Make this Section a part of the Standard Specifications:

SECTION 675 – MASS CONCRETE

675.01 Description. This Section describes mass concrete, which is the placement of any large volume of cast-in-place concrete with dimensions large enough to require taking measures to cope with the generation of heat from hydration of cement and attendant volume change.

675.02 Materials.

Portland Cement	701.01
Fine Aggregate for Concrete	703.01
Coarse Aggregate for Portland Cement Concrete	703.02
Admixtures	711.03
Water	712.01

675.03 Construction.

(A) Submittals.

(1) At least 14 days prior to the mass concrete pour, submit a Thermal Control Plan prepared by a specialty Engineer with at least 5 years of experience in the design and temperature control of mass concrete. The plan shall follow ACI 207.1R "Guide to Mass Concrete" and also address the following issues:

(a) An analysis of anticipated thermal developments within the mass pour placements using proposed materials and casting methods. List locations of anticipated mass concrete pours, type of structure, and anticipated volume of concrete

(b) A plan which includes mix design, insulation and cooling outlining specific measures to be taken to control the temperature differential and the maximum temperature

(c) The proposed monitoring system

(d) Duration and method of curing

(e) An outline of corrective actions to maintain the temperature differential and the maximum temperature to avoid cracking

(e) Proposed methods of repairs or corrective actions if the mass concrete member is not accepted as well as preventative measures to ensure issues do not reoccur

(2) Drilled shaft concrete heat of hydration development shall be addressed independently from the Thermal Control Plan considering ambient ground conditions and range of expected placement temperatures to ensure conformance with the maximum temperature limit and gradients set forth herein.

(B) Quality Control. Mass Concrete production requires Contractor responsibility for quality control of materials during handling, blending, mixing, curing, and placement operations.

Sample, test, and inspect concrete to ensure quality control of component materials and concrete. Sampling and testing for quality control in accordance with standard methods shall be performed by certified ACI Concrete Field Technician Grade I. Perform quality control tests for slump, air content, temperature, and unit weight during production of mass concrete other than concrete for incidental construction. Submit quality control test results.

Cease all mass placement operations and revise the Thermal Control Plan as necessary if either the maximum core temperature or maximum differential temperature is exceeded.

If any mass concrete placed under these Specifications proves unsatisfactory, the Contractor will be required to make the necessary repairs or to remove and replace the material at the Contractor's expense.

The Engineer will be the sole judge in determining the acceptance of a mass concrete member. Corrective actions, as approved in the Thermal Curing Plan Report, shall be made in those areas directed by the Engineer before the mass concrete member will be considered for acceptance.

(C) Mix Design. The specialty Engineer shall select the concrete mix proportions that will generate the lowest maximum temperature possible to ensure that no Delayed Ettringite Formation (DEF) will occur and also the lowest temperature differential to ensure there will be no thermal cracking. Mass concrete shall conform to the provisions in Section 601 – Structural Concrete with the following exceptions:

(1) Select concrete ingredients, e.g., aggregates, gradation, admixtures, and cement types that minimize the heat of hydration.

(2) Cementitious Material: Mass concrete shall contain a minimum of 505 pounds of cementitious material per cubic yard of concrete. To better control the heat of hydration of the mass concrete, the concrete mix design shall contain a pozzolanic material such as fly ash, silica fume, or ground granulated blast furnace slag (GGBFS). GGBFS shall be compliance with ASTM C989. The minimum amount of fly ash or natural pozzolan shall be the weight of the total amount of cementitious material.

(a) When supplementary cementitious (SCM) material is GGBFS, the amount of SCM shall be 50 to 75 percent by weight of the total cementitious material used in the mix. When the SCM is not GGBFS, the SCM content shall be from 25 to 35 percent by weight of the total cementitious material used in the mix.

(3) Temperature Sensing Equipment: Use thermistor-type temperature-sensing devices or an approved equal capable of indicating temperatures over a range of 50 to 200 degrees Fahrenheit, with an accuracy and precision of ±1 degree Fahrenheit. Connect the sensors to a device that continuously records and displays temperatures and produces a record that can be detached and filed.

(D) Monitoring and Controlling Temperature.

(1) Thermally cure the concrete in order to maintain a temperature differential between the internal (hottest: located as close as possible to the center of the pour but not less than 12 inches from the surface) and external (coolest temperature of the concrete) of 35 degrees Fahrenheit maximum. In addition, the internal temperature of the concrete (measured at the hottest point located at the center of the pour) shall at no time exceed 160 degrees Fahrenheit.

(2) Use a combination of the following elements to thermally cure the concrete to maintain internal and differential temperature:

(a) Use of shaved, flaked, or chipped ice or other concrete cooling ingredients

(b) Use of liquid nitrogen dosing systems

(c) Controlling the rate or time of concrete placement

(d) Using insulation or supplemental external heat to control heat loss

(e) Using supplementary cementing materials or additives that will reduce heat of hydration without affecting strength or durability

(f) Using a mechanical cooling system

(g) Using a cooling system to control the core temperature

(h) Other methods accepted by the Engineer

(3) Provide temperature monitoring devices to record temperature development between the interior and exterior of the element at points approved by the Engineer, and shall monitor the mass pours to measure temperature differentials. Temperature monitoring shall continue until the interior temperature is within 35 degrees Fahrenheit of the lowest ambient temperature, and when the interior temperature has plateaued and is decreasing.

(a) Furnish and install a temperature monitoring and recording system. This system shall consist of temperature sensors and a data acquisition system. Use these devices to simultaneously measure and record the temperature of the concrete at the core and the surface. The Engineer may adjust the locations for all temperature sensors from those stated in the Contractor's Thermal Control Plan.

(b) Record each set of readings as they are taken and make a temperature chart for each mass pour element showing temperature readings vs. time. The temperature chart showing temperature differential shall have both the interior temperature and ambient temperatures on the same chart. Submit to the Engineer the readings and chart. If the temperatures indicate temperatures are trending toward non-compliant temperatures immediately inform the Engineer and take action as presented in the Thermal Control Plan. Record the temperature readings hourly or more frequently. The Engineer may change the recording frequency of the reading at any time.

(c) Methods of concrete consolidation and placement shall prevent damage to the temperature monitoring and recording system. Wiring from temperature sensors cast into the concrete shall be protected to prevent movement. Wire runs shall be kept short as possible. The ends of the temperature sensors

shall not come into contact with concrete form or with bar reinforcing steel or casing.

(4) If monitoring indicates that the proposed measures are not controlling the concrete temperature differential within the 35 degrees Fahrenheit specified, implement corrective actions as presented in the Thermal Curing Plan to maintain the temperature differential.

695.04 Measurement. The Engineer will measure mass concrete as concrete used in other sections in accordance with that other applicable sections.

695.05 Payment. The Engineer will pay for the accepted mass concrete as concrete used in other sections as concrete under that other applicable sections."

END OF SECTION 675