VALVE INSPECTION, EXERCISING, AND MAINTENANCE SOP

SOP #331

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SOP VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Approved by

STAFF ACKNOWLEDGEMENT

I certify that the requirements of this SOP have been communicated to me and that I am trained in its use. A copy of this page will be distributed to the employee training record file.

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APPROVAL SIGNATURES

Prepared by: Arcadis U.S., Inc. Date: 01/31/2018

Approved by: _____ Date: _____

1 DEFINITIONS AND ACRONYMS

AWWA	American Water Works Association
EAM	enterprise asset management
GIS	geographic information system
GPS	global positioning system
PPE	personal protective equipment

2 KEY PERSONNEL AND RESPONSIBILITIES

- Water Distribution Superintendent:
  - Maintain schedule and create work orders for valve inspection, exercising and maintenance.
  - Identify additional planning/scheduling activities and resources for each valve (such as establishing additional traffic control measures, performing customer notification, and assessing the hydraulic impact).
- Water Distribution Operator (2-4):
  - Perform field inspection, exercising and maintenance of valves as generated by work orders.
  - Prepare records of field testing, exercising and maintenance for each valve and enter into enterprise asset management (EAM) system.

3 SCOPE/PURPOSE

The purpose of this SOP is to ensure regular and consistent execution of the preventative maintenance, inspection and exercising of valves throughout the distribution system. Valve exercising and maintenance shall be performed in accordance with American Water Works Association (AWWA) Manual M44 – Distribution Valves: Selection, Installation Field Testing and Maintenance.

Care should be taken to prioritize maintenance on those valves that are most critical to distribution system performance and those impacting sensitive populations while continuing a 3 to 5-year rotation schedule for all gate valves. Valves affecting hospitals, schools, and valves on water mains of diameter 16-inches or greater should be given priority, and should be exercised/assessed once per year.

This SOP should be used in coordination with a comprehensive asset management plan and hydraulic model. Any updates to condition, status, or operation of valves shall be relayed to the appropriate staff so that information is consistent across distribution system operations.

This SOP does not cover valve installation and replacement procedures, which would include inspection before installation, installation or replacement, and testing and/or inspection after installation.

4 HEALTH AND SAFETY

One of the most significant health and safety risks during valve inspection, exercising and maintenance is vehicle traffic. The field service team shall use trucks, temporary signs, and traffic cones to prevent automotive accidents and injury to staff. In addition, a flag crew may be needed to direct traffic in some locations. Trucks should be parked between oncoming traffic and the work area to provide a barrier. In addition, the following personal protective equipment (PPE) should be worn during maintenance activities:

- City employee identification
- Hard hat
- High visibility safety vest
- Knee pads (as needed)
- Safety glasses
- Steel-toed boots
- Work gloves

5 PROCEDURE

Equipment Required:

- Valve key or valve box keys for all sizes (and extension kits if needed)
- Valve exerciser tool. There are portable, truck-mounted, or trailer-mounted exercising tools. A combination of one portable and either a truck-mounted or trailer-mounted model is desirable. These tools can be powered by electric, hydraulic, or pneumatic means. Keep in mind that for the portable valve exerciser, you have to provide the power supply (i.e., a generator for an electric tool, a hydraulic pump for hydraulic, or an air compressor for the pneumatic).
- Water system map (with clear labels for pipe diameter, street names, parcel addresses, critical water users, and all valve/appurtenance identification numbers)
- Flashlight
- Oversized screw driver
- Probing rods and/or metal detector
- Pry bar
- Tape measure (25-foot and 100-foot real)
- Shovel
- Traffic cones
- Temporary signs/arrow board (warning lights, strobe lights, arrow boards, traffic maintenance signs)

- Spare parts (valve boxes, lids/covers, etc.)
- Vacuum equipment and water pump
- Blue marking paint
- GPS unit (optional)
- Digital camera (optional)

Procedure:

1. Once a work order is received from the Water Distribution Superintendent, identify the maintenance crew to perform the valve maintenance. Note that:
    - Two (2) maintenance resources should be dispatched for work on residential streets.
    - Up to four (4) resources may be required on main arterial roads or busy intersections.

2. Prior to driving to the site, perform the necessary pre-planning activities. This includes reviewing system maps, GIS, as-builts, and asset history to identify valves that may meet the following criteria:

Criteria	**Action**
Busy Intersection	Notify the Water Distribution Superintendent that work will need to be performed at night or additional traffic control measures will be needed.
High-Profile or Sensitive Customers • Hospitals/medical facilities • Large water users • Special manufacturing process facilities	Notify the Water Distribution Superintendent to confirm if additional planning/coordination is required. Advance customer notification may also be needed.
Potential Hydraulic Impact • Pumping stations • Reservoirs • Special pipe or valve configurations	Notify the Water Distribution Superintendent to confirm if additional planning or coordination is required.
Valves Located in Vault	Requires staff with confined space entry certification.
Pipe Diameters Larger than 14-inches	Notify the Water Distribution Superintendent to confirm special equipment to be used (valve turning machine).

3. Identify the best route to conduct the work. This includes identifying the starting and ending point (valve location), sequence of valves to be completed for the day, and potential parking areas.

4. Upon arrival at the site, evaluate the site for safety (including the appropriate PPE) and set up the appropriate traffic control measures. This may include: warning lights, strobe lights, arrow boards, traffic maintenance signs, cones, flagmen (if necessary), safety vests, and/or other PPE. Document the following information on the work order:

    - Operator last name
    - Inspection date
    - Arrival time

5. Locate the valve to be exercised. This is completed by visual inspection, probing rods and metal detectors. If the valve cannot be located expeditiously (within 15 minutes), label the valve as “cannot locate”. Valves that are believed to be “paved over” should also be documented on the work order.

6. Once the valve is located, identify the unique identification number for the valve on the map and confirm the actual field location is a correct match. Information to be field-verified and documented on the work order include:

    - Valve ID number
    - Map grid/page number
    - Street
    - Cross street
    - Address
    - GPS position (if applicable)
    - Other location notes (i.e. measurements from the property line)
    - Size (per map)
    - Surface cover
    - Valve use (i.e., potable water)
    - Map discrepancies (if applicable)

7. Remove the cover/lid in order to gain access to the valve. If the cover is tightly stuck, a screwdriver, pry bar, sledge hammer, or other tools may be used. If the cover is damaged in the process of accessing the valve or has a hole in it, it should be replaced using spare parts in the truck.

8. Clean the valve box or vault, removing any debris or water, so that the operating nut and bonnet bolts can be seen visually for inspection. Where water is present, use an industrial vacuum equipment or water pumps capable of de-watering a vault. Exercise caution with snakes, spiders, or other potential hazards.

9. Visually inventory the valve specifications. Document the following information on the work order:

    - Manufacturer[1]
    - Model
    - Serial number (for 12-in and larger)

- Other information stamped on the valve cover plate (such as Rated Working Pressure or special coating)
- Valve type (i.e., gate, butterfly, cone, check, air valve, blow-off)
- Function/use (in-line main, hydrant isolation, service line, bypass, division, pressure reducing, etc.)
- Structure (i.e., box, vault)
- Operating nut depth
- Cleaning equipment required (i.e., vacuum, pump)
- Map discrepancy (if applicable)

10. Once clean, inspect the stem and nut for damage or obvious leakage. If applicable, document the following findings in the appropriate work order fields:

    - Stopped packing leak (yes/no)
    - Replacement recommendations
    - Comments
    - Picture taken (for raises or other conditions)

11. After valve casing is clean, exercise the valve. As recommended by AWWA M44 (2015), every valve should be operated through a full close and open cycle on a regular schedule to clear the operating stem and wedge guides of naturally occurring encrustation or other debris. In general, the AWWA operating formula for opening/closing a gate valve is 3 times the nominal valve size plus 2 or 3 turns of the operating nut. (Example; 6 x 3 = 18 plus 2 or 3 = 20 to 21). However, each valve manufacturer has detailed operation and maintenance procedures for each of the various types of valves[1].

Valve Diameter (in)	Approximate Number of Turns (full 360-degree rotation)	Recommended Tool
2	8	Valve Key (Manual)
3	11	
4	14	
6	20	
8	26	
10	32	
12	38	
14	44	

[1] The City of Flint estimates approximately 17 various valve manufacturers currently in-use. This includes: A.P. Smith, Clow, Crane, Darling, DeZurik, East Jordan, Flower Stevens, Henry Pratt Co, Kennedy, Ludlow, M.I.W Co., Michigan Laydown, MJ, Mueller, T. S. & W., T.C., and Waterous. Once information is collected on model/serial numbers, details from the corresponding operation manuals should be integrated into this SOP.

Valve Diameter (in)	Approximate Number of Turns (full 360-degree rotation)	Recommended Tool
16	50	
18	56	
20	62	
24	74	
30	92	Actuator or Valve Turning Machine[2]
36	110	
42	128	
48	146	
72	218	

Tips to be aware of before exercising a valve:

- Because debris can be stirred up during valve exercising, notify the public before starting the process. This will reduce dirty water complaints.
- Specify open left (counter-clockwise) or open right (clockwise). Wrench nuts on valves that open to the right are painted red for identification purposes.
- The valve should be opened and closed with a steady amount of pressure in the pipeline. Slow closure is critical to minimize the potential for operational failure of the valve or water hammer. The valve should function freely with no binding or vibration.
- Begin with rotating 5 to 10 rotations, then reverse for two or three rotations. Reverse again and rotate 5 to 10 more turns in the closing direction. Repeat this procedure until full closure is obtained.
- Make sure to accurately count the number of turns to fully closed. This will reveal an obstruction if the correct number of turns are not achieved.
- Listen closely. Sometimes you can hear the flow change when operating a valve. This will help determine if the valve is moving.
- Do not operate valves in systems that exceed the rated working pressure of the valve.
- Do not close the valve too tight as it will damage the valve and cause the valve to leak.
- If the valve is resistant, avoid using a T-handle or extension to force the valve closed; this could cause damage to the valve.
- To determine if a valve is closed, an aquaphone or other listening device can be used.

12. Once the valve is fully closed, compare the actual number of turns to the approximate number of turns from the table in Step 11 based on the valve size as found on the map. If the operating nut continues to rotate even after you have reached the proper number of

[2] See equipment operating instructions for full details.

turns, the valve may be larger than shown on the plans. Continue to operate based on the next size valve. Document the following information on the work order:

- Found position (open, closed, partially open)
- Direction to close (close right, close left)
- Torque (beginning)
- Turns
- Initially operable (yes/no)
- Torque (final)

13. Once the valve is fully closed, it should be opened a few turns so that high velocity water flowing under the gates can move the remainder of the sediment downstream with more force and clear the bottom part of the valve body for seating. Coordination with hydrant flushing is also recommended.

14. Once potential sediment has been flushed, the valve should be re-opened to reestablish system flows (or returned to the original state). Some manufactures recommend that a valve stem never be left in a fully open position. They recommend that after fully opening a valve, back off the stem by one turn. Consult the appropriate manufacturer's operation and maintenance manual.

15. A valve condition score should be identified and documented on the work order. The following examples and scoring system definitions should be used as a guide to ensure consistency:

Condition	**Definitions**
Inoperable	• Broken teeth or stem • Main valve or by-pass that spins free • Frozen at operating torque limit • Additional work order item required
Poor	• Packing leak that cannot be "snugged" • High torque level, >300 ft-lbs • Unstable torque (such as a bent stem that was reduced by exercising) • Open and closed positions may not be clearly seen on a torque chart
Fair	• Valve had to be left in "snugged" position to stop a packing leak • Required multiple exercise cycles to reduce torque (more than 3) • Intermediate torque level, >200 ft-lbs • Stable torque • Open and close positions can be clearly seen on a torque chart • Valve works, has a small problem, will likely stop water flow

Condition	Definitions
Good	• Operating nut is able to be backed off a ¼ turn after last exercise to relieve pressure on packing gland without water leaking • Low torque, <200 ft-lbs • Stable torque

Document the following additional details on repairs or recommendations on the work order:

- Stopped packing leak (yes/no)
- Replacement recommendations
- Comments
- Picture taken (for raises or other conditions)
- Difficulty of repair notes (optional)

16. In addition to exercising the valve, other maintenance tasks should also be completed in accordance with the manufacturer's operation and maintenance manual. This may include:
    - Check all gaskets and joints for leakage and tightness.
    - With the valve closed and pressure against the wedge, check for leakage by "listening" to the valve for flow. A stethoscope will help in this procedure. Attached actuators should be inspected per manufacturer's recommendations provided with those units.
    - Some valves should have the exposed stem lubricated at each inspection. Check stuffing box bolts for tightness.

17. Restore the area to a clean and safe condition. This includes replacing the valve cover and clearing the area of any traffic control devices.

18. Mark the completed valve cover with blue marking paint.

19. Document the following information on the work order:
    - Time work order completed
    - Comments (other relevant observations or items requiring additional maintenance on the work order)

6 TROUBLESHOOTING

Problem	Cause / Corrective Action
When closing the valve, you do not achieve the proper number of turns	Tuberculation/Debris may have built up in the seat area, particularly in the double disc valve. Create flow through the valve (open a nearby downstream hydrant) then exercise the valve to loosen/remove the debris.

Problem	Cause / Corrective Action
The operating nut continues to rotate even after you have reached the proper number of turns	• The valve may be larger than shown on the plans. Continue to operate based on the next size valve. The valve may have a bevel or spur gear to help during operation. Check the plans to see if it a gear was installed on the valve. The typical gear ratio is 4 or 4.5 to 1. Multiply the standard number of turns by the gear ratio. • Excessive torque may have been applied to the operating nut at some point and damaged the stem or stem nut. Expose the valve and inspect the stem and stem nut. Replace if necessary. • Potential diameter discrepancies will be documented and further reviewed and/or researched. If confirmed, update asset attribute data in GIS.
The operating nut will not turn in either direction	• The valve box may be interfering with the operating key. Look down the valve box to see if it is too close to the operating nut. Reposition if necessary. • The stuffing box bolts and nuts may have been tightened down unevenly during assembly. Loosen and retighten stuffing box bolts and nuts evenly. • Debris/corrosion may have built up between the stem and stuffing box due to lack of operation or gritty backfill. Remove the stuffing box (stem if needed) and clean and/or replace the stem and stuffing box. • Debris could be wedged under the disc. Expose the valve. Remove the bonnet. Clean out the debris.
The gate valve is leaking from between the body and bonnet flange	• Make sure the bonnet bolts and nuts are tight. • The bonnet gasket o-ring may be damaged or pinched. Remove the bonnet. Replace the gasket • The body or bonnet flange may be cracked or broken. Inspect the valve body and bonnet flanges. Replace damaged items.
The gate valve will not pass a pressure test	• Be sure the valve is completely closed. Count the number of turns. • Compare to the manufactures published information. • The disc may have been closed on some debris. Create flow through the valve (open a nearby downstream hydrant) then exercise the valve to loosen/remove the debris. • Air may be trapped in the line. Flush the line to remove the trapped air. Add an Air release valve if necessary.

Problem	Cause / Corrective Action
Valves found closed	Notify the Water Distribution Superintendent immediately. Leave the valve in the same position found until a decision is made to operate and what position to leave it in.
By-pass valves (16" and larger double disc gate valves will typically have an associated by-pass valve)	The by-pass valves will be exercised before the main valve is exercised. If the by-pass valve is inoperable (e.g., spins free, frozen) crew is to exercise the main valve ¾ of the expected turns and note this in the valve database. An inoperable by-pass valve will be a significant factor in determining if the entire valve assembly (by-pass and main valve unit) should be recommended to be replaced.
Stuck/inoperable Valve	Consult the Water Distribution Superintendent to determine whether to further increase torque and attempt to rehabilitate valve into working condition (at the risk of breaking valve). The Water Distribution Superintendent should indicate which valves will be used to shut down the location should a valve failure occur (bonnet lifts off of the valve). At that time, the torque will be increased, as necessary, with no upper limit, until the valve is either operable or fails. • 4-in (crew limit is 200 ft-lbs turn and count only - hand turn) • 6-12in (crew limit is 300 ft-lbs) • 16-in & larger (crew limit is 500 ft-lbs) • Butterfly (crew limit is 200 ft-lbs turn and count only - hand turn)
Packing leaks	A number of packing leaks will be found in the field, most of which can be stopped by "snugging" the valve up to the packing gland. Valves that are "snugged up" in order to stop a packing leak will be documented in the work order because these valves may take more torque to shut after they have been "snugged up."
Map discrepancies • "Found" valves that are not on the map • Valves with turn/size conflicts • Street name changes • Other	Document information on the work order and update asset attribute data in GIS.

7 DATA RECORDING AND MANAGEMENT

Following completion of a valve inspection, exercise or maintenance work order, enter all necessary information, including the date of maintenance, valve identification, condition, test results, and personnel completing the maintenance, into the EAM system.

The Water Distribution Superintendent must be notified of any additional required maintenance or if the valve is inoperable or in disrepair. The Water Distribution Superintendent shall assign work orders for any follow-up items and coordinate updates to the asset management plan.

8 REFERENCES

American Water Works Association. (2015). *M44 Distribution Valves: Selection, Installation, Field Testing, and Maintenance, Third Edition*. Denver, CO: AWWA