

1 INTRODUCTION

This section of the Quality Assurance/Quality Control Manual presents the Project's background, defines quality-related terms, and gives an outline of the Manual.

1.1 Background

The Government of Rajasthan has undertaken the implementation of the Rajasthan Urban Infrastructure Development Project (RUIDP, the Project) during the period from 1999 to 2004 with assistance from the Asian Development Bank. The project is being implemented in the towns of Jaipur, Jodhpur, Ajmer, Kota, Udaipur and Bikaner.

Infrastructure facilities to be provided include water treatment plants, supply mains and distribution systems, sewage treatment plants and sewer systems, roads and bridges, storm water drainage, truck and bus terminals, solid waste management systems, community buildings, truck and bus terminals, and other schemes. The Project Management Unit and the Project Implementation Units have been setup. The Project Management Consultants and Design and Supervision Consultants have been appointed and have started functioning from months of June and July 2001 respectively.

The Project is unique in its nature and complexity, characterized by its spread across six locations, estimated over 150 construction or procurement contracts of different nature, and participation by multiple agencies. In view of this complexity, it is essential and important to put in place a comprehensive, consistent, and common system for quality assurance and control during implementation. This document has been prepared with this purpose in mind.

1.2 Quality Definitions

Quality is the totality of features and characteristics of a product or service that bear on its ability to satisfy a given need. The term 'given need', in case of project works, can be interpreted as the functional requirements. The quality of outputs is always agreed upon between the supplier and the client (in project works, contractor and the owner), and the quality objective must be to achieve zero defects. It can be made possible only by ensuring the quality at all stages of project works.

The following are some definitions pertaining to quality and how to achieve it:

- Quality: Conformance to requirements.
- Quality Control (QC): The operational techniques and activities (such as reviewing, checking, inspecting, testing, etc.) that are used to fulfill requirements for quality.
- Quality Assurance (QA): The planned and systematic actions necessary to provide adequate confidence that the work will satisfy quality requirements.
- Quality System (QS): A set of documented processes, which seek to provide confidence that the project outputs will fulfill the functional requirements. The Quality System should encompass the organization, responsibilities, human resources, materials, equipment, processes, inspections, testing and other parameters of the project. A key element of QS is the QA/QC Manual.
- Quality Surveillance: This normally covers two aspects:
 - At the project level, a review to ensure that the quality practices are implemented and documented in relation to the quality system; and
 - At the contract package level, inspection and testing to ensure that the works executed meet the required quality standards.

1.3 QA/QC Manual

This QA/QC Manual focuses on the implementation activities of the project following contract award, and primarily on supervision and quality control of construction works. Other aspects of project implementation are also covered but in less detail. The QA/QC Manual is intended to be used primarily by the project staff of the PIUs and the Design and Supervision Consultants.

The QA/QC Manual for the Project does not attempt to suggest technical specifications, since these are stated in the contract documents. Its aim is to ensure that the works are executed as per specifications, i.e. it is looked at as a means to achieve the end results. Quality control and test results shall be interpreted as applicable for different packages, in accordance with the contract conditions.

The subsequent sections of this Manual are as follows:

- Organization, Responsibilities and Authorities
- Design Control
- Construction Quality Control – General
- Control of Materials and Equipment Components
- Control of General Civil and Structural Works
- Control of Road and bridge Works
- Control of Pipeline Works
- Control of Electro-mechanical Works
- Document Control
- Reporting

2 ORGANIZATION, RESPONSIBILITIES AND AUTHORITIES

This section of the QA/QC Manual describes the organizational arrangements for project implementation and outlines the responsibilities of each organization.

2.1 Project Implementation Arrangements

- a) As agreed between the Government of Rajasthan and the Asian Development Bank, the Rajasthan Urban Infrastructure Development Project (RUIDP) will be executed through the Project Management Unit (PMU) of the RUIDP. The State has appointed a Project Director for the PMU, and the PMU has the overall responsibility for coordination and management of the Project activities, including Project design, implementation, budgeting and financial planning, benefit monitoring and evaluation, socioeconomic surveys, environmental assessment and protection, institutional and policy development, community participation and coordinating the work of all consulting services under the Project.
- b) Project Implementation Units (PIUs) have been established in each of the six cities to support the PMU in its works. They have the primary responsibility for planning and implementing all the Project components in time, within cost estimates, and to the quality standards specified in the contract documents within their respective areas.
- c) An Empowered Committee under the Chairmanship of the Honble Minister Local Self Government of Rajasthan (Minister LSG) has been established to enable making speedy decisions regarding all Project components. The Project Director is the Member Secretary of the Empowered Committee, which has been given full authority regarding all Project implementation aspects including awarding of contracts.
- d) A City Level Committee has been constituted in each city by the Empowered Committee to periodically review the project and assure coordinated work within the city. The committee is headed by the District Collector except in Jaipur where it is headed by the Secy. UDD.
- e) The Government has formed a Technical Committee for according technical sanction to the estimates. It is however proposed to delegate authority to the PMU for issuing technical sanctions up to a limit of Rs. 1.0 crores.
- f) For prequalification of contractors Evaluation Committees has been formed for evaluating the Prequalification documents submitted by contractors and to assist the EC finalize the prequalified contractor list. Similarly in order to facilitate approval of other tenders, the Empowered Committee has formed Tender Evaluation Committees (TEC) and Tender Approval Committees separately for Local level Civil Works < Rs. 1.0 crores and works of LCB. These committees will evaluate and approve tenders up to their delegated powers.
- g) All the activities proposed under the Project are in jurisdiction of an existing department of the State (PHED, PWD, JDA, UITS Municipal Corp., etc.). These departments are termed as line department for the work. They have assisted in shaping the Project and will have an important role of providing the details of existing status, related studies and reports available and in finalizing the works to be taken up. They will also be associated in detailed work planning and will ultimately take over the assets after the works have been completed.
- h) The PMU has recruited an International Consulting Agency M/s Louis Berger International, Inc. as Project Management Consultant (PMC). They are based in Jaipur. They are responsible for assisting the PMU in implementing, managing and monitoring Project activities, recommend ways to accelerate Project implementation.

- i) The PMU has also recruited three Design and Supervision Consultants (DSC) as below:
- j) M/s Shah Consultants for Jaipur
- k) M/s Consulting Engineering Services for Kota, Ajmer and Udaipur
- l) M/s TCE Consulting Engineers for Jodhpur and Bikaner.
- m) The DSC are responsible for all Project activities in the respective cities along with the PIU. This includes identification of the work packages, design, tender document preparation, evaluation and implementation. They are also responsible for quality assurance.
- n) It is also proposed to engage a separate NGO for carrying out the Community Awareness and Participation Program. A City Liaison Officer (CLO) responsible for maintaining liaison in the city and the Project will be deputed in the PIU of each City.
- o) There is an overlap in the responsibilities as generally elaborated above. The details of the individual responsibilities of each wing related to various activities are laid down as below to avoid any misunderstanding. The list of responsibilities as enumerated below may all not appear to be of direct bearing on the quality, do contribute to clarity of responsibility and hence help organize the works better. This is only to facilitate smooth functioning and is not meant in anyway to dilute the responsibilities and authority various wings have in their respective jurisdiction.

Table 2.1: Responsibilities of Key Agencies

S. No.	TASK	RESPONSIBILITY	Unit
1.0	APPROVAL OF WORKS		
1.1	Administrative and Financial Approval of the Project	Submission Approval	PIU/ PMC/PMU EC
1.2	Identification of detailed work packages with preliminary estimates at city level for administrative approval	Compilation Feasibility and estimation	DSC/PIU DSC/PIU
1.3	Approval of Work Packages	Review Approval	PMC PMU/EC/ ADB
1.4	Subsequent changes in the list of works	Submission & review Approval	PIU/ PMC/PMU EC/ADB
2.0	TECHNICAL SANCTION		
2.1	Collection of data, necessary surveys and investigations and preparation of detailed Engineering design, drawings and estimates (above Rs.1.0 crore)	Preparation Check review & recommend Approval	DSC/PIU PMC PMU/TC

2.2	Collection of data, necessary surveys and investigations and preparation of detailed Engineering design, drawings and estimates (below Rs 1. 0 crore)	Preparation Check, review and recommend Approval	DSC/PIU PMC PMU/TC
3.0	CONCEPT DESIGNS AND PARAMETERS		
3.1	Concept designs after preliminary investigation including different alternatives and proposed design parameters for all major works and specialized works.	Preparation Check, review and recommend Approval	DSC/PIU PMC PMU
3.2	Preparation of typical drawings for the Project	Primary Secondary	DSC PMC
4.0	TENDER DOCUMENTS		
4.1	Prequalification Documents for LCBs	Preparation, Review and recommend Approval	PMC PMU EC/ADB
4.2	Tender documents for local works <= Rs. 1.0 crores, ICB, LCB and material procurement	Preparation Evaluation Review Approval	DSC/PIU TEC PMC/PMU TAC
5.0	TENDER AND AWARD		
5.1	Prequalification of contractors	Notice inviting offers receiving offer Evaluation and Comparative statement Review Approval	PMU PMU PMC/ Evaluation committee PMU EC/ADB

5.2	Tenders for works with estimated value < = Rs. 1.0 crores	NIT /receiving tenders Comparative statement Evaluation Bid examination Approval	PMU /PIU DSC/PIU TEC PMC/PMU TAC/ADB
5.3	Tenders for LCB civil works more then Rs. 1.0 crores and less then \$ 5.0 million.	NIT /receiving tenders Comparative statement Bid examination Evaluation Approval	PMU/ PIU DSC/PIU PMC/PMU TEC TAC/ADB
5.4	Tenders for civil works more then \$ 5.0 million ICB packages	NIT /receiving tenders Comparative statement & examination Bid examination Evaluation Approval	PMU PMC PMU TEC EC/ADB
5.5	International shopping for items less then \$ 1.0 million, ICB for grater than \$ 1.0 million	NIT /receiving tenders Comparative statement &examination Bid examination Evaluation Approval	PMU PMC PMC/PMU TEC TAC/EC/ ADB
5.6	Issue of Work Orders, Signing of Agreements and upkeep of original contract documents for all works and local procurement.		PIU
5.6	Issue of Purchase order, signing of agreement and upkeep of original contract documents for centralized procurement.		PMU

6.0	CONTRACT ADMINISTRATION AND CONSTRUCTION SUPERVISION GENERAL	PRIMARY SECONDARY	DSC /PIU PMC/PMU
6.1	overall administration and management of the contracts including interpretation of the technical specifications and other contract documents as may be required;	Primary Secondary	PMU/PIU PMC/DSC
6.2	Review and revise construction drawings as may be necessary from time to time, either to suit site conditions, changes in construction strategy or changes in design, and provide clarifications / explanations on the designs and drawings to the contractor.	Submission Review, check and recommend Approval	DSC/PIU PMC PIU/PMU
6.3	review and recommend acceptance or modification of the construction drawings and designs prepared by the contractors for the turnkey contracts	Review, check and recommend Approve	DSC/PMC PIU
6.4	giving level and layout for those items of work where dimensional accuracy has a direct bearing on the quality and performance of the finished work to ensure conformity with the quality requirements stipulated in the contract;	Primary Secondary	DSC PIU
6.5	Assess the adequacy of the inputs such as materials, labor and equipment provided by the contractor and the construction methods proposed and ensure that they are satisfactory with reference to the technical requirements, implementation schedule, environmental aspects, and safety of the works, project personnel, and general public welfare. Inform PMU and PIU, in writing, of any deficiencies found, and recommend any remedial actions which are required to be taken	Primary Secondary	DSC PIU
6.6	proper inventories and accounts are maintained of all dismantled materials, particularly for those materials which are to be re-used in the works;	Primary Secondary	DSC PIU
6.7	the work site is maintained in a neat, orderly and safe manner;	Primary Secondary	DSC PIU
6.8	any inconvenience to the public is minimized; and Payments are made to the Contractor in a timely manner.	Primary Secondary	PIU DSC
6.9	Necessary assistance to solve any contractual dispute and sort out issues requiring external interdepartmental coordination, which has an overall obligation to ensure the successful implementation of the project, works.	Primary Secondary	PIU/PMU DSC/PMC
6.10	providing continuous on-site supervision during construction and ensuring the safety of the works;	Primary Secondary	DSC PIU
6.11	supervising and monitoring the progress of the works, including identifying cause(s) of delays, determining remedial actions to correct such delays, and issuing instructions to contractors;	Primary Secondary	PIU/PMU DSC/PMC

6.12	the contractor fulfills his obligations under the contract and satisfactorily completes all contractual obligations and complies with all applicable statutes, regulations, contract conditions, specifications and instructions;	Primary Secondary	PIU/PMU DSC/PMC
6.13	the contractor completes the work within the scheduled time	Primary Secondary	DSC/PIU PMC/PMU
6.14	ensuring that Site Order Books, Daily Work Records, Labor, Material and Machinery Logs are properly maintained	Primary Secondary	DSC PIU
6.15	making test records and results available to the PMC/PMU for review and assessment	Primary Secondary	DSC PIU
6.16	acting on project issues and problems as they arise, and promptly issuing written instructions to the contractors to address the problems; The contractual notices can be given by the PIU only, but letters for quality and other matters can be given by DSC	Primary Secondary	PIU/PMU DSC/PMC
6.17	ensuring that the contractor properly prepares the "As Built" drawings for the completed works;	Primary Secondary	DSC PIU
6.18	ensuring that the contractor prepares and submit Monthly Progress Report in the approved format and on time	Primary Secondary	PIU DSC
6.19	developing and implementing efficient O&M procedures and practices for Project infrastructure ensuring the participation of Project Affected Persons (PAPs) in planning, implementation and monitoring of the slum up gradation component	Primary Secondary	DSC PIU
7.0	QUALITY ASSURANCE AND INSPECTIONS	Primary Secondary	DSC/PIU PMC/PMU
7.1	prepare a simplified Quality Control Manual for use of the field staff, and assist in providing on-the-job training to PIU and Contractor staff	Primary Secondary	DSC PIU
7.2	Provide effective supervision of the works in order to ensure the quality and conformity with the standards and specifications prescribed in the contract	Primary Secondary	DSC PIU
7.3	Regular and frequent inspections of all work sites should be made to check the nature and quality of work being done, to verify the materials, equipment and labor engaged at the site, to review the quality control tests and test results, and to ensure that the work is being implemented in accordance with the approved standards and that the quality control procedures set forth under the contract are being followed. Any problems observed and recommended remedial actions are to be immediately notified to the PIU, PMC and PMU. The problems noted and actions taken or to be taken are to be recorded in the site order book and signed by DSC/PIU.	Primary Secondary	DSC PIU

7.4	Witness all quality control sampling and testing done by the contractor. Compile and review all quality control data obtained from tests conducted by the contractor or by others and verify the accuracy of the test data by checking the procedures used in the field for sampling and testing of the materials and works. Carry out independent sampling and testing wherever considered necessary, or as may otherwise be required to check and verify the accuracy of the test results conducted by the contractor. Assess the test results and recommend on acceptance of the materials supplied and on the works completed. To ensure that proper records of the tests conducted are maintained.	Primary Secondary Conducting Tests Witness and verification JE-PIU/ Support Engineer DSC AE/EE-PIU/ ACM SE PIU/ CM/DyCM	DSC PIU Contractor 100% 30% 5%
7.5	Periodic inspections on an as-required basis should be made jointly by the DSC Senior Engineer and PIU representative to inspect and accept interim work completion stages (i.e., completion of sub grade, sub base, base course, etc.) in order to permit the contractor to proceed with further works. All approvals should be entered into the site order book and signed by all parties, and no work on further stages should be permitted until the earlier stage work has been inspected and accepted. In the event that the work fails to meet the required standards, any removal and replacement or other remedial measures which may be required should be clearly explained along with a time schedule for completing such work;	Primary Secondary	DSC PIU
7.6	joint final inspection(s) of the completed works of by Construction Manager DSC, PIU and contractor, preparing a statement of exceptions for any works which may remain to be completed, approving and accepting the completed works, issuing the Certificate of Acceptance and making final payment to the contractors	Primary Secondary	DSC/PIU PMC/PMU
7.7	inspections of the completed works, ensuring that any defects in materials or workmanship are properly identified in a timely manner, and ensuring satisfactory maintenance of the works for one year following completion as per contract	Primary Secondary	DSC PIU
7.8	Participate in monthly inspections and site coordination meetings of PIU, DSC and Contractor for all works to review the overall progress and quality of the works, review the problems which may have arisen, the instructions which were issued to the contractor to address these problems and the contractor's compliance with these instructions, and to agree on any further actions which may be required to be taken to improve either the progress or quality of the works. The DSC shall be responsible to prepare the minutes of the site coordination meetings in order to maintain a permanent record of all agreements reached, instructions issued and actions to be taken. (Note: The PIU will be solely responsible to issue any written instructions to the contractor.	Primary Secondary	PIU DSC

7.9	Provide certification on the quality of the works accomplished and included in the contractor's monthly progress billings, and on its conformity to the specifications and drawings, and recommend on acceptance of and payment for the completed works. If the consultant considers that any item of work or construction material is substandard or unacceptable, recommend that such work or supply of material be deducted from the progress payment or that payment be deferred until necessary rectification's are made by the contractor and provide a full written explanation of the deficiencies noted along with necessary supporting data, including test results, to the PIU as well as to the PMU. Recommend on remedial measures to be taken to bring the substandard work up to the necessary standard	Primary Secondary	DSC PIU
7.10	following expiration of the Maintenance Period/defect liability period, inspecting the works, identifying any defects in materials or workmanship, issuing the Maintenance Certificate and releasing the security deposit or balance of security deposit following satisfactory correction of all defects;	Primary Secondary	DSC PIU
8.0	CONTRACT VARIATIONS	Proposal Approval	DSC PIU/PMC/ PMU
8.1	Make a monthly assessment of the progress and quality of the works and recommend to the PIU on any necessary variations to the contracts, including work programs, work procedures, inputs, safety, quality, variation orders, completion dates, and/or any other matters which may affect the timely and satisfactory completion of the work. Propose and present for approval any changes in the plans which may be deemed necessary, and indicate any effect such changes may have on the contract. Assist the PIU in preparing any required variation orders and obtaining necessary approvals from the PMU and PMC prior to issuance to the contractor where required.	Proposal Approval	DSC PIU
8.2	Examining and approval of all proposed variation orders or claims from the contractor for time extensions, extra compensation, or expenses or other similar matters, preparing variation orders and obtaining necessary approvals from PMC/ PMU prior to issuance to the contractor where required.	Proposal Approval	DSC PIU
9.0	MEASUREMENT AND PREPARING BILLS AND PAYMENTS	Preparing Approval and Payment	DSC PIU

9.1	<p>Conducting with contractor joint measurement of the works in the stipulated format for payment and ensuring timely approval and payment of the contractor's running bills. The DSC & PIU will provide certification on the quality of the works accomplished and included in the contractor's monthly progress billings, and on its conformity to the specifications and drawings. The measurements will be entered by Support Engineer DSC. The responsibility for quality, correct and accurate measurements is of CM or Dy CM, DSC, subject to overall control of SE PIU.</p>	<p>Preparation/ measurement of bills</p> <p>Checking by AMC DSC & AEn/XEn PIU</p> <p>Checking by CM or Dy CM DSC/ SE PIU</p> <p>Payment</p>	<p>DSC</p> <p>30%</p> <p>5%</p> <p>SE PIU</p>
9.2	<p>Conducting with contractor joint measurement of the works for payment of Final Bills after satisfactory completion of works and payment as per the works contract provisions. The DSC & PIU will provide certification on the quality of the works accomplished and included in the contractor's monthly progress billings, and on its conformity to the specifications and drawings, and recommend on acceptance of and payment for the completed works. The responsibility for quality, correct and accurate measurement is of CM or Dy CM-DSC, subject to overall control of SE-PIU.</p>	<p>Preparation/measurement of bills.</p> <p>Checking by AMC DSC & AEn/XEn PIU</p> <p>Checking by CM or Dy CM DSC/ SE PIU</p> <p>Payment</p>	<p>DSC Support Engineer & JEn PIU-100%</p> <p>30%</p> <p>10%</p> <p>SE PIU</p>
9.3	<p>Record Measurement for such measurements which cannot be verified subsequently. The responsibility for quality, correct and accurate measurement is of CM or Dy CM-DSC, subject to overall control of SE-PIU.</p>	<p>Measurement and record</p> <p>Checking by AMC DSC & AEn/XEn PIU</p> <p>Checking by CM or Dy CM DSC/ SE PIU</p>	<p>DSC Support Engineer & JEn PIU-100%</p> <p>100%</p> <p>10%</p>
9.4	<p>Preparing necessary payment release order of security and payment thereof after completion of the defect liability period as per the contract. The DSC(CM) and SE PIU will provide a certificate regarding fulfillment of conditions related to defect liability period. The responsibility for quality, correct and accurate measurement is of CM or Dy CM-DSC, subject to overall control of SE-PIU.</p>	<p>Preparation and verification of bills</p> <p>Checking by CM or Dy CM DSC/ SE PIU</p> <p>Payment</p>	<p>ACM DSC & AEn/XEn PIU-100%</p> <p>100%</p> <p>SE-PIU</p>

9.5	Passing of the bills for supplies received under the material procurement packages after due inspection and checking and payment thereof. The DSC, Line Agency and PIU will provide a certificate regarding full confirmation of the goods to the specifications and being in good condition. Physical verification of all supplies by SE-PIU and CM or Dy. CM-DSC is compulsory.	Preparation and Verification of bills Verification & checking by ACm-DSC/ AEn or SE-PIU/ Line Department Checking by CM or Dy CM-DSC & SE-PIU Payment	DSC Support Engineer & JEn-PIU-100% 100% 10% SE-PIU
10.0	REPORTING		
10.1	Monthly Progress report to DSC	Submission	Contractor
10.2	Preparing Monthly Progress Reports in the approved format, including physical and financial progress, problems encountered and actions taken for each city, and submitting to the PIU, PMC AND PMU in a timely manner incorporating the contractor's report.	Submission	DSC
10.3	reporting to PMC and PMU from time to time regarding overall physical and financial progress of work, with specific mention of problems encountered and actions taken or remedial measures recommended, variation orders approved, anticipated slippage in any item of work, rectification measures recommended, and any specific assistance required from PIU or PMC or PMU	Submission Comments / Recommendations	DSC PIU/PMC
10.4	Submission of the contract completion report summarizing the construction activities and indicating, among other things, contract changes, claims or disputes, or any other substantive matters having an effect on the cost and progress of the works and accurate and complete "As Built" drawings (to be submitted by the contractor)for the completed works	Primary Secondary	DSC PIU
10.5	assist the PMU in preparing the Project Completion Report	Preparation Review	DSC/PMC PIU/ PMU
10.6	Monitor Progress and submit a monthly report for the Project including Physical, Financial progress of works and other components of the Project		PMC
10.7	Submit a quarterly Progress report for submission to DEA and ADB through PMU		PMC
11.0	BUDGET		
11.1	Annual plan of work and forecast of funds requirement for each component of the Project for each city.	Primary Secondary	PIU/DSC PMC

11.2	annual Project plan and forecast of funds requirement for the Project	Submission Review	PMC PMU
12.0	FINANCE AND MAINTAINANCE OF ACCOUNTS		
12.1	Financial Management Control and maintenance of Project Accounts	Primary Secondary	PIU/PMC DSC/PMC
12.2	Preparation and submission of reimbursement claims for each city to PMU	Primary Secondary	PIU DSC/PMC
12.3	Compilation, preparation and submission of reimbursement claims for the Project to the ADB	Primary Secondary	PMU PMC
13.0	INTER DEPARTMENTAL AFFAIRS		
13.1	Land acquisition	Identification Acquisition Proceedings	DSC/PIU/ LD LD
13.2	Identification of Power Connection, Railway crossing, and Road crossings. Pipe/Sewer interconnections with existing systems, permission for use of Forestland, etc.	Primary Secondary	DSC PIU
13.3	Obtaining permissions from the other departments and organizing the works as required through them.	Primary Secondary	PIU DSC
14.0	OTHER RESPONSIBILITIES		
14.1	Selection of appropriate commercially available software for routine activities	Primary Secondary	DSC/PMC PIU/PMU
14.2	Preparation and implementation of time bound Management Action Plan (MAPs) to assist ULBs to improve their financial management and increase their resource generation, including computerization of activities.	Primary Secondary	DSC/PMC PIU/PMU
14.3	Generating draft operational budgets (ULBs) for new works and facilities including normal operations and maintenance.	Primary Secondary	PIU/PMU DSC/PMC
14.4	Assist (LDs/ULBs) in implementing cost recovery alternatives for recovering the cost of the capital improvements and meeting the recurring O & M expenditure.	Primary Secondary	DSC/PMC PIU/PMU
14.5	Review and assess training needs / requirements of the PMU, PIU & ULB.	Primary Secondary	DSC/PMC PIU/PMU

14.6	Development of a comprehensive training plan to meet identified needs.	Primary	DSC/PMC
		Secondary	PIU/PMU
14.7	Preparation of Training manuals and modules.	Primary	DSC/PMC
		Secondary	PIU/PMU
14.8	Providing on the job training for PMU, PIU and ULB staff	Primary	DSC/PMC
		Secondary	PIU/PMU

Note: The above procedures are prepared with a view of ensuring a smooth action in various activities, which generally have an overlapping responsibility. They are only a clarification on the responsibilities as prescribed in the respective contract documents. In case of variance, the contract documents will precede over the above stipulations. Wherever the responsibilities are shown to more than one agency, the order of precedence of responsibility is from left and that of authority is from right.

Contractors are responsible for the execution of the works in conformance with the requirements of the contract documents.

2.1.1 General responsibilities

Contractors are responsible for providing:

- all necessary plant, labor, equipment and construction materials to be used in the works;
- all plant, equipment, materials and labor for temporary and auxiliary works;
- all equipment and components to be installed or incorporated in the works;
- transportation and storage facilities for all materials and equipment.
- office and accommodation for staff and labor;
- sanitation facilities at the site; and
- all necessary staff and equipment for testing and quality control.

Contractors are responsible for executing and completing the works in accordance with the specified standards and specifications, within the contractual time allowed, and within the contract price for these works. On water supply and sewerage turnkey contracts, contractors are also responsible for preparing final design documents and obtaining their approval.

2.1.2 Quality assurance/quality control duties

The contractor's QA/QC duties are summarized in Table 2.2. Other duties shall be performed as stipulated in the contract documents or directed by the Engineer (PIU).

Table 2.2 : List of Contractor's QA/QC Duties

Activity/Item	Contractor's QA/QC Duties
Designs for turnkey contracts	<ul style="list-style-type: none"> • Prepare designs using appropriate QA/QC procedures • Submit designs and drawings to PIU for review and approval • Maintain design register at site • Use only approved drawings for construction
Designs for item-rate contracts	<ul style="list-style-type: none"> • Maintain design register at site • Use only approved drawings for construction
Test laboratory and equipment	<ul style="list-style-type: none"> • Intimate PIU and DSC the details, date of completion with requisite manufacturers' and calibration certificates • Maintain the equipment in good condition and calibrate as necessary
Material receipts	<ul style="list-style-type: none"> • Enter receipts in material register • Intimate PIU and DSC in writing
Materials testing	<ul style="list-style-type: none"> • Prepare mix designs as required by contract and submit test results to PIU and DSC • Take test samples in presence of PIU and DSC when requested • Perform materials tests • Submit test reports to PIU and DSC with monthly reports • Maintain test log
Rejected materials	<ul style="list-style-type: none"> • Enter in material register at site • Intimate PIU and DSC in writing the proposed date of removal from site and confirm after removal
Material consumption	<ul style="list-style-type: none"> • Enter daily consumption of materials in material register and indicate balance quantity
Construction equipment	<ul style="list-style-type: none"> • Intimate PIU and DSC the details, date of mobilization along with requisite insurance certificate • Maintain equipment in good working condition
Construction	<ul style="list-style-type: none"> • Intimate PIU and DSC in writing when construction is going to commence and what activities are proposed to be undertaken. • Intimate PIU and DSC in advance when critical works, such as concreting, embankment, paving, pipeline laying and jointing, testing, etc., would be undertaken, along with the test certificates of the materials proposed to be used in these works. No critical activity shall start unless the material test certificates are verified and approved by the Engineer. • Provide necessary QA/QC

Activity/Item	Contractor's QA/QC Duties
Daily work progress	<ul style="list-style-type: none"> • Maintain in daily log
Testing of works in progress	<ul style="list-style-type: none"> • Perform tests as per contract requirements • Submit test reports to PIU and DSC • Maintain test log
Rejected work items	<ul style="list-style-type: none"> • Intimate PIU and DSC in writing the proposed date of removal from site and confirm after removal, or (if so agreed by PIU and DSC) • Rectify defective work and invite PIU and DSC for re-inspection.
Instructions from Engineer	<ul style="list-style-type: none"> • Enter change orders, site instructions, letters and minutes of meetings issued by the Engineer and Consultants in the Instruction Log
Inspection of Engineer	<ul style="list-style-type: none"> • Take instructions in Site Order Book. • Advise PIU and DSC of compliance
Progress scheduling and control	<ul style="list-style-type: none"> • Prepare and maintain project schedules and undertake work in accordance with approved schedule
Reporting	<ul style="list-style-type: none"> • Prepare and submit Monthly Progress Reports
Records	<p>Maintain the following records on site:</p> <ul style="list-style-type: none"> • Material Register • Site Order Book • Hindrance Register • Daily Log • Design Register • Test Log • Instruction Log (to be maintained by DSC and Contractor both) • Equipment Register • Labor Register • Approved Construction Drawings • Test Reports • Site Laboratory Record • Permissions Issued by Departments • Correspondence Record • Copies of Monthly Progress Reports • Any other records as specified in the Contract and/or as instructed by the Engineer

3 DESIGN CONTROL

This section outlines the final design preparation and review processes under the Project and presents basic design review criteria. As discussed in Section 2, the final design and drawing preparation responsibilities under the Project vary depending on the contracting procedure, as follows:

- For water supply, sewerage and solid waste management components under turnkey contracts, the final designs are prepared and submitted by the contractor, reviewed by the DSC & PIU and approved by the PIU. However the PIU may consult for special features with the PMC before approval. The PMU/PMC may at their own stipulate issues referred to them. Preliminary designs and estimates for tendering purposes are prepared by DSC and reviewed by Technical committee
- For all other item rate contracts (such as roads and bridges, water supply, sewerage storm water drainage, buildings, sites and services etc.) the designs are prepared by DSCs, reviewed by PIU, checked, reviewed and recommended by PMC, and approved by PMU.

Design control requirements are outlined below. The flow, handling and control of documents during design preparation and review are discussed in Section 10 of this Manual.

3.1 Design Preparation Process

Designs shall be prepared in accordance with the requirements of the Project, and applicable design standards and criteria, codes, specifications, and methodology. Final designs prepared by contractors on turnkey contracts shall be based on the preliminary designs prepared by DSC.

For design calculations performed by computer, the design engineer shall verify design inputs and check outputs for reasonableness and compliance to requirements. Calculations prepared by hand shall be rechecked. The design engineer shall check the prepared designs and documents for completeness, correctness and legibility.

Design documents and calculations shall be reviewed by a senior engineer to ensure that the design method is acceptable and in accordance with the contractual design criteria, codes and standards, that the inputs are correct and the outputs reasonable.

Drawings will generally be prepared by computer aided design methods. As with design calculations, the designer shall check drawings for completeness, correctness, legibility and conformance to the design calculations, design standards, codes and specifications. A senior engineer shall then review drawings.

A common discussion with senior engineer DSC & engineer in charge (PIU) are held. The comments of engineer in charge PIU being incorporated.

Design documents, calculations and drawings shall be signed and dated by the draftsman (if applicable), the design engineer, and the reviewing senior engineer of DSC And Engineer In charge of PIU Should counter sign the same .

3.2 Design checking Review Process

The design checking reviewer (PMC) shall examine the design documents, and if he has comments, prepare comment sheets and mark up a copy of the documents. If designs need to be reviewed by more than one person or agency, the primary reviewer shall consider the comments of other reviewers, discuss them as needed, and incorporate them into the marked up copy of the document.

Each design document and drawing shall be reviewed for compliance with contract requirements and specifications, applicable standards, codes and criteria. If the reviewer questions the accuracy of calculations or dimensions established by the designer, he shall ask the designer to verify them but shall not change them himself. THE PMC will Provide a certificate for checking , reviewing & recommending the design for approval to PMU.

3.3 Design Review Checklist

A basic design review checklist is as follows:

- o Check document revision number and revision dates (if applicable).
- o Check that the designer and reviewer have signed the document.
- o Verify the list of reference drawings and sources of special information and, as necessary, refer to the listed documents.
- o Check the general notes for clarity and completeness.
- o Review contract plans, specifications, addenda and all approved change orders, and check that the document complies with them.
- o Check the accuracy and completeness of a representative set of calculations.
- o Consider the aspect of constructability.
- o Annotate the drawing, specification, addendum or other document as appropriate.
- o Return the documents to the manager of the reviewing organization for return to the designer (PIU, DSC or contractor, as applicable).

Specific items to be checked depend on the type of facility being designed.

4 CONSTRUCTION QUALITY CONTROL – GENERAL

This section provides an overview of construction quality control activities, including testing and site inspection. Materials control requirements are presented in detail in Section 5, while specific testing and inspection requirements for each category of works are presented in Sections 6 to 9 of this Manual.

4.1 Introduction

Construction quality control (CQC) is intended to provide a comprehensive, common and consistent framework for quality control across various contract packages. CQC comprises two main elements of quality control:

- Testing
- Inspections

Testing control covers the type of tests to be carried out, frequency of testing and stage of testing. Inspection control covers the timing of inspections, what has to be inspected and the inspection procedures.

CQC should be affected at five stages:

- Input Materials and Equipment Components
- In-process Activities
- Stage Completion
- Interfacing (of special importance in water supply and sewerage contract packages)
- Final Completion

The contractor is responsible to inform the DSC and PIU giving sufficient notice time so they can witness the test.

4.2 Testing

Various site tests on materials and works are required to be carried out by the contractor during construction. A well-equipped and properly operating site test laboratory is an important element of the quality assurance plan. A checklist showing typical testing equipment to be provided in the contractor's site laboratory is presented as Table 4.1.

The contractor shall set-up the site laboratory at the start of his project and inform the PIU and the DSC for conducting inspections. Laboratory equipment shall be properly calibrated, and calibration certificates should be kept at the laboratory for review by PIU and DSC, as necessary. Specialized tests at outside laboratories shall only be undertaken with the prior approval of the PIU.

Tests should be performed in accordance with the contract documents, as described in Sections 5 through 8 of this Manual. The control of test reports shall be done as stipulated in Section 10 of this Manual. All test samples should be preserved, with proper identification numbers, test log reference, test date, and other applicable information. These samples must be stored on site by the contractor.

Table 4.1
Checklist of Site Testing Laboratory Equipment

Contract Package No: _____ Name of Work: _____ Contractor Name: _____

Testing Equipment	Type of Test	Yes (1)	No (1)
Balance (2 type) volume measuring apparatus & hand tools etc.	General laboratory test		
Oven	Drying and moisture content determination		
Sieves, sieve shaker and hydrometer	Grain size analysis and classification of soil and aggregates		
Atterberg limit apparatus	<i>Plasticity of Soil</i>		
Procter/modified proctor (IS heavy) density equipment	Soil compaction test		
Sand replacement cylinder and core cutter	In-situ density test for field compaction control		
Compression testing machine 100 MT and 5 MT capacity	Compressive strength of cement, concrete, brick, etc.		
Cylinder and cube moulds	Concrete sampling		
Slump test	Workability and control of water in concrete casting		
Vicat apparatus	Setting time determination of cement		
Laboratory CBR equipment	Determination of strength of road pavement and layers		
Dynamic cone penetration test equipment	Determination of strength of road pavement and layers		
SPT equipment and hand auger	Boring, sampling and soil strength test		
Unconfined compression testing machine	Determination of shear strength of cohesive soil		
Direct shear equipment	Determination of angle of internal friction of soil		
Consolidation test equipment	Determination of settlement /compressibility of soil		
Los Angeles Abrasion test/ Impact Testing Machine	Los Angeles Abrasion test/ Impact Test		
Core drilling equipment	In-situ sampling		
Bitumen test equipment	Ductility test and Penetration test		
Measuring instruments	Measurement of sizes		
Leak test equipment	Pipeline jointing		
Marshal stability test equipment	Road works. To be available at Hot Mix Plant site.		
Metallic Contact Digital Thermocouple	Checking temperature of bitumen		
Leveling instruments	Tolerances of roads surfaces		
Any Others, Specify			

Note: 1. Yes or No to be tick marked by PIU to indicate the equipment at the site laboratory)

In addition to tests performed on site, the contractor is responsible for specialized tests which are performed at approved laboratories, and for factory inspections and tests performed by manufacturers or third parties during the manufacturing of various materials and equipment components, as stipulated in the contract documents.

4.3 Site Inspections

Site inspections shall be carried out to ensure that the materials and construction activities conform to the prescribed standards. Site inspections can be divided into day-to-day supervision and periodic quality inspection. The suggestions in respect of these two have been elaborated herein.

4.3.1 Day-to-day supervision

The day-to-day site supervision of all construction activities shall be carried out by the DSC. This includes checking of lines, levels and layouts and on-site checks. Progress monitoring and expediting shall also be carried out by the DSC. The supervisory team of the DSC shall ensure that materials that have been rejected or for which a conformance report has not yet been issued are not used in works.

Construction equipment is a major component of quality assurance system. The equipment requirements have been laid out in the Contract documents. It is necessary that the DSC check the adequacy of the equipment used by the contractor for construction as per the prescribed standards and specifications. The equipment used for construction shall be recorded in the daily logs.

4.3.2 Periodic quality inspections

The ACM DSC & AE/EE PIU (engineer in charge) shall carry out periodic quality inspections during in-process, stage completion, interfacing and final completion, and during all critical activities as per the following examples:

- excavation
- formation of embankments
- placing of reinforcing steel
- concrete batching and pouring (100% in presence of Support Engineer DSC and JE PIU)
- hot mix operation
- laying of pavement layers
- laying and jointing of pipes
- installation of electrical and mechanical equipment
- testing, trial runs and commissioning of electro-mechanical equipment and plants

The PIU and DSC shall also inspect the materials certified by manufacturers and materials and equipment components approved by third parties upon delivery to the site. The contractor shall give advance notice to the PIU and DSC when critical activities are proposed or major equipment items are to be delivered.

On completion of one stage of the construction and before proceeding to the next stage (such as from sub-base to base in road works or from steel binding to concreting for RCC works) the DSC & engineer in charge of PIU shall inspect and certify the quality of the works completed before granting approval for the next stage of the works to start. The final inspection shall encompass tests on completion and trial runs. The certification of quality will

be based on the documents and the periodic site visits. The DSC representative and the PIU representative should witness not less than 30% and 10% of the test conducted respectively.

4.3.3 Squad checks

The concept of Squad Checks has been adopted to have an external review of quality of works executed. The squad checks should be conducted jointly by the PMU, PIU, PMC and DSC. A fixed timetable is not suggested for this. The tentative agenda for the squad checks is described as follows:

- physical inspection of the works under execution and inspection of quality of workmanship;
- review of site documentation and contractor compliance;
- sample verification of test reports and quality certificates;
- review of issues, constraints and lacunae in quality system implementation;
- preparing of action plans for improving the quality; and
- performance appraisal of the contractors.

Formats for recording minutes of progress review meetings and for recording interim evaluations of contractor's performance are included in Appendix C, as Format F-16 and F-17 respectively.

4.4 Quality Certification and Acceptance

The DSCs shall be responsible to certify that the items included in the contractor's Interim Payment Certificate satisfy the required quality of works and are acceptable with regard to the specifications and standards prescribed under the contract before the progress bill is passed for payment. PIU should signify acceptance of the DSC's quality certification by countersigning it. A format for this quality certification and acceptance is included in Appendix C, as Format F-18.

5 CONTROL OF MATERIALS AND EQUIPMENT COMPONENTS

This section provides an overview of control requirements for materials and equipment components, including site testing, manufacturers' certification and third party inspection.

5.1 General

Control and approval of construction materials and equipment components to be incorporated in the works shall be based on the following:

- Test reports for materials tested at site, such as cement, sand, water, aggregates and bitumen; The contractor will perform all tests. The designated DSC representative & PIU representative shall witness as per chapter 2. THEY shall sign the report in token of witnessing.
- Manufacturer's certificates and IS mark for manufactured items indicated in table 5.3 or as stipulated in the contract; and
- Third party inspection for various items as per contract documents.

5.2 Materials Tested on Site

The materials to be tested on site include cement, water, aggregates for concrete, bricks and stones, soil for embankments, and aggregates and bituminous materials for road works. For aggregates and soil, the contractor shall obtain the approval of the borrow source or quarry from the PIU the DSC before extracting material. The list of materials to be tested on site is given in Table 5.1 below. Test procedures are presented in Table 5.2, under the referenced procedure numbers. Test report formats are included in Appendix A. The reports are to be maintained in a bound register, where in 3 copies of report will be prepared, two copies to be submitted with monthly report to DSC & PIU and third copy to be retained by contractor.

Table 5.1

List of Materials Tested on Site

Sl. No.	Material	Test Procedure No.
1	Cement	QC-M-01
2	Sand	QC-M-02
3	Water for Construction Works (can be got tested in approved laboratory)	QC-M-03
4	Bricks	QC-M-04
5	Size Stone	QC-M-05
6	Coarse Aggregate for Concrete Work	QC-M-06
7	Soil/Earth/Sub-grade Material	QC-M-07
8	Granular Sub-base (GSB) Material	QC-M-08
9	Material for WBM / WMM	QC-M-09
10	Metal for BM/DBM/BC/Surface Dressing/MSS/Premix Carpet	QC-M-10
11	Binder for WBM	QC-M-11
12	Fine Aggregate for DBM/BC	QC-M-12
13	Lime	QC-M-13
14	Bitumen	QC-M-14
15	Borrow Material	QC-M-15
16	Steel (to be procured directly from manufacturer along with his test certificates) This shall also be got tested in local authorized test laboratory (by SE-PIU)	

Table 5.2
Procedures for Testing Materials on Site

CEMENT			QC-M-01	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Normal consistency	TC-M-01-01	One for each source and when called for by the Engineer	On receipt of material at site and before using as directed by the Engineer. Test certificate to be produced to the Engineer before use.
2	Fineness	TC-M-01-01		
3	Setting time – Initial / final	TC-M-01-01		
4	Compressive strength - 72 hrs, 168 hrs, 672 hrs.	TC-M-01-01		
For sulphate resistant cement as per IS-12330 OPC 43/53 shall conform to IS 8112/ 12269 and both 56 and 90 days strength shall be tested.				

SAND			QC-M-02	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Sieve analysis	TC-M-02-01	One test for 15 m ³	On receipt at site and test certificate to be produced to the Engineer before use.
2	Fineness modulus	TC-M-02-01	One test for 15 m ³	
3	Deleterious constituents	TC-M-02-01	One test for 15 m ³	
4	Bulking test	TC-M-02-01	One test per Source	

WATER FOR CONSTRUCTION WORKS			QC-M-03	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Alkalinity and acidity as per IS-3025	TC-M-03-01	Once per source of supply and when called for by the Engineer	Before use of water from that source
2	Solids	TC-M-03-01		

BRICKS			QC-M-04	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Compressive strength	TC-M-04-01	One test per 50,000 bricks or part thereof	On receipt at site
2	Physical properties	TC-M-04-01		
3	Water absorption test	TC-M-04-01		

SIZE STONE			QC-M-05	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Water absorption test	TC-M-05-01	One test per source and when called for	On receipt at site
2	Dimension check	Lab format	As directed by the Engineer	
3	Type of rock	Lab format		

COARSE AGGREGATE FOR CONCRETE			QC-M-06	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Aggregate Impact or Los Angeles Abrasion Value as per IS-2386 Part-IV	TC-M-06-01/1 TC-M-06-01/2	One for each source of supply and when called for by the Engineer	On receipt of material at site
2	Soundness as per IS-2386 Part-V	TC-M-06-02		
3	Alkali Aggregate Reactivity as per IS-2386 Part-IV	Lab Format		
4	Flakiness Index	TC-M-06-03		
5	Gradation by wet sieve analysis	TC-M-06-04		
6	Water Absorption	TC-M-05-01		

When required, the contractor shall furnish the mix design along with material properties at least 15 days in advance.

SOIL/EARTH/SUB-GRADE MATERIAL			QC-M-07	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1.	Swelling index IS 2720 part XL	TC-M-09-01	Two sets for 3000 m ³ or part thereof	On receipt at site
2.	Liquid limits and plasticity index	TC-M-09-02		
3.	Deleterious material IS 1498	Lab format		
4.	OMC & MDD Test	TC-M-09-03		
5.	Chemical properties	Lab format		
6.	Grain Size Distribution Graph (by wet sieve analysis)	TC-M-09-04		
7.	Void ratio gradation	Lab format		
8.	Soaked CBR test (optional)	TC-M-07-01	Two sets for 3000 m ² or part thereof and as directed by the Engineer	

GRANULAR SUB-BASE MATERIAL			QC-M-08	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	California Bearing Ratio Test	TC-M-07-01	As required	On receipt at site
2	Material combinations	Daily log		
3	Moisture content as per IS-2270	TC-M-07-02	1 test per 250 m ³ or part thereof	Prior to compaction
4	Fineness value BS 812 Part III	Lab format	As required	On receipt at site
5	Soundness of material	TC-M-06-02		
6	Air voids content	Lab format		
7	Gradation by wet sieve analysis	TC-M-06-04	1 test per 200 m ³ or part thereof	
8	Atterberg limits	TC-M-09-02		
9	Deleterious constituents	Lab format		
10	OMC and MDD	TC-M-09-03		
The contractor shall furnish the GSB design mix along with material properties and test results at least 15 days before laying GSB at site.				

MATERIAL FOR WBM / WMM			QC-M-09	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Aggregate Impact Value	TC-M-06-01/1	One test for 200 m ³	On receipt at site
2	Grading by wet sieve analysis	TC-M-06-04	One test for 100 m ³	
3	Flakiness Index and Elongation Index	TC-M-06-03	One test for 200 m ³ of aggregate	
4*	Atterberg limits of binding material *(Only for WBM)	TC-M-09-02	One test for 25m ³ of binding material	
5	Atterberg limits of portion of aggregate passing 425 micron sieve.	TC-M-09-02	One test for 100 m ³ of aggregate	
6	Water Absorption Test	TC-M-05-01	Initially one set of 3 representative specimen for each source of supply and subsequently, when warranted by changes in the quality of aggregate	
7	Soundness Test	TC-M-06-02	One for each source of supply and when called for by the Engineer	
8*	Density of compacted layer of WMM *(Only for WMM)		One test for 500 m ³	

METAL FOR BM / DBM / BC / SURFACE DRESSING / MSS / PRE-MIX CARPET			QC-M-10	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Aggregate Impact Value	TC-M-06-01/1	One test for 50 m ³ of aggregate or part thereof	On receipt at site and before using in the hot mixing
2	Flakiness Index and Elongation Index of aggregates	TC-M-06-03		
3	Water absorption of aggregates	TC-M-06-06	Initially one set of 3 representative	

METAL FOR BM / DBM / BC / SURFACE DRESSING / MSS / PRE-MIX CARPET			QC-M-10	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
4	Stripping value	TC-M-11-01	specimen for each source of supply and subsequently, when warranted by changes in the quality of aggregate	
5	Gradation by wet sieve analysis	TC-M-06-04	As directed by the Engineer for individual component and for combined coarse, fine aggregate and filler.	
6	Soundness Test	TC-M-06-02	One for each source of supply and when called for by the Engineer	On receipt at site and when absorption value is more than 2%
For DBM and BC, the contractor shall furnish the material properties and proposed job mix formula at least 20 days in advance.				

BINDER FOR WBM			QC-M-11	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Atterberg Limit Test	TC-M-09-02	One test for 100 m ³ of binding material	On receipt at site

FINE AGGREGATE FOR DBM/BC			QC-M-12	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Passing 2.36 mm sieve and retained on 75 micron sieve	Daily log	As directed by the Engineer	Before use
2	Deleterious matter	Daily log	Visual observation of lot before use	

LIME			QC-M-13	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Chemical properties as per IS: 6932, 1514	Lab format	3 final test samples for a lot size up to 100 tons as per Table 3 in IS 712-1984.	On receipt at site.
2	Physical properties as per IS: 6932	Lab format		

BITUMEN			QC-M-14	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Grade of bitumen as directed/defined (Penetration Test)	TC-M-10-01	Two samples per test subject to all or some tests as directed by the Engineer	On receipt of material at site before unloading from the truck
2	Ductility Test	TC-M-10-02		
3	Flash and Fire Point Test	Lab format		
4	Viscosity Test	Lab format		
5	Softening Test	Lab format		

BORROW MATERIAL (Soil to be used in Embankment / Subgrade / GSB)			QC-M-15	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Digging of borrow area for sampling	No format	25 m c/c or closer depending upon soil strata variation	Before material is extracted for use in construction.
2	Sand Content	TC-M-15-01 (use relevant test report formats and summarize results in TC-M-15-01)	2 sets of observation per 3000 m ³ of soil and in each 6 observations required.	Before material is extracted for use in construction.
3	Wet Sieve Analysis			
4	Plasticity Index			
5	Modified Proctor Density			
6	Soaked CBR Test			
7	OMC			
8	MDD			
Borrow material source must be approved before extracting material.				

5.3 Materials And Equipment Certified By Manufacturer

Acceptance of certain manufactured materials and equipment components, as stipulated in the contract, shall be based on test certificate(s) from the manufacturer conforming to IS and on visual inspection. These items shall bear the IS mark. PIU and DSC shall review the manufacturers' certificates for conformance to contract requirements before these items are delivered to the site. Upon their delivery and before their installation or otherwise incorporation in the works PIU and DSC shall inspect the condition of these items. Inspection criteria shall be decided jointly by PIU and DSC. They may decide to have the material additionally tested in Laboratory. The cost of such tests will be borne by the contractor. Materials and equipment subject to manufacturer's certification are listed in Table 5.3.

Table 5.3**List of Materials and Equipment Certified by Manufacturer**

- Steel/Reinforcing Steel
- Paint, Primers and Protective Coatings
- Glazing
- Water Proofing Compound
- GI, CI and PVC Pipes for general civil works
- Glazed Stoneware Pipes (GSW) for general civil works
- Gratings & Plates
- Manhole Covers
- Sanitary Fittings
- Metal Works such as windows, barbed wire, MS ladder, footrest, rolling shutters, etc.
- Joint Filler Material
- Pre-fabricated Water Tanks
- Traffic Signs
- Flow Measuring Devices – General
- Foot Rests
- Electrical Conduits
- Electrical Wires/Cables
- Switches & Sockets
- Distribution Boards
- Lights, Fans and Fixtures
- Earthing Material
- Insulators
- GOS
- DOLO
- Lightning Arrestor
- Batteries
- Cable Termination Kit
- Fire Fighting Equipment
- Reduction Gearboxes
- Level Indicator & Controllers
- Laboratory Equipment
- Electrical Poles
- All other items as specified in the contract documents

5.4 Materials And Equipment Inspected By Third Party

Materials and equipment to be inspected by a third party vary from package to package, as stipulated in the contract documents. Third party inspection would normally take place at the factory during or upon completion of manufacture. Before site delivery, PIU and DSC shall review the third party inspection certificates for conformance to requirements. Upon delivery and before installation or incorporation in the works, PIU and DSC shall inspect the physical condition of these items and, if necessary, test them on site. Inspection criteria should be stipulated in the contract document. A list of materials and equipment suggested for inspection by third party is given in Table 5.4.

Table 5.4

List of Materials and Equipment Inspected by Third Party

- Flow Measuring Devices – Special
- Cranes & Lifting Tackles
- Electrical Cables – Special
- Butterfly Valves
- Sluice Valves
- Reflux Valves
- Air Valves
- Control Valves
- Vertical Turbine Pumps/Other Pumps
- Vertical Motors/Other Motors
- Gauges
- Electrical Starters
- Power Transformers
- Voltage Transformers
- Current Transformers
- Bus Ducts
- Switch Boards (HV/MV/LV)
- Battery Chargers
- DC Distribution Panel
- Steel Pipes – Lined & Coated
- Pre-stressed Concrete (PSC) Pipes
- NP Pipes for Sewers
- GSW pipes for sewers
- DI, CI ad PVC pipes for PHED works
- All specials and fittings for Water Supply and Waste Water Systems

- In-situ Welding of Pipes
- In-situ Lining of Pipes
- Aerators for STP
- Clariflocculator
- Flash Mixer for WTP
- Motor Control Centre
- Indication-cum-Enunciation Panel
- Capacitors
- Sluice Gates
- Cable Trays
- All other items as specified in the contract documents

6 CONTROL OF GENERAL CIVIL AND STRUCTURAL WORKS

This section of the QA/QC Manual covers the testing of works and the inspection of workmanship for general civil and structural works. The key elements to be inspected in these works are concreting, stone masonry, and brickwork and finishes. The requirements for testing and control of materials for these works are outlined in Section 5.

6.1 Construction Sequence and Control Flow Charts

Flow charts indicating the construction sequence and control points for cement concrete and mortar works are shown in Figure 6.1 and 6.2 respectively.

6.2 Testing of Works

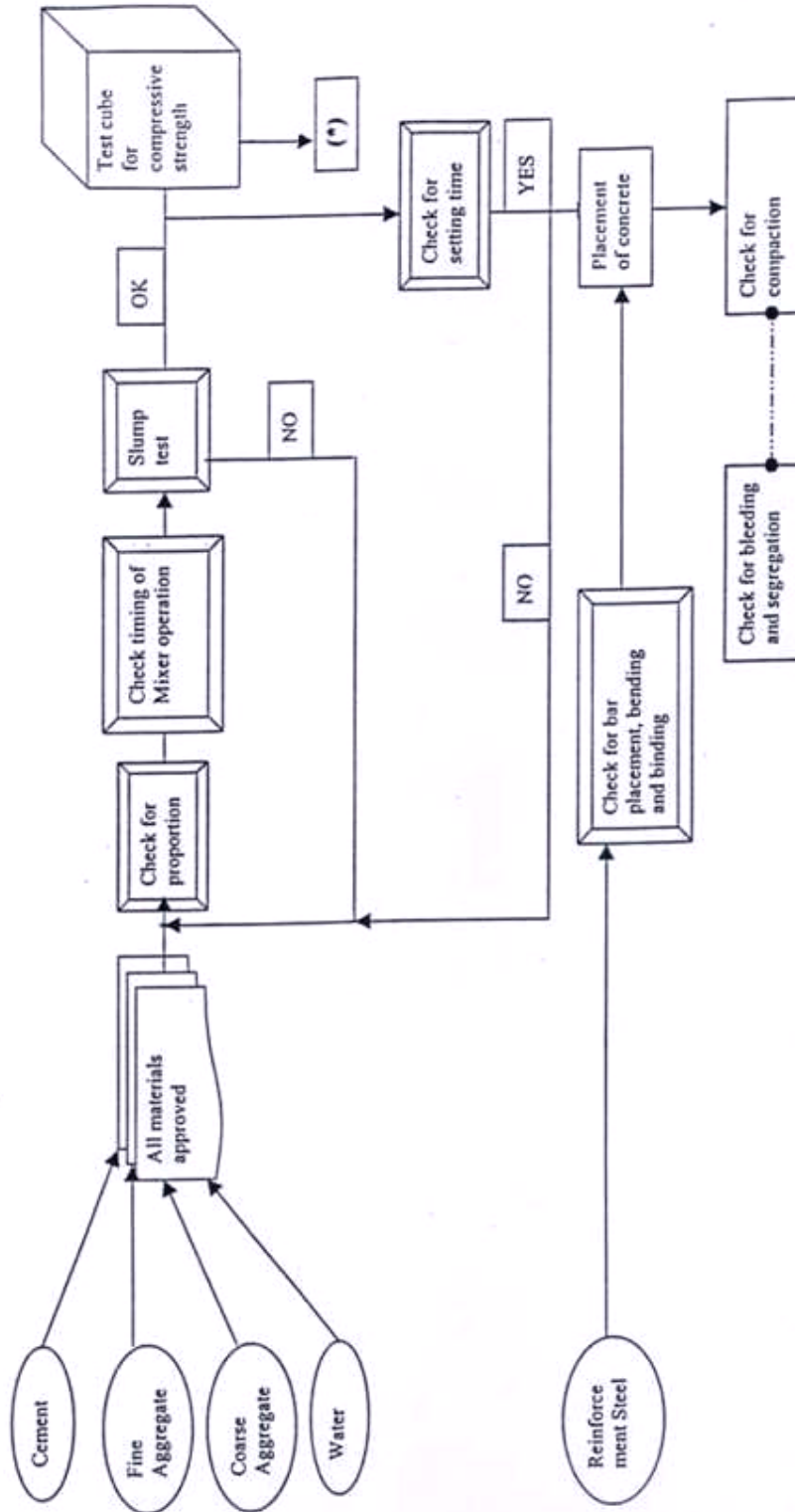
The works to be tested on site include excavation, cement concreting, and stone and brick masonry. All the materials proposed to be used in these works must have been tested by the contractor and approved by the DSC well in advance of these works. The contractor shall submit the concrete pouring report to the PIU and DSC as and when concreting is done, and shall obtain the approval of the DSC when a particular stage is completed and before proceeding to the next stage.

Tests for general civil and structural works are listed in Table 6.1. Test procedures are presented in Table 6.2, under the referenced test numbers. Required materials tests are also indicated (materials testing procedures are presented in Section 5). Test report formats are included in Appendix A. The contractor shall conduct tests as stipulated. The Representative of DSC and PIU will witness not less than 30% and 10 % of all the test conducted respectively.. This minimum percentage is not applicable where a higher % of this inspection is stipulated elsewhere.

6.3 Inspection Checklists

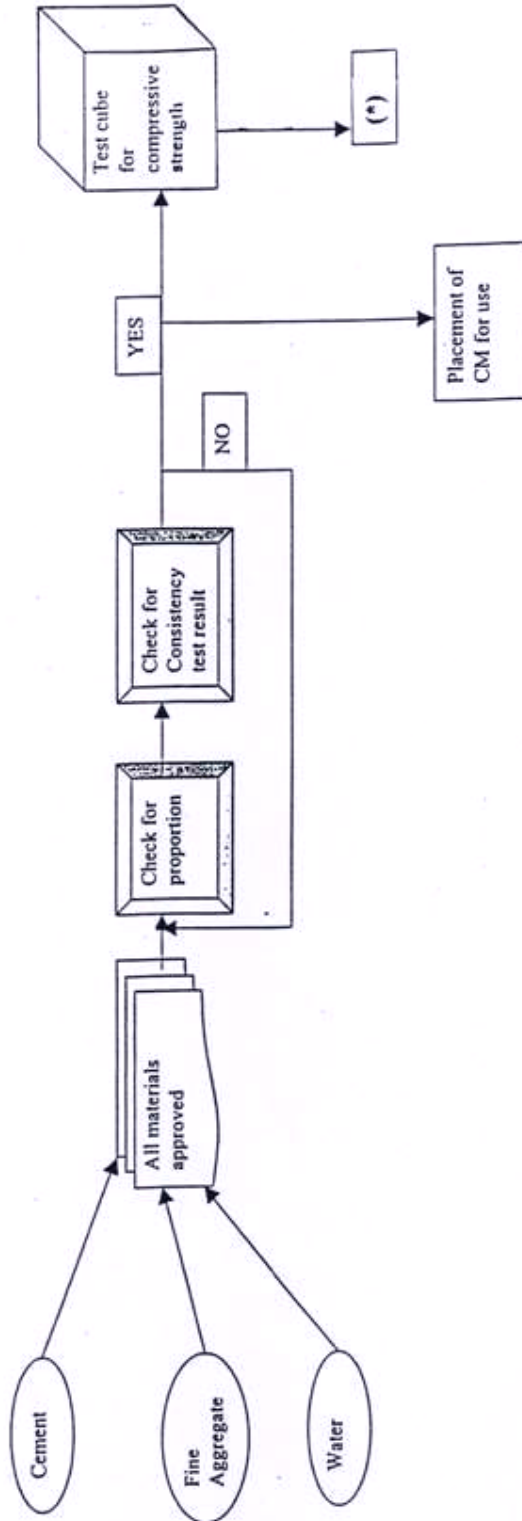
Inspection checklists for concreting, stone masonry, and brick masonry work and finishes, and building services and finishes are presented in Appendix B.

Figure 6.1
PROCESS CHART FOR PLAIN CEMENT CONCRETING/RCC WITH STAGES OF INSPECTION



Note (*): If test results are not satisfactory, corrective action shall be taken as directed by the Engineer.

Figure 6.2
PROCESS CHART FOR CEMENT MORTAR WITH STAGES OF INSPECTION



Note (*): If test results are not satisfactory, corrective action shall be taken as directed by the Engineer.

Table 6.1
List of Tests for General Civil and Structural Works

Sl. No.	Process	Material		Test Ref. No.
		Name	Format No.	
1	Embankment Formation	Soil/Earth	QC-M-07	QC-G-01
2	Excavation/Backfilling			QC-G-02
3	Concreting	Steel	MC (1)	QC-G-03
		Cement	QC-M-01	
		Coarse Aggregates	QC-M-06	
		Sand	QC-M-02	
		Water	QC-M-03	
4	Size Stone Masonry	Size stone	QC-M-05	QC-G-04
		Cement	QC-M-01	
		Sand	QC-M-02	
		Water	QC-M-03	
5	Brick Masonry	Bricks	QC-M-04	QC-G-04
		Cement	QC-M-01	
		Sand	QC-M-02	
		Water	QC-M-03	

Note: 1. MC = manufacturer certified.

Table 6.2
Procedures for Testing General Civil and Structural Works

Embankment Formation			QC-G-01	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Moisture content as per IS-2720	TC-M-09-03	One test for each 250 m ³ of soil	In-process
2	Field density test as per IS-2720	TC-M-09-03	5-10 density tests for each 1000 m ² compacted area, or as directed by Engineer	
3	Compaction	Daily log	As per required number of passes	While compacting

Excavation/Backfilling			QC-G-02	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Layout, slopes of excavation, benching and over-burden	Daily log	As directed by the Engineer	After excavation
2	Sub-soil water, shoring and strutting	Daily log		
3	Bottom levels and compaction	Daily log		
4	Soil classification	Daily log		
5	Backfilling and compaction	Daily log		After backfilling

Concreting			QC-G-03	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Compressive strength as per IS-516	TC-G-01-01	<ul style="list-style-type: none"> • 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.
2	Slump test per IS-1199	TC-G-01-02	Random checks throughout concreting as directed by the Engineer	Before pouring concrete
3	Inspection of steel reinforcement placement and bending, and formwork	Daily log	Before pouring concrete	Before pouring concrete
4	Concrete Pour Report	TC-G-01-03	When pouring is done	Immediately after pouring

Mortar			QC-G-04	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Compressive strength as per IS-2250	TC-G-01-01	One sample for every 2 m ³ of mortar subject to a minimum of three samples for a day's work	Test samples to be taken while before mortaring. Testing to be done as specified in contract.
2	Consistency as per IS-2250	TC-G-02-01		

7 CONTROL OF ROAD WORKS

This section of the QA/QC Manual covers the testing of works and the inspection of workmanship for road works, including earthworks, placement of sub-base and WBM layers, application of prime and tack coats, and placement of bituminous layers. The requirements for testing and control of materials for road works are outlined in Section 5.

7.1 Construction Sequence and Control Flow Charts

Flow charts indicating the construction sequence and control points for road works are shown in Figures 7.1 to 7.9.

7.2 Testing of Works

The works to be tested on site include earthworks, placement of granular sub-base and WBM layers, application of prime and tack coats, and placement of bituminous layers. All the materials proposed to be used in these works must have been tested by the contractor and approved by the DSC well in advance of the works. The contractor shall obtain the approval of the DSC when a particular stage is completed and before proceeding to the next stage. Surface regularity and alignments shall be checked by leveling instrument.

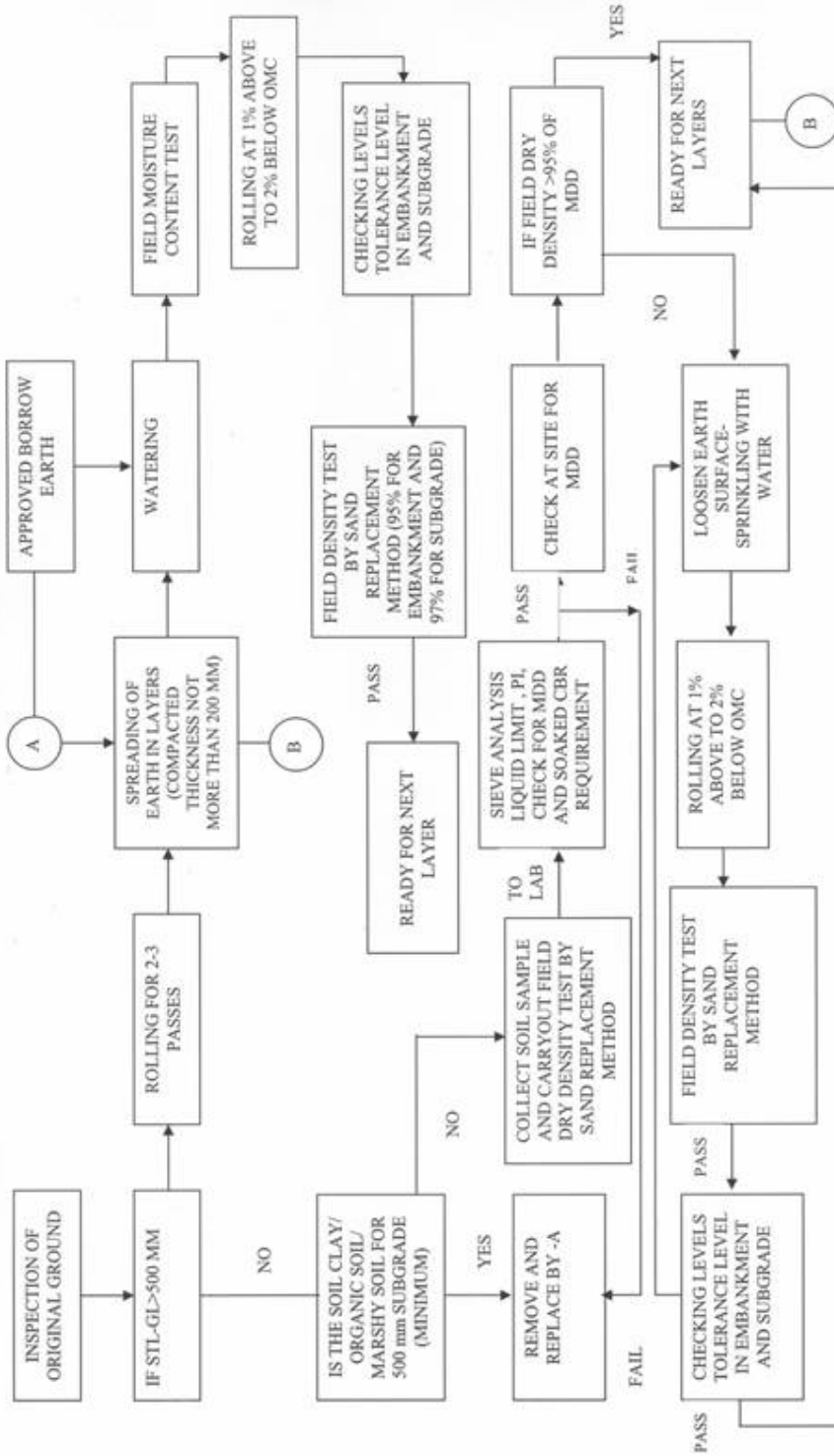
Hot mix designs shall be submitted by the contractor to PIU and DSC for review and approval well before the planned start of hot mix operations. The hot mix plant shall be inspected by PIU and DSC and approved by PIU before commencing operations. Temperature tests on bitumen shall be carried out at the hot mix plant before delivery to the site, and immediately before placing and after compaction. Temperature tests shall be carried out by using metal contact digital thermocouple based temperature measuring device. The Contractor shall provide such devices as part of his site laboratory, and in sufficient quantity so that all required testing can be carried out as-and-when required. The contractor shall take the temperature readings in the presence of the DSC, and shall submit his test reports on a daily basis.

Tests for road works are listed in Table 7.1. Test procedures are presented in Table 7.2, under the referenced test numbers. Required materials tests are also indicated (materials testing procedures are presented in Section 5). Test report formats are included in Appendix A.

7.3 Inspection Checklists

An inspection checklist for road works is presented in Appendix B.

Figure 7.1
FLOW CHART FOR THE CONSTRUCTION OF EMBANKMENT AND SUBGRADE



Note : STL = Subgrade Top Level, GL = Ground Level, MDD = Maximum Dry Density (Modified Proctor)

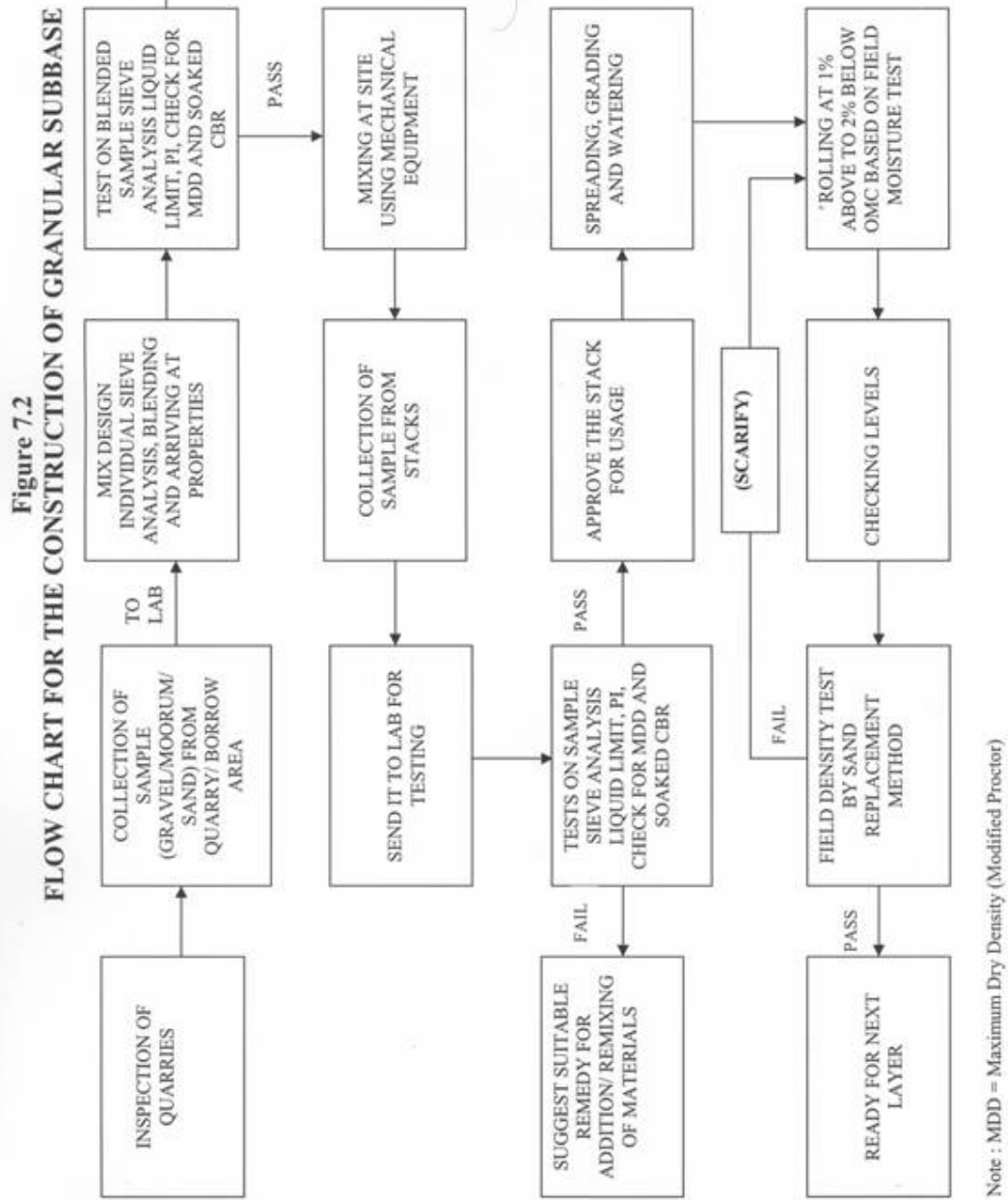


Figure 7.3
FLOW CHART FOR THE CONSTRUCTION OF WBM LAYERS

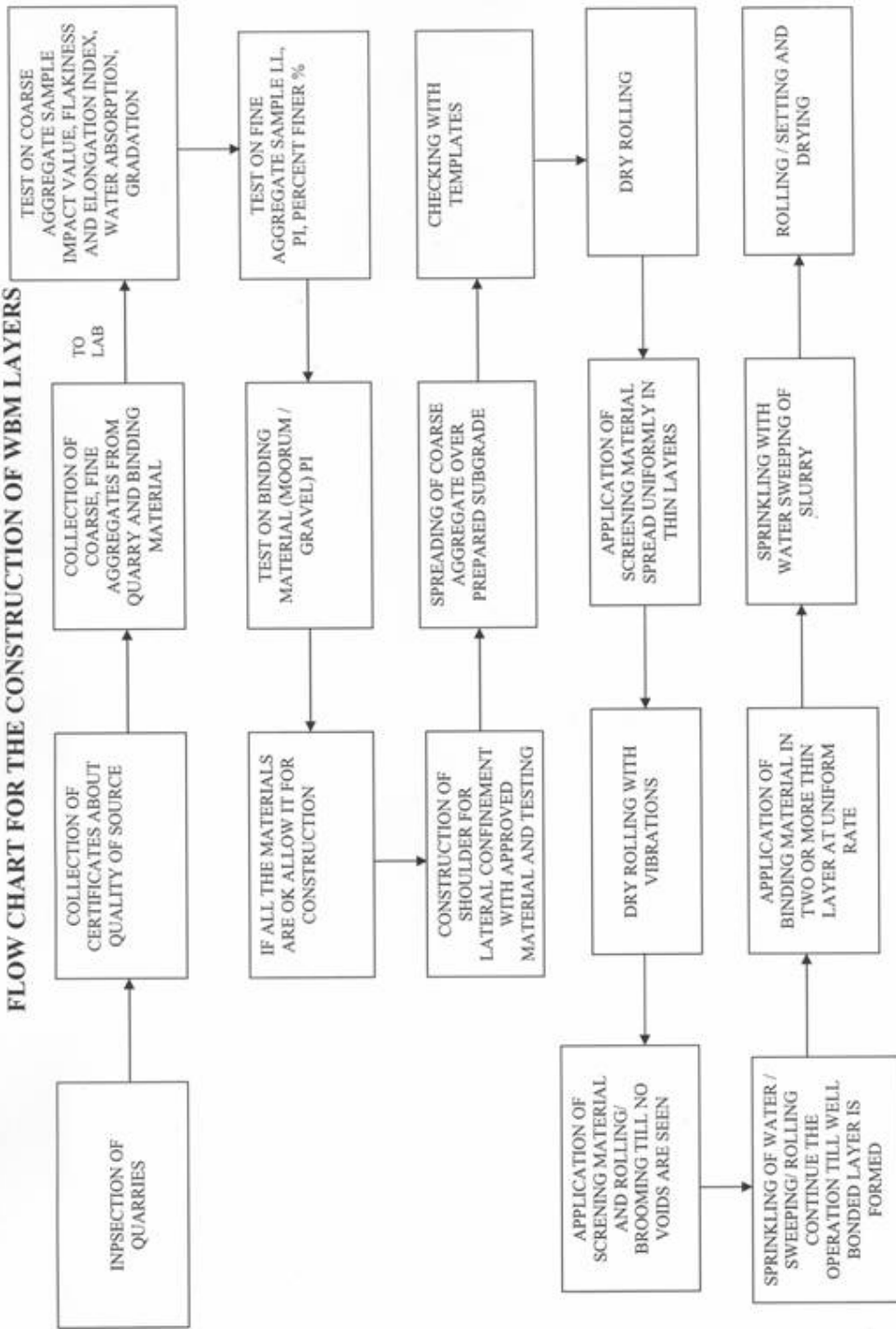


Figure 7.4
 FLOW CHART FOR APPLICATION OF PRIMER/ TACK COAT

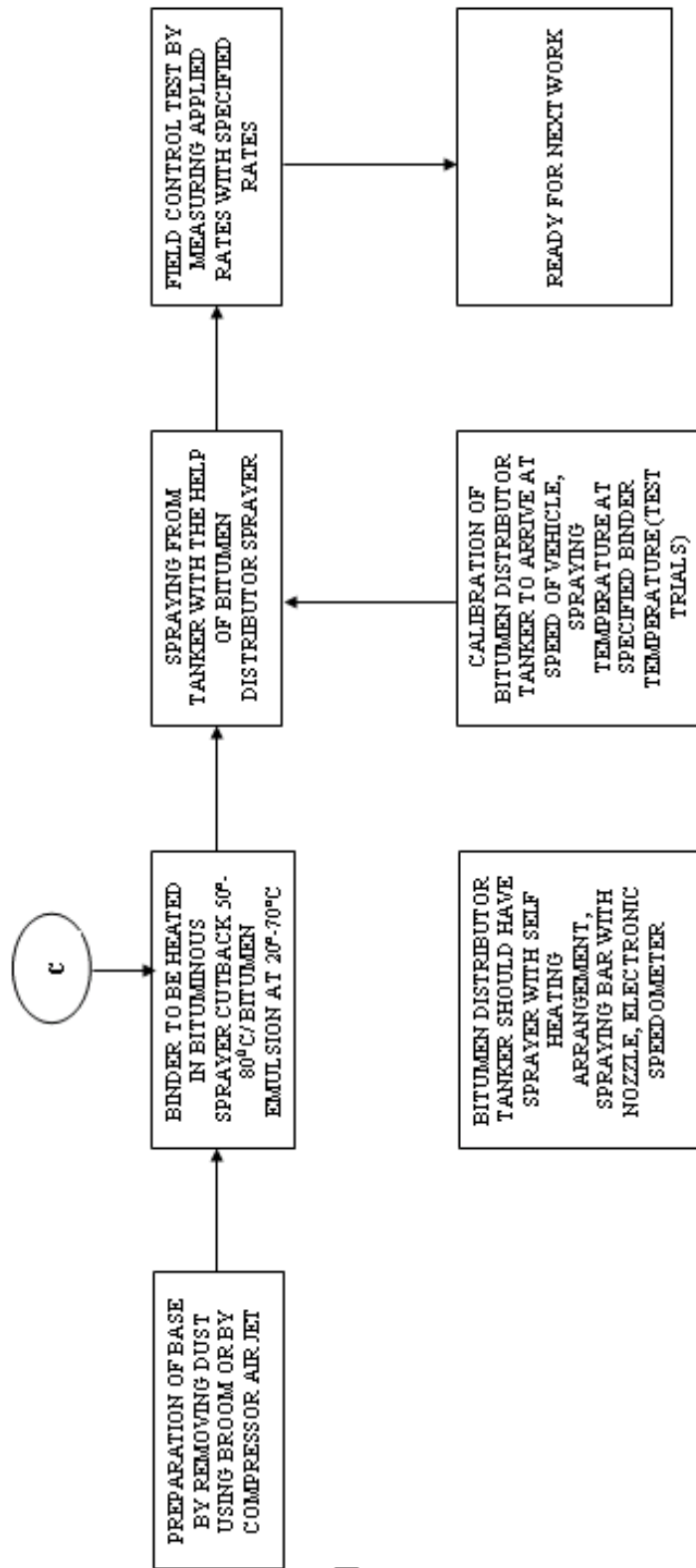


Figure 7.5
FLOW CHART FOR BITUMINOUS MIX DESIGN (DBM)

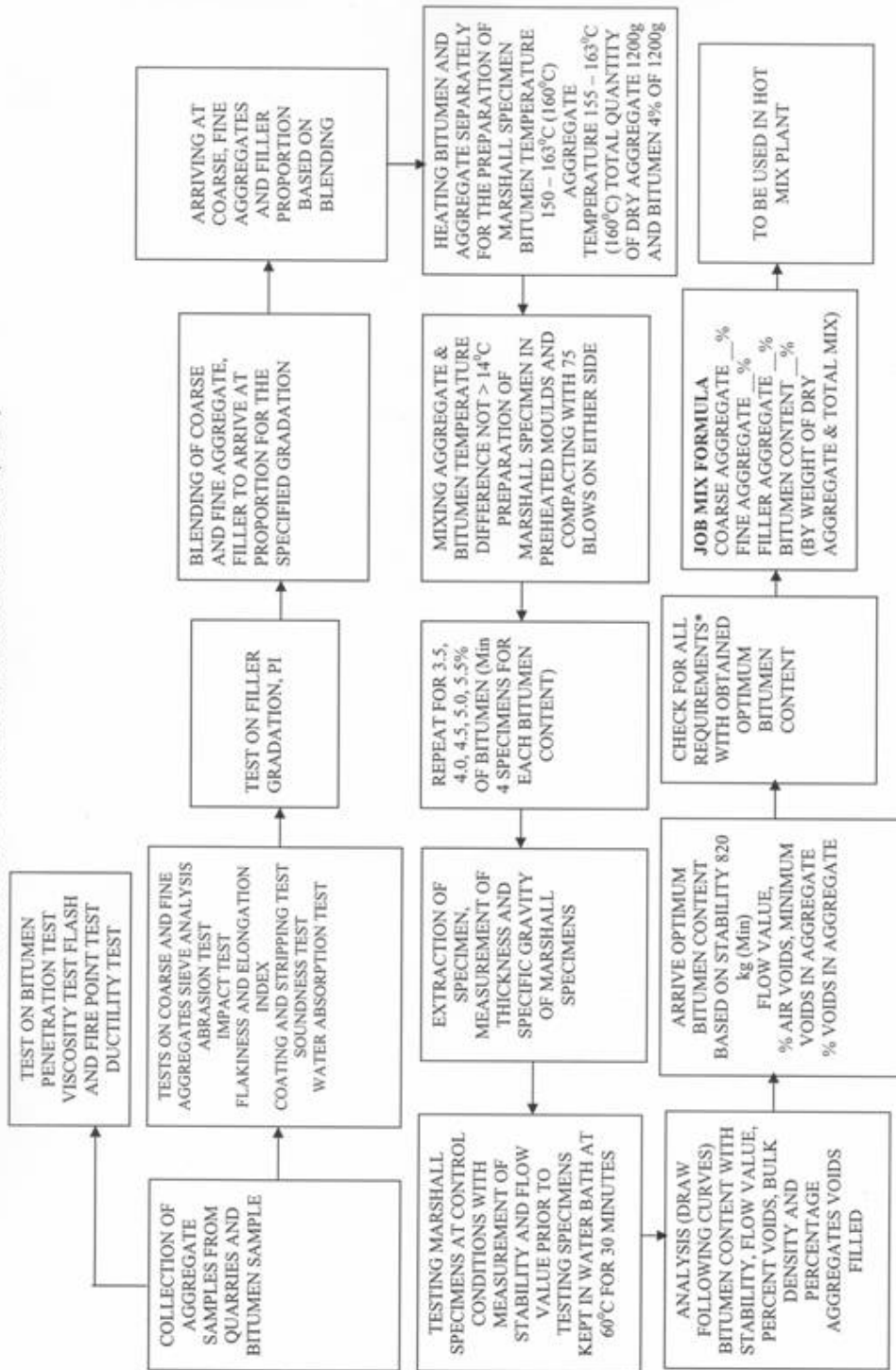


Figure 7.6
FLOW CHART FOR BITUMINOUS MIX DESIGN (BC)

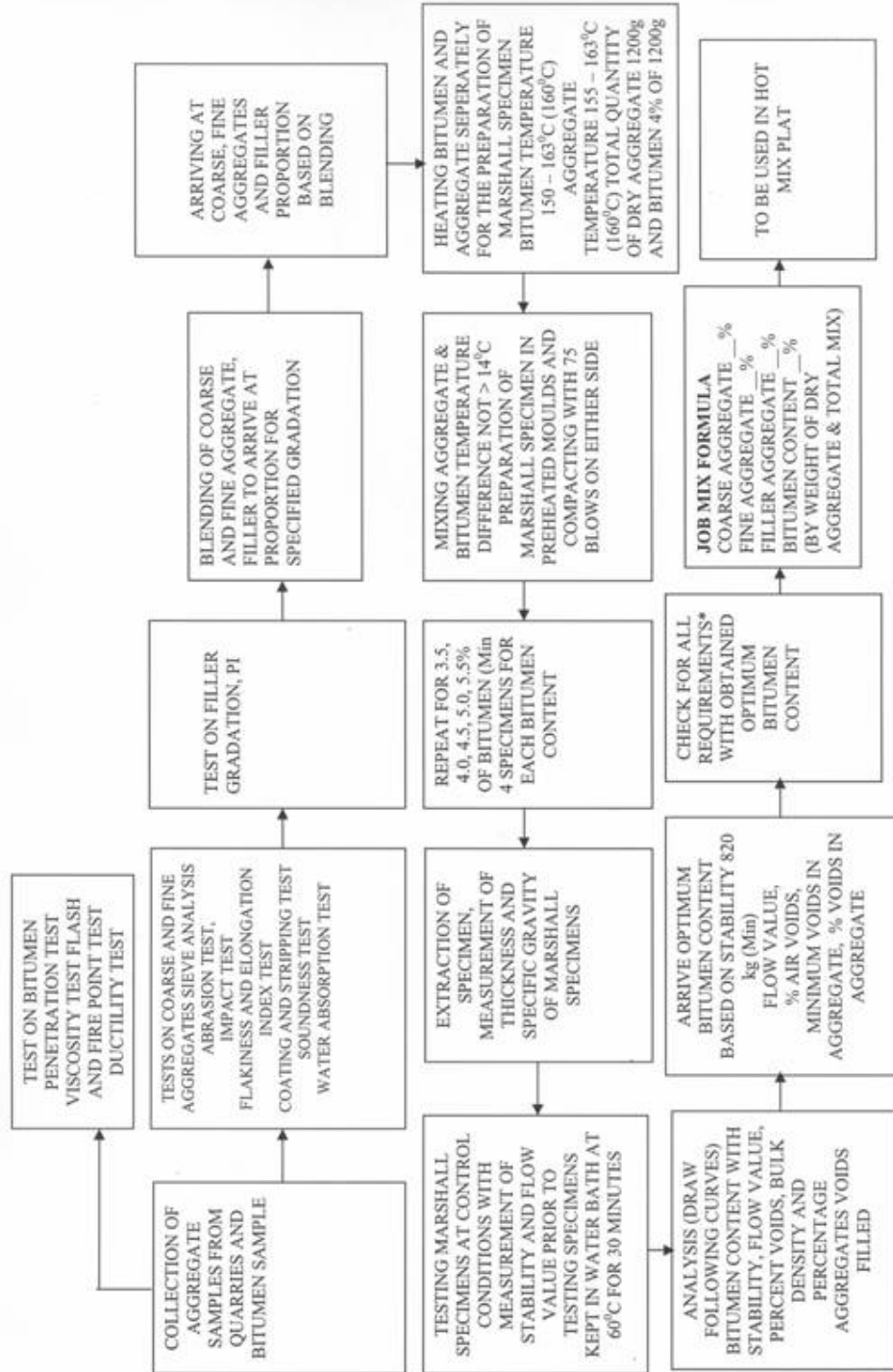


Figure 7.7
FLOW CHART FOR INSTALLATION AND RUNNING OF HOT MIX PLANT

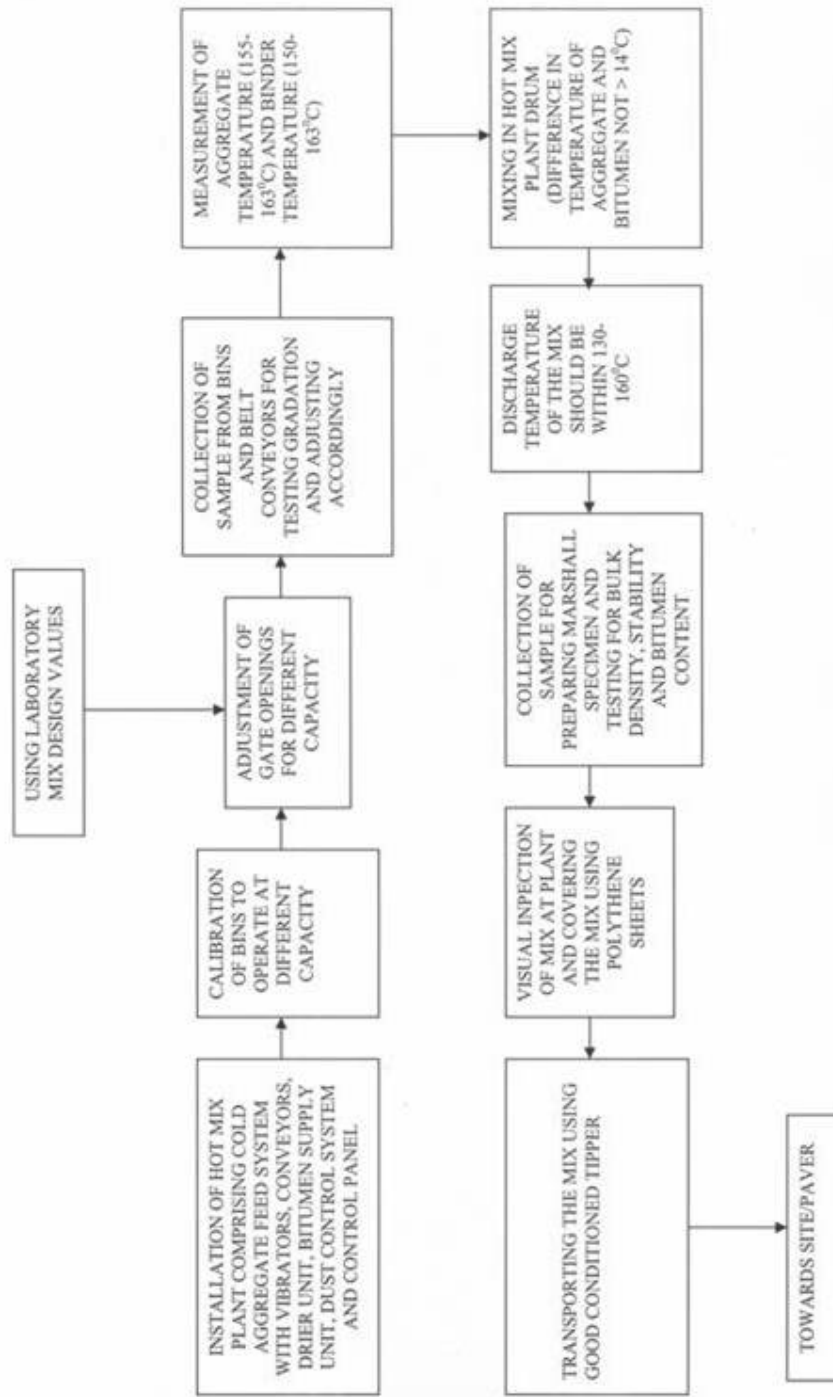
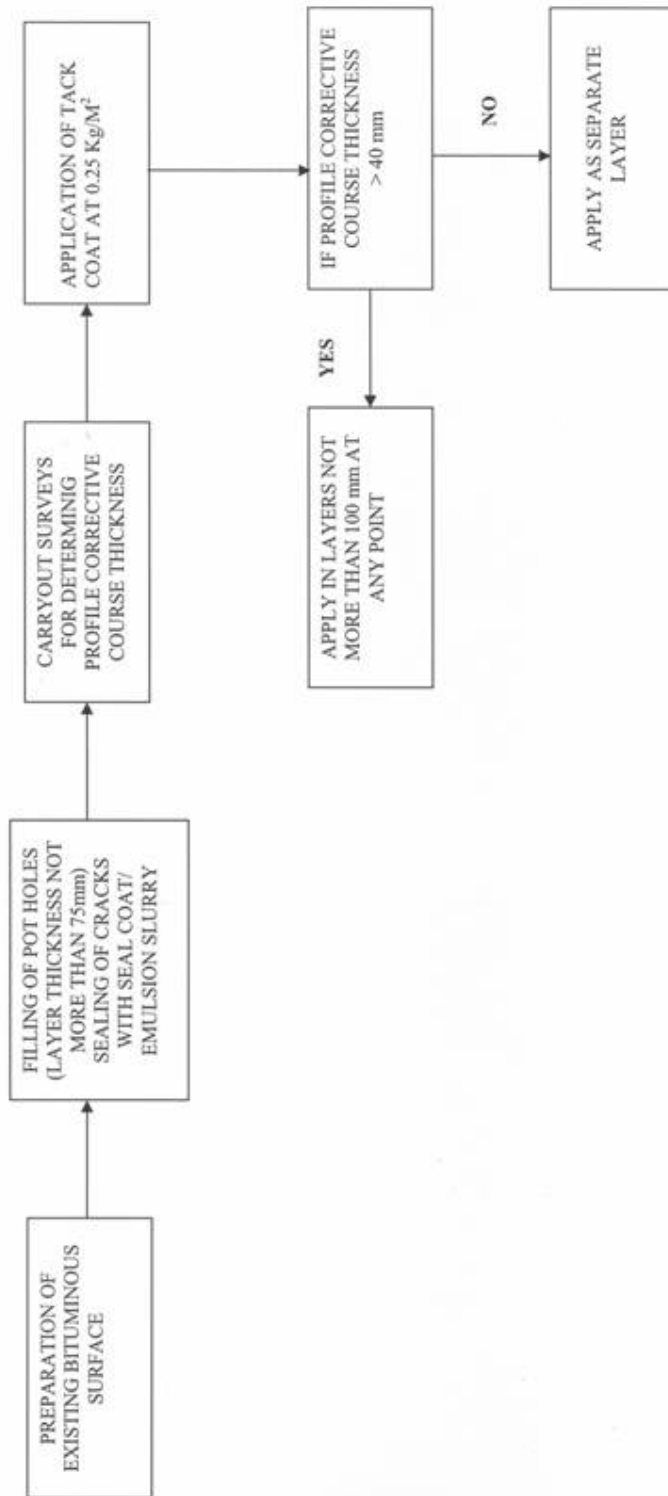


Figure 7.8
FLOW CHART FOR LAYING PROFILE CORRECTIVE COURSE



Note : PCC = Profile Corrective Course

Figure 7.9
FLOW CHART FOR CONSTRUCTION OF DBM/BC LAYERS

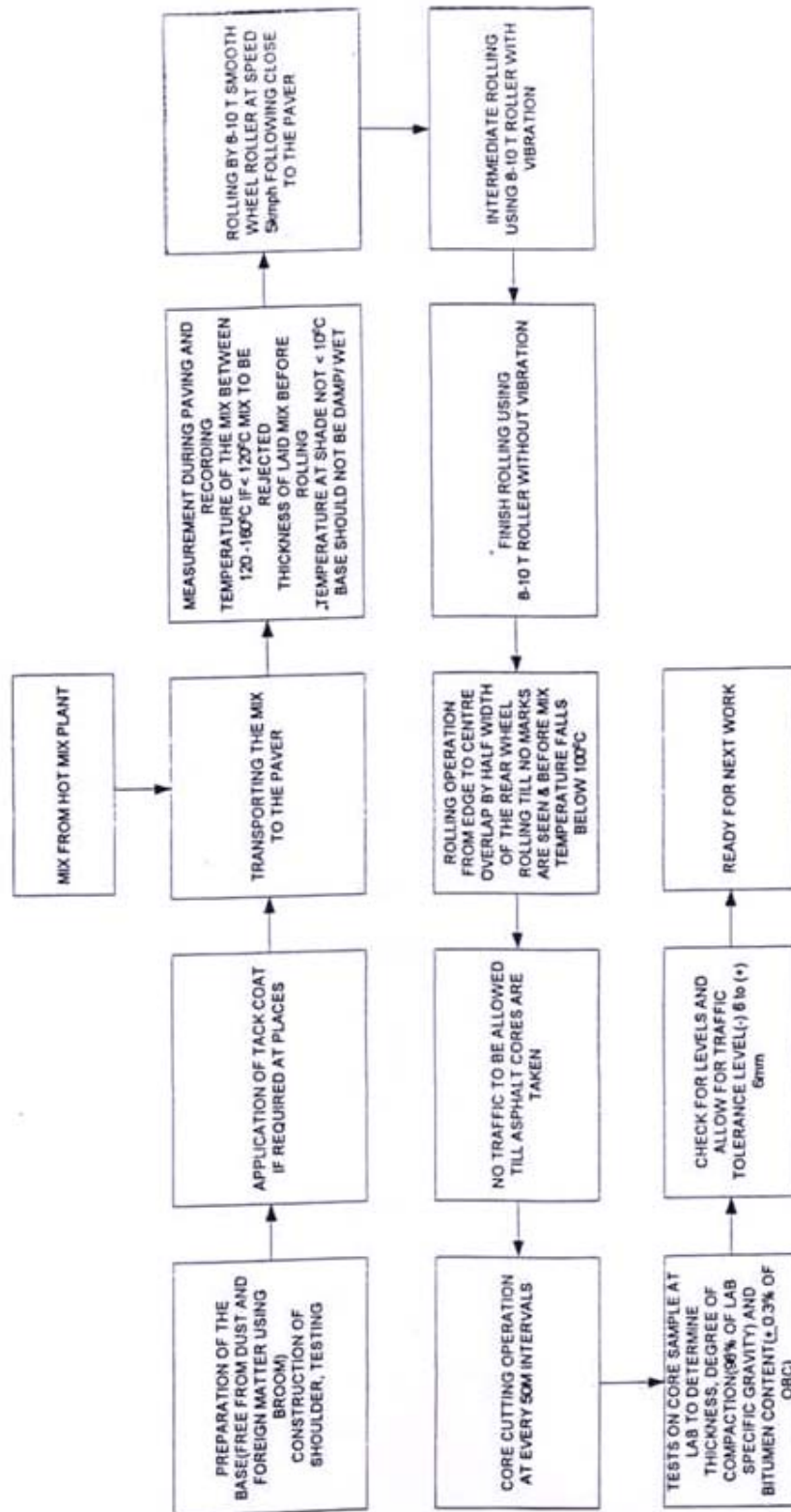


Table 7.1
List of Tests for Road Works

SI. No.	Process	Material		Test Ref. No.
		Name	Format No.	
1.	Embankment Formation	Soil/Earth	QC-M-07 QC-M-15	QC-R-01
2.	Excavation			QC-R-02
3.	Granular Sub-base Laying	Granular Sub-base	QC-M-08	QC-R-03
4.	WBM Laying	WBM	QC-M-09	QC-R-04
		Binder	QC-M-11	
5.	Prime Coat Application	Bitumen	QC-M-14	QC-R-05
6.	Tack Coat Application	Bitumen	QC-M-14	QC-R-05
7.	Surface Dressing	Bitumen	QC-M-14	QC-R-06
		Metal	QC-M-10	
8.	Bituminous Macadam Laying	Bitumen	QC-M-14	QC-R-07
		Metal	QC-M-10	
9.	DBM Laying	Bitumen	QC-M-14	QC-R-08
		Metal	QC-M-10	
		Fine Aggregates	QC-M-12	
		Filler (Lime)	QC-M-13	
10.	Mix Seal Surfacing	Bitumen	QC-M-14	QC-R-06
		Metal	QC-M-10	
		Fine Aggregates	QC-M-12	
11.	Bituminous Concrete Laying	Bitumen	QC-M-14	QC-R-08
		Metal	QC-M-10	
		Fine Aggregates	QC-M-12	
		Filler (Lime)	QC-M-13	
12.	On Completion of Laying of BM / DBM / BC	Stage completion test		QC-R-09

Table 7.2
Procedures for Testing Road Works

Embankment Formation			QC-R-01	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Moisture content as per IS-2720	TC-M-09-03	One test for each 250 m ³ of soil	In-process
2	Field density test as per IS-2720	TC-M-09-03	<ul style="list-style-type: none"> • For earthwork in embankment/cutting 5-10 density tests for each 1000 m² compacted area • For earthwork in sub grade/GSB and shoulders, 10 density tests for 500 m² compacted area 	
3	Rolling operation	Daily log	As per required number of passes	While rolling

Excavation			QC-R-02	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Layout, slopes of excavation, benching and over-burden	Daily log	As directed by the Engineer	After excavation
2	Sub-soil water, shoring and strutting	Daily log		
3	Bottom levels and compaction	Daily log		
4	Soil classification	Daily log		

Granular Sub-Base Laying			QC-R-03	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Moisture content as per IS-2720	TC-M-09-03	One test for 500m ² of compacted soil (3 observations per test)	In-process
2	Field density test as per IS-2720	TC-M-09-03	10 observations selected randomly for every 500m ² of compacted area	
3	Rolling operation	Daily log	Required No. of passes	While rolling

WBM Laying			QC-R-04	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Field Density Test by sand replacement method	TC-R-06-01	As directed by the Engineer	In-process

Prime Coat/Tack Coat Application			QC-R-05	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Temperature Test	Daily log	At regular close intervals	In-process
2	Rate of spreading	TC-R-02-01	Three tests for every 50 m length	

Surface Dressing/Mix Seal Surfacing/ Pre-mix Carpet			QC-R-06	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Rate of spread of mix material	TC-R-02-01	One test for every 500 m ³ of mix with 6 observations	In-process

Bituminous Macadam Laying			QC-R-07	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Temperature Test	Daily log	At regular close intervals	In-process
2	Rate of spread of mix material	TC-R-02-01	2-3 observations at every 10 m interval during paving	

DBM/BC Laying			QC-R-08	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Temperature Test	Daily log	At regular close intervals	In-process
2	Rate of spread of mix material	TC-R-02-01		
3	Stability of Mix/Marshal Stability Test	TC-R-05-01	3 samples for each 400 tons of mix produced subject to a minimum of 2 tests per plant per day.	While hot mixing

On Completion of BM / DBM / BC Layers Stage Completion Test			QC-R-09	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Core test for compacted layer (bitumen content, density and voids)	TC-R-07-01	One test for 250 m ² of compacted area	On completion of stage and before proceeding to next stage
2	Surface regularity and control of alignment	TC-R-07-02	One test for every 300 m of road length	

7.4 Guidelines for Pavement Layers

Guidelines for gradation and placement of WBM layer are given in Table 7.3 and 7.4, respectively; guidelines for application of prime and tack coats are given in Table 7.5; and requirements of bituminous mixes are given in Table 7.6. (These guidelines are provided for easy reference. The standards and specifications stipulated in the contract shall be adhered to.)

Table 7.3
Gradation for WBM Layers

Grade-II (Size: 63 mm to 45 mm)		Grade-III (Size: 53 mm to 22.4 mm)		Screening Material (Size: 11.2 mm)	
IS Sieve Designation (mm)	% by weight passing	IS Sieve Designation (mm)	% by weight passing	IS Sieve Designation (mm)	% by weight passing
90	100	63	100	11.2	100
63	90-100	53	95-100	5.6	90-100
53	25-75	45	65-90	0.18	15-35
45	0-15	22.4	0-10		
22.4	0-5	11.2	0-5		

Table 7.4

Guidelines for Placement of WBM Layers

Quantity Required for 10 Sq. m Area (Compacted thickness 75mm)		
Grading	Size (mm)	Loose Quantity (m³)
II	63-45	0.91-1.07
III	53-22.4	0.91-1.07
Screening Material for II	11.2	0.20-0.22
Screening Material for III	11.2	0.18-0.21
Binding Material (II/III)	---	0.06-0.09

Table 7.5

Guidelines for Prime/Tack Coat Application

Particulars	Standard Specified Rate (kg/m²)
Granular surface treated with primer	0.25-0.30
Granular base not primed	0.35-0.40
Normal bituminous surfaces	0.20-0.25

Table 7.6

Requirements of Bituminous Mixes

Minimum stability (kN at 60° C)	9.0
Minimum flow (mm)	2
Maximum flow (mm)	4
Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
Percent air voids	3-6
Percent voids in mineral aggregate (VMA)	See table 7.6(a)
Percent voids filled with bitumen (VFB)	65-75

Table 7.6 (a)

Minimum percent Voids in Mineral Aggregate (VMA)

Nominal Maximum Particle size (mm)	Minimum VMA, percent Related to Design Air Voids, Per cent ²		
	3.0	4.0	5.0
9.5	14.0	15.0	16.0
12.5	13.0	14.0	15.0
19.0	12.0	13.0	14.0
25.0	11.0	12.0	13.0
37.5	10.0	11.0	12.0

- Notes: 1. The nominal maximum particle size is one size larger than the first sieve to retain more than 10 per cent.
2. Interpolate minimum voids in the mineral aggregate (VMA) for design air voids values between those listed.

7.5 Tolerances

Requirements for surface regularity and tolerances are given below. (These requirements are for easy reference; the standard and special technical specifications as per the contract must be referred.)

7.5.1 Horizontal alignment tolerances

The horizontal alignment with respect to the centerline of the carriageway shall have a tolerance of ± 10 mm at the edges of roadway and of ± 25 mm lower layers.

7.5.2 Surface levels tolerances

Surface level tolerances are shown in Table 7.7.

Table 7.7 : Surface Level Tolerances

Type of Surface	Tolerance in Level Compared with Longitudinal and Cross Profile
Sub-grade	+ 20 mm/- 25 mm
Sub-base	+10 mm/- 20 mm
Base Course	
(a) Machine laid	± 10 mm
(b) Manually laid	± 15 mm
Wearing Course	
(a) Machine laid	± 6 mm
(b) Manually laid	± 10 mm
Cement concrete pavement	+5 mm -6 mm*

* This may not exceed -8 mm at 0-30 cm from the edges.

7.5.3 Surface regularity of pavement courses

The maximum allowable difference between the road surface and a straight line parallel with or at right angles to the centerline of the road at points shall be:

- For bituminous surface: 3 mm
- For GSB/base courses : 8 mm

The maximum permitted number of surface irregularities measured under a 3 m long straight edge at the middle of each traffic lane along a line parallel to the center line of the road shall be as shown in Table 7.8.

Table 7.8

Maximum Number of Surface Irregularities

Maximum Number of Surface Irregularities on Bituminous Road and Shoulders				
Irregularity	4 mm		7 mm	
	300	75	300	75
Length (m)				
National/State Highways	20	9	2	1
Town Roads	40	18	4	2

8 CONTROL OF PIPELINE WORKS

This section of the QA/QC Manual covers the testing of works and the inspection of workmanship for pipeline works (i.e. water and sewer lines) and liquid retaining structures. The requirements for testing and control of input materials are outlined in Section 5.

8.1 Construction Sequence and Control Flow Charts

Flow charts indicating the construction sequence and control points for materials used in pipeline work and for pipeline works are shown in Figure 8.1 and 8.2 respectively.

8.2 Testing of Works

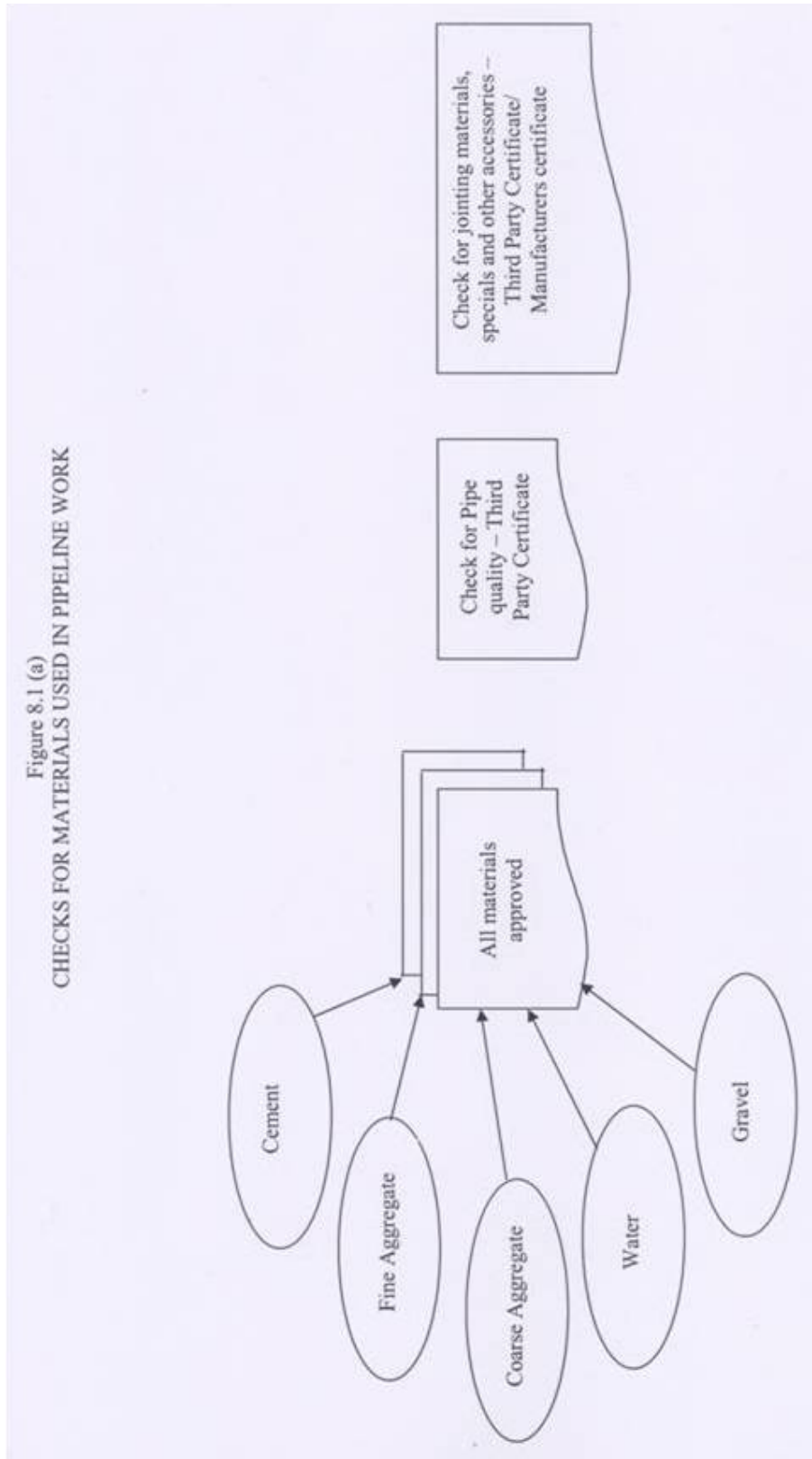
The works to be tested on site include bedding for pipelines, pipeline laying and jointing, and hydrostatic, leakage and water tightness tests after completion. All the materials proposed to be used in these works must have been tested by the Contractor and approved by the DSC well in advance of commencing works. The contractor shall obtain the approval of the DSC when a particular stage is completed and before proceeding to the next stage.

Tests for pipeline works and liquid retaining structures are listed in Table 8.1. Test procedures are presented in Table 8.2, under the referenced test numbers. For excavation, back-filling and re-paving works refer to Sections 6 and 7 of this Manual. Required materials tests are also indicated (materials testing procedures are presented in Section 5). Test report formats are included in Appendix A.

8.3 Inspection Checklists

An inspection checklist for pipeline works is included in Appendix B.

Figure 8.1 (a)
CHECKS FOR MATERIALS USED IN PIPELINE WORK



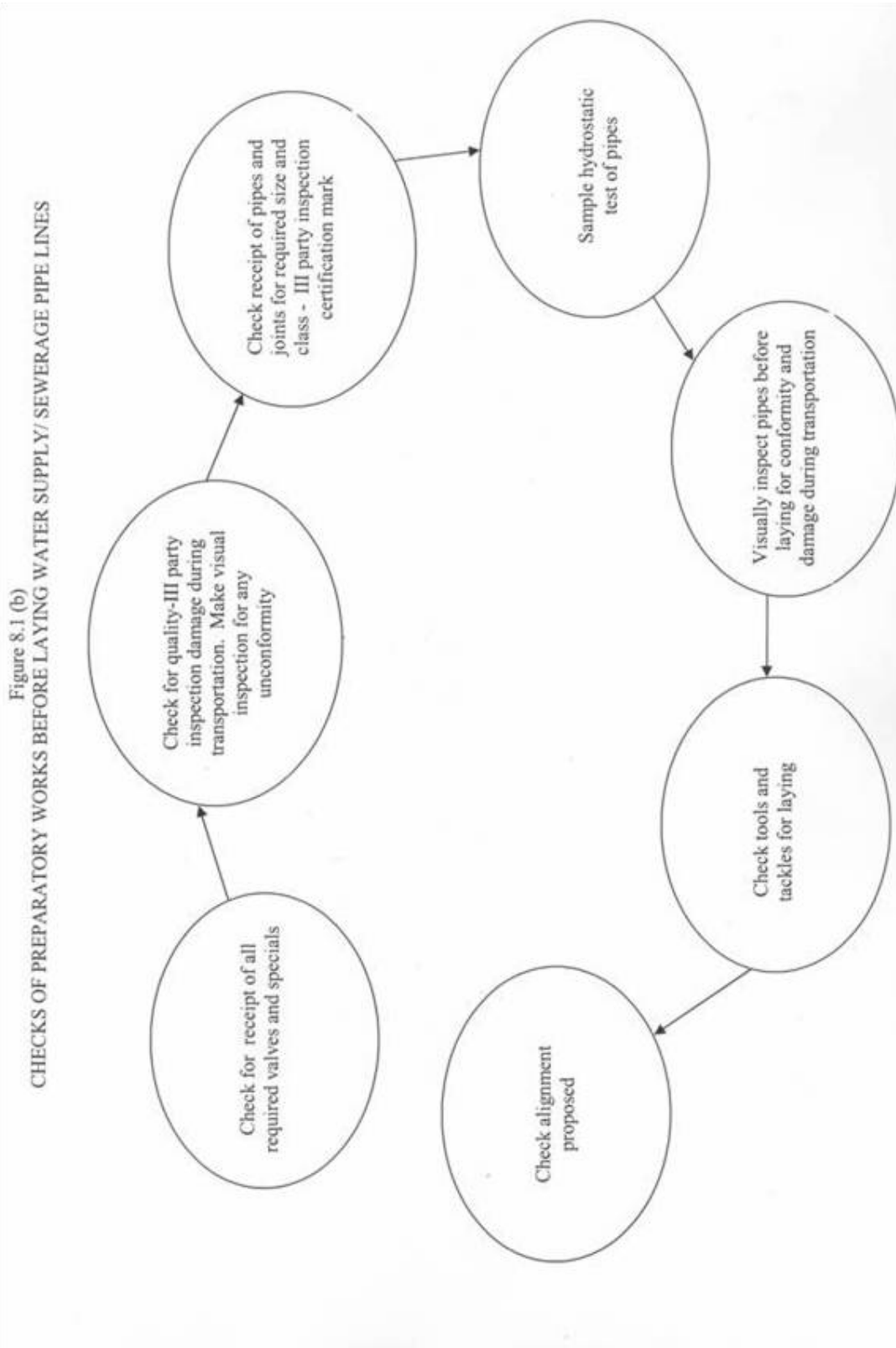


Figure 8.2
PROCESS CHART FOR PIPELINE WORKS WITH STAGES OF INSPECTION

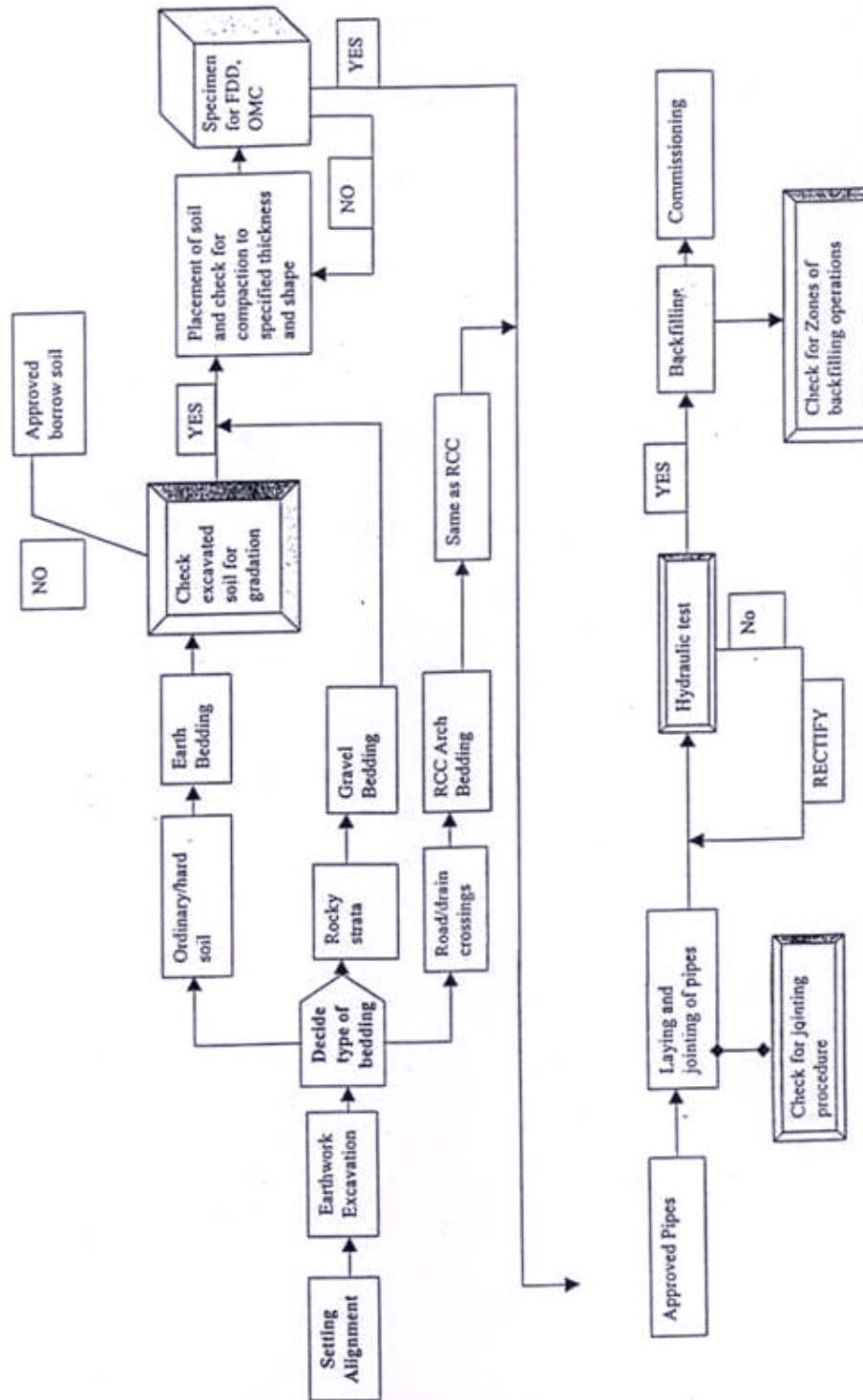


Table 8.1
List of Tests for Pipeline Works and Liquid Retaining Structures

SI. No.	Activity	Material		Test Ref. No.
		Name	Format No.	
1	Bedding for Pipeline			
1.1	Earth Bedding	Earth/Soil	QC-M-07	QC-P-01
1.2	Gravel Bedding	Gravel	QC-M-08	
1.3	Concrete Bedding	Cement	QC-M-01	QC-P-02
		Sand	QC-M-02	
		Water	QC-M-03	
		Coarse Aggregate	QC-M-06	
		Steel	MC (1)	
2	Pipeline Laying and Jointing			
2.1	GSW Pipe	Cement	QC-M-01	QC-P-03
		Sand	QC-M-02	
		Water	QC-M-03	
		Pipes	MC (1)	
2.2	RCC and CI Pipes	Pipes	TPI/MC (1)	QC-P-02
		Gaskets	TPI/MC (1)	
2.3	Coated and Lined Steel/PSC Pipes	Coated and lined steel/ PSC pipes	TPI (1)	
3	Manhole/Valve Chamber Construction	Cement	QC-M-01	QC-P-02
		Sand	QC-M-02	QC-P-03
		Water	QC-M-03	
		Bricks	QC-M-04	
		Coarse Aggregate	QC-M-06	
		Cover	TPI (1)	
		Frame/Vent shaft etc.	MC (1)	
		Steel	MC (1)	
4	Completion of Pipeline Laying and Jointing	Stage Completion Test		QC-P-04
5	Completion of Manhole/ Valve Chamber Construction	Stage Completion Test		QC-P-05
6	Completion of Liquid Retaining Structures (Wet Wells, Storage Reservoirs, Pretreatment Units, RCC Open Channels, etc.)	Stage Completion Test		QC-P-06

Note: 1. MC = manufacturer certified; TPI = third party inspection.

Table 8.2
Procedures for Testing Pipeline Works and Liquid Retaining Structures

Earth Bedding			QC-P-01	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Moisture content as per IS-2720	TC-M-09-03	One test for each 250 m ³ of soil	In-process
2	Field density test as per IS-2720	TC-M-09-03	One test for each 100 m ² of compacted area	

Concreting			QC-P-02	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Compressive strength as per IS-516	TC-G-01-01	<ul style="list-style-type: none"> • 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 of concrete + one set every 50 m³ of additional concrete work. 	Test samples to be taken while pouring. Tests to be done as specified in the contract.
2	Slump test per IS-1199	TC-G-01-02	Random checks throughout concreting period as directed by the Engineer	Before pouring concrete
3	Steel reinforcement placement and bending	Daily log	Before pouring concrete	Before pouring concrete
4	Concrete Pour Report	TC-G-01-03	When pouring is done	Immediately after pouring

Mortar			QC-P-03	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Compressive strength as per IS-2250	TC-G-01-01	One sample for every 2 m ³ of mortar subject to a minimum of three samples for a day's work	Test samples to be taken while placing. Tests to be done as specified in the contract.
2	Consistency as per IS-2250	TC-G-01-02		

Completion of Pipeline Laying and Jointing			QC-P-04	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Hydrostatic test for NP pipes	TC-P-04-01	One test for defined stretch	On completion of stage
2	Hydrostatic test for pressure pipes	TC-P-04-02	One test for defined stretch	On completion of stage

Completion of Manhole/Valve Chamber			QC-P-05	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Leakage Test	TC-P-05-01	100% inspection	On completion of stage

Completion of Liquid Retaining Structures			QC-P-06	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Water tightness for underground structures	TC-P-06-01	One test per structure	On completion of stage
2	Water tightness for elevated structures	TC-P-06-02	One test per structure	

9 CONTROL OF ELECTROMECHANICAL WORKS

This section of the QA/QC Manual gives an overview of the quality control requirements for electromechanical works, such as water treatment and supply systems, sewage treatment plants, compost plants, pumping systems, and power supply and distribution systems. The requirements for testing and control of input materials and components, including manufacturers' certification and third party inspections, are outlined in Section 5.

Materials and components to be incorporated into electromechanical works shall be inspected by PIU and DSC as soon as they are delivered, to ensure that they meet the specifications and design requirements, are in agreement with shipping documentation, and are accompanied by manufacturer's certifications or third party inspection certificates, as applicable. Accepted materials and equipment shall be properly stored by the contractor until needed. If manufacturer's installation instructions conflict with design or contract requirements, the PMU, PIU and PMC shall be notified immediately. Installation shall proceed only after the conflict has been resolved.

A series of inspections and tests during installation and completion of electromechanical works shall be performed by the contractor or the equipment manufacturer and witnessed by PIU and DSC, as follows:

- **Preparatory Inspections:** Prior to installation, the civil and structural works where electromechanical equipment is to be installed shall be inspected to ensure conformance with designs and equipment installation requirements.
- **Installation Inspections and Tests:** A system of inspections and tests, as specified in the contract or recommended by the equipment manufacturer, shall be employed throughout movement to position and installation of equipment and systems. Inspections shall be performed by DSC at critical points during installation. Surveillance shall be provided by PIU/DSC throughout the progress of work to ensure that installation is performed in accordance with the contract requirements, approved drawings, acceptable workmanship standards and configuration control requirements. All field modifications and retrofit work shall be performed under the surveillance of the PIU and DSC installation inspector.
- **Installation Verification Inspections:** Prior to all mechanical and electrical testing, verification inspections shall be performed to ensure that equipment has been satisfactorily installed.
- **System Tests:** These tests shall be conducted as appropriate to demonstrate that the installed systems are free from damage due to shipment and installation, and that equipment performs in accordance with specifications.
- **Integrated Tests:** After completion of system tests, integrated tests shall be performed to demonstrate that the system performs satisfactorily when connected to its interfacing systems or sub-systems. These tests will be followed up by commissioning tests.
- **Commissioning Tests:** These consist of a series of tests performed under service operating procedures to demonstrate compatibility of the physical plant with operating procedures.
- **Final Inspections:** Final inspections shall be performed to ensure that the completed work is in accordance with the contract and that all previously identified discrepancies have been resolved satisfactorily.

10 DOCUMENT CONTROL

Document control is intended to provide a consistent framework for transmittal, receipt, recording, processing, filing and retrieval of documents, and to ensure commonality in formats. The most important documents for QA/QC are final design documents, test reports and instructions. A flow chart for control of these documents is shown in Figure 10.1. Document control procedures, including guidelines for correspondence control, are outlined below.

10.1 Design Document Control

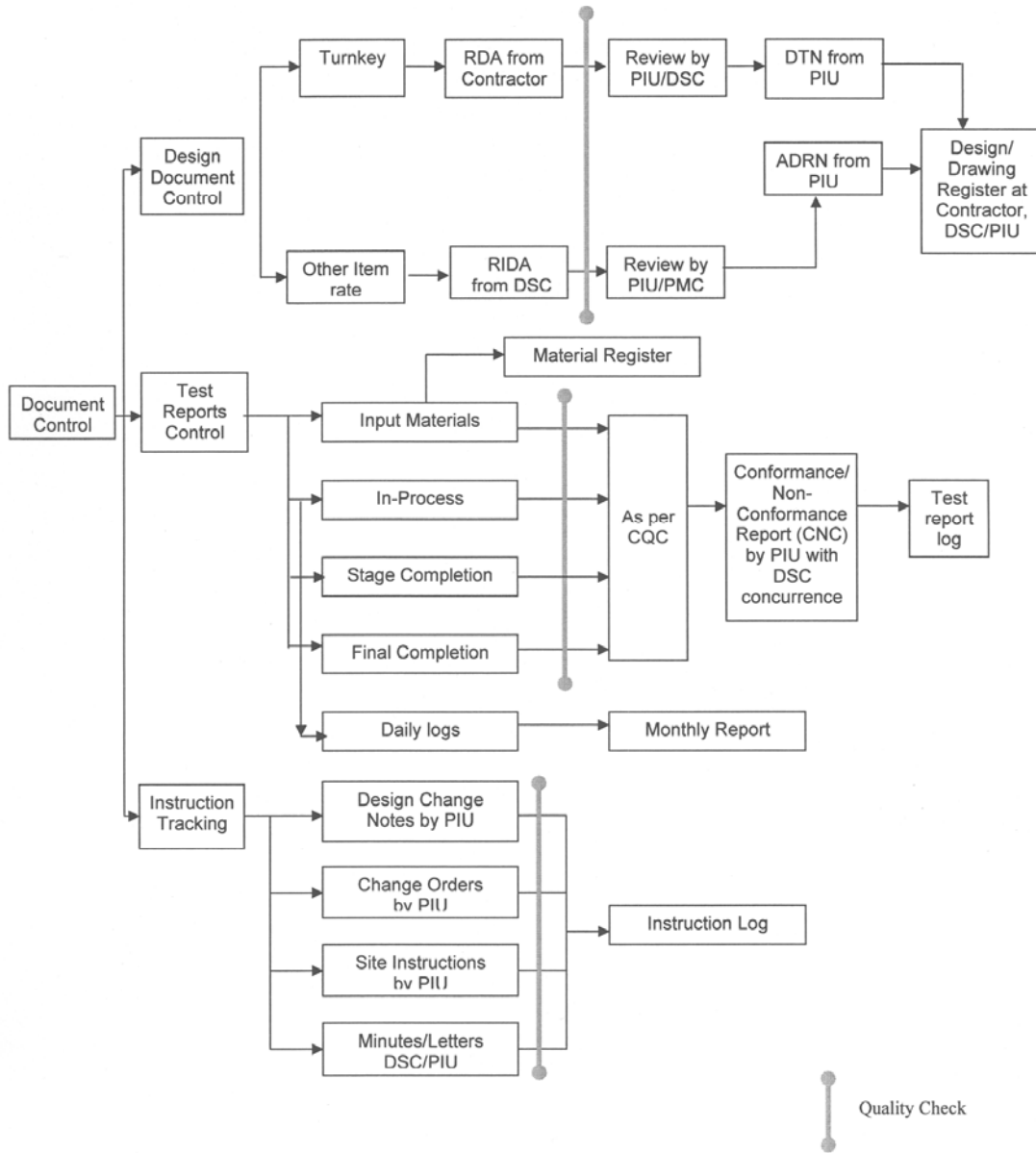
As discussed earlier (See Section 3), final design documents (drawings, calculations, estimates, etc.) are generated at three separate levels, depending on the contracting procedure and type of work. These factors have been considered in suggesting the design document control system.

10.1.1 Turnkey contracts

The flow of final design documents prepared by the contractor in turnkey contracts shall be as follows:

1. The contractor shall submit three copies of design documents to PIU for review, using the Request for Design Approval (RDA) Format F-1 of Appendix C.
2. The PIU shall send one copy of the documents to DSC for review and comments, using the Request for Internal Design check Review and recommendation (RIDCRR) Format F-2 of Appendix C.
3. After review, the DSC shall return the documents with its comments, using the Internal Design check Review and recommendation Note (RIDCRR) Format F-3 of Appendix C.
4. Taking into account the comments of DSC, the PIU shall get it reviewed & checked from PMC with its recommendation for approvals & not approval using (RIDCRR) format F-2 and accordingly return the design documents to the contractor, using the Design Transmittal Note (DTN) Format F-4 of Appendix C. Design documents shall be marked (or stamped) 'Approved', 'Approved as Noted' or 'Not Approved'.
5. For design documents marked 'Not Approved', steps 1 to 4 above shall be repeated. For documents noted 'Approved' or 'Approved as Noted', the contractor shall submit originals to PIU for affixing 'Approved' signatures (using a format similar to F-1.).
6. The PIU shall have the design documents signed 'Approved' and return them to the contractor (using a format similar to F-4).
7. The design document details are to be recorded in the contractor's Design/Drawing Register, using the Format F-5 of Appendix C. (Similar registers shall also be kept by PIU and DSCs.)

Figure 10.1
FLOW CHART FOR DOCUMENT CONTROL



10.1.2 Item rate contracts (Wending Drawings)

The design documents are prepared by the DSC. The flow of documents is summarized below.

1. Copies of design documents prepared by DSC shall be forwarded to PIU and PMC for review, using the Request for Internal Design Approval (RIDA) Format F-2 of Appendix C with copy to PMU for information.
2. After review, PMC shall forward to PIU the documents with its comments, using the Internal Design Review Note (IDRN) Format F-3 of Appendix C.
3. Taking into account the comments of PMU/PIU/PMC for modification if any, the PIU shall return the design documents to DSC, using the Internal Design Transmittal Note (IDTN) format F-9 of Appendix C. Design documents shall be marked (or stamped) Recommended for approval as 'Noted' or 'Not Approved'.
4. For design documents marked Recommended for approval as noted 'Not Approved', steps 1 to 3 above shall be repeated. For documents noted 'Approved', the DSC shall submit originals to PIU/PMU for affixing 'Approved' signatures (using a format similar to F-8.).
5. After the design documents have been signed 'Approved' for construction, they shall be transmitted to the contractor by PIU, using the Approved Design Release Note (ADRN) Format F-6 of Appendix C.
6. The document details are to be recorded in the contractor's Design/Drawing Register, using Format F-7 of Appendix C. (Similar registers shall also be kept by DSCs.)
7. The detailed construction drawings prepared by contractor/DSC may be approved by PIU. PIU may refer if they feel it necessary to PMC/PMU for review.

10.2 Test Report Controls

All the tests and field checks are to be carried out as per the applicable quality control requirements. The tests are carried out by the contractor who will designate (Engineer) a laboratory-in-charge authorized to sign test reports for him. The witnessing officer will sign the reports and put his name and designation. The flow of test report documentation shall generally be as follows:

1. Test reports shall be submitted by the contractor to the DSC.
2. The DSC shall forward a copy of the test reports to PIU for its review in its monthly report along with contractor's monthly report.
3. The DSC shall issue a Conformance/Non-Conformance Report (CNC Report) to the contractor after review of test results by the DSC, using Format F-10 of Appendix C. The CNC reports will have a running serial number for each contract package.
4. The CNC report shall be entered in the Test Report Log by the contractor at the site, using Format F-11 of Appendix C. The details of input materials will be recorded in the Material Register, using Format F-12 of Appendix C. The contractor shall maintain all test records properly.

Other approvals given to the contractor will be recorded in the daily logs of the contractor which should form part of the contractor's monthly report. A recommended format for Daily Work Record/Site Order Book is illustrated in Format F-13 of Appendix C.

Similar procedures shall be followed for the transmittal and review of test reports for tests performed at outside laboratories, for manufacturers' certificates, and for third party inspection reports.

10.3 Tracking of Instructions

During the process of construction, different agencies are expected to conduct site visits and instruct the contractor to ensure quality and timely construction within the costs to the extent possible. The multiplicity of agencies is a special feature of the Project. Hence there may be some ambiguity in the instruction flow if these are not transmitted and recorded properly.

All the instructions to the contractor shall flow through the Engineer of the PIU. The instructions are of the following types:

1. All instructions related to the contract administration including approval of the contract variation orders, time extensions, notices related to rate of progress etc..
2. The instructions regarding quality, testing, monitoring and work scheduling can be issued by the DSC also. In case of conflict of instructions of the PIU and DSC in these matters, the instructions of the PIU would prevail.
3. Instructions issued during site visits or inspections of the PMU, PMC, PIU and DSC, which are normally recorded in the contractor's Site Order Book, shown in Format F-13 of Appendix C; and
4. Instructions issued during review meetings in the form of minutes, letters, etc.

All instructions noted above are to be recorded by the contractor in the Instruction Log, using Format F-15 of Appendix C. Instructions also include notices of rejection of work inspected because it was found to be non-conforming to requirements and which has to be redone or rectified.

10.4 Site Order Book

The Contractor shall be responsible to maintain a Site Order Book, in duplicate, at the site of the works at all times, and this shall be open for inspection by authorized representatives of RUIDP, the PMC, the PIU and the DSC.

The Site Order Book has two primary purposes – to record the day-to-day instructions to the Contractor and the Contractor's compliance with these instructions, and to record the inspection and acceptance of work completion stages along with issuing approvals to the Contractor to proceed with the next stage of construction.

As noted above, the status of the Contractor's compliance with instructions issued is to be summarized in the Instruction Log (Format F-15 of Appendix C), and reviewed monthly by the DSC/PIU and during the periodic Squad Checks. In cases where the Contractor has failed to comply with the instructions, the reasons therefore shall be determined and necessary remedial actions taken.

The Support Engineer DSC will also maintain a parallel site Order Book to ensure compliance.

10.5 Correspondence Control

Out-going letters (including transmittal letters and notes) originating from various organizations involved in the Project (PMU, PIUs, PMC, DSCs, contractors, manufacturers, etc.) shall be signed only by the designated project executive of that organization (for example PMU Director or person authorized on his behalf, PIU Superintending Engineer, PMC Team Leader, DSC Team Leader).

All letters should have a reference code and number, and should refer to a single subject only, which shall be clearly stated on top of the letter, after the recipient's address. All

outgoing letters should be numbered sequentially. All replies should refer to the originator's reference code and number and subject.

Incoming correspondence should be stamped and dated, and preferably given an internal reference code and number. All incoming and outgoing correspondence should be logged chronologically, either in computer correspondence registers or in manual correspondence logs.

Copies of outgoing correspondence and originals of incoming should be filed in chronological files at the document center of each project organization. There should be only one chronological file for all outgoing correspondence. Regarding incoming correspondence, there could be more than one chronological file, based on the volume of correspondence expected to be received from project related organizations (for example IAs can maintain separate incoming chronological files for each contractor, etc.)

10.6 Inspection of Site Documentation

During site visits and inspections, DSC and PIU will check and follow up with the documentation maintained on site by the contractor, as follows:

- Check the Design/Drawing Register and ensure that the approved designs and drawings are being used during construction.
- Check the Test Report Log and ensure that a Conformance Report has been issued by the DSC for the materials being used.
- Check the Material Register and cross-check the material test reports with inward and consumption entries of the Material Register.
- Check the Instruction Log and the Daily Work Record/Site Order Book and ensure that the instructions, as recorded in these registers and issued through any letters or minutes of meeting, are being implemented by the contractor.
- Check the Daily Logs and ensure that the standard of works and documentation is of acceptable quality.
- Deviations, if any, are to be recorded in the Site Order Book and a copy circulated by the contractor to the PMU, PMC, PIU and DSC.
- The registers that are verified by the PIU and DSC are to be signed by them.

11 REPORTING

This section of the QA/QC Manual outlines the Project's requirements for progress reporting and suggests formats for reports.

11.1 Types of Progress Reports

The Project provides for four main levels of reporting, as follows:

1. Contractors' Monthly Progress Reports;
2. Design and Supervision Consultants' (DSC) Monthly Progress Reports; counter signed by PIU.
3. Project Management Consultant's (PMC) Monthly Progress Reports; and
4. Quarterly Progress Reports (prepared with assistance from PMC and DSC)

11.2 Reporting Schedule and Distribution

The timetables for submission of progress reports and distribution requirements are summarized below.

11.2.1 Contractors' progress reports

The contractor's Monthly Progress Report, along with his monthly running bill, shall be submitted to the DSC (Support Engineer, who will give a receipt) by the 8th of the month (original plus 5 copies). To facilitate timely payment, joint measurements shall be taken by the Contractor, Junior Engineer PIU and the DSC by the 7th of each month. The Support Engineer DSC will enter the agreed measurements. The JE-PIU will verify 100% measurements in MB. The reporting period would be up to end of previous month.

11.2.2 Monthly contract reports

The DSC shall prepare a Monthly Progress Report for each contract, consisting of (i) a "Statement of Exceptions" commentary on the contractor's progress report, and (ii) a discussion of the major problems and actions taken or proposed to be taken. This shall be distributed, together with a copy of the Contractor's report, by the 10th of the month, to:

- PMU
- PMC
- PIU

The DSC would also submit the monthly running bill received by him from the PIU duly verified and entered as accepted in measurement book (DSC will make quality certification and 100% check of measurements) along with his monthly progress report copy to PIU by the 10th of each month.

11.2.3 Monthly finance reports

The PIU will send a monthly finance report to the PMU by 31st of every month to report the funds receipt and utilization, statement of expenditure pending liabilities and expenditure forecasts.

The DSC shall also prepare a Monthly Financial Report for the works under his jurisdiction consisting of (i) a "Summary Statement of Fund Utilization", and (ii) a "Statement of Expenditures" report(s) in the approved ADB format and submit to PIU with supporting documentation by the 25th of each month. Copies of "Summary Statement of Fund Utilization" are to be provided to PMC and PMU.

11.2.4 Design and supervision consultants' progress reports

DSCs shall also consolidate the contractors and its monthly reports into one Monthly Progress Report (This should be signed by the PIU also) for each town and distribute by the 30th of the month to.:

- PMU (5 copies)
- PIU (1 copy)
- PMC (1 copy)

11.2.5 Project management consultant's progress reports

The PMC shall prepare and issue a consolidated Monthly Progress Report for the Project as-a-whole by the 5th of the month to:

- PMU (5 copies)
- PIUs (1 copy each)
- DSC (1 copy each)

11.2.6 Quarterly progress reports

Based on the monthly progress reports, PMC shall assist RUIDP in preparing and issuing Quarterly Progress Reports by the 20th of the month following the end of the Quarter for submittal to the Asian Development Bank, Empowered Committee and all involved agencies.

11.3 Report Formats

Suggested formats for contractors' and DSCs' monthly reports are presented in Appendix D.1, D.2 and D.3 respectively.

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