/8	6-7/8 6-3/8	7 6-3/8				

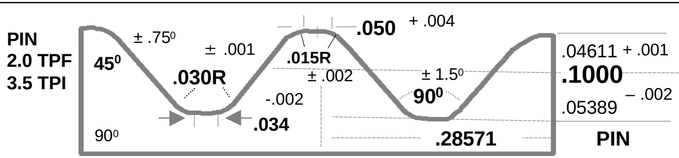
INTERCHANGES WITH:

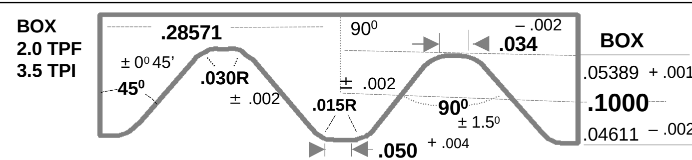












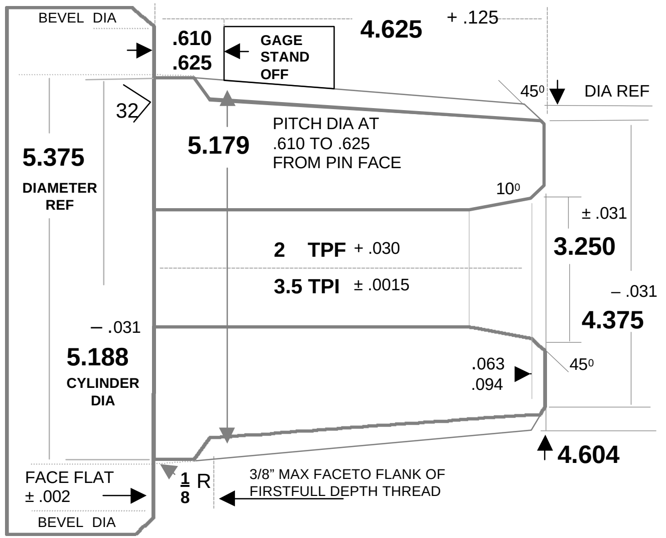
CONNECTION DIMENSIONS

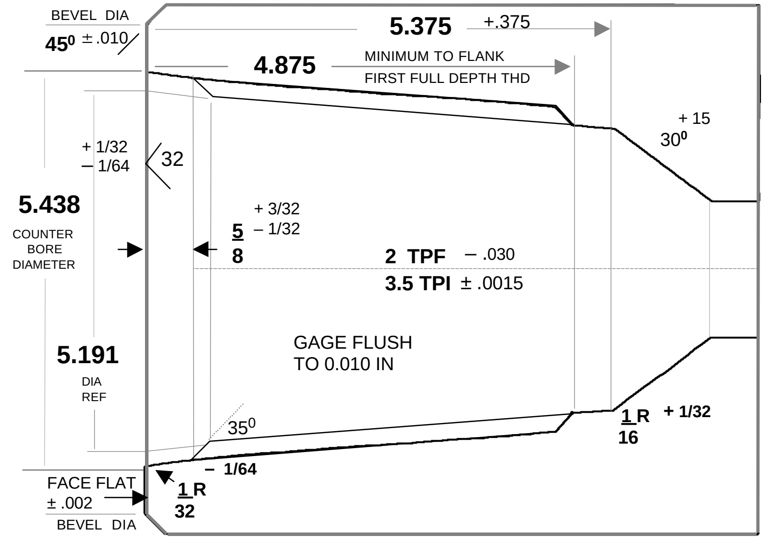
5-1/2 H90

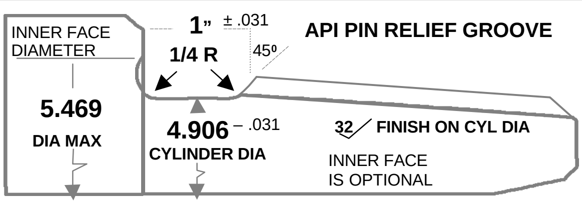
COMMON O.D AND BEVELS (± 1/64)

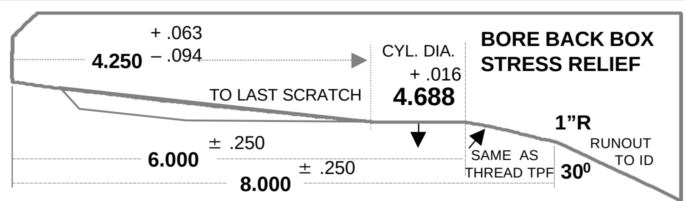
OD BEV	6-3/4 6-3/8	6-7/8 6-5/8	7 6-5/8	7-1/4 6-5/8	7-1/2 6-5/8				

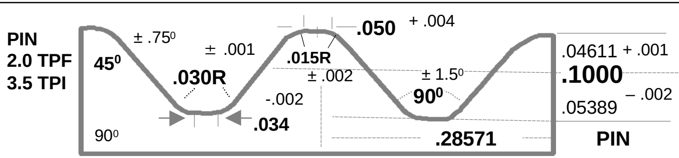
INTERCHANGES WITH:

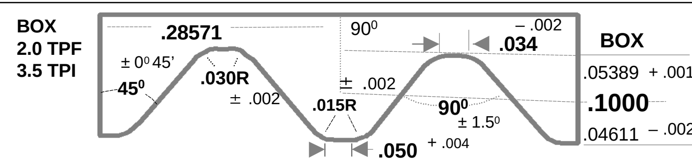












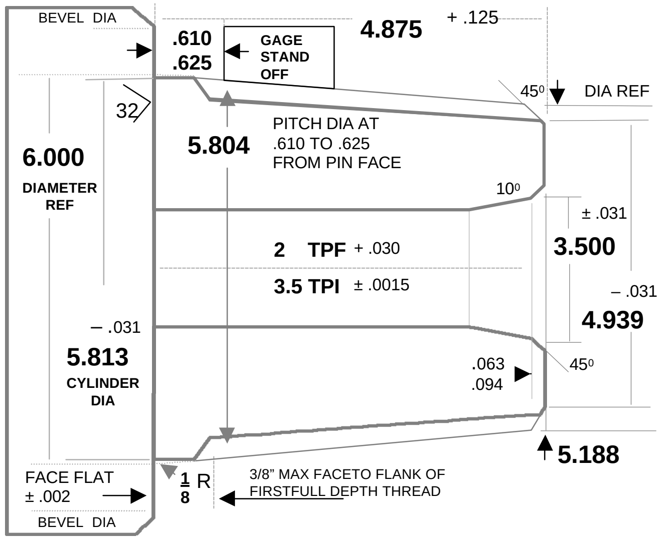
CONNECTION DIMENSIONS

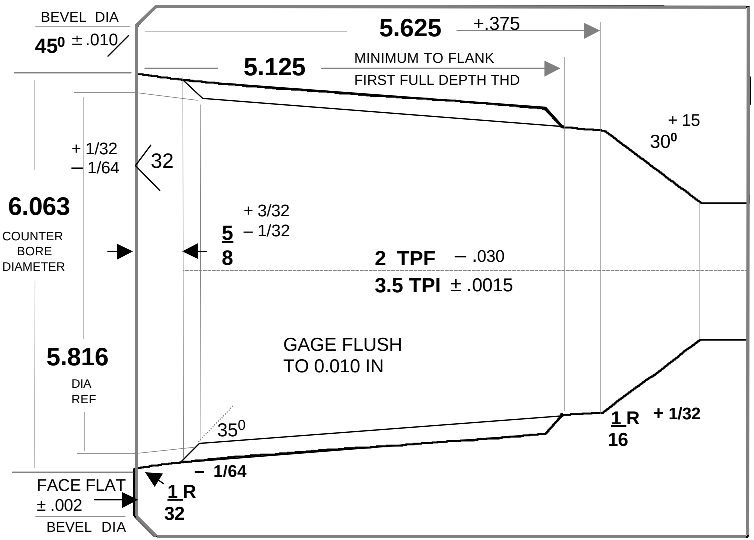
6-5/8 H90

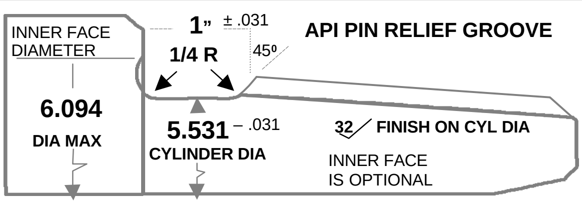
COMMON O.D AND BEVELS (± 1/64)

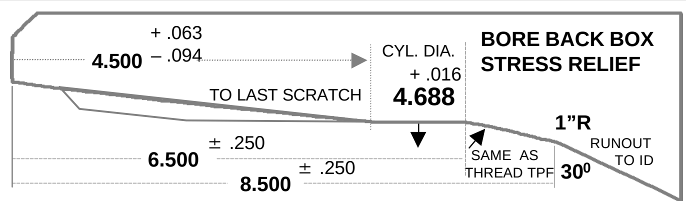
OD BEV	7-5/8 7-1/4	7-3/4 7-1/2	8 7-1/2	8-1/4 7-1/2	8-1/2 7-1/2				

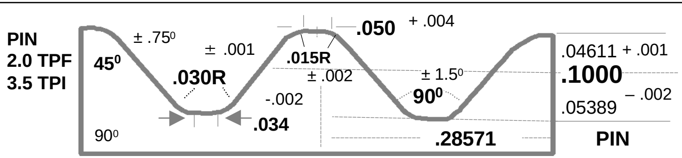
INTERCHANGES WITH:

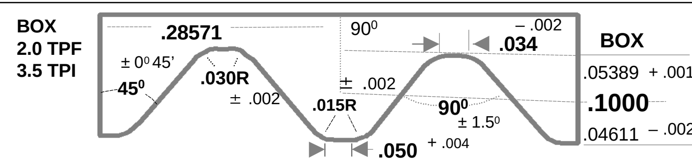












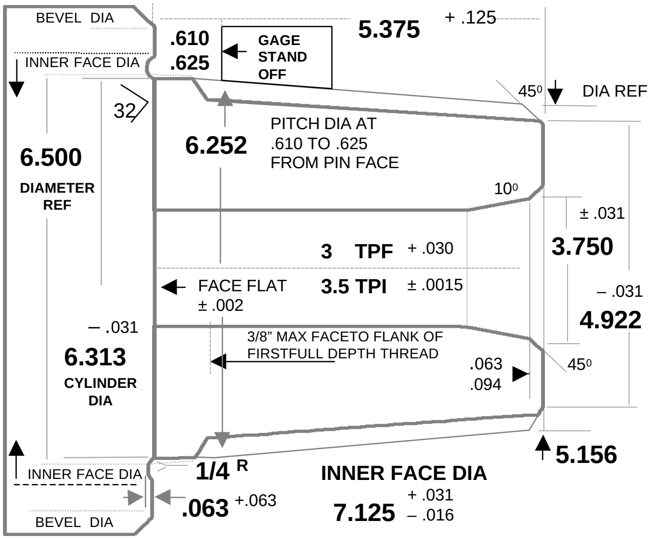
CONNECTION DIMENSIONS

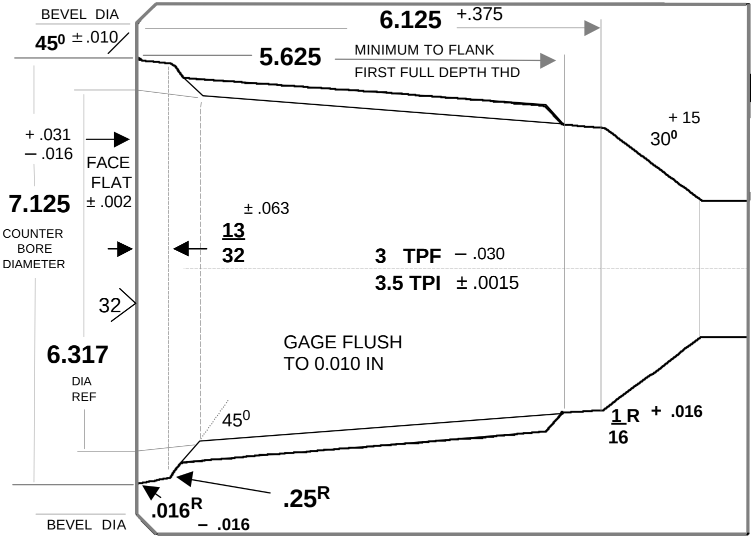
7 H90 *1

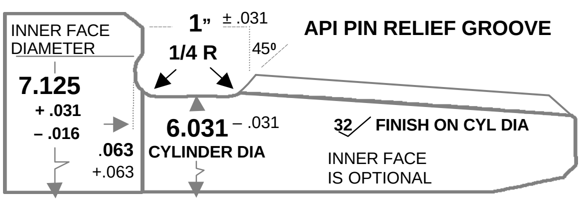
COMMON O.D AND BEVELS (± 1/64)

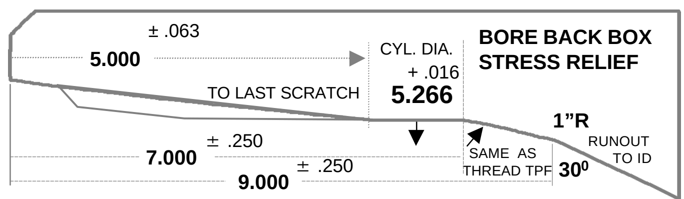
OD BEV	8-5/8 8-1/4	8-3/4 8-1/4	9 8-5/8	SEE 7 H90 *2 FOR LESS THAN 8-5/8 OD DRILL COLLARS

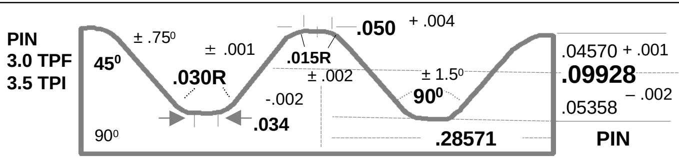
*1 - Original design. For drill collars of 8-5/8 OD or greater.

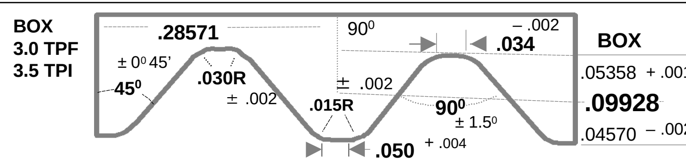












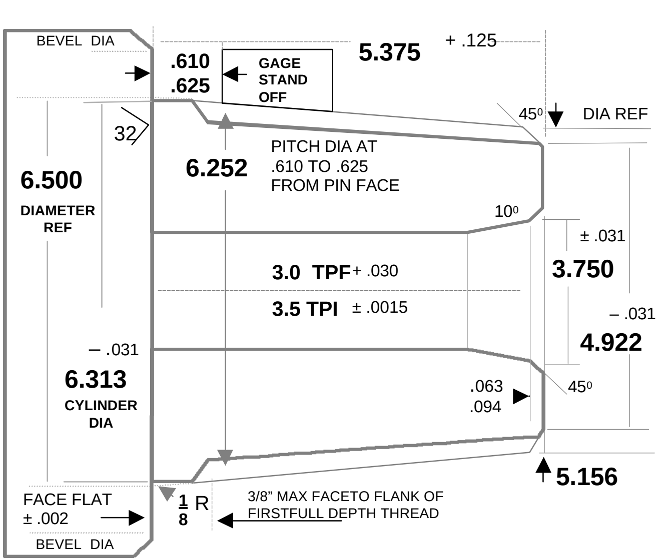
CONNECTION DIMENSIONS

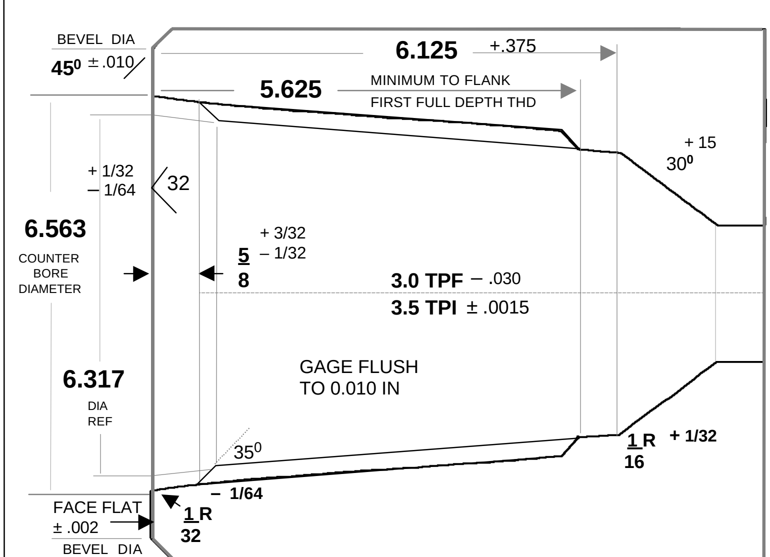
7 H90 *2

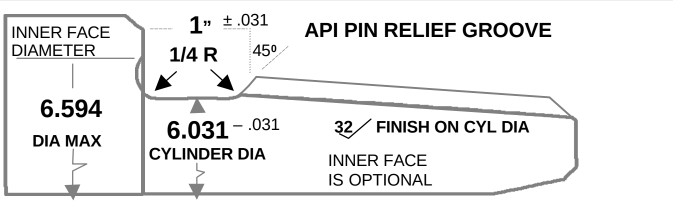
COMMON O.D AND BEVELS (± 1/64)

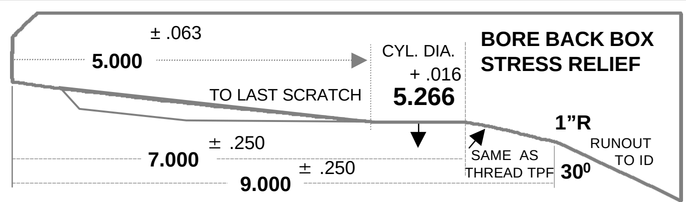
OD BEV	8-1/4 8	8-3/8 8	8-1/2 8-1/4	SEE 7 H90 *1 FOR 8-5/8 OR LARGER DRILL COLLARS

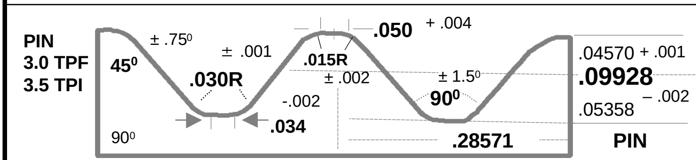
*2 - Modification for drill collars less than 8-5/8 OD.

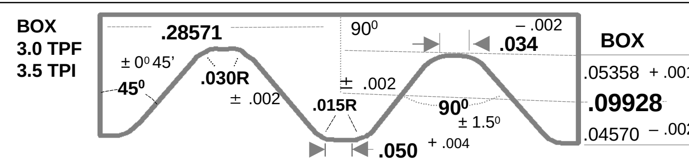












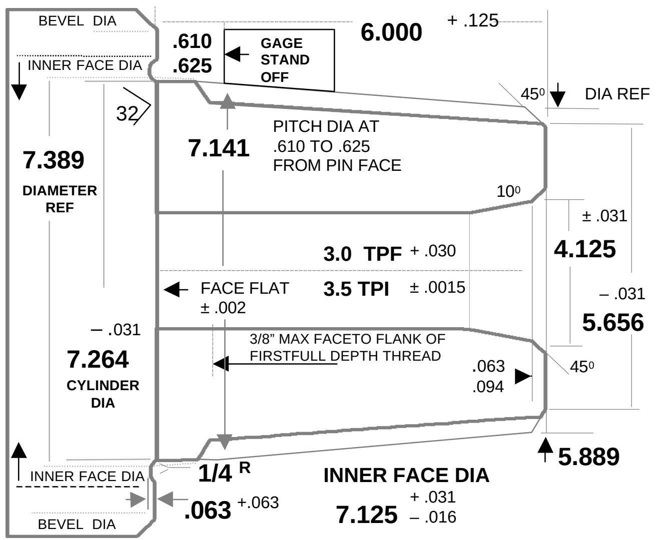
CONNECTION DIMENSIONS

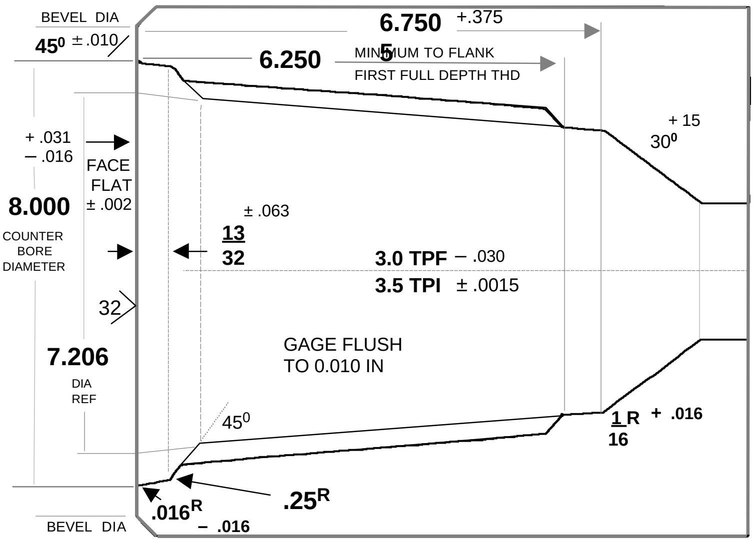
7-5/8 H90 *1

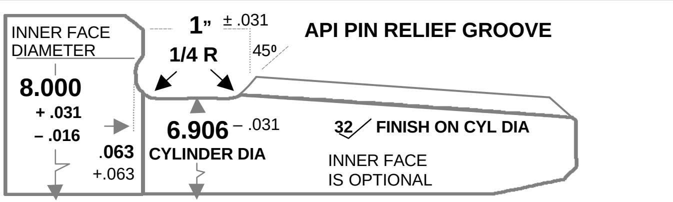
COMMON O.D AND BEVELS (± 1/64)

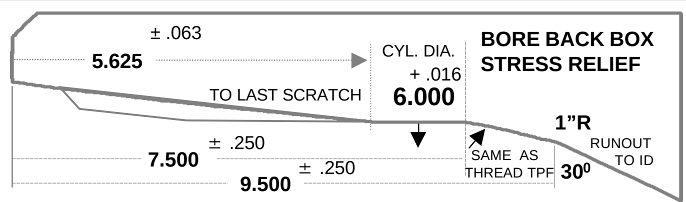
OD / BEV	9-3/4	9-7/8	10	10-1/4	SEE 7-5/8 H90 *2 FOR LESS THAN 9-3/4 OD DRILL COLLARS
OD	9-3/4	9-7/8	10	10-1/4	
BEV	9-1/4	9-5/8	9-5/8	9-5/8	

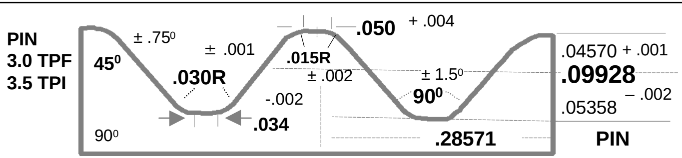
*1 - Original design. For drill collars of 9-3/4 OD or greater.

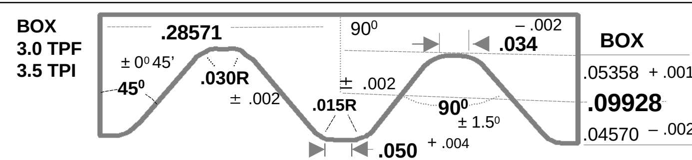












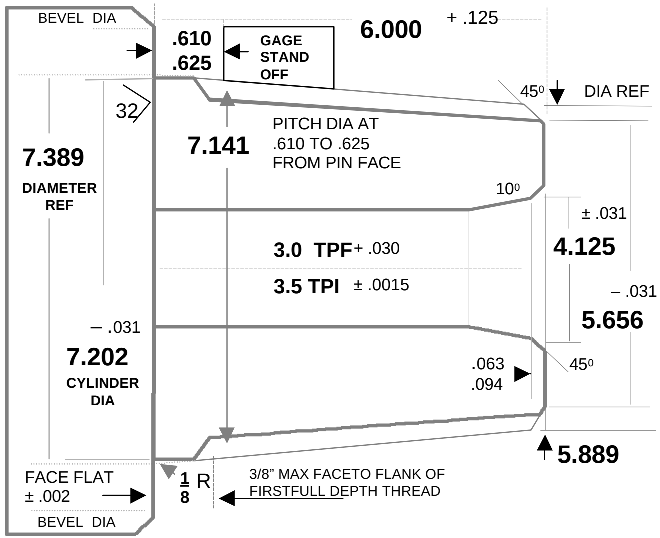
CONNECTION DIMENSIONS

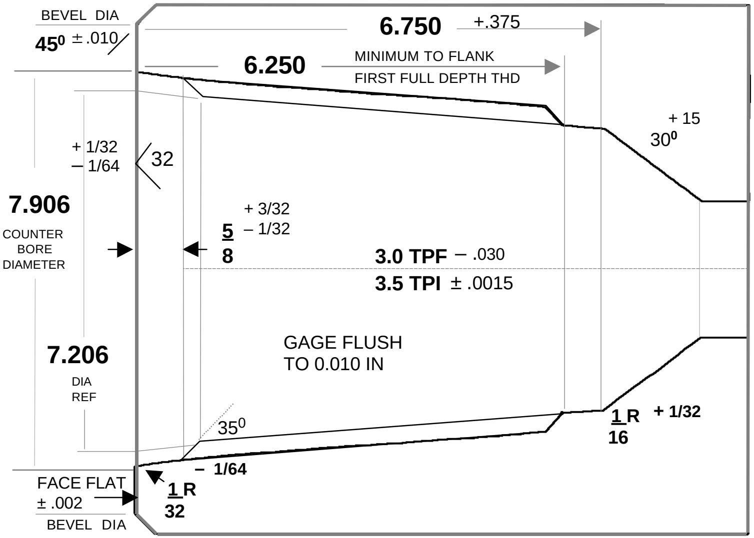
7-5/8 H90 *2

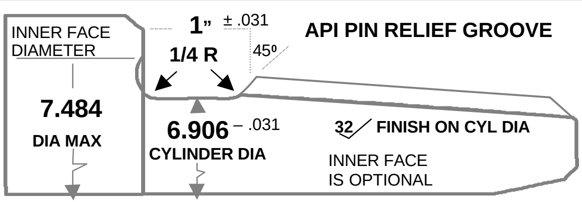
COMMON O.D AND BEVELS (± 1/64)

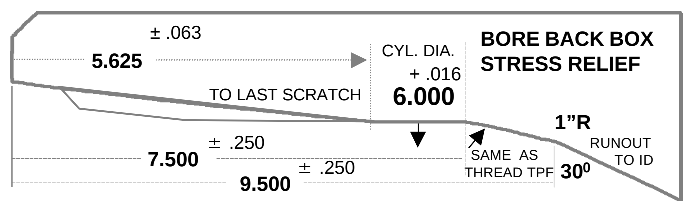
OD / BEV	9-1/2 / 9-1/4	9-5/8 / 9-1/4		SEE 7-5/8 H90 *1 FOR 9-3/4 OD OR LARGER DRILL COLLARS

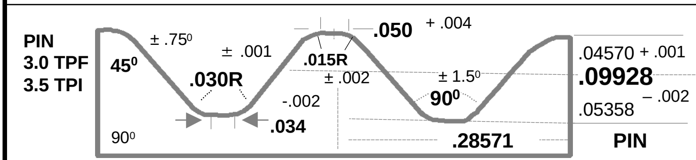
*2 - Modification for drill collars less than 9-3/4 OD.

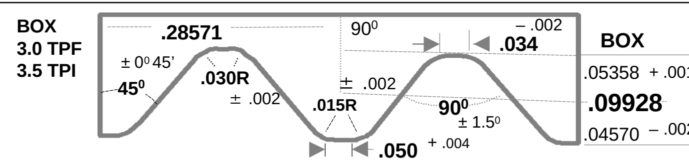












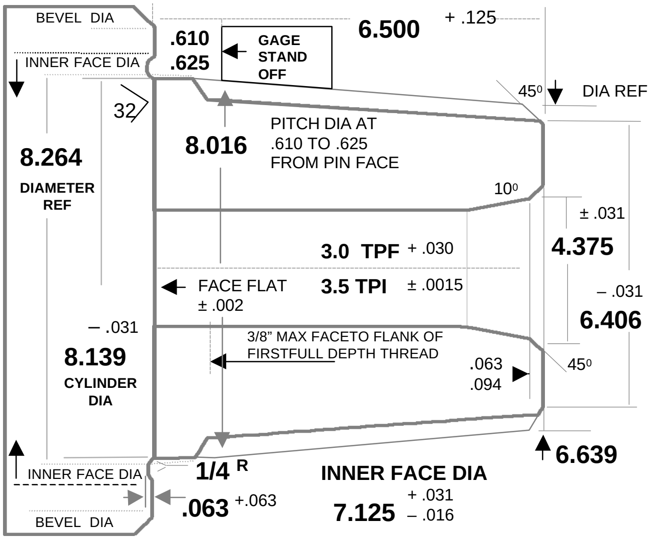
CONNECTION DIMENSIONS

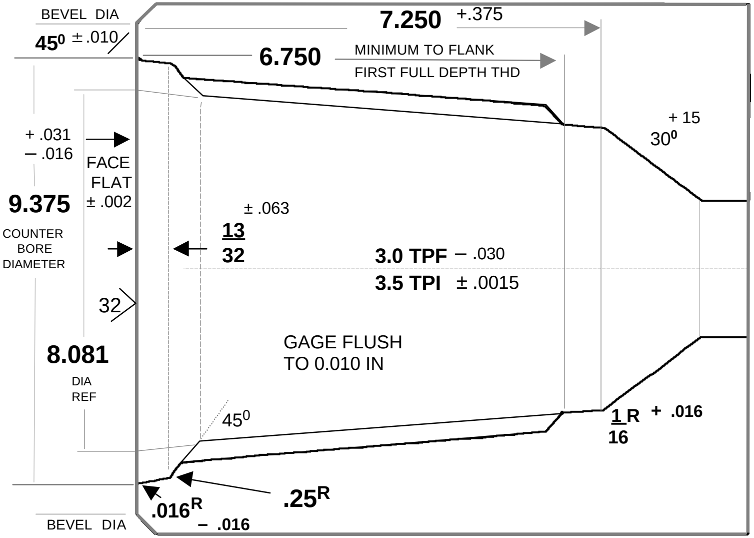
8-5/8 H90 *1

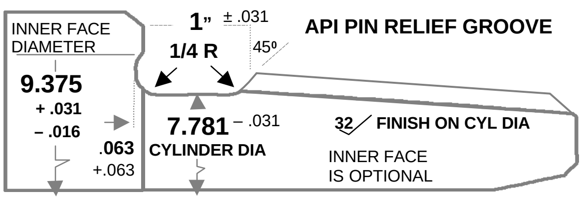
COMMON O.D AND BEVELS (± 1/64)

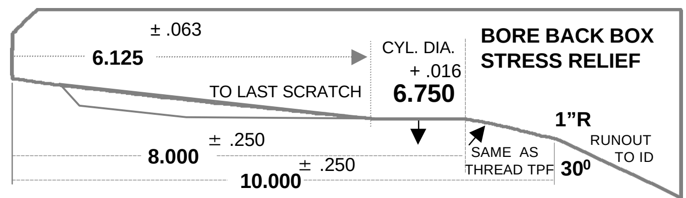
OD BEV	10-3/4 10-1/2	11 10-1/2	11-1/4 10-1/2	11-1/2 10-3/4	SEE 8-5/8 H90 *2 FOR LESS THAN 10-3/4 OD DRILL COLLARS

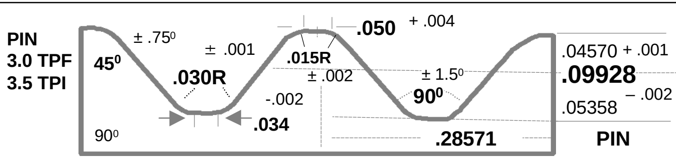
*1 - Original design. For drill collars of 9-3/4 OD or greater.

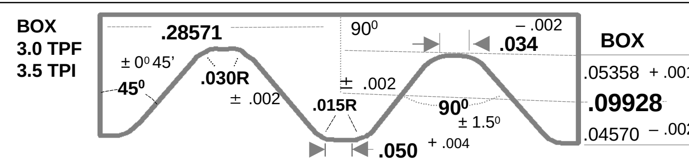












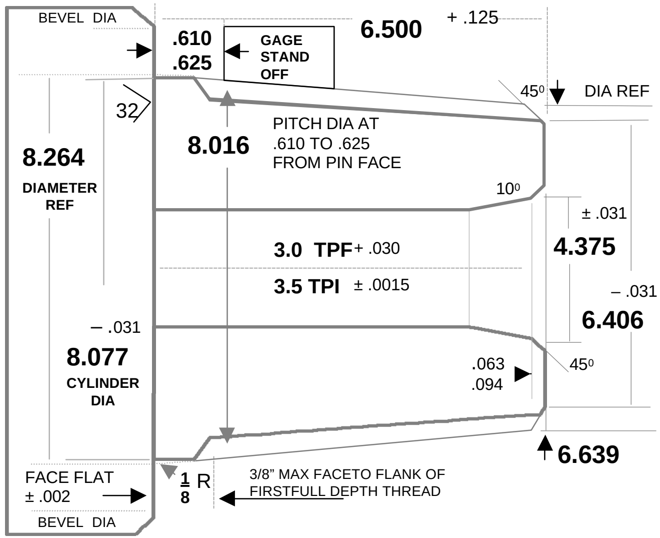
CONNECTION DIMENSIONS

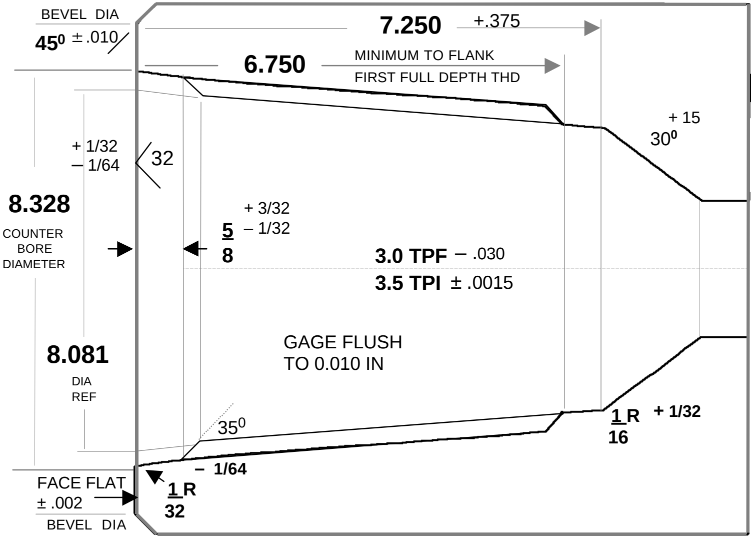
8-5/8 H90 *2

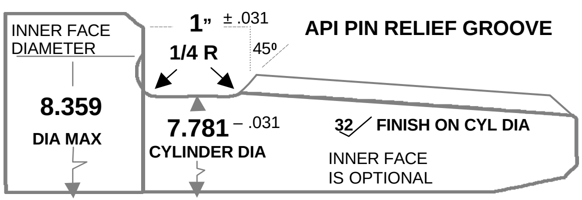
COMMON O.D AND BEVELS (± 1/64)

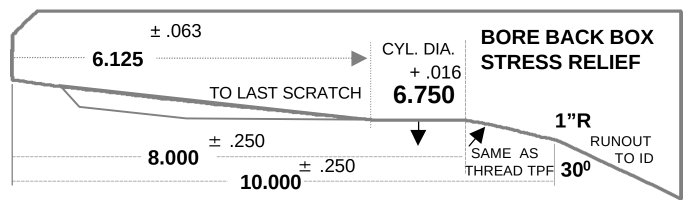
OD	**10-1/2**	**10-5/8**		**SEE 8-5/8 H90 *1** FOR 10-5/8 OD OR LARGER DRILL COLLARS
BEV	**10**	**10**		

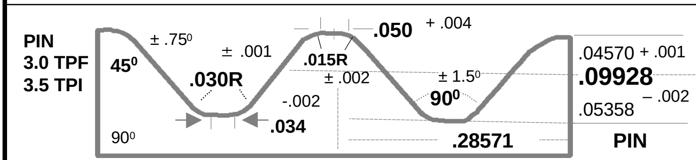
*2 - Modification for drill collars less than 9-3/4 OD.

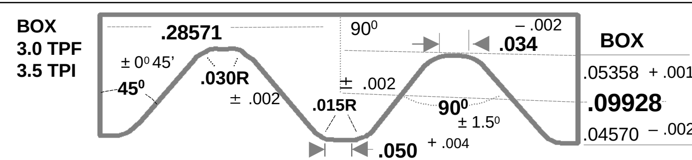




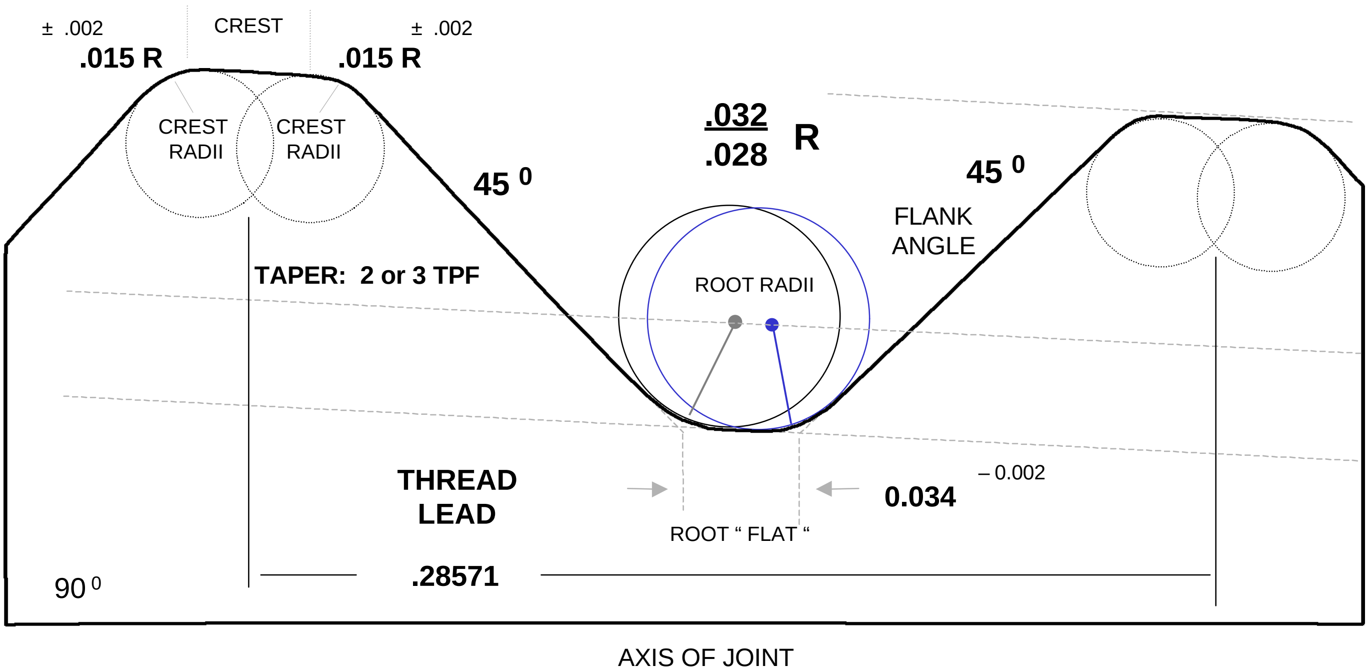








HUGHES H90 THREAD FORM (example Pin)



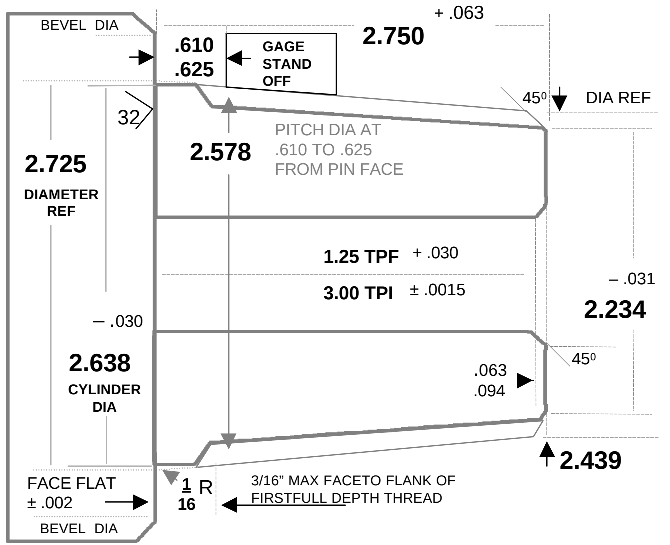
CONNECTION DIMENSIONS

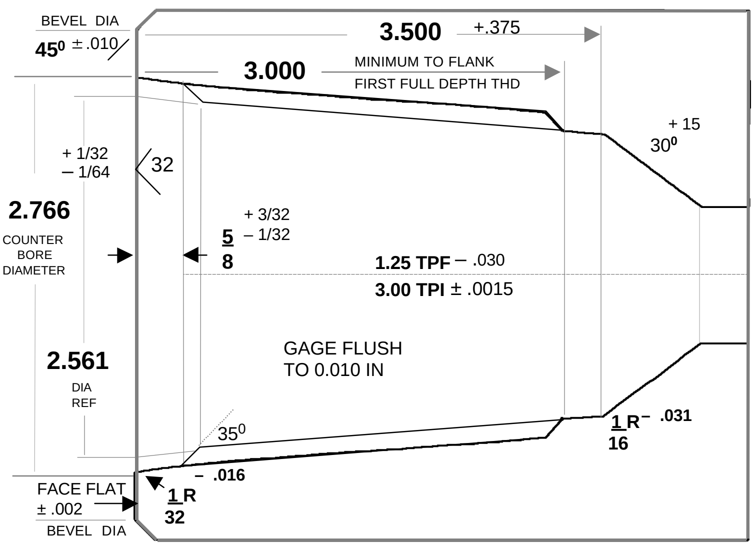
2-3/8 SLIMLINE H90 (Hughes)

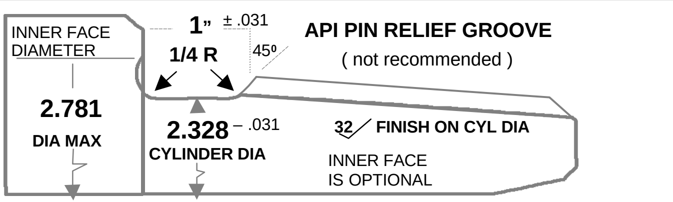
COMMON O.D AND BEVELS (± 1/64)

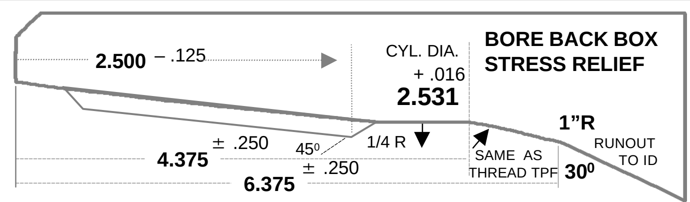
OD **BEV**	**3-1/4** **3-1/8**								

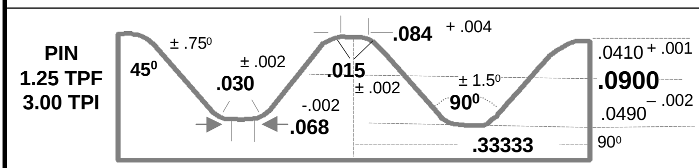
INTERCHANGES WITH:

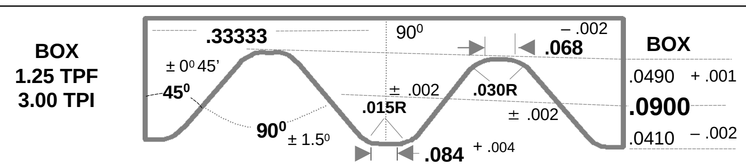












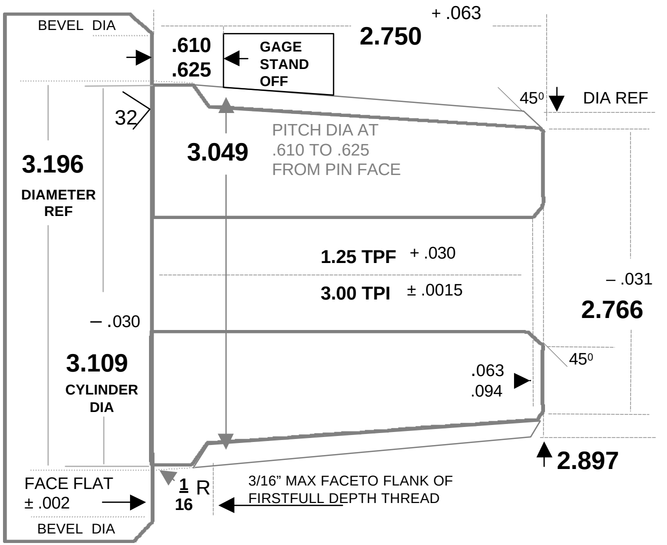
CONNECTION DIMENSIONS

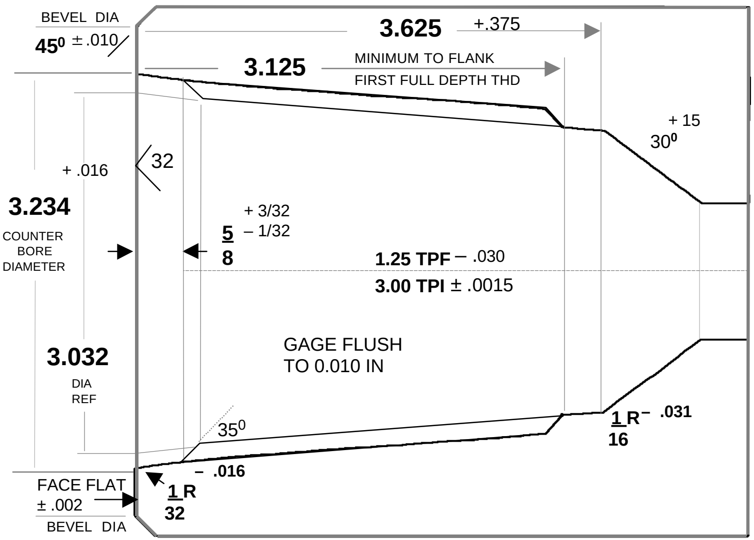
2-7/8 SLIMLINE H90 (Hughes)

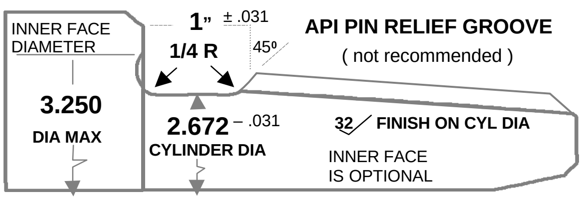
COMMON O.D AND BEVELS (± 1/64)

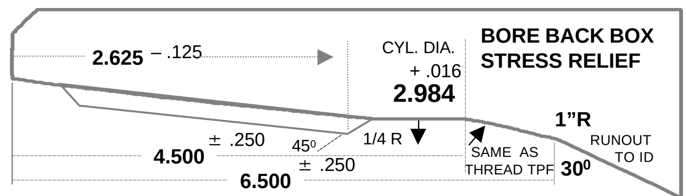
OD BEV	4-1/8 3-7/8	4-1/4 4-1/8							

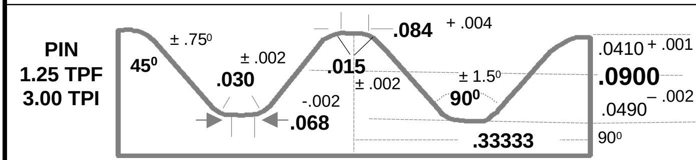
INTERCHANGES WITH:

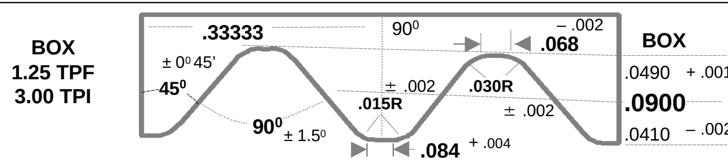












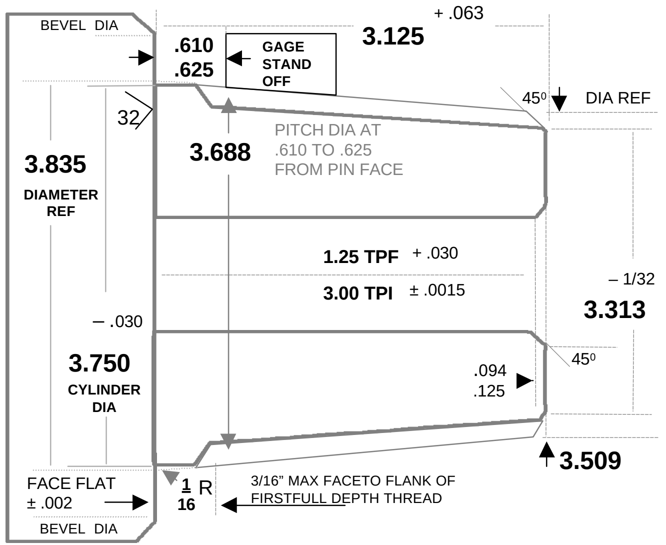
CONNECTION DIMENSIONS

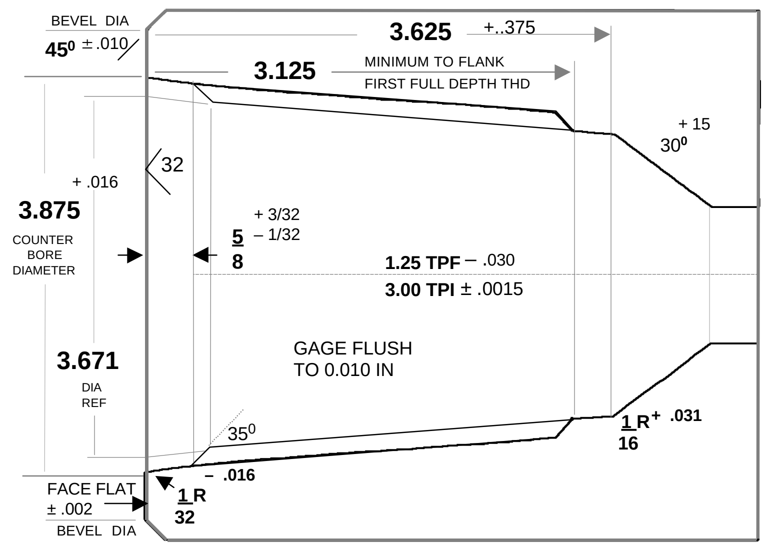
3-1/2 SLIMLINE H90 (Hughes)

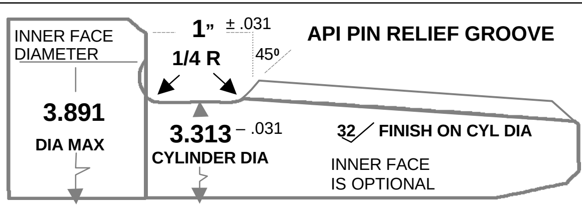
COMMON O.D AND BEVELS (± 1/64)

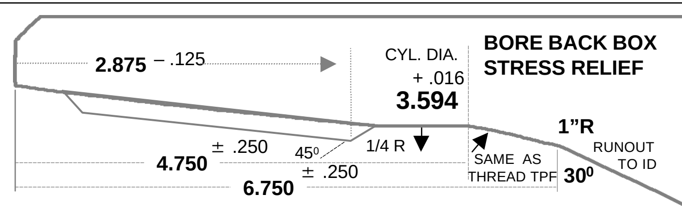
OD BEV	4-7/8 4-5/8	5 4-7/8							

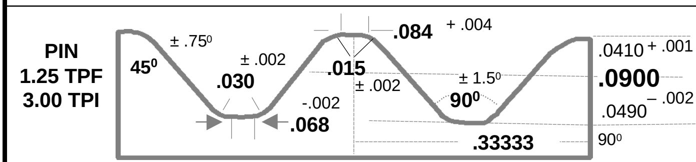
INTERCHANGES WITH:

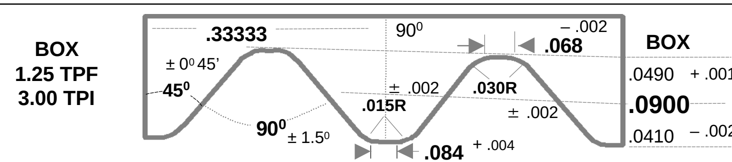












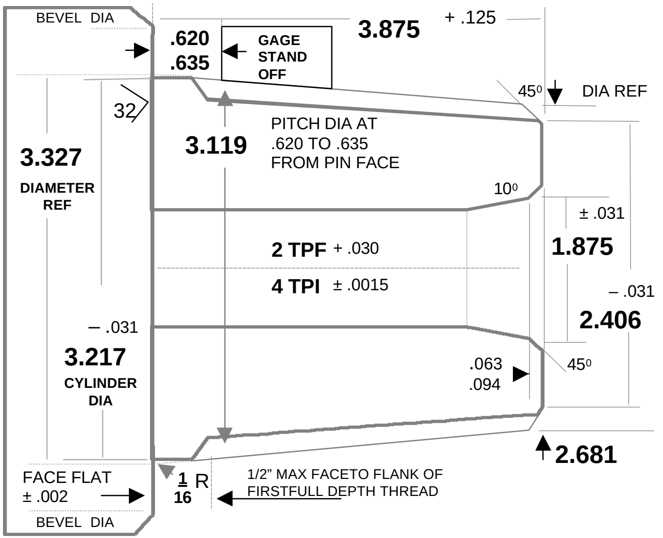
CONNECTION DIMENSIONS

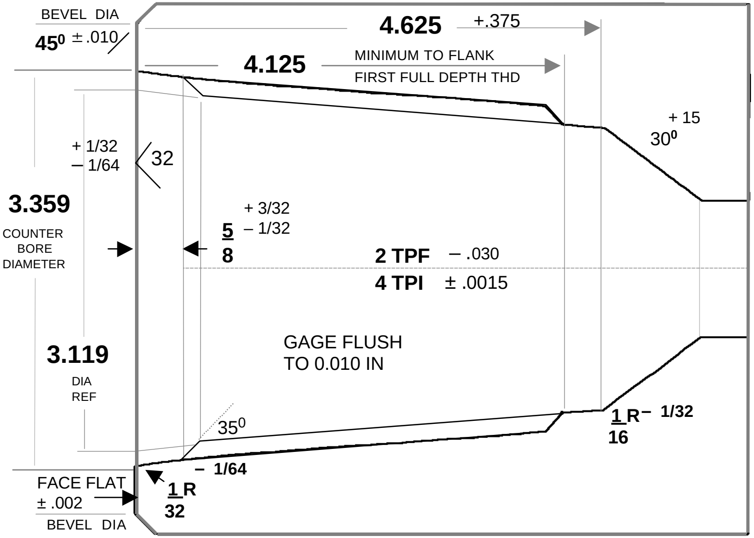
2-7/8 XTRA HOLE

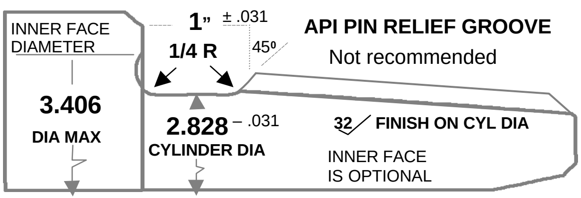
COMMON O.D AND BEVELS (± 1/64)

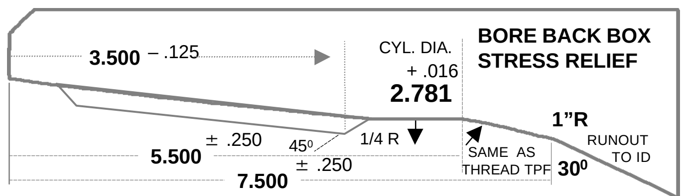
OD BEV	4-1/8 3-27/32	4-1/4 3-27/32	4-3/8 4-1/32						

INTERCHANGES WITH: 3-1/2 Dbl StreamLine

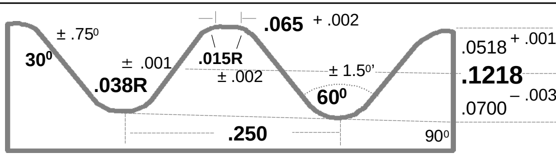




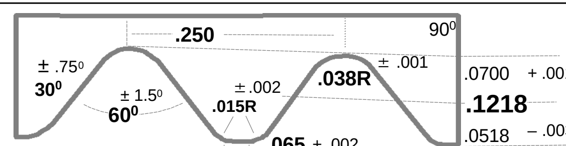




PIN
2 TPF
4 TPI



BOX
2 TPF
4 TPI



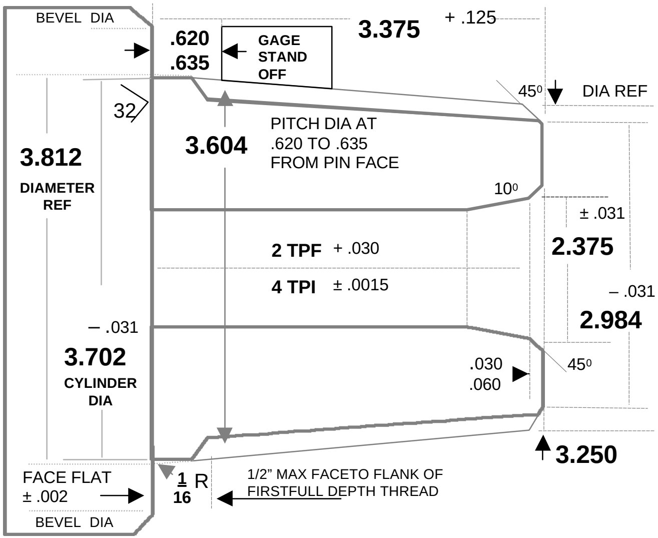
CONNECTION DIMENSIONS

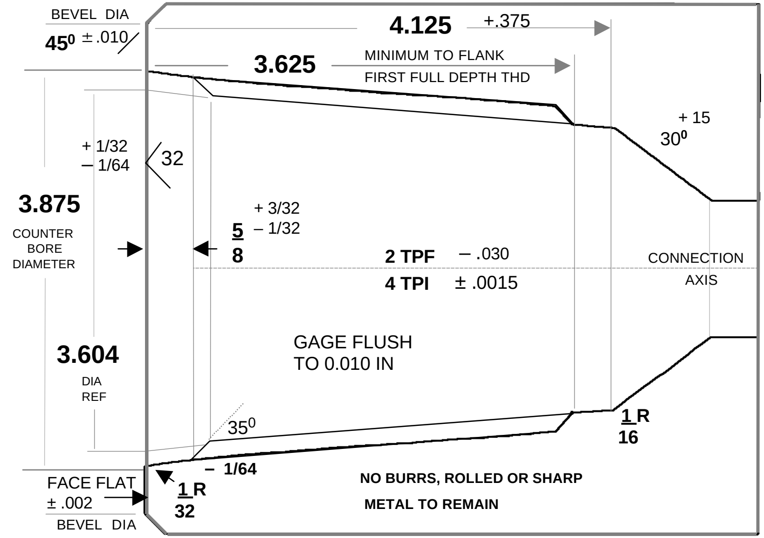
3-1/2 XTRA HOLE

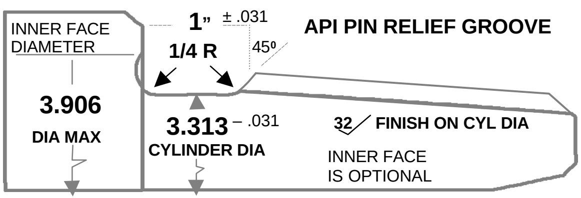
COMMON O.D AND BEVELS (± 1/64)

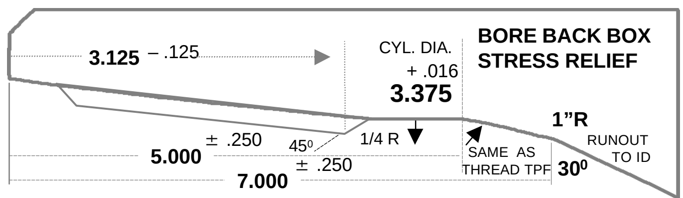
OD BEV	4-3/4 4-17/32	4-7/8 4-17/32	5 4-23/32						

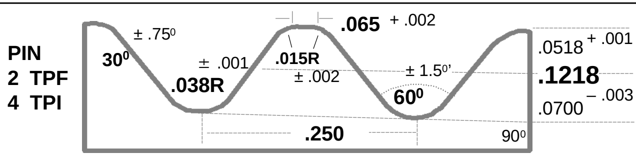
INTERCHANGES WITH: 4 SlimHole

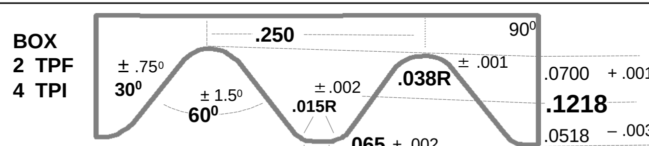












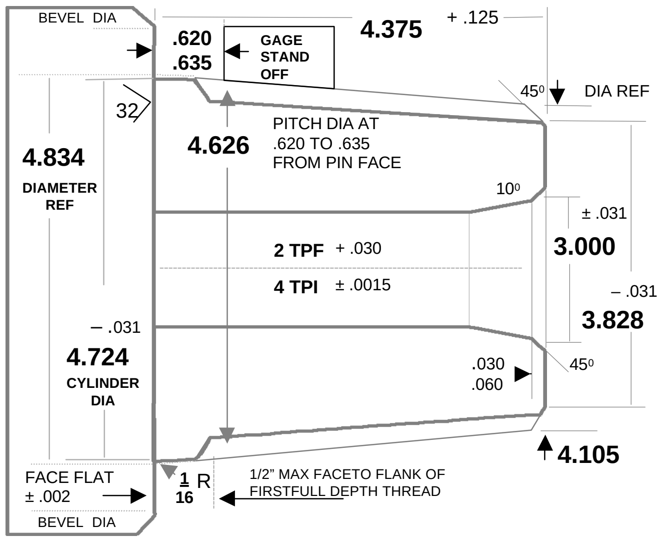
CONNECTION DIMENSIONS

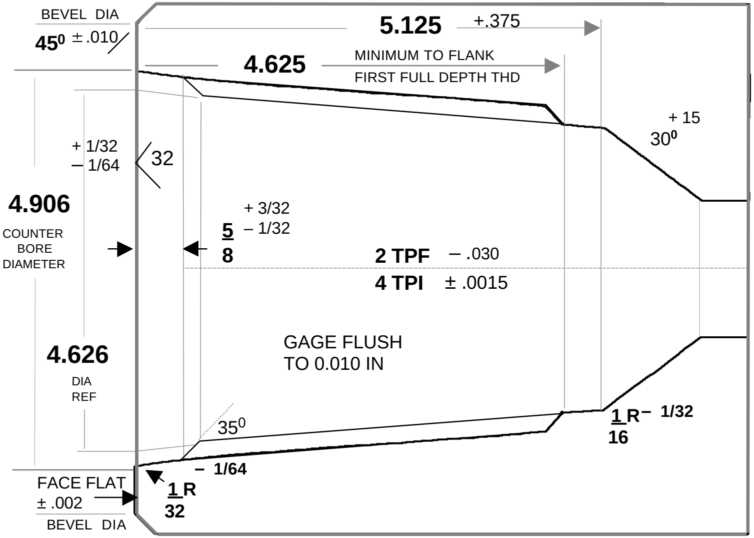
4-1/2 XTRA HOLE

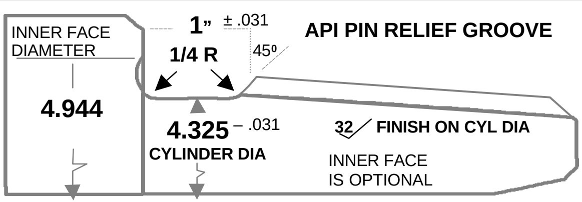
COMMON O.D AND BEVELS (± 1/64)

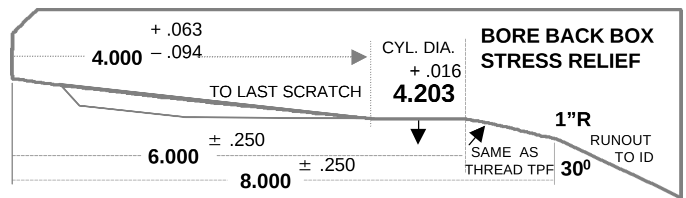
OD BEV	6 5-23/32	6-1/8 5-23/32	6-1/4 5-29/32	6-3/8 5-29/32	6-1/2 6-3/32	6-5/8 6-3/32	6-3/4 6-9/32		

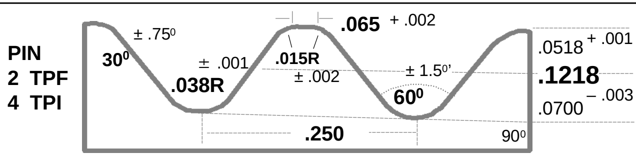
INTERCHANGES WITH: 4 IF, API 46

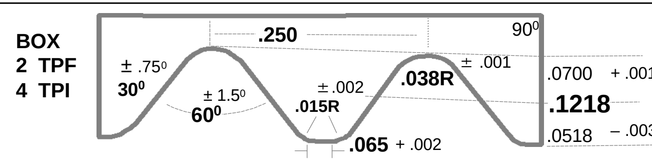












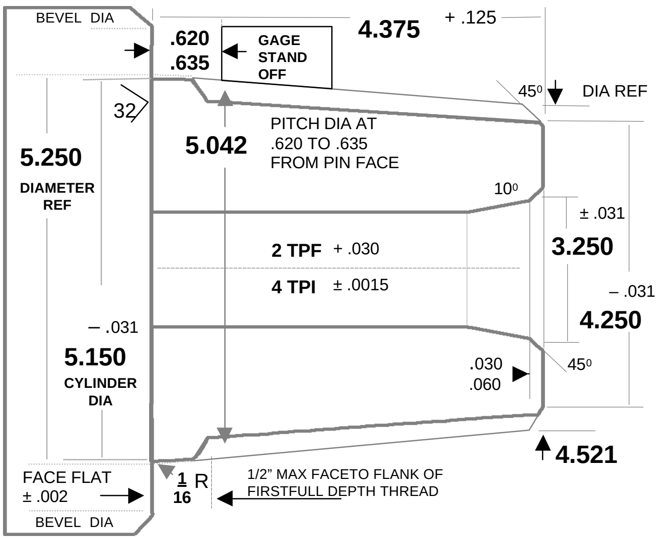
CONNECTION DIMENSIONS

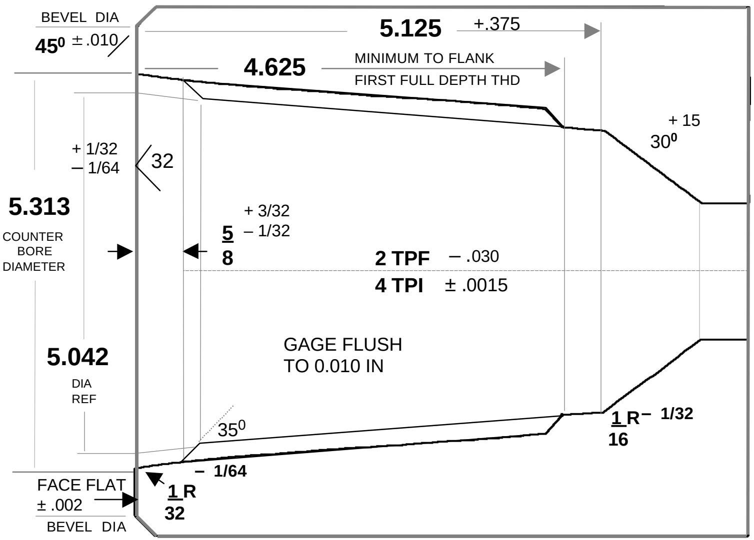
5 XTRA HOLE

COMMON O.D AND BEVELS (± 1/64)

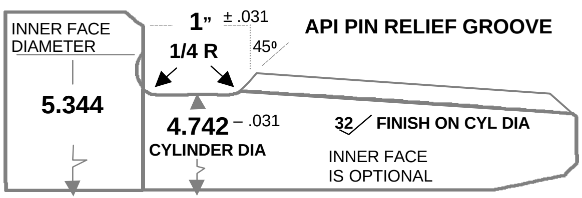
OD	6-1/4	6-3/8	6-1/2	6-5/8	6-3/4	6-7/8	7	7-1/8	7-1/4
BEV	6-1/16	6-7/64	6-7/64	6-19/64	6-19/64	6-31/64	6-31/64	6-43/64	6-43/64

INTERCHANGES WITH: 4-1/2 IF, API 50, & 5-1/2 Dbl. STEAMLINE

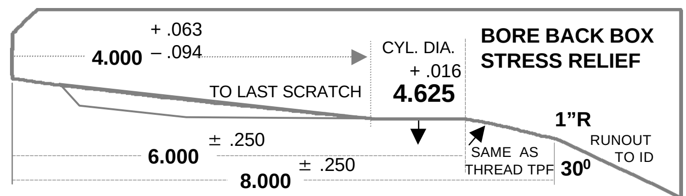




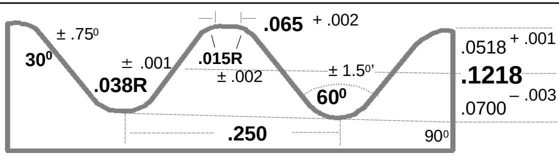
API PIN RELIEF GROOVE



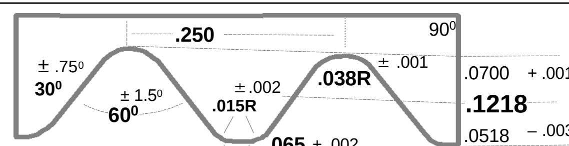
BORE BACK BOX STRESS RELIEF



PIN
2 TPF
4 TPI



BOX
2 TPF
4 TPI



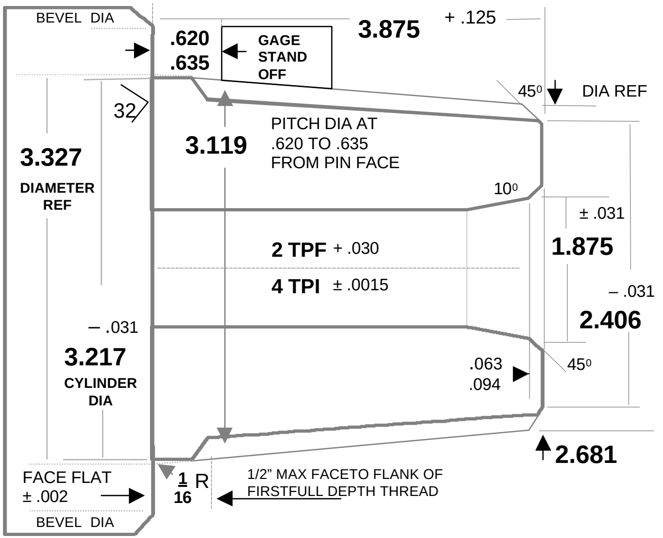
CONNECTION DIMENSIONS

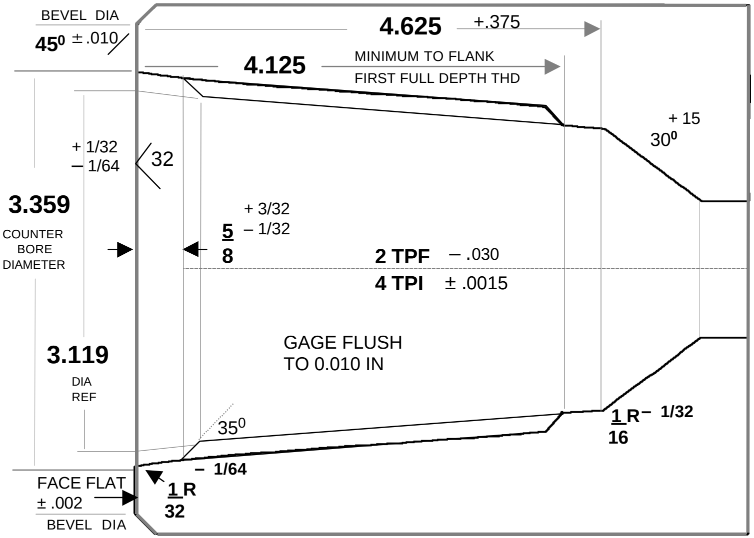
3-1/2 Double StreamLine (Hughes)

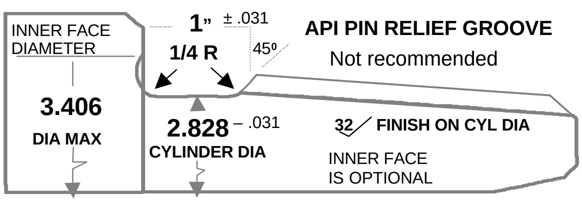
COMMON O.D AND BEVELS (± 1/64)

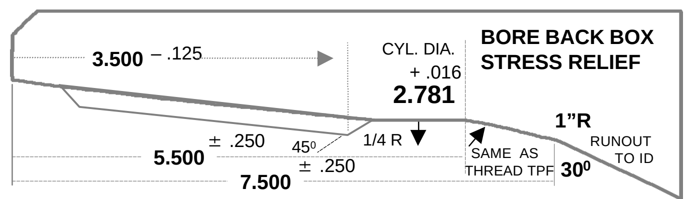
OD BEV	4-1/8 3-27/32	4-1/4 3-27/32	4-3/8 4-1/32						

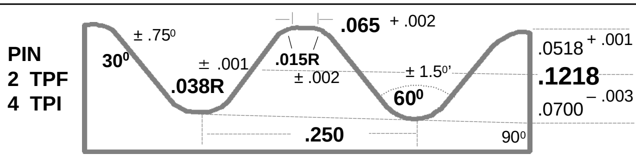
INTERCHANGES WITH: 2-7/8 XH

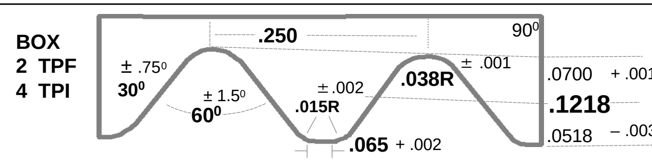












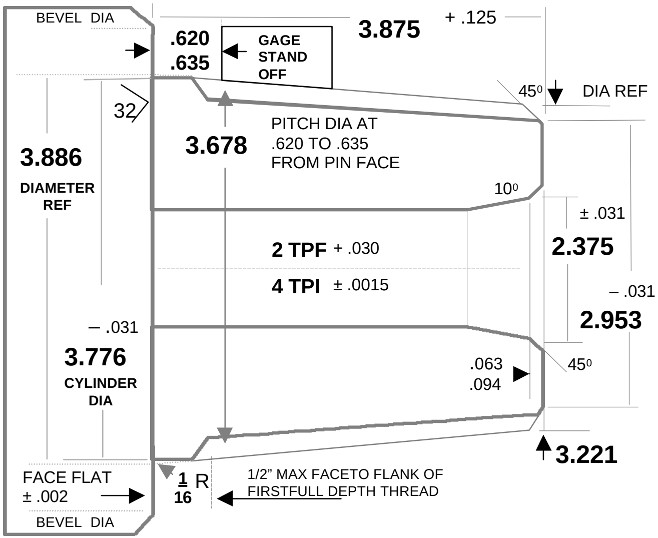
CONNECTION DIMENSIONS

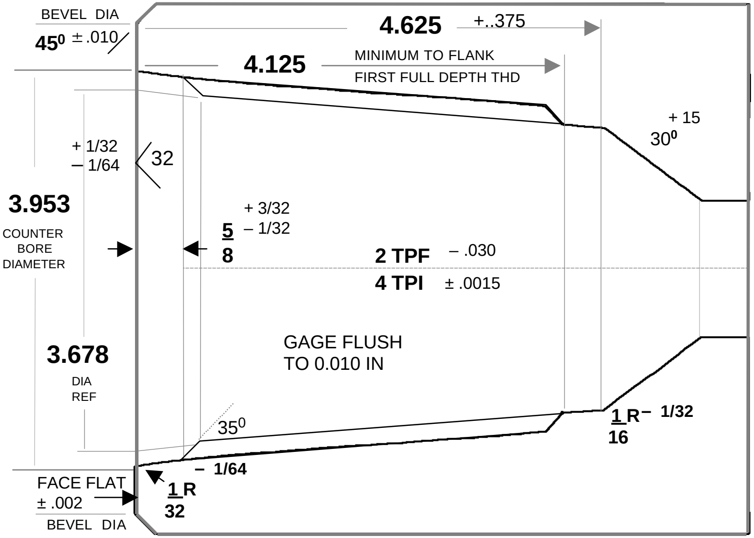
4 Double StreamLine (Hughes)

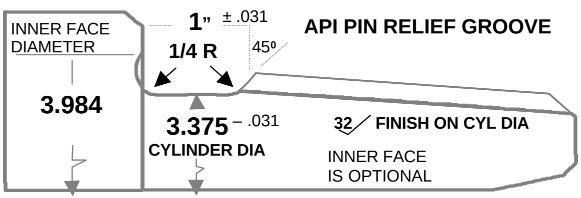
COMMON O.D AND BEVELS (± 1/64)

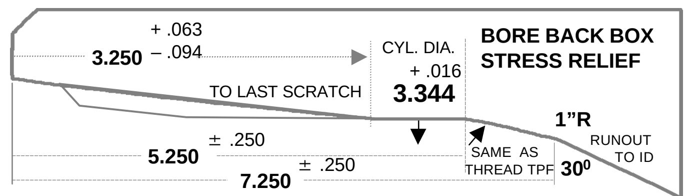
OD BEV	4-5/8 4-1/2								

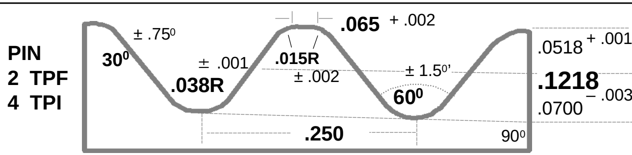
INTERCHANGES WITH:

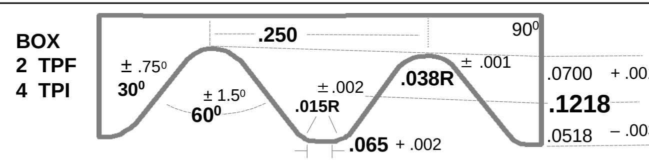












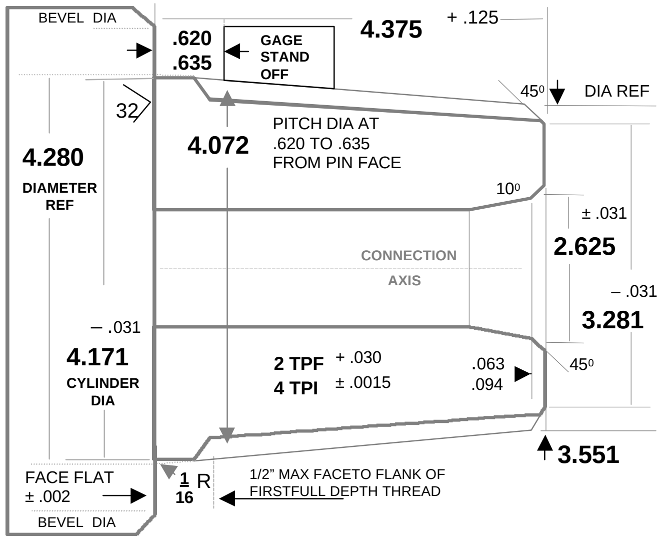
CONNECTION DIMENSIONS

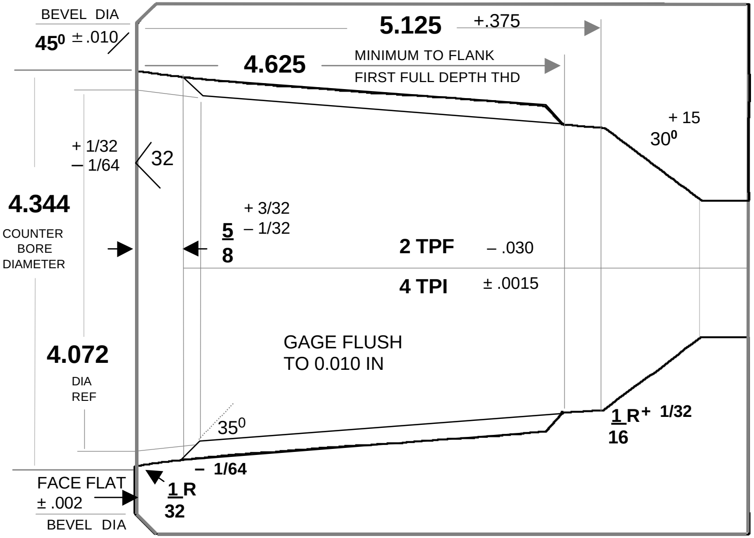
4-1/2 Double StreamLine (Hughes)

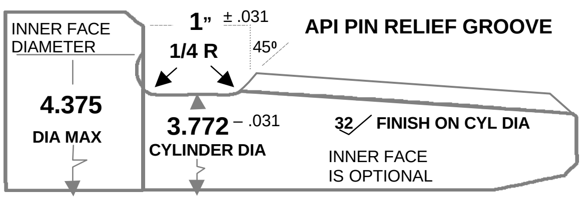
COMMON O.D AND BEVELS (± 1/64)

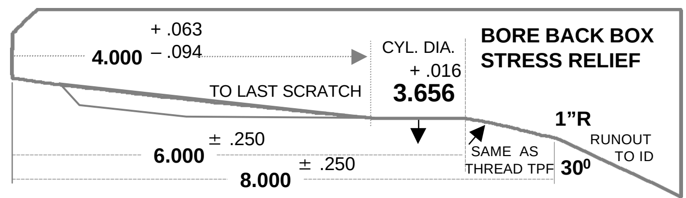
OD BEV	5-1/4 5-1/64	5-3/8 5-1/64	5-1/2 5-13/64	5-5/8 5-13/64	5-3/4 5-25/64				

INTERCHANGES WITH: 4-1/2 4 FH, API 40

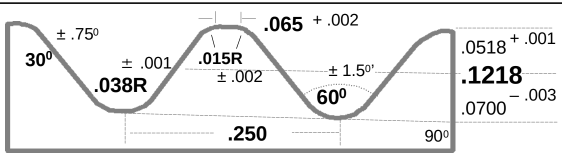




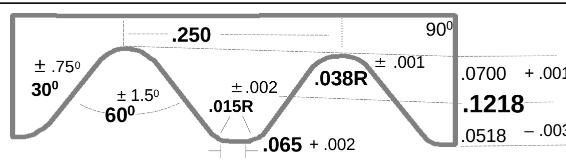




PIN
2 TPF
4 TPI



BOX
2 TPF
4 TPI



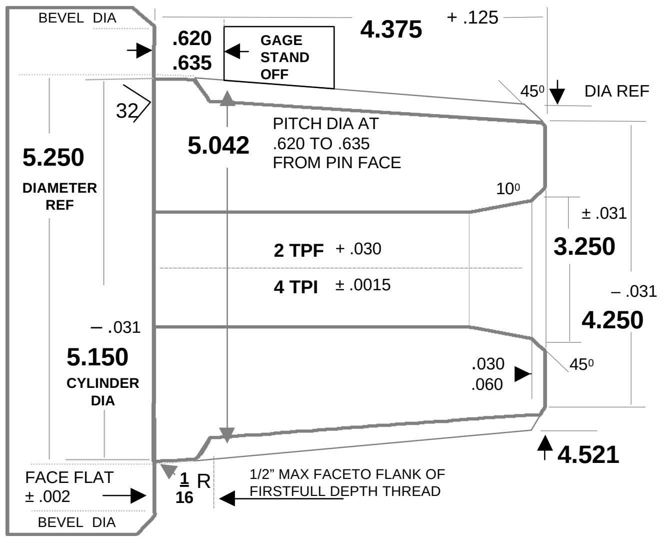
CONNECTION DIMENSIONS

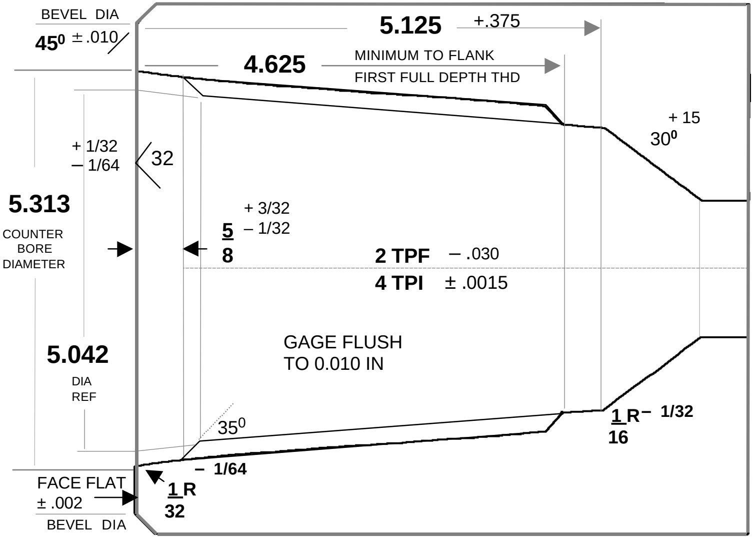
5-1/2 Double StreamLine (Hughes)

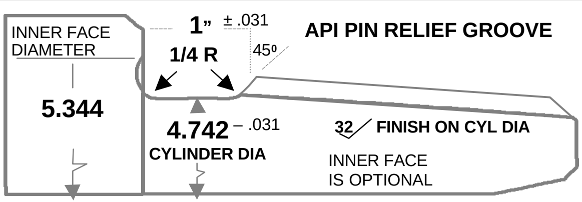
COMMON O.D AND BEVELS (± 1/64)

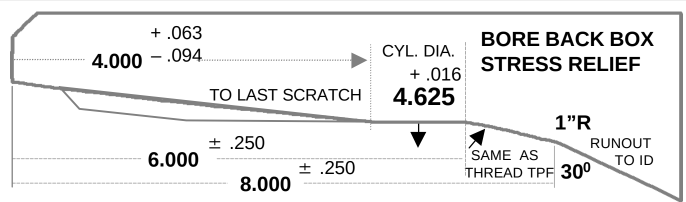
OD BEV	6-1/4	6-3/8	6-1/2	6-5/8	6-3/4	6-7/8	7	7-1/8	7-1/4
	6-1/16	6-7/64	6-7/64	6-19/64	6-19/64	6-31/64	6-31/64	6-43/64	6-43/64

INTERCHANGES WITH: 5 XH, 4-1/2 IF, & API 50

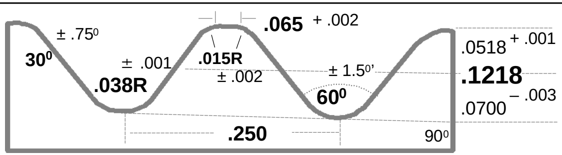




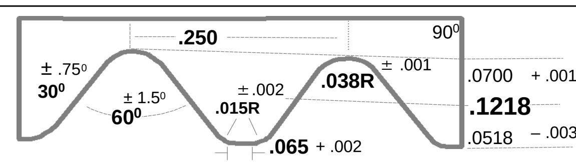




PIN
2 TPF
4 TPI

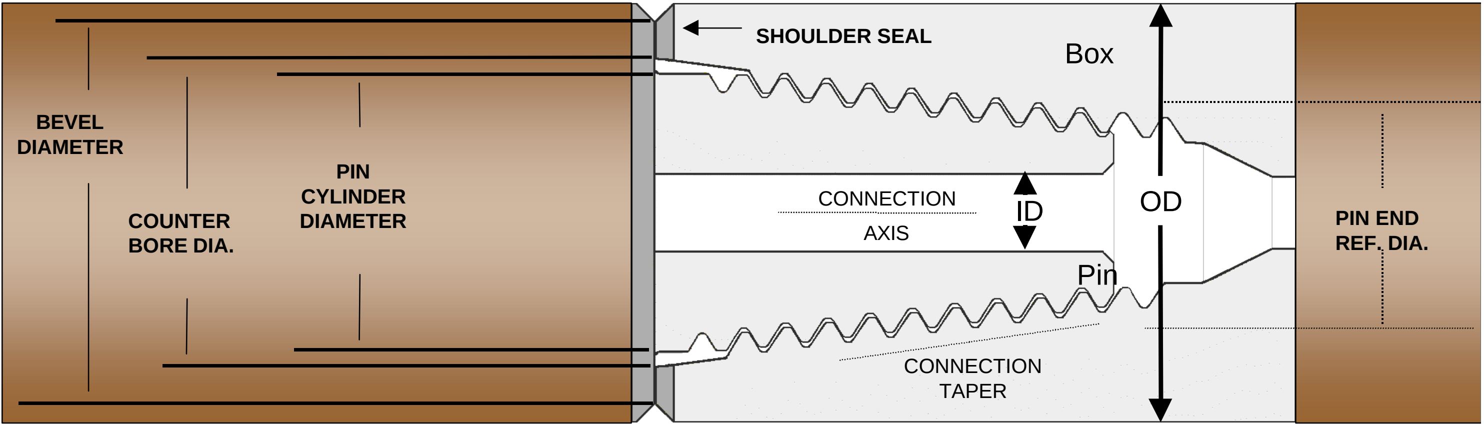


BOX
2 TPF
4 TPI

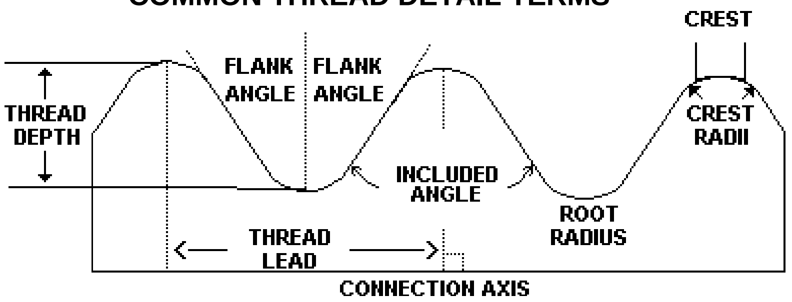


The following pages are intended to enhance a basic understanding of Rotary Shouldered Connections. No proprietary connections or tools are considered although most of the same principals apply to both.

Below are some common terms related to connections.



COMMON THREAD DETAIL TERMS

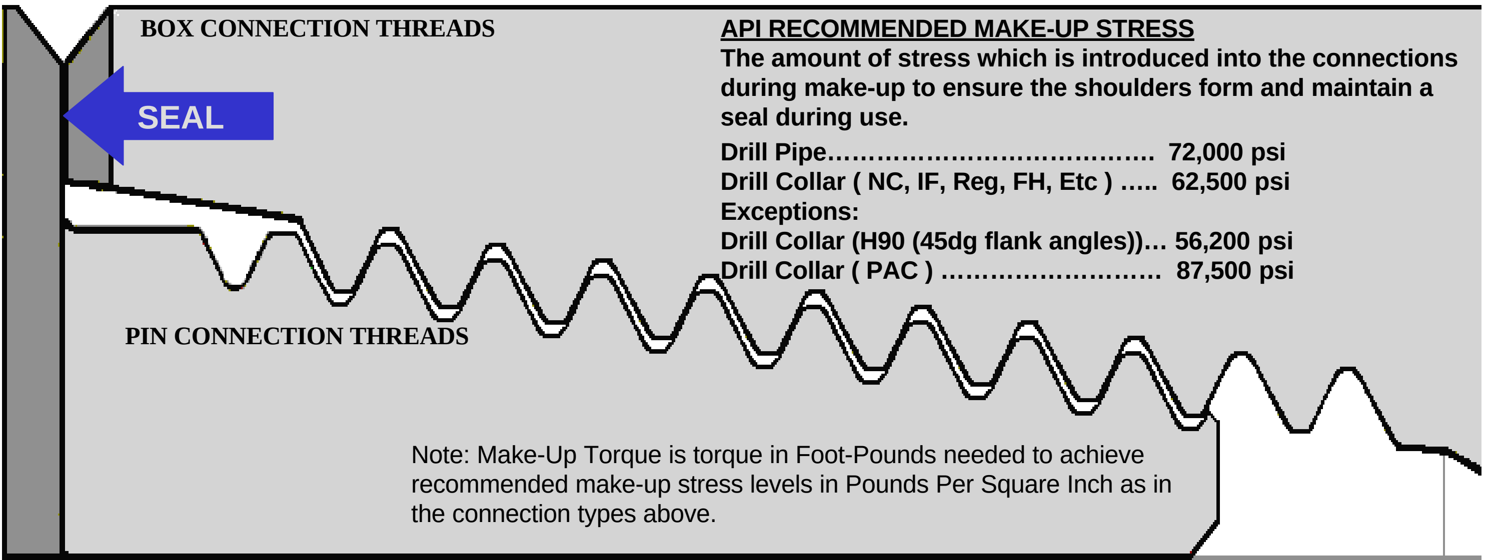


Rotary Shouldered Connection Threads do not seal having an open channel at thread roots and non-pressure thread flanks which runs from the bore to the shoulder. This space accommodates excess thread compound, thread wear, and foreign material.

Rotary Shouldered Connections only seal at their shoulders. The R.S. Connection is a tapered threaded jack screw that force the shoulders together. Proper make-up torque seals the shoulders, pre-loading compression of the shoulders to A.P.I. recommended make-up stress levels designed to maintain this seal during drilling operations. Proper make-up also structurally bonds the two connection members together such that the box supports the pin making it equally as resistant to bending as is the box.

Insufficient Make-Up can lead to washouts, pin cracking, galling, make-up down hole and many other types of failures. Under torque is the most common cause of premature connection failures and damages.

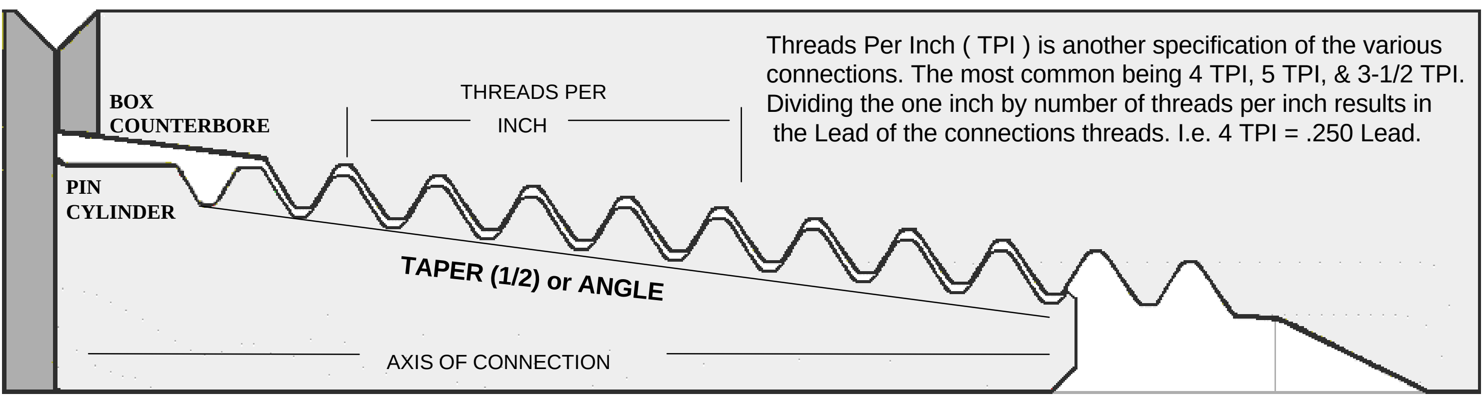
It is essential that rig personnel and equipment make-up connections properly. It is also necessary for field service personnel stipulate the proper make-up of their equipment.



Connections threads have a certain overall slope which is commonly expressed as “ taper per foot” (TPF). This simply means the amount of change in diameter in inches over a foot in length. Most connections in a group have a similar TPF such as Internal Flush (IF) connections with a 2” TPF. There are exceptions. All Regular connections have a 3” TPF with only a 6-5/8 Regular connection having a 2” TPF. Some common tapers for connections are listed below.

Taper per Foot DIA. CHANGE / FT	Taper per 1” DIA. CHANGE / INCH	Angle vs Axis Angle CONN. ANGEL vs CENTER LINE	Axial Movement Factor CONN OR GAGE MOVEMENT FACTOR
0.750”	0.06250”	1.78999 degrees	16
1.000”	0.08333”	2.38611 degrees	12
1.250”	0.10416”	2.98139 degrees	9.6
1.500”	0.12500”	3.57639 degrees	8
2.000”	0.16667”	4.76361 degrees	6
3.000”	0.25000”	7.12500 degrees	4
3.373”	0.28104”	8.00000 degrees	3.558

The axial movement factor indicates the longitudinal movement of a ring or plug gage in relation to a diameter change of a connection. Enlarging the thread diameter 0.010” on a 2 TPF connection results in 0.060” increase gage stand-off. Similar results occur in the field where burrs or defects on connection threads effectively change their diameters.



Threads Per Inch (TPI) is another specification of the various connections. The most common being 4 TPI, 5 TPI, & 3-1/2 TPI. Dividing the one inch by number of threads per inch results in the Lead of the connections threads. I.e. 4 TPI = .250 Lead.

Connection Factors and Criteria

The sizes and types of connections that are used in a Bottom Hole Assembly must take many variables into consideration. Tensile Strength, Torsion Strength, and Bending Strength Ratio (BSR) as well as the Make-Up Torque required. Connections should meet or exceed acceptable limits of these criteria when used with a drill string member's OD and ID.

Make-Up Torque : The amount of torque or pre-loaded stress required to force and maintain shoulder sealing. Factors are Dimensional, Material Strength, and to a lesser degree - Friction.

Tensile Yield Strength: The amount of pull that can be exerted on a connection. Factors are Dimensional and Material Strength.

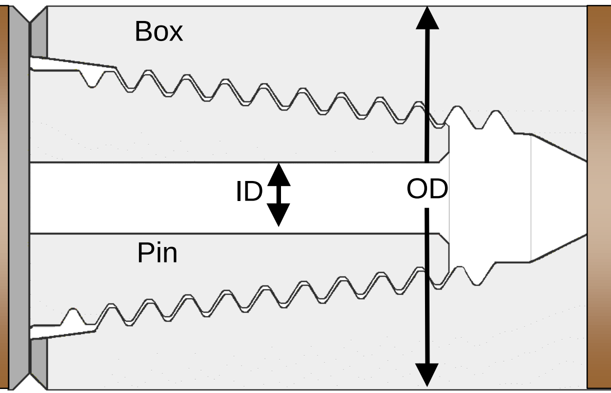
Torsion Yield Strength: The amount of twist that can be exerted on a connection. Factors are Dimensional and Material Strength.

Bending Strength Ratio: The ratio of resistance to bending fatigue of a box versus a pin (Balanced at 2.5 to 1) Factors are dimensional so long as both connections are made of same material.

API Material Minimum Specifications

Steel Drill Collar Material: 4140 series, Heat Treated, Quenched and Tempered to specifications below:

Drill Collars to 6-7/8" od………………..	110,000 psi
Drill Collars above 6-7/8 od…………..….	100,000 psi
Drill Pipe Tool Joints………………….	120,000 psi



Note: It is assumed throughout this presentation that Non-Magnetic Material is 100,000 minimum yield strength. Some companies recommend 10 % less make-up for Non-Mag than for steel seeking to reduce thread galling. Non-Mag's higher galling tendency is caused by an inability to etch the thread surfaces. This results in metal to metal contact as the grease does not stay coated on the Non-Mag surfaces under the high friction of make-up. It is not relative to material yield strength.

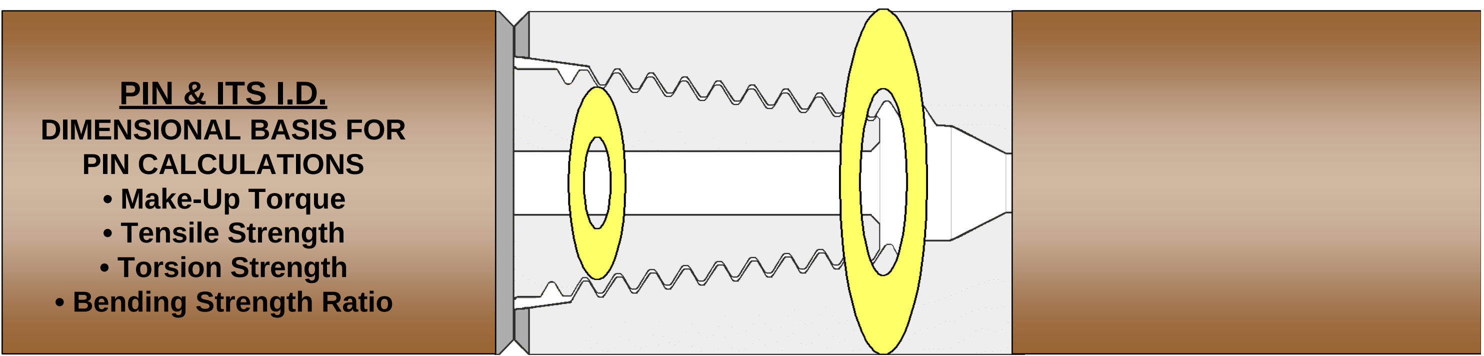
Tensile Strength, Torsion Strength, and Make-Up Torque of mated connections are each found by their own set of calculations. In each case, individual calculations are done for both the pin connection & its ID as well as the box connection & its OD with the smallest result being the final value. Bending Strength Ratio involves two similar calculations but with the results being compared to establish the ratio of each members resistance to bending or bending strength ratio.

No value for a connection can be considered as final until the value of its mate is known. The final results are based on values of the pin & its ID on one tool and box & its OD on another tool that is to be made-up.

The ID of a box does not impact a box’s strength so long as thread roots are not eliminated which would engage pin threads. The OD of a pin does not impact the pin’s values as long as the OD does not reduce the shoulder of the pin below its bevel. This can be seen in illustration below.

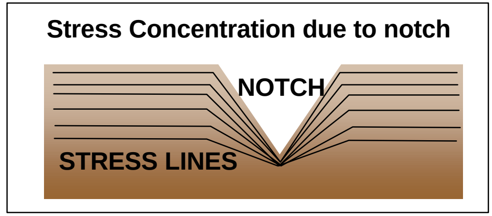
API Calculation Locations of Adjusted Cross-Sectional Areas

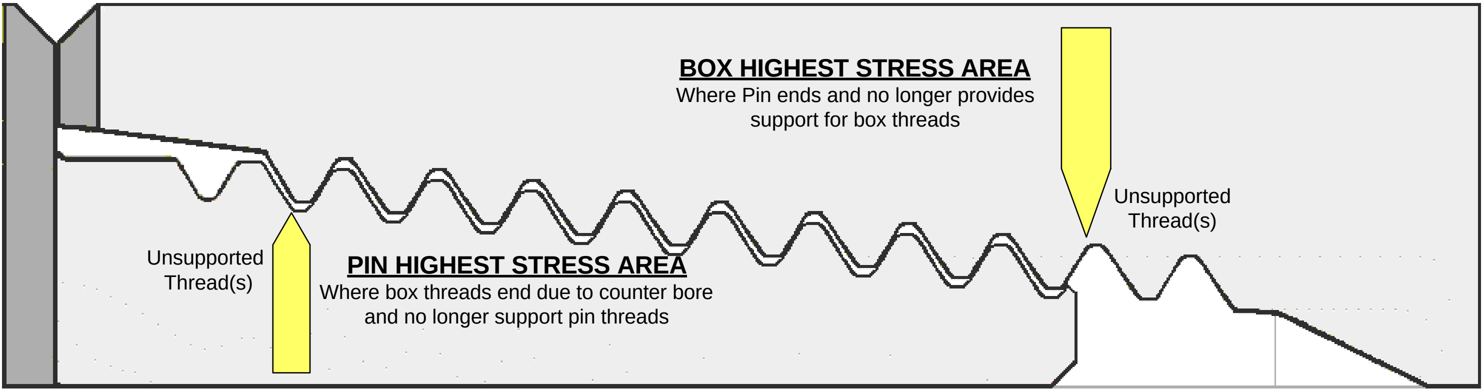
R.S. Connection Calculation Type	Location of Pin & ID Cross Section Area	Location of Box & OD Cross Section Area
• Make-Up Torque	0.750” from face	0.375” from face
• Torsion Yield Strength	0.750” from face	0.375” from face
• Tensile Yield Strength	0.625” from face	Box at pin end
• Bending Strength Ratio	0.750” from face	Box at pin end

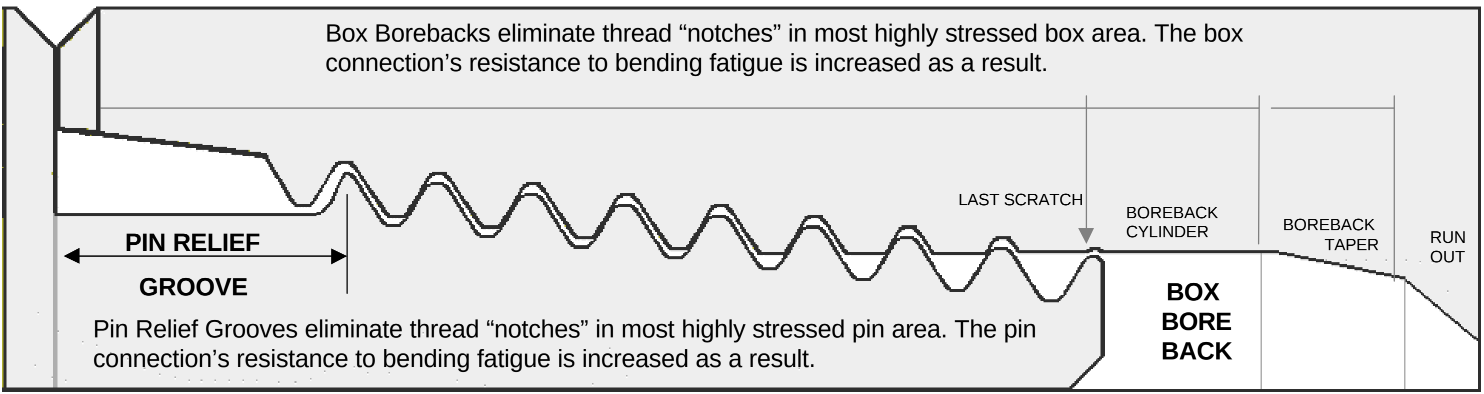


Notch Effect of Threads & Relief Features

Threads are in effect notches in a bar. Notches concentrate stress induced by bending. The sharper the notch, the higher the resulting concentration of stresses and the more likely fatigue is to begin a crack. This is why thread roots have a radius - to spread stresses. It is also the reason that relief grooves and bore backs increase a connections resistance to bending fatigue.







Make-Up Torque

Make-up torque involves two sets of calculations. The pin & its I.D. is the dimensional basis for one calculation . The box & its O.D. is the dimensional basis for the other calculation. Material yield strength of each member is also factored into the calculations. The lesser results then determine the actual make-up to be used.

There can be confusion in interpreting make-up charts and the exact values to use. This is especially true of MWD tools where a box connection with a large ID can lead to reading a make-up chart incorrectly. In reading make-up charts, the connection must first be found. Second, the proper OD row is found based on the box OD. Third, the ID column is found based on the Pin ID.

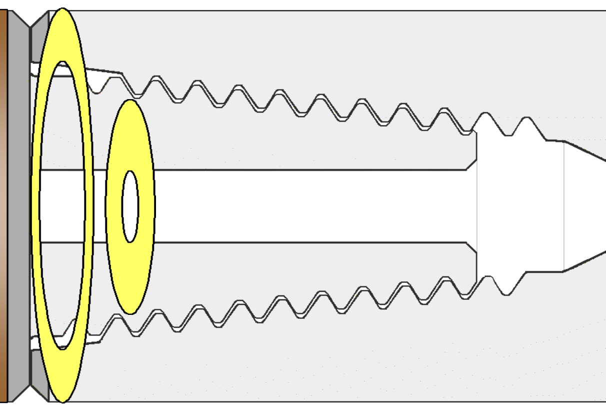
The make-up chart OD should be the box OD and the chart ID should be the pin ID.

Similar separate calculations are done for both Box and Its OD and Pin and its ID in order to determine the connections Tensile and Torsion Strength as well as its Bending Strength Ratios.

PIN & ITS I.D.

DIMENSIONAL BASIS FOR PIN CALCULATIONS

- **Make-Up Torque**
- **Tensile Strength**
- **Torsion Strength**
- **Bending Strength Ratio**



BOX & ITS O.D.

DIMENSIONAL BASIS FOR BOX CALCULATIONS

- **Make-Up Torque**
- **Tensile Strength**
- **Torsion Strength**
- **Bending Strength Ratio**

ROTARY SHOULDERED CONNECTION MAKE-UP TORQUE VALUES (FT-LBS)

MAKE-UP TORQUE = (SA / 12) • Trq • MUS

Where:
SA = PSA OR BSA (whichever is least)
MUS = Make Up Stress (PSI - per Coon Type)
Trq = P + RT + RS

To Find Trq
P = Lead / (2 ¶)
RT = [(C + (C- (Tpr • (Lpc - .625))) / 4• F] / Cos
RS = [(Qc + Od) / 4] • F

Where:
C = Pitch Diameter (0.625 from face)
Tpr = Taper per inch
Lpc = Length of Pin Connection
F = Friction Factor (0.008)
Lead = Thread Lead per Inch
¶ = Pie (3.14159)
Qc = Counterbore Diameter of Box
Od = Outside Diameter of Box

MAKE-UP STRESS

The amount of stress which is induced into the connections during make-up to ensure the shoulders act together, forming a seal.

API Recommendation include:

Drill Pipe	72,000 psi
Drill Collar (NC, IF, Reg, FH, etc. . .	62,500 psi
Exceptions:	
Drill Collar (H90 w/ 45º flank angle. .	56,200 psi
Drill Collar (PAC conn.s	87,500 psi

PIN CROSS SECTION SQUARE AREA

PSA = (¶ / 4) • (R^2 - Id^2)

Where:
Id = Inside Diameter of Pin
R = Pin adjusted thread root diameter @ 3/4" from pin face
= [C - (H - (2 Frn)) - (Tpr • .125)]

Where:
C = Pitch Diameter (0.625" from face)
H = Non-Truncated thread depth
Frn = Root Radius of threads
Tpr = Taper per inch

BOX CROSS SECTION SQUARE AREA

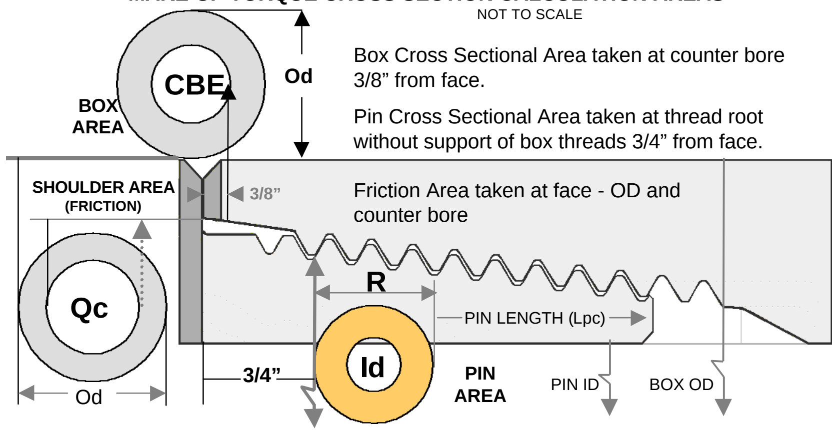
BSA = (¶ / 4) • (OD^2 - CBe^2)

Where:
od = Outside Diameter of Box
CBe = Inside Diameter of Counter Bore at 3/8" from box face
= Qc - (Tpr • .375)

Where:
Qc = Counter Bore Diameter
Tpr = Taper per inch

MAKE-UP TORQUE CROSS SECTION CALCULATION AREAS

NOT TO SCALE



Note: Shoulder Square Area is used in the "Trq" calculation to compensate for friction between the shoulders as they are made up. The bevels are ignored as they may vary by customer. This may introduce a small error of little significance when comparing connections with the same bevels but widely differing od's. This error is much less than API recommendation of the minimum make-up torque plus 10 %.

ROTARY SHOULDERED CONNECTION TORSIONAL YIELD STRENGTH

MAKE-UP TORQUE = (SA / 12) • Trq • MYS

Where:
SA = PSA or BSA (whichever is least)
MYS = Material Yield Strength
Trq = P + RT + RS

To Find Trq
P = Lead / (2 ¶)
RT = [(C + (C- (Tpr • (Lpc - .625))) / 4• F] / Cos
RS = [(Qc + Od) / 4] • F

Where:
C = Pitch Diameter (0.625 from face)
Tpr = Taper per inch
Lpc = Length of Pin Connection
F = Friction Factor (0.008)
Lead = Thread Lead per Inch
¶ = Pie (3.14159)
Qc = Counterbore Diameter of Box
Od = Outside Diameter of Box

MATERIAL YIELD STRENGTH

API Minimum Yield Strength specifications for material expressed in Pounds per Square Inch.

Common values per API:

Drill Pipe Tool Joints.	120,000 psi
Drill Collar to 6-7/8" OD	110,000 psi
Drill Collar over 6-7/8" OD	100,000 psi

PIN CROSS SECTION SQUARE AREA

PSA = (¶ / 4) • ($R^{\wedge 2}$ - $Id^{\wedge 2}$)

Where:
Id = Inside Diameter of Pin
R = Pin adjusted thread root diameter @ 3/4" from pin face
= [C - (H - (2 Frn)) - (Tpr • .125)]

Where:
C = Pitch Diameter (0.625" from face)
H = Non-Truncated thread depth
Frn = Root Radius of threads
Tpr = Taper per inch

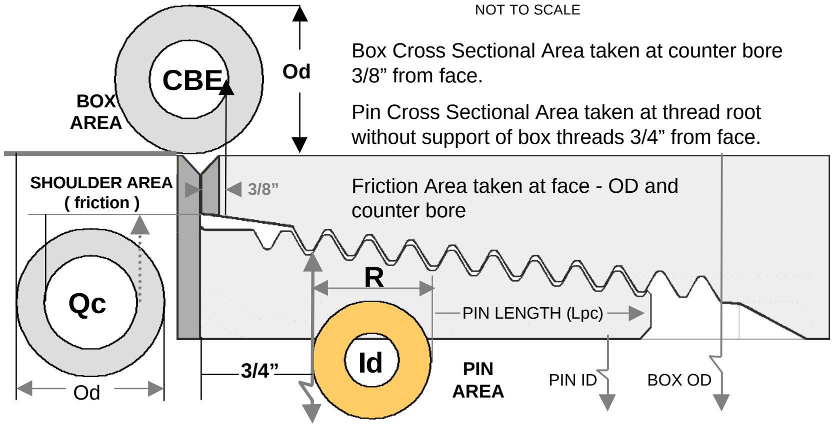
BOX CROSS SECTION SQUARE AREA

BSA = (¶ / 4) • ($OD^{\wedge 2}$ - $CBe^{\wedge 2}$)

Where:
od = Outside Diameter of Box
CBe = Inside Diameter of Counter Bore at 3/8" from box face
= Qc - (Tpr • .375)

Where:
Qc = Counter Bore Diameter
Tpr = Taper per inch

TORSIONAL STRENGTH CROSS SECTION CALCULATION AREAS



Note: Shoulder Square Area is used in the "Trq" calculation to compensate for friction between the shoulders as they are made up. The bevels are ignored as they may vary by customer. This may introduce a small error of little significance when comparing connections with the same bevels but widely differing od's. This error is much less than API recommendation of the minimum make-up torque plus 10 %.

ROTARY SHOULDERED CONNECTION TENSIL YIELD STRENGTH	PIN CROSS SECTION SQUARE AREA	BOX CROSS SECTION SQUARE AREA
Tensil = Area x Material Yield Strength Where the square area is that of the pin or the box - whichever is the least.	**PSA = (¶ / 4) • (TR^^{2} - Id^^{2})** Where: Id = Inside Diameter of Pin TR = Pin adjusted thread root diameter at 0.625" from pin shoulder.	**BSA = (¶ / 4) • (OD^^{2} - B^^{2})** Where: Od = Outside Diameter of Box B = Box adjusted thread root diameter located at end of pin.

Additional required formulas and data

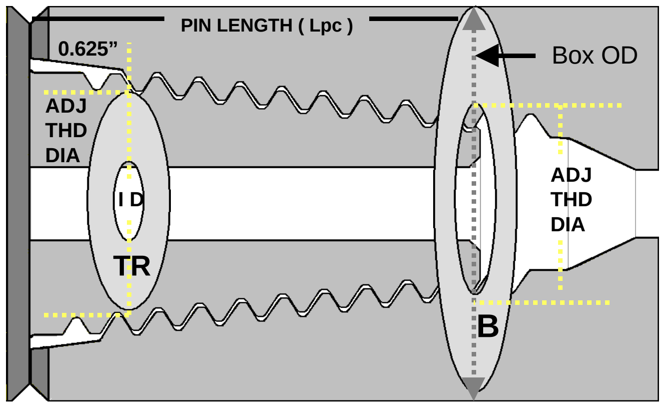
To Find: B (dia) and TR (dia)
B = C - (Tpr • (Lpin -.625) + (H - 2•ddd))
TR = C - (H - (2 • ddd))
ddd = ((H / 2) - Rr

Where:
C = Pitch Diameter
Tpr = taper per inch
Lpin = Length of Pin
H = Non-Truncated thread height
ddd = dedendum (thread roots)
Rr = Root Radius

Material Yield Strength

Material Yield Strength is expressed in Pounds per Square Inch (PSI)
Common values per API:
Drill Pipe Tool Joints. 120,000
Drill Collars to 6-7/8" OD 110,000
Dril Collars over 6-7/8 100,000

CROSS SECTIONAL AREAS



The Pin Square Area is taken at the point having the smallest "thread root od" which is subjected to tensil loads and is not supported by the box threads LESS the square area of the pin id.

The Box Square Area equals the square area of the box od Less the square area of the box connectionat the point having the largest "thread root id" and which is not supported by the threads of the pin connection (at pin end).

The smallest cross sectional area determines the weakest point, thereby determining the Tensil Strength value to be used.

Bending Strength Ratio (BSR) describes the relative capacity of a pin with a certain ID and a box with a certain OD to resist bending fatigue when mated together. A BSR of 2.50 to 1.00 is generally considered to be balanced under average drilling conditions with both the box and the pin being equally resistant to bending fatigue. BSR values above 2.50 : 1.00 indicate stiffer boxes relative to the pin while values below 2.50 : 1.00 indicate stiffer pins. The stiffer member transmits greater bending stresses to the weaker member causing a faster rate of bending fatigue than would occur in balanced connections.

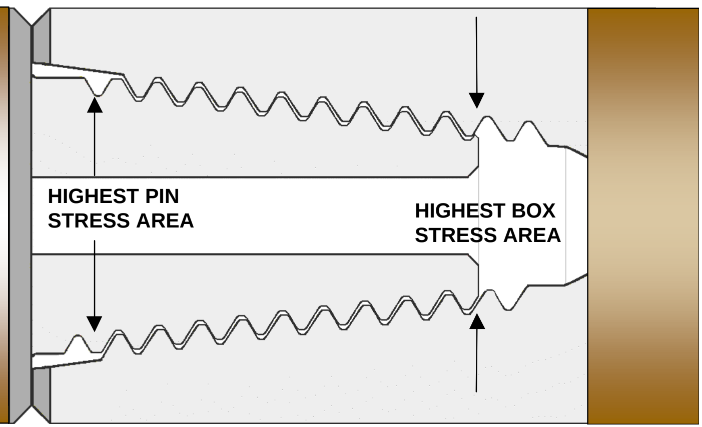
Few of the most commonly used drill collar combinations of OD, ID, and connection size and type meet the BSR criteria exactly, therefore BSR ranges are established using general guidelines. The guidelines include:

1. 2.25:1 to 2.75:1 — Small drill collars, 6" od or less
2. 2.25:1 to 2.85:1 — Small drill collars relative to hole size. ie 8" od in 12-1/4" hole. High RPM, Soft formations
3. 2:25:1 to 3.20:1 — Large drill collars relative to hole size. Ie 10" od in a 12-1/4" hole, 8" in 9-7/8" hole Low RPM, hard or abrasive formations.
4. 2.25:1 to 3.40:1 — Condition as in #3 with large collars having low torque and relief features
5. 2.50:1 to 3.00:1 — Abrasive formations where loss of OD is severe. Extremely corrosive eviroments.

The threads of each connection lend support to the other. The highest bending stresses occur in thread roots where this support ends causing most pins to crack 3/4" to 1" from the shoulder and most boxes to crack at pin end.

BSR values are based upon the ratio of the cross sectional area of the box at its highest stress point to a similar cross sectional area of the pin at its highest stress point.

BSR values commonly relate to drill collars and other stiff members of a drill string. BSR values are not calculated for drill pipe as the flexible tubes do not concentrate high bending stresses in the tool joints.



ROTARY SHOULDERED CONNECTION Bending Strength Ratio	Box Cross Section Modulus	Pin Cross Section Modulus
$$BSR = \frac{\text{Box Section Modulus (BSM)}}{\text{Pin Section Modulus (PSM)}}$$	$$BSM = \frac{0.098 \cdot (Od^{4} - Bdia^{4})}{Od}$$ Where: Od = Outside Diameter of box Bdia = Box thread root diameter at pin end	$$PSM = \frac{0.098 \cdot (Pdia^{4} - Id^{4})}{Pdia}$$ Where: Id = Inside Diameter of pin Pdia = Pin thread root diameter at 3/4” from face.

Additional required formulas and data

To Find Bdia and Pdia

Bdia = C - (Tpr / 12) • (Lpin - .625) + (2 • ddd)

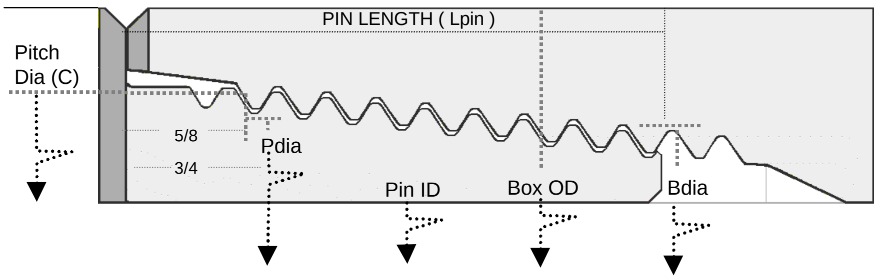
Pdia = C - ((Tpr / 12) • (.125) - (2 • ddd))

Where:
C = Pitch Diameter
Tpr = taper in inches per foot.
Lpin = Length of pin
ddd = dedendum (thread roots)

Calculate dedendum by:

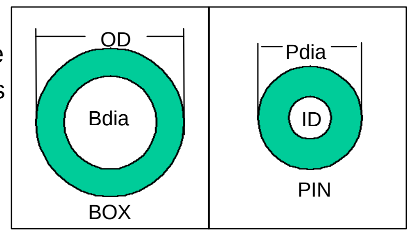
ddd = (H / 2) - Frn

Where:
H = Non-truncated thread height
Frn = Root Truncation.



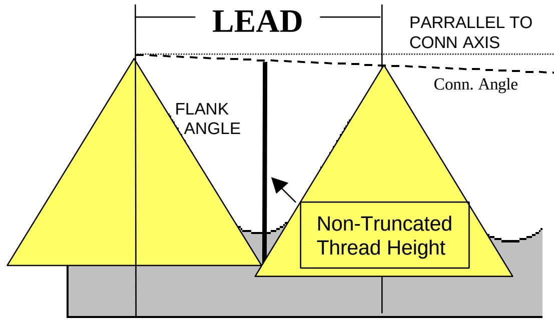
Cross Section Modulus

BSR equals ratio of the cross sectional modulus of the box to the pin at their respective highest stress point.



Non-Truncated Thread Height

Non-Truncated thread height is the height of threads perpendicular to the connection axis should the flank angles be extended with no root or crest radii.



It will be used in connection calculations. It has the effect of reducing the square area in the calculations between the pin & its ID and the box & its OD.

Below is an example of calculation using 4 threads per inch , 2 taper per foot, and 30^0 flank angles. Drawing is exaggerated for illustration purposes.

Thread flank angle	= 30 degrees
Thread per inch	= 4
Thread Lead per each (AC)	= 0.250
Changed per Thread (CB)	= 0.02083333333
Line CD = TAN(30)*0.0 020833	= 0.012023130608
Line AD = AC + CD	= 0.262028130608
Line AE = AD / 2	= 0.131014065304
Line EF = AE * TAN(60)	= 0.226923017613
Line EG = AE * 0833333	= 0.010917617207
Line FG = EF - EG	= 0.216005400407
Non-Truncated Thread Height	= 0.216005400407