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From

Engineer-in-Chief, Haryana,
Public Health Engineering Department,
Panchkula

To

All Superintending Engineers,
Public Health Engineering Circles in Haryana.

Memo No. 40132-45-PHED/Urban Dated: - 5-5-15

Subject: - Regarding safety measures and safe equipments for operation and maintenance staff employed on sewerage systems.

In respect of issues involved in the safety measures and safe equipment requirements for operation and maintenance staff employed on sewerage systems, though there are many issue related to this aspect, since the main theme is the safety measures to be adopted by the workman for safe operation maintenance of the sewerage system particularly cleaning of the choked sewers, it is suggested that the recommendations may presently be concerning the main theme i.e. the safety measures to be adopted by the workman.

After detailed deliberations the recommendations are grouped as under: -

- i) Hazards involved.
- ii) Precautions to be adopted by the workman.
- iii) Safety equipment to be provided to such workman and guidelines for safe operation & maintenance.
- iv) Preventive and corrective maintenance of the sewerage system.

The sub head wise details of each item are covered as under: -

i) **Hazards involved**

"Sewer gas" is a mixture of gases in sewers and manholes containing abnormally high percentage of carbon dioxide, considerable amounts of methane, hydrogen sulphide and low percentage of oxygen caused by septic action through the accumulation of organic matter inside the sewer. The actual hazard is due to the presence of high levels of methane, which forms an explosive mixture and hydrogen sulphide is in excess of permissible levels. Some times industrial wastes may also contribute to other gases like chlorine, ammonia, carbon monoxide and sulphurdioxide etc.

ii) **Precautions to be adopted by the workman:--**

a) **Precautions against Gas Hazards:-**

While entering a sewer or a manhole for cleaning/ clearing an obstruction, it is advisable to maintain efficient ventilation, either natural or forced and ensure that the atmosphere inside the manhole of sewer has sufficient oxygen and is free from toxic gases or vapours. Where such clearance of the toxic atmosphere by ventilation is not possible or time consuming, the following precautions must be taken before entering into the manhole or sewer: -

- i) The manhole cover should be left open for atleast half an hour before entering into it for cleaning.
- ii) Traffic warning signs should be erected, when the manhole cover is open, to avoid accident.
- iii) No smoking or open flames should be allowed, as methane gas is highly inflammable.

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- iv) Only safety, explosion-proof electric lighting equipment or mirrors for reflection of light should be used.
- v) The atmosphere should be tested for toxic gases and oxygen deficiency.
- vi) If the atmosphere is normal, the worker/ sewerman may enter into the manhole or sewer with safety harness attached with two men available at the top.
- vii) If any toxic gas or oxygen deficiency is found, forced ventilation should be resorted to by using a portable blower.
- viii) Frequent tests as in item (v) should be confirmed even if the initial tests are satisfactory, as conditions may change during the period workers are inside the manhole or sewers, as toxic gases may be trapped inside some hidden pockets inside the sewer.
- ix) If forced ventilation is not possible or satisfactory and sewermen are required to enter into the manhole urgently, a gas mask along with respirator should be worn and extreme care should be taken to avoid ignition, if inflammable gas is not within permissible limits, safety lights (not ordinary fly lights), rubbers or non sparking shoes and non sparking tools should be used.
- x) Only personnel experienced in the task and familiar with the dangers involved in working in a toxic gas environment and fully equipped with the proper protective safety equipment should be allowed to enter.

b) Precautions against infections

The personnel working in sewerage maintenance systems are prone to infections and hence the following precautions should be taken: -

- i) Emergency first aid treatment kits shall be provided to take care of all minor injuries like cuts and burns.
- ii) The workers should be educated about the hazards of waterborne diseases such as typhoid and cholera through sewage and tetanus through cuts and wounds.
- iii) The importance of personal hygiene should be emphasized and the workers should be instructed to keep finger nails short and well trimmed, not to brush fingers when they are sore, wash hands with antiseptic soap and hot water before taking food and to keep fingers out of nose, mouth and eyes, because the hands carry most infection causing germs/ viruses.
- iv) Use of rubber gloves and gum boots should be insisted so that sewage or sludge does not come into direct contact with the hands and feet of the sewermen.
- v) Chemists, while working in laboratory for testing sewage samples, should use only pipettes with rubber teats to prevent contamination of the mouth. Laboratory glassware should not be used for drinking purposes. In no event, food should be prepared in the laboratory.

III) Safety equipments to be provided to such workman and guidelines for safe operation & maintenance

a) Safety Equipments

The various safety equipments that are normally required in sewer maintenance work are breathing apparatus, gas mask, portable lighting equipment, non sparking tools, portable air blowers, rubber boots, safety belts and inhalers. The use of particular safety equipments is governed by the detection of various gases and oxygen deficiency. Appropriate knowledge of the type of gases in the atmosphere of the working location becomes essential for the selection of the right type of safety equipments.

Normally, following safety equipments should be available in each Sub Division, their number will depend upon the size of the town:-

- i) Safety belts.
- ii) Safety helmets.
- iii) Emergency First Aid Kits
- iv) Air blowers.
- v) Gas masks alongwith respirators.
- vi) Air line respirators.
- vii) Pure oxygen respirators.
- viii) Air respirators.
- ix) Portable lighting equipments hand lamps.
- x) Two mirrors and torch equipments.

b) Procedure for working in a Sewer:-

In order to ensure proper safety standards, the following steps should be followed: -

Step - I Before leaving the stores.

- c) Collect and check all safety equipments.
- d) Check working location with supervisor and list out all known or potential hazards.

Step - II On arrival at site.

- a) Set up at site.
- b) Ventilate the system (guarding all openings) by opening up the following manholes:-
 - i) The working manhole, which is to be cleared from silt/ obstruction.
 - ii) The manhole immediately upstream to the working manhole.
 - iii) The manhole immediately downstream to the working manhole.

This is a minimum requirement, but, preferably two manholes on upstream and two manholes downstream should be kept open. Use of air blowers may be made, if necessary.

Step - III Entry Procedure

- a) Natural ventilation as described in Step II (b) above should be ensured, preferably for 2 hours before entry into the manhole.
- b) Check for the toxic gases (stay out, if there is doubt for presence of toxic gases).
- c) Tie safety belts and ropes before entering into the manhole.
- d) Check ladders, steps of the manhole etc. before stepping inside the manhole (if in doubt use a rope attached to the safety belt).
- e) Keep safety ropes, spare lamp, breathing sets close to working area for immediate use in case of occurrence of any emergency.
- f) With the help of mirrors and torch, the status of sewer to be cleared may be checked.

In case of working in deep sewers, the water level in the sewers should be checked before entering. Portable safety sets should be available while working in deep sewers.

Step - IV Working inside the sewer:-

- a) At every three minutes interval, the sewer man at the top/ outside should make a call to the sewer man working inside the sewer. Every such message shall be acknowledged.

Step - V Completion of work:-

- a) Sewer man working inside the manhole should inform the sewer man at his top/ outside to be prepared and ready.
- b) Last sewer man out should check that all tools, ropes etc. are out and that the sewer is clear.

- c) All grids, guard rails, manholes covers should be placed.
- d) Road signs should be removed and site should be made clear.
- e) Supervisor shall be informed that work is completed.
- f) Hands, feet etc. should be washed thoroughly with antiseptic soap before eating.
- c) **Guidelines for giving first aid to a gas victim:-**
 - a) Remove him outside the manhole to fresh air as soon as possible.
 - b) Apply artificial respiration with resuscitator, if available, if he is not breathing, otherwise, mouth to mouth resuscitation be administered and rush him to hospital.
 - c) If the victim does not respond inspite of the above deliberations within two minutes, rush him to the nearest hospital.

iv) **Preventive and Corrective maintenance of the sewerage system**

a) **Preventive Maintenance:-**

- i. Many of the causes leading to the clogging of sewers can be prevented by periodic cleaning and removal of silt accumulations in sewer lines including manholes while the system is functioning.
- ii. Each of the sewer maintenance team shall be under the supervision of a competent person, who is well trained in using of sewer cleaning and safety equipments and qualified to render first aid service in case of emergencies.
- iii. While cleaning of the sewer, other repairs, if any, inside of the manhole, the foot steps, the manhole cover etc. should be carried out. In case of larger conduits through which a sewerman can walk, may also include the examination of the inner surface of the conduit and carrying out necessary repairs. If a sewer is damaged, it has to be tackled separately and not by routine maintenance personnel.
- iv. Based on local needs, a schedule of cleaning of all the sewers in the system has to be prepared and followed. The frequency of cleaning depends on the nature of sewage flowing in a particular section of sewer and the velocities obtained in the sewers during the peak flow.

b) **Corrective maintenance**

Corrective maintenance becomes necessary for removal of obstructions in sewers caused by excessive silt accumulation or damage leading to the break down of the system with flows much lower than the self cleansing velocity.

For locating the exact position of blockages, it is necessary to make an observation from the overflowing manhole and the manholes at downstream, until the first manhole with little or no flow is reached. The section between these manholes and the one immediately upstream is the one which should be cleaned at first instance, after taking the necessary precautions for the safety of the sewermen. The accumulated sewage should be pumped out from the manhole at downstream and the mouth of the sewer should be exposed after allowing for natural ventilation for one hour, by keeping all manholes within a radius of 200 metre open, tests shall be conducted to ensure that the conditions are satisfactory for the sewermen to enter the manhole, resorting to forced ventilation, if necessary. Air from the bottom of the manhole should be sucked out by an exhaust pump which will enable fresh air being drawn into the manhole. This is helpful to evacuate gases heavier than air such as Carbon Dioxide, Petrol vapour and Hydrogen sulphide. Sometimes air may be blown inside the manhole which pushes out the foul gases from the manhole. This is very effective for gases which are lighter than air, such as Carbon monoxide, Methane, Nitrogen etc. If the sewage flow into the manhole

is heavy and pumping has to be carried out continuously to enable sewer men to get in work, it is preferable to block the mouth of the sewer on the upstream side and start pumping from the next upstream manhole while the work of clearing the obstruction in the sewer at downstream end is being carried out.

In case of simple blockages, the flexible sewer bamboo rods and manila rope type may be sufficient. A ferret with a fire hose can also be used for breaking and removing sand stoppages. Where a rodding machine with flexible sewer rods is available, it can be used with suitable tool attachments to break the blockage.

When the above methods are not successful or damage to the sewer is suspected, the location of the blockage can be found by the use of sectional rods from either end of the blocked sewer. Once this is located, the sewer length near the blocks can be exposed by the open excavation to examine and set right the sewer line. If the damage to the sewer is extensive and is caused by poor foundation then the stretch between the two manholes may have to be relaid on a proper foundation.

In case it is not possible to wait for proper evacuation due to the foul atmosphere inside a manhole or a septic tank and sewer men have to enter urgently, then only sewer men, who are trained to work with safety belts, gas masks and other safety equipment may be allowed to enter the manhole, observing the precautions against gas hazards and under the guidance and supervision of a competent supervisor. In an emergency the supervisor should promptly get in touch with the nearest police station, a fire station and a hospital for help.

Where the material of the sewer, especially concrete is damaged, the cause must be investigated and due rectification must be carried out. If flows much lower than the designed ones lead to low velocities and consequent septicity resulting in the production of hydrogen sulphide, routine chlorination of the sewage may have to be considered.

If the damage is caused by the indiscriminate discharge of industrial waste of high acidic or alkaline nature or with high organic matter or solids, steps should be stop the waste in case it is not meeting with the standard as follows:-

S. No.	Parameter	Public sewers
1.	Suspended solids mg/l, max.	600
2.	pH value	5.5 to 9.0
3.	Oil and grease mg/l max.	20
4.	Ammonical nitrogen (as N), mg/l max	50
5.	Biochemical	350
6.	Arsenic (as As)	0.2
7.	Mercury (As Hg), mg/l, max.	0.01
8.	Lead (as Pb) mg/l, max	1.0
9.	Cadmium (as Cd) mg/l max	1.0
10.	Hexavalent chro-mium (as Cr + 6), mg/l, max	2.0
11.	Total chromium (as Cr) mg/l, max.	2.0
12.	Copper (as Cu) mg/l, max.	3.0
13.	Zinc (as Zn) mg/l, max	15
14.	Selenium (as Se)	0.05
15.	Nickel (as Ni) mg/l, max.	3.0
16.	Cyanide (as CN) mg/l, max.	2.0
17.	Fluoride (as F) mg/l, max.	15
18.	Phenolic compounds (as C ₆ H ₅ OH)mg/l, max.	5.0
19.	Radioactive materials (a) Alpha emitters micro curie mg/l, max. (b) Beta emittersmicrocurie mg/l	10-7 10-6
20.	Bio-assay test	90% survival of fish after 96 hours in 100% effluent
21.	Manganese	2 mg/l
22.	Iron (as Fe)	3mg/l
23.	Vanadium (as V)	0.2mg/l

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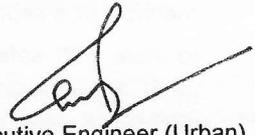
Problems created due to poor design and construction methods, which leads to frequent complaints of chokes in the sewers have to be set right by redesigning and construction. The use of bucket-type sewer cleaning machine is quite common. This is very effective way of removal of silt/grit and deserted solids from the sewerline which does not flow by itself. The removal of solid matter is utmost essential.

With the changing times, new technologies with innovative ideas are developed for desilting/ cleaning of sewerlines, suction type, jetting type and suction-cum-jetting type sewer cleaning machines are available in most PHE Divisions, which shall be maintained and repaired periodically and should be in working condition for the purpose. Talking of new technology, Super sucker machines are very effective for cleaning of sewers and should be used by PHE Divisions, where these are available. But these have their own limitations in case of space constraints and resources required for its operation. The bucket cleaning machines may be employed under supervision of skilled personnel to achieve the results effectively.

These instructions may be brought to the notice of all concerned.

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