701 Special Requirements, New Equipment Purchases

701.1 Design and Construction Features

801.701.1 Scope

The following special requirements are to be incorporated into specifications for purchase of new equipment by contractors, engineering consultants, or the City of Tulsa. In case of conflict between the "Special Requirements, New Equipment Purchases", and the purchase order, unless specifically stated by the order as an exception, the vendor shall obtain a written determination from the City of Tulsa Division Engineer before proceeding with the work affected.

701.1.1 Pumps – Horizontal, Vertical, Submersible

1. All hardware including bolts, studs, washers, nuts, nameplate / fasteners, grease caps or plugs, drain plugs or fittings, etc. shall be of plated steel minimum. Hardware for wastewater service shall be of 316 stainless-steel constructions.316 stainless steel fasteners specified will include nickel-based anti-seize and shall be applied to threaded fasteners during factory assembly and all piping installation applications.
2. Bolts and studs shall fully engage nuts and shall have a minimum of three threads visible beyond nut. All wastewater fasteners shall not be painted. Refer to 801.1.2 section 1 for required fastener type.
3. All through-bolt flanges shall be full-faced on back side or shall be back spot-faced.
4. Horizontal and vertical pumps in wastewater service with 8 inch and larger nozzles shall have a minimum 5-inch diameter hand hole clean-out ports with closure flange to allow access to the suction and discharge areas of the impeller. If impractical to locate the hand hole clean-out ports on the pump nozzles, the ports shall be added to the suction and discharge piping. (This requirement is referenced in "Piping" section 801.1.27.1.)
5. Horizontal and vertical pump nozzles (both suction and discharge) shall each have minimum 0.50-inch NPT (National Pipe Thread) connections for air relief, and minimum 0.75 inch NPT connections for pressure measurements. If this is not standard for the pump manufacturer, the taps are to be incorporated into the adjacent suction and discharge piping. (This requirement is referenced in "Piping" section 801.1.27.2.)
6. An air relief valve shall be fitted at high point(s). The ARV shall be supplied either by the pump manufacturer or by the engineering contractor. (N/A to submersible pumps.) (This requirement is referenced in "Piping" section 801.1.27.2.)
7. Bearing housings containing oil shall be vented to the atmosphere through a desiccant breather to prevent ingestion of dirt and moisture. (N/A to submersible pumps.)
8. Equipment and accessories shall be designed and constructed for continuous operation.
9. Pumps which spare each other shall be identical.

10. Pumps that have stable head/capacity curves which continuously rise to shutoff are preferred for all applications and required when parallel operation is specified by purchaser.
11. NPSHA and NPSHR (Net Positive Suction Head Available and Net Positive Suction Head Required) margin shall be a minimum of 3 feet at rated capacity and speed, or the margin recommended by Hydraulic Institute, whichever is greater.
12. Suction specific speed (NSS) greater than the Hydraulic Institute allowable of 8,500 shall require specific approval by the City of Tulsa Water and Sewer Division Engineer.
13. For sewage applications, pumps to be non-clog design, and must allow passage of spheres of the diameter specified by the City of Tulsa Water and Sewer Division Engineer.
14. For all solids-handling applications, the pump speed is not to exceed 1800 RPM per the Hydraulic Institute.
15. Impellers shall be keyed to the shaft to prevent harmful effects of any possible reverse rotation. A locking ring or threaded nut shall fix the impeller's axial position to the shaft and withstand maximum hydraulic thrust loads.
16. All pump casings shall be unpainted when hydrostatically tested with water at 1.5 times the maximum casing design pressure. The hydrostatic tests shall be considered satisfactory when no leaks are observed for a minimum of 10 minutes.
17. Pipe strain shall be minimized during installation of piping and rotating equipment per vendor's IOM and Standard Maintenance Guideline AM-SMG-803, "Pipe Strain Allowed on Rotating Equipment." (N/A to submersible pumps.)
18. Vibration of pumps, compressors, motors, etc. shall not exceed the values given in Tables 1 and 2 below as measured on the bearing housing(s). The maximum allowable vibration levels under any circumstance are per "ANSI/Hydraulic Institute Vibration Limits" per Tables 1 and 2 below. The "Preferred Vibration Limits" are to be aimed for with all applications. Note: ANSI/Hydraulic Institute 9.6.4-2016 specifies vibration limits in "RMS" values. The "RMS" values have been converted to "Inches / Sec. Peak" values which are 1.414 X the "Inches / Sec. RMS" values in the referenced ANSI/HI spec. A field vibration certificate shall be supplied by the installation contractor after commissioning. (N/A to submersible pumps.)
19. Overhead cranes shall be installed to provide lifts directly over the pump CG (center of gravity) and motor CG. Not applicable for supply of equipment for existing installations.
20. Peripheral piping of steel or stainless-steel construction shall have wall thicknesses sized per "Piping" section 801.1.27.3 and 4. This is not a requirement for the supply of replacement pumps.
21. When required by the City of Tulsa Plant Engineer, high bearing temperature sensors and alarms on pump bearings are specified. (N/A to submersible pumps.)
22. When required by the City of Tulsa Plant Engineer, vibration sensors and alarms on pump bearings are specified.

Table 1 – Maximum Acceptable Field Vibration Levels of Rotating Equipment Not in Solids-Handling Service

Driver Size, HP	ANSI / Hydraulic Institute Vibration Limits, Inches / Sec. Peak	Preferred Vibration Limits, Inches / Sec. Peak
Less than 33 (25 kW)	0.21	0.07
Above 33 (25 kW) and below 268 (200 kW)	0.21	0.11
Greater than 268 (200 kW)	0.27	0.18

Table 2 – Maximum Acceptable Field Vibration Levels of Rotating Equipment In Solids-Handling Service

Driver Size, HP	ANSI / Hydraulic Institute Vibration Limits, Inches / Sec. Peak	Preferred Vibration Limits, Inches / Sec. Peak
Less than 33 (25 kW)	0.35	0.17
Above 33 (25 kW) and below 100 (75 kW)	0.40	0.20
100 (75 kW) and above	0.44	0.22

701.1.2 Pumps – Horizontal

1. Stainless steel shims are to be placed under the motor feet and in bearing housings, when necessary, with allowance to specific needs for shim sizes and shall be applied for alignment purposes which is determined by the alignment technician if needed. Plastic shims are not allowed.
2. Alignment positioning screws shall be provided for all horizontal motors 25 HP and larger, to facilitate longitudinal and transverse horizontal adjustments. The ends of screws that contact motor feet shall be rounded convex. The lugs holding these positioning screws shall be attached to the baseplate so that they do not interfere with the installation or removal of the motor, or the placement of shims.
3. Casing drains shall be valved and plugged on the valve outlet.
4. Pumps shall not be doweled to the baseplate but shall be provided with dowel holes pre-drilled in the casing feet and supports only. (Drilling of the dowel holes in the baseplate may be done in the field after alignment.) Dowel pins shall be of the pullout design and shall be supplied by the manufacturer.

701.1.3 Pumps – Vertical

1. Vertical pump shaft or shaft sleeve maximum runout measured immediately above the mechanical seal or stuffing box when pump is turned by hand shall be 0.002-inch TIR

(Total Indicator Reading) for pumps operating above 1400 RPM, and 0.004-inch maximum TIR for pumps operating below 1400 RPM.

2. Vertical suspended can pumps shall be furnished with a separate mounting plate for bolting and grouting to the foundation. The top of the mounting plate shall be flat within 0.002 inch of the surface plane and level to within 0.002 inch per foot of width or diameter. The foundation shall be designed so that the pump can is directly attached to the separate mounting plate and is removable without damaging the grout below the mounting plate. The foundation bolts shall not be used to secure the flanged joint under pressure.
3. Vertical pumps shall operate in continuous hydraulic down-thrust over the pump's full operating range.
4. When vertical pump shafts of more than one piece are approved by the City of Tulsa Water and Sewer Division Engineer, the joints shall be secured against reverse rotation by utilizing a ring and key joint connection(s).
5. All vertical pumps with mechanical seals shall have a vent connection on the stuffing box or flush piping located to ensure that fluid is present at the seal faces before start-up.
6. Vertical pumps and vertical in-line pumps shall have spacer couplings connecting the pump and motor shafts. The distance between shaft ends (DBSE) and length of spacer coupling manufactured shall allow removal of the mechanical seal without removal of the motor.
7. Vertical pumps and vertical in-line pumps shall be provided with a close-clearance register fit on the mating flanges of the motor and pump, or jacking screws provided.

701.1.4 Pumps – Submersible

1. Lifting devices (ring, chain, cable, eye, etc.) shall be of stainless-steel construction.
2. The power cable shall be supplied 6 feet longer than what is required by the manufacturer.
3. For solids applications, the vertical discharge piping shall be sized to maintain at least 4 feet / second flow velocity.

701.1.5 Installation and Commissioning of Pumps

1. A pump to motor shaft alignment certificate shall be supplied by the installation contractor. (N/A to submersible pumps.)
2. Confirm the numbering of the pump to be inspected matches sign off documentation.
3. Written and documented certificate provided by the contractor ensuring that pipe strain, soft foot, alignment, and runout are all within the acceptable range as stated in AM SMG 803.
4. Run the motor on no-load (decoupled from the pump) for a time which should achieve operating temperature. Vibration, thermal imaging scans, amperage and voltage values shall be recorded and documented and qualified and supplied by the contractor and needs to meet OEM specifications.
5. Run pump with flooded suction for a minimum period of seventy-two hours of operations before signing off and accepting ownership by operations, maintenance, and engineering.
6. The lines going to the pump inlet should be flushed with demineralized water while being disconnected from the pump.
7. The strainer on the inlet should be cleaned if applicable and accessible.

8. Recommended oil should be used to flush the pump and drained.
9. Recommended oil should be filled in the pump and the level should be confirmed satisfactory.
10. Suction lines are then connected to the pump.
11. The suction lines are to be bled off to prevent air pockets from getting through to the pump.
12. Pump should be coupled with motor in preparation for load run.
13. The discharge valve should be fully closed (Centrifugal pumps only) to check for maximum pump pressure/head.
14. Upon startup of pump, the system should be checked for leaks, abnormal sound, vibration and bearing temperature and be documented and certified by the contractor and OEM.
15. The flow should be checked (upon certification from the measuring instrument and gauge calibration has been checked and calibrated) by the contractor and pump OEM.
16. Confirm power consumption of the pump is in line with equipment data sheet and efficiencies are documented by the contractor and pump OEM.
17. Ensure OEM documentation is correct, and all manuals (digital and physical) are supplied by contractor 4 weeks before the project is completed.
18. Should all parameters fall within range, the pump needs to be signed off by engineering, operations, and maintenance before being put in operation.

701.1.6 Mechanical Seals

1. Unless otherwise specified, mechanical seals shall be furnished with all pumps. The mechanical seal and seal support system shall be designed to ensure fluid film stability, to minimize the effect of erosion of the component parts, and to ensure that process dilution is minimized.
2. For vertical, horizontal, and submersible pumps, the mechanical seal face materials are specified per Table 3. For seal flush plans refer to Table 4.
3. All mechanical seal metallic seal components shall be constructed of stainless steel. For water service, all flush and circulation tubing and/or piping shall be constructed of PEX or copper (painted on OD) tubing. For wastewater service, all flush and circulation tubing and/or piping shall be constructed of 3/16 stainless-steel tubing. PEX tubing deteriorates in sunlight and shall be used for indoor applications only. All steel and stainless-steel piping shall have wall thickness per "Piping" section 801.1.27.3 and 4.
4. Elastomers shall be constructed of Aflas. Elastomers are not to fret the shaft sleeve OD.
5. Seal glands shall bolt to the pump seal chamber with four equally spaced stainless-steel fasteners. The mechanical seal shall not be mounted to a standard packing cross-section stuffing box. The seal chamber shall be specially constructed to optimize the mechanical seal environment. The radial clearance of the mechanical seal ID to the sleeve OD shall have a minimum of 0.187-inch radial clearance. The cross section around the outside diameter of the mechanical seal components shall optimally be a minimum of 1.00-inch radial clearance.
6. A throttle bushing of a non-sparking material shall be provided in the mechanical seal gland to minimize leakage in case of complete seal failure.
7. For applications other than AESSEAL (or equal) double seals and Plan 53A, each pump to be provided with a pressure switch that will send a signal to shut down the electric motor in event of no external flush water going to the mechanical seal faces.

8. For applications other than AESSEAL (or equal) double seals and Plan 53A, to always maintain flush water inside the seal, a solenoid-activated flow switch shall be located downstream of the pump mechanical seal. The energizing of the electric motor activates the solenoid. A flow indicator (paddlewheel, etc.) shall be installed on this line near the solenoid-activated flow switch.
9. Water service mechanical seals shall be single or split cartridge design and shall be equivalent to ANSI standard single cartridge seals, Chesterton 42, AESSEAL CURC, or equal.
10. Sewage service mechanical seals shall be equivalent to ANSI standard dual cartridge mechanical seals, AESSEAL CDSA, or equal. The inboard seal faces shall operate on a clean barrier water fluid, pressurized to a minimum of 15 PSI greater than the maximum process pressure in the pump seal chamber. The inboard seal face shall be pressure balanced to the barrier fluid with approximately a 30 / 70 (process / barrier) pressure.

11. The mechanical seal face drive mechanism should be metal against metal for durability. The seal environment shall be protected by a close clearance between the back plate and the rotating shaft on the process side of the seal. The optimal diametrical clearance shall be 0.125 inch, and this closed frame plate configuration shall be designed for the purpose of reducing the velocity of the process slurry in the seal housing. The double mechanical seal shall reduce heat by thermosiphon flow through the seal support system and connecting piping. Alternatively, the double mechanical seal can be equipped with a pumping ring to maintain circulation through the seal and Plan 53A system.
12. The API Plan 53A seal support system shall be AESSEAL SSE25 Water Management System or equal. Vessel capacity shall be 6.6 gallons (25 liters). The vessel shall be constructed of 304 SS and designed to ASME VIII, Div. 1. The Vessel shall be designed to 145 psig MAWP and shall be hydro tested to 218 psig for a minimum of 10 minutes.

The bottom of the vessel shall be located 1-2 feet above the centerline of the mechanical seal. The connecting tubing shall have extra-large radius, sweeping bends. The exit from the seal (BO = Barrier Out) shall enter the upper of the two vessel barrier fluid connections. The lower of the two vessel barrier fluid connections shall connect to the seal (BI = Barrier In) connection. A drain shall be fitted to the lowest portion of the vessel with a valve and a plug to allow periodic (possibly quarterly) purging of accumulated contaminates (a few ounces of water.) A stainless-steel non-return valve and a stainless-steel flow indicator shall be provided. A brass water supply regulator and a brass pressure gauge shall be provided. A stainless-steel pressure switch shall be supplied to alarm on falling pressure. The water quality shall be filtered to 1 micron. A pre-filter of 5 microns can be, but is not required, fitted upstream of the 1-micron filter. The in-line filter shall be constructed of stainless steel, brass, or a UV-stabilized material, and be rated to 120 psig MAWP minimum. The filter is preferred, but not required, to be fitted with a flush valve. The inter-connecting tubing and tube fittings shall be stainless steel material. The barrier fluid shall be potable city water. If city water is not available, plant effluent

water (PEW) can be used but with great caution as it will quickly plug filters, greatly degrade the seal life, and should be avoided.

13. For each dual pressurized mechanical seal, the manufacturer shall provide a computerized report detailing the operating conditions for each application to include Shaft diameter, RPM, process pressure, barrier fluid pressure, ambient temperature, designed for dry running and hard-face combinations. The report to state the heat removal capability of the system in HP and/or kW. The maximum temperature of seal water as it returns to the seal should not exceed 158 deg. F (70 deg. C), and the report should show the expected steady state temperature for the system. The City of Tulsa Plant Engineer to verify applicability considering a possible cost adder for additional submittals.

14. Plan 53A seal support system (where applicable) shall include a unique serial number referenced to a pressure test certificate. The City of Tulsa Water and Sewer Division Engineer to verify applicability considering possible cost adders and additional submittals.
15. Each mechanical seal shall be individually serialized with a unique reference number, and that detail to be permanently electrochemically etched on the seal gland. The City of Tulsa Plant Engineer to verify applicability considering a possible cost adder for additional submittals.
16. Each double mechanical seal to be statically air tested to API 682 pressure test parameters. The City of Tulsa Water and Sewer Division Engineer to verify applicability considering a possible cost adder for additional submittals.
17. Documentation and Certifications – Vendor shall supply: Mechanical Seal GA certified drawing and Seal Support System certified drawing. Installation instructions shall be included with each seal in the shipping box. Installation instructions for system installation shall be provided separately prior to the construction phase and detail mounting position relative to the pump seal. The City of Tulsa Division Engineer to verify applicability considering a possible cost adder and additional submittals.

Table 3 – Mechanical Seal Face Materials

Type of Pump	Water Service	Sewage Service PH <5	Sewage Service PH >5
Horizontal	SiC vs. Carbon	SiC vs. SiC	TC vs. TC
Vertical	SiC vs. Carbon	SiC vs. SiC	TC vs. TC
Submersible	SiC vs. Carbon	TC vs. TC	TC vs. TC

Table 4 – Mechanical Seal Flush Plans per API 682

Type of Pump	Water Service	Sewage Service PH <5	Sewage Service PH >5
Horizontal	11/32	53A (32 Not Allowed)	53A (32 Not Allowed)
Vertical	13/32	53A (32 Not Allowed)	53A (32 Not Allowed)
Submersible	N/A	N/A	N/A

701.1.7 Motors – Low and Medium Voltage

1. All hardware including frame bolts, conduit box bolting, nameplate fasteners, grease caps or plugs, fan clamp and bolt, drain plugs or fittings, etc. shall be of plated steel minimum. Hardware for wastewater service shall be offered with an option of stainless-steel construction. If stainless steel hardware is specified, nickel-based anti-seize to be applied to threaded fasteners during assembly.
2. Motor thrust bearings for vertical pumps shall be designed to carry the maximum thrust loads that may develop while starting, stopping, or operating at any capacity.
3. Bearing housings containing oil shall be vented to the atmosphere through a desiccant breather to prevent ingestion of dirt and moisture. (N/A to submersible pumps / motors.)
4. Equipment and accessories to be designed and constructed for continuous operation.
5. For pumps rated less than or equal to 250 BHP, motors shall be sized for end of curve BHP for rated impeller and specific gravity without including the motor service factor above 1.0. Where it appears, this will lead to unnecessary oversizing of the motor, vendor shall submit an alternate quotation for the City of Tulsa Water and Sewer Division Engineer's approval.
6. Insulation Class F 155 deg. C (311 deg. F) is required. Temperature rise of 105 – 115 deg. C (221 – 239 deg. F) is required.
7. Noise level shall not exceed 85 dB A sound pressure level (SPL) generated by the motor at a three-foot distance from the motor in any direction.
8. Space heaters shall be 110V, 60 Hz, and supplied for 25 HP and larger motors when approved by the City of Tulsa Plant Engineer and specified on the data sheet. Space heaters shall be arranged to provide optimum uniform heating of the stator windings.
9. When required by the City of Tulsa water and Sewer Division Engineer, the Premium Efficiency motor design is specified. (The US Dept. of Energy recommends P/E for motors 500 HP and under that operate more than 2,000 hours per year. Payback is approximately 3-5 years.)
10. When required by the City of Tulsa Plant Engineer, high bearing temperature sensors and alarms on motor bearings are specified.
11. When required by the City of Tulsa Water and Sewer Division Engineer, vibration sensors and alarms on motor bearings are specified.
12. Electric motors in variable speed applications require special engineering considerations. These motors shall be purchased as part of a packaged system including the motor and the VFD controller. The City of Tulsa Plant Engineer and the drive system supplier should be included in discussions regarding the application and specifications and requirements. The electric motor shall be compatible with the variable frequency drive. The motor shall be inverter duty rated, have insulated bearings, and a grounding ring and brush. If any of these requirements are cost-prohibitive, vendor shall also submit an alternate quote.
13. Motors shall be designed, constructed, and rated for the NEMA area classification.

701.1.8 Gear Boxes

1. (No criteria presented.)

701.1.9 Blowers, Fans

1. (No criteria presented.)

701.1.10 Valves – Air Relief, Ball, Butterfly, Check, Plug, Gate

1. Ball valves shall be constructed of stainless-steel material.
2. Check valves shall have a visible outward arm to identify "open" and "closed" operation.
3. All valves that utilize electrical motor operators shall be fitted with mechanical stops on the stem (or other mechanical device) to prevent mechanical damage to valve while opening or closing.

701.1.11 Electrical Cable, Fiber Optic Cable

1. Individual conductor electrical cable shall be XHHW rated for 90 deg. C (194 deg. F.)
2. Three conductor electrical power cables shall be oil resistant, water resistant and high heat resistant Type XHHW.

701.1.12 Variable Frequency Drives 60-400 HP

1. VFD's shall be provided with internal bypasses, electrical input and output filters, internal heat sinks, internal cooling fan(s), and reusable air filters.
2. VFD's for wastewater service shall have filters impregnated with KMNO4 (potassium manganate – obtain and read the MSDS) to exclude H2S.
3. When required by the City of Tulsa Water and Sewer Division Engineer, the VFD is to be oversized at 125% of the motor HP to extend service life. Doing such addresses temperature issues due to the possibility of the VFD being in un-conditioned spaces, dirty filters on cooling fans, etc.
4. Applications of 100 HP and greater to be 18 pulse design to reduce harmonics.

701.1.13 Variable Frequency Drives 401 HP and Larger

1. VFD's shall be provided with internal bypasses, electrical input and output filters, internal heat sinks, internal cooling fan(s), and reusable air filters.
2. VFD's for wastewater service shall have filters impregnated with KMNO4 (potassium manganate – obtain and read the MSDS) to exclude H2S.
3. When required by the City of Tulsa Plant Engineer, the VFD is to be oversized at 125% of the motor HP to extend service life. Doing such addresses temperature issues due to the possibility of the VFD being in un-conditioned spaces, dirty filters on cooling fans, etc.
4. Applications of 100 HP and greater to be 18 pulse design to reduce harmonics.
5. VFD's are required and specified by the City of Tulsa Water and Sewer department shall be housed in humidity and climate-controlled buildings or shall be housed and cooled (air conditioned) in a NEMA 4 cabinet to prevent VFD thermal breakdown.

701.1.14 Low Voltage Switchgear and MCC'S

1. All applicable requirements of the latest edition of the National Electrical Code shall be

met. All switchgear and MCC shall include ultrasound and thermal imaging ports for Predictive Maintenance practices.
2. Color coding is per latest edition of IEEE.
3. Infrared windows and power monitoring capability are to be supplied.

701.1.15 Low Voltage Circuit Breakers

1. All applicable requirements of the latest edition of the National Electrical Code shall be met.
2. Integrated surge suppression shall be provided.

701.1.16 Motor Starters

1. All applicable requirements of the National Electrical Code shall be met.
2. NEMA design is preferred over IEC design because NEMA design allows more start/stop cycles and is more robust in design.
3. For critical assets only, a spare set of heaters to be included with the order – two sets of heaters total per motor starter. The City of Tulsa Water and Sewer Division Engineer to determine criticality.

701.1.17 Lighting

1. Unless otherwise specified, all lighting shall be designed and rated for the NEMA area classification.

2. LED lighting is required.

701.1.18 Programmable Logic Controllers

1. Rockwell Allen-Bradley ControlLogix systems using the L72 or better processor and provided with a fully functional licensed copy of the same version of Rockwell Studio 5000 software used by the contractor to program the system using ladder logic.
2. Or the CTI 2500-C200 based systems or CTI 2500C-C200 Compact-based systems can be provided. There is no requirement to provide programming software for the two CTI options because the City of Tulsa maintains an existing site license for all CTI PLC processors.

701.1.19 Control Panel Instruments

1. (No criteria presented.)

701.1.20 Level Measurement Instruments

1. (No criteria presented.)

701.1.21 Flow Measurement Instruments

1. Flow measurement devices shall have a local display provided and wired for a remote display.

701.1.22 Pressure / Vacuum Measurement Instruments

1. Pressure and vacuum gauges shall be liquid filled. When required by the City of Tulsa Plant Engineer, the gauges shall have isolators of the diaphragm seal design to exclude

debris from the gauge function.

2. Piping of steel or stainless-steel construction from the gauge-to-line or gauge-to-vessel shall have wall thickness sized per "Piping" section 801.1.27.3 and 4.
3. Pressure transducers shall have a local display provided and wired for a remote display.

701.1.23 Uninterruptable Power Supplies (UPS)

1. The UPS shall be designed and nameplated for 20% more capacity than required.
2. Air conditioning shall be provided if the UPS is in a cabinet that could reach an internal temperature over 104 deg. F (40 deg. C) were A/C not provided.
3. If A/C is provided for wastewater service and Lift Stations, the condenser coils shall be coated with Blygold or equal to prevent corrosion.
4. Continuous duty rating for Raw Water control panels for I/C engines and electric starters.

701.1.24 Analytical Meters (PH, Dissolved Oxygen, etc.)

1. Hach, HF Scientific analytical meters for PH, dissolved oxygen etc. shall be used in all related applications.

701.1.25 Gas Detectors, Wall-Mount

1. Gas detectors shall have a local display provided and wired for a remote display.

2. A visual (red, amber for warning and green lights) and audible alarm (bull horn, etc.) shall be mounted outside of the area monitored.

701.1.26 Piping

1. Refer to paragraph 801.1.2.4 for hand hole clean-out ports as required. For small diameter nozzles on equipment, hand hole clean-out ports will need to be incorporated into the adjacent suction and discharge piping.
2. Refer to paragraph 801.1.2.5 and 801.1.2.6 for pipe tap connections as required. Piping adjacent to equipment nozzles may require pipe taps also.
3. Piping of steel construction shall be Schedule 80 for 2-inch NPS and smaller and shall be Schedule 80 for 1.75 inch and 2.00 inch NPS (National Pipe Size). This paragraph is referenced in 801.1.2.20, 801.1.6.3, and 801.1.23.2.
4. Piping of stainless-steel material shall be Schedule 40S minimum for all sizes. This paragraph is referenced in 801.1.2.20, 801.1.6.3, and 801.1.23.2.
5. P-traps for floor drains that are inaccessible and are under concrete floors of sewage lift stations shall not be utilized because they clog easily and cannot readily be cleaned out.
6. Schedule 40 PVC piping shall be the minimum required thickness for standard projects. All chemical piping applications shall be in schedule 80 PVC piping. Spears shall be the preferred manufacturer with no alternative for PVC fittings for serviceability.
7. All schedule 80 and schedule 40 PVC for plumbing parts including unions installed for operable monitoring devices, regulators, valves, or equipment shall have standard NPT threaded (not metric) unions and fittings of the preferred brand Spears as a standard installed on the inlet and outlet of device piping and any additional threaded pipe or nipples needed for serviceability.
8. All schedule threaded 80 and schedule 40 valves shall have standard NPT threads, (not metric). If metric equipment is selected, adapters shall be installed to convert to standard

NPT to allow for serviceability. Standardization requirements will be Spears as a preferred manufacturer with no alternative.

701.1.27 Preparation for Shipment

1. Spare parts that are subject to corrosion (steel, cast iron, etc.) shall be individually prepared for long term storage in an unheated warehouse. Solvent washable preservative coatings shall be applied, and additional wrapping using waxed cloth, plastic shrink wrap, wood crating, or equal shall be used to protect the preservative coating. Each part shall be individually tagged external to any preservation materials.
2. Preparation of the pumps, gear boxes, fans, motors, electrical components, etc. for shipment shall be made including all exterior surfaces subject to atmospheric corrosion (with exception of machined surfaces) shall be given a coat of the manufacturer's standard paint (unless specified otherwise.) All external machined surfaces shall be coated with suitable rust preventative.
3. All threaded openings shall be plugged with pipe plugs of a material comparable to that of the casing. In no case shall nonmetallic plugs (such as plastic) be used. Exposed shafts and shaft couplings shall be wrapped with waterproof moldable wax cloth or vapor phase inhibitor paper or equal.
4. Each piece of equipment shall be properly identified as required by the purchase order with a metal tag showing the City of Tulsa Equipment ID.
5. One copy of the vendor's standard installation instructions shall be packed and shipped with the equipment.
6. Storage of pumps, electrical motors, electrical components, etc. shall follow the manufacturers' guidelines. Space heaters, if provided in electrical motors, are normally energized during storage at site regardless of if motor is stored inside or outside.

701.1.28 OEM Literature and Warranty logs, Tagging and Equipment Documentation

1. Ensure OEM and Warranty and contractor documentation and contacts are correct, and all manuals (digital and physical) are supplied by contractor 4 weeks prior to acceptance of equipment, which allows maintenance and operations to enact new Preventive and Predictive maintenance practices and asset information to be entered into the CMMS (Lucity) system.

2. All equipment documentation (which includes the OEM and general contractor warranty start and end dates), project information, tag information, equipment description, purchase and commissioning date, equipment initial and final test readings, supplier and phone number per The City of Tulsa's Water and Sewer Asset Management protocol. Startup inspection reports, OEM manuals and in-service dates are due 4 weeks prior to acceptance of equipment. All information shall be included in the Water and Sewers Asset Management spreadsheet, which will be supplied at no additional cost and is part of the contractual agreement for all new equipment purchased. All warranty logs shall be provided by the general contractor which applies to the actual purchase date and the date of commissioning.

3. Warranties for all new equipment whether purchased by the general contractor for a project or by the City of Tulsa Water and Dewer Department requires an extended warranty or applicable

extension applied for the first year of operation, even if it includes additional costs and the warranty will be covered by the OEM in the first year with no alternate exceptions.

701.1.29 Failure Modes, Troubleshooting Flow Diagrams and Equipment Machine Blueprints

1. OEM manufacturer shall be required to provide known and common failure modes, troubleshooting flow diagrams, designated format, and equipment design blueprints in either an excel or alternative format designated by The City of Tulsa Water and Sewer Department. All mentioned documentation shall be provided 4 weeks prior to the end of the project by the OEM to the general contractor and provided to the City of Tulsa Water and Sewer Department in accordance with Water and Sewer Asset Management protocols.

Note: The City of Tulsa Water and Sewer Division Engineer's input is needed regarding the following 22 paragraphs: AM-SMG-801.1.1, AM-SMG-801.1.2.12, 13, 21, and 22, AM-SMG-801.1.4.4, AM-SMG-
801.1.6.12, 13, 14, 15, and 16, AM-SMG-801.1.7.5, 8, 9, 10, 11, and 12, AM-SMG-801.1.12.3, AM-SMG-801.1.13.3 and 5, AM-SMG-801.1.16.3, and AM-SMG-801.1.23.1., SMG 801.1.29, SMG 801.1.30

702 Preferred Manufacturers, New Equipment Purchases

702.1 Types of Equipment and Preferred Manufacturers

702.1.1 Scope

The following list of preferred manufacturers is to be incorporated into specifications for purchase of new equipment by a Contractor or an Engineering Consultant or the City of Tulsa. If there should be any conflict between this Guideline and the City of Tulsa Purchasing Ordinance #6-4 or its Revisions, the Ordinance #6-4 or its Revisions shall take precedence. This Guideline includes a list of manufacturers that is not comprehensive, and it is not required that manufacturers be chosen specifically from this list. The manufacturers listed in this Guideline are preferred due to past performance, ability, parts availability, matching of site equipment, support, total cost of ownership, etc. Full and open competition is to be encouraged on all purchases and sales.

In order to reduce any possible conflicts, and to eliminate any omissions of manufacturers during the bid request / review stages, the City of Tulsa Engineering Department and/or the Using Department shall provide all technical specs, Standard Maintenance Guidelines, a listing of any suggested potential bidders, and any supporting documents to the Contractor or Engineering Consultant or the City of Tulsa Purchaser before a purchase requisition is submitted by any of these parties. Manufacturers (or their rep's or their distributors, etc.) are invited to bid, whether they are or are not currently on this list. Therefore, all parties shall agree on the specific manufacturers selected for the new equipment before award.

702.1.2 Pumps – Horizontal

1. Manufacturers preferred are Flowserve (including Ingersoll-Dresser), RuhrPumpen, Flygt, AC-Flygt, Fairbanks-Morse, Vaughan, Yeomans/Grundfos, Peerless, Patterson.

702.1.3 Pumps – Vertical

1. Manufacturers preferred are Flowserve (including Ingersoll-Dresser), RuhrPumpen, Flygt, AC-Flygt, Fairbanks-Morse, Vaughan, Yeomans/Grundfos, Peerless, Patterson.

702.1.4 Pumps – Submersible

1. Manufacturers preferred are Vaughan, Flyght, Fairbanks-Morse, Hayward Gordon, Yeomans/Grundfos.

702.1.5

1. Sump pumps; Manufacturers preferred are: Barnes, Goulds, Dayton, Zoeller, Little Giant, Homa.
2. Grinder pumps; Manufacturers preferred are: Environment One Model 2010-74.

3. Chopper pumps; Manufacturers preferred are: Vaughan, (or equal).
4. Progressive Cavity pumps; Manufacturers preferred are: Seepex, Moyno.
5. Peristaltic pumps; Manufacturers preferred are: Watson / Marlow.
6. Metering pumps; Manufacturers preferred are: Wallace and Tiernan, Watson-Marlow, Milton Roy.

702.1.6 Mixers

1. Manufacturers preferred are: Mixtec, Flyght, Philadelphia, Jensen, Plenty

702.1.7 Mechanical Seals

1. Manufacturers preferred are AES, Chesterton, Flowserve, John Crane.

702.1.8 Motors – Low and Medium Voltage

1. Manufacturers preferred are US, Baldor, GE, Siemens.

702.1.9 Gear Boxes

1. Manufacturers preferred are Dodge and Lufkin.

702.1.10 Blowers, Fans

1. Manufacturers preferred are New York Blowers, Continental Blowers and Fans.

702.1.11 Valves – Air Relief, Ball, Butterfly, Check, Plug, Gate

1. Air relief, ball, butterfly, check (refer to para. 802.1.11.3 below), gate valves; Manufacturers preferred are: per City of Tulsa "Division II Material Specifications Approved Fittings Manufacturers." Web site path: City of Tulsa (external web site) / Development – Business / Engineering Services / Government Departments – Engineering Services / Specifications, Checklists, and Details.
2. Plug valves are not included in Div. II spec referenced in no. 1 above; Manufacturers preferred are per City of Tulsa Div. II spec manufacturers of gate valves, (or equal).
3. Check Valves, in addition to Div. II spec referenced in no. 1 above of Section 802.1.10; Manufacturers preferred are: due for ease of maintenance is AVK, (or equal), unless the City of Tulsa Engineering states otherwise per application.

702.1.12 Electrical Cable, Fiber Optic Cable

1. For electrical cable, Manufacturers preferred are: Beldon, Southwire.
2. For fiber optic cable, Manufacturers preferred are: (no criteria presented).

702.1.13 Variable Frequency Drives

1. Manufacturers preferred are:

A. Raw Water prefers Rockwell Allen-Bradley, ABB.
B. ABJ WTP prefers Rockwell Allen-Bradley, ABB.
C. Mohawk WTP prefers Rockwell Allen-Bradley, ABB.

D. Water Operations prefers Dan Foss (less than or equal to 300 HP).
E. NS WWTP prefers Schneider Electric (Square D), Rockwell Allen-Bradley, Eaton.
F. LBC WWTP prefers Schneider Electric (Square D), Rockwell Allen-Bradley, Eaton.
G. SS WWTP prefers Rockwell Allen-Bradley, Schneider Electric (Square D).
H. HC WWTP prefers Rockwell Allen-Bradley, Schneider Electric (Square D).

702.1.14 Low Voltage Switchgear and MCC'S

1. Manufacturers preferred are Schneider Electric (Square D), GE, Eaton, Siemens

702.1.15 Low Voltage Circuit Breakers

1. Manufacturers preferred are: Schneider Electric (Square D), GE, Eaton, Siemens.

702.1.16 Motor Starters

1. Manufacturers preferred are: Schneider Electric (Square D), GE, Eaton, Siemens

702.1.17 Lighting

1. Manufacturers preferred are: Cooper, Dialight

702.1.18 Control Systems

1. Manufacturers preferred are Rockwell Allen-Bradley, Control Logix, Siemens, Control Systems Inc. (CTI)

702.1.19 Programmable Logic Controllers

1. Manufacturers preferred are: Rockwell Allen-Bradley Control Logix using L72 or better processor with fully functional licensed version of Rockwell RSLogix 5000 using ladder logic, or Control Technologies Inc. CTI 2500-C200 based systems or CTI 2500C-C200 Compact based systems (The City of Tulsa already maintains CTI programming software).

702.1.20 Control Panel Instruments

1. Manufacturers preferred are: Rockwell Allen-Bradley, APC by Schneider Electric (Square D).

702.1.21 Level Measurement Instruments

1. Ultrasonic instruments; Manufacturers preferred are: Endress+Hauser, Siemens.

702.1.22 Flow Measurement Instruments

1. Ultrasonic instruments: Manufacturers preferred are Siemens.
2. Magnetic instruments: Manufacturers preferred are Krone.

702.1.23 Pressure / Vacuum Measurement Instruments

1. Pressure or vacuum gauges; Manufacturers preferred are Ashcroft.
2. Differential pressure gauges: Manufacturers preferred are Siemens.

702.1.24 Uninterruptable Power Supplies (UPS)

1. Manufacturers preferred are APC by Schneider Electric (Square D).

702.1.25 Analytical Meters (PH, Dissolved Oxygen, etc.)

1. Manufacturers preferred are: Hach, Fisher Scientific.

702.1.26 Gas Detectors, Wall-Mount

1. Manufacturers preferred are: Scott Safety, Capitol Controls, Siemens, MSA, Honeywell, Drager.

702.1.27 Actuators

1. Manufacturers preferred are: Limitorque, Rotork.

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.

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.

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 Lucity 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 Lucity 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

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.)