

Partie 1 General

1.1 SCOPE

- .1 This section specifies the production of stone, including the decision-making process for acceptance of the supply sources of stone by the Departmental Representative. Also included are the tasks pertaining to quality control and to quality assurance. The Contractor is responsible for Quality Control (QC) and the Departmental Representative for the Quality Assurance process (QA).

1.2 RELATED SECTIONS

- .1 Section 01 45 00 – Quality Control.

1.3 REFERENCES

- .1 The most recent releases of the standards listed below are integral to this section of the specifications within the indicated boundaries.
 - .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM C88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
 - .2 ASTM C127: Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
 - .3 ASTM C136: Sieve Analysis of Fine and Coarse Aggregates
 - .4 ASTM C295: Petrographic Examination of Aggregates for Concrete
 - .5 ASTM D6928: Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
 - .6 ASTM D7012: Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures.

1.4 MEASUREMENT AND PAYMENT

- .1 Measurement
 - .1 All stones will be measured for payment per metric tonne (1 000 kg) of materials accepted for incorporation in the work according to certified scale tickets as described below:
 - .1 Contractor to perform the installation and certification of electronic scales before transporting stones. The certified scales shall be of the recording type and of the size required to weigh both the stone and carrier used. Scale dimensions shall accommodate all the wheels of the carriers used by the Contractor.
 - .2 Contractor to provide Departmental Representative with daily copies of weight tickets for every stone delivered to the site.
- .2 Payment
 - .1 All the stone will be paid according to contract unit prices for stone categories. The amount of payment will be determined by the certified scale weight tickets minus any deductions for rejected stones or items outside tolerance limits.

1.5 SUBMITTALS AND SAMPLES

- .1 The following information and data shall be submitted to the Departmental Representative.
 - .1 Information concerning the supply source of stones
The Contractor shall provide the information listed below for all the proposed supply sources within fifteen (15) working days following acceptance of the Offer:
 - .1 Name and location of the quarry;
 - .2 Areas and lifts to be worked in the quarry;
 - .3 Specific geological stratum or strata to be used;
 - .4 Laboratory test results representative of the quarry areas and strata to be worked (refer to Table 1 for requirements);
 - .5 List of completed maritime engineering projects carried out with the same stone.
 - .2 Stone control plan and staffing
The contractor shall submit in writing a control plan for stones within ten (10) working days following acceptance of the Offer. The plan shall describe the means, methods and equipment to be provided, as well as the inspection and follow-up program during production, handling, transportation and placement of stones in a manner that results in satisfactory quality of the Work.
The control plan shall include the name and the qualifications of the supervisor and of a licensed professional geologist. The specific qualifications and functions required of these persons are described in paragraph 1.8 below.
 - .3 Pre-production stones
Within twenty (20) working days following the granting of the contract, the Contractor shall submit a set of pre-production stones for evaluation by the Departmental Representative at the source. At least 25 pre-production stones shall be furnished for stones to be produced at each intended supply source. The specific requirements for pre-production stones are described in paragraph 1.9 below.
 - .4 Review of the stone control plan and staffing
Should the Contractor choose to propose a review of the control plan for stones, he shall submit the new version of the plan no less than five (5) days before its implementation date and the revised control plan shall not be implemented before Departmental Representative has reviewed the issues. Proposed changes in the staffing are also subject to assessment. Revisions required by the Departmental Representative in the control plan for stones and staffing shall follow the procedure described elsewhere in this section.
 - .5 Stone control plan reports
The Contractor shall keep daily records of all the work carried out with respect to the approved control plan for stones. These reports shall be made available for examination to the Departmental Representative upon request. In addition, the records shall be gathered and submitted weekly to the Departmental Representative. Daily reports shall be drafted by each inspector and include the following information and data:
 - .1 Inspector's name.
 - .2 Identification of the stone handling equipment in all the phases of the work and names of machinery operators who prepared the stone for inspection.
 - .3 Date of inspection of the stone.

- .4 Weather conditions, including temperature.
- .5 Weather conditions and date at which the stone was removed from the working face of the quarry; date of mining and break down details as the case may be.
- .6 Mining location and strata from which the stones are broken down in the quarry (horizontally and vertically).
- .7 Colour coding and other symbols and markings used by the inspector with aerosol paint to identify the stones individually sorted (and not mechanically sorted), and the rejected stones.
- .8 Distribution of the approximate quantity of accepted and rejected stones processed during the day for the project, by category.
- .9 Summary of main reasons for stone rejection during the day.
- .10 Total quantity of stone shipped from the supply source at date of report.
- .6 Gradation testing
Submit all gradation testing for review, including testing data sheets, calculations and testing results in chart form.
- .7 Weigh scale installation and certification
The Contractor shall make arrangements for the installation and certification of an electronic weigh scale before transporting stones according to the requirements set forth in paragraph 1.4.1.1. Costs of installing and certifying the scale to be borne by the Contractor.
At least five (5) business days prior to loading, provide details on the location and scale type installed for the project and include copy of the certification of the scale's accuracy issued by an Industry Canada accredited company.
- .8 Weigh scale operators
The Contractor is responsible for providing weigh scale operators and he shall cover all associated costs.
- .9 Other weighing devices
Submit details of any equipment incorporating gauges or any other device used for weighing individual stones. These devices are also at Contractor's expense.
- .10 Certified scale tickets
A copy of each weigh scale ticket certifying the accurate weight, the time of weighing and delivery shall be submitted to Departmental Representative the day following the weighing.

1.6 TERMINOLOGY

- .1 The expressions below are defined as follows:
 - .1 Aspect Ratio (l/d) – Ratio of the length (l) of a stone to its thickness (d) when measured over three mutually perpendicular axes. Stone length (l) is defined as the longest distance between two points on the stone (i.e., diametrically opposite corners of the stone block). Stone thickness (d) is defined as the minimum dimension between any two opposite faces of the stone.
 - .2 The term “ton” (t) refers to the metric ton (1 t = 1 000 kg).

1.7 QUALITY CONTROL

- .1 The control plan for stones shall be included to the Contractor's general quality control (QC) program as required in Section 01 45 00, Quality Control.

1.8 QUALITY CONTROL STAFFING

- .1 General

The Contractor shall assign a supervisor in charge of the overall process governing stone control, as well as qualified inspectors at the quarry and the loading point. Further, the Contractor shall commission a licensed professional geologist to assist the supervisor as needed throughout the duration of the project. The staff shall ensure that all the stone produced, delivered at the worksite and placed in the structure is in accordance with the requirements in the contract documents, drawings and specifications.

- .2 Supervisor's qualifications and duties

The supervisor is responsible for implementing all the elements in the control plan for stones. He must have at least two years of specialised experience in the inspection and assessment of armour stone for marine projects. The experience must have been acquired in the quality assessment of the type and size of stone involved in the project at hand. Where the Contractor obtains the stones for this project from a subcontractor, the supervisor shall not be an employee of the latter.

The supervisor shall be responsible for the implementation and fulfilment of the control plan for stones, including the management, control and assessment of the work performed by all the inspectors. He shall provide qualified inspection personnel at all times and replace any person whose performance is unsatisfactory. The supervisor is responsible for the quality of all the stone produced.

- .3 Geologist's qualifications and duties

The geologist shall be qualified and licensed and have at least one year of practical experience in the inspection and assessment of armour stone. He shall assist the supervisor in selecting the stone supply source; this includes visual inspection and petrographic assessment (ref. Table 1), identification of acceptable and unacceptable rock zones and layers at the quarry, and the selection of pre-production stones. Further, the geologist shall remain involved during the stone production period if the ongoing QC and QA (quality control, quality assurance) activities indicate that the quality of stones supplied does not comply with the requirements or is questionable; do as instructed by the Departmental Representative.

- .4 Inspectors' qualifications and duties

Inspectors shall hold adequate training and have at least one year of relevant experience to carry out in a capable and independent manner the tasks indicated below under the supervisor's general foremanship.

- .1 Participate in the selection of pre-production stones and in the evaluation of stockpiled stones.
- .2 Hold a clear and legible daily record of their activities and observations in a format to be approved by the Departmental Representative. Draft daily inspection reports and submit them as required.

- .3 Proceed to visual examination of stones to assess whether they meet the quality criteria herein described. The inspection shall focus on the quality of the stone, fractures, stone geology and detrimental characteristics likely to cause deterioration and fragmentation of the stones in smaller pieces during or after placement in the structure.
- .4 Clearly mark all stones with spray paint using a colour code and/or symbol system approved by the Departmental Representative. Unless otherwise directed, each stone shall be suitably marked on three mutually perpendicular sides. Inspection duties also include identifying and marking stones that do not meet the acceptance criteria either for size, quality and/or shape. Mark rejected stones with an X in red aerosol paint on three (3) mutually perpendicular sides.
- .5 Measure each stone over three (3) mutually perpendicular sides and reject those that do not meet the required dimensional ratio.
- .6 Unless each stone is weighed individually using appropriate equipment, estimate the weight of each unit based on the weight and dimensions of this type of stone.
- .7 Proceed to regular checks of estimated weights against the scaled weights using a weight measurement method approved by the Departmental Representative.
- .8 Build and maintain separate stockpiles for each category of stone.
- .9 Ensure that rejected stones are stockpiled in the “reject” pile or that they are removed without delay from the site after being marked. Rejected stones shall always be segregated from accepted stones.
- .10 Carry out regular verifications aimed at ensuring that the gauges and other weighing devices fitted on the equipment accurately weigh the stones accurately for quality control purposes.

1.9 PRE-PRODUCTION STONES

.1 Preparation

The Contractor shall provide a collection of pre-productions stones within twenty (20) working days from acceptance of the Offer. The supervisor shall select the pre-production stones for evaluation by the Departmental Representative. Pre-production stones shall be arranged in rows at the supply source. At least twenty-five (25) pre-production stones shall be provided for each stone category to be produced from each supply source. They shall be typical of the areas, geologic units, faces and lifts in the quarry of origin where stone is to be produced; and typical of the stone quality to be produced and of the range of sizes specified for that category.

.2 Inspection of the pre-production stones

The Contractor’s supervisor and inspectors shall accompany the Departmental Representative in his inspection of the stones. The Contractor shall ensure that the stones are not covered with dust or mud and he shall provide the means required to turn the stones to facilitate the Departmental Representative’s inspection of the pre-production material. The latter will mark unsuitable stones with an X in red over three (3) mutually perpendicular sides. If twenty percent (20%) or more of the stones in a collection of pre-production stones are deemed unsuitable, the Contractor shall replace the rejected stones and another inspection shall ensue. Should, after two failed attempts, the Contractor be unable to provide a complete and adequate collection of pre-production stones, the quarry shall be disqualified for the work of this contract. The Contractor shall then be invited to indicate a new supply source for approval. The Contractor is responsible for all costs incurred in the replacement of

collected pre-production stones or changes in the supply source. No extension of the execution date set for this contract shall be granted due to changes in the stone supply sources.

.3 Retention of pre-production stones as samples

Acceptable pre-production stones as well as typically unsuitable stones as established by the Departmental Representative shall remain at the quarry as examples (of the quality, size and shape requirements) throughout the stone shipment period of this contract. Each and all pre-production stones shall be clearly graded with its weight marked on the stone.

1.10 DECISION PROCESS FOR ACCEPTING STONE SUPPLY SOURCES AND STONE CONTROL PLAN

.1 The Departmental Representative reserves the right to conduct independent investigations and evaluations, where necessary, including other stone quality evaluations as shown in Table 1, in order to assess whether compliant materials may be produced from the proposed supply sources. Additional testing may be carried out on stone samples selected by the Departmental Representative and paid for the Departmental Representative.

.2 Departmental Representative to decide on the acceptance of the stone supply sources proposed by the Contractor, and on the control plan for stones and staffing, based the following information:

- .1 Review of the information and data on the supply sources and control plan for stones provided by the Contractor (ref. paragraphs 1.5.1 and 1.5.2);
- .2 Visual inspection of the pre-production stones (ref. paragraph 1.9);
- .3 Evaluation of the information and data regarding the specified quality requirements for the stones (ref. paragraph 2.3 and Table 1), the stone gradation and shape (ref. paragraph 2.4).
- .4 Review of results of additional laboratory testing, if need be (ref. paragraph 1.10.1).

.3 The Departmental Representative will determine acceptance or non-acceptance of the stone supply sources proposed by the Contractor, of the stone control plan and staffing within ten (10) working days following his inspection of the pre-production stones or the reception of additional laboratory test results whichever comes last.

- .1 Where the stone supply source and the stone control plan and staffing are deemed acceptable, the Contractor may then proceed with the production of materials providing they comply with the accepted pre-production stones.
- .2 Should the control plan for stones be rejected, the Contractor shall prepare and submit a new control plan – which may involve new staff, and obtain the approval of the Departmental Representative before proceeding with the production of stones for the work of this project. No further payment shall be issued for the work until an acceptable control plan is submitted to the Departmental Representative. The Contractor is responsible for all costs involved in preparing a new plan. Moreover, no extension of the execution date set for this contract shall be granted due to changes in the control plan for stones.
- .3 If the supply sources for stones are not approved, the Contractor shall find and indicate new supply sources and proceed to sampling and testing as required toward their approval by the Departmental Representative. All costs incurred by a change in supply sources shall be paid for by the Contractor. Finally, no extension of the

execution date set for this contract shall be granted due to changes in the supply sources for stones.

- .4 No extension of any milestone or deliverable due dates will be granted to compensate for the time spent by the Departmental Representative on the decision process aimed at accepting or declining the proposed supply sources.

1.11 QUALITY ASSURANCE

.1 General

- .1 Quality assurance (QA) activities are conducted by the Departmental Representative. Quality assurance activities aim at providing independent observations on the compliance of stones with the requirements of this section before stones are shipped to the worksite. QA activities shall in no way relieve the Contractor of his obligations.
- .2 The Contractor shall provide the machinery and the operators to turn and handle unpromising stones that must be submitted to another evaluation by the Departmental Representative.
- .3 Where the QA activities conducted by the Departmental Representative uncover non compliance with the requirements of this section, the Departmental Representative will reject the non compliant stones. Materials rejected at the source shall immediately be marked (with an X over three mutually perpendicular faces), segregated and removed from the storage area.
- .4 If, during his QA activities, the Departmental Representative finds that the stone provided does not meet the quality requirements or seems questionable, additional samplings and laboratory tests may be required. Stone sampling and the required testing shall be carried out as directed by the Departmental Representative. In this instance, the Contractor shall pay all costs involved in the additional sampling and laboratory testing of stones.
- .5 Persistent non-compliance shall be sufficient reason to reject the control plan for stones as described in paragraph 1.10.3.2, and/or to reject supply sources as provided in paragraph 1.10.3.3.

Partie 2 Products

2.1 GENERAL

- .1 All the stones shall comply with the entire range of requirements herein set forth. The Departmental Representative may, at any time during construction and throughout the project, refuse materials at the source or the worksite if they do not meet specifications. Materials delivered to the worksite and rejected either in a stockpile or after placement in the work, shall be removed at Contractor's expense.
- .2 In this project, the control plan and the QC and QA activities shall systematically apply throughout both the quarrying and construction phases.

2.2 STONE SOURCES

- .1 The Contractor is exclusively responsible for ensuring that the selected supply sources will be able to meet the delivery schedule and produce stones of the required quality in sufficient quantities for the project.

- .2 If, as construction activities unfold, the Contractor is unable to provide acceptable stones in sufficient quantities from the original supply source, he may request an authorisation to use another source. All costs resulting from a change in the supply sources, including the required sampling and testing, shall be at Contractor's expense. In addition, no extension of the execution date set for this contract will be allowed.

2.3 STONE QUALITY REQUIREMENTS

.1 General (all stone)

All stone shall be highly resistant to weathering, deterioration and disintegration under freeze-thaw cycles and exposure to water, and of suitable quality to ensure permanence in the structure and climate in which it is to be used. Stone shall be rough, broken quarry material of angular and irregular shape. Stone shall be durable, sound and free of cracks, seams and other defects that would tend to increase deterioration from natural causes or result in breakage during handling and/or placement. Inclusions of dirt, sand, clay, shale, of quartz or mica, pegmatite, oil or oil-stained stones, rock fines or any organic or other deleterious material will not be permitted, including iron sulphide veins or nodules.

.2 Class A stone

- .1 Conglomerate materials will NOT be accepted in Class A materials for this project regardless of the fact that they comply with the other acceptance criteria.
- .2 Any stone for which there is some uncertainty as to whether it is sandstone or not shall be subject to a petrographic examination, including thin section analyses to ASTM C295-03 at Contractor's expense.
- .3 Categories to be produced using Class A stone are as follows:
 - a) 3 to 5 metric tons.
 - b) 300 to 500 kg
 - c) 50 to 200 mm ϕ
 - d) Quarry run.

.3 Class B stone

- .1 Conglomerates will not be accepted as Class B stones for this project regardless of the fact that they comply with the other acceptance criteria.
- .2 Stones must have a minimum density of 2600 kg per cubic meter, show an absorption rate of less than 1% (to ASTM-C127) and yield less than 5% loss in soundness tests with magnesium sulfate after 5 cycles (to ASTM-C88).
- .3 The stone category to be produced with Class B stone is as follows:
 - a) MG-20.

.4 Stone sampling and testing method

- .1 References concerning testing methods are listed above in paragraph 1.3 - References.
- .2 Stone samples used in laboratory tests shall be typical of the lithostratigraphic unit of each category of stone proposed for use in the work of this project.

2.4 TOLERANCE ON WEIGHT AND FORM OF STONES

- .1 At least 90% by weight of stones in categories 300 to 500 kg, and 3 to 5 m.t. as specified shall display a weight within the limits of their category.
- .2 At most 5% by weight of stones in categories 300 to 500 kg, and 3 to 5 m.t. as specified may weigh between 0,75 and 1 time (1x) the minimum weight required for these categories.
- .3 Any stone whose weight is less than 0,75 times the minimum weight or greater than 1,25 times the maximum weight of the category in which it is classified will be refused, deducted from quantities and shall be removed from production.
- .4 Should the Departmental Representative's decision be challenged, the Contractor must demonstrate that the disputed stones fully respond to the three criteria above.
- .5 Any stone broken during handling or shipping will be reassessed based on the above criteria.
- .6 Stones must be angular or short-oblong with a maximum aspect ratio (l/d) of 3/1. There should not be more than 10% of stones in count having a dimensional ratio greater than 2,5/1.

Table 1 – Required stone quality testing – Methods and acceptance criteria

Test designation	Testing method	Acceptance criteria
		Class A stone
Field observations / Visual inspection / Assessment		
Field examination ¹	ASTM D4992-07	No conglomerates or sandstone No deleterious materials; good to excellent quality for the use intended
Petrographic examination ²	ASTM C295-03	No deleterious materials; good to excellent quality for the use intended
Weathering resistance	Visual	IA – fresh, unweathered rock IB – slightly weathered rock (some staining on main discontinuity surfaces)
Laboratory testing		
Bulk specific gravity, SSD	ASTM C127-07	2,65 to 2,85
Water absorption ³	ASTM C127-07	□ 0.5%
Compressive strength ⁴	ASTM D7012-07	<i>f</i> 80 MPa
Wear resistance (micro-Deval) ⁵	ASTM D6928-06	□ 15
MgSO ₄ soundness	ASTM C88-05	□ 1,5 % loss after 5 cycles
Petrographic examination ²	ASTM C295-03	No deleterious materials; good to excellent quality for the use intended

Notes:

- 1 Field examination to include preparing a written report comprised of a summary of the quarry and proposed quarry development plan as per ASTM D4992-07, including: general lithology, geologic unit and age, source homogeneity, stratigraphic faces; metamorphic and weathering phases; dip, strike and thickness of the bedding; proposed blasting procedure and expected curing time.
- 2 Petrographic examination shall be repeated before AND after the MgSO₄ soundness testing. Petrographic examination shall be summarized in a written report and include the geological name of the rock, weathering grade, main constituents, texture, anisotropy and porosity. In addition, the report shall indicate the presence of any constituents, of micro-fractures and/or signs of induced stress (and therefore possible stress release – ref. paragraph 3.2) of concern for the proposed use.
- 3 Water absorption testing shall be repeated on five (5) different pieces of rock.
- 4 Compressive strength testing shall be repeated on three (3) different pieces of rock.
- 5 Wear resistance micro-Deval testing shall be repeated on two (2) different pieces of rock.

Partie 3 Execution

3.1 QUALITY CONTROL DURING PRODUCTION

- .1 The Contractor shall perform Quality Control activities throughout the stone production and placement period as required in this section and in Section 01 45 00, Quality Control.
- .2 The weighing of stones, or their re-measurement, shall be carried out to ascertain the calculated weight either when the Departmental Representative questions the size of stones or when the inspector deems it appropriate.
- .3 Drop tests shall be carried out when the Departmental Representative questions the quality or integrity of stones or when the inspector deems it appropriate. Drop tests shall be carried out as follows:
 - .1 Visual inspection of the stone on all sides; marking/recording of all existing cracks.
 - .2 Lift the stone to 3 m and drop it onto a rigid surface (bedrock or stone of similar size).
 - .3 Visual inspection of the stone on all sides to identify existing and/or developing cracks.
 - .4 Repeat at least three times as directed by the Departmental Representative.
 - .5 The stone is acceptable for intended use if existing cracks have not opened and no new cracks have developed.

3.2 TRANSPORTATION AND TEMPORARY STORAGE

- .1 The Contractor shall take charge of the transportation and storage of the stones and ensure that stockpiles are not contaminated with dirt or other substances; he shall also inhibit size segregation of stockpiled material.
- .2 The storage of stones after shipment from the quarry shall be submitted to the Departmental Representative for approval.

END OF SECTION