

- C13.06 on Manholes and Specials. Current edition approved Aug. 15, 1993. Published October 1993.  
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4. Summary of Practice
- 4.1 All lift holes and any pipes entering the manhole are to be plugged. A vacuum will be drawn and the vacuum drop over a specified time period is used to determine the acceptability of the manhole.
5. Significance and Use
- 5.1 This is not a routine test. The values recorded are applicable only to the manhole being tested and at the time of testing.
6. Preparation of the Manhole
- 6.1 All lift holes shall be plugged.
- 6.2 All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.
7. Procedure
- 7.1 The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.
- 7.2 A vacuum of 10 in. of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 in. of mercury.
- 7.3 The manhole shall pass if the time for the vacuum reading to drop from 10 in. of mercury to 9 in. of mercury meets or exceeds the values indicated in Table 9.1.
- 7.4 If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained.
- 7.5 Use or failure of this vacuum test shall not preclude acceptance by appropriate water infiltration or exfiltration testing, (see practice C969, or other means).
8. Precision and Bias
- 8.2 No justifiable statement can be made either on the precision or bias of this procedure, since the test result merely states whether there is conformance to the criteria for the success specified.
9. Keywords

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- 9.1 Acceptance criteria: Concrete; manhole sections; test method; vacuum test.

| TABLE 9-1<br>Minimum Test Times for Various Manhole Diameters<br>(seconds) |    |                   |    |    |    |    |    |     |     |     |  |  |  |
|----------------------------------------------------------------------------|----|-------------------|----|----|----|----|----|-----|-----|-----|--|--|--|
|                                                                            |    | Diameter (Inches) |    |    |    |    |    |     |     |     |  |  |  |
|                                                                            |    | 30                | 32 | 34 | 42 | 48 | 54 | 60  | 66  | 72  |  |  |  |
| Depth (feet)                                                               | 8  | 11                | 12 | 14 | 17 | 20 | 23 | 26  | 29  | 33  |  |  |  |
|                                                                            | 1  | 14                | 15 | 18 | 21 | 25 | 29 | 33  | 36  | 41  |  |  |  |
|                                                                            | 2  | 17                | 18 | 21 | 25 | 30 | 35 | 39  | 43  | 49  |  |  |  |
|                                                                            | 3  | 20                | 21 | 25 | 30 | 35 | 41 | 46  | 51  | 57  |  |  |  |
|                                                                            | 4  | 22                | 24 | 29 | 34 | 40 | 46 | 52  | 58  | 67  |  |  |  |
|                                                                            | 5  | 25                | 27 | 32 | 38 | 45 | 52 | 59  | 65  | 73  |  |  |  |
|                                                                            | 6  | 28                | 30 | 35 | 42 | 50 | 53 | 65  | 72  | 81  |  |  |  |
|                                                                            | 7  | 31                | 33 | 39 | 46 | 55 | 64 | 72  | 79  | 89  |  |  |  |
|                                                                            | 8  | 33                | 36 | 42 | 51 | 59 | 64 | 78  | 87  | 97  |  |  |  |
|                                                                            | 9  | 36                | 39 | 46 | 55 | 64 | 75 | 85  | 94  | 105 |  |  |  |
| 10                                                                         | 39 | 42                | 49 | 59 | 69 | 81 | 91 | 101 | 113 |     |  |  |  |
| 11                                                                         | 42 | 45                | 53 | 63 | 74 | 87 | 98 | 108 | 121 |     |  |  |  |

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#### 9.04 LIFT STATION AND FORCE MAIN TESTING

The following section describes the testing that shall be performed on the lift station pumps, piping and force main for acceptance and dedication to the District.

NOTE: The Contractor shall be responsible for providing sufficient notice of all lift station and force main testing to the District, 48 hours minimum, to ensure that the following personnel shall be present at the time of testing: (1) District engineering representative, (2) private inspector, (3) contractor's representative, (4) developer's representative, (5) Fall Creek Regional Waste District Lift Station Maintenance representative.

##### A. FORCE MAIN TESTING

###### 1. General

Under the observation of the District's Inspector, force mains shall be tested for leakage after installation and prior to final acceptance. The Contractor shall be responsible for providing all equipment and tools necessary to perform an air pressure test or hydrostatic pressure test conducted in accordance with AWWA standards for testing pressure pipe.

\*These standards are material specific and generally reference manufacturer's guidelines. The standards apply to method of conducting air pressure tests only. Established pass/fail criteria are contained in the following sub-sections.

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###### 2. Air Pressure Testing

Force mains shall not be tested using air pressure test methods.

###### 3. Hydrostatic Pressure Testing

Hydrostatic pressure testing of force mains is the only method of force main testing approved by the District.

The Contractor shall be responsible for providing all of the equipment and tools necessary to conduct the hydrostatic test including, but not limited to, the following:

- a. Hydrostatic test pump (jockey pump).

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- b. Four and one half (4 1/2") inch diameter calibrated pressure test gauge of range 0-150 psi graduated in 1 psi increments. The manufacturer's calibration papers and test date information shall be made available at the request of the District.
- c. All pipe plugs and/or caps required to perform the hydrostatic test.
- d. Calibrated/graduated container to measure quantity of water required to be added during hydrostatic pressure test to maintain specified test pressure.
- e. The hydrostatic pressure test shall be conducted in accordance with the applicable AWWA standard based on force main material and in accordance with ASTM E103 - "Standard Method for Hydrostatic Leak Testing," in conjunction with and in addition to the aforementioned standards, the hydrostatic pressure test shall proceed as follows:
- f. The force main shall be completely backfilled prior to testing.
- g. The influent line and effluent discharge shall be appropriately plugged/backheaded. The plugs/backheads shall be equipped with a minimum of two (2) openings for filling/drainage of the pipeline and for bleeding air from the line. Thrust blocking restraints are required at each backhead and shall be furnished in accordance with the bulkhead manufacturer's requirements.
- h. The test line shall be filled with water at a slow rate to prevent air entrapment. In the case where concrete force main materials are being tested, the line shall be left at low pressure for 24 hours prior to pressure testing in order to minimize the apparent leakage due to water absorption by the pipe walls.
- i. Trapped air shall be expelled through high point bleed off valves as the line is being filled.
- j. The test line shall be pressurized to 1.5 times the pump shut-off head as determined from the pump manufacturer's performance curves or to 100 psi whichever is greater.
- k. Water shall be added to the test segment to maintain the test pressure for a period of no less than 2 hours and no more than 8 hours. The District's inspector must be present for at least the first 2 hours of testing.
- l. If the force main or any portion thereof fails the hydrostatic pressure test, the Contractor shall remove and replace or otherwise repair the force main to the satisfaction of the District and the force main shall be retested.

##### B. WET WELL LEAKAGE TESTING

Leakage tests shall be made and observed by the District's Inspector in the wet well. The test shall be the exfiltration test made as described below.

After the wet well has been assembled in place, all lifting holes shall be filled with an approved non-shrinking mortar. The test shall be made prior to placing any fill material. If the ground water table has been allowed to rise above the bottom of the wet well, it shall be lowered for the duration of the test. All pipes and other openings into the wet well shall be suitably plugged and the plugs braced to prevent blow out.

The wet well shall then be filled with water to the top. If the excavation has not been backfilled, and observation indicates no visible leakage after 1 hour, the wet well may be considered to be satisfactorily water-tight. If the test described above is unsatisfactory or if the wet well excavation has been backfilled, the test shall be continued for a period of 24 hours to allow for absorption. At the end of this period, the wet well shall be refilled to the top, if necessary, and the measuring time of at least 8 hours begun. At the end of the test period, the wet well shall be refilled to the top, measuring the volume of water added. This amount shall be extrapolated to a 24-hour rate and the leakage determined on the basis of depth. The leakage for each wet well shall not exceed 1 gallon per vertical foot for a 24-hour period. If the test fails this requirement, but the leakage does not exceed 2 gallons per vertical foot per day, repairs by approved methods may be made as directed by the District to bring the leakage within the allowable rate of 1 gallon per foot per day. Leakage due to a defective joint or joint exceeding the 2 gallon per vertical foot per day maximum shall be cause for the rejection of the wet well. It shall be the Contractor's responsibility to uncover the wet well as necessary and to disassemble, reconstruct, or replace it as directed by the District. The wet well shall then be retested.

No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorptions, etc.; i.e., it will be assumed that all loss of water during the test is a result of leaks through the joints or through the concrete. Furthermore, the Contractor shall take any steps necessary to assure the District's Inspector that the water table is below the bottom of the wet well throughout the test.

##### C. LIFT STATION PUMP TESTING

Lift Station pump test will be performed by the Contractor during the lift station's final inspection. The Contractor shall be responsible for providing the clean water to run the pumps and perform the tests).

###### 1. Manufacturer's Start-up

Prior to the District's final inspection of the lift station equipment, the Contractor shall be responsible for coordinating start-up activities with the pump manufacturer's representative in accordance with the manufacturer's requirements. The District's Inspector must be present at the time of manufacturer's start-up.

The manufacturer's representative shall complete the appropriate one of the two lift station check lists attached at the end of this Section. The checklist shall be witnessed to in writing by the District's Inspector. Any deficiencies in equipment and/or workmanship noted during the manufacturer's start-up shall be remedied by the Contractor prior to final inspection.

Upon successful completion of the manufacturer's start-up, the manufacturer shall deliver to the Contractor:

- a. Three-(3) copies of the completed, witnessed checklist with cover letter certifying that all pumping and electrical equipment has been installed and is operating in accordance with manufacturer's requirements;
- b. Five (5) sets of Operation and Maintenance Manuals as specified in Section 10 of these Standards; and
- c. One (1) complete set of Spare Parts as specified in Section 10 of these Standards.
2. Final Inspection
- Contractor shall deliver two (2) copies of the manufacturer's start-up checklist at the time of final inspection. In addition, the Contractor shall provide the following pump test equipment and materials:
- a. Water to conduct test,
- b. Amp/volt meter,
- c. Stop watch,
- d. Tape level rod to measure settings,
- e. Calibrated test gauge to measure operating head. The gauge shall be calibrated in feet of water from 0 to 100 feet in one foot increments, and
- f. Manufacturer's pump performance curves.

The District's representative attending the final inspection shall review the manufacturer's checklist and re-check any deficiencies. The District's representatives shall then complete a cursory final inspection checklist and perform pump draw down tests which shall include the following:

- a. Manual check of all on-off operations, alarm and run lights;
- b. Determination of inflow rate (if any);
- c. Determination of pump capacity for each pump individually and both/all pumps simultaneously;
- d. Determination of pump capacity with force main full. Verification of full force main shall be determined by pressure gauge provided by Contractor. Force main shall be considered full when the line pressure stabilizes; and
- e. Plot performance of each pump or pump curves provided by Contractor.
- Contractor shall provide all water necessary to conduct the pumping tests, and shall provide a connection for the test gauge on the blind flanged tee in the valve vault. The stem connection shall be equipped with a plug valve to close the connection after testing is complete. The connection shall be left in place and shall be suitable for use as an air bleed off.

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#### 9.05 CLOSED CIRCUIT TELEVISION INSPECTION

When Mandrel Test shows areas of deflection failure along the pipe or when air testing fails, the Contractor shall be required to perform a closed circuit television inspection of the sanitary sewer between manholes as follows:

- A. A camera equipped with a rotating lens and remote control devices to provide the light intensity and one thousand (1,000) lineal feet of sewer cable shall be provided. The camera should be able to transmit a continuous image to the television monitor as it is being pulled through the pipe. The image shall be clear enough to enable the District representative and others viewing the monitor to easily evaluate the interior condition of the pipe. The camera shall have a digital display for lineal footage and project number and an audio voice-over shall be made during the inspection identifying any problems.
- B. The pipe shall be thoroughly cleaned before the camera is installed and televising is commenced.
- C. The VHS tape of the entire sewer line and reproduction map indicating the pipe segment numbers of all the pipe that has been televised shall be submitted to the District for their records.
- If any pipe and/or joint is found to be leaking, the Contractor shall be required to repair that portion of the pipe to the satisfaction and approval of the District.
- D. FCRWD will perform a closed circuit television inspection of all new sanitary sewer lines prior to final acceptance by the District. Any deficiencies noted must be repaired and re-televised by the Contractor before final acceptance by the District.

Table 9-2  
(9-Arm Mandrel)  
Dimensions for ASTM D3034 SDR 35 PVC Pipe

| Nominal Diameter | Length | Deflection  |
|------------------|--------|-------------|
| 8                | 8      | 7.71 7.56   |
| 10               | 10     | 9.63 9.45   |
| 12               | 12     | 11.46 11.26 |
| 15               | 12     | 14.03 13.78 |

(10-Arm Mandrel)  
Dimensions for ASTM D3034 SDR 35 PVC Pipe

| Nominal Diameter | Length | Deflection  |
|------------------|--------|-------------|
| 8                | 8      | 7.72 7.58   |
| 10               | 10     | 9.65 9.48   |
| 12               | 12     | 11.48 11.29 |
| 15               | 12     | 14.06 13.82 |

#### EXAMPLE LOW PRESSURE AIR TESTS

##### A. GENERAL

The purpose of this Section is to illustrate the proper application of this recommended practice with regard to appropriate test selection. The examples that follow include a variety of conditions which may be encountered in the field.

###### 1. EXAMPLE A

A manhole to manhole reach of nominal 12-inch pipe is 350 feet long. No lateral connections exist in the reach. What is the required test time for a 0.5 psig pressure drop?

Solution: The required test time can be read directly from Table 9.1B. For 350 feet of 12-inch pipe, the required test time is 9:58 (9 minutes and 58 Seconds).

###### 2. EXAMPLE B

A 350 foot section of nominal 12-inch pipe is ready for testing. A total of 128 feet of 4-inch lateral sewer pipe is connected to the 350 foot section and will be included in the test. What will be the required test time for a 0.5 psig pressure drop?

Solution: Lateral sewers may be disregarded when selecting test times. Therefore, the required test time will be the same as for Example A, i.e. 9 minutes and 58 seconds.

Note: If lateral sewers had not been disregarded, the required test time would be 10 minutes and 22 seconds, i.e. only 24 seconds longer.

3. EXAMPLE C

What should the required test time be for a 1.0 psig pressure drop in 327 feet of nominal 8-inch diameter pipe between two manholes?

Solution: The exact test time is easily calculated by using Table 9.1A. Table 9.1A is used because a 1.0 psig pressure drop is specified. Since 327 feet exceeds the minimum test time for an 8-inch pipeline, the fourth column in Table 9.1A shall be used to quickly calculate the required test time as follows:

$$T = 1.520 \cdot L = 1.52 \times 327 = 497 \text{ seconds}$$

Therefore, the required test time for a 1.0 psig pressure drop is 497 seconds, or 8 minutes and 17 seconds.

##### 4. EXAMPLE D

A manhole to manhole reach of nominal 24-inch pipe is 82 feet long. What is the required test time for a 0.5 psig pressure drop?

Solution: Table 9.1B must be used because a 0.5 psig pressure drop is specified. Since 82 feet is less than the 99 foot length associated with the minimum test for a 24-inch pipeline, the minimum test time shall apply. Thus, the required test time for a 0.5 psig pressure drop must be 1:20 (11 minutes and 20 seconds).

##### 5. EXAMPLE E

A 412 foot section of nominal 15-inch sewer pipe has been readied for air testing. A total of 375 feet of nominal 6-inch lateral piping and 148 feet of nominal 4-inch lateral piping branch off of the 15-inch sewer line. All laterals have been capped and/or plugged and will be tested together with the 15-inch main line. The specified pressure drop which will be timed is 0.5 psig. What is the appropriate test time for this pipe network?

Solution: All lateral sewer sizes and lengths may be disregarded since their influence is generally not significant enough to warrant computation. Table 9.1B must be used for a

$$0.5 \text{ psig pressure drop. The fourth column in the Table provides the appropriate formula for calculating the required test time because 412 feet is longer than the third column value of 159 feet.}$$
$$T = 2.671 \cdot L = 2.671 \times 412 = 1,100 \text{ seconds}$$

The required test time is 1,100 seconds or 18 minutes and 20 seconds.

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Table 9-3  
SPECIFICATION TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015

|                                |                                               | Specification Time for Length (L) Shown (min:sec) |        |        |        |        |        |        |        |       |       |       |       |
|--------------------------------|-----------------------------------------------|---------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|
|                                |                                               | 100 ft                                            | 150 ft | 200 ft | 250 ft | 300 ft | 350 ft | 400 ft | 450 ft |       |       |       |       |
| 1<br>Pipe<br>Diameter<br>(in.) | 2<br>Length<br>for<br>Minimum<br>Time<br>(ft) | 4                                                 | 1:01 L | 1:53   | 1:53   | 1:53   | 1:53   | 1:53   | 1:53   | 1:53  | 1:53  | 1:53  | 1:53  |
|                                |                                               | 5                                                 | 5:07   | 5:07 L | 2:50   | 2:50   | 2:50   | 2:50   | 2:50   | 2:50  | 2:50  | 2:50  | 2:50  |
| 6                              | 10                                            | 4                                                 | 1:47   | 2:00   | 2:43   | 3:26   | 4:09   | 4:52   | 5:35   | 6:18  | 7:01  | 7:44  | 8:27  |
|                                |                                               | 5                                                 | 2:47   | 2:59   | 3:43   | 4:26   | 5:09   | 5:52   | 6:35   | 7:18  | 8:01  | 8:44  | 9:27  |
| 12                             | 15                                            | 4                                                 | 2:39   | 1:51 L | 4:43   | 4:43   | 4:43   | 4:57   | 5:09   | 5:23  | 5:37  | 5:51  | 6:05  |
|                                |                                               | 5                                                 | 3:47   | 2:59   | 5:01   | 5:01   | 5:01   | 5:15   | 5:29   | 5:43  | 5:57  | 6:11  | 6:25  |
| 16                             | 20                                            | 4                                                 | 3:50   | 1:20 L | 6:40   | 5:40   | 5:42   | 6:38   | 8:58   | 11:24 | 12:90 | 14:56 | 16:22 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 2:07 L | 7:50   | 7:50   | 8:54   | 11:08  | 13:21 | 15:35 | 17:48 | 20:01 |
| 18                             | 25                                            | 4                                                 | 3:50   | 1:23   | 3:46 L | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 20                             | 30                                            | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 24                             | 40                                            | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 27                             | 45                                            | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 32                             | 60                                            | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 36                             | 75                                            | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 48                             | 120                                           | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 60                             | 150                                           | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 72                             | 180                                           | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 96                             | 240                                           | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 120                            | 300                                           | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 144                            | 360                                           | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 180                            | 450                                           | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 216                            | 540                                           | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 240                            | 600                                           | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 288                            | 720                                           | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 360                            | 900                                           | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 432                            | 1080                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 540                            | 1350                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 648                            | 1620                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 720                            | 1800                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 864                            | 2160                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 1008                           | 2520                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 1152                           | 2880                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 1296                           | 3240                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 1440                           | 3600                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 1728                           | 4320                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 2016                           | 5040                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 2304                           | 5760                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 2592                           | 6480                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 2880                           | 7200                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 3168                           | 7920                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 3456                           | 8640                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 3744                           | 9360                                          | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 4032                           | 10080                                         | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 4320                           | 10800                                         | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 4608                           | 11520                                         | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 4896                           | 12240                                         | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 5184                           | 12960                                         | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 5472                           | 13680                                         | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 5760                           | 14400                                         | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 6048                           | 15120                                         | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 6336                           | 15840                                         | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 6624                           | 16560                                         | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 | 23:12 | 26:22 | 29:32 |
| 6912                           | 17280                                         | 4                                                 | 3:50   | 1:26   | 3:46   | 3:46   | 3:46   | 3:57   | 12:49  | 19:11 | 22:20 | 25:30 | 28:41 |
|                                |                                               | 5                                                 | 5:45   | 1:59   | 4:41   | 4:41   | 4:41   | 4:52   | 13:41  | 20:03 |       |       |       |