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ROYAL GOVERNMENT OF BHUTAN

MINISTRY OF WORKS AND HUMAN SETTLEMENT

DEPARTMENT OF ENGINEERING SERVICES

“Construction Industry: Solutions through innovation and improved technology”

FRAMEWORK FOR QUALITY CONTROL AND QUALITY ASSURANCE

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1. INTRODUCTION

It is a global fact that any construction is rated by the quality of the infrastructure built. In construction Industry, quality is a measure of excellence in how well a product or service meets the client and end-user's requirements and needs. A quality infrastructure is free from defects and significant shortcomings. It is the result of a process that adheres to the local applicable code, measurable and verifiable standards, and achieves its performance goals and requirements. Ensuring quality in a project is a standard goal for construction professionals for many reasons, one of which is that helps manage the risks against unwanted results like defects and untimely failure of the structure. Having a Quality Control (QC) and Quality Assurance (QA) in place would not only help achieve the required quality of the construction, it would also help avoid so many unwanted and undesired consequences, including financial losses.

The Quality Control (QC) and Quality Assurance (QA) are valuable practices to help ensure quality of the works. It is also required to detail the testing methods and quality assurance procedures for the works. It pays to determine what exactly quality is.

2. OBJECTIVES

The specific objectives of the QC and QA framework are:

- a. To define the QC and QA set up and responsibilities.
- b. To detail the role of the QC and QA set up.
- c. To define the interaction between the QC program of the Procuring agency and Contractor's Quality Assurance (QA) plan.

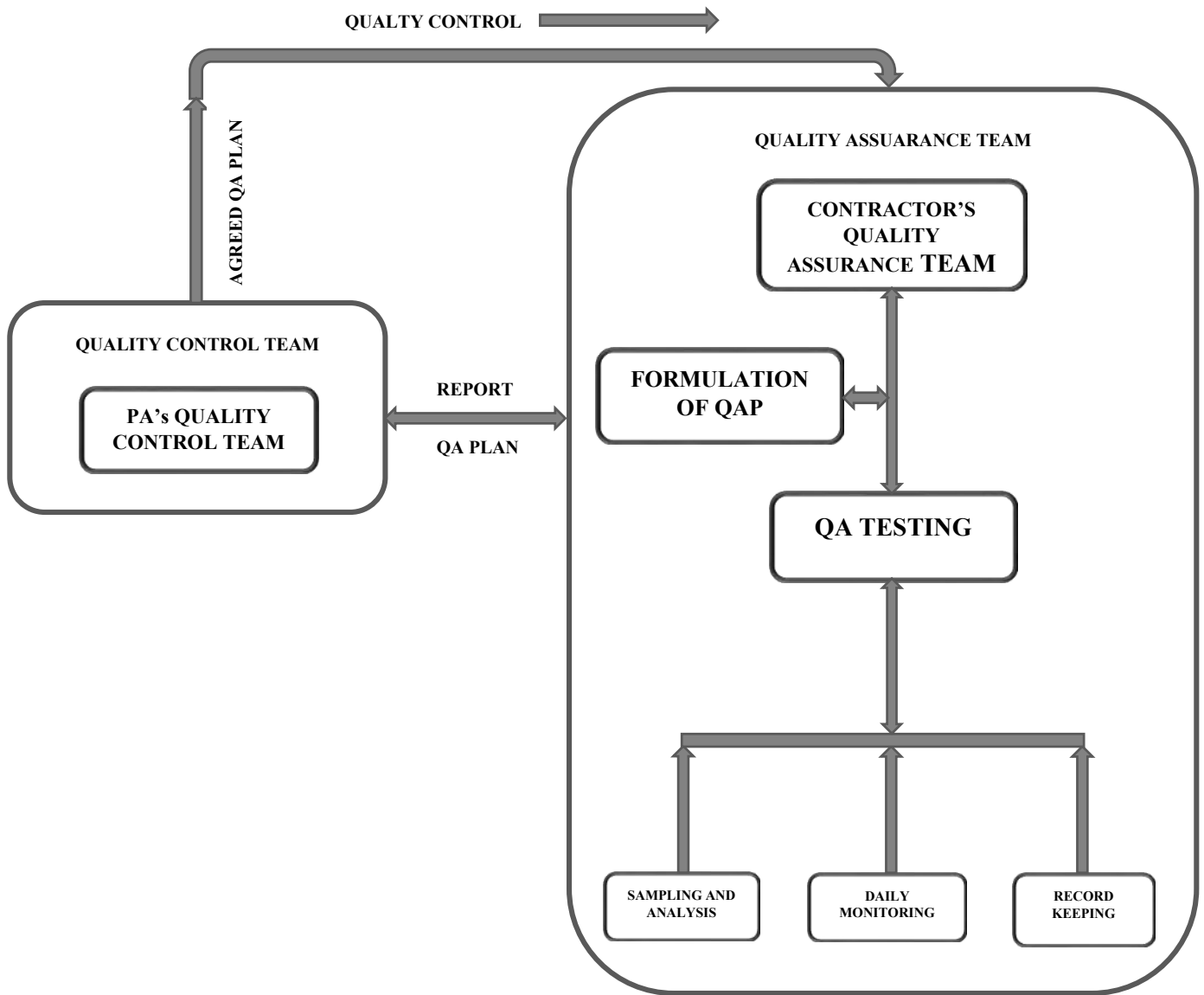
3. QUALITY CONTROL AND QUALITY ASSURANCE ORGANIZATION

The Project Engineer of the procuring Agency (PA) shall be designated as the leader of the QC Team and the Project Engineer of the Contractor shall be designated as the leader of the QA Team.

The QC and QA Team shall be comprised of engineers, surveyors and technicians qualified and experienced in similar work.

Laboratory analysis and testing shall be accomplished in certified/recognized testing laboratories.

Figure below shows a typical organization of QC & QA



4. QUALITY CONTROL TEAM RESPONSIBILITIES

In general, the QC Team of the Procuring Agency shall be responsible during construction activities for:

- a. Reviewing and approving the QAP submittals of the QA team.
- b. Promoting and ensuring construction QAP
- c. Reviewing and approving submittals for material approval/certifications and various construction plans;
- d. Perform factory visit if specified in the contract. All contracts may not require factory visit. Depending on the type of work, the requirement of factory visit shall be specified in the tender document.
- e. Verify conduct of field testes, sampling and material analysis.
- f. Conducting random verification field tests, sampling, and material Analysis;

5. QUALITY ASSUARANCE TEAM RESPONSIBILITIES

The QA Team of the Contractor is responsible during construction activities for:

- 5.1.** Formulation of QAP
- 5.2.** Testing, Sampling, and Analysis
- 5.3.** Review of QAP
- 5.4.** Reporting
- 5.5.** Submissions
- 5.6.** Record Keeping

5.1. Formulation of QAP

The QA Team shall submit for approval a program of work within the specified time from the date of letter of Acceptance including QAP.

The QAP shall specify the followings.

- a. Work Methodology (Where applicable).
- b. Work Plan.
- c. Quality Control test and intervals in accordance with the specifications for each item of the work.
- d. Scheduling of factory visit if specified in the contract.

The QA team shall submit all the submittals based on technical specifications within specified days for review and agreement.

If in the opinion of the QC Team, the QAP submitted by the QA team does not fully represent the spirit of the General Conditions of Contract or Specifications, QC Team may seek further clarification from the QA Team before the approval.

The QA Team shall strictly follow the QAP in the execution of the work. If the QA Team does not comply with the QAP, the Contractor shall not be allowed to proceed further with the Works.

5.2. Testing, Sampling, and Analysis

The QA Team will be required to conduct QC testing/schedule of tests, sampling, and Analysis in accordance with the approved QAP.

QA team shall also ensure that the construction activities like, QA verification testing, sampling, and Analysis are conducted by the QA Team to maintain construction integrity and fulfill the intent of the design.

Random Testing, sampling, and Analysis will also be carried out by QC Team in accordance with the provisions of this Plan.

The anticipated parameters of the construction but not limited to which will need verification, testing, sampling, and Analysis are annexed at the end of the framework for guidance.

5.3.Review of QAP

QAP review meetings shall be proposed and conducted by the QA Team with QC Team whenever required to review the progress of the Quality Assurance programs.

5.4.Reporting

The QA Team will prepare and submit to Project Engineer of the PA a periodic Progress Report. These reports will present summaries of the important information relating to the construction activities gathered during that period from the various records that are mandated to be recorded during the construction.

The Periodic Progress Report will include any proposed or field approved modifications and justifications to the QAP.

The Periodic Progress Report will include QA Team's collected information as well as a summary of the laboratory analytical results.

5.5.Submissions

All imported/manufactured material must be approved by QC Team prior to installations. The QA Team must submit samples of all the imported/manufactured materials that are to be used for construction for approval along with the manufacturer's data and test certificates.

QC Team shall conduct the following procedures for verification of imported material suitability:

- a. Obtain the sample/material submittal.
- b. Review material testing results/certificates.
- c. Collect and analyze samples and perform visual inspections for compliance with contract documents using the criteria and frequency described in specifications.
- d. Contact the manufacturers and make confirmations if required.

5.6. Record Keeping:

The QA Team is responsible for maintaining a complete and accurate record of all significant observations and inspections of all field or laboratory testing.

These records will be kept on-site for review. The record keeping activities of the QA Team shall include the following:

- 5.6.1. Project logs
- 5.6.2. Photographs
- 5.6.3. QA Testing Documents
- 5.6.4. Other Documents.

5.6.1. Project Logs:

The QA Team shall keep project logs which will be reviewed by the QC Team periodically. Log entries will document significant activities, abnormal observations, and topics/results of any significant meetings or discussions in the form of Hindrance Register, Site Order Books etc.

The attendance of the committed key personnels at site will also be maintained by the QA Team as per work plan and the requirement of Key Personnels at site.

5.6.2. Photographs:

Construction photographs, videos and associated logs will be recorded on a basis by the QC Team as well as the QA Team to visually document significant construction activities and to provide visual reference material.

5.6.3. QA Testing Documents:

The QA Team shall maintain a file to compile the testing documents sampling forms, sample logs, documentation forms, sample analysis requests, and any other documents related to QA testing. These documents shall be kept on-site for record and review.

5.6.4. Other Documentation:

The QA Team shall also maintain a file to record other documentation required, but not limited to, includes:

- a. Shop drawings,
- b. Inspection records,
- c. Relevant construction files,
- d. Manufacturers recommended installation or operating instructions.

These documents shall be kept on-site for record and review.

6. QAP VALIDATION REPORT

At the completion of the work, the QC Team shall submit a signed final certification report to the management of Procuring agency. This report will document that:

- a. Work has been performed in compliance with the construction documents;
- b. Physical sampling and testing has been conducted at the appropriate frequencies specified in the QAP Plan; and
- c. The required QAP documentation has been completed.

As a minimum, this report will include:

- a. Imported/manufacturers quality control documentation;
- b. A summary describing the QAP activities and indicating compliance with the drawings and Technical Specifications;
- c. A summary of QAP testing, including failures, retest results, non-conformances and corrective measures;
- d. Records of sample and resample locations, the name of the individual conducting the tests and the results of the tests;
- e. Progress photographs;
- f. Any other relevant information; and
- g. As built drawings.

The validation report must contain a statement by the Team leader of the QC Team that the works have been carried out in accordance with the QAP Plan (and specifications attached to it) and that the validation report (including the drawings and appendices) represent a fair and accurate record of the works.

7. CONDITIONS

1. The procuring agency must list down the anticipated activities of the construction which will need verification testing, sampling and analysis which will form a part of the tender.
2. As per GCC 23.2 the QA team shall give notice to the Project Engineer for any examination, inspection, measurement and testing of the work, whenever any work is ready as specified in SCC.
3. As per GCC. 27.1 the QA team shall submit the complete QAP to the Project Engineer of the QC team for review and approval within the time stated in the SCC, after the date of the Letter of Acceptance, before the signing of the contract.
4. Non submission of QAP within the specified time shall lead to rejection of bid. The bid will then be treated as non-responsive bid and the contract will be signed with the second lowest evaluated bidder upon completing all the parameters.
5. In case of updates in QAP programs after signing of the contract, the QA team shall submit updated program to the Project Engineer of the QC Team for approval within the time stated in the SCC as per GCC 27.2.
6. The amount to be withheld for late submission of an updated QAP shall be specified in SCC as per GCC 27.1
7. Delay in work due to late submission of QAP will not be treated as compensation event allowing for time extension.
8. The concerned site engineer shall 'verify and rate' the APS, Supervising Engineer shall carry out the 'test check' which shall be 'approved' by the Head of the agency."

8. SPECIAL PROVISIONS

The procuring agency shall lay down all the special provisions that are required for the construction.

9. VERIFICATION OF TECHNICAL PARAMETERS

The following describe the anticipated parameters of the construction but not limited to which will need verification testing, sampling, and Analysis.

9.1.Civil Works.

BUILDING WORKS				
Sl No	Project Activity	Type of Test	Frequency of Test	Timing of Test/ Inspection
1	Excavation/Backfilling	Layout, slopes of excavation, benching and over-burden	As directed by the Engineer	After excavation
		Sub-soil water, shoring and strutting		
		Bottom levels and compaction		
		Soil classification		
		Backfilling and compaction		After backfilling
2	Concreting	Cement	One for each source and when called for by the Engineer. Sampling should comply with IS 3535	On receipt of material at site and before using as directed by the Engineer. Test certificate to be produced to the Engineer before use.
		Sand	One test for 20 m3	
		Coarse Aggregates	One for each source of supply and when called for by the Engineer	
		Water	Once per source of supply and when called for by the Engineer	Before use of water from that source
		Compressive strength as per IS-516	One test for 1-5 m3 of concrete Two tests for 6-15 m3 of concrete Three tests for 16- 30 m3 of concrete Four tests for 31-50 m3 + one set every 50 m3 of additional concrete work.	Test samples to be taken while pouring. Testing to be done as specified in contract
		Slump test per IS-1199	Random checks throughout concreting as directed by the Engineer	Before pouring concrete
		Inspection of steel reinforcement placement and bending, and formwork	Before pouring concrete	Before pouring concrete
		Concrete Pour Report	When pouring is done	Immediately after pouring
3	Masonry Work	Stone	One test per source and when called for	On receipt at site
		Bricks	One test per Truck Load bricks or part thereof	
4	Wood Work	Timber	As directed by the Engineer	Before using as directed by the Engineer.
5	Steel Work	TMT Bar	Manufacturer Certified	On receipt at site. Test certificate to be produced to the Engineer before use.
		Roofing Sheet		
		Other steel		
6	Plumbing Works	Pipes and fittings	Manufacturer Certified	On receipt at site. Test certificate to be produced to the Engineer before use.
		Pressure Testing	One Test for defined work and when called for by the Engineer	On completion of stage.



9.2. Electrical Works:

Procedure for Testing and Inspections of Electrical works.				
Sl. No	Project Activity	Type of Test/Inspection	Frequency of Test/Inspection	Timing of Test/Inspection
1	Conduiting	Review manufacturer's test result and certificates	As and when required	When the materials are bought at site.
2	Wiring	Review manufacturer's test result and certificates	As and when required	When the materials are bought at site.
3	Fixing of Fittings, accessories & appliances	Review manufacturer's test result and certificates.	As and when required	When the materials are bought at site.
4	Laying of Cables	Review manufacturer's test result and certificates.	As and when required	When the materials are bought at site.
5	Fixing of Control Gears	Review manufacturer's test result and certificates.	As and when required	When the materials are bought at site.
6	Providing Compound/Street lighting works	Review manufacturer's test result and certificates.	As and when required	When the materials are bought at site.
7	Earthing	Measure the resistance of earth	When the earthing work is complete	When the earthing work is complete
8	Testing of Installation	Insulation Resistance Test	As and when required	After the installation
		Polarity test of the switch	As and when required	After the installation
		Earth Continuity Test	As and when required	After the installation
		Measurement Earth Electrode Resistance	As and when required	After the installation


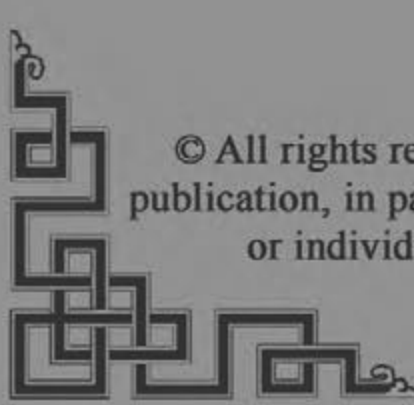
9.3.Road Works

Sl. No	Project Activity	Type of Test	Frequency of Test	Timing of Test/ Inspection
1	General Materials	Cement	One for each source and when called for by the Engineer. Sampling should comply with IS 3535	On receipt of material at site and before using as directed by the Engineer. Test certificate to be produced to the Engineer before use.
		Sand	One test for 20 m3	
		Coarse Aggregates	One for each source of supply and when called for by the Engineer	
		Water	Once per source of supply and when called for by the Engineer	Before use of water from that source
		Stone	One test per source and when called for	On receipt at site
		Bricks	One test per Truck Load bricks or part thereof	
		TMT Bar	Manufacturer Certified	
2	Excavation	Layout, slopes of excavation, benching and over-burden	As directed by the Engineer	After excavation
		Sub-soil water, shoring and strutting		
		Bottom levels and compaction		
		Soil classification		
3	Embankment Formation	Moisture content as per IS-2720	5-10 density tests for each 500 m2 compacted area	In-process
		Field density test as per IS-2720		
		Rolling operation		
4	Granular Sub-Base Laying	Moisture content as per IS-2720	One test for 500m2 of compacted soil (3 observations per test)	In-process
		Field density test as per IS-2720	10 observations selected randomly for every 500m2 of compacted area	
		Rolling operation	Required No. of passes	
5	WBM Laying	Field Density Test by sand replacement method	As directed by the Engineer	In-process
6	Prime Coat/Tack Coat Application	Temperature Test	At regular close intervals	In-process
		Rate of spreading	Three tests for every 50 m length	
7	Surface Dressing/Mix Seal Surfacing/ Pre-mix Carpet	Rate of spread of mix material	One test for every 500 m3 of mix with 6 observations	In-process
8	Bituminous Macadam Laying	Temperature Test	At regular close intervals	In-process
		Rate of spread of mix material	2-3 observations at every 10 m interval during paving	
9	DBM/BC Laying	Temperature Test	At regular close intervals	In-process
		Rate of spread of mix material		
		Stability of Mix/Marshall Stability Test	3 samples for each 400 tons of mix produced subject to a minimum of 2 tests per plant per day	While hot mixing
10	On Completion of BM / DBM / BC Layers Stage Completion Test	Core test for compacted layer (bitumen content, density and voids)	One test for 250 m2 of compacted area	On completion of stage and before proceeding to next stage
		Surface regularity and control of alignment	One test for every 300 m of road length	
11	Rigid Pavement & General Concrete works	Compressive strength as per IS-516	One test for 1-5 m3 of concrete	Test samples to be taken while pouring. Testing to be done as specified in contract
			Two tests for 6-15 m3 of concrete	
			Three tests for 16- 30 m3 of concrete	
			Four tests for 31-50 m3 + one set every 50 m3 of additional concrete work.	
			Random checks throughout concreting as directed by the Engineer	
		Slump test per IS-1199		Before pouring concrete

Note: The procuring agency must list down the anticipated activities of the construction which will need verifications testing, sampling and analysis. The anticipated testings that are required to carry out in order to verify the quality of the construction must also be listed against each anticipated activities.



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