GENERAL PROVISIONS
OF THE
SPECIFICATIONS

DISINFECTION AND BACTERIOLOGICAL SAMPLING OF MAINS, FACILITIES AND APPURTENESS

1.00 PURPOSE

These specifications describe the work necessary to accomplish disinfection of new and repaired water mains and appurtenances and the bacteriological sampling actions required to allow connection of new facilities to the existing San Jose Water Company distribution system. The work shall be performed in accordance with the latest revision of the AWWA Standard C651 manual except as herein specified, and as directed by the Engineer.

2.00 GENERAL

Personnel responsible for construction or repair of water mains shall be aware of the potential health hazards and shall be trained to carefully observe prescribed construction practices, disinfection procedures, and bacteriological sampling requirements.

Disinfection of new water mains shall be accomplished using one of the following methods:

2.01 Tablet Method

The tablet method consists of placing calcium hypochlorite tablets in the water main as it is being installed. Place the tablets according to Section 3.01 in order to achieve an applied dose of 25-50mg/L. The tablets shall be the quick dissolving type and attached by a food grade adhesive. At the end of a 24-hr period, free chlorine residual must be detected at each sampling point.

2.02 Continuous-Feed Method

The continuous-feed method consists of filling the main to remove the air pockets and then dosing chlorine continuously to obtain a concentration of not less than 25 mg/L free chlorine throughout the main. The chlorinated water in all portions of the main shall have a residual of not less than 10 mg/L of free chlorine after the 24-hr period.

2.03 Slug Method

The slug method consists of filling the main to eliminate air pockets and dosing a slug of water so that as it moves through the main, all interior surfaces are exposed to a concentration of approximately 100 mg/L for at least 3 hours. Ensure that the chlorine residual measured in the slug of water as it moves through the main does not drop below 50 mg/L at any time.

The main shall be flushed prior to disinfection, except when the tablet method is used. The flushing velocity should not be less than 3.0 feet per second which can be achieved with the following minimum flows, 4” diameter = 120 gpm, 6” diameter = 260 gpm, 8” diameter = 470 gpm, 10” diameter = 730 gpm, 12” diameter = 1060 gpm.
Disinfection shall be accomplished by full isolation of the new pipe or facility as necessary to allow heavily chlorinated water (25-100mg/l available chlorine depending upon method) to stand in the line for the time specified above. Heavily chlorinated water shall not be used against valves which isolate the active distribution system from new construction. New facilities shall be tested in a fully isolated condition with any connection to the live distribution system protected by an approved backflow device. Any deviation from this procedure requires approval of the Engineer.

At the end of the contact period, the line shall be thoroughly flushed of highly chlorinated water from the main fittings, valves and branches until the chlorine residual that is measured is no higher than that generally prevailing in the surrounding distribution system. The highly chlorinated water must be dechlorinated and meet the Regional Water Quality Control Board’s requirements for planned and unplanned discharge of potable water. The Contractor shall be responsible for disposing of and monitoring discharge of all chlorinated water in a manner compliant with SJWC discharge policies WQ5030, WQ5040, WQ5050, WQ5060, WQ5070.

For new construction, the Contractor shall collect representative samples for bacteriological examination as directed by AWWA Standard C651 Section 5.1.1.1(Option A) and “Section 7.0 Disinfection and Bacteriological Sampling of Mains, Facilities, and Appurtenances,” and deliver the samples to SJWC Water Quality Department at 1221A S. Bascom Ave., San Jose, CA 95128. On the regular printed label, mark the date, sampling point and work order number for the job. Contractors shall fill out the standard SJWC Chain of Custody form marking all required data for turning over samples to SJWC. All bacteriological testing shall be analyzed by the current SJWC designated laboratory. No samples used for determination of water quality shall be performed by alternative laboratories unless specifically approved, in writing, by the SJWC Director of Water Quality.

Many positive tests may be due to improper sample collection. Where feasible, the sample should be taken through the same blowoff as used for flushing the heavily chlorinated water out of the main so that it is disinfected. Prior to sampling, the hose bib, temp blow off, fire hydrant, etc., shall be thoroughly cleaned and sprayed with a 1% hypochlorite solution and then rinsed. See Appendix A for water sampling instructions.

### 3.00 CHLORINE APPLICATION METHODS

Chlorine shall be applied by one of the following methods:

#### 3.01 Method No. One - Calcium Hypochlorite Tablet Method

This method is specified for short jobs and for most small diameter pipe (up to 12 in.); it cannot be used where the pipe can become filled with trench water. The main cannot be flushed prior to disinfection, so the method requires that the pipe be kept clean during installation.

The tablets (see Table I for quantity) shall be attached by a Dow Corning 732 Multi-Purpose Sealant, or an SJWC approved equal, to the broadside of the tablet attached to the surface of the pipe. Attach tablets inside and at the top of the main. If the tablets are attached before the pipe section is placed in the trench, their position shall be marked on the section to indicate that the pipe has been installed with the tablets at the top. Care should be taken to see that the adhesive does not cover the sides or exposed end of the tablet so that water can come in contact with as much of the tablet as possible.

When installing bolted couplings, half a tablet shall be crushed and placed in the annular space between the coupling and the pipe in addition to the tablets placed in the pipe.

Fill the pipe slowly (velocity no greater than 1 ft./sec.) with water. Allow to stand 24 hours and proceed as outlined under general instructions.
TABLE I

CALCIUM HYPOCHLORITE TABLETS

NUMBER OF 5-GRAM TABLETS REQUIRED FOR MAIN DISINFECTION*

<table>
<thead>
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<th>Diameter of Pipe</th>
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<th>4&quot;</th>
<th>6&quot;</th>
<th>8&quot;</th>
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<td>49</td>
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</tbody>
</table>

*Based on 3.25g available chlorine per tablet; to produce 25-50 mg/L available chlorine solution in line.

3.02 Method No. Two - Sodium or Calcium Hypochlorite Solution with Pump

1. Make up chlorine solution.
2. Connect pump to main. Use a corporation cock for this purpose and make connection at or ahead of the inlet end of the new line. The actual location is a matter of convenience, providing the chlorine solution is applied to the water at or before it enters the main which is to be chlorinated.
3. If line has been flushed as specified in the general instructions, open hydrant or blowoff at outlet and adjust flow.
4. When the flow is adjusted to the desired rate, start pumping concentrate chlorine solution into the line.
5. Continue pumping until tests on a sample taken from discharge end of line being treated shows the required 25-50mg/L of available chlorine
6. After finishing application of chlorine, close valve or blowoff and disconnect pump.

3.03 Method No. Three - Slug Method for Chlorination of Large (18 inches and larger) Pipelines

The pipeline shall have a direct contact with a concentrated (100 mg/L available chlorine) chlorine solution for a minimum period of three hours. This chloride solution shall be moved through the pipeline at a uniform rate to give the required contact time. Chlorine solution shall be pumped into the pipeline after it has been filled with water.

The free chlorine residual shall be measured in the slug as it moves through the pipe. If it drops below 50 mg/L, additional chlorine shall be applied at the head of the slug to restore the free chlorine to not less than 100 mg/L. As the chlorinated water flows past fittings and valves, related valves and hydrants shall be operated so as to disinfect appurtenances and pipe branches. The amount of solution, the length of time for the injection, and the rate of flow in the pipeline to carry the concentrated chlorine solution its entire length will be submitted by the contractor to SJWC staff for review and approval. The injection pump used shall be of minimum capacity to inject the chlorine solution at a uniform rate during the three-hour contact period.
3.04 Other Methods

None of the above methods are applicable to short tie-ins or to cutting in fittings in existing pipe. Such jobs generally preclude the use of high chlorine residuals and seldom permit the 24-hour period of contact. For short tie-ins, all pieces of pipe and fittings shall be swabbed with concentrated 1% hypochlorite solution. All effort shall be made to keep trench water out of the pipe when cutting in fittings or making tie-ins. When this is unavoidable, the trench water shall be treated with sodium hypochlorite solution or calcium hypochlorite powder or tablets. Enough chlorine shall be added so that the trench water has a noticeable chlorine odor. If the chlorine residual is higher than 4.0 mg/l, consumers need to be notified to not use the water until the disinfection process is complete, and the residual is 4.0 mg/l or less. Service connections should be shut off to prevent accidental ingestion of highly chlorinated water.

On such jobs, it is particularly important that a sample be taken at the nearest tap downstream from the tie-in. If in doubt as to the direction of the flow of water, samples shall be taken on each side of the tie-in.

4.00 DISINFECTION OF TAPPING SLEEVES

Before a tapping sleeve is installed, the exterior of the main to be tapped shall be thoroughly cleaned and the inside surface of the tapping sleeve must be swabbed with concentrated hypochlorite solution. If the annular space is filled with concrete, no special disinfection is required.

Equipment required includes a hydraulic test pump, solution hose, and a small container, such as a five-gallon can, for holding the chlorine solution.

5.00 EMERGENCY DISINFECTION PROCEDURE

See Appendix B.

6.00 CHEMICALS

Strong chlorine or hypochlorite solutions should be handled with care, since they are irritating to the skin and prolonged exposure to fumes is seriously irritating to the membranes in the nose and throat. These solutions will damage leather goods rapidly and bleach most fabrics.

7.00 BACTERIOLOGICAL SAMPLING REQUIREMENTS PRIOR TO TIE IN

AWWA C651 requires representative bacteriological sampling be performed to assure the cleanliness of new pipe prior to connection to the existing distribution system. Sampling shall include chlorine residual levels for all samples turned in. Chlorine residual shall be measured using a Hach Pocket Colorimeter II or approved equal instrument with accuracy no worse than +/-0.05ppm and recorded to the nearest .05ppm on the SJWC Chain of Custody form. The contractor may request to tie into the existing SJWC distribution system after receiving two consecutive sets of negative sample results, taken 16 hours apart, at a minimum of every 1000 feet and at each dead end, branch and point of input. Contractor shall include a representative source water sample for each round of testing taken from after the supply backflow device and prior to entry of the source water into the new main to be tested. Only after dual sets of consecutive negative sample results are obtained and with scheduling by SJWC staff may the contractor tie into the existing distribution system or change over customer water services to use the new pipeline. Should the contractor receive a positive bacteriological result for any sample location from the SJWC laboratory prior to the tie-in phase of bacteriological sampling the following procedures shall be in effect.

A) Pre Tie-In Single (TC) Positive Sample Actions:

In the event of a positive Total Coliform (TC) sample during either the first or second round of proof sampling a new pipe; new samples shall be retaken using potable water for flushing to determine if sampling error may have been responsible for the positive test. If two additional consecutive sampling rounds performed per AWWA Standard C651 Section 5.1.1.1 Option A return all clean, the pipe shall be considered suitable for service installation and tie in to the existing system.
Only after dual sets of consecutive negative sample results are obtained and with scheduling by SJWC staff may the contractor tie into the existing distribution system or change over water service meters to use the new pipeline. Should the contractor receive an additional positive bacteriological result from the SJWC laboratory during the pre tie-in phase of bacteriological sampling the following procedures shall be in effect:

B) Pre Tie-In Multiple (TC) Positive Sample Actions:

- In the event that a positive TC sample is received from a second round of sampling the assumption shall be that pipe cleanliness is compromised and it shall be the responsibility of the Contractor, in consultation with SJWC, to take affirmative actions to rectify the situation. These actions shall be one of the following:
  
  1. Flushing of the main at greater than 5 fps in velocity and if service laterals are installed - thoroughly flushing each service lateral. This may require the modification of end caps and supply ports to allow sufficient flow to be achieved. Flushing velocities of 5fps can be achieved at the following minimum flows, 4” diameter = 220 gpm, 6” diameter = 480 gpm, 8” diameter = 870 gpm, 10” diameter = 1340 gpm, 12” diameter = 1920 gpm.

  2. Opening the pipe at sufficient intervals to allow the introduction of a pig for mechanical removal of any foreign material followed by flushing at greater than 3.0 fps.

  3. Ice pigging of the pipe to breakup and remove any foreign matter.

  4. Opening the pipe in sufficient and appropriate locations to allow the introduction of a self-propelled hydro-flushing unit to hydro scour the inside of the pipe and bring any foreign material outside the pipe.

  5. Removal and replacement of either the entire pipe or specifically identified subset of the pipe with new clean pipe.

- After performing one or more of the above actions the contractor may choose to begin standard sampling protocols again in an attempt to gather the required dual sets of negative samples using only source water and without re-chlorination. If service laterals have been installed, samples shall additionally be taken from a representative number of service laterals to be determined by SJWC. Should additional positive TC samples be received during any of the follow up sampling procedures the contractor will be required to re-chlorinate and sample as directed immediately below.

- After each of these actions, the pipe shall be re-chlorinated using Section 2.02 Continuous Feed methodology to greater than 25 ppm and allowed to sit at least 24 hours. Samples shall be taken as previously described after purging of super chlorinated water and again no sooner than 16 hours later. Should dual rounds of negative samples be attained, it will be the practice of SJWC to wait 48 additional hours and take one addition round of sampling to further gain confidence that the cleaning and re-chlorination has made the new pipe suitable for connection without regrowth occurring. If service laterals have been installed, samples shall be taken from a representative number of service laterals. Should a positive TC sample be achieved during any of the follow up sampling procedures SJWC shall evaluate the need for further action up to removal of the pipe.

C) Pre Tie-In Single (EC) Positive Sample Actions:

- In the event that a positive EC sample is received the assumption shall be that pipe cleanliness is compromised and it shall be the responsibility of the Contractor, in consultation with SJWC, to take affirmative actions to rectify the situation. These actions shall be one of the following:

  1. Flushing of the main at greater than 5 fps in velocity and if service laterals are installed through each lateral. This may require the modification of end caps and supply ports to allow sufficient flow to be achieved. Flushing velocities of 5fps can be achieved at the following minimum flows, 4” diameter = 220 gpm, 6” diameter = 480 gpm, 8” diameter = 870 gpm, 10” diameter = 1340 gpm, 12” diameter = 1920 gpm.
2. Opening the pipe at sufficient intervals to allow the introduction of a pig for mechanical removal of any foreign material followed by flushing at greater than 3.0 fps.

3. Ice pigging of the pipe to breakup and remove any foreign matter.

4. Opening the pipe in sufficient and appropriate locations to allow the introduction of a self-propelled hydro-flushing unit to hydro scour the inside of the pipe and bring any foreign material outside the pipe, followed by flushing at greater than 3.0 fps.

5. Removal and replacement of either the entire pipe or specifically identified subset of the pipe with new clean pipe.

- After each of these actions, the pipe shall be re-chlorinated using Section 2.02 Continuous Feed methodology and allowed to sit at least 24 hours. Samples shall be taken as previously described after purging of super chlorinated water and again no sooner than 16 hours later. Should dual rounds of negative samples be attained, it will be the practice of SJWC to wait 48 additional hours and take one addition round of sampling to further gain confidence that the cleaning and re-chlorination has made the new pipe suitable for connection without regrowth occurring. Should a positive TC or EC sample be achieved during any of the follow up procedures SJWC shall evaluate the need for further action up to removal of the pipe.

Post Tie-In Positive (TC or EC) Sample Actions:

If a positive sample is received after tie in to the system for either construction or maintenance activities, the SJWC Water Quality Department may request assistance from the contractor in taking the necessary corrective actions to bring SJWC into compliance with the applicable regulations.
APPENDIX A

Water Sampling Instructions:
The procedures to be used for taking water samples for either chemical tests or bacteriological examination are as follows:

Bacteriological Samples:
Prior to sampling, the hose bib, temp blow off, fire hydrant, etc. shall be thoroughly cleaned and sprayed with a 1% hypochlorite solution and then rinsed.

Bacteriological samples must be taken in a sterile 100 mL bacteriological sample bottle furnished by Owner. When taking a sample, remove the protective seal from the cap and unscrew the cap. Remove the cap and hold onto it. To avoid sample contamination, do not invert the cap, touch the cap to any surface, or touch the inside of the cap or rim of the bottle. Fill bottle to the 100 mL line. Do not overfill. Water which touches the rim can wash into the bottle and contaminate the sample. Never rinse a bacteriological sample bottle.

The Contractor shall not open a faucet full force to flush a sample line because this will disturb sediment which is difficult to flush out. Avoid taking samples from fire hydrants. Samples shall be placed in a cooler with ice and delivered to Owner at Water Quality, 1221A S. Bascom Avenue, San Jose, CA before 3:00 PM.

Chemical Samples:
Samples for chemical tests must not be taken in bacteriological sample bottles because these contain traces of sodium thiosulfate to destroy chlorine. Sodium thiosulfate interferes with many chemical tests. Always rinse a chemical sample bottle with the water to be tested.

Label the sample bottles legibly and accurately. If a number of sample bottles are labeled before the samples are collected, show that each sample corresponds with the label by putting your initials on the corner of the label when the sample is taken. Also, check to be sure each pre-labeled bottle has a sample in it.
APPENDIX B

Procedures For Emergency Disinfection Of Water Mains

This section describes procedures for disinfecting water mains subjected to emergency repairs. The necessary steps include:

1. Minimize the entry of contaminants into the pipe.
2. Remove any contaminants that may have entered the pipe.
3. Disinfect any contaminants that remain.
4. Flush the disinfectant from the pipe.
5. Determine the bacterial quality after disinfection.

Minimize Entry Of Contaminants

As long as the main is pressurized (and water is observed to flow continuously from the break) it is not necessary to disinfect the pipe following repairs. If the main is shut down and depressurized during repair, the main shall be thoroughly flushed and disinfected before it is returned to service. The job is made easier and has a greater probability of success if special precautions are taken to ensure that the pipe stays as clean as possible during repair. The following precautions shall be taken:

1. Excavate to provide at least 18 inches of clearance all around the pipe.
2. Carefully observe the excavation site for signs of broken sewer lines, such as odor or sewer pipe pieces. If sewage is present, disinfection of the main is necessary.
3. Keep water pumped out of the trench to prevent dirty water from contacting the pipe.

Remove Contaminants

Contaminants shall be physically removed before attempting disinfection. Following any shutdown, always back flush in both directions. Achieve as much flushing velocity as is practical without causing damage to property. The minimum flushing velocity should be 2.5 feet per second (fps).

If the pipe is cut and a section is removed, back flush into the trench to remove pieces of pipe scale, or anything that may have broken loose or entered the pipe. Provide adequate pumping to keep the water level below the open pipe. In a small excavation, it may be necessary to dig a sump.

When back flushing the pipe, plug the open end of the side not being flushed. Use a cap, plastic bag with straps, or a redwood plug. As a general rule, flush with enough water to replace all of the pipe volume at least once. Always flush until the water runs clear.

Disinfection Of Pipe

The preferred disinfection procedure may vary with the availability of chemicals and equipment, as well as the nature of the main break. The two procedures described below, swabbing and hypochlorite injection, are applicable to a wide range of main-break situations.

Swabbing

This method is applicable to main breaks where significant contamination of the pipe (for example, by sewage) has not occurred. With this method, all new pieces of pipe, couplings, clamps, or sleeves are swabbed or sprayed with a concentrated solution of hypochlorite to disinfect the interior surfaces. Following swabbing, the repair is completed and the main flushed without allowing further contamination of the pipe and fittings. The procedure is as follows:

1. Back flush the existing pipe in both directions.
2. In a bucket, prepare a concentrated (1-percent available chlorine) hypochlorite solution. Add approximately 2 oz. (58g) of dry calcium hypochlorite to 1 gallon of water to produce a concentrated hypochlorite solution. This is equivalent to about 26 fl. oz. (0.76L) of household bleach (5-percent available chlorine) in 1 gallon of water.

3. Using clean rags dipped in the hypochlorite solution, swab the inside of both ends of the open pipe as far as can be reached. Swab the interior of all new pieces of pipe, couplings, clamps and sleeves that will be used in the repair. An acceptable alternative is to apply the hypochlorite solution using a sprayer.

4. As a safety precaution, wear proper eye and respiratory protection when working with hypochlorite. To prevent damage to skin and personal clothing, wear rubber gloves and protective clothing. Hypochlorite will irritate skin and bleach clothing, so avoid splashing the solution on yourself or co-workers.

5. Following completion of the repair, flush the main to remove high concentrations of hypochlorite and any materials dislodged from the pipe wall during the repair.

The swabbing method and variations thereof are quick and effective for main breaks where repairs are made without the threat of significant contamination by sewage. Most main breaks are disinfected using this technique. However, if there is a potential for more serious contamination (for example, when sewage is detected in the trench during repairs and the main has been shut down) the main should be disinfected more thoroughly. This is accomplished by filling the main with heavily chlorinated water. The method of choice is the hypochlorite injection method.

**Hypochlorite Injection**

Using this method, hypochlorite solution is injected into a flowing main to achieve high chlorine residual throughout the pipe section. Hypochlorite solution can be injected using a manual, gasoline, or electrically powered chemical-feed pump designed for feeding chlorine solutions (hypochlorinator). After sufficient contact time, the main shall be flushed to remove the heavily chlorinated water.

Ideally, disinfection is accomplished by maintaining a high chlorine residual (100 mg/L) throughout the pipe for at least 3 hours. However, this much time is not practical if customers are out of water, so disinfection is usually accomplished by using shorter contact times and higher chlorine dosages (at least 300 mg/L.) The following steps are necessary to ensure that adequate disinfection and safety for the consumer are provided:

1. Shut off all service connections prior to attempting disinfection. This will prevent the entry of highly chlorinated water to the consumer’s premises.

2. In cases where flushing through the consumer’s service line is not possible, remove the meter and install a standpipe at the meter connection. Extend the standpipe at least 12 in. above ground to prevent the backflow of dirty water from the meter box during flushing.

3. Install the hypochlorinator not more than 10 ft. from the downstream side of the valve that will supply water to the shut down area. The hypochlorinator may be adapted to pump through a hydrant or meter connection. If there is no such connection close to the supply valve, it may be necessary to tap the main in order to introduce hypochlorite.

4. Always flush the main to remove dirty water and air before attempting disinfection.

5. Following the flush, adjust the flow to a constant measured rate. The flow rate and the pipe size (diameter and length) will determine the time required to dispense the hypochlorite solution throughout the pipe.
In the absence of a meter, approximate the flow rate by measuring the time required to fill a container of known volume.

6. Begin disinfection by pumping hypochlorite solution into the repaired main. The minimum chlorine dosage should be 100 mg/L when the chlorine contact time is at least 3 hours.

Table 1A indicates the gallons of hypochlorite solution (15%) available chlorine) necessary to achieve chlorine dosages of 100 and 300 mg/l in mains of various sizes. The table is useful for estimating the minimum amount of hypochlorite that will be necessary for any main disinfection.

The hypochlorite pumping rate must be adjusted with the flushing rate to achieve the desired amount of hypochlorite in the main. The pumping rate is calculated from the formula:

\[ R = \frac{D}{C \times Q} \]

Where:
- \( D \) is the desired chlorine dose
- \( C \) is the concentration of the concentrated hypochlorite solution
- \( Q \) is the flushing rate

For example, to achieve a chlorine dose of 300 mg/l when flushing at a rate of 200 gpm, a 12.5% (125,000 mg/l) sodium hypochlorite solution must be pumped into the main at a rate of 0.48 gpm.

7. To determine when the hypochlorite solution has reached the end of the repair main, measure the chlorine residual at the terminal hydrant or blow off.

8. Once the residual has been detected at all blow-offs, shut down the main and allow the heavily chlorinated water to stand in the pipe. For a chlorine dose of 100 mg/L, the recommended minimum contact time is 3h.

9. If the main cannot be kept out of service for 3h, apply a chlorine dosage of at least 300 mg/L. Allow the chlorine solution to remain in the pipe for the maximum permissible contact period consistent with the need for service from the repaired main, but in no case should the contact time be less than 30 min.

Flush Disinfectant from the Pipe

At the end of the hypochlorite contact period, flush the main until the chlorine residual has been reduced to the level normally present in water supplied to the area. As a general rule, flush until the pipe volume has been replaced at least once. Prior to restoring service, flush each service line to eliminate air and high concentrations of chlorine.

Determine Bacteriological Quality

Bacteriological samples shall be taken after repairs to provide a record of the effectiveness of the disinfection procedure. After the residual disinfectant has been removed from the repaired main, collect a sample from at least one point located immediately downstream of the repair. If the direction of flow is unknown, collect samples on each side of the repair.

A combination blow-off and sample tap is useful for sampling repaired mains. Samples also may be collected from customer services that have been disinfected and thoroughly flushed. Do not collect samples from hoses or fire hydrants. For additional information on sampling, refer to Appendix A.

END OF SECTION