

## SECTION 924 ADMIXTURES FOR CONCRETE

### 924-1 General.

This Section covers materials for use as admixtures for concrete. The use of admixtures is restricted to those admixtures as may be allowed or required elsewhere in the specifications for specific concrete applications. Admixtures shall comply with applicable AASHTO and ASTM specifications as modified in 924-2.3 through 924-2.78. Admixtures that have been previously qualified for Department use are listed on the Department's Approved Product List (APL).

### 924-2 Acceptance of Admixtures.

**924-2.1 Approved Product List (APL):** The Department maintains a list of qualified admixtures for air-entraining, water-reducing (Type A), accelerating (Type C), water-reducing and retarding (Type D), water-reducer and accelerating (Type E), high range water reducing (Type F) and high range water-reducing and retarding (Type G), high range water-reducing (Type I - Plasticizing and Type II - Plasticizing and retarding) in producing flowing concrete, specific performance (Type S), and corrosion inhibitor, which have been determined as meeting requirements for use on Department projects. Admixtures included on this list, will be permitted without further testing.

The inclusion of any specific product on the APL, as specified in 6-1, indicates that the product has been given contingent approval, as evidenced by previous tests and apparent effectiveness under field conditions.

Except as specified in Sections 346 and 347, no further testing will be required for any product on the APL unless there is indication in actual field use of inadequate or unreliable results.

**924-2.2 Certification:** Manufacturers of admixtures shall submit certified test results from an independent laboratory inspected by the Cement and Concrete Reference Laboratory (CCRL) on a regular basis for applicable tests, with all deficiencies corrected for APL approval and upon request of the Engineer.

**924-2.3 For Air-Entraining:** Air-entraining admixtures shall meet the requirements of AASHTO M154, except for the flexural strengths, relative durability factor, and length change requirements are waived.

**924-2.4 For Type A (Water-Reducing) and Type D (Water-Reducing and Retarding):** Water-reducing and water-reducing and retarding admixtures shall meet the requirements of AASHTO M194 for Type A and D, respectively, except for the compressive strength at six months and one year, flexural strengths, and relative durability factor requirements are waived.

**924-2.5 For Type C (Accelerating) and Type E (Water Reducing and Accelerating):** Accelerating and water reducing and accelerating admixtures shall meet the requirements of AASHTO M194 for Type C and Type E, respectively, except for the compressive strength at six months and one year, flexural strengths and relative durability factor requirements are waived.

**924-2.6 For High Range Water-Reducing:** High range water reducing admixtures shall meet the requirements of the applicable AASHTO or ASTM specifications as modified in 924-2.6.1 and 924-2.6.2.

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**924-2.6.1 For Type F or Type G:** High range water reducing (Type F) and high range water reducing and retarding (Type G), shall meet the requirements of AASHTO M194, except for the compressive strengths, at one year, and relative durability factor requirements are waived.

**924-2.6.2 For Type I and Type II:** High range water reducing (Type I) and high range water reducing and retarding (Type II), for use in producing flowing concrete shall meet the requirements of ASTM C1017, except for the compressive strength, at one year, and relative durability factor requirements are waived.

**924-2.7 For Corrosion Inhibitors:** Corrosion inhibitors shall meet the requirements of ASTM G109 and all requirements in this Section.

Calcium nitrite is a chemically reactive admixture used in concrete to inhibit the corrosion of embedded reinforcing steel and other metallic components. The calcium nitrite supplier shall submit to the Engineer test certificates from an independent laboratory indicating compliance with this Specification. The test certificate shall include corrosion inhibiting properties per ASTM G109 and results of physical tests included in this section. Calcium nitrite shall be supplied by the same manufacturing source throughout the project. If a single primary source of calcium nitrite cannot be maintained throughout the project, new test certificates shall be submitted. The Engineer will determine specification compliance of a new supplier's product, and evaluate the effectiveness of the new calcium nitrite product before approving the source.

The active ingredient shall be calcium nitrite  $\text{Ca}(\text{NO}_2)_2$ .

The calcium nitrite shall be furnished in solution containing not less than 29% calcium nitrite solids. The concentration of the calcium nitrite solution shall be verified by spectrophotometric analysis or other comparable methods. The nitrite concentration shall be measured in accordance with Standard Methods for the Examination of Water and Waste Water, 18th Edition.

A volume of one gallon of calcium nitrite solution shall weigh within the range of 10.40 to 11.92 lb.

The calcium nitrite solution shall be added to the concrete mixture at a rate of 4.50 to 4.60 gal/yd<sup>3</sup> of concrete.

The addition of calcium nitrite to the concrete mix shall not adversely affect the properties of fresh and hardened concrete.

Calcium Nitrite concrete shall meet the following physical requirements when mixed and tested in accordance with AASHTO M194:

Water Content, % of control	95 to 100
Time of setting, allowable deviation from control, h:min:	
Initial: at least not more than	1:00 earlier nor 1:30 later
Final: at least not more than	1:00 earlier nor 1:30 later
Compressive Strength, min. % of control:	shall be 100 for all ages
Flexural strength, min, % of control:	shall be 100 for all ages
Length change, max Shrinkage (alternative Requirements): % of control	135
Increase over control	0.010
Relative durability factor, min	80

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The following table lists the corrosion inhibiting test result limits for calcium nitrite concrete tested in accordance with ASTM G109:

<u>Maximum Allowable Test Results of Calcium Nitrite Concrete</u>	
<u>Measured average macrocell current any time during the test</u>	<u>10 <math>\mu</math>A</u>
<u>Average macrocell current at test completion</u>	<u>2 <math>\mu</math>A</u>
<u>Average visible corrosion measured as percent corroded area of control</u>	<u>85%</u>

**924-2.8 Type S (Specific Performance):** Specific performance admixtures shall meet the requirements of ASTM C494 for Type S admixtures except the compressive strength at one year, flexural strength and relative durability factor requirements are waived. The following Type S admixtures may be added to plastic concrete.

**924-2.8.1 Workability Retention:** Workability retention admixtures are used to extend workability and slump life without retarding the setting time. The dosage rate used shall be based on the manufacturer's recommendation in order to maintain 80% of the initial measured slump after 60 minutes.

**924-2.8.2 Shrinkage Reducing:** Shrinkage reducing admixtures are used to minimize the shrinkage of plastic and hardened concrete. The dosage rate used shall be based on the manufacturer's recommendation and may vary for a specific application.

**924-2.8.3 Rheology Modifying:** Rheology modifying admixtures are used to maximize the rheology of plastic concrete. The dosage rate used shall be based on the manufacturer's recommendation and may vary for a specific application.

<u>Maximum Allowable Test Results of Calcium Nitrite Concrete</u>	
<u>Measured average macrocell current any time during the test</u>	<u>10 <math>\mu</math>A</u>
<u>Average macrocell current at test completion</u>	<u>2 <math>\mu</math>A</u>
<u>Average visible corrosion measured as percent corroded area of control</u>	<u>85%</u>

### **924-3 Performance Test on Air-Entraining Admixtures, for Effect on Strength of Concrete.**

**924-3.1 Conditions under which Test is Required:** For any air-entraining admixture selected for use the Engineer may call for a performance test (either prior to or at any time during construction) for determining its effect on the strength of the concrete. In general, this check-test will be required only when there is indication that such admixture is giving erratic results or is unduly reducing the strength of the concrete. Testing shall be in accordance with 924-3.2 and 924-3.3.

**924-3.2 Permissible Reduction in Strength of the Concrete:** For concrete composed of the same cement and aggregates (and in the same proportions) to be used in the work, and containing the admixture under test, in an amount sufficient to produce between 3 and 5% entrained air in the plastic concrete, the compressive strength at seven days shall be at least 90% of the strength of the same concrete without the admixture.

**924-3.3 Method of Test for Strength Reduction:** The percentage reduction in strength shall be calculated from the average strength of at least three standard 6 inch by 12 inch, or 4 inch by 8 inch, cylinders of each class of concrete. Specimens shall be made and cured in the laboratory in accordance with ASTM C192, and shall be tested in accordance with ASTM C39.

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The percentage of entrained air shall be determined in accordance with ASTM C173 or ASTM C231.

**924-4 Retesting.**

The approved admixtures are required to be tested for their uniformity and equivalence whenever there is an indication of erratic results. The tests shall be performed in accordance with the following procedure. The admixture shall be checked for comparison between infrared spectrophotometry, pH value, specific gravity, and solids content. Any marked variation from the original curve, pH value, specific gravity, or solids content will be considered sufficient evidence that the chemistry of the original material has been changed and, therefore, the use of this material will be rejected and the material will be removed from the APL.