



**NET4GAS, s.r.o**

**COMPRESSOR STATION JIRKOV  
73 BAR**

**CAPACITY EXTENSION OF BTS  
HORA SV. KATEŘINY**

**Concrete and Reinforcement - Specifi-  
cation**

24.10.2017

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## 1 GENERAL

### 1.1 Scope of the Document

The purpose of this document is to describe concrete and reinforcement works and other related material and works for the project of CS Jirkov 73 bar.

### 1.2 Definitions

Term	Explanation
Project	Compressor Station Jirkov 73 bar
Employer	NET4GAS
Consultant	ILF Consulting Engineers

### 1.3 References

No.	Number	Title
1	C4G-JI73-ILF-KS007- GEN-MAN-800	CS Jirkov 73 Bar - General technical Requirements

### 1.4 Codes and Standards

No.	Number	Title
1	ČSN EN 1990	Eurocode: Basis of structural design
2	ČSN EN 1992	Eurocode 2: Design of concrete structures
3	ČSN EN 197-1	Cement - Part 1: Composition, specifications and conformity criteria for common cements
4	ČSN EN 197-2	Cement - Part 2: Conformity evaluation
5	ČSN EN 206	Beton - Specifikace, vlastnosti, výroba a shoda

6	ČSN EN 1008	Mixing water for concrete - Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete
7	ČSN EN 12620	Aggregates for concrete
8	ČSN EN 13369	Common rules for precast concrete products
9	ČSN EN 13670	Execution of concrete structures
10	ČSN EN 12350	Testing fresh concrete
11	ČSN EN 12390	Testing hardened concrete
12	ČSN EN 934-1	Admixtures for concrete, mortar and grout - Part 1: Common requirements
13	ČSN EN 934-2	Admixtures for concrete, mortar and grout - Part 2: Concrete admixtures - Definitions, requirements, conformity, marking and labelling
14	ČSN EN 13791	Assessment of in-situ compressive strength in structures and precast concrete components
15	ČSN EN 12504	Testing concrete in structures

## 2 STANDARDS

Concrete works shall be designed and constructed according to the latest edition of applicable Czech Standards (ČSN), Eurocodes and European standards (EN).

## 3 GENERAL REQUIREMENTS

The Contractor bears the sole responsibility for achieving the required concrete properties in the structure within the limits allowed.

The origin of the individual concrete components (cement, aggregates and additives) as well as reinforcing steel and the water stops is to be made known to the Client before commencement of work and when any changes are made.

Testing of the quality properties of the water stops and the reinforcing steel and concrete components and the qualification test for the individual types and concrete must be per-

formed by the Contractor before they are used. The test must be carried out or supervised by an independent certified laboratory and must be made available to the Client. The test must be done according to the applicable standards.

The Client reserves the right to have additional quality tests or tests of the structures performed by the Contractor at any time and at the Contractor's expense.

All surfaces of concrete in contact with soil shall be isolated with two coats of water proofing bitumen painting.

## **4 MATERIALS**

### **4.1 General**

All materials for the works shall be new and have the properties as specified and approved.

The approved samples shall be representative of the delivered materials. All materials shall be delivered to the batching site well in advance of use to enable testing on the site of the delivered materials.

The materials shall be tested regularly and at a frequency necessary to ensure continuous compliance with a specification and not less than specified as a minimum. New deliveries shall be tested before use.

Materials shall be transported, handled and stored in such a manner as to prevent damage, deterioration or contamination.

### **4.2 Concrete Components**

#### **4.2.1 Cement**

Cement shall comply with ČSN EN 197. For concrete structures in areas with critical sulphate content, high resistant cement according to ČSN EN 197-1, ČSN EN 197-2 is to be used to counteract sulphate attacks.

Before ordering the cement the Contractor is to furnish the following:

- Test report and certificate from the producer stating that the material meets the pertinent requirements
- Information on manufacturers

The water used to test the cement must correspond to the water used for mixing concrete on site.

The values given in the standards and the Specification are to be checked in the course of a qualification test performed by an independent laboratory at least every four months during the construction period. The results are to be submitted to the Client.

Basically, different types of cement are to be stored separately according to production plant, cement type and quality class in such a way that confusion is avoided. Closed, watertight silos are to be foreseen for cement storage.

In order to minimize the effect of penetrative solar radiation, the outer surfaces of the silos are to be coated with a light-reflecting material (to keep the temperature of the cement as low as possible).

Cement, which is older than three months, may be used with permission of the Client only. This permission may only be given by the Client under special circumstances.

Cement may only be mixed in the mixing plant with water having a maximum temperature of 30°C.

#### 4.2.2 Water for Concrete

Water for use in concrete and mortar and for curing shall be obtained from an approved source and shall comply with ČSN EN 1008. The water shall not affect the strength and durability of the concrete or the mortar and shall not create discolouration of the hardened concrete or affect the reinforcement.

The water shall be clean and demineralised and shall comply with the following:

pH Value:	max. 8.0 – min. 7.0
Total dissolved solids:	max. 2000 ppm
Suspended solids:	max. 500 ppm
Chloride as Cl:	max. 500 ppm
Sulphates as SO <sub>3</sub> :	max. 1000 ppm
Alkali HCO <sub>3</sub> /CO <sub>3</sub> :	max. 1000 ppm

Water shall be stored in clean covered containers and protected from any contamination.

Water shall kept cool and the temperature of the water added to the concrete shall be the lowest possible.

In hot periods crushed ice from an approved source of water may be used if approved by the Client.

The Contractor shall as a minimum record the check on following items:

- Laboratory test of water
- Temperature of water during concrete mixing

#### 4.2.3 Aggregates

Aggregate shall comply with ČSN EN 12620. Before the commencement of works, the Contractor must submit the aggregate he intends to use to a qualification test. The aggregates must be in accordance with the applicable standards. The aggregate should be as coarse-grained as possible and should have very few voids. The largest grain size is to be chosen in accordance with the demands set forth by the mixing, transporting, lacing and handling of concrete. Its nominal size may not exceed 1/3 of the dimensions of the smallest construction element.

Aggregates must be free of clay, soil, loam and other organic materials and must be washed before use, if the Client considers them unclean. The aggregates must be free of dripping water before entering the mixing plant.

Aggregates from quarries must be “double broken” in an approved crushing plant by impact pulverizers. Broken stone shall be of hard, durable rock and no soft, clayey, shale or decomposed stone will be approved.

Aggregates shall be frost-resistant and must also be investigated with respect to alkali-reactive components according to the applicable standards.

The aggregate mixture must consist of four separate grain size groups, one of which must qualify as a sand group, all amounts being measured according to weight.

The following values constitute the maximum allowable deviations from a given specified gradation:

Grain Diameter	Deviation Allowed
0.06 mm	-/+ 1 %
0.25 mm	-/+ 1 %
1 mm	-/+ 2 %
4 mm	-/+ 3 %

Table 1: Allowed deviation of grain diameter

The concrete aggregates may not be dirtied by other materials during transportation or storage on site. Grain sizes and other aggregates which are delivered separately are to be stored separately on site, so that no mixture occurs at any point.

#### 4.2.4 Concrete Additives

Concrete additives, added to the concrete shall comply with ČSN EN 934-1, ČSN EN 934-2.

Concrete additives, added to the concrete, must not affect the concrete's hardening, strength and durability or cause corrosion of the reinforcement.

Chlorides or materials containing chlorides which promote steel corrosion may not be added to reinforced concrete or concrete which comes into contact with reinforced concrete. The prerequisite for using additives is a qualification test to be performed by the Contractor.

The test results must be submitted to the Client.

### 4.3 Reinforcing Steel

For concrete reinforcement reinforcing bars grade B 500 B according to ČSN EN 1992-1-1 and for mats grade B 500 A shall be used.

The Contractor shall furnish the Client with copies of the manufacturer's certificates of tests for the steel reinforcement to be supplied. The Client may, however, order independent tests to be made, and any steel which does not comply in all respects with the specification will be rejected.

### 4.4 Water Stops

Water stops for sealing construction and expansion joints shall be manufactured from non-reclaimed, durable, weld able plasticized PVC of a hydrocarbon resistant material quality, using softening agents with a polymer molecular structure.

The centre-part of the tape must be apt to take up tension pressure and shearing strains. So as to guarantee a good connection to the concrete, the side parts must be equipped with reinforced ribs and marginal bulbs. In case of welding the joint-tapes must be welded at the joints with temperature of 160°C. The strain at failure of the joint tape must be 400%, the min. thickness and width of the joint-tape must be 4.5 mm and 300 mm respectively.

The separation layer inserted into expansion joints shall be a bitumen coated soft fiber insulation board or styropor slab with a thickness of 10 mm.

The sealing of expansion joints must be carried out with sealing compounds on basis of silicon-rubber. After the setting the sealing compound must be permanently elastic. The maximum extensibility for permanent extension must be app. 35%. Further demands are the strain at failure of 600%.

- Temperature resistance from -20°C to +120°C
- Water resistance immediately after placing
- Shrinkage below 1%
- Range of placing temperature 0 to +50°C
- Service life 50 years

The sealing compound must be resistant and apt to be placed both in vertical joints and above head without the danger of running out.

Minimum requirements for ultimate tensile strength, elongation at break, etc. shall be in accordance with the applicable standards.

Fittings for expansion joint water stops joints shall be factory-made.

The required field connections shall be welded by experienced personnel as per the manufacturer's or the Client's instructions. When installing the water stops special care shall be taken in order to avoid shifting during concreting (the fix clips recommended by the manufacturer are to be used).

The Contractor shall furnish the Client with copies of the manufacturer's test certificates for the water stops to be supplied.

#### **4.5 Type of Concrete and Concrete Cover**

Concrete grades in relation to exposure to environment shall follow the requirements given in EN 1992-1-1 and ČSN EN 206. The minimum requirements for concrete structure grades are defined in reference document C4G-JI73-ILF-KS007-GEN-MAN-800 CS Jirkov 73 Bar - General technical Requirements. The stricter value from referenced document and referenced standards shall be applied.

The required type of concrete will be defined on the relevant formwork drawings as well as in the static calculation.

## **5 WORKMANSHIP**

### **5.1 Concrete Production, Mixing**

Concrete production shall comply with ČSN EN 206, ČSN EN 13670 and standards referenced therein. The use of ready mixed concrete shall be the preferred solution for the concrete supply of the construction site.

To install concrete mixing plants on site is only acceptable if ready mixed concrete is not available in a reasonable distance from the construction site. For the installation of a site mixing plant the approval of the Client is required.

### **5.2 Ready-Mixed Concrete**

All ready-mixed concrete shall meet the requirement of the Specifications.

The Contractor shall submit name and address of the ready-mix Contractor with the full details of operation and plant to the Client for approval. The details of the ready-mix Contractor shall include information of plant, equipment, storage depots, transportation and quality systems. The Client shall have access to the ready-mix site for inspection at any time. The Client may reject the proposed ready-mix Contractor and at any time cancel an approval, if the quality of the concrete or the documentation of the quality control in the opinion of the Client is not satisfactory.

Concrete shall comply in all respects with the applicable standards except where amended herein.

All testing of the mixed concrete shall be executed on the Site.

The Contractor shall ensure that the Supplier keep records of all the required tests and the quality control for mixing and transportation.

The concrete shall be delivered to the site in truck mixers or agitators operating continuously and must be accompanied by a delivery note with the following information:

- Name of Supplier
- Type and grade of concrete
- Mix code number
- Time and date of mixing
- Temperature of mixing
- Additives
- Cement type
- Cement content

- Water cement ratio or quantity of added water
- Time of arrival of truck on the Site
- Time of end of discharge
- Registration number of truck
- Delivery certificate number

One copy of the delivery note shall be submitted to the Client immediately after the truck has arrived on the site.

Truck mixing and addition of water and admixtures to the concrete after the concrete has been discharged from the mixing plant shall not be accepted.

### 5.3 Site Mixing Plant

For the production of all types of concrete the individual concrete components are to be measured according to their weight share, using automatic dosing equipment.

The composition of each type of concrete to be mixed is to be posted at the mixing plant in a clearly legible form and must include the points given in the applicable standards.

The concrete components (cement, aggregates, water and additives) must be measured with an accuracy of 3 %. The weight batching machines shall be carefully maintained and cleaned and provided with simple and convenient means of checking the weighing mechanisms and they shall be checked when required by the Client.

The materials must be mixed in concrete mixers which are suitable for the pertinent concrete composition.

The concrete mixer must be fitted out with an electrical current indicator in order to facilitate regulation of the concrete's consistency.

The concrete mixing plant is to be laid out for a separated and automatic batching of 3 different additives.

To permit monitoring of the levels of additives added to the concrete mixture, a transparent gauge glass must be foreseen.

During hot weather the temperature of the fresh concrete is to be kept as low as possible, e.g. by

- protecting the aggregates from solar radiation and by sprinkling with water (sand is excepted here)
- cooling of the water used for mixing
- coating of sunlight-reflecting material on the outside of the mixing compound housing

Mixing plants for sites in cold weather areas experiencing frost periods are to be equipped with heating systems for the mixing water and the aggregates.

Test mixes must be made for every type of concrete. The results must be submitted to the Client.

The mixers shall be approved by the Client and a trial mix shall be prepared under full-scale conditions with workability tests and test cubes.

If the specific water content of the aggregates varies, the amount of wet material used plus the necessary amount of mixing water must always be chosen so that the total amount of water remains constant.

A site laboratory has to be set up and operated with equipment meeting the requirements of the applicable standards. An expert in concrete technology and concrete production (concrete Client) shall be in charge of this laboratory.

#### **5.4 Concrete Transportation**

During transportation the concrete is to be protected from the damaging effects of weather.

The concrete must not separate during transportation on the construction site. The concrete shall be of the required workability at the place and time of placing.

#### **5.5 Working with Concrete**

The workability of the concrete shall remain satisfactory until placing and compaction is finished. This shall as a minimum mean for 3 hours at 25°C after arriving on site.

During hot weather periods the temperature of the fresh concrete must be kept as low as possible. It may in fact by no means exceed 30°C up to the point of spreading. During hardening, the concrete temperature may not exceed 50°C.

During cold weather and frost periods the concrete shall be placed at a specified minimum temperature because of the lower hardening rate and the danger of permanent impairment of defined concrete properties.

With ambient temperatures of +5°C to -3°C the concrete temperature upon placing must not fall below +5°C. With ambient temperatures below -3°C the concrete temperature must not fall below +10°C.

Before the concrete is placed, formwork and all surfaces to come into contact with the concrete shall be cleaned of dust, mud and other impurities.

Concrete shall not be placed in standing water unless so specified or approved.

During placing, suitable means shall be provided to prevent premature hardening of the concrete placed in contact with hot surfaces. All concrete areas, formwork and reinforcement shall be shielded the sun's direct rays and sprayed with water when necessary.

When placing concrete in layers, if no construction joint is foreseen, placing may only be interrupted for such a period of time during which the concrete does not set, so that a good and even connection is possible between the two layers of concrete.

Concrete shall be brought up in level layers of such depth that each layer is readily and properly mixed with the layer below with the use of internal vibrators.

The types and numbers of vibrators shall be approved by the Client and should vary depending upon the mass of concrete to be compacted, the density of reinforcement and the type of formwork.

Except where otherwise directed, concrete shall not be placed unless the Client or his Representative is present, and has previously examined and approved the positioning, fixing and condition of reinforcement and any other item to be embedded and the cleanliness, alignment and suitability of the containing surface of formwork.

## 5.6 Prefabricated Concrete

The manufacture of prefabricated concrete components shall be in accordance with the specifications and ČSN EN 13369.

The moulds of all prefabricated concrete works shall be to the accurate dimensions and shapes as shown on the drawings and shall be of sound construction. Moulds shall be thoroughly cleaned before each casting. Exposed faces shall be towelled smooth. All edges of the prefabricated unit shall be formed with a chamfer as shown on the drawings.

The standard of workmanship and the quality of materials used in the manufacture of all prefabricated components shall comply with the relevant clauses of this specification.

Detailed records of mixes, cubes, curing methods, dates of manufacture, etc., shall be kept and submitted to the Client within 7 days of manufacture.

All prefabricated members shall be marked with a unique reference.

The Contractor shall be fully responsible for supplying adequate lifting points and any additional reinforcement and equipment as necessary to ensure the safe handling, transport and erection of the prefabricated members.

Holes left in the prefabricated units to facilitate lifting shall be neatly pointed with an approved expanding grout as soon as the units are finally positioned.

Stacking of prefabricated units shall be properly carried out after curing in a separate area set aside for that purpose and so arranged that the units may be removed and used in order in which they were cast.

Where in-situ concrete is placed against prefabricated concrete the prefabricated elements shall be prevented from movement during the placing of the in-situ concrete.

Generally the external faces of prefabricated units which will be visible after their inclusion in the Works shall be finished with a fair face as described in the relevant section of this Specification.

Levelling devices shall be released or removed with the Client's approval.

At all stages of construction, the Contractor shall adequately protect installed prefabricated concrete units and other concrete associated therewith to prevent damage to permanently exposed concrete surfaces.

Damaged concrete elements shall not be dispatched to the Site and elements which sustain damage during transportation shall be removed from the Site and replaced at the Contractor's expense. The same provision shall apply to prefabricated elements damaged prior to or during construction of the works or thereafter. Only minor repairs as approved by the Client will be permitted to be carried out on prefabricated elements at the Site.

## **5.7 Mortar Bedding of Prefabricated Units**

Where shown on the drawings, prefabricated concrete units shall be bedded in cement mortar composed of one part cement to three parts sand.

Sand for mortar shall be naturally occurring sand or consist of crushed rock or gravel or a combination thereof. It shall be clean hard and free from impurities and shall comply with the applicable standards and shall be in accordance with the relevant clause of this specification.

The water content of mortar shall be just sufficient to ensure a dense mortar with adequate workability, when towelled or worked into place. Mortar that has begun to harden shall not be used in any part of the Works.

All materials shall be accurately gauged by gauge boxes and mechanically mixed and used within 30 minutes of first mixing. Re-tempering of mortar will not be permitted. Gauge boxes and mixers shall be kept clean.

Mortar joints shall be pointed with a neat flush joint as the work proceeds. Joints shall be protected from the harmful effects of the environment for a minimum of three days after completion.

Joints between or around prefabricated members which are cast in the Works shall be carefully sealed using an approved tape or other means to ensure there is no grout loss during concreting.

## 5.8 Joints

All joints, both construction and expansion joints, are to be made watertight by means of water stops.

The results of tests performed on waterproofing materials are to be submitted to the Client before installing the materials.

### 5.8.1 Construction Joints

The individual concreting sections are to be determined before concreting is commenced. The construction joints are to be constructed in such a way that they allow for all occurring stresses.

Provision must be made in the construction joints for a sufficiently firm and tight connection between the concrete layers.

Construction joints in structures of waterproof concrete are also to be watertight.

### 5.8.2 Expansion Joints

Longer structures or construction elements in which shrinkage, changes in temperature or settlement differences can cause constraint, cracks should be limited by use of the appropriate constructive measures, for example appropriate reinforcement, constraint-free bearing and expansion joints.

The expansion joints must run through the entire structure including the siding and the roof and, if at all possible, should be laid out so that especially rigid elements such as staircases and elevator shafts are located between two joints or between a joint and the end of the building.

Expansion joints in waterproof concrete structures are also to be watertight.

In reinforced concrete elements which must remain crack-free, for example containers for liquids, the tensile stresses in the concrete are to be reduced to a value under the allowable tensile strength of the concrete by choice of the appropriate adjustments in the design.

In this connection, compulsive force stresses, for example as a result of steady or sudden changes in temperature and shrinkage, are also to be taken into consideration.

### 5.8.3 Water Stops

The joint tape for water stops must be fixed to the formwork. At the side where the concreting is carried out at first, the tape must be connected with the reinforcement so as to keep it in the right position. Before the concreting or after the formwork removal of the partial concreting a suitable joint-strip at least as thick as the hollow section is being inserted either above or beneath the joint-tape. After the remaining half of the tape has also been fixed in its position the second section can be concreted.

Welding must be carried out less than 160°C. The two ends to be welded must be cut clean, even and rectangular, must form butt joints and must be welded with each other by means of a welding iron.

Only after cooling-off to hand-temperature the same must be checked by tearing and bending, objectionable spots are to be re-welded. Factory made fittings are to be used for mitrings and crossings.

Expansion joints and/or separation joints between buildings and structural part are constructed by insertion of a fiber board or styropor. The joints shall be sealed with permanently elastic sealing compound. The sealing work shall only be commenced after completion of the concrete works to avoid damage of the sealant.

## 5.9 Installation of Reinforcement

Before being used, the steel is to be cleaned of components such as dirt, grease and loose rust which could influence the bond. Special care is to be taken that the shapes, lengths and positions of the steel reinforcement are in accordance with the applicable standards.

The bond between the reinforcement and the concrete is to be guaranteed by means of a sufficiently thick, waterproof layer of concrete. The concrete cover shall be determined based on the requirements and definitions of EN 1992-1-1 and shall meet also the minimum requirements defined in chapter 4.5. Stricter requirement from EN 1992-1-1 and from chapter 4.5 shall be applied.

The contractor shall provide any necessary pads for ensuring that this cover is attained.

The correct cover shall be maintained by the use of specially manufactured high quality impermeable concrete or mortar spacers. The blocks shall be well compacted and water cured for a minimum of 7 days after casting and shall have a 30 minute absorption of less than 3.5 % by weight. Concrete spacers shall be comparable in strength, durability and appearance to the surrounding concrete.

The reinforcement shall be approved by the Client before starting the concreting works.

**5.10 Formwork**

The applicable standards are to be referred to for analysis of stability and for the type of construction to be used for formwork (shuttering) and supporting framework.

Formwork and formwork joints have to be completely tight so as to prevent leakage of grout. Formwork joints and formwork skin joints have to be spaced at regular distances. Wooden formwork may not be exposed to the sun and wind for excessive periods of time. If the surface of the formwork is not impregnated, it is to be wetted before concreting. The formwork must be thoroughly cleaned before use; before concreting, appropriate shutter oil, for instance SIKA Blankol-0 or equivalent, is to be applied in such a way that no concrete sticks to the formwork.

Visible concrete edges shall be chamfered with triangular cleats inserted into the formwork.

Use of formwork more than once must be approved by the Client.

Construction elements may only be stripped and support removed when the concrete is sufficiently hardened. The concrete is sufficiently hardened when the element is strong enough to support all loads to which it is subjected when it is stripped with the prescribed safety.

The surface of the concrete must be smooth, free of voids and pores.

Extensive discolorations, caused by rust of any kind, by inexpert pre-treatment of formwork, by inappropriate curing of concrete, by aggregates of various origins, as well as line-shaped discolouration (imprints of reinforcement material) are not permitted. Discolouration associated with the use of cements of various kind and origin or of different additives is not admissible either.

The concrete surfaces shuttered or not have to be so even that they (e.g. slab surface) meet the following requirements:

Tolerance Class	Range of Tolerance in mm with Reference Lengths of	
	2.5 m	4 m
E1	-/+ 16 mm	-/+ 20 mm
E2	-/+ 8 mm	-/+ 12 mm

Table 2: Formwork - tolerances

Particular care must be taken in the construction of formwork for facing walls to ensure that the shuttering is especially tight. Without exception, shuttering for facing walls must be of smooth-planed boards with parallel, tongue-and-groove jointing; the forms must have a minimum thickness of 20 mm and must be of uniform width. Joints are to be so tight as to be unrecognisable, and the finished wall surface is to be perfectly smooth and even. Any formwork support materials subject to rust or corrosion are to be removed upon striking of the formwork. Any reinforcement or support materials remaining in the concrete must be rust- and corrosion proof.

Plastering of defective concrete as a means of making good will not be permitted except with the express permission of the Client.

Details of all proposed wrought shuttering and shuttering to produce special finishes are to be submitted for approval by the Client. Samples of formwork shall be constructed and concrete placed so that the proposed methods and finish effect can be demonstrated.

Generally, the formwork system, including spaces of skin joints and supports must be calculated and submitted to the Client for approval.

## 5.11 Curing

Until the concrete is sufficiently hardened, it is to be protected from detrimental influences - for example excessive warming, drying out due to the sun or wind, running water, chemical aggression, frost, as well as from shaking - which could loosen the concrete texture and damage the bond between the reinforcement and the concrete. This is also true for grouting mortar and concrete used in the joints between prefabricated elements.

The methods of preventing the concrete from prematurely drying are to be submitted to the Client for approval before use. The concrete must be cured during the first three weeks.

When water curing is applied, occurrence of chill (snap) shocks is to be avoided (as could occur when cool water comes into contact with warm concrete surfaces) due to danger of peeling, or scaling. The quality of water used for curing shall be the same as used for mixing concrete.

Unformed concrete areas, especially flat exposed surfaces (slabs) must be protected against drying out immediately after placing of concrete.

Compounds incorporating reflective, white or light coloured pigments shall be used. Liquid membranes must not affect the normal setting reaction of cement.

Concrete shall be efficiently protected against heat loss, freezing and desiccation until it has sufficiently hardened.

## **6 QUALITY ASSURANCE AND QUALITY CONTROL**

### **6.1 General**

The Contractor shall establish, document and maintain an appropriate Quality Assurance system for his works. The system shall be clearly documented and submitted to the Engineer for approval within eight weeks from the Contractor's taking over the site.

During the performance of the work, the Contractor shall document that he adheres to the system and that it is adequate to ensure a consistent and acceptable quality throughout the works.

The Contractor shall hold regular quality assurance meetings at not more than one month's interval, with participation of all senior key staff. The meetings shall be used to monitor the quality assurance performance and identify any need for improvement of the system. The meetings shall be minuted with copy to the Engineer.

The Contractor's quality assurance shall comprise but be limited to the following which is to be read in conjunction with all other contract documents.

### **6.2 Quality Assurance System and Organization**

The Contractor shall in the Quality Assurance system define and document his policy and objectives for quality.

The system shall show an organisation diagram and job descriptions which shall clearly define responsibility, authority and inter-relation of all key staff.

All Quality Assurance functions shall be kept separate from the quality control function. The Contractor shall appoint one senior person as Quality Assurance Manager for this particular job. This person shall be authorized to liaise with the Engineer in any Quality Assurance matter. The Quality Assurance Manager shall have direct access to the Contractor's top management and such access shall not be interfered with by the Contractor's project management.

The system shall include adequate plans for document handling, ensuring that all necessary documents on site are properly identified, planned, distributed and filed, keeping track of any revisions. The purpose is to ensure that necessary documents are available in time, reach the people concerned, are kept up-to-date, are easily retrievable, and that no obsolete documents are used on site.

### **6.3 Quality Plans**

The Contractor shall prepare a Quality Plan and submit it for approval by the Engineer not less than two weeks before commencement of the related activities. It may be subdi-

vided into several plans, each covering work on one or more of the structures to be built. No work must commence until the Quality Plan for the work has been approved.

The Quality Plan shall include:

- The scope of work which they cover
- Method planning with identification of all works sequences, procedures and identification of all equipment needed for the work, including stand-by spares. The method planning shall be consistent with the approved method statements submitted with the tender.
- Identification of staff responsibilities
- Control Plan as specified in next paragraph

#### **6.4 Control Plans**

For each Quality Plan, the Contractor shall prepare a Control Plan clearly identifying each and all Contractor's supervision, inspection, sampling and testing to be performed. The Control Plan shall be specific and terms like "as per the relevant specification" will not be accepted. The main contents in the Control Plan shall be:

- Definition of control sections
- Listing of Contractor's supervision duties and all required quality control documentation
- Hold-points for inspection by Contractor's supervision
- Type and number of all tests in each control section
- Sampling and testing method identified by code and number
- Responsibilities for inspection, sampling, testing
- Responsibility for assessing the test results and taking initiative to corrective action wherever required
- Reporting procedures, including the agreed format of all required documentation

The Control Plan shall clearly define the control sections. Each control section shall coincide with one or more casting sections.

If the Contractor's Quality Control in any one control section reveals non-conformity with the specified requirements, all the works in that control section are not approved. The Contractor shall immediately inform the Engineer about the non-conformity results and he shall propose appropriate corrective action which may be re-test, re-work, or remove the non-conforming section.

The Engineer shall decide if re-testing or re-working is acceptable. Otherwise, the Contractor shall remove the non-conforming section at his own cost.

## **6.5 Independent Testing Contractor and Laboratory Facilities**

Testing of fresh concrete shall comply with ČSN EN 12350, testing of hardened concrete shall comply with ČSN EN 12390.

Unless specifically stated in the Contract Documents or agreed later in writing, all frequent testing shall be done in a properly equipped site laboratory.

The Contractor shall engage an approved independent testing laboratory to perform all tests which are not done on site. Such testing shall always be done in the presence of the Engineer.

All test results shall be submitted in duplicate to the Engineer at the same time as they are submitted to the Contractor.

The Contractor shall submit his request for approval of the independent testing contractor and the laboratory facilities with a complete description of capabilities, experience, equipment, staff and organisation. The Client reserves the right not to approve or to withdraw approval of the testing contractor and/or the facilities if they in the opinion of the Client do not perform at an acceptable level.

## **6.6 Planning and Quality Control**

The Contractor shall be responsible for the comprehensive quality assurance and quality control in accordance with this chapter. The responsibility shall include but not be limited to the submission of the individual method statements and the specific quality control actions mentioned in the chapters of this Specification.

## **6.7 Engineer's Approval or Acceptance**

Acceptance or approval by the Engineer shall not in any way relieve the Contractor of any part of his full responsibility for all design, methods, materials, workmanship, etc.

## **6.8 Quality Control of Materials**

During the entire period of construction the Contractor has to verify the material properties and qualities as defined by the specifications and standards.

In addition to the tests and investigations contained in the standards and specifications all other tests deemed necessary by the Client are to be performed.

Records are to be kept of all test results and submitted to the Client. The Contractor shall grant the Client full access to and use of the laboratory and shall produce on demand the records of all tests carried out.

6.8.1 Reinforcing Steel

Every 4 months the tensile strength  $\beta_Z$ , the tensile yield strength  $\beta_S$  or  $\beta_{0-2}$ , as well as the elongation at break are to be checked.

The mark indicating the type of reinforcing steel, the manufacturer's mark and the note of delivery, however, shall be checked on each delivery.

6.8.2 Water Stops

Every 4 months the tensile strength and the elongation at break are to be checked and the plastic material shall be chemically analysed with regard to its molecular structure.

The mark indicating the type of water stops, the manufacturer's mark and the note of delivery shall be checked on each delivery.

6.8.3 Concrete

6.8.3.1 Tests of concrete components

Test	Frequency
<b>Cement:</b>	
• Compressive strength	Once every 4 months
• Specific surface	Ditto
• Chemical analysis	Ditto
• Certificates issued by the supplier	Every vessel
<b>Aggregates:</b>	
• Grading analysis	At each delivery and each day of concreting
• Wet analysis	At each delivery and each day of concreting

Test	Frequency
<ul style="list-style-type: none"> <li>Moisture content, for sand</li> </ul>	At each delivery and each day of concreting
<ul style="list-style-type: none"> <li>Organic impurity</li> </ul>	At each delivery and each day of concreting
<ul style="list-style-type: none"> <li>Chloride, sulphate test</li> </ul>	Once every 4 months and in case of suspected change
<ul style="list-style-type: none"> <li>Visual inspection of aggregate type, granulometric composition, aggregate condition, particle shape, detrimental components (e.g. coal, humic substances, brittle grains, etc.)</li> </ul>	At each delivery
<b>Water:</b>	
<ul style="list-style-type: none"> <li>Test for components inhibiting the setting and hardening processes and components developing steel corrosion</li> </ul>	In case of suspected changes or different origin
<b>Additives:</b>	
<ul style="list-style-type: none"> <li>Certificates issued by suppliers</li> </ul>	every vessel

Table 3: Tests of concrete components

### 6.8.3.2 Tests of fresh-mixed concrete

Test	Frequency
<ul style="list-style-type: none"> <li>Consistency</li> </ul>	Daily for every type of concrete before starting placing of concrete (visual inspection of every vessel)
<ul style="list-style-type: none"> <li>Water / cement ratio</li> </ul>	Daily for every type of concrete before starting placing of concrete (visual inspection of every

Test	Frequency
	vessel)
• Unit weight	Daily for every type of concrete before starting placing of concrete (visual inspection of every vessel)
• Air void content	3 times per day
• Grading analysis	Once a week and concrete type

Table 4: Tests of fresh-mixed concrete

6.8.3.3 Tests of hardened concrete (using test samples prepared in moulds)

Test	Frequency
• Compressive strength	Once per 50 m3 or once per construction element
• Water permeability	Once per 50 m3 or once per construction element
• Chloride penetration	Once per 50 m3 or once per construction element
• Cement content	Once per 50 m3 or once per construction element
• Water / cement ratio	Once per 50 m3 or once per construction element

Table 5: Tests of hardened concrete