



**Water and Sewer Department**  
Standard Maintenance Guideline  
Pipe Strain Allowed on Rotating and  
Static Equipment

Version No.	1
Date Created	01/11/2018
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Approved by	AMC/MRT
Control No.	AM-SMG-703
Section	AM

## 703 Pipe Strain Allowed on Rotating and Static Equipment

### 703.1 Practical Guidelines to Minimize Pipe Strain on Rotating and Static Equipment

#### 703.1.1 Scope

Pipe strain imposed on the suction and discharge nozzles of pumps, blowers, compressors, etc. causes shaft wear, seal and bearing failures, case breakage, etc. Static equipment is also susceptible to imposed strain. This Guideline is written to apply to both rotating and static equipment (some portions of Guideline N/A to static equipment.) This guideline shall be incorporated into specifications for purchase of new equipment by contractors, engineering consultants, or the City of Tulsa. In case of conflict between this guideline and the purchase order, unless specifically stated as an exception in the PO, the vendor shall obtain a written ruling from the City of Tulsa Plant Engineer before proceeding with the work affected. API 686 "Recommended Practice for Machinery Installation and Installation Design" is referenced for allowable values of field measurements. This guideline is applicable to rotating and static equipment connected to external piping, etc., but is not applicable to electric motors or submersible pumps. Before performing any work, Lock-Out, Tag-Out (LOTO) all sources of energy including electrical power, suction and discharge valves, etc., and drain liquid from equipment / lines, etc.

### 703.2 Check for Pipe Strain During Removal of an Installed Pump, Blower, Compressor, and Static Equipment

#### 703.2.1 Check Motor to Pump Shaft Alignment

1. With pump and motor, or right-angle gear and engine uncoupled, check alignment of shafts with a laser alignment tool. Alternatively, use dial indicators. Record in Table 1.

#### 703.2.2 Dial Indicator Placement Prior to Pump / Piping Maintenance

1. Place magnetic bases of two dial indicators on motor frame and/or baseplate. Place dial indicator needles perpendicular to pump shaft in the vertical and horizontal positions.

#### 703.2.3 Remove Suction and Discharge Piping Stud-Bolts / Measure Pipe Strain

1. Remove stud-bolts and gasket on pump suction and discharge flanges to adjacent piping flanges. Pump anchor bolts to remain tightened.
2. Check movement of dial indicator needles. Record in Table 1.
3. Measure distance between pump flanges and connected piping flanges. Allowable limits per Table 3, measured at flange outside diameter. Check bolt hole misalignment, and flange face separation within gasket spacing +/- 0.06 inch. Record values in Table 1.

#### 703.2.4 Check Motor to Pump Shaft Alignment

1. With pump and motor, or right-angle gear and engine uncoupled, check alignment of shafts with a laser alignment tool. Alternatively, use dial indicators. Record in Table 1.



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### 703.3 Correcting Pipe Strain / Strain Measurements

#### 703.3.1 Correct Pipe Strain if Required for Rotating and Static Equipment

1. If pipe strain is present as determined from all readings taken and recorded, the strain must be corrected. Methods for achieving piping alignment include shimming supports, adjusting spring hanger tie-rod turnbuckles, retorquing flanges, installing piping support spacers, installing an expansion bellows in the piping line, field machining mating flange faces (portable rig), selectively heating one side of the pipe (piping disconnected from pump), ring heating (piping attached to pump w/ an insulating gasket), cutting and rewelding, or completely refabricating the piping. The methods vary for each installation. Consult with the City of Tulsa Plant Engineer and Maintenance Supervisor for allowable method(s). Verify all machined flanges are plane to within 0.002 inch. Record in Table 2.

### 703.4 Install Pump in New or Existing Installation

#### 703.4.1 Dial Indicator Placement Prior to Pump / Piping Maintenance

1. Place magnetic bases of two dial indicators on motor frame and/or baseplate. Place dial indicator needles perpendicular to pump shaft in the vertical and horizontal positions.

#### 703.4.2 Strain Measurements, Tighten Suction and Discharge Piping Stud-Bolts

1. Measure distance between pump flanges and connected piping flanges. Allowable limits per Table 3, measured at flange outside diameter. Check bolt hole misalignment, and flange face separation within gasket spacing +/- 0.06 inch. Record values in Table 2.
2. Install new gaskets on pump flanges. Lube all fasteners w/ anti-seize. Tighten all stud-bolts on pump flanges. In a crisscross fashion, tighten stud-bolts snug to 10% of final torque, then to 30%, then to 100%. Refer to Table 4 for final stud-bolt torque. Record actual final stud-bolt torques in Table 2.
3. Check for any movement of dial indicator needles against pump shaft. If either vertical or horizontal dial indicator registers more than 0.002 inch allowable at end of reassembly process, this indicates excessive pipe strain that must be corrected. Record in Table 2.

#### 703.4.3 Check Motor to Pump Shaft Alignment

1. With pump and motor, or right-angle gear and engine uncoupled, check alignment of shafts with a laser alignment tool. Alternatively, use dial indicators. When correcting any misalignment, shim under motor feet only. Record in Table 2.

#### 703.4.5 If Pipe Strain is Present for Rotating and Static Equipment

1. In case pipe strain is present, correct to within allowable limits. Repeat applicable portions of section 803.4.

#### 703.4.6 Dowel Pump to Baseplate

1. After all steps are completed, if required dowel the pump to the baseplate according to the manufacturer's recommendations. Dowels shall be a pullout design.

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**Table 1 Removal of Rotating and Static Equipment – Actual Vs. Allowable Strain Measurements. – Contractor or City of Tulsa Personnel to Provide Data to Site Maintenance Supervisor Including Equipment No., Date, Name(s) of Person(s) that Recorded Data. Data to be Entered Into Lacity for the Equipment No.**

Parameter	Description	Actual Strain Measurement	Allowable Strain Measurement
Motor to Pump Shaft Alignment	Parallel / Angular	/	Laser "Green" or 0.002 Inch by Dial Indicators
Pump Shaft Movement Relative to Motor	Vertical / Horizontal	/	0.002 Inch
Flange Face Outside Diameters Out of Parallel / Strain Measurement	Suction / Discharge.	/	Table 3
Bolt Hole Misalignment	Suction / Discharge	/	0.062 Inch
Flange Face Separation	Suction / Discharge	/	Within Gasket Spacing +/- 0.06 Inch
Motor to Pump Shaft Alignment	Parallel / Angular	/	Laser "Green" or 0.002 Inch by Dial Indicators

**Table 2 Installation of Rotating and Static Equipment – Actual Vs. Allowable Strain Measurements. – Contractor or City of Tulsa Personnel to Provide Data to Site Maintenance Supervisor Including Equipment No., Date, Name(s) of Person(s) that Recorded Data. Data to be Entered into Lacity for the Equipment No.**

Parameter	Description	Actual Strain Measurement	Allowable Strain Measurement
Flange Faces Plane	All Rotating Equipment and Connected Piping	/	0.002 Inch
Flange Face Outside Diameters Out of Parallel / Strain Measurement	Suction / Discharge	/	Table 3
Bolt Hole Misalignment	Suction / Discharge	/	0.062 Inch
Flange Face Separation	Suction / Discharge	/	Within Gasket Spacing +/- 0.06 Inch
Stud-Bolt Torque	Suction / Discharge	/	Table 4
Pump Shaft Movement Relative to Motor	Parallel / Angular	/	0.002 Inch
Motor to Pump Shaft Alignment	Parallel / Angular	/	Laser "Green" or 0.002 Inch by Dial Indicators



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**Table 3 Allowable Out-of-Parallel / Strain of Flange Faces for Rotating and Static Equip.**

Class 125/150/250/300 Flange Size (Inches)	Out-of-Parallel, Flange Faces (Inches)	Preferred Out-of-Parallel, Flange Faces (Inches)
0.25 / 0.50 / 0.75 / 1	0.005	0.005
1.25 / 1.50	0.005	0.005
2	0.006	0.005
2.5	0.007	0.005
3 / 3.5	0.008	0.005
4	0.009	0.005
5	0.010	0.005
6	0.011	0.005
8	0.014	0.010
10	0.016	0.010
12	0.019	0.010
14	0.021	0.010
16	0.024	0.010
18	0.025	0.010
20	0.028	0.015
24	0.032	0.015
30	0.039	0.015
36	0.046	0.015
42	0.053	0.015
48	0.060	0.015

Measure gap between flanges at flange OD's. Column 2 values are per API 686 and shall not be exceeded. Column 3 values are common practice, tighter than API 686, and should be aimed for, but not required.

**Table 4 Stud-Bolt Torque Recommended for Rotating and Static Equipment**

Stud-Bolt Diameter (Inches)	Torque, ASTM A307, and SAE GR. 2 (ft.-lbs.)	Torque, ASTM A193 B7, and SAE GR. 5 (ft.-lbs.)
0.500	35	75
0.625	70	150
0.750	120	270
0.875	170	450
1.000	250	650
1.125	350	900
1.250	500	1400
1.500	870	2300

Check IOM for specific torques. Torque values based on stud-bolts, nuts, and nut-bearing surface contacting flange coated w/ anti-seize, etc. (Note: Newton-meters X 0.74 = ft.-lbs.)