Drainage Services Department Practice Note No. 1/2007

Safety Supervision of Work in Confined Space

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1. SCOPE

1.1 This Practice Note aims to provide DSD site supervisory staff and consultants with guidelines for safety supervision of confined space work where man-entry is necessary in order to prevent gassing accidents. It updates and supersedes the previous Practice Note No. 2/2006 having the same title.

1.2 This Practice Note should be read in conjunction with the Factories and Industrial Undertakings (Confined Spaces) Regulation, the "Code of Practice for Safety and Health at Work in Confined Spaces" issued by Labour Department, the relevant guidelines set out in DSD Safety Manual (2002) and other divisional work instructions for confined space work, whichever are applicable.

2. BACKGROUND

2.1 The construction, operation and maintenance of sewerage and drainage systems and sewage treatment facilities undertaken by DSD involve inevitably working in confined spaces like sewers, drains, tunnels, manholes, chambers, tanks, etc. Man-entry is often needed where working from the outside is considered impracticable.

2.2 Working in confined space is an extremely high-risk activity, especially in live sewers and manholes. Apart from other risks that may be present in such workplaces, the restricted access and poor ventilation characteristics of a confined space not only create risks of accumulation of dangerous gases and oxygen deficiency but also increase greatly the difficulty for escape and rescue in the event of emergency. Many dangerous gases are invisible. This lack of apparent threat has been a major cause of most gassing accidents involving multiple casualties. Very often the person who attempts to rescue a collapsed colleague will enter a confined space without realizing the invisible danger of the atmosphere.

2.3 The dangerous gases that are usually present in sewerage and drainage facilities include combustible gases (mainly methane (CH_4) and the like), carbon monoxide (CO) and hydrogen sulphide (H_2S), which are the products resulting from decay of organic matters. CH_4 is highly flammable and creates risks of fire and explosion. CO and H_2S are toxic and are the major cause of gassing accidents. The decay of organic matters consumes oxygen (O_2) and is liable to create oxygen deficiency. Common gas detectors available in the market are able to measure the concentration of all these four gases and help assess whether the atmosphere in a confined space is safe to work in.

2.4 The legislative control of work in confined space was significantly tightened after the enforcement of the revised Factories and Industrial Undertakings (Confined Spaces) Regulation on 19.6.2000 and the number of concerned accidents in the construction industry has been declining since then. Notwithstanding, gassing accidents, though very rare, did occur in DSD works in the past few years for one reason or another.

2.5 This Practice Note highlights the salient issues to be observed during safety supervision. The responsibilities of the DSD site supervisory staff and consultants are to check if the contractor complies with the legal and contractual obligations. It should be noted that the ultimate responsibility of the safety at work rests with the contractor concerned as described in para.3 below.

3. LEGAL REQUIREMENTS

3.1 The legislation that governs safety at work in confined space is the Factories and

Industrial Undertakings (Confined Spaces) Regulation (F&IU(CS)R). It sets out the responsibilities of the contractors and the workers engaged in such work. The "Code of Practice for Safety and Health at Work in Confined Spaces" issued by Labour Department also provides practical guidance and technical information to facilitate compliance of the Regulation. They are not repeated here.

3.2 In brief, the F&IU(CS)R requires that:

(a) the contractor has to appoint a "competent person" (CP) to carry out a risk assessment and make recommendation on suitable safety precautionary measures;

(b) the contractor has to verify the CP's risk assessment report and issue a certificate (commonly referred to as the "permit-to-work") to ensure that all necessary safety precautionary measures have been taken;

(c) the contractor has to ensure that no workers enter a confined space unless all recommended safety precautions in the risk assessment report have been taken and a certificate has been issued;

(d) the contractor has to ensure that no workers other than "certified workers" (CWs) enter or work in a confined space and a person is stationed outside to maintain communication with the workers inside;

(e) the contractor has to ensure that a worker entering a confined space is wearing an approved breathing apparatus (B.A.) of a type that gives appropriate protection having regard to the nature of the confined space and a safety harness connected to a lifeline that the free end is held by a person outside the confined space where (i) the risk assessment recommends the use of B.A., or (ii) a person has to enter a confined space for underground pipework;

(f) the contractor has to formulate and implement appropriate procedures to deal with emergencies; and

(g) the contractor has to provide all workers working in confined space and those assisting from outside with suitable training and instructions, as well as all necessary equipment.

4. ENHANCED SAFETY MEASURES

4.1 Gassing accidents which had occurred in DSD undertakings and accident investigation revealed that most, if not all, of them were caused by human error. In reality human error can never be completely eliminated, no matter how good a safe system-of-work has been in place. It is considered necessary to add a second line of defense to enable an early warning signal to be given out so as to increase the possibility of escape or being rescued when the prescribed safety measures fail.

4.2 In addition, the contractor shall take special precaution when working in confined space located in industrial areas. It is because the typical 4-in-1 type gas detectors available in the market, which cover the hazardous gases commonly present in the majority of sewerage and drainage systems, might not be able to detect some hazardous gases that may be brought about by industrial effluents (e.g. hydrogen cyanide (HCN) in plating industry, etc.).

4.3 To this end, the following enhanced safety measures are introduced for DSD confined space work with immediate effect.

(a) Continuous Gas Monitoring: The person entering a confined space shall bring along a gas detector, which can give out warning signals of the sudden presence of dangerous gases or oxygen deficiency, to continuously monitor the atmosphere so as to enable immediate evacuation, and

(b) Personal Alarm: A personal alarm of dead-man type, which is able to give out signals soon after a person loses his mobility (commonly 20 seconds), shall be worn by all persons entering a confined space to facilitate early rescue.

4.4 The above measures in para. 4.3 should be followed in all DSD confined space work, unless the risk assessment demonstrates that such measures produce no added benefit to safety at work. The enhanced safety measures will be incorporated into the specifications of future contracts to step up the safety control of confined space work.

5. SAFETY SUPERVISION BY SITE SUPERVISORY STAFF

5.1 Notification of Work

5.1.1 At the commencement of a contract, the Engineer's Representative (ER) should check if the main contractor has established a written notification system that enables ER to be precisely informed, in such detail as to the satisfaction of the ER, of all confined space operations. The system should also include means to ensure that the main contractor is to be informed for any such work to be carried out by all persons including his subcontractors in all circumstances, particularly during public holidays or urgent situations.

5.1.2 Upon the contractor's notification of work in confined space with man-entry, the ER should deploy his site supervisory staff to check the setting up of the confined space work before its commencement and properly supervise it. Reference shall be made to para. 5.3 below for determining the supervision level required.

5.2 Site Check for Confined Space Work

5.2.1 The site supervisory staff shall check together with the main contractor the setting up of the confined space work against the recommendations of the risk assessment report before work is allowed to proceed. During checking, the site supervisory should request the contractor to produce the relevant documentary evidence and demonstrate that the safety equipment is in good working order. The check should include, among other things, the following:

(a) whether the risk assessment has been duly prepared by a CP and a certificate (commonly known as the "permit-to-work") has been issued by the contractor and that the permit-to-work is displayed at the entrance to the confined space,

(b) whether all workers are CWs,

(c) whether the necessary safety equipment and rescue equipment are readily available and in good working order,

(d) whether the safety measures specified in the risk assessment and the permit-to-work have been implemented,

(e) whether the necessary measures to deal with emergency are in place,

(f) whether the contractor's Safety Officer (SO) or other staff having the qualification of a CP and sufficient knowledge and experience in confined space work is present to oversee the work, if man-entry is needed, and

(g) whether all the PPE specified in the risk assessment and/or permit-to-work has been provided.

5.2.2 In checking, the site supervisory staff should take note of the following for compliance by the contractor:

(a) Risk Assessment: Risk assessment is often a complex task involving the consideration of a number of parameters that affect the consequence and likelihood of the risks. It has to be conducted by the contractor's CP with extreme care, having due regard to the confined space working environment (e.g. condition of the interior of a manhole, geometry, access and egress points, natural ventilation, presence of utilities etc.) and surroundings (e.g. seafront, hillside, nearby factories, hospitals etc. where there is a possibility of sudden ingress of floodwater, hot liquid, solvents or other dangerous materials, whether in form of liquid, solid, dust, fume or vapour, etc.), the nature of the work process and duration, plant and materials to be used (i.e. whether they will generate safety hazards themselves such as use of solvents and diesel plant in confined space etc.).

(b) Gas Monitoring: Gas monitoring is an essential part of the risk assessment for determining the level of concentrations of dangerous gases and oxygen in a confined space. It should be conducted by persons with adequate training and experience, having regard to the possible changes in concentrations that may arise as a result of change in time and surrounding environment, e.g. sudden discharge from a factory. Continuous monitoring over a suitable period of time can detect the presence of certain gases that might not be picked up in one single test. Further, common gas detectors are only able to detect concentrations of CH_4, CO, H_2S and O_2. Attention should also be paid to the possible presence of other hazardous gases that may not be detected by common 4-in-1 type gas detectors, e.g. those associated with industrial effluents.

(c) Safety Equipment: It is important for the contractor to ensure that all safety equipment, including audio-visual alarms (dead-man type), B.A., gas detectors, safety harnesses attached with lifeline, torches, communication equipment, fire extinguishers, personal protective equipment etc., and rescue equipment, including man-lifting tripods, first-aid boxes, resuscitators, standby B.A.s for rescue use etc., are properly provided in sufficient quantity and used according to the recommendation of the risk assessment report prepared by the contractor's CP. The checking shall also include inspection of the maintenance and calibration certificates of the safety equipment and observation of demonstration by the contractor to verify that the safety equipment is in good working condition.

(d) Permit-to-Work: All safety precautionary measures as recommended by the risk assessment report (e.g. mechanical ventilation, use of B.A., etc.) must be implemented throughout the course of the work and recorded in a checklist, which forms part of the permit-to-work, in an attempt to obviate human errors. The period of time that the CWs are allowed to stay and work in a confined space must be specified in the permit. The permit shall be cancelled after the work is completed and that all personnel shall be evacuated and all tools and equipment shall be removed from the confined space. The permit must be signed by the contractor or his authorized representative.

(e) Competent Person and Certified Workers: It is a legal requirement for a contractor to appoint a CP to conduct the risk assessment and CWs to perform the work in confined space. The CP should have the necessary knowledge and experience to conduct a comprehensive risk assessment and oversee the site safety matters, including briefing the CWs of the risks and the safety measures to be taken right before entry into a confined space. The CWs should observe all safety instructions and keep alert at all times to watch out for any sudden danger during work in order to safeguard themselves. They shall carry a gas detector with them and continuously monitor the atmosphere in the confined space. Each CW must wear a personal alarm (dead-man type) preferably at waist level. A safety harness attached with a lifeline of which the end is manned by the standby person outside must be worn, unless the risk assessment report recommends otherwise.

(f) Standby Person: The contractor shall provide a standby person, who shall keep watching out for possible change of environment and danger and shall make himself readily available at all times to summon assistance and rescue immediately. He shall not be engaged in other activities and shall maintain communication with the CWs inside the confined space at regular intervals, normally from 1 to 2 minutes, to ensure that the situation inside the confined space remains safe and the CWs inside are conscious.

(g) Emergency Preparedness: The emergency preparedness shall also form part of the necessary safety measures. It shall include the availability of the emergency life saving equipment, including man-lifting tripod, first-aid box, resuscitator, standby B.A. set for rescue use etc., and a qualified first aider as recommended by the risk assessment report. The telephone numbers of the nearest fire brigade and ambulance should also be in hand so that assistance can be summoned immediately. The most important consideration in preparing an emergency plan is how the workers can evacuate safely from the inside of a confined space, or how the workers, if found unconscious or unable to move by themselves, can be retrieved speedily to a safe place, in the event of emergency.

5.2.3 Through the process of site checking of the setting up for confined space work, DSD site supervisory staff and consultants should draw the attention of the contractor to any non-compliance of the recommendation of the risk assessment report or any obvious deficits and require the contractor to rectify them immediately. The contractor should also be reminded to maintain vigilance at all times to watch out for possible unknown changes, even though all necessary safety precautionary measures as recommended in the risk assessment report are in place.

5.3 Determination of Supervision Level

5.3.1 A risk classification system, which aims to assist DSD site supervisory staff and consultants to determine the supervision level of confined space work, is presented in the Appendix A for reference.

5.3.2 The ER of DSD's site supervisory staff and consultants should appoint a staff having the qualification of a CP to supervise the confined space work. The appointed CP should first review the possible consequence of the confined space work concerned and its likelihood and evaluate the risk level by means of the risk level matrix and then determine the supervision level accordingly. Reference shall also be made to the risk assessment report prepared by the CP appointed by the contractor. In the event of doubt, the risk level should err on the side of safety.

6. CONFINED SPACE WORK UNDERTAKEN BY IN-HOUSE STAFF

6.1 The officer-in-charge of confined space work undertaken by in-house staff of the direct labour force (DLF) and sewage treatment facilities should appoint a staff having the qualification of a CP to supervise the confined space work. The appointed CP should ensure that the enhanced safety measures as listed in para. 4.3 are followed. Reference should also be made to the guidelines for checking of the setting up of confined space work and the determination of supervision level as detailed in para. 5.2 and 5.3 respectively.

6.2 In particular, the officer-in-charge of confined space work undertaken in-house should ensure that the work is carried out under the supervision of a CP and that the workers are CWs each wearing a dead-man type personal alarm, and a gas detector is brought into the confined space to continuously monitor the atmosphere throughout the stay.

7. ENQUIRY

7.1 The Commissioner for Labour enforces the F&IU(CS)R and provides advice on the safety at work in confined space. The ER or officer-in-charge of confined space work undertaken in-house should consult the Occupational Safety & Health Branch of the Labour Department in case of enquiry (Tel. No.: 2559 1410). Alternatively, they may contact Senior Engineer/Safety Adviser (Tel. No.: 2834 9681) as appropriate.

8. REFERENCE DOCUMENTS

8.1 Hong Kong SAR Law Cap.59, "Factories and Industrial Undertakings (Confined Spaces) Regulation", HKSAR Government

8.2 Code of Practice - Safety and Health at Work in Confined Spaces, Labour Department, HKSAR Government

8.3 A Reference Note on Occupational Exposure Limits for Chemical Substances in the Work Environment, Labour Department, HKSAR Government

8.4 Safety Manual (2002), Drainage Services Department, HKSAR Government

9. APPENDICES

Appendix A - Risk Classification System of Confined Space

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Risk Classification System of Confined Space

This risk classification system aims to assist DSD site supervisory staff and consultants to determine the supervision level of confined space work.

Risk Level Matrix (Risk Level = Consequence x Likelihood)

Consequence	Likelihood			
	Likely Occurs repeatedly	**Less Likely** May occur sometimes	**Possible** Could occur in time	**Unlikely** Occurs unlikely
Severe Immediate danger to life and prolonged harmful effects inside the confined space	Level A	Level B	Level B	Level C
Moderate Potential hazards which would cause major injury and illness inside the confined space	Level A	Level B	Level C	Level D
Minor Potential hazards to cause minor injury inside the confined space	Level B	Level C	Level C	Level D

Supervision Requirement

Risk Level	Supervision Level Required
Level A	Full time attendance during the man-entry period
Level B	Inspection Frequency – no less than twice every day
Level C	Inspection Frequency – no less than once every day
Level D	Inspection Frequency – no less than once every 2 days

Examples:

Example 1 Confined space work in a live sewage manhole in industrial area

Consequences - Severe (Immediate danger to life and prolonged harmful effects inside the confined space)
Likelihood - Likely (Occurs repeatedly)

Therefore, the Risk Level should be Level A.

Example 2 Confined space work in a stormwater drain without the presence of foul sewage and under good ventilation condition

Consequences - Moderate (Potential hazards which would cause major injury and illness inside the confined space)
Likelihood - Possible (Could occur in time)

Therefore, the Risk Level should be Level C.

Example 3 Confined space work in a newly constructed sedimentation tank

Consequences - Minor (Potential hazards to cause minor injury inside the confined space)
Likelihood - Unlikely (Occurs unlikely)

Therefore, the Risk Level should be Level D.

Notes:

1. The risk classification system is derived from the Risk Matrix described in the "Risk Assessment – A Practical Guide" written by Brain Kazer and published by The Institute of Occupational Safety and Health, UK.

2. The ER or officer-in-charge of confined space work undertaken in-house should first review the possible consequence of the confined space work concerned and its likelihood and evaluate the risk level by means of the risk level matrix and then determine the supervision level accordingly. In the event of doubt, the risk level should go to the safe side.

3. It should be noted that the working conditions vary from one workplace to another. There are many factors, such as the presence of polluted substances, industrial effluents, ventilation condition, flow condition, ground condition, structural condition of the pipes, etc., which will affect the safety of the working environment.

4. The ER or officer-in-charge of confined space work undertaken in-house should conduct the evaluation very carefully and avoid the across-the-board classification. The risk level should be evaluated on a case-by-case basis and the situation should be reviewed whenever there has been a significant change in the conditions of the confined space or of the activities therein.