OFFICE OF PROJECT DIRECTOR

RAJASTHAN URBAN INFRASTRUCTURE DEVELOPMENT PROJECT (RUIDP)

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HAND BOOK
ON
WATER SUPPLY SECTOR
FOR
FIELD ENGINEERS

RUIDP

RAJASTHAN URBAN INFRASTRUCUTRE DEVELOPMENT PROJECT

1 Introduction

Drinking Water Supply is one of the most important sectors for intervention. There are existing water supply systems in the towns proposed to be covered. The demands for the system improvements in these towns can be very large. The proposals for improvement of the water supply will therefore have to be tailored to be within the limitations of the funds available for the sector in the town. A comparative benefit/cost of different works should be considered and the most beneficial and cost effective proposals have to be prepared after interaction with the PHED and the local city level authorities. The following guidelines should be considered during taking up projects under this sector:

2 Objective

The objective of public protected water supply system is to supply safe and clean water in adequate quantity, conveniently and as economically as possible. Water supplied should be free from pathogenic organisms, clear, palatable and free from undesirable taste and odour, of reasonable temperature, neither corrosive nor scale forming and free from minerals which could produce undesirable physiological effects.

3 Design overview

The Water Supply Systems when being re-organized, should be targeted for the projected population of the city for next 30 years (Year 2041 for RUSDIP). The population projections for the city should be developed adopting all the standard methods, looking into the dynamism and future prospects of the town and keeping in view the projections that may have been developed by the Town Planning Department for the city.

The population projections of the city should be further subdivided in projection of population of wards. This will differentiate in the growth according to the present status of the wards e.g. an already crowded ward is likely to not grow or grow slowly, an average developed ward will grow moderately and the wards which are new and sparsely developed so far will grow faster. These projections should be discussed with the local town planning officials, PHED and the city officials. Their opinion on the distribution of population and it's projection should also be considered before finalizing the figures. These figures should then be used for arriving at the distribution zone wise population and water demand projections. No proposals for any individual locality can be considered unless this city exercise is complete and the proposal is in line with the city projection.

The rate of water supply may be adopted as 135 lpcd with addition of 20% losses (this includes losses for transmission system if very long @ 2% (max.) and 3% for treatment plant may be taken where applicable and 15% distribution losses ie. 169 lpcd for production purpose).

The rate of supply includes all institutional and small industry demands. However if there is a major bulk consumer, that may be taken separately.

Capacity of raw water reservoir should be as per periodic availability of raw water from canal on case to case basis. The water to be taken for drinking purposes from source should be got reserved from the Irrigation Department before taking it in to account.

The confirmation of the reliability of the water sources proposed is an important aspect and the data should be carefully collected and evaluated. In case of ground water sources, the reports of the hydro geologist conversant with the local areas should be obtained.

The transmission system should be designed in accordance to the capacity of the water source. The most economic option of using 1, 2 or 3 pipes can be worked out for major and long period transmission systems. The discount rate is adopted as 10.0 %, the rate of power may be adopted as Rs. 4.75 / unit. No provision for escalation of power rates is made in the evaluation. Usually the period for evaluation should be 15 or 30 years.

The possibility of using recycled water for restricted usage should be considered as a part of the water resource development.

Opportunities for recharging of water basin should also form a component of resource development.

New Pumps should be designed for a 15 year period. However space should be planned for a period of 30 years.

All elements of our design should be assumed for working of 22 hours. It should be supported through reliable power supply system.

4 Proactive Action before starting of work

It is very important to envisage and foresee the hindrances and bottlenecks at the very early stage, so as to facilitate smooth and time-bound functioning of a Contract. All concerned personnel of DSC & IPIU and Contractor are required to enlist such issues, take pro-active action and evolve strategies to ensure speedy action narrated below. It should be our endeavor to expedite matters in the following fields:

(a) Handing over of hindrance free site to the Contractors

(b) Approval from Forest Department / Land acquisition / Removal of encroachments etc.

(c) Shifting of underground utilities & charged electrical over head lines;

(d) Timely issue of Construction / working drawings.

(e) Timely approval of work plan for the contract and its strong monitoring.

(f) Approvals from Railways like (a) crossings of the Railway lines (b) activities through their lands.

(g) Statuary clearances, safeguard compliances as per requirement of the sub-project.

(h) Excise benefit in RUIDP Contracts on the basis of Essentiality Certificate.

(i) Early submissions of designs for proof checking and pursuance for prompt compliance of observations/comments of PMC and proof checker.

(j) Timely foresee the hindrances and bottlenecks, so as to facilitate, smooth and time-bound functioning of a Contract.

(k) Process for Mobilization advance to the Contractor.

(l) Adequate mobilization of Man power, Material, Machinery and finances.

The site should be immediately handed over in writing at the time of issue of Notice to Proceed (NTP). Record should also be made before physically handing over the site.

The DSC & PIU engineers should assess the quantities in accordance to the BOQ well before the NTP for issue of Essentiality certificate and to facilitate the Contractor for timely procurement of material & equipments.

The delay in shifting of utilities may become major constraint in timely completion of the work. The EE PIUs & DSC's Engineers needs to have pro-active approach in advance assessment of the quantum of work and should involve line agencies much before the Letter of acceptance is issued. The EE PIUs are required to take estimates

& necessary approval from the line agencies well in advance and should be ready to take up the work of shifting of utilities immediately after the issue of Notice to Proceed. In order to carry out correct assessment of hindrances & utilities at the work site, layout in lime powder should be marked at the site right in the design phase or at the earliest. It should be clearly understood that this is the job of PIU & DSC and contractor can be facilitated greatly if advance actions are taken much before his arrival on the scene.

A list of required designs & construction drawings good for execution (to be provided at the time of issue of NTP) and their issue date to the Contractor should be prepared jointly by the DSC & PIU for item rate contracts. The copy of the issue of drawings should be given to IPMC & PMU. The IPMC will monitor the issue of such drawings for each package.

A list should be prepared by the DSC & PIU for required designs & construction drawings good for execution to be submitted by the Contractor at the time of issue of NTP for Turnkey contracts. The detailed chart should be prepared and monitored weekly by the PIU for targeted dates of initial submission, joint review by DSC & PIU, approval from IPMC if required, re-submission if required and final approval.

It has been assumed that there will be no need for more then one review. This depends on the comprehensiveness of the review and the attention paid during the first re-submission. Both the agencies should ensure that no case goes beyond one review. If for some reason, it is felt that the case may require more reviews, the submission should be proponed for the period of issue of comments and review. This would be the responsibility of the agency making first submission.

It is very important to prepare & weekly monitor a detailed work plan of each Contract identifying minutest activities to the last detail. Successful contract management requires preparation of detailed work plan. If planning is detailed & accurate, half the battle is won. The four M's of Construction Management i.e. Man power, Material, Machinery and Money resources should be thoroughly assessed while approving the work plan of the contractor. This is also most important document under the Contract to implement escalation clause.

Lack of communication is not desirable for better performance of the work. There should be proper coordination with the consultants, better rapport between client and contractor, better formal communication systems and proper crisis management.

Contractor should be pressed hard to make initial efforts for procurement of material, equipments, staff to maintain good progress in the very first month, so that pace & momentum in the coming months can be maintained at desired level. The timely payment of the mobilization advance should be ensured to the Contractor.

Proper file maintenance should be ensured in PIU office for each contract. All correspondence with the contractor should be carried out on that file.

The measurement books should be procured in advance and the register should be maintained for the issue & movement of the same. The MBs should be issued only through this register mentioning all relevant details.

This circular should be abided by all the members of IPMU, IPIU, IPMC and DSC

5 Execution of Water Supply Pipe Line works.

5.1 Sequence of Work for Pipe Laying

The required fittings, valves and jointing material for pipe laying should be carefully worked out in beginning. This material should be received first of all on site and

stored as pre-directions of manufacturer or as directions given elsewhere in this manual on standards.

a. The pipes should be received on site only after the above fittings, valves and material for joints has been received and all necessary preparation for laying has been made.
b. The material received should be checked for inspection certification as per contract and damage during transportation. All damaged material should be separated and not used.
c. The pipes received should be stored strictly as per directions of the manufacturer or as mentioned elsewhere in the manual or standards.
d. The pipes and other material should be again inspected for any damage before use in the Trench.
e. The fittings and valves should be installed in sequence with the laying of pipes without leaving any gaps.
f. It is desirable to lay the pipe lines from the end from where it can be connected to the water source to enable regular flushing of laid pipes.
g. The entry of dirt of any foreign material in the pipe should be religiously prevented.
h. Each joint should be carefully checked for its completeness before covering up.
i. There should be a commensurate progress in trench excavation, laying and jointing of pipes, fittings, valves etc. and testing of laid pipes in sections so as to complete of all pipes laid in quick follow up of completing laying and jointing.
j. Disinfection of pipe lines should be carried out before commissioning.

5.2 Marking

Each pipe shall be clearly marked as indicated below:

- Manufacturers name and trademark
- Outside diameter in mm.
- Class of pipe and pressure rating
- Month and year of manufacturing
- Length of pipe
- Marking of insert depth of spigot
- 'RUIDP'

Each pipe shall also be marked in centre strip as circumference 1" wide at intervals not more than 3 meters to show the class of pipe.

- Class 3 – Green
- Class 4 – Brown

5.3 Excavation

Before excavating the trench the alignment of pipeline shall be approved by Engineer. The excavation of trenches and pits for manholes / chambers shall be carried out in accordance with the Specification and shall be done such that it does not get far ahead of the laying operation as approved by Engineer.

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work until it is safe for the

traffic to use the roadways. The Contractor shall provide sign boards at salient points in streets and keep men to guide the traffic at his own cost. The relevant Indian Standards and the rules and regulations of local authorities in regard to safety provisions shall be observed.

Trial pits may be dug by the Contractor, without being directed to do so, along the lines of the trenches as shown on the drawings in advance of the excavations for the purpose of satisfying himself as to the location of under ground obstructions or conditions. The Contractor shall proceed with caution, in any excavation and shall use every means to determine the exact location of underground structures, pipelines, conduits etc., and prior to excavation in the immediate vicinity thereof. The Contractor shall be solely responsible for the cost of protection or repair or replacement of any structure, pipeline, conduit etc., above or below ground which may be broken or otherwise damaged by his operations.

Suitable fencing shall be provided along the sides of trenches and pits. The posts of fencing shall be of timber securely fixed in the ground not more than 3 m apart and they shall not be less than 75 mm in diameter or less than 1.2 m above the surface of the ground. There shall be two rails, one near the top of the posts and the other about 50 mm above the ground and each shall be of 50 mm to 70 mm in diameter and sufficiently long to run from post to post to which it shall be bound with strong rope. The method of projecting rails beyond the posts and tying them together where they meet will not be allowed on any account. All along the edges of the excavated trenches a bank of earth about 1.2 m high shall be formed where required by Engineer for further protection..

The lighting, barricading, guarding of the trenches and the maintenance of watchman shall be done by the Contractor at his cost. At every 30 meters interval and at every change in the gradient, sight rails shall be provided and fixed by the Contractor at his own cost. The sight rails and boning rods for checking the excavation and inverts of the pipes shall be of the quality approved by the Engineer. In all streets in the City/Town at every 15 meters interval, blank board shall be provided by the Contractor at his own cost, to facilitate crossing of the trench by the Public residing on the either side.

The road metal and also the rubble packing shall first be stripped off for the whole width of the trench / pit and separately deposited in such place or places as may be determined by Engineer.

During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit or as may be necessary to prevent the sides of the trench / pit to slip or fall or at such a distance and in such a manner so as to avoid covering fire hydrants, sluice values, manhole covers, etc. and so as to avoid abutting the wall or structure or causing inconvenience to the public and other service organization or otherwise as Engineer may direct.

Contractor shall take into account additional excavation if any as Engineer may require in order to locate the position of water pipes, drains, sewers, etc. or any other works which may be met with, in or about the excavation of trenches / pits while quoting the rates for excavation. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting, planking over, padding or otherwise as Engineer may direct, and shall be protected by Contractor from damage during the progress of the work.

Wherever extra width of excavation shall be necessary for shoring and strutting, of the trenches on account of the nature of the soil, such extra width required to accommodate the shoring boards shall not be paid for separately and the rates quoted for trench work are deemed to be inclusive of all such incidental work.

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structures/pipelines of water, gas, sewage etc.

If the work for which the excavation has been made is not complete by the expected date of the setting in of monsoon which is First week of June or the setting in of rain whichever is earlier, or before the day fixed by Engineer for filling in any excavation on account of any festival or special occasion, Contractor shall backfill such excavation and consolidate the filling.

Utmost care shall be taken to see that the width of the trench at the top of pipe is not more than [External diameter of pipe in mm + 600 mm] + [400 mm for every 1500 mm Depth of cutting] or as specified in the Cross Section Drawing (in case there is any difference, the latter shall prevail). In case additional width is required it shall be provided only in the top portion from the ground level upto 300 mm above the crown of pipe. If any extra width is provided in the area below this portion, Contractor shall have to provide remedial measures in the form of lime concrete or rubble masonry or otherwise at the discretion and to the satisfaction of Engineer. If rock is met with, it shall be removed to 15 cm below the bottom of pipes and fittings / specials and the space resulting shall be refilled with lean cement concrete of adequate depth, properly consolidated to give the curved seating. The bottom of the trench shall be properly trimmed to permit even bedding of the pipeline. Bottom of trenches / pits shall be saturated with water and well rammed wherever Engineer may consider it necessary to do so. For laying of pipes larger than 1200 mm in diameter, in earth and moorum, the curvature of the bottom of the trench should match the curvature of the pipe as far as possible, subtending an angle of 120 degrees at the centre of the pipe.

Wherever a socket or collar of pipe or fitting / special occurs a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand, all around the socket in order to make the joint and the grip shall be maintained clear until the joint has been approved by Engineer.

When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60 cm in depth and 90 cm in length shall be made at joints in order to facilitate welding.

The excess excavated material shall be carried away from site of works to a place upto to a distance as directed by Engineer. This shall be done immediately so as not to cause any inconvenience to the public or traffic. If the instructions from Engineer are not implemented within seven days from the date of instructions to cart the materials and to clear the site, the same shall be carried out by Engineer at Contractor’s risk and cost and any claim or dispute shall not be entertained in this respect.

Refilling of trenches, where the excavation is in rock shall be with the surplus soft soil from pits located within 200meters from the reach in question.

It is to be distinctly understood that no extra payment shall be made for the excavation from borrow pits located within 200 metres for obtaining earth for refilling, any instructions of the Engineer to bring earth from beyond 200 metres for refilling shall be detailed in writing and a separate extra payment shall be made for the additional conveyance. No payment shall be made for disposal of soil for excavation, surplus to or unsuitable for filling.

5.3.1 Work included in Excavation

Unless otherwise directed on the project Specifications, all of the following items are included in the excavation:

1. Removing all surface obstructions including shrubs, jungle etc.,
2. Making all necessary excavations true to line and grade,
3. Furnishing and installing all shoring and bracing as necessary or as directed,
4. Pumping and bailing out water to keep trenches free of water during pipe laying and jointing and thereafter until joints mature,
5. Providing for uninterrupted surface water flow during work in progress,
6. Providing for disposing off water flows from storm, drains, nallas or other sources, suitably,
7. Protecting all pipes, conduits, culverts, railway tracks, utility poles, wire fences, buildings, and other public and private property adjacent to or in the line of work,
8. Removing all shoring and bracing which is not ordered to be left in place or not required by the project plans or Specifications to remain in place,
9. Hauling away and disposing of excavated materials not necessary or else unsuitable for back filling purposes. The extra excavated soil will have to be properly dressed in soil banks along with the trench as directed,
10. Back filling the trenches as directed or as per Specifications,
11. Restoring all property injured or disturbed by these construction activities to the condition as near its original condition as possible,
12. Restoring the surfaces and repairing of all roads, streets, alleys, walks, drives, working spaces, and rights of way to a condition as good as prior to excavation

5.3.2 Change of Trench Location

In case the Engineer orders that the location of trench be moved a reasonable distance, on account of the presence of an obstruction or due to such other cause or if a changed location is authorized at the Contractor's request, the Contractor shall not be entitled to extra compensation or to a claim for damage. If however such change is made at the orders of the Engineer, which involves abandonment of excavation together with the necessary back fill, will be measured, classified and paid for in the same manner as for other trench excavation and back fill of the same character. In case the trench is abandoned in favour of new location at the Contractor's request, after its approval, the abandoned excavation and back fill shall be at Contractor's expense.

5.3.3 Minimum earth cover

If a profile is not furnished for a pipeline, the main will be constructed with a minimum earth cover of 1000 mm from the top of the pipeline, unless otherwise indicated on plans and ordered by the Engineer.

5.3.4 Dewatering

During the excavation, if subsoil water is met with, Contractor shall provide necessary equipment and labourers for dewatering the trenches / pits by bailing out water or water mixed with clay. If pumping out subsoil water is found to be necessary, Contractor shall provide sufficient number of pumps for the same. In both the above cases the excavation shall be done to the required level and the pipes shall be laid to proper alignment and gradient. Contractor shall also make

necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by Engineer. In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer / drain, Contractor shall take necessary permission from the local authorities.

The Contractor shall be responsible for the adequate pumping, drainage and bailing out of water from the excavation. Failure to make such provisions which results in unsuitable subgrade conditions, and which will require any special foundations as directed by the Engineer, such foundations shall be placed at the entire cost of the Contractor and will not be measured or paid for as separate pay items. If the Contractor selects to under cut the trench and use gravel or tile bailing, drainage of well pointing, the additional work will be considered as incidental work and additional compensation will not be allowed

5.4 Bedding

The bedding for pipe shall be provided as specified in the Drawings or as per direction of Engineer.

5.5 Laying of Pipe Line

The alignment of pipe line shall be kept as straight as possible with minimum bends in horizontal and vertical direction and far away from road carpet with minimum interference of underground utilities. If houses are only on one side of the road, then distribution pipe line shall be laid towards the houses, for ease of water connections. The alignment shall be marked on ground by using ranging rods and pegging. The levels shall then be taken along the fixed up alignment.

There is tendency to lay pipe line with minimum prescribed cover every where. Thus pipe line follows the ground profile and results in many bends in vertical plane. The bends in vertical plane not only increases pipe line losses and consequently more energy consumption but also entraps air which adversely affects performance of the pipe line. Therefore, while laying pipe line, the undulation in ground should be removed or dampened in pipe line by properly designing the 'L' Section. The pipe line should be laid at designed gradients and bend should be designed when it is essential.

For all type of pipes, the L section of the selected alignment shall be prepared in such a manner that at least 1.0 meter earth cover is provided over the socket or coupler or joint of the pipe line. In no case clear cover less than 1.0 meter should be accepted. However, if the alignment of the pipe line is likely to come under the widening of road/crossing important road, the clear cover over the socket portion shall not be less than 1.50 meter. In case of other roads minimum 1.0 meter clear cover shall be provided. It should be seen that there is minimum quantity of earth work and minimum bends in vertical direction.

The excavation of the trench shall be done according to the width and depth in accordance of the finally approved L-section. In case excavation is done by mechanical means, then last 15 cm depth shall be excavated manually. It shall be ensured that bed levels of the trench are as per L section and bed of trench is firm and compact. If bed is loose then it shall be compacted. The bed of the trench shall be made straight before laying of the pipe line so that the whole length of the pipe rests on it. It may be ensured by having some more excavation in the portion where socket of pipe will be placed.

The pipe and its socket portion shall be cleaned before placing in position. The rubber ring shall be kept in proper position in the socket only after cleaning of the socket. The pipe shall be lowered slowly in to the trench either mechanically or manually, but in no case it shall be throne in to the trench. Crane shall be used for lowering of heavy pipes. The new pipe placed in trench shall be inserted in

previously laid pipe with lubricant soluble in water and it should be ensured that it goes inside the socket up to prefixed length. The level of the pipe shall be checked to match with level given in L-section.

The pipes shall be laid in about 50-100 m length. Then it shall be ensured that the pipes are straight by putting a rope over pipes in this length. The pipe sockets which are out from straight alignment should be rectified immediately. The specials / valves shall be laid and fixed along with laying pipe line and no gaps shall be left in the pipe for this purpose. All pipe lines shall be sectional tested at given pressure and leakage shall not exceed the permissible limit.

The pipe shall be well packed at bottom with earth by hand before refilling the trench. The earth shall be then filled up to pipe level and compacted in layers of 15 cm each after watering to optimum moisture content. More care shall be taken for compaction up to top of pipe. The refilling of remaining trench shall than be done in layers after compaction.

In case of road crossing, minimum cover on pipe, proper and firm bedding, refilling with optimum compaction shall be ensured. The work of laying pipe line below road crossings should be supervised by officer not below the rank of AEn, PIU and ACM, DSC.

The fittings for DI pipes shall be only DI fittings with socket or flanged as the case may be. In PVC pipe, PVC specials such as bends, double sockets shall be used. Where PVC specials are not manufactured such as tees, reducers etc. flanged cast Iron fittings shall be used. Detachable joints should not be used for jointing.

The standard quality of rubber ring (EPDM), rubber gaskets (EPDM) and nut bolts shall only be used.

In service line MDPE pipe shall only be allowed. The ferule connection shall be done with standard and heavy duty ferule & saddle piece and rubber packing of not less than 6 mm thickness.

5.6 Testing of Water supply pipe lines

As you are aware, under various Water Supply Packages, Sectional field testing of laid pipe line is mandatory requirement and has been provided in all contracts under RUIDP. The procedure of sectional field testing is clarified below for guidance and strict compliance.

(a) Pressure test and Leakage test during sectional testing of newly laid pipe lines should be done only after constructing thrust blocks wherever required. Even after construction of such blocks **at least 5 days time should pass** before testing the pipe line so that thrust blocks are well set**.**

(b) At the dead ends of pipe line thrust develops. In case of permanent dead end, thrust block should be constructed before testing. In case of temporary dead end, temporary anchor should be provided to take complete thrust. The blind face of such end cap shall be properly braced during testing by screw jack and wooden planks or steel plate**.**

(c) The length of pipe line to be tested may initially be kept as 500M which can be increased in subsequent tests by Engineer**.**

(d) The water should be filled in from lowest point in network to be tested and air vents should be provided at higher points. During such filling of pipe line with water, air should be released from air vent pipes and care should be taken to close air vents only when complete air has been released from the pipe line and smooth flow of water starts**.**

(e) Partial backfilling and compaction to hold the pipes in position while leaving the joints exposed for leakage control

(f) Opening of all intermediate valves (if any)

(g) Fixing the end pieces for tests and after temporarily anchoring of these against the soil (not against the preceding pipe stretch)

(h) At the lower end with a precision pressure gauge and the connection to the pump for establishing the test pressure

(i) At the higher end with a valve for air outlet

(j) If the pressure gauge connot be installed at the lowest point of the pipeline, an allowance in the test pressure to be read at the position of the gauge has to be made accordingly

(k) Slowly filling the pipe from the lowest point(s)

(l) The water for this purpose shall be reasonably clear and free of solids and suspended matter

(m) Complete removal of air through air valves along the line

(n) Closing all air valves and scour valves

(o) Slowly rising the pressure to the test pressure while inspecting the thrust blocks and the temporary anchoring

(p) Keeping the pipeline under pressure for the duration of the pre-test/ saturation of the lining by adding make – up water to maintain the pressure at the desired test level. Make up water to be arranged by Contractor himself at his own cost.

(q) Start the test by maintaining the test pressure at the desired level by adding more make up water; record the water added and the pressure in intervals of 15 minutes at the beginning and 30 minutes at the end of the test period.

(r) Water used for testing should not be carelessly disposed off on land which would ultimately find its way to trenches.

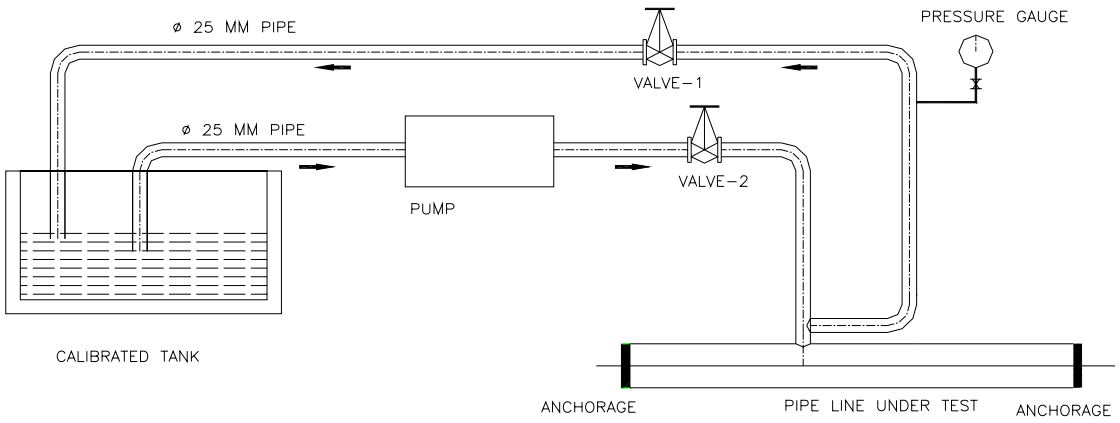
(s) The testing conditions for the pipelines shall be as per the test pressures and condition laid out in IS: 8329 for DI pipes.

(t) **Field test pressure:** The field testing of the entire pipeline laid shall be done for pressure of 1.5 times working test pressure as per relevant IS code in general; however in case of DI pipe the field test pressure may be considered as 2 x maximum design pressure (with minimum design pressure as 6.0 Kg/ sq cm). Some example of such field test pressures are:

S.No.	Type of pipe	Working Pressure	Field Test Pressure
1.	uPVC Pipe class 3	6 Kg./sq cm	9 Kg./ sq cm
2.	uPVC Pipe class 4	8 Kg./ sq cm	12 Kg./ sq cm
3.	AC Pipe class 15	7.5 Kg./ sq cm	11.25 Kg./ sq cm
4.	DI Pipe K 9	As per pipe size & up to 45 kg / sq cm	2 x maximum design pressure (with minimum design pressure as 6.0 Kg/ sq cm)
5.	PSCC Pipe	Say WP 8 Kg./ sq cm	12 Kg./ sq cm
6.	MS Pipe	Say WP 8 Kg./ sq cm	12 Kg./ sq cm

Requirement of water for sectional testing			
DI Pipe		uPVC	
Dia (mm)	Water required (Litre) in 1 Km length	Dia (mm)	Water required (Litre) in 1 Km length
100	7850	90	5996
150	17663	110	8954
200	31400	125	11569
250	49063	140	14519
300	70650	160	18957
350	96163	180	23986
400	125600	200	29605
450	158963	225	37443
500	196250	250	46277
600	282600	280	57992
700	384650	315	73408

(u) **Filling water:** Water should be filled in pipe line from the point in pipe line section having lowest RL. The air vents should be provided on high RL points. Air should be released simultaneous to water filling and once air is totally released and smooth flow of water starts the air vent can be closed. Reciprocating pump having pressure capacity more than pressure test requirement should be used. The pump should suck water from calibrated tank. The delivery of pump should be connected to pipe for filling the pipe. One more pipe should take off excess water from pipe line under test as shown in sketch below**.**



(v) **Procedure:** Pressure gauge of 150 mm diameter and pressure rating 1.5 to 2 times test pressure should be installed. The pressure gauge should be

calibrated and certified from standard test house. Valve 1 & 2 should be controlled and pump should be kept running so that pressure in pipe line shown by pressure gauge remains constant and equal to required test pressure, readings should be taken of calibrated tank every 15 minutes. The leakage in pipe line is indicated by the volume reduced in calibrated tank and which has gone in the pipe line to maintain constant testing pressure. This reading should be carefully taken. If the tank is not calibrated then it should be kept full initially and any reduction in water level during testing in this tank should be replenished by adding carefully measured quantity of water (by Measuring Jars) from some other tank. Such additional quantity should be equal to leakage in the pipeline. Before starting testing, the pipe may be kept filled in with water for suitable time decided by the Engineer. Thrust of pipe during testing should not be transferred on next section of Pipe line. One Test pressure gauge duly calibrated & certified from standard test house should be kept by field Engineer for verifying the reading of pressure gauge installed by the contractor.

(w) **Time of Test:** The test should be done for three (3) hours**.**

(x) **Maximum Permissible Leakage:** This is given in contracts. However where not given in contract document following should be adopted**.**

Type of Pipe	Permissible limits	Example	Permissible values of leakages (litre) for 3 hours testing
uPVC	Q=1.125 litre per Km length per 10 mm diameter of pipe per 30 mtr. test pressure per 24 hrs	90mm dia, 500m length for 3 hours testing at 9kg/sqcm	1.90
AC	Allowable Leakage $(q_l) = \frac{ND\sqrt{p}}{10}$ Where q_l = the allowable leakage in cm^3/hour N= no. of joints in the length of the pipe line D= Diameter in mm and P= the average test pressure during the leakage test in MP_a	300mm dia, 2000m length for 3 hours testing at 1.125Mpa (N/mm^2) taking length of each pipe as 5m.	38.18
PSC	Q=30 litre per Km length per 10mm diameter of pipe per 30 mtr. test pressure per 24 hrs	800mm dia, 500m length for 3 hours testing at 12kg/sqcm	600
MS	Q=1 litre per Km length per 10 mm diameter of pipe per 30 mtr. test pressure per 24 hrs	800mm dia, 1500m length for 3 hours testing at 12kg/sqcm	60
DI	Q=1 litre per Km length per 10 mm diameter of pipe per 30 mtr. test pressure per 24 hrs	300mm dia, 2500m length for 3 hours testing at 18kg/sqcm	56.25

Maximum Permissible quantity of make-up Water required for acceptance of sectional hydraulic testing

DI/MS Pipe		uPVC		
Dia (mm)	Permissible value of leakage (Litre) in 1 Km length for 3 hour testing & 18 kg/sqcm pressure	Dia (mm)	Inside dia (mm)	Permissible value of leak (Litre) in 1 Km length for 3 hour testing & 9 kg / sqcm pressure
100	7.50	90	87.4	3.69
150	11.25	110	106.8	4.51
200	15.00	125	121.4	5.12
250	18.75	140	136	5.74
300	22.50	160	155.4	6.56
350	26.25	180	174.8	7.37
400	30.00	200	194.2	8.19
450	33.75	225	218.4	9.21
500	37.50	250	242.8	10.24
600	45.00	280	271.8	11.47
700	52.50	315	305.8	12.90

(y) **Recording of Test Results**: One register for testing pipe line should be maintained. All tests including failure tests should be recorded. (Performa attached)

(z) **Witnessing testing of pipe:** All sectional tests should be witnessed and signed in register, by concerned ACM and EE.

(aa) **Reference:** Handbook on Pipes and Fittings for Drinking Water Supply (SP-57: QAWSM) and relevant IS Codes (amended up to date) published by BIS may be referred for details. This Hand Book describes in Chapter of testing and disinfection in details.

5.7 Backfilling and compaction in trenches.

Restoration of road, in case of trenches excavated for laying of water supply lines etc. is a critical activity in the project. It is our responsibility that these excavated trenches are backfilled and compacted to required standards with in the shortest possible time to avoid public inconvenience. Backfilling in prescribed thickness of layers & compaction to required density is very important. Any sub standard work will result settlement in the trench in near future and will be liable for criticism from all circles. Proper care is therefore required to be taken at every level to ensure refilling of trench and restoration of road to desired standards. It has been observed that there is wide gap between the length of excavated trench and the refilling of trench in the works. This should be minimized and ensured that only minimum trench length is kept open with all safety measures. The following procedure should be adopted for backfilling and compaction:

(a) Laboratory test should be conducted for different nature of soils to be backfilled in the trench by Standard Proctor Test and maximum dry density at Optimum Moisture Content should be worked out.

(b) The trench should be refilled in the layers not more than 15 cm and should be compacted by mechanical means in top 1.5 m and rammed manually with rammer below 1.5 m depth (portion in which timbering is there) so as to achieve the desired dry density.

(c) The field density should be checked for every layer by sand replacement method or core cutter method. The sand replacement method is easier and requires less effort in comparison to core cutter method.

(d) The water content ratio shall be gauged quickly by calcium carbide method. It is difficult to use oven drawing method in case of determination of field density in trenches located at several places and it takes time too.

(e) It is therefore advised that required number of these equipments should be kept at site by the Contractors so that field density can be checked immediately and work is not held up due to this reason.

(f) It is also desired that in each package where restoration of work is to be done, the backfilling and compaction to required standards should be carried out on one stretch of road in the presence of the person not below the rank of Executive Engineer for setting up an example and for enforcing the procedure in the remaining work of refilling of trenches. This effort should be repeated regularly.

5.8 Quality Assurance and Quality Control –

The thickness of granular bedding (once laid) should be physically checked by support engineer and AEn / JEn after going down in the trench. Sieve analysis of the bedding material should be carried out in site laboratory for every lot of material received.

The trench filling and further laying of pipes should be taken up only after satisfactory sectional hydraulic testing of the laid pipe line. The test results should be recorded by the support engineer and AEn / JEn. It should be ensured that such hydraulic testing is witnessed in 100% cases by support engineer and AEn / JEn, in 30% cases by XEn & ACM of consultant. In no case a section should be back filled without satisfactory hydraulic testing.

The construction engineer of consultant and AEn / JEn should thoroughly check the pipes for any defects before lowering in the trench i.e. surface cracks, visible reinforcement, departure from circularity in the socket ends, broken/fractured mouth edges etc.

It should be ensured that complete construction material for a section has been procured before excavation and the work of manhole, roadside chamber & laying of pipe in that section should be taken up simultaneously.

It should be ensured that open ends of the pipes are suitably plugged to prevent entry of sand/soil and other construction material in the sewers at the end of the day.

Officers of end user line agency should be encouraged to witness various tests during construction and should be formally invited at the time of network testing before finalization of the work and issue of completion certificate. The defects noticed should be jointly recorded and corrective action taken immediately.

5.9 Safety-

In addition to the Cost, Time & Quality, the safety is also one of the important components of the construction management. The safety should not be compromised in any construction activity. The term "Safety" is defined as "A thing is provisionally categorized as safe if its risks are deemed known and, in the light of that knowledge, judged to be acceptable".

The most important ingredient in a safety program is the quality of the people and quality of their training. Safety is habit that can only be developed through repetition. Good habits are only developed by constant trainings in task in correct manner until the act is performed in a safe manner. It is therefore envisaged that stress shall be given on complying safety measures during construction and on-site training for the working staff.

5.9.1 Safety in Excavation and trenching

All trenches, 1.5 metres or more in depth shall at all times be supplied with at least one ladder for each 30 metres in length or fraction thereof.

(a) Ladder shall be extended from the bottom of the trench to at least 1 metre above surface of the ground. Sides of a trench which is 1.5 metres or more in depth shall be stepped back to give suitable slope, or securely held by timber bracing, so as to avoid the danger of sides collapsing. Excavated material shall not be placed within 1.5 metres of the edge of a trench or half of the depth of the trench, whichever is more.

(b) Cutting shall be done from top to bottom. Under no circumstances shall undermining or undercutting should be done.

(c) Minimum Check and Clear Edge of Trench -There is a tendency to dump the excavated material just on the edge of the trench when excavation is done manually. The material may slide back into the trench or apply additional load on shoring. A provision of clear berm of a width not less than one third of the final depth of excavation is recommended. In areas where this width of the berm is not feasible, the reduced berm width of not less than one metre should be provided. It is always better to provide substantial toe board to prevent 'roll back' into the trench.

5.9.2 Handling of Plant and Machinery

The excavation equipment should be parked at a distance of not less than the depth of the trench, or at least 6 metres away from excavated sides for trenches deeper than six metres.

With the use of power shovels and draglines, the banks of trenches become Instable and thus dangerous for persons working nearby. These conditions should be watched and suitably remedied.

The vehicles should not be permitted to be driven too close to the pit. Care should be taken for locating roads leading to or from the pit. While loading manually, the vehicle should not be taken too near the wall of the pit. Use of post legs will reduce the risk of accidents where the vehicle is reversed for loading.

Workers should be provided with proper tools. Overlooking the importance of providing the right tools and protective gears for the job is perhaps the most serious risk to workers.

Workers using tools should guard against the danger arising out of the sudden movement of material which may throw them off balance. They should be

adequately spaced to avoid being accidentally struck by tools of others working nearby.

5.9.3 Barricading

Proper safety arrangements like barricading, timbering in trenches, access to trench, proper stacking of construction material, immediate disposal of surplus excavated material should be ensured during construction.

(a) For excavated sites close to public roads/pathways, the area notice boards should have lights during darkness hours.

(b) Barriers or covering should be provided to excavations, shafts, pits and openings having a vertical fall distance of more than 2 metres, except during the period necessary for the access of persons and movement of plant, equipment and materials.

5.9.4 Shoring

As far as possible, the installation of shores should be done from the surface.

The trench jack or horizontal braces should never be used as a ladder for getting in or out of a trench as they are not designed to take vertical load.

5.9.5 Removal of shoring

When the removal of shoring is planned, the possible collapse of trench sides should be anticipated. The newly installed utility line will then be safeguarded in the normal course by being covered with loose or compact fill before the shores are removed. If the trench is likely to cave in on removal of the shores, it can be filled up to the bottom with horizontal brace. It is a safe way for the worker to go down on the ladder and remove this brace, after which additional trench space can be filled up to the next horizontal brace or screw jack.

If the trench is to stay after the removal of shoring, the ladder should not be removed till all work within the trench is completed and the newly installed utility line has been protected or covered.

5.9.6 Access and Escape

The workers should be able to escape fast in the event of any mishap during excavation. It is recommended that one ladder should be provided for every length If 15 metres or fraction thereof in the case of relatively less hazardous work.

Quite often the pathways become slippery due to accumulation of mud, sand or gravel. This should be avoided. Further, the pathways should be strong enough to withstand the intended use.

5.9.7 Additional Precautions

The precautions should be taken of the power lines, cables during excavation and other operation. The alignment should be checked properly prior to excavation for any power cable etc.

(a) Ignorance and carelessness are major causes of accidents. Tendency to employ cheaper unskilled workers for jobs requiring proficiency and skill can lead to accident. This should not be permitted.

(b) Water for construction activities, rain water and water flowing in the drains are major cause of slides. Proper arrangement of diversion/ bailing out of such water should be done.

5.10 Barricading, diversions, display boards for safety

The adequate & proper barricading shall be provided at site to have proper safety and facilitation to traffic / inhabitants in their day to day activities and should be decided by the Engineer in-charge to follow adequate safety measures based on prevailing site conditions.

It should be ensured that the barricading has been carried out properly and display boards for diversion, warning, work in progress, schedule of completion of activity in the area are displayed at required places and proper lighting arrangement at work sites are made during night for convenience & safety of the public.

5.11 Safety during Execution of Overhead Civil Works

The Over head works should be pre-planned and properly supervised in respect of safety. Adoption of pre-determined safety measures will not only prevent or reduce accidents but also promote quicker and risk-free working of labour resulting in increased efficiency along with reduced costs of construction.

(a) **General safety requirements**

i. All workers shall be physically and psychologically fit and have the necessary knowledge and experience for such work. They shall be provided with safety helmets, safety boots and proper clothing when work at higher elevations is in progress.

ii. Nylon safety-mesh shall enwrap working platforms of high-rise structures like overhead service reservoirs etc.

iii. Over head works should not be carried on in-weather conditions that threaten the safety of workers.

iv. Elevated workplaces should be provided with safe means of access and egress such as stairs, ramps or ladders.

v. Elevated workplaces, including roofs more than 2 m or as prescribed, above the floor or ground should be protected on all open sides by guard-rails and toe boards. If guard-rails are not practicable, persons employed at elevated workplaces including roofs should be protected by means of adequate safety nets/ safety sheets or platforms, or be secured by safety harnesses with lifelines securely attached.

vi. Crawling boards, walkways and roof ladders should be securely fastened to a firm structure.

vii. Scaffolds shall be provided for all work that cannot be safely performed from the ground, or from solid construction or other equally safe and suitable provision should be made.

viii. "Men working overhead" signboards shall be placed around structures on which work is in progress at higher elevations.

ix. The construction site should be properly managed for storage of materials and equipment; and removal of scrap, waste and debris at appropriate intervals.

(b) **Scaffolding:**

Scaffolding and lifting appliances for e.g. hoists, cranes etc are essential construction equipment for overhead civil works which needs to be designed, installed and operated properly.

The scaffolding needs compliance of certain safety practices not only for the security of the men employed on the scaffolds but also for the safety of those

who may be working or passing below. The accidents from the scaffolds are generally caused either as a direct collapse of the scaffold or as a result of workmen or any material falling down. Great care is therefore necessary in the erection, use and dismantling of scaffolds with respect to its various components. The following safety norms and precautions should be taken while using the scaffolds and lifting appliances:

i. Every scaffold of suitable and sound material and of adequate size and strength should be properly designed, constructed, erected and maintained so as to prevent collapse or accidental displacement when properly used.

ii. Scaffolds should be inspected before being taken into use and atleast at an interval of 15 days / after any alteration, interruption in use, exposure to weather or seismic conditions / any other occurrence likely to have affected their strength or stability.

iii. The scaffold may be constructed either of timber or metal. Timber used in the construction of the scaffolds should be reasonably straight, sound, free from splits, shakes and large cracks, large knots, dry rot, worm holes and other prohibited defects and shall be conforming to IS: 3629-1966. Metal scaffolds shall conform to IS: 2750-1964.

iv. The use of barrels, boxes loose tile blocks or other unsuitable objects as supports for working platforms shall not be permitted.

v. Every platform, gangway, run or stairs shall be securely fastened in place and be kept free from any unnecessary obstruction, material, rubbish and projecting nails.

vi. The use of cross braces or framework as means of access to the working surface shall not be permitted.

vii. The-supporting member shall be placed on a firm, rigid, smooth foundation of a nature that will prevent lateral displacement.

viii. If scaffolds are to be used to a great extent or for a long period of time, a regular plank stairway wide enough to allow two people to pass shall be erected. Such stairways shall have handrails on both sides.

ix. Grease mud, paint gravel or plaster or any such hazardous substances shall be removed from scaffolds immediately. To prevent slipping on the platforms, either sand or saw dust or other suitable material shall be spread.

x. Ladders, boards and planks used in scaffolds should not be painted so that any defects are visible.

xi. Where persons are required to work or pass underneath a scaffold upon which men are working, a screen or canopy shall be provided for their protection from falling objects. Such overhead screens should be of adequate strength and dimensions.

xii. Scaffolding materials should not be thrown from scaffolds or from heights.

xiii. Metal scaffolds should not be erected in closer proximity than 5m to overhead electricity transmission lines equipment. It should be ascertained that no un-insulated electric wire exist within 3m from working platform, gangway ,etc, of the scaffold.

xiv. While carrying bars, rods or pipes of any kind conducting material of length greater than 3 m, in the vicinity of electric wires, special care shall be taken that these do not touch the electric wires.

xv. Care shall be taken to see that no part of a scaffold is struck by a truck or other heavy moving equipment.

(c) **Means of Access:**

During construction of overhead structures, a safe and convenient means of access should be provided to all platforms. The means of access may consist of (a) Ladder (b) Ramp (c) Stairway. The following safety norms should be followed while using means of access:

i. Portable Ladder should be placed at the angle of approximately 75^0 from the horizontal. The top and bottom of Portable Ladder should be secured to prevent displacement. The ladder rails should be extended at least 1 m above the top landing.

ii. Fixed ladders should be provided for flights above 4 m. The width of the ladder should not be less than 30 cm and the rungs shall be spaced not more than 30 cm.

iii. Stairways are the safest means of access for scaffolds exceeding 4 m height. Treads and risers of stairways, in any one flight, should be of uniform width and height. The minimum width of stairway shall be 1.0 m. There should be no unbroken vertical rise of more than 4 m. The maximum angle of ascent should be 50 degrees.

(d) **Lifting Appliances:**

In case of overhead structures, the lifting appliances are generally used for transportation of material. Hoists and Cranes are main lifting appliances used in the overhead structures. Following norms should be followed installation, operation and dismantling of lifting appliances:

Hoists

i. The complete hoist-way throughout its height shall preferably be enclosed with wire mesh in order to contain the accidentally dislodged material from the hoist platform.

ii. There must be only one operating position for the hoist and the driver must be trained in the job, able to see the platform of the hoist throughout its travel.

iii. All materials carried on the platform must be so placed as not to be dislodged and any moveable equipment, wheel-barrows etc. must be stopped.

iv. The safe working load must be plainly marked on the hoist and never exceeded.

v. Every hoist must be fitted with an automatic device which will support the platform in the event of any failure of the ropes or gear.

vi. Every hoist must be inspected once a week and wire ropes of hoist should be checked frequently.

Cranes

vii. No crane should be used unless a competent person has inspected and tested it and furnished a certificate specifying the maximum safe working load.

viii. Access to and exit from the operator's stand should be safe from any position of the crane.

ix. Cranes should not be used to pullout fixed objects, with a slanting pull, drag objects or move vehicles.

x. Before being put into use for the first time, jib cranes with variable radius should undergo tests of stability and of all movements such as travel, swinging, raising and lowering the load, breaking the crane and breaking the load.

xi. Jib cranes should not be operated in dangerous proximity to electric power lines.

5.12 Safety in Construction during Monsoon

Almost in all civil works, excavation and refilling of earth are common activities, which if not carefully executed may pose problems to the safety of works as well as passerby's and road users during the impending Monsoon. Normal to heavy rainfall event may affect our ongoing works in different manners. It should be our endeavor to ensure that such events do not prove to be problematic to people and structures in particular. A separate circular should be sent to all contractors to ensure safety of citizens and works during rainy season citing provisions of Agreement and BIS. During monsoon EE IPIU should ensure that any further excavation work is taken up only after ensuring that the earlier work is in safe stage. It is desired that ACM-DSC & EE IPIU should inspect all sites during rains. Some of the probable occurrences are discussed below.

i. The settlement in refilled trenches of sewerage and water supply lines may occur during monsoon. ACM of consultant and EE should inspect all sites and oversee the arrangements to effectively deal with the eventuality after a storm to identify such reaches and take immediate corrective action by refilling and compacting. The contractor should be asked to designate an engineer / supervisor by name to look after this activity during monsoon.

ii. The contractor's crew should be equipped with vehicle, gum boots, raincoats and T&P to tackle such situation during and after rains. Adequate quantities of earth, debris and gravel should be stacked at strategic places so that no time is lost in procuring such material.

iii. In trenches where pipe laying has been done and duly tested and approved, refilling should be done soon after and all surplus material relocated to safe disposal sites such that it does not obstruct traffic or waterways.

iv. The execution of works having deep excavation in smaller lanes and congested areas should be completed well before monsoon. The works of deep excavation during monsoon should not be preferably taken up or extensive care should be taken for execution of such works.

v. All open ends of sewer lines should be firmly plugged to prevent debris from entering the line. Manhole covers of sewer lines should be fixed in place to avoid any harm to road users.

5.13 Storage of Steel & Cement

These are very vital ingredients for quality construction work but in absence of proper storage, especially during monsoon, cement and steel may rapidly decline in quality and strength.

Care should be taken to protect these materials during wet weather by proper storage and use of any exposed material should be allowed only after conducting fresh tests. use of any apparently affected material should be done after permission of EE IPIU.

5.14 Site Clearance

The surplus material lying at site after completion of the work creates inconvenience to the citizens. The incharge package should specifically ensure that after completion

of work no surplus material is there and in the ongoing works the surplus material is properly placed. It should be clearly understood that there should be no hindrance in the public safety and traffic convenience and the Contractor shall be compelled to ensure that no public inconvenience is caused due to excavation, stacking of excavated material, storage of material during execution etc.

5.15 In house and on-site Trainings

Consultant of RUSDIP should conduct trainings monthly at every work contract for assurance of quality, safety and environmental & social safeguards. The staff of IPIU, supervising staff of consultant & Contractor, technicians, operators and labour at site should be given on site training so that the personnel engaged on the supervision of the contract should be fully conversant with the safety parameters and environmental & social safeguards, its documentation and techniques of supervision.

5.16 Reporting the Occurrence of Accident

(a) Where any dangerous occurrence or an accident leading to the death of a worker takes place at a construction site, the site in charge should report this occurrence or fatal accident as the case may be, within 4 hours of the happening, by telephone, special messenger or telegram, to EE; Asstt. Construction Manger of town & Team Leader DSC; District Magistrate or Sub-Divisional Magistrate in whose jurisdiction the site lies; The Officer in-charge of the nearest police station; Workmen's Compensation Inspector, or in his absence the Factories Inspector concerned and; the nearest relative of the deceased person, in the case of fatal accident. The notice so given should be confirmed by the site in charge to the authorities mentioned above within 12 hours of the taking place of any such accident or occurrence.

(b) If in the case of an accident, the injured person subsequently dies due to such accident, the information of his death, wherever known, should be sent by the site in charge to the earlier mentioned authorities, within 24 hours of the death. This procedure will also apply where an accident results in loss of any part of the body or any limb, severe burns or scalds or unconsciousness.

(c) Whenever a worker reports that he has received an injury at the work place, the site engineer should take the following action:

- ✓ Arrange to render first aid on the spot and make an entry in the first aid register as well as the accident register.
- ✓ If the injury received is serious i.e. crushing, burning, breaking of any limb or any part of the body, unconsciousness, danger of loss of any part of the body or a limb etc.
  - ➢ Render first aid and make entry in the first aid register as well as the accident register.
  - ➢ Send the injured person to the Medical Officer/ dispensary/ hospital in a vehicle/ ambulance, accompanied by another person.
  - ➢ Report the accident to the four prescribed authorities within 12 hours.

6 Separation of water supply lines from sewer lines and avoiding water pipe line from sewer manholes

More care needs to be taken in maintaining adequate separation of water lines and sewer while laying new water lines/sewers. Pollution in water pipe line from sewers/drains can endanger human health. It is of utmost importance that all

measures are taken to prevent it. Your attention is invited to the Water Supply and Treatment Manual (clause 10.11 page 389) which stipulates measures for protection against pollution near sewer and drains. These stipulations should be followed strictly.

The maximum possibility of pollution in water supply lines is when these lines pass through manholes of sewers. Therefore this condition should be totally avoided and during construction of manhole/ laying of water supply pipe line it should be ensured that no water pipe line passes through Manhole. The subsequent detection of any pipe line passing through manhole becomes extremely difficult. In these circumstances either location of manhole should be changed or pipe line should be shifted to lay it out side the manhole. This should be strictly followed.

7 Water Treatment Plant (WTP) Process design and GAD

i. All the units (Proposed/existing) are required to be drawn in a drawing with scale so as to check the accommodation of all the units suitably within the available space.

ii. The raw water quality mentioned in the document is required to be checked with the data available with PHED and accordingly the design should be carried out.

iii. Reference of different consideration has to be mentioned (i.e. contract Agreement, CPHEEO, etc.) and those are required to be checked.

iv. Proposed component of the WTP are required to be checked with the same mentioned in the document.

v. Flow balance diagram should be prepared and enclosed considering losses. The flow mentioned in the diagram is required to be referred in the design.

vi. Design norms:

Sr. No	Treatment Plant Unit and design Parameter	Range Given in Manual	Value recommended to be used in this contract
1	Aerator Cascade Type a) Area of Contact	 .015 to .045 m^2/ m^3 /hour flow	 .045 m^2/ m^3 /hour flow
2	Flash Mixing Tank a)HRT b) Power Input	 20 to 60 sec 1 to 3 watts/m^3/hr flow	 40 sec. 1.8 watts/m^3/hr flow
3	Flocculation Tank a) HRT b) Power Input c) Velocity Gradient (G Value) d) Area of paddle	 10 to 40 min. 10 to 36 kW/ MLD 10 to 75 S^{-1} 10 to 25 % of cross section of tank	 20 20 60 25 %
4	Clarifier (Conventional) a) HRT b) Surface Loading	 2 to 8 hours 25 to 75 m^3/m^2/day	 2.5 hours 35
5	Dirty Backwash Water clarifier a) HRT b) Loading rate	As per CPHEEO manual	As per CPHEEO manual
6	**Rapid Gravity Sand Filter**		

Sr. No	Treatment Plant Unit and design Parameter	Range Given in Manual	Value recommended to be used in this contract
	Variable Head Constant rate Type a) Filtration Rate b) Backwash Rate c) Air Scour rate **Rapid gravity Sand filter** **Declining Rate Type** a) Filtration Rate b) Backwash Rate c) Air Scour rate	 4.8 to 6 m/hour 36 to 50m/hour 36 to 45 m /hour 3m – 6m/hour 36 to 50m/hour 36 to 45 m /hour	 5 m/hour 35 m/hour 40 m/hour 5m/hour 35 m/hour 40 m/hour
7	Chlorine Contact Tank HRT Dose	 20 to 30 min	 30 min 2 to 3 PPM based on Chlorine Demand
8	Velocity for gravity line	0.6 m/s to 1.0 m/sec	0.6 m/s to 1.0 m/sec
9	Velocity for gravity line	1.5m/sec	1.5 m/sec

vii. **Instrumentation**

Sr. No	Instrument	Type	Location
1	Water Flow Meter	Magnetic/ Ultra sonic type	Inlet line to plant between after Raw water pumps and Aeration Fountain
2	Water Flow Meter	Magnetic/ Ultra sonic type	Pure water rising main after Pure Water Pumps
3	Level sensor & transmitter for filter beds	Ultra Sonic / Capacitance Type	One in each Filter bed
4	Level sensor Controller for water tanks	Float / Capacitance type	Pure Water Sump
5	Residual Chlorine Analyzer	On line type	Pure water rising main
6	Turbidity Analyzer	On line type	Raw water Line
7	Turbidity Analyzer	On line type	Clarifier water out let
8	Turbidity Analyzer	On line type	Filtered water out let
9	Level indicator		For Alum Solution tanks
10	Pressure Gauges	Bourdon type	On all pump and air blower discharge lines

viii. **Material of Construction (MOC)**

Sr. No	Pipe details	MOC
1	Pipe from Raw Water Take off point to Aerator	DI
2	All interconnecting piping between plant units	DI

Sr. No	Pipe details	MOC
3	Filter Back wash water line	D.I / C.I.
4	Scour Air Line	MS
5	Sludge and dirty back wash water lines	DI
6	Chemical dosing line	HDPE/ PP
7	Chlorine solution line	HDPE/PP
8	Pure Water pipes & fittings within pump house	DI

ix. Design methodology should be included in the process design interrelating with the raw water quality with the treated water quality.

x. Hydraulic flow diagram should be included with the process design. Different levels achieved should be supported with head loss calculation.

Construction of WTP involves the civil, mechanical, Electrical & Instrumentation work:

(a) Civil work-

Civil Work should be carried out as per the specifications specified in the contract agreement & as per Standard specification of RUSDIP. Following construction activities are involved

- Excavation
- Concreting
- Building work
- Road work
- Drainage work
- Plantation & land Scaping
- Other miscellaneous
- Pipe line work

(b) Mechanical Work

Following activities are involved

- Fabrication
- Installation of machinery such as pumps screens grit separator units, Blowers
- Air pipe line fabrication
- Installation of valves & gates
- Installation of pumps & motors
- Testing of all Mechanical works

(c) Electrical Work

Following activities are involved

- Electric Cabling work
- Panel/ Starters installation
- Installation of motors & pumps
- 2 pole/ 4 pole installation work
- Building electrification work
- Campus Electrification
- Testing of all electrical machinery

(d) Instrumentation Work

Following activities are involved

- Instrumentation Cabling Panel/ Starters installation
- Installation of PLC if proposed

- Instrumentation connectivity
- Testing of all instrumentation work

8 Water Quality Standards - Chemical and Physical Criteria;

S. No.	Constituent or Characteristic	WHO guideline Value	ISS-10500-91 Max. permissible limit	Remark
1.	Colour	15TCU (true color units)	25 Hazen units	
2	Odour	Inoffensive	Unobjectionable	-
3.	Taste	Inoffensive	Agreeable	-
4.	Turbidity	5 NTU	10 NTU	-
5.	ph	6.5-8.5	6.5-8.5	-
6.	Total Hardness (as CaCO)	500 mg/l	*600 mg/l*	Encrustation in water supply structure and adverse effects on domestic use.
7.	Calcium (as CaCO,)	-	*400 mg/l*	-do-
8.	Chloride (as 0)	*250 mg/l*	*1000 mg/l*	Corrosion and palatibility are effected.
9.	Sulphate (as SO.)			400 mg/l 400 mg/l MgS04 at ncns. above 1000 mg/l acts as a purgative in normal humans.
10.	Aluminium (as AI)	*0.2 mg/l*	*0.2 mil*	Corrosion of metals. Discolaration. May cause certain neurological disorders such as dialysis dementia and alzheimer's disease.
11.	Iron (as Fe)	*0.3 mg/l*	*1.0 mg/l*	Discoloration Promotes iron bacteria.
12.	Manganese (as Mn)	*0.1 mg/l*	*0.3 mg/l*	Discoloration and taste problem.
13.	Residual free chlorine	0.2 to 0.5 *mg/l*	*0.2 mg/l* min.	When protection against viral infection is required, it should be min. 0.5 mg/l.
14.	Copper (as Cu)	*1.0mg/l*	*1.5 mg/l*	Astringent taste, discoloration and corrosion of pipes, fittings & utensib.
15.	Anionic Detergents (as MASS)	-	*1.0mg/l*	Foaming, taste & odour problems.
16.	Total Dissolved	*1000 mg/l*	*2000 mg/l*	Palatibility decreases & may

S. No.	Constituent or Characteristic	WHO guideline Value	ISS-10500-91 Max. permissible limit	Remark
	Solids			cause gastro intestinal irritation. .'
17.	Alkalinity (as CaCO,)	-	*600 mg/l*	Taste becomes unpleasent.
18.	Sodium (as Na)	*200 mg/l*	-	Taste threshold.
19.	Zinc (as Zn)	*5 mg/l*	*15 mg/l*	Can cause astringent taste and opalescence in water.
20.	Arsenic (as As)	0.05 mg/I	0.05 mg/I	Toxic
21.	Cadmium (as Cd)	0.005 mg/I	0.01 mg/I	Toxic
22.	Chromium (as Cr)	0.05 mg/I	0.05 mg/I	Carcinogenic
23.	Cyanide (as CN)	0.1 mg/I	0.05 mg/I	Toxic
24.	Fluoride (asF)	1.5 mg/I	1.5 mg/I	Fluorosis
25.	Lead (as Pb)	0.05 mg/I	0.05 mg/I	Toxic
26.	Mercury (as Hg)	0.001 mg/I	0.001 mg/I	Toxic
27.	Nitrate (as NO,)	45 mg/I	100 mg/I	Mathaemoglobinemia
28.	Nitrite (as NO,)	3.0 mg/I	-	Indication of pollution
29.	Selenium (as Se)	0.01 mg/I	0.01 mg/I	Toxic
30.	Boron	-	5 mg/I	-

9 IMPORTANT INDIAN STANDARDS/MANUALS FOR WATER SUPPLY ENGINEERS:

CPHEEO	Manual on Water Supply and Treatment, Ministry of Urban Development, New Delhi
CPHEEO	Manual on Operation & maintenance of Water Supply Systems
SP 7	National Building Code of India
SP 35	Handbook on Water Supply and Drainage (with Special Emphasis
SP 57 (QAWSM)	Handbook on Pipes and Fittings for Drinking Water Supply
SP 58	Handbook on Pumps for Drinking Water Supply
IS 1172	Code of Basic Requirements for Water Supply, Drainage and
IS 2065	Code of Practice for Water supply in Buildings
IS 1200 : Part 19	Method of Measurement of Building and Civil Engineering Works - Part XIX :Water Supply, Plumbing and Drains
IS: 12183	Code of Practice for Plumbing in Multi-storied Buildings (Part-1,
IS: 10500	Drinking Water Specifications
IS: 5477	Methods for fixing the Capacities of Reservoirs
IS: 1112	Specification for 43 Grade Ordinary Portland Cement (OPC)
15:9668	Code of Practice for Provision and Maintenance of Water Supply for
IS: 12269	Specification for 53 Grade Ordinary Portland Cement (OPC)
IS: 456	Code of Practice for Plain and Reinforced Concrete.

IS: 1343	Code of Practice for Pre stressed Concrete
IS 3370 : Part 1	Code of practice for concrete structures for the storage of liquids: Part 1- General requirements
IS 3370 : Part 2	Code of practice for concrete structures for the storage of liquids: Part 2 Reinforced concrete structures
IS 3370 : Part 3	Code of practice for concrete structures for the storage of liquids: Part 3 Prestressed concrete structures
IS 3370 : Part 4	Code of practice for concrete structures for the storage of liquids:
IS: 376	Safety Code for Excavation Work.
IS: 458	Specification for Concrete Pipes (with and Without Reinforcement).
IS:784	Specifications for Pre stressed Concrete Pipes (Including Fittings)
IS: 7322	Specification for Specials for Steel Cylinder Reinforced Concrete
IS: 3597	Methods of Test for Concrete Pipes
IS: 783	Code of Practice for Laying of Concrete Pipes.
IS: 5382	Specification for Rubber Sealing Rings for Gas Mains, Water Mains
IS: 651 and IS:	Specification for GSW Pipes.
IS: 1536	Specification for Centrifugally Cast (Spun) Iron Pressure Pipes for
IS: 1538	Specification for Cast Iron Fittings for Pressure Pipes for Water,
IS: 3114	Code of Practice for Laying of CI Pipes
IS: 111	Code of Practice for Ancillary Structures (Part I) - Manholes.
IS: 555	Cast Iron Steps for Manhole.
IS: 1077	Common Burnt Clay Building Bricks
IS: 3102	Classification of Burnt Clay Bricks.
IS: 395	Method of Sampling and Testing Clay Building Bricks.
IS: 2212	Code of Practice for Brick Work.
IS: 269	Specification for Ordinary, Rapid-Hardening and Low Heat Portland
IS: 455	Specification for Portland Blast Furnace Slag Cement.
IS: 1489	Specification for Portland-Pozzolana Cement.
IS: 4031	Methods of Physical Tests for Hydraulic Cement.
IS: 650	Specification for Standard Sand for Testing of Cement.
IS: 383	Specification for Coarse and Fine Aggregates From Natural Sources
IS: 2386	Methods of Test for Aggregates for Concrete. (Part I To VIII)
IS: 516	Method of Test for Strength of Concrete.
IS: 1199	Method of Sampling and Analysis of Concrete.
IS: 3025	Method of Sampling and Test (Physical and Chemical) Water Used
IS: 432	Specification for Mild Steel and Medium Tensile Steel Bars and
IS: 1139	Specification for Hot Rolled Mild Steel and Medium Tensile Steel
IS: 1566	Specification for Plain Hard Drawn Steel Wire Fabric for Concrete
IS: 1785	Specification for Plain Hard Drawn Steel Wire for Prestressed
IS: 1786	Specification for Cold Twisted Steel Bars for Concrete
IS: 2090	Specification for High Tensile Steel Bars Used In Prestressed
IS: 4990	Specification for Plywood for Concrete Shuttering Work.
IS: 2645	Specification for Integral Cement Water-Proofing Compounds.
BS4461	Cold Worked Steel Bars for The Reinforcement of Concrete.
IS: 4098	Lime Pozzolana Mixture (1st Revision) (Amendment 2)

IS: 1791	Specification for Batch Type Concrete Mixers.
IS: 2438	Specification for Roller Pan Mixer.
IS: 2505	Specification for Concrete Vibrators, Immersion Type.
IS: 2506	Specification for Screen Board Concrete Vibrators.
IS: 2514	Specification for Concrete Vibrating Tables.
IS: 3366	Specification for Pan Vibrators.
IS: 4656	Specification for Form Vibrators for Concrete.
IS: 2722	Specification for Portable Swing Weigh Batchers for Concrete
IS: 2750	Specification for Steel Scaffoldings.
IS: 2438	Roller Fan Mixer (Reaffirmed 1990)
IS: 456	Code of Practice for Plain and Reinforced Concrete.
IS: 1343	Code of Practice for Prestressed Concrete.
IS: 457	Code of Practice for General Construction of Plain and Reinforced
IS: 3370	Code of Practice for Concrete Structures for Storage of Liquids
IS: 3955	Code of Practice for Composite Construction.
IS: 3201	Criteria for Design and Construction of Precast Concrete Trusses.
IS: 2204	Code of Practice for Construction of Reinforced Concrete Shell
IS: 2210	Criteria for The Design of R.C. Shell Structures and Folded Plates.
IS: 2751	Code of Practice for Welding of Mild Steel Bars Used for Reinforced
IS: 2502	Code of Practice for Bending and Fixing Vibrators for Consolidating
IS: 3558	Code of Practice for Use of Immersion Vibrators for Consolidating
IS: 3414	Code of Practice for Design and Installation of Joints In Buildings.
IS: 4014	Code of Practice for Steel Tubular Scaffolding. (Part I & II)
IS: 2571	Code of Practice for Laying Insitu Cement Concrete Flooring.
IS: 2250	Code of Practice for Preparation and Use of Masonry Mortar (1st
IS: 3696	Safety Code for Scaffolds and Ladders. (Part I& II)
IS: 3385	Code of Practice for Measurement of Civil Engineering Works.
IS: 1200	Method of Measurement of Building Works.
IS: 3385	Code of Practice for Measurement of Civil Engineering Works.

References:-

Manual on Water Supply & Treatment issued by Ministry of Urban Development New Delhi

Guide lines issued by RUIDP

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