SECTION 316

COMPACTION FOR GRANULAR AND OTHER MATERIAL

INDEX

316.01 SCOPE

This specification covers the requirements for the compaction of granular and other materials by the contractor unless otherwise identified in the Contract Documents. Where contract documents indicate otherwise, the Quality Control and Quality Assurance requirements of this specification shall be performed by Department Representatives. Use of this specification or any other specification referenced herein shall be in accordance with the Contract Documents.

316.02 REFERENCES

Reference standards shall be the latest revision at the date of Tender closing. This specification refers to the following standards, specifications or publications:

- ASTM D698 “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3))”
- ASTM D4718 “Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles”
- ASTM D6938 “Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods”
- ASTM D7759 “Standard Guide for Nuclear Surface Moisture and Density Gauge Calibration”

316.03 DEFINITIONS

Control Strip: A single lift of material constructed and compacted as to determine the control density. The strip shall be a minimum of 500 square metres.

Control Density: The maximum dry density attained on a “Control Strip”.

316.04 MATERIALS

All materials must conform to the requirements in the Contract Documents.

316.05 EQUIPMENT

Compaction Equipment: The type of compaction equipment used shall be suited to the material to be compacted, degree of compaction required and accessible area. Compaction equipment for control strips shall have a minimum vibratory roller not less than 9 tonnes with a vibratory capacity of at least 1500 VPM.

Nuclear Gauge: Gauges shall be capable of measuring moisture and density. Each nuclear gauge must have been calibrated within the last 12 months either by the manufacturer or other qualified agent in accordance with ASTM D7759. Standard counts must be completed on site daily prior to testing. The density standard count must be within 1.0% of the most recent values and the moisture standard count shall be within 2.0% of the most recent values. The registered owner of the gauge shall maintain a valid Nuclear Substance and Radiation Device License and comply with the regulations outlined by the Canadian Nuclear Safety Commission.

316.06 CONSTRUCTION

316.06.01 General Construction

The Contractor is responsible to ensure granular and other material is placed according to lift thicknesses and cross section requirements as per the contract documents.

Compaction operations shall be carried out as closely as possible behind the placing and spreading operation. At the end of each working day, all materials placed shall have been compacted to the specified density.

Material must be handled and compacted without segregating or adversely breaking down (such that its gradation falls outside the specified grading limits, as determined by sieve analysis on random samples obtained from the compacted in place material). Frozen material shall not be incorporated into the roadbed and material must not be placed on a frozen roadbed.

Water can be applied as necessary to facilitate compaction in order to achieve the degree of compaction required. However, it must not be added in such quantities that it seeps into the underlying subgrade or exceeds the optimum moisture content (as determined by ASTM D698 and ASTM D4718, if applicable) by 1.0%.

Each layer of material shall be graded, compacted and verified prior to placing the next layer and have a finished surface free from loose material.

Lifts shall be compacted to meet or exceed the requirements for the granular or other material in accordance with this specification. Percent compaction shall be based off the maximum dry density obtained by ASTM D698 and ASTM D4718, if applicable. When field tests indicate that the required degree of compaction cannot be obtained with the equipment in use or the procedures being followed, the operations shall be modified so that the equipment will produce the required results.

Hand operated vibratory type compaction equipment shall be used behind all structures to compact fill material within restricted zones such as abutments, retaining walls, wingwalls, pipes, culvert, etc. Details of the restricted zones shall be as per the Contract Documents and any design recommendations.

316.06.02 Control Strip

As an alternative to using the maximum dry density obtained as per ASTM D698 and ASTM D4718, if applicable (as described above in 316.06.01), a control strip may be constructed at the beginning of the Work to determine a control density. Prior to construction of a control strip the Contractor shall:

- Give a minimum notice of 24 hours to the Owner’s Representative.
- Determine the optimum moisture content as per ASTM D698 and ASTM D4718, if applicable.

The control strip shall be a minimum of 500 square metres constructed using the maximum thickness in accordance with Contract Documents. Additional control strips will be required if lift thicknesses change, the source of material changes or there is a change in the compaction equipment. No additional lifts shall be placed until the control density has been reviewed by the Owner's Representative.

Control strips shall not be constructed during freezing ambient temperatures, with frozen aggregate or on frozen subgrades.

The type and mass of the compaction equipment used shall be such that uniform density is obtained throughout the depth of the layer being compacted. Equipment shall be a vibratory roller not less than 9 tonnes with a vibratory capacity of at least 1500 VPM. After initial placement of the material, the compaction equipment shall make a full pass over the entire control strip in vibratory mode at a speed of no more than 5 km/h. After each pass moisture and density measurements shall be determined at 6 random locations using nuclear equipment. Test results will be averaged to determine the in-place dry density.

The control strip moisture content shall be adjusted to provide necessary compaction without inadvertently breaking down or segregating the material. Care must be taken to avoid saturating the granular material. The average field moisture content must be maintained within the range of not less than 2.0% lower than and no more that 1.0% greater than the optimum moisture content of the control strip material as determined by ASTM D698 and ASTM D4718, if applicable.

Testing will continue after every pass until the average dry density either:

- Remains constant,
- Increases by less than 10 kilograms per cubic metre,
- Decreases.

The maximum dry density shall be the control density and used to determine percent compaction throughout the project.

Lifts shall be compacted to meet or exceed the requirements for the granular or other material as per the applicable Contract Documents. Percent compaction shall be based off the control density as determined from the control strip.

316.06.03 Deficient Areas

Deficient areas shall be re-compacted with adjustments to the moisture content, as required, until satisfactory compaction is achieved. The re-compacted area is required to be retested.

316.07 QUALITY CONTROL

The Contractor is responsible to ensure Quality Control (QC) testing is carried out on granular and other material used in the work and compacted according to the requirements as specified in the Contract Documents. The Contractor shall be responsible for the QC testing of compacted material and establishing the control density test strip, if applicable. All testing shall be carried out in the presence of the Owner's Representative.

316.07.01 Submission Requirements

The following records must be submitted on behalf of the Contractor to the Owner's Representative and Materials Engineering Division 10 days in advance of testing:

- Name of professional engineering services licensed in practice in Newfoundland and Labrador.
- Copy of their Nuclear Substance and Radiation device license number.
- Copy of the nuclear gauge original certificate and calibration certificate.
- Copy of their CCIL certification for Type D Advanced Aggregate Quality testing.
- Identification of the nuclear gauge operator(s) and proof of training and proficiency as required below.
- A copy of all QC laboratory test results for ASTM D698 and D4718 (when required) used in determining optimum moisture and maximum dry density. Results must be reviewed, signed and stamped by a Professional Engineer.

The following records must be submitted on behalf of the Contractor to the Owner's Representative and Materials Engineering Division within 24 hours after completion of testing:

- All documentation used to determine the control density for the control strip, if utilized, must be reviewed, signed and stamped by a Professional Engineer. Further, this must be reviewed by the Owner's Representative prior to the construction of additional lifts. No further compaction activities are to take place until this review has been completed.

- All field QC test results and associated information including date, station location, offset, lift thickness, probe depth, moisture content, wet density, dry density, percent compaction and any retests.
- The name of operator completing the testing, test reading count time (must be greater than or equal to 60 seconds), daily moisture and density standard counts including the previous four standard counts.
- The compaction requirement and laboratory testing results utilized for density testing.

Failure to submit documentation, within the required time frame, will result in a $1,000 holdback and a $250 liquidated damage for each delayed test result.

QC records will be audited by the Owner's Representative for errors and missing test data. If errors or omissions are found that identify insufficiently compacted or improperly/untested areas, the Contractor shall make those areas available and re-compact or retest to ensure they comply with the specified compaction requirements.

316.07.02 Equipment and Personnel

Field density and moisture measurements for QC compaction testing must be carried out by means of nuclear testing equipment. The Contractor shall utilize professional engineering services licensed to practice in Newfoundland and Labrador. The laboratory must be CCIL certified for Type D advanced aggregate testing and must include ASTM D698.

The Contractor shall ensure the records as outlined in 316.07.01 are submitted to the Owner's Representative prior to use of the nuclear gauge. If the nuclear gauge does not meet the requirements of this specification or exhibits malfunctions of any kind it must be replaced.

Only qualified operators using properly calibrated gauges shall conduct QC compaction testing. Each nuclear gauge operator must be trained in the safe operation, transportation and handling of the gauge. The operator must provide acceptable proof of training and proficiency in the use of the gauge to the Owner's Representative prior to any compaction testing. Proof of training must include a copy of a valid certificate from an acceptable training program. Proof of proficiency must be a signed document from the qualified testing firm that the operator has demonstrated proficiency in utilizing the gauge on other projects.

316.07.03 Testing

The Contractor is responsible to ensure that prior to on site compaction the QC representative has completed testing as per ASTM D698 and ASTM D4718, if applicable, or the control strip, to determine the maximum dry density and optimum moisture content. The results of this testing must be submitted to the Department prior to commencing any onsite testing.

Once the control/maximum dry density has been established all further compaction testing will occur at a minimum frequency of one nuclear gauge tests every 40 metres in each lane. Locations must be randomly selected across the entire width of the lane, including the shoulder. Conditions may require an increase in the frequency of compaction testing, the decision, arrangements and cost for which are the responsibility of the Contractor.

The QC representative must utilize the direct transmission method and ensure that the gauge probe extends the full depth of the lift but not beyond. Results must be available at any time for review and submitted to the Owner's Representative prior to the placement of any subsequent lift and within 24 hours following testing. Failure to do so may result in a stoppage of work.

The Contractor and their QC Consultant must ensure that the established rolling pattern is followed and the entire cross section is compacted uniformly throughout the project. This includes warranting compaction requirement are met under all granular windrows, at centerline and edge locations. Care must be taken to ensure no bridging of the roller during compaction operations.

Previously accepted compacted materials damaged by traffic or other means shall be restored and retested prior to placement of any overlying material. Any costs for making the materials acceptable again will be at the Contractor's expense.

316.08 QUALITY ASSURANCE

Quality Assurance (QA) verification testing will be randomly carried out by the Department who at its sole discretion can examine, inspect or test any aspect of the Contractor's work as deemed appropriate. Such inspection or testing shall not in any way relieve the Contractor of their QC responsibilities. The Department may verify any aspect of control strip including the control density established.

Areas found to be deficient shall require immediate remedial action at the Contractor's expense and may include removal and replacement. Subsequent lifts may not be placed until QA testing has been conducted or as instructed by the Owner's Representative.

316.09 BASIS OF PAYMENT

Payment is considered incidental to the tender item requiring compaction and includes all labour, equipment and material to complete the work in accordance with this specification including the supply and application of water for compaction purposes.

Any work required to be repaired or removed shall be at no additional cost to the Department.

Replacement of a gauge shall be at no additional cost to the Department.