MANHOLE MANUAL

QUALITY CAST IN CONCRETE

CONCRETE MANUFACTURERS ASSOCIATION (NPC)

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The Concrete Manufacturers Association NPC has had this manual published for the guidance of specifying bodies, consultants and contracting organisations using precast concrete manholes and components manufactured to the relative SANS standards. The CMA expresses appreciation to Tony Dutton, Professional Engineer for the preparation of this manual. Also producer members of the Precast Infrastructure Pillar of the CMA namely Aveng Infraset, Civilworks, Concrete Units, Rocla and Southern Pipeline Contractors for their contribution and photographs.

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1. INTRODUCTION

A manhole is defined as a "small covered opening, giving access beneath". In Engineering terms "beneath" is normally a vertical shaft giving access to a buried pipeline or other underground structure.

It follows from this definition that a manhole cannot exist independently, it must be part of a buried system to which it gives access. Therefore when considering a manhole, it is important to be aware of, and to understand the total system in which the manhole is to be used.

Buried pipelines have been in use for thousands of years, and without them modern urbanisation would not have been possible. There is thus a great deal of embedded knowledge to be found in the Engineering Departments of our major Towns and Cities, in the proceedings of Professional Institutions, and in National Codes of Practise. This publication must be read within this context.

A manhole must satisfy three basic criteria:

- It must provide safe and convenient access to the buried pipeline in order that maintenance and obser vation can be carried out;
- It must not interfere with the hydraulics of the system; and
- It must be durable.

Precast high strength concrete is perhaps the most durable construction materials known to man. This publication deals with manholes constructed using precast concrete sections. Concrete pipe sections have been used for many years in South Africa as manholes, but their use was only standardised in 1981, when SABS 1294 " Precast Concrete Manholes" was published by the South African Bureau of Standards. This was followed by two publications in the SABS 1200 series for Civil Engineering Construction -

1200LD Sewers
1200LE Storm water Drainage.

In producing this publication reference has been made, and material used from publications, produced by member companies of the Concrete Manufacturers Association, and their contribution is gratefully acknowledged.

This publication succeeds the "Concrete Manhole Installation Manual" published by the Concrete Pipe Division of the Concrete Society of Southern Africa.

2. COMPONENTS

The components of a standard precast manhole are shown in figure 1a, a description of the components is as follows.

2.1 Precast base, this factory made high strength unit provides for six possible flow channels, all of which have been provided with the required falls. Benching is cast into the unit. Knock out holes are provided for connecting reticulation pipes, knocking out must always be done from inside the unit.

Base units are available for 1000mm diameter chamber sections.

2.2 Chamber sections provide the working space for manholes and are available in the following standard diameters: 1000mm, 1250mm, 1500mm, 1750mm, and in lengths of 250mm, 500mm, and 1000mm.

2.3 Reducer slab provides a roof to the working chamber, and a 750 mm hole to accept an access shaft.

2.4 Access shaft sections are 750mm in diameter and provide access from the surface to the working chamber, and are available in lengths of 250mm, 500mm, and 1000mm.

2.5. Adaptor slabs can be square or round and fit on top of the access shaft and provide a 560mm entry hole.

2.6 Spacer slabs can be either square or round, 75mm thick and are used to make up the final level.

2.7 Concrete frame, or a Type 4 Cast Iron Frame is used on a round adaptor.

2.8. A type 2A cast iron frame is used on a square adaptor.

2.9. Lids for concrete frames are available in medium and heavy duty configurations.

2.10. A concrete replacement lid is available to fit a Type 4 cast iron frame.

2.11. A cast iron lid is used for the Type 2A frame.

Alternative components are available to suit different conditions and applications.

2.12. Starter ring, this is used where an in-situ base is the preferred option. The diameter will match the chamber, and the length is 250mm. Figure 1b.

2.13. Precast chamber base used for valve and scour chambers. This is a precast base cast with the starting ring of the chamber. The units are custom made, as the access holes in the starter ring must be drilled after casting to meet customer requirements.

2.14. Cover slab, this fits onto a chamber section where the manhole chamber ends near the surface, the slab has a 560mm hole and the adaptor and the spacer (if needed) are placed over the hole.

3.15 Enlarger slab, this fits onto a standard 1000mm precast base and enables a1250mm Chamber section to be fitted.

Photo of cover slab and reducer slab.

Photo of detail at top of manhole.

Photo of manhole installed with steps.

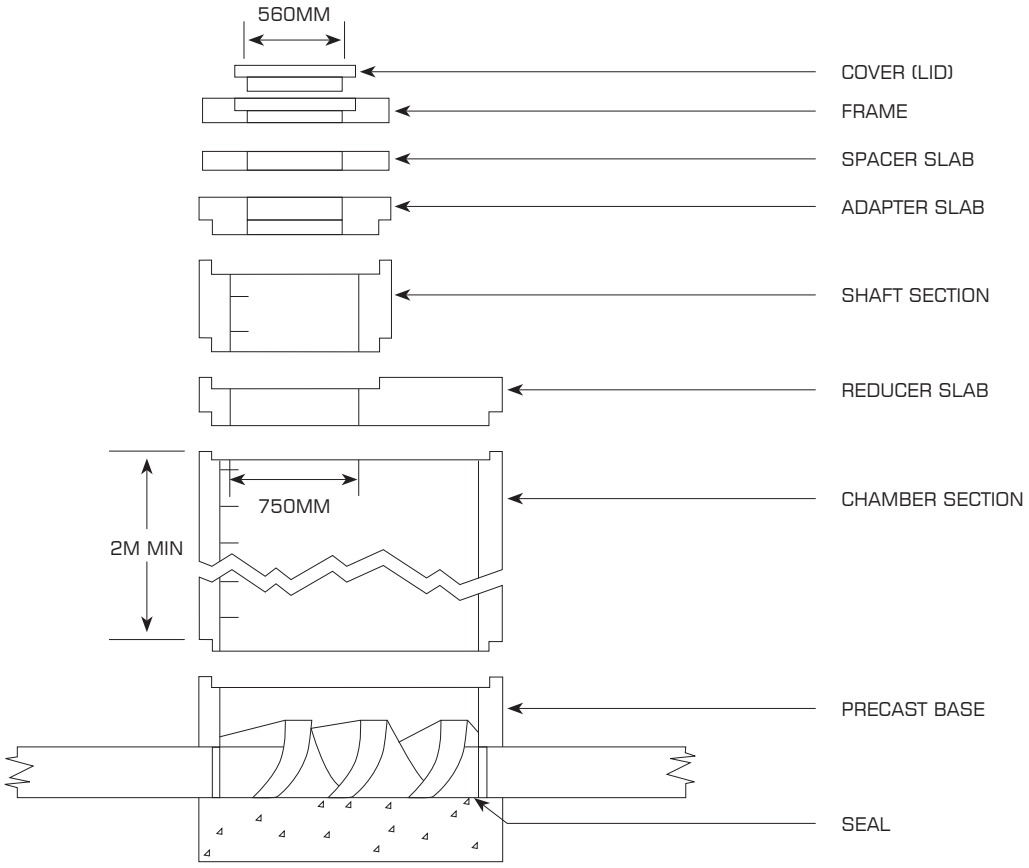

FIGURE 1A: Composition of a manhole.

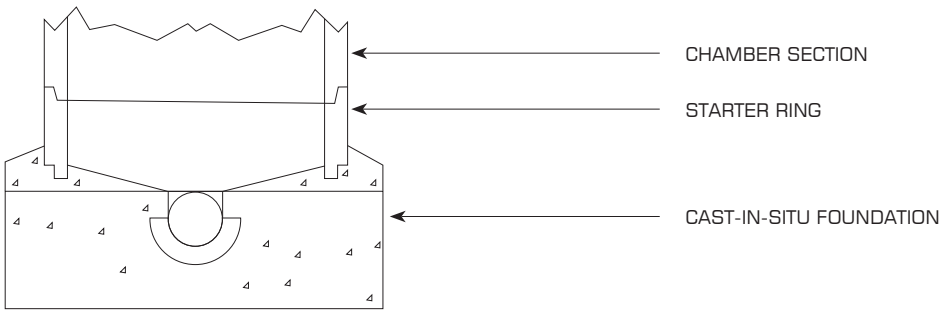

FIGURE 1B: Manhole with cast-in-situ foundation.

FIGURE 1: Components of a standard precast manhole.

3.16 Steps where they are required, are normally factory fitted. The original steps were made of cast iron, but were susceptible to the corrosive gases sometimes produced in the sewer, and were replaced by steel covered by Polypropylene Copolymer. The current trend is for virgin poly-propylene steps to be used.

3. COMPONENT SPECIFICATIONS AND TESTING

3.1 The specification for Concrete Manhole Sections is SABS 1294.

This specification covers the materials to be used in the manufacture of the sections, the dimensional tolerances required and also the load test which is a line load of 15kN/m applied as for the line load for a concrete pipe.

NOTE THAT THIS TEST IS FOR INTEGRITY ONLY AND IS MUCH SMALLER THAN PIPE LOADS. MANHOLE SECTIONS MUST NEVER BE USED AS HORISONTAL PIPE.

The specification specifies frames and lids in terms of a wheel load on the lid

- Round Lid:
  Extra Heavy Duty - wheel load 200kN
  Heavy Duty - wheel load 120 kN
  Medium Duty - wheel load 60 kN

- Square Lid:
  Medium Duty - wheel load 40kN

- Rectangular Lid:
  Medium Duty - wheel load 40 kN

3.2 Manhole steps are specified in SANS 1294: 2006 Clause 5.3. STEPS.

Load resistance - wheel load 2,5 kN

Some authorities specify step spacing which is different to that of SANS 1294.

The manufacturer should therefore always be consulted before ordering manhole sections with cast-in – steps.

4. DESIGN AND APPLICATIONS

Before using these guidelines on a particular project they should be confirmed in writing by the responsible Engineer.

4.1 Loads

Lateral loading due to the pressure of the earth, if the manhole is below the water table the earth would be saturated which would present the greatest possible pressure. This lateral pressure is radial and uniform, and the stress in the manhole is a uniform compression. The most conservative calculations would indicate that a concrete manhole would need to be buried many meters deep, before any possibility of compression failure could occur. In practise this depth will never be achieved.

In the event of a manhole being constructed against a barrier of some sort, a check must be made to ensure that bending stresses are not set up in the wall of the manhole which could lead to cracking.

CONCRETE MANHOLES SHOULD NEVER BE USED HORIZONTALY AS THEY ARE NOT DESIGNED TO CARRY ANY VERTICAL LOAD IN THAT SITUATION.

Vertical loads due to traffic over the top of the manhole, are transferred through the lid and frame to the chamber sections. This load is purely compressive and will not cause distress.

Lids and frames are designed and manufactured to withstand a wheel load (medium or heavy) and provided the right lid and frame are used in the application all will be well. The key issue is to ensure that the lid and frame have

a uniform seating because any uneven seating will create a "rocking " motion which in time can cause the lid to fail.

4.2 Manhole spacing

Manholes are usually installed at points of intersection in a reticulation system, and also at changes in grade or in alignment.

On straight run sewers the maximum spacing is normally 100m, or as otherwise indicated in the specification.

A manhole at the upper end of a sewer line is convenient for cleaning and flushing of the sewer.

4.3 Manhole Sizing

A standard 1000mm diameter manhole section in a reticulation system will normally provide sufficient working space.

In cases where the intersection is congested, it is possible to use an enlarger base slab to enable the Manhole section size to be increased to 1250mm.

Photo of a large diameter pipe with built in manhole.

Detailed photo showing cut out for constructiopn of manhole on large diameter pipe.

For manholes on larger pipelines, the normal rule is that there should be at least 300mm standing room on either side of the channel i.e.:

600mm channel	-	minimum 1250mm manhole section.
900mm channel	-	minimum 1500mm manhole section.

For large diameter sewers it is possible for the manhole to be incorporated on the centre line of the pipe, and temporary platforms erected for monitoring and measurement purposes.

4.4 Manhole sections as valve chambers

Precast manhole sections lend themselves to the construction of chambers for control, scour, and other types of valve required in a pipeline.

Custom made chamber bases and starter units can be obtained from the manufacturer, otherwise a suitably drilled starter ring can be placed on a level cast in situ concrete base.

The size of the chamber must be such that a spanner plus lever can be easily manipulated, and it is also important to allow for the occasional removal of the valve.

For large diameter valves, special large diameter manhole sections are available, as well as square and rectangular sections in the range of 2.0m to 2.3m, these sections have cast-in lifting sockets to simplify installation.

Image of rectangualr manhole for valve chambers.

4.5 Drop Manholes

It is sometimes unavoidable that the incoming sewer is at a higher elevation than the outgoing.

In this case the designer's first step is to reconsider the design, because drop manholes are dangerous and troublesome.

If a drop manhole is used, the sewage from the higher level must be piped down inside the manhole, and on no account should it be allowed to just drop. The head of the drop pipe must allow access for cleaning, and end in a bend which carries the sewage smoothly into the outgoing channel.

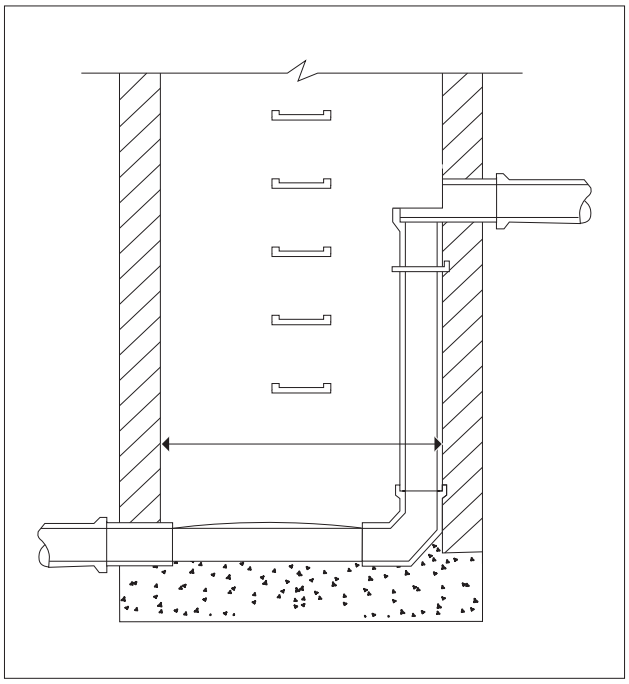

FIGURE 3: Diagram of a drop manhole.

4.6 Manhole ground conditions

Provided a manhole is well constructed the only causes of infiltration are due to ground movements, and it is therefore important to understand the nature of the ground on which the manhole is founded and through which it passes.

In normal ground conditions the foundation should be capable of supporting 120kPa, this can be easily checked using a Dynamic Cone Penetrometer (DCP). The result of a DCP test should be above the 22mm/blow line, if the result falls below this line the material should be excavated to a depth of 400mm below the foundation level. The material should be mixed with 5% cement, and refilled and compacted.

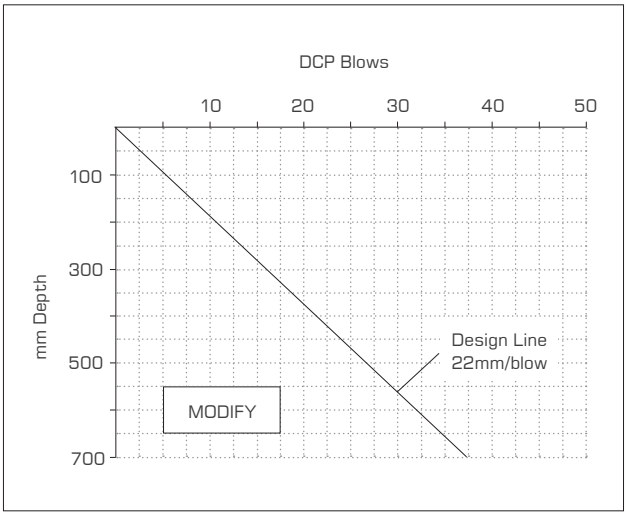

FIGURE 4: Diagram showing the design line for foundation using dcp.

If the foundation is in heaving clay, at least 400mm of the clay must be removed and replaced with sand which must be saturated and allowed to stand for 24 hours before proceeding with foundation construction.

The backfill around a manhole must be of inert material, and built up in 150mm layers, removing large rocks and uniformly compacted.

5. INSTALLATION

The manholes are part of the total system and must therefore be integral to the overall planning of the project. The planning will begin with the route of the pipeline, followed by the longitudinal section of the complete contract, and the sequence of pipe laying. Manhole can be numbered, and from the longitudinal section the requirements of each individual manhole can be determined and scheduled.

5.1 Ordering

Manholes are complex structures with many possible components and it is therefore important to pay careful attention to ordering manholes for a project. The order should contain the following information.

- Name and address of customer
- Name and location of the project
- Schedule of requirements (see above)
- Jointing material
- Detailed delivery instructions
- Detailed delivery schedule which relates to the schedule of requirements
- Invoicing instructions
- Name and contact details of responsible person at site and head office.

5.2 Receiving and acceptance of the product

There must be a responsible person on site to accept deliveries, otherwise the load will return, incurring needless expense and frustration.

The transporter will off load, and the site receiver will check:

- Quantities and sizes against the delivery note
- All markings on the product
- Note and record, and stack separately, any damaged product
- Note and record, and stack separately, any perceived poor quality product.

Only when the receiver is satisfied must the delivery note be signed. Delivery notes signed by unqualified people are a major source of dispute.

5.3 Site Handling and Handling Equipment

Manhole sections will be delivered in the vertical position and should be handled in the same way. The supplier is in a position to supply special lifting gear with which to do this, or to advise on suitable tested lifting gear.

ON NO ACCOUNT MUST MANHOLE SECTIONS BE LIFTED BY MEANS OF THE STEPS, OR ROLLED AROUND THE SITE.

Access roads to and around the site must be capable of carrying articulated vehicles. If for any reason the roads are impassable the supplier should be notified immediately so that deliveries can be suspended.

Manhole components should be stored in an orderly fashion on a levelled site, and the manhole sections stacked vertically not more than 1.8m high.

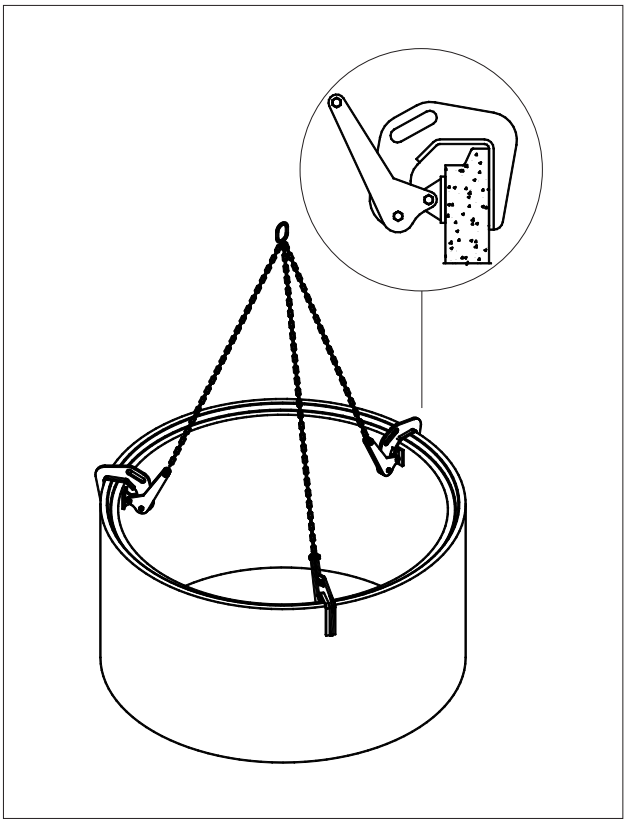

FIGURE 5: Diagram depicting correct lifting gear.

Photo depicting correct lifting gear.

Photo depicting an alternative method of correct lifting gear.

5.4 Excavation

The planning of the excavation of the manhole pit, like all other excavations on a pipeline site, must ensure that the excavation is open for the minimum amount of time. This will limit the possibility of storm and other damage.

The excavation site must be suitably demarcated and barricade as per Safety requirements.

The excavation should be at least 300mm greater than the outside diameter of the manhole.

The depth of the manhole excavation will be determined by the ground conditions. Where there are drainage problems, a sump should be excavated in one corner to facilitate pumping.

Photo of a well barricaded neat excavation.

5.5 Foundation

The founding condition should be checked, and if necessary the pit should be over excavated to enable foundation modification measure to be carried out.

It is important that the adjacent pipe trenches have the same degree of compaction as the manhole pit in order to minimise chances of differential movement.

5.6. Construction with precast base

Wherever possible a precast concrete base should be used and installed as part of the pipe laying process. The base provides the foundation, channelling, benching and starter ring all in one unit.

The base has a channel with a built in fall so the base is laid level, with the centre of the base channel at the invert level of the manhole. Time spent on the correct alignment of the concrete base is time well spent because if the base is right all else follows.

Apply the specified jointing material in accordance with the manufacturer's instructions. If a cement mortar joint is to be used, the mix should be 1:3.

Using the correct lifting gear lower the first section onto the starter ring and carefully check the level, this must be done at every stage because errors are difficult to rectify at a later stage.

A chamber should be not less than 1.8m high and not more than 2.3m.

The frame and cover should wherever possible be raised above the surrounding ground level to reduce storm water inflow. If the cover and frame must be in the road or pavement, they must be flush with the pavement surface and present no impediment to the flow of water.

5.7. Construction with a cast in situ base

The foundation condition should be checked and if necessary modified (see 5.5). The top of the foundation is levelled to 150mm below the invert level of the manhole. The pipes should be laid through the manhole position, leaving a gap equal to the internal diameter of the manhole, this gap to be made up with suitable channelling (precast concrete, or vitrified clay) which must be supported on pyramids of boney concrete.

Concrete with a 28 day strength of 20 mPa is poured from one side of the pipe only and vibrated under and around the channel up to a level equal to the crown of the pipe.

Allow the base to set for three days and then place a starter ring on the set base. Carefully check the position and level of the starter ring and then set the starter ring in place with concrete around the perimeter. Check position and level before allowing the starter ring to set for three days.

Benching should be done from the channel to the starter ring at a slope of 1:6 and this benching should be finished with a cement rich mortar layer.

Once the benching and starter ring have been set the construction continues as for section 5.6.

5.8 Testing

When the construction of a manhole is complete and before backfilling is commenced, a test for water tightness should be conducted.

All openings at the bottom of the manhole should be sealed, the joints visually inspected and any obvious flaws repaired before proceeding.

The manhole should be filled with water and allowed to stand for 24 hours.

Should the drop in the water level be greater than 150mm, the manhole must be inspected for faults and repaired.

6. SAFETY

We live in a world where skills are short, supervision limited and unskilled and untrained labour abounds. This is particularly true of construction sites in areas where there is a great demand for pipelines to meet the need for basic services.

This situation puts huge emphasis on the need for all concerned on a pipeline contract to understand, and actively promote safety principles. The Occupational Health and Safety Act NO 85 of 1993(OSH Act) places the responsibility for safety on the site on the Contractor, as the Employer.

The Employer is required to:

- Identify hazards
- Take steps to remove such hazards 'as far as reasonably possible"
- Inform the Employees of such hazards
- Issue necessary protective equipment
- train employees to work in the conditions found on site.

When dealing with precast concrete manhole sections there are three particular hazards which should be top of mind for all concerned. These are:

6.1 Handling

Manhole components are heavy and they have sharp arises and therefore they must always be approached with safety boots and gloves. If the layout of the stockyard is untidy the hazards are increased - a safe yard is a tidy yard.

All manhole sections must be lifted to be moved – NEVER rolled over the site – and therefore hard hats must always be worn.

Access to a concrete component stack yard must be restricted.

Correct tested and certified lifting gear must be used.

6.2 Excavation

A substantial barrier should be placed around the area to be excavated, the barrier should be clearly visible and an obvious deterrent to entry.

Spoil from the excavation must be placed at least 1000mm from the side of the excavation in order to reduce the risk of wall collapse.

Any excavation that is deeper than 1.5m should be noted in the site diary and inspected on a daily basis. The safety of such excavations should be referred to the Engineer who will provide a suitable design to maintain side stability.

6.3. Manhole entry

Should it be necessary to enter any manhole for inspection or measuring purposes, the following steps are to be followed.

A permit must be obtained from the relevant Engineering Authority to open and enter the manhole or manholes.

A team of two is required for any manhole entry, which is a "confined space"

The manhole must be opened at least 15 minutes before entering, and the area barricaded. If possible the upstream manhole should also be opened and barricaded.

The person entering the manhole must be fully equipped with safety clothes, hard hat, boots, safety harness and light.

The surface member of the team must keep careful watch over the surroundings, take control of the safety line and winch, and maintain contact with person in the manhole.

When the operation is complete the team must double check that the manholes have been closed, and report to the Engineering Authority.

NOTES

HARD FACT #1 OF 6:

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