



**SECTION 724**

**PIPE CULVERTS**

**724.1 Description.** This work shall consist of providing pipe or pipe arch of the diameter or shape designated, laid upon a firm bed and backfilled as specified. Where appropriate this specification will also apply to pipe arches.

**724.1.1** The contract will specify either the type of pipe or the group of permissible types of pipe. If a group of permissible types is specified, the contractor may use any of the types listed within the specified group and size range as follows:

		Group A <sup>b</sup>	Group B <sup>b</sup>	Group C
<b>Rigid Pipe</b>		<b>Size</b>	<b>Size</b>	<b>Size</b>
Reinforced Concrete Culvert Pipe		ALL	ALL	ALL
Vitrified Clay Pipe		ALL	ALL	ALL
<b>Flexible Pipe – Metal<sup>a</sup></b>		<b>Size</b>	<b>Size</b>	<b>Size</b>
Aluminum Coated Steel Pipe		ALL	ALL	ALL
Polymer Coated Steel Pipe		ALL	ALL	ALL
Aluminum Alloy Pipe		ALL	ALL	ALL
Bituminous Coated Steel Pipe		NA	NA	ALL
Zinc Coated Steel Pipe		NA	NA	ALL
<b>Flexible Pipe - Thermoplastic</b>		<b>Size</b>	<b>Size</b>	<b>Size</b>
Polypropylene Pipe	Double Wall	≤ 30"	≤ 30"	≤ 30"
	Triple Wall	30" – 60"	30" – 60"	30" – 60"
Polyethylene Pipe	Corrugated	≤ 24"	≤ 60"	≤ 60"
	Steel Reinforced	≤ 24"	≤ 60"	≤ 60"
Polyvinyl Chloride Pipe (PVC)		≤ 36"	≤ 36"	≤ 36"

<sup>a</sup> Metal Pipe used for storm sewer applications shall be Type IA or Type IR

<sup>b</sup> Pipe used for storm sewers under the influence of a pavement section or future anticipated influence of a pavement section which has a 3,500 ADT or greater shall be Group A pipe. Pipe used in other storm sewer applications shall be Group B. No other substitutions will be allowed.

**724.1.2** If the contract specifies pipe culverts by group and the contractor elects to furnish metal pipe, the culvert shall be constructed in accordance with [Sec 725](#). If the contractor elects to furnish vitrified clay or reinforced concrete pipe, the culvert shall be constructed in accordance with [Sec 726](#). If the contractor elects to furnish thermoplastic culvert pipe, the culvert shall be constructed in accordance with [Sec 730](#).

**724.1.3** When Group A, Group B and Group C pipe are specified, two pipe diameters will be shown on the plans at those locations. The first dimension will indicate the diameter of pipe that shall be provided if the contractor elects to provide pipe for that location with a corrugated interior wall, and the second dimension provided in parenthesis will indicate the diameter of

pipe that shall be provided if the contractor elects to provide pipe for that location with a smooth interior wall. Helical rib (Type IA) pipe may be considered to have varying hydraulic coefficients and may be substituted in accordance with FHWA HD-5 hydraulic design of highway culverts considering the corrugation configuration at the joints. The specified diameters may be the same or different and will be dependent upon the design features for that pipe location. Regardless of which diameter of pipe is selected for a given location, the pipe flow line shall be maintained at the elevations shown on the plans.

**724.1.4** The contractor may elect to furnish pipe one size larger than specified so long as the minimum fill heights are met. No additional compensation shall be given for the larger diameter pipe or any related items necessary to construct the larger pipe.

#### **724.2 Construction Requirements.**

**724.2.1 Construction Loads.** Before heavy construction equipment is operated over the pipe, the contractor shall provide adequate depth and width of compacted backfill or other cover to protect the pipe from damage or displacement. Any damage or displacement shall be repaired or corrected at the contractor's expense.

**724.2.2 Installation.** Pipe installation shall be according to the plans and specifications. Care shall be taken when preparing the subgrade and compacting fill around the pipe especially in the haunch areas. The contractor shall verify adequate compaction during construction of the pipe by performing density tests.

**724.2.3 Pipe Plugs.** The ends of all pipe stubs for future connections at inlet and manhole structures, and all pipe installed as part of future sewers, shall be sealed with approved plugs. The plugs shall be installed in such a manner that infiltration of soil into the pipe is prevented.

#### **724.3 Performance Inspection, Performance Report and Evaluation.**

**724.3.1** The contractor shall conduct either manual performance inspection or remote performance inspection along with performance reporting and evaluation as it relates to this specification.

**724.3.2** The contractor shall notify the Engineer at least five workdays before conducting a performance inspection. The inspection shall be performed no sooner than 30 days after the completion of the finished grade when not below pavement and after the completion of the aggregate base when any portion of the culvert pipe is below pavement. The condition of the culvert pipe shall allow for an accurate inspection. The contractor shall inspect the entire length of the pipe. The frequency of inspection shall be as follows:

- a) 100% of locations for Group A pipe
- b) 25% of locations for Group B. Locations to be determined by the engineer. Criteria for selection will include pipes under large fills or any locations of potential concern.
- c) Group C pipe shall be inspected at the discretion of the engineer.
- d) If issues are found with any pipe from the performance inspection the engineer may require that all pipe be inspected according to this specification.

**724.3.3** The actual inside diameter of flexible pipe products shall be determined for the purposes of measuring deflection by averaging nine equally spaced measurements at one location in the barrel of an unloaded pipe. If the pipe has a corrugated interior, the measurements shall be from the top of corrugation to top of corrugation as viewed from the inside of the pipe.

**724.3.4** The contractor shall furnish a video recording of each inspection. The recording shall identify the date and time of the inspection, a description of the culvert pipe, the location, and the viewing direction. The recording shall be for the entire run of the culvert pipe being inspected. The contractor shall provide sufficient enough source of light to allow all areas of concern to be readily observed on the video recording in a digital, reproducible format on one of the following media types: DVD, CD or other media type approved by the engineer.

**724.3.5 Manual Inspection.** Perform a manual inspection by entering the culvert pipe to record video and to make measurements. Culverts should be entered only by inspection personnel trained in working with confined spaces and using procedures in full compliance with applicable State, Local, and Federal OSHA regulations. The manual inspection shall include the following at a minimum:

- 1) Measure the deflection of the culvert pipe to the nearest 1/4 inch. A minimum of three measurements shall be taken: vertically from the crown to invert (12 o'clock to 6 o'clock), and at 60 degrees from vertical (2 o'clock to 8 o'clock and 4 o'clock to 10 o'clock).
- 2) Measure crack width using a crack comparator, micrometer or a feeler gage capable of measuring 0.01 inch. Other measuring devices may be used if approved by the Engineer. Record the measurements and include them in the written inspection performance report including: For rigid culvert pipe, document the location, length, width, and greatest width of each crack exceeding .01 inch. For flexible culvert pipe (Corrugated Metal Pipe and Thermoplastic Pipe), document the location and length of all cracks.
- 3) For all culvert pipe, measure and record the widest gap at each joint in the run.
- 4) For culvert pipe with manufactured seams, measure the location, length, and greatest width of any separation at the seam.
- 5) Measure the location, length and greatest width of each crack and the widest gap at each culvert pipe entering a drainage structure or transition.

**724.3.6 Remote Inspection.** Perform a remote inspection by using a crawler mounted camera with low barrel distortion to record video and that has the capability to make measurements. In addition deflection shall be measured by either laser profiling and measuring technology or use of a mandrel capable of verifying deflection on a minimum of 9 points. Laser profiling and measurement technology must be certified by the company performing the work to be in compliance with the calibration criteria as per MoDOT TM 84. Reports shall be submitted by electronic media in a format approved by the Engineer.

**724.3.7 Inspection Criteria.** Based on the type of culvert pipe, in the measurements and acceptance criteria shall be in accordance with the table below. Also record the location of any other defect not listed in the table and describe the defect. Potential defects include, but are not limited to damaged coatings on corrugated metal pipe, racking, dents, protrusions, misalignment of line or grade, slabbing, and excessive corrugating of thermoplastic pipe. For each measurement location in a culvert pipe, record the length from the left end of the pipe according to roadway stationing.

Inspection Criteria				
Pipe Type	Measurement Equipment	Type of Measurement	Limitations	Required Action
Rigid Culvert Pipe	Manual: Video Camera  Remote: Crawler mounted camera with crack measuring capability	Joint gaps	Soiltight in accordance with AASHTO PP 63-09	Seal joints with excessive gap
		Crack widths	Greater than .01 inch less than 0.10 crack	Note for future evaluation
			Greater than 0.1 inch crack	Unacceptable
Flexible Culvert Pipe with Hydraulically Smooth Interior	Manual: Video Camera  Remote: Crawler mounted camera with crack measuring capability and laser profiler or Crawler mounted camera with crack measuring capability and 9 point minimum mandrel	Joint gaps	Soiltight in accordance with AASHTO PP 63-09	Seal joints with excessive gap
		Crack widths	None allowed	Unacceptable
		Deflection	Greater than 5% less than 7.5%	Replace deficient pipe or 50% of pay item for entire line
			Greater than 7.5%	Unacceptable
Flexible Culvert Pipe with Corrugated Interior	Manual: Video Camera  Remote: Crawler mounted camera with crack measuring capability and mandrel	Joint gaps	Soiltight in accordance with AASHTO PP 63-09	Seal joints with excessive gap
		Crack widths	None allowed	Unacceptable
		Deflection	Greater than 5% less than 7.5%	Replace deficient pipe or 50% of pay item for entire line
			Greater than 7.5%	Unacceptable

**724.3.8 Performance Report.** The contractor shall provide a performance report for each performance inspection per drainage structure. Each report shall include:

- a) Project number and County-Route-Section
- b) Date of performance inspection
- c) Type and size of culvert pipe including any transitions in pipe run
- d) Time of video recording

- e) Location (e.g. station and offset) and viewing direction.
- f) Summary of all defects including type, measurement, and location
- g) For remote inspections using a mandrel, indicate in the performance report the size of the mandrel and whether or not it was successfully pulled through the culvert pipe.
- h) For remote inspections using a crawler mounted camera with laser profiler, include:
  - 1) Three dimensional model of the culvert pipe based on the laser profile measurements.
  - 2) Digital profile of culvert pipe extracted from the inspection video
  - 3) Calculations of the ovality, capacity and delta of the culvert pipe
  - 4) Explanation as to why data was unattainable for any section of the culvert pipe

The contractor shall submit a performance report to the Engineer within 5 days of completing the performance inspection of the culvert pipe run. Submit the performance report in an electronic format approved by the Engineer.

**724.3.9 Culvert Pipe Evaluation.** The culvert pipe shall be evaluated based on the Performance report. Defects exceeding limitations in this specification will require an action plan addressing noted deficiencies. Other defects will require the contractor to submit an action plan to the Engineer.

**724.3.10 Repairs.** Required repairs shall be made at no additional cost to the Department and to the satisfaction of the Engineer. The contractor shall submit their required action plan including repair process and/or revised installation plan to the Engineer for approval at least 7 days before performing the repairs. The action plan shall provide written confirmation from the culvert pipe manufacturer that the repair methods are appropriate. Any repairs shall have a performance evaluation conducted of the repaired portion of the culvert pipe and any culvert pipe potentially affected by the repair work 30 days after the repair has been made, at no additional cost to the Department.

#### **724.4 Method of Measurement.**

**724.4.1** Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. When two different diameters of pipe are shown on the plans for a given location for Group A, Group B or Group C pipe, the quantity of pipe installed will be based on the plan quantity for the larger diameter pipe and will not be considered as an appreciable error in the contract quantity if the smaller allowed diameter pipe is used. Where required, measurement of pipe, complete in place, will be made to the nearest foot along the geometrical center of the pipe. The revision or correction will be computed and added to or deducted from the contract quantity.

**724.4.2** When concrete pipe is used, the length of the structure may be increased by no more than 3 feet as necessary to avoid cutting the pipe, but such increased length will not be included in the contract quantity for payment.

**724.4.3** When PVC pipe is used, measurement will include any other pipe used to protect the pipe from exposure to sunlight.

#### **724.5 Basis of Payment.**

**724.5.1** The accepted quantities of pipe, complete in place, including all necessary tees, bends, wyes, coupling bands, cutting and joining new pipe to existing pipe or structures,

unless otherwise specified, will be paid for at the contract unit price for each of the pay items included in the contract.

**724.5.2** The accepted quantities of corrugated metal drop inlets and metal curtain walls, complete in place, including coupling bands, toeplates, nuts and bolts will be paid for at the contract unit price for each of the pay items included in the contract.

**724.5.3** Unless specified otherwise, no direct payment will be made for the following:

- (a) Beveling, skewing or additional work required in laying pipe with beveled or skewed ends.
- (b) Work involved in elongating pipe.
- (c) Any required backfilling, except as specified in [Sec 206.6.3](#).
- (d) Construction of bedding or for bedding material.
- (e) Furnishing and installing plugs.
- (f) Material or work required for placing couplings on exposed ends of pipe.

**724.5.4** Payment for removal of unsuitable material and for backfilling will be made in accordance with [Sec 206.6.3](#), unless the unsuitable material is a result of the contractor's operations, in which case the removal and backfilling shall be at the contractor's expense.