Approval Conditions
for Operating
Mandatory Safety Training Courses

Part II – Module 2(b)

Course Design and Specifications

For

(A) Safety Training Course for Competent Persons of Confined Spaces Operation

(B) Safety Training Course for Top-Up to Competent Persons of Confined Spaces Operation

(C) Safety Training Revalidation Course for Competent Persons of Confined Spaces Operation

Version Control Record

Version	Release Date	Effective Date	Significant Changes
1.0	5 September 2011	26 September 2011	
1.1	1 June 2015	1 June 2015	Address of Occupational Safety and Health Training Centre, Labour Department
2.0	25 June 2019	25 September 2019	Sections 1.10, 2.2, 6.1-6.5, 8.1, 9.1, 10.1, 10.2 & 11.1-11.5 Annexes 2-8
2.1	26 October 2023	29 December 2023	Annex 5 Sections 2.2.1, 3.2.3, 3.2.5, 4.1, 5.2.1,5.2.2, 5.2.3, 6, 7.2.1, 7.2.5, 8.2, 8.3, 11.1 & appendices 2-3; Annex 6 Sections 2.2, 2.3 & 5.1; Annex 7 Sections 2.2.1, 3.2.3, 3.2.5, 4.1, 5.2.1, 5.2.2, 5.2.3, 6.2, 6.3, 7.2.1, 7.2.5, 9.1, 10, 11.2.1, 11.2.5 & appendices 2-3; and Annex 8
3.0	30 September 2024	30 November 2024	Sections 2.2, 3.2.5, 6, 7.1, 10, 11, 12.1, Table 1 & Annexes 1-10

Inquiry

For further inquiry on matters relating to the application for recognition of the MST courses, please contact:

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Contents

1. Overview

1.1 The terms and abbreviations adopted in module part follow those defined in Part I. This module is Part II – 2(b) of the AC which covers 3 competent person ("CP") courses, i.e. full course, top-up course and revalidation course. This module should be read together with Part I of this AC.

1.2 Section 5 of the Factories and Industrial Undertakings (Confined Spaces) Regulation ("the Regulation"), Cap 59AE, requires a proprietor or contractor responsible for a confined spaces operation to appoint a CP to carry out an assessment of the working conditions and nature of tasks to be performed in the confined space. Being a CP, the person should have successfully completed the relevant safety training course and have been issued with a relevant certificate as well as having one year's relevant post-training experience. In this regard, the CL is empowered by section 4(2) of the Regulation to recognise the following safety training courses:

(A) Safety Training Course for Competent Persons of Confined Spaces Operation ("full course");

(B) Safety Training Course for Top-Up to Competent Persons of Confined Spaces Operation ("top-up course"); and

(C) Safety Training Revalidation Course for Competent Persons of Confined Spaces Operation ("revalidation course").

1.3 Procedures for application for course recognition are stipulated in the GN. Applicant who wishes to run full course, top-up course or revalidation course should submit an application to the CL for course recognition.

1.4 Unless stated otherwise, requirements stated in this module are applicable to full course, top-up course and revalidation course.

1.5 TCP should ensure that the course materials used should comply with the requirements of this module.

1.6 The objective of the full course or top-up course is to provide specific occupational safety and health training to persons who are to work as competent persons in connection with confined space activities. The trainees will be issued with a combined certificate of CP and certified worker ("CW") upon successful completion of the course.

1.7 Revalidation course aims to provide refresher training to holders of certificate of CP or combined certificates of CP and CW, which are expiring or expired, to enhance or reinforce their occupational safety and health knowledge in connection with confined space activities. Upon successful completion of the course, the trainee will be issued a new certificate.

1.8 A person who has successfully completed the full course, top-up course or the revalidation course is deemed to have received the same training as required for certified workers. The TCP should issue a CP combined certificate (Figure 1) to this person to show that he had completed competent person and CW training.

1.9 At the end of full course or top-up course, the trainees should be able to:

1.9.1 Describe the basic legal requirements prescribed under relevant safety legislation applicable to confined spaces;
1.9.2 Describe the nature and potential harmful effects of hazards that are likely to be present when working in confined spaces;
1.9.3 Conduct a risk assessment, make recommendations on measures to be taken and prepare an appropriate report pertaining to working in confined spaces;
1.9.4 Devise a safe system of work as a follow-on action from the risk assessment report, the system of work must include measures to minimize the risk of injuries arising from the hazards;
1.9.5 Describe possible emergency situations arising from working in confined spaces, appropriate response procedures and

limitations of such procedures;

1.9.6 Describe the types, principles, operation, purpose and limitations of safety equipment to be used when working in confined spaces;

1.9.7 Familiarize and practise the correct and proper use of safety equipment to be used when working in confined spaces; and

1.9.8 Describe the past accidents (including causes and related preventive measures) associated with working in confined spaces. The accidents should include alarming and/or serious nature ones.

1.10 At the end of revalidation course, the trainees should be able to:

1.10.1 Describe the basic legal requirements prescribed under relevant safety legislation applicable to confined spaces;

1.10.2 Describe the nature and potential harmful effects of hazards that are likely to be present when working in confined spaces;

1.10.3 Conduct a risk assessment, make recommendations on measures to be taken and prepare an appropriate report pertaining to working in confined spaces;

1.10.4 Devise a safe system of work as a follow-on action from the risk assessment report, the system of work must include measures to minimize the risk of injuries arising from the hazards;

1.10.5 Describe possible emergency situations arising from working in confined spaces, appropriate response procedures and limitations of such procedures;

1.10.6 Describe the types, principles, operation, purpose and limitations of safety equipment to be used when working in confined spaces;

1.10.7 Familiarize and practise the correct and proper use of safety equipment to be used when working in confined spaces; and

1.10.8 Describe the past accidents (including causes and related preventive measures) associated with working in confined spaces. The accidents should include alarming and/or serious nature ones.

2. Admission criteria

2.1 Full course is run for trainee who does not possess a CP certificate or combined certificate of CP and CW or possesses one of the said certificates which has expired for more than 3 months.

2.2 A TCP should ensure that trainee admitted to top-up course should possess a certificate of CW issued on or after 30 November 2024 with validity time not less than 1 year at the time of enrolment.

2.3 A TCP should ensure that applicant to be admitted to a revalidation course should, at the time of application, be holding a CP certificate or combined certificate of CP and CW which either will expire within 6 months or has expired for not more than 3 months.

2.4 A TCP should ensure that trainee admitted to its full course, top-up course and revalidation course has attained the age of 18 years.

3. Qualifications of trainer

3.1 A TCP should ensure that its trainers on the **theory session** of CP courses should at least possess either one of the qualifications from (i) to (v) stipulated in **Annex 1**.

3.2 A TCP should ensure that its trainers on the **hands-on session** of CP courses should at least the following :

3.2.1 complete Form 5 or higher education;

3.2.2 possess a certificate of Safety Supervisor Course issued either by the Occupational Safety and Health Council ("OSHC") or Construction Industry Council ("CIC") or equivalent;

3.2.3 complete an acceptable instructional skills training course, such as the certificate course of Basic Instructional Techniques by The Education University of Hong Kong or the certificate course of Occupational Safety and Health Trainer by the OSHC or the certificate course of Effective Site Safety

Training and Instructing Technique by the CIC or equivalent;

3.2.4 possess a valid first aid certificate issued by a recognized body; and

3.2.5 i) have at least two years of practical experience directly involving working in confined spaces;

ii) a person recognised by the CL as being competent to teach the hands-on session of CP course; or

iii) a person recognised by the CL as being competent to teach the hands-on session of CW course.

3.3 A TCP should ensure that its trainers should be CP under the Regulation.

3.4 A TCP should ensure that its trainers possess relevant experience in the use of air testing equipment and rescue equipment (such as tripod and personal motion-sensing alarm device) and hold relevant training certificates in the use of approved breathing apparatus and reviving apparatus/resuscitator.

4. Trainees to trainer ratio

4.1 A TCP should ensure that the maximum ratio of trainees to trainer is 20 to 1 and it is the same for theory session and hands-on session.

5. Class size

5.1 A TCP should ensure that the maximum size of a class is 20 trainees and it is the same for theory session and hands-on session.

6. Course duration

6.1 A TCP should ensure that the minimum course duration of full course should be 20 hours in 3 whole days (8 hours in first & second days and 4 hours in third day, but excluding break between half-day sessions, lunch time and practical examination sessions) and it should include hands-on sessions of about five hours on the practice of safety equipment, a written examination session of 45 minutes and a total of not more than 30 minutes recess time in first & second days and not more than 15 minutes recess time in third day.

6.2 A TCP should ensure that the minimum course duration of top-up course should be 12 hours (8 hours in first day and 4 hours in second day, but excluding break between half-day sessions, lunch time and practical examination sessions) and it should include a hands-on session of about three hours on the practice of safety equipment, a written examination session of 45 minutes and a total of not more than 30 minutes recess time in first day and not more than 15 minutes recess time in second day.

6.3 A TCP should ensure that the minimum course duration of revalidation course should be 16 hours in 2 whole days (8 hours in first & second days, but excluding break between half-day sessions, lunch time and practical examination sessions) and it should include hands-on session of about five hours on the practice of safety equipment, a written examination session of 45 minutes and a total of not more than 30 minutes recess time in first & second days.

6.4 A TCP is allowed to use the time saved from the practical training, particularly in a small class size situation, to supplement additional relevant materials in the practical session if all the trainees have completed the practical training as specified in relevant course materials. In such case, the TCP should properly record the supplemented training and produce the records, upon request, to an occupational safety office of the LD for inspection.

6.5 A TCP may refer to the "Work Safety Alert (animation)" or "Work Safety Alert (text version)" provided by the Labour Department's website when formulating the supplementary teaching materials mentioned in paragraphs 6.4 to compile relevant accident case studies and analysis related to confined space operations in recent years for trainees to study and discuss.

6.6 A TCP should make an application in writing to the CL for seeking approval for a special arrangement on the partition of course duration, if needed, where the duration of each half-day session should not be less than 3 hours. The CL will consider the application when the special arrangement does not affect the quality of training and course monitoring.

7. Attendance

7.1 Without prejudice to section 6.6, a TCP should ensure that any trainee who is absent from the class for more than 15 minutes for any half-day sessions will be disqualified to attend the examination.

8. Lesson plan

8.1 A TCP should ensure that its full course, top-up course and revalidation course should be taught in accordance with the lesson plans stipulated at **Annex 2**, **Annex 3** and **Annex 4** respectively.

9. Course contents

9.1 A TCP should ensure the course materials used for full course, top-up course and revalidation course should include all the topics and details stipulated at **Annex 5**, **Annex 6** and **Annex 7** respectively. The course contents include the reference teaching time and the additional requirements for the delivery. The TCP should also supplement additional materials in accordance with the needs of the trainees and the latest safety information.

10. Display, demonstration and practising

10.1 A TCP should provide suitable and sufficient equipment for the purpose of display, demonstration and practising. The details are stated in relevant sections of the course contents at **Annex 5**, **Annex 6** and **Annex 7**.

10.2 A TCP should ensure that every trainee should safely complete the hands-on practices. A TCP should provide the following equipment (for shared use) for trainee for hands-on practice of Full, Top-up Course and Revalidation Courses:

- Minimum one set of Lifeline and Tripod/ Quadpod;
- Minimum two personal motion-sensing alarm devices;
- Minimum two sets of Self-contained Type Approved Breathing Apparatus with sufficient compressed air; and
- Minimum two continuous air monitoring equipment which have a two-level alarm system and can display readings on levels of oxygen, carbon monoxide, hydrogen sulphide and combustible gas.

10.3 A TCP should also provide the following equipment for each trainee for hands-on practice of Full, Top-up Course and Revalidation Courses:

- One set of Safety Harness; and
- One mask for Self-contained Type Approved Breathing Apparatus.

11. Examination

11.1 A TCP should ensure that every trainee attending the examination should meet the required attendance and the requirement of completing the hands-on practice.

11.2 A TCP should ensure that the trainee should pass the written examination and the practical examination before qualifying him/her to get the certificate.

Written examination

11.3 A TCP should ensure that the examination papers used are issued and specified by LD.

11.4 A TCP should provide the answer sheet at **Annex 8** to the trainee for the examination.

11.5 A TCP should ensure that the invigilator and the trainee should sign on the answer sheet.

11.6 The written examination is divided into Part 1 and Part 2. Time allowed for Part 1 is 15 minutes with a passing score of 100%. Time allowed for Part 2 is 30 minutes with a passing score of 75%. Trainee must obtain passing scores in both Parts 1 and 2 of the examination. A TCP should ensure that the Part 1 of the examination paper is completed before distributing and starting the Part 2 of the examination paper.

11.7 A trainee who fails the written examination can re-sit it once. A TCP should arrange for a re-examination to be held within 20 working days immediately after the written examination. During the re-examination, the trainee only needs to obtain passing scores in all the previously failed part(s) (i.e. Part 1 and / or Part 2 of the examination paper) within the specified time limit to pass the written examination.

Practical examination

11.8 The practical examination consists of proper use of personal motion-sensing alarm device, approved breathing apparatus (self-contained type) and continuous air monitoring equipment.

11.9 A TCP should provide suitable, sufficient equipment and venues for the practical examination. The assessment items that trainee need to complete are listed in the score sheet for practical examination in

Appendix 9.

11.10 A TCP should ensure that every trainee should safely complete the practical examination. A TCP should provide the following equipment (for shared use) for trainees for practical examinations of Full, Top-up and Revalidation Courses:

- Minimum two personal motion-sensing alarm devices;
- Minimum two sets of Self-contained Type Approved Breathing Apparatus with sufficient compressed air; and
- Minimum two continuous air monitoring equipment which have a two-level alarm system and can display readings on levels of oxygen, carbon monoxide, hydrogen sulphide and combustible gas.

11.11 A TCP should also provide the following equipment for each trainee for practical examination of Full, Top-up and Revalidation Courses:

- One set of Safety Harness; and
- One mask for Self-contained Type Approved Breathing Apparatus.

11.12 A TCP should ensure that the examiner(s) of the practical examination is/are the TCP's trainer(s) for the hands-on sessions or for the theory sessions. Meanwhile, the TCP's trainer(s) for the theory session should possess with relevant experience in the use of air testing equipment and personal motion-sensing alarm device and hold relevant training certificates in the use of approved breathing apparatus. Each examiner can assess up to two trainees at the same time, but the TCP should provide appropriate and sufficient separation between the trainees to prevent adjacent trainees from cheating and plagiarizing during the practical examination.

11.13 Trainees must correctly complete all the assessment items stipulated in **Appendix 9** within the time allowed for each assessment item in order to pass the practical examination. **Those trainees who exceeded the time limit will be regarded as having failed.** A TCP should provide a suitable timer to inform trainees of the remaining examination time.

11.14 A TCP should provide the score sheet at **Appendix 9** to examiner(s) for the examination and display the assessment instructions for practical examination in **Appendix 10** at the venues for the practical examination for trainees to follow.

11.15 A TCP should ensure that the examiner, invigilator and the trainee should sign on the score sheet immediately after each trainee completes the practical examination.

11.16 A TCP should arrange the practical examination to be conducted immediately after the post-examination review of the written examination. A TCP should also arrange the order of each trainee in practical examination by random drawing, and notify each trainee of the arrangements for the practical examination (such as examination times, venues, etc.) on the first day of the course.

11.17 A trainee who fails the practical examination can re-sit it once. A TCP should arrange for a re-examination to be held within 20 working days immediately after the practical examination. During the re-examination, the trainee only needs to correctly complete all the previously failed assessment item(s) within the specified time limit to pass the practical examination.

12. Validity period of certificate

12.1 A TCP should ensure that the validity period of combined certificate of CP and CW issued is 2 years.

12.2 For full course and top-up course, validity period of the certificate should be counted from the date when the trainee successfully completes the course.

12.3 For revalidation course, validity of the certificate should be counted from the day—

12.3.1 immediately after the expiry date of the current certificate if the revalidation course is successfully completed within 6 months prior to expiry of the current certificate, or

12.3.2 of completing the revalidation course if the revalidation course is successfully completed within 3 months after expiry of the current certificate.

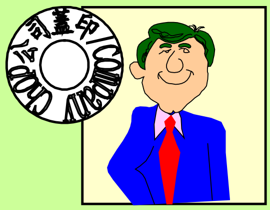
13. Standard certificate format

13.1 A TCP should ensure that the front side of the combined certificate of CP and CW should be designed with the required words, in the format as shown in **Figure 1** and according to the specifications below. The reverse side is left to the TCP to include other information as appropriate, which should be commensurate with the purpose of the certificate.

Figure 1: Required Words and Design Format of the Front Side of Combined Certificate of CP and CW

合資格人士和核准工人合併證明書
Combined Certificate of Competent Person and Certified Worker
工廠及工業經營(密閉空間)規例第 4(1)條和第 4(2)條
Sections 4(1) and 4(2) of the Factories and Industrial Undertakings (Confined Spaces) Regulation

持證人姓名 Holder's Name
（中文） :
(English) :



編號 Reference No. :

證明日期 （日日/月月/年年年年） **Date of Certification :** (dd/mm/yyyy)

完成課程日期 （日日/月月/年年年年） **Date of Course Completion :** (dd/mm/yyyy)

有效期限 （日日/月月/年年年年） **Validity Period :** (dd/mm/yyyy) **由 From** **至 To** **止**

本證明書由 ***[某發證機構]*** 簽發
Issued by *[provider of recognised training course]*

此證明書須由持證人擁有及保存。
This certificate is owned and should be kept by the certificate holder.

(not to scale)

13.1.1 The certificate should be made of durable materials, either laminated or plastic, and in standard size of 85 mm x 55 mm;

13.1.2 A photograph (minimum size of not less than 20 mm x 25 mm) of the trainee should be incorporated into the certificate for easy identification;

13.1.3 For laminated card, the corner of the trainee's photo should be stamped with the TCP's company's chop;

13.1.4 For plastic card, the trainee's photo should be printed on the card;

13.1.5 Unless otherwise specified, information on the certificate should be printed in both Chinese and English;

13.1.6 The certificate should contain the following information:

- The name of certificate, i.e. "合資格人士和核准工人合併證明書" and "Combined Certificate of Competent Person and Certified Worker";
- The empowering legislation, i.e. "工廠及工業經營（密閉空間）規例第 4(1)條及 4(2)條" and "Sections 4(1) and 4(2) of the Factories and Industrial Undertakings (Confined Spaces) Regulation";
- The Chinese and English name as printed on the Hong Kong Identity Card (or equivalent identity documents) of the certificate holder;
- Reference number of the certificate (an "R" should be appended to the last digit of the reference number to denote that the certificate is issued for a revalidation course);
- Date of Certification (in the format of DD/MM/YYYY) refers to the date the certificate holder successfully completed his or her first full course or top-up course;
- Date of Course Completion (in the format of DD/MM/YYYY);
- Validity period with starting date and expiry date (in the format of DD/MM/YYYY);
- Name of the certificate issuing course provider; and
- The wordings of "此證明書須由持證人擁有及保存。" and "This certificate is owned and should be kept by the certificate holder."

14. Training records

14.1 A TCP should submit the record of every certificate issued according to the required details stipulated in Table 1 as well as the name of the course.

Table 1：Example of Training Records

HKID/ Passport No. (TRT1)	Name of trainee (TRT2)	Class Ref. (TRC1)	Name of Trainer (TRC2)	Date of Course completion (TRC3)	Certificate Effective Date (TRT3)	Certificate Expiry Date (TRT4)	Certificate Serial No. (TRT5)	Are the trainees approved by the HKSAR government as imported workers? (Y : Yes) (N : No)
A123456(1)	Chan Siu On	ABC1	HAU To-si	13/06/2011	13/06/2011	12/06/2014	W396000201R	Y
A123457(2)	Chan Siu Chuen	ABC1	HAU To-si	13/06/2011	23/09/2011	22/09/2014	W396000202R	Y
A123458(3)	Chan Siu Feng	ABC2	HAU To-si	18/06/2011	18/06/2011	17/06/2014	W396000203	N
A123459(4)	Chan Siu Lin	ABC2	HAU To-si	18/06/2011	18/06/2011	17/06/2014	W396000204	N

Annex 1
Qualifications of a Competent Persons Course Trainer (theory session)

Qualifications			
A person possessing at least any one of the following qualifications and experience from (i) to (v)			
	Academic Qualifications	**Experience**	
(i)	A Registered Safety Officer under the Factories and Industrial Undertakings (Safety Officers and Safety Supervisors) Regulations.	At least two (2) years of practical experience directly involving working in confined spaces; a person recognised by the CL as being competent to teach the theory session of CP course; or a person recognised by the CL as being competent to teach the theory session of CW course.	or
(ii)	A recognized degree or post-graduate diploma in occupational safety and health, or equivalent, and with a cumulative total of **not less than one (1)** year of experience directly involving occupational safety and health related work.	Ditto.	or
(iii)	A degree in Science or Engineering, or equivalent, and a recognized certificate, diploma or higher diploma in occupational safety and health, and with a cumulative total of **not less than one (1)** year of experience directly involving occupational safety and health related work.	Ditto.	or
(iv)	A recognized certificate, diploma or higher diploma in occupational safety and health, and with a cumulative total of **not less than two (2)** years of experience directly involving occupational safety and health related work, **one (1) year of such experience must be obtained after the academic qualification.**	Ditto.	or
(v)	A recognized certificate in construction safety and with a cumulative total of **not less than two (2)** years of experience directly involving occupational safety and health related work, **one (1) year of such experience must be obtained after the academic qualification.**	Ditto.	

Annex 2
Lesson Plan for Safety Training Course for Competent Persons of Confined Spaces Operation

Day 1

Section	Topic & Content	Time (Minutes)
1	Introduction to Arrangements of the Course	10
2	Relevant Occupational Safety and Health Legislation Applicable to Confined Spaces	35
3	Basic Concept of a Confined Space and Common Potential Hazards	60
	Recess	**15**
4	Case Study and Analysis of Common Serious Accidents	70
5	Basic Concept of Safe System of Work and Permit-to-work System	135
	Break between Half-day Sessions or Lunch Break	
5	Basic Concept of Safe System of Work and Permit-to-work System **(continued)**	
6	Emergency Situations and Response Procedures	55
	Recess	**15**
6	Emergency Situations and Response Procedures **(continued)**	
7	Explanation, Display, Demonstration and Practice on Safety Equipment	85
	Total Time of Day 1【Class】	**480 (8 Hrs)**

Lesson Plan for Safety Training Course for Competent Persons of Confined Spaces Operation

Day 2

Section	Topic & Content	Time (Minutes)
7	Explanation, Display, Demonstration and Practice on Safety Equipment	130
	Recess	**15**
8	Risk Assessment	225
	Break between Half-day Sessions or Lunch Break	
8	Risk Assessment **(continued)**	
	Recess	**15**
9	Air Testing Procedures and Points to Note	35
10	Practice on Use of Multiple-Sensor Air Monitoring Equipment	60
	Total Time of Day 2【Class】	**480 (8 Hrs)**

Lesson Plan for Safety Training Course for Competent Persons of Confined Spaces Operation

Day 3

Section	Topic & Content	Time (Minutes)
10	Practice on Use of Multiple-Sensor Air Monitoring Equipment	30
11	Application of Safe System of Work and Permit-to-work System	130
Recess		**15**
11	Application of Safe System of Work and Permit-to-work System **(continued)**	
12	Conclusion of the Course	10
13	Written Examination	45
14	Review of the Examination Paper After the Examination	10
Total Time of Day 3【Class+Written Exam+Review】		**240 (4 Hrs)**
15	Practical Examination	

Annex 3
Lesson Plan for Safety Training Course for Top-Up to Competent Persons of Confined Spaces Operation

Day 1

Section	Topic & Content	Time (Minutes)
1	Introduction to Arrangements of the Course	10
2	Risk Assessment	225
Recess		**15**
2	Risk Assessment **(continued)**	
Break between Half-day Sessions or Lunch Break		
2	Risk Assessment **(continued)**	
3	Air Testing Procedures and Points to Note	35
4	Practice on Use of Multiple-Sensor Air Monitoring Equipment	90
Recess		**15**
5	Practice on Safety Equipment	90
Total Time of Day 1【Class】		**480 (8 Hrs)**

Lesson Plan for Safety Training Course for Top-Up to Competent Persons of Confined Spaces Operation

Day 2

Section	Topic & Content	Time (Minutes)
5	Practice on Safety Equipment	30
6	Application of Safe System of Work and Permit-to-work System	130
Recess		**15**
6	Application of Safe System of Work and Permit-to-work System **(continued)**	
7	Conclusion of the Course	10
8	Written Examination	45
9	Review of the Examination Paper After the Examination	10
Total Time of Day 2【Class+Written Exam+Review】		**240 (4 Hrs)**
10	Practical Examination	

Annex 4
Lesson Plan for Safety Training Revalidation Course for Competent Persons of Confined Spaces Operation

Day 1

Section	Topic & Content	Time (Minutes)
1	Introduction to Arrangements of the Course	5
2	Relevant Occupational Safety and Health Legislation Applicable to Confined Spaces	30
3	Basic Concept of a Confined Space and Common Potential Hazards	40
4	Case Study and Analysis of Common Serious Accidents	45
	Recess	**15**
5	Basic Concept of Safe System of Work and Permit-to-work System	70
6	Emergency Situations and Response Procedures	45
	Break between Half-day Sessions or Lunch Break	
6	Emergency Situations and Response Procedures **(continued)**	
7	Explanation, Display, Demonstration and Practice on Safety Equipment	215
	Recess	**15**
7	Explanation, Display, Demonstration and Practice on Safety Equipment **(continued)**	
	Total Time of Day 1【Class】	**480 (8 Hrs)**

Lesson Plan for Safety Training Revalidation Course for Competent Persons of Confined Spaces Operation

Day 2

Section	Topic & Content	Time (Minutes)
8	Risk Assessment	145
Recess		**15**
9	Air Testing Procedures and Points to Note	35
10	Practice on Use of Multiple-Sensor Air Monitoring Equipment	75
Break between Half-day Sessions or Lunch Break		
10	Practice on Use of Multiple-Sensor Air Monitoring Equipment **(continued)**	
11	Application of Safe System of Work and Permit-to-work System	130
Recess		**15**
11	Application of Safe System of Work and Permit-to-work System **(continued)**	
12	Conclusion of the Course	10
13	Written Examination	45
14	Review of the Examination Paper After the Examination	10
Total Time of Day 2【Class+Written Exam+Review】		**480 (8 Hrs)**

Lesson Plan for Safety Training Revalidation Course for Competent Persons of Confined Spaces Operation

Day 3

Section	**Topic & Content**	**Time (Minutes)**
15	Practical Examination	

Annex 5

Course Contents for Safety Training Course for Competent Persons of Confined Spaces Operation

Course Contents for

Safety Training Course for

Competent Persons of Confined Spaces Operation

Section 4(2) of the Factories and Industrial Undertakings

(Confined Spaces) Regulation

Occupational Safety and Health Branch
Labour Department

The Course Contents are prepared by
The Occupational Safety and Health Branch
Labour Department

This Edition September 2024

Information on the services offered by the Labour Department and on major labour legislation can also be found by visiting our Home Page in the Internet.

Contents

1. Introduction to Arrangements of the Course

[Reference teaching time for Section 1: 10 mins]

1.1 Training Venue, Training Equipment and Examination Requirements

- To introduce briefly about the training venue, training equipment and the examination requirements

1.2 Introduction to the Course Contents

- To introduce briefly about the course structure and contents

1.3 Objectives of the Course

Under the Factories and Industrial Undertakings (Confined Spaces) Regulation (Chapter 59AE) (hereinafter referred as the FIU(CS)R), a proprietor or contractor responsible for a confined space work shall appoint a competent person to carry out an assessment of the working conditions in the confined space and make recommendations on measures to be taken in relation to safety and health of workers while working in that space. Being a competent person, the person shall has attained the age of 18 years; and who is a registered safety officer or has successfully completed the relevant training course to prepare risk assessment reports and been issued with a relevant certificate recognized by the Commissioner for Labour; as well as having one year's relevant post-registration or post-training experience.

Upon successfully completing the course and passing the examination, the trainee should be issued with a certificate in a format to be specified by the Commissioner. At the end of the course, the trainees should be able to:

- Describe the basic legal requirements prescribed under relevant safety legislation applicable to confined spaces;
- Describe the nature and potential harmful effects of hazards that are likely to be present when working in confined spaces;
- Conduct a risk assessment, make recommendations on measures to be taken and prepare an appropriate report pertaining to working in confined spaces;
- Devise a safe system of work as a follow-on action from the risk assessment report, the system of work must include measures to minimize the risk of

injuries arising from the hazards;

- Describe possible emergency situations arising from working in confined spaces, appropriate response procedures and limitations of such procedures;
- Describe the types, principles, operations, purposes and limitations of safety equipment to be used when working in confined spaces;
- Familiarize and practise the correct and proper use of safety equipment to be used when working in confined spaces; and
- Describe past accidents (including causes and related preventive measures) associated with working in confined spaces. The accidents should include alarming and/or serious nature ones.

2. Relevant Occupational Safety and Health Legislation Applicable to Confined Spaces

[Reference teaching time for Section 2: 35 mins]

2.1 Occupational Safety and Health Ordinance and Subsidiary Legislation (Chapter 509)

Purposes

- To ensure the safety and health of employees when they are at work
- To prescribe the occupational safety and health measures
- To improve the safety and health standards applicable to workplaces
- To improve the safety and health aspects of working environments of employees

Coverage

- This ordinance covers almost all workplaces - places where employees work, including offices, department stores, supermarkets, hospitals, construction sites, etc.
- However, there are a few exceptions, including places where only self-employed persons work and domestic premises where the only employees are domestic servants.
- Every employer must, so far as reasonably practicable, ensure the safety and health at work of all his employees.

Subsidiary Regulations include:

- Occupational Safety and Health Regulation
- Occupational Safety and Health (Display Screen Equipment) Regulation

2.2 Factories and Industrial Undertakings Ordinance and Subsidiary Legislation (Chapter 59)

- Provide for the safety and health protection to workers in the industrial sector
- Coverage
    - factories
    - construction sites

- catering establishments
- cargo and container handling undertakings
- repair workshops and other industrial workplaces

- **General Duties of Proprietors**

  Every proprietor of an industrial undertaking must, so far as is reasonably practicable, ensure the safety and health at work of all persons employed by him. The matters to which that duty extends include:
  - providing and maintaining plant and work systems that do not endanger safety or health;
  - making arrangements for ensuring safety and health in connection with the use, handling, storage or transport of plant or substances;
  - providing all necessary information, instruction, training, and supervision for ensuring safety and health;
  - providing and maintaining all parts of the workplace and means of access to and egress from the workplace that is safe and without risk to health; and
  - providing and maintaining a working environment that is safe and without risk to health.

- **General Duties of Persons Employed**
  - every person employed at an industrial undertaking must take reasonable care for the safety and health of himself and others; and
  - co-operate with the proprietor of an industrial undertaking to enable any duty or requirement for securing the safety and health of persons employed at the industrial undertaking to be performed or complied with.

Subsidiary Legislation under the Factories and Industrial Undertakings Ordinance:

Under the Factories and Industrial Undertakings Ordinance (hereinafter referred as the FIUO), there are subsidiary regulations covering various aspects of hazardous work activities in factories, building and engineering construction sites, catering establishments, cargo and container handling and other industrial workplaces. The subsidiary regulations prescribe detailed safety and health standards on work situations, plant and machinery, processes and substances.

Subsidiary Regulations include Factories and Industrial Undertakings Regulations, Construction Sites (Safety) Regulations, FIU(CS)R, Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations, Factories and Industrial Undertakings (Electricity) Regulations, Factories and Industrial Undertakings (Loadshifting Machinery) Regulation, Factories and Industrial Undertakings (Gas Welding and Flame Cutting) Regulation, Factories and Industrial Undertakings (Safety Management) Regulation, etc.

2.2.1 Factories and Industrial Undertakings (Confined Spaces) Regulation

Application

The FIU(CS)R applies to work in an industrial undertaking that takes place:

- within a "confined space"; and
- within the immediate vicinity of, and is associated with work occurring within, a "confined space".

"confined space" means any place in which, by virtue of its enclosed nature, there arises a reasonably foreseeable **"specified risk"**, and without limiting the generality of the foregoing, includes any chamber, tank, vat, pit, well, sewer, tunnel, pipe, flue, boiler, pressure receiver, hatch, caisson, shaft or silo in which such risk arises.

"specified risk" means a risk of:

(a) serious injury to any person at work arising from a fire or explosion;

(b) the loss of consciousness of any person at work arising from an increase in body temperature;

(c) the loss of consciousness or asphyxiation of any person at work arising from gas, fume, vapour or the lack of oxygen;

(d) the drowning of any person at work arising from an increase in the level of liquid; or

(e) the asphyxiation of any person at work arising from a free flowing solid or the inability to reach a respirable environment due to entrapment by a free flowing solid.

For the purpose of Code of Practice for Safety and Health at Work in Confined Spaces,

- "risk" (危險) expresses the likelihood that the harm from a particular hazard is realised and the severity of the harm.
- "hazard" (危害) is something with the potential to cause harm (this includes any atmospheric hazards, hazards from in-rush of mud or water, hazards from machines, substances or job methods, and other aspects of work in a confined space).
- "atmospheric hazard" (空氣危害) refers to the presence of gases, vapours, dusts, fumes, smoke or oxygen-deficient air in a confined space, which potentially causes harm to the safety and health of persons staying in the confined space.

Duties of a proprietor or contractor

- **Risk assessment and recommendations**
  - appoint a "competent person" to carry out risk assessment for work in confined space and make recommendations on safety and health measures before undertaking the work.
  - appoint a "competent person" to carry out fresh assessment and make recommendations whenever there has been a significant change in the conditions of the confined space or of the work activities or whenever there is any reason to suspect that such change likely to affect the safety and health of workers working therein may occur.

  "competent person" means a person:

  (a) who has attained the age of 18 years;

  (b) who is either:

  (1) a safety officer registered under the Factories and Industrial Undertakings (Safety Officers and Safety Supervisors) Regulations; or

  (2) a person who holds a certificate issued by a person whom the Commissioner for Labour has authorized to certify persons as being competent to prepare risk assessment reports; and

(c) who has at least one year's relevant experience, after obtaining the registration or certification referred to in paragraph (b)(1) or (2), in assessing risk to the safety and health of workers working in confined spaces.

- **Compliance with risk assessment report and certification**
  - verify the “risk assessment report” submitted by the competent person.
  - issue a certificate (i.e. permit-to-work certificate) stating that all necessary safety precautions in relation to the hazards identified in the “risk assessment report” have been taken and the period during which workers may remain safely in the confined space before allowing workers enter the confined space for the first time.
  - ensure no worker enters or remains in a confined space unless all recommendations in the “risk assessment report” have been complied with.
  - keep the “permit-to-work certificate” and “risk assessment report” for one year after work in the confined space has been completed and make them available, on request, to an occupational safety officer.

“risk assessment report” is a written report which contains the assessment and recommendations carried out by a competent person for the work in confined space. It identifies the hazards likely to be present in the confined space, evaluates the extent of the risks arising from such hazards and, without limiting the foregoing, covers the following:

(a) the work method to be used and the plant and materials to be used in work activities;

(b) whether or not there is any hazardous gas, vapour, dust or fume present or there is any deficiency in oxygen;

(c) the possibility of:

  (1) ingress of hazardous gas, vapour, dust or fume;

  (2) sludge or other deposits being present that are liable to give off hazardous gas, vapour, dust or fume;

  (3) in-rush of free flowing solid or liquid;

  (4) a fire or explosion in the confined space; and

  (5) loss of consciousness of a certified worker arising from an increase in body temperature;

(d) recommendations on the measures required, including whether or not the use of approved breathing apparatus is necessary;
(e) the period during which workers may remain safely in the confined space; and
(f) recommendation on use of such monitoring equipment if there is a substantial likelihood of a change in the environment leading to an increased risk from the aforementioned possible hazards in the course of work.

Template of the "Risk Assessment Form for Confined Spaces" is attached in Appendix 1.

- **Safety precautions**

■ Before allowing workers enter a confined space for the first time:

(a) disconnect and lock out power source to mechanical equipment which is liable to cause danger inside the confined space;
(b) blank off pipe or supply line whose contents are liable to create a hazard;
(c) test to ensure absence of any hazardous gas and no deficiency of oxygen in the confined space;
(d) purge, cool and ventilate the confined space to ensure it is a safe workplace;
(e) provide adequate respirable air and effective forced ventilation inside the confined space; and
(f) prevent ingress of hazardous gas, vapour, dust, fume and in-rush of free flowing solid or liquid into the confined space.

■ When work is being carried out in a confined space:

(a) ensure only "certified workers" enter or work in the confined space;
(b) ensure a "standby person" is stationed outside the confined space to maintain communication with the workers inside and adopt emergency response;
(c) ensure the risk assessment report and related "permit-to-work certificate" are displayed in a conspicuous place at the entrance of the confined space; and
(d) ensure the safety precautions undertaken continue to be effective.

"certified worker" means a person:

(a) who has attained the age of 18 years; and
(b) who holds a certificate issued by a person whom the Commissioner for Labour has authorized to certify workers as being competent to work in a confined space.

"**standby person**" means when there is a certified worker working in the confined space, another worker, namely the "standby person", shall be assigned by the proprietor or contractor to be stationed outside the confined space to maintain communication with the worker inside the confined space and be responsible for contacting the emergency rescue team when necessary. Standby person shall have sufficient physical strength to be capable of pulling workers out of the confined space. The "standby person" may use mechanical devices to assist him when he is pulling the worker out of the confined space. In addition, the "standby person" should be a certified worker or competent person as defined in the FIU(CS)R.

- **Use of personal protective equipment**
  - ensure the person entering a confined space or remaining therein has worn an "approved breathing apparatus" of a type that gives appropriate protection given the nature of the confined space:
  (a) for "underground pipework"; or
  (b) where the risk assessment report recommends the use of "approved breathing apparatus".
  - ensure the person who uses an "approved breathing apparatus" is also wearing a safety harness connected to a lifeline with the free end held by a person outside who is capable of pulling him out of the confined space.

"approved breathing apparatus" used in confined space work shall be of a type approved by the Commissioner for Labour. Notice of approval of these apparatus will be published in the Gazette. [Reference can be made to the "approved breathing apparatus" list provided by the Labour Department's website]

"underground pipework" in confined space means work in a confined space, which meets the definition of a confined space in the FIU(CS)R and the underground pipework as set out in section 9 of the Regulation. When assessing whether a particular job constitutes "underground pipework" under section 9 of the FIU(CS)R, the following determining factors should be considered:

(a) whether the work is performed within a confined space as interpreted under section 2 of the FIU(CS)R;

(b) whether the aforementioned confined space is located underground; and

(c) whether the work involves any pipework which would have specified risk associated with atmospheric hazard.

Typical underground pipework includes (1) workers are required to enter any underground drains or their associated manholes, which may have atmospheric hazards and have been classified as confined spaces, to carry out inspection or maintenance of drainage works, etc.; or (2) workers are required to enter any underground confined spaces which may have atmospheric hazards for inspection or maintenance work of pipes.

- **Emergency procedures**
  - formulate and implement emergency procedures to deal with any serious and imminent danger to workers inside confined space.
  - provide and keep readily available in satisfactory condition sufficient supply of :

    (a) approved breathing apparatus;

    (b) reviving apparatus;

    (c) vessels containing oxygen or air;

    (d) safety harnesses and ropes; and

    (e) audio and visual alarm (such as personal motion-sensing alarm device) for alerting others outside confined space.
  - ensure sufficient number of persons who know how to use the safety equipment including above items (a) to (e) are present when work is taking place in confined space.

- **Provision of information, instructions, etc.**
  - provide all workers working within a confined space and those outside assisting in such work with information, instructions, training and advice as are necessary to ensure safety and health of workers.

- provide all necessary equipment to ensure safety and health of workers.
- The relevant information or instructions to be given to the workers should be easily comprehensible by the workers or other relevant personnel, taking into account their knowledge and experience. Such information or instructions could be in written form, symbols, diagrams, notices or any other forms as appropriate, so long as they can be clearly understood by the workers and are suitable to the confined space work concerned. (Please see Warning Notice Samples (Sample 1 and Sample 2)).

危險 Danger

- 本密閉空間非常可能含有具危害性的氣體，可令人中毒、窒息或死亡。
- 任何人沒有配戴認可呼吸器具或沒有配戴適當並與救生繩連接的安全吊帶，嚴禁進入。
- This confined space probably contains hazardous gases which can cause poisoning, asphyxiation or death to any person.
- No entry is allowed by any person without wearing an approved breathing apparatus or without wearing a suitable safety harness connected to a lifeline.

Warning Notice (Sample 1)

危險 Danger

- 本密閉空間的工程是屬於地底喉管工作，任何進入或在其內逗留的人必須已妥當地配戴認可呼吸器具；及已配戴適當並與救生繩連接的安全吊帶，讓該人在緊急情況時可被拉出該密閉空間。
- The works in this confined space are underground pipework. Anyone entering or staying inside must be properly wearing an approved breathing apparatus; and wearing a suitable safety harness connected to a lifeline so that the person can be pulled out of it in case of emergency.

Warning Notice (Sample 2)

Duties of a competent person

- carry out an assessment of the working conditions of a confined space covering all the aspects specified under the FIU(CS)R .
- make recommendations on measures in relation to safety and health of workers while working in that space.
- submit the assessment report with recommendations to the proprietor or contractor within a reasonable period of time.
- prohibit from making a risk assessment report which is to his knowledge false as to a material particular.

Duties of a certified worker

- observe emergency procedures implemented by the proprietor or contractor.
- observe instructions and advice and attend training provided by the proprietor or contractor.

- make full and proper use of, and forthwith report to the proprietor or contractor of any fault or defect in, any safety equipment or emergency facilities.

2.2.2 Construction Sites (Safety) Regulations

These regulations control the construction, maintenance, use and operation of hoists, scaffolds and working platforms. There are also provisions for the use of personal protective equipment for protection against falling of person, falling objects and drowning in a construction site. There are miscellaneous safety requirements such as prevention of inhalation of dust and fumes, protection of eyes and the provision of first aid facilities.

Under this regulation, at least one person trained in first aid should be employed on site, where 30 to 99 workmen are employed on a site. Adequate ventilation shall be provided to prevent workmen from inhaling dust or fumes arising from grinding, cleaning, spraying, mixing or working of any material which causes dust or fumes to be given off of a character and extent likely to be injurious to the health of workmen employed in work. Suitable and adequate lighting necessary to secure workmen's safety shall be provided. Drinking water must be provided to workers.

2.2.3 Factories and Industrial Undertakings (Safety Management) Regulation

The proprietor and contractor covered by the Regulation shall implement a safety management system which consists of 14 elements. The proprietor and contractor are required to carry out safety audit or safety review as the case may be of their safety management system.

2.3 Code of Practice

The Code of Practice (hereinafter referred as the Code) is approved and issued by the Commissioner for Labour under Section 7A of the FIUO. It provides a practical guidance to proprietors of industrial undertakings and the employees for compliance with the requirements under the provisions of the Sections 6A and 6B of the FIUO concerning the general duties of proprietor and employee. It is important to note that compliance with the Code does not of itself confer immunity from legal obligations.

The Code has a special legal status. Although failure to observe any guidance contained in the Code is not in itself an offence that failure may be taken by a court in criminal proceedings as a relevant factor in determining whether or not a person has breached any of the provisions of the regulations to which the guidance relates.

Codes of practice that are often used include:

- Code of Practice for Safety and Health at Work in Confined Spaces
- Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace
- Code of Practice: Safety and Health at Work for Gas Welding and Flame Cutting
- Code of Practice: Safety and Health at Work for Manual Electric Arc Welding

3. Basic Concept of a Confined Space and Common Potential Hazards

[Reference teaching time for Section 3: 60 mins]

3.1 Basic Concept of a Confined Space [Playing Video: Manhole]

Work in confined spaces can kill or cause injuries in any industries, ranging from those involving complex plant through to simple storage. Those victims include not only people working in the confined space but also those who try to rescue them without proper training and equipment.

Under the FIU(CS)R, **"confined space"** means any place in which, by virtue of its enclosed nature, there arises a reasonably foreseeable **"specified risk"**, and without limiting the generality of the foregoing, includes any chamber, tank, vat, pit, well, sewer, tunnel, pipe, flue, boiler, pressure receiver, hatch, caisson, shaft or silo in which such risk arises.

"specified risk" means a risk of:

(a) serious injury to any person at work arising from a fire or explosion;

(b) the loss of consciousness of any person at work arising from an increase in body temperature;

(c) the loss of consciousness or asphyxiation of any person at work arising from gas, fume, vapour or the lack of oxygen;

(d) the drowning of any person at work arising from an increase in the level of liquid; or

(e) the asphyxiation of any person at work arising from a free flowing solid or the inability to reach a respirable environment due to entrapment by a free flowing solid.

Places having an enclosed nature and their compartments can give rise to **"specified risks"** due to their structure, location or contents. Common examples include ducts, vessels, culverts, boreholes, bored piles, manholes, excavations, sumps, inspection pits, cofferdams, freight containers, ship cargo holds/tanks, ballast tanks, double bottoms, ships' engine rooms, building voids, some enclosed rooms (particularly plant rooms/mechanical rooms), some cellars and interiors of machines/ plant vehicles, open-topped tanks and vats, wells, hatches, caissons, shafts, closed and unventilated or inadequately ventilated rooms or constructions during their manufacture, etc.

Some places with enclosed nature can give rise to a "**specified risk**" due to the work to be undertaken , the material to be used, a change in the condition inside the space or the degree of enclosure/confinement Typical examples include using volatile chemicals for waterproofing works in water tanks which can lead to the accumulation of chemicals and cause workers to lose consciousness, or using gasoline or diesel-powered engine equipment in poorly ventilated areas which can generate and accumulate carbon monoxide causing workers to asphyxiate.

The major hazards associated with the entry into or working in confined spaces arise through the combination of the confined nature of the place of work and the possible presence of substances or conditions which, taken together, could lead to the **"specified risks"** which threaten the safety and health of workers entering or staying in the confined space.

3.2 Common Potential Hazards in Confined Spaces

3.2.1 Flammable or Explosive Atmosphere

Flammable or explosive atmosphere is the mixture of oxygen in air and flammable gas, vapour or combustible dust of concentration within the flammable range. Flammable or explosive atmosphere will burn or explode in the presence of an ignition source such as sparks from welding or portable electric tool.

Flammable gas and vapour may arise from residues of flammable substances, using of flammable substances or chemical reaction (e.g. generation of methane). The flammable vapour released by the flammable liquid can also diffuse away. Even if it is ignited at a distance, the flame could flash back to the flammable liquid and start a fire.

Combustible dust may arise from crops (e.g. flour), chemicals, plastic particle, pharmaceuticals and metal powder.

3.2.2 Fire

Burning, welding, gas cutting and other hot work are inherently hazardous. They not only create hazards of fire, but also lead to emission of toxic gas, vapour, dust or fume, causing deficiency of oxygen, raising the atmospheric temperature, etc. In a fire, people may get hurt by heat and flames, but the majority of death and injuries in fires were due to inhalation of hazardous smoke or toxic gases.

Hot work should be prohibited in confined space work as far as practicable. However, when hot work is necessary, a hot work permit system should be drawn up detailing the precautionary measures to be taken. For example:

- All electrical plant, equipment and tools that are likely to give off sparks or become hot should not be installed or used in areas where combustible substances exist.
- The quantity of gas cylinders stored should be kept to a minimum as far as practicable.
- All combustible substances in the proximity should be removed, and all workpieces should be checked to ensure that no residues of any combustible substances left on them.
- Continuous monitoring of the atmospheric temperature and air quality, and good ventilation should be maintained.
- Devise a fire emergency plan in writing so that all workers can respond quickly and correctly in case of fire.
- Proper fire-fighting installations (e.g. fire blanket and suitable water and foam type extinguishers) should be provided and maintained. N**ever use carbon dioxide gas or dry powder type fire extinguishers in confined spaces.** Except for those are marked in accordance with international standards to indicate that they are suitable for use on live electrical equipment, ordinary water and foam-type fire extinguishers cannot be used on fires of electrical origin.
- The access to the fire-fighting equipment and emergency escape route should be kept free from obstruction.

3.2.3 Hazardous Gas, Vapour or Fume

Hazardous gases may be present naturally in confined spaces. However, some may arise from the work being carried out. The enclosed nature of the workspace may increase the danger, as hazardous gases can accumulate in the work area and their concentrations in air can rise rapidly.

Typical sources of hazardous gases present in confined spaces (e.g. sewers, manholes and pits of the drainage system) include the following:

- Decomposition of organic matters will generate methane and/or hydrogen sulphide. Hydrogen sulphide, being very soluble in water, often dissolves in sewage and can be trapped within sediment and sludge in sewers as gas pockets. Disturbing the sewage, sediment or sludge can release the trapped or dissolved gas.
- Leaks from underground fuel tanks, gas utility pipes, connected sewer systems or contaminated land, such as landfills, may enter the work area.
- Hazardous gases, fumes and vapours can be generated due to work or equipment nearby being improperly performed or isolated. For examples,
    - leaks from pipes which are connected to the confined space;
    - the use of generators and fuel-driven tools that can consume the oxygen and generate carbon monoxide;
    - hazardous gases, fumes and vapours released from the chemical substances being discharged into underground drains in industrial areas; or
    - welding or the use of volatile solvents, adhesives, etc, that can generate hazardous gases, fumes or vapours.

A number of hazardous gases, such as carbon monoxide, are colourless and odourless. On the other hand, some hazardous gases like hydrogen sulphide may have an unpleasant smell at low concentrations but such smell disappears at higher concentrations due to olfactory fatigue. It can be very dangerous if drainage workers think they can easily recognize the presence of toxic gases by smell.

Hazardous gases of different densities may accumulate at different levels and locations in the confined space. Gases heavier than air will fall in the lower part of the confined space, while gases lighter than air will accumulate in the upper part of the confined space.

Hydrogen sulphide, carbon monoxide and methane are the most common hazardous gases found in confined spaces (e.g. sewers, manholes and pits of the drainage system). The characteristics of these hazardous gases are listed below:

Hazardous gas	**OEL-TWA (ppm)**	**IDLH (ppm)**	**Relative density (air=1.0)**	**LEL/UEL**	**Remarks**
Hydrogen Sulphide (H_2S)	10	100	1.2	4.3% / 45.5%	Rotten egg smell; Olfactory fatigue, coma and death by suffocation at high concentrations
Carbon Monoxide (CO)	25	1,200	1.0	12.5% / 75%	Colourless and odourless; Confusion, coma and death by suffocation at high concentrations
Methane (CH_4)	---	---	0.6	5.3% / 15%	Colourless and odourless; Displace air causing asphyxiation and death

Note:
ppm – Parts per Million
OEL–TWA – Occupational Exposure Limit - Time-Weighted Average
IDLH – Immediately Dangerous to Life or Health Concentration
Relative density – <1.0 means lighter than air; > 1.0 means heavier than air
LEL/UEL – Lower Explosive Limit / Upper Explosive Limit

- Hydrogen sulphide (H_2S)
  - Hydrogen sulphide is a deadly gas with a distinctive "rotten egg" odour that can be detected at very low concentrations. At concentrations above 100 ppm, hydrogen sulphide has a paralysing effect on the sense of smell. Even at lower concentrations, hydrogen sulphide can affect the olfactory nerve and workers cannot detect the changes in concentrations. Therefore, it is very dangerous to rely on the smell to detect the presence of hydrogen sulphide by smelling. A reliable method for detecting hydrogen sulphide is by using a calibrated air monitoring equipment. An airborne concentration of hydrogen sulphide above 100 ppm is immediately dangerous to life or health and concentrations over 1,000 ppm could cause immediate collapse. As sewage is very often present in a drainage system, workers overcome by hydrogen sulphide could be easily killed by drowning.

- Carbon monoxide (CO)
  - The lethal colourless and odourless gas, carbon monoxide, is given off when charcoal is burnt in poorly ventilated areas. Similarly, it is produced when gasoline/diesel generators or other fuel-driven tools are used in inadequately ventilated workplaces. Exposure to carbon monoxide at concentrations over 350 ppm can cause confusion, fainting on exertion and collapse. An airborne concentration of carbon monoxide above 1,200 ppm is immediately dangerous to life or health.

- Methane (CH_4)
  - Methane is commonly generated when organic matter is decomposed by a variety of bacterial processes. It is a colourless, extremely flammable and explosive gas that can cause fire and explosion. The accumulation of methane in a poorly ventilated area will displace normal air and result in an oxygen-deficient environment.

Apart from gases, hazardous fumes or vapours can be generated from the work, e.g. welding or the use of adhesives, paints, volatile or flammable solvents, etc.

Residues left in tanks, vessels, etc. can also give off hazardous gases, vapours or fumes.

3.2.4 Hazards of Excess Oxygen or Oxygen Deficiency in the Environment

The percentage of oxygen in air in a confined space should not be less than 19.5% by volume nor greater than 22% by volume at normal atmospheric pressure.

Cause of excess oxygen includes:

- Excess of oxygen in the environment due to leaking of oxygen supply may cause fires and explosion.

Causes of oxygen deficiency include:

- Oxygen consumption caused by chemical reactions:
  - Welding, cutting by oxy-acetylene, rusting (e.g. inside steel tanks and vessels when rust forms), naked flame operations, fermentation and

mould growth.

- Displacement of oxygen:
  - The accumulation of methane in a poorly ventilated area will displace normal air and result in an oxygen-deficient environment.
  - A confined space which has been purged by an inert gas (e.g. nitrogen and carbon dioxide).

- Absorption of oxygen:
  - A reaction between the soils and the oxygen in the atmosphere, resulting in the oxygen being used up by the soil ingredients.
  - A reaction between the goods stored and the oxygen in the atmosphere, resulting in the oxygen being used up.

3.2.5 Heat

Without taking appropriate protective measures, workers prolongedly working under a hot environment may cause heat rashes, heat cramps, heat exhaustion and even heat stroke. The problem may be aggravated if impermeable protective clothing is worn when undertaking heavy work or working in an enclosed area with a strong heat source, poor ventilation and high humidity. Examples that lead to hot working conditions include performing underground work, hot work and using machines that give out heat, etc.

The best strategy to prevent heat stress is to avoid heavy manual work in hot environment. It is worthwhile to consider whether the work can be accomplished by mechanical means or done in cooler parts of a day or season. Heat stress can be reduced by providing blowing fans, adequate cool potable water to replace water loss from sweating and sufficient rest breaks.

If an employer believes that the employees are facing high levels of heat stress while working, he may measure the Wet Bulb Globe Temperature (WBGT) index at the workplace as the basis for assessing the heat stress of employees and formulating necessary preventive measures including risk management, control strategy and provision of personal protective equipment. The method for evaluation of heat stress using WBGT index can be referred to the National Standard.

3.2.6 An Increase in the Level of Liquid or a Free Flowing Solid

Drowning of workers arising from an increase in the level of liquid includes:

- Sudden changes in water level in sewers due to rainfall in the catchment area, changes in tide levels, sudden discharge of floodwater into the drainage culverts.
- In-rush of underground water in hand-dug tunnel.

Asphyxiation of workers arising from a free flowing solid includes:

- Free flowing solids such as grain and concrete which can partially solidify or "bridge" in silos. They can collapse unexpectedly when disturbed and press against workers resulting in asphyxiation.
- In-rush of soil in hand-dug tunnel.

3.2.7 Dust

Processes involving drilling, breaking and crushing of rocks will generate silica dust. Besides, dry cement for use in processes such as grouting, concreting, transporting and tipping of spoil could produce excessive dust.

Exposure to excessive silica dust for prolonged period can lead to silicosis - a disease with lung fibrosis causing difficulty in breathing. The risk of suffering from silicosis is high in the confined spaces with poor ventilation such as the construction of hand-dug tunnels.

To reduce the workers' exposure to silicosis, the following control measures should be taken:

- Using water suppression to reduce the dust level.
- Improving the work process or equipment to reduce the emission of dust.
- Providing adequate ventilation in the workplace.
- Applying local exhaust system at source to effectively remove dust.
- If, and only if, the dust level cannot be adequately controlled by any

combination of the measures mentioned above, appropriate and adequate respiratory protective equipment ("RPE") should be provided to the workers and ensure that the RPE is properly worn.

3.2.8 Use of Machinery Hazards

If a dangerous part of a machine is not properly guarded, a worker could be hurt by the dangerous part due to entanglement, shearing, crushing, trapping or cutting. Do not use machines (such as saw, grinder and drill) unless their dangerous parts have been effectively guarded.

Workers should not wear cotton gloves while operating or working on machines with revolving parts where there is a possibility of the gloves being caught by rapidly moving parts.

For machine repairing, workers should not dismantle the protective guard while testing a machine for ease of adjustment. For repairing the revolving parts of a machine, avoid contact of the revolving parts with personal belongings to prevent from being caught by the machine. Do not conduct cleaning work on a machine which is in motion and adopt measures to prevent personnel not responsible for the repairing work from coming near.

3.2.9 Biological Hazards

The workers in confined spaces (e.g. sewers, manholes and pits of the drainage system) may be exposed to biological hazard from the bite of rodents or pests. Infection from bacteria or virus is not impossible if the workplace has been contaminated.

Measures to protect workers from biological hazards include:

- Remind workers of the importance of good personal hygiene.
- Inform workers of the importance of first aid treatment to prevent infection through wounds and cuts.
- Tidy up the workplaces.

3.2.10 Noise Hazards

High noise level in the work environment can distract concentration, cause difficulties in oral communication and even cause accidents. Long term exposure to excessive noise can cause permanent hearing damage. Construction plant, such as drillers and rock breakers, frequently create very loud noise level.

Engineering control measures should first be adopted to reduce the noise at the source. Such measures include the use of machines with less noise, installation of anti-vibration materials, muffler or silencer, removal of machines with a high noise level from places with more workers, installation of sound absorbing materials or sound barriers. If it is not possible to reduce the noise to an acceptable level, approved ear protectors (ear muffs or ear plugs) must be worn.

3.2.11 Radiation Hazards

Radiation produced when using radioactive equipment, such as laser, and conducting welding in confined spaces may hurt workers' eyes.

3.2.12 Work-above-ground Hazards

Potential hazards arising from work-above-ground in confined spaces include:

- Workers falling from locations of work-above-ground, including working platforms, scaffolds or other workplaces.
- Workers falling from toppling or collapsing working platforms or scaffolds.
- Falling objects from the working platform hitting workers below.
- Toppling of the power-operated elevating work platform.
- The safe working load of the platform exceeded, leading to breaking of the hydraulic boom and subsequently collapse of the platform.

3.2.13 Electrical Hazards

Common sources of electric hazard associated with confined space work included underground power cables, electrical plant, equipment and tools involved in the work. For the confined spaces with humid environment, prevention of electric shock is of paramount importance. To eliminate the hazards associated with the electrical plant, equipment and tools involved in the confined space work, the following should be ensured:

- Except for the water pumps, ventilation blowers and arc welding equipment, the rated voltage of all portable electrical tools and the power supply within the confined space should not exceed 110V a.c.
- All switchboards should be securely locked and can only be accessible to authorised registered electrical workers.
- The power supplying circuitry used within the confined space should be provided with a suitable residual current device to prevent electric shock.
- All electrical plant, equipment and tools should be designed to be adequately waterproof, dustproof, explosion-proof (where applicable) and double-insulated/earthed to prevent any harmful effects caused by ingress of water and dust.
- All electrical plant, equipment, tools and their associated cables and connections should be properly located and protected.
- All plant, equipment, tools and exposed utilities should be regularly checked and maintained to ensure that they are in safe working order.

3.2.14 Hazards from Manual Handling Operations

The working environment of a confined space is generally narrow and working in such an environment is very physical demanding. Especially if personal protective equipment is worn, performing manual handling operations would become even more difficult.

Incorrect manual handling operations involving awkward posture, incorrect application of bodily force, prolonged or frequently repetitive motions, jerky motion or unexpected movements and pressure, etc. can lead to injuries such as strain and sprain, back pain, hernia and damage to the back, damage to the joints, ligaments, muscles and intervertebral discs.

3.2.15 Insufficient Lighting

Good lighting helps us to see and to recognise hazards. Adequate and suitable lighting shall be provided for entry and work in a confined space.

3.2.16 Other Hazards

The entrances of some confined spaces are located on footpaths or roads (e.g. sewers, manholes and pits of the drainage system). Workers who access to and egress from the entrances may be in danger of being knocked down by cars. Also, passersby may be in danger of falling into such confined spaces from the entrances. Vehicular access and pedestrian access should be separated as far as practicable. Traffic should be controlled through gates, barriers, traffic signs, speed and height limits etc. Steps should be taken to ensure sufficient illumination to the roads. Appropriate banksmen should be appointed to direct traffic if in need. Road closures or traffic diversion arrangements should be implemented when necessary.

Workers may inhale the fibers of asbestos during renovation/demolition works or boiler chipping works etc. Assessment for asbestos work should be conducted by a person who is qualified by training and experience to make the assessment in accordance with the Factories and Industrial Undertakings (Asbestos) Regulation and suitable steps should be taken to prevent workers from exposing to asbestos.

4. Case Study and Analysis of Common Serious Accidents

[Reference teaching time for Section 4: 70 mins]

[This section must be conducted in an interactive manner through discussion with trainees]

Workplace accidents not only cause sufferings to the victims and their families, but also result in financial losses arising from stoppage of work, insurance claims, medical and rehabilitation expenses, etc.

In fact, most of the workplace accidents are preventable. Very often, they share common scenarios and causes. These scenarios and causes should be properly understood in order that lessons are learnt and suitable measures implemented to prevent recurrence of such accidents.

4.1 Case Analysis of Serious Confined Space Accidents

<u>Case 1</u>

Poisoning in manhole sewer

Circumstances

A team of workers had to clear an underground sewer which was about 2 metres in diameter. An air test was conducted before commencement of work. The result indicated that the environment was safe. Also, an air blower was provided at the top of the manhole to blow fresh air into the sewer. When the work was close to completion, the workers removed the air blower. A worker fell unconscious when entering the sewer for final clean-up, and so did the other workers during the rescue as they did not wear any breathing apparatus when going inside.

Case Analysis

The causes of accident include:

- Inadequate Safety Awareness
  - In an enclosed space, if there is sludge or other deposits present, it is likely to be a confined space operation. Particularly in sewer works, the process can release accumulated or dissolved gases such as hydrogen sulphide. Without a proper assessment of the potential presence of harmful gases, vapours, dust, or fumes from the sludge or other deposits, the risk assessment report also lacks recommendations for the use of approved breathing apparatus.
  - not aware of the risk of sudden ingress of toxic gases because there was no continuous air monitoring.
  - lack of a standby person stationing outside the manhole for communication and appropriate emergency response.
  - disregard the risk of sudden ingress of toxic gases as a result of the engineering work.
  - ignore the risks of toxic gases that may be generated when conducting drainage work in a poorly ventilated environment.
  - the effluent in the sewer produced toxic gases. Toxic gases accumulated more easily in the absence of an air blower.
- Performing Underground Pipework Improperly
  - The proprietor or contractor and the competent person did not determine whether the confined space entry work involves underground pipe work, nor did they correctly classify the relevant drainage works as underground pipework, and therefore failed to ensure, as required in section 9 of the FIU(CS)R, properly wearing approved breathing apparatus and wearing a suitable safety harness connected to a lifeline to enable the person to be pulled out of the confined space in an emergency.
- Inappropriate Emergency Rescue
  - when a worker was found unconscious inside a drainage, the co-workers often instinctively entered the drainage immediately in an effort to rescue the worker even though they neither had proper rescue equipment nor proper training. As a result, the co-workers were also succumbed to the gas poisoning.
- Lack of Continuous Air Monitoring

- the air composition in drains could be changed rapidly due to work processes, activities, or other environmental factors. For example, hazardous gases dissolved inside sludge might be released when it was disturbed and therefore the concentrations of hazardous gases in air could rise rapidly. Since workers did not monitor the air composition continuously, it was difficult for workers to determine the presence of hazardous gas or oxygen deficiency in the working environment. This situation would lead to severe consequences.

- Inadequate Safety Management and Supervision
  - the proprietor or contractor or their authorized persons did not verify the hazard assessment report, nor did they check whether underground pipes were working, whether continuous air monitoring was required, and whether workers needed to wear approved breathing apparatuses, etc.
  - failure to implement appropriate access controls for confined space work.
  - the proprietor or contractor did not assign persons with relevant confined space experience as "safety supervisory personnel".

    "safety supervisory personnel" means a person responsible for supervising and guiding the occupational safety and health issues related to confined space work. It would be desirable if the safety supervisory personnel is a competent person as defined in the FIU(CS)R or a registered safety officer.

Lessons to Learn

- The proprietor or contractor shall take alternative measures that can be substituted for workers from entering confined spaces for work. With the advancement in science and technology, there are many ways to conduct various works within the confined spaces without man-entry e.g. inspecting the internal part of a sewer by remote control monitoring, using suitable equipment and tools to perform sampling and cleaning work from outside of the confined space without requiring workers to enter the confined spaces.

- A risk assessment, with recommendations on safety and health, should be conducted by a competent person before work is carried out in a confined space. The competent person should make a judgment as to whether the work is underground pipe work in accordance with the recommendations in paragraph 2.10 of the "Code of Practice for Safety and Health at Work in Confined Spaces". The competent person should also recommend measures necessary for the safety and health of workers including that any person entering or remaining there must be properly wearing approved breathing apparatus and wearing a suitable safety harness connected to a lifeline to allow the person can be pulled out of the confined space in an emergency. [Reference can be made to Appendix 1 - "Risk Assessment Form for Confined Space"]

- The implementation of permit-to-work system to tie in with the risk assessment of the confined space work. The proprietor or contractor should issue a "permit-to-work certificate" only when all necessary safety measures have been implemented, including all necessary safety precautions specified in the risk assessment. [Reference can be made to Appendix 2 - "Permit-to-work Certificate" for Entry into Confined Space]
- Recommendations made by the competent person and emergency procedures laid down by the proprietor or contractor should be strictly followed.
- Suitable mechanical ventilation and continuous air monitoring should be maintained while work is being conducted inside a sewer.

- Workers without proper safety training and not wearing protective equipment should not be allowed to enter a confined space to work or to carry out a rescue operation. The workers should:

  - wear suitable and approved breathing apparatus.
  - wear a safety harness connected to a lifeline, with the free end of the lifeline held by the worker staying outside for immediate rescue.
  - equip with audio and visual alarm devices (i.e. personal motion-sensing alarm devices and continuous air monitoring devices) and communication devices to keep in touch with the worker stationed outside.

Other Points to Note

- The proprietor or contractor shall ensure that:
  - only certified workers are allowed to enter or work in the confined space.
  - safety precautions shall be taken before work begins and when work is being carried out (e.g. conducting air testing, continuous air monitoring and using suitable ventilation equipment, etc.).
  - the safety precautions shall be effectively maintained (e.g. providing suitable ventilation equipment and continuous monitoring of the air quality inside the sewer, etc.) while workers are working inside the confined spaces.
  - any person entering the confined space should be wearing suitable approved breathing apparatus and suitable safety harness connected to a lifeline (where the use of approved breathing apparatus is recommended in a risk assessment report, or entry into a confined space for underground pipework is required).
  - all workers understand the safe system of work and the emergency rescue procedures formulated and shall provide all necessary rescue equipment for emergency rescue.

- The employees shall:

- check whether the “risk assessment report” and the related “permit-to-work certificate”, which state that work can be carried out safely, have been displayed in a conspicuous place at the entrance of the confined space.
- strictly follow safe working procedures and emergency procedures implemented by the proprietor or the contractor (e.g. wearing approved breathing apparatus, use of rescue equipment and protective equipment, etc.).
- make full and proper use of safety equipment provided by the proprietor or contractor.
- inform the worker stationed outside and get out immediately should any changes in the environment or physical discomfort be noticed.

Discussion

- Common confined spaces in construction sites (e.g. chamber, tank, vat, pit, well, sewer, tunnel, pipe, flue, boiler, pressure receiver, hatch, caisson, shaft, silo, etc.).
- Potential hazards associated with confined space work, including all specified risks, in particular, the atmospheric hazards of underground sewers and their connected manholes.
- Entering underground sewers and their connected manholes is considered underground pipe work as described in Section 9(b) of the FIU(CS)R. Anyone entering or staying in these spaces must properly wear approved respiratory protective equipment and a suitable safety harness connected to a lifeline, so that they can be pulled out of the confined space in an emergency.
- Underground sewers and their connected manholes contain sludge or other deposits that can emit hazardous gases, vapours, dusts, or fumes. Continuous monitoring of the air in the confined space is required until everyone has exited the confined space.
- All members of the rescue team shall have been properly and adequately trained in the related emergency rescue procedures, including the detailed particulars of an emergency rescue plan and full knowledge of how to properly use all the rescue equipment specified in section 10(2) of the FIU(CS)R.
- Even if workers are in the immediate vicinity of the confined space and perform associated work in that confined space, the proprietor or contractor

shall appoint a competent person to assess the reasonably foreseeable risk arising from the work (e.g. releasing of hazardous gases or falling from height, etc.) and make recommendations on measures necessary to ensure the safety and health of workers.

- The proprietor or contractor shall exercise sufficient supervision over confined space work, including recording videos at the entrance and exit of the confined space throughout the entire work period to monitor that relevant personnel have complied with the safety precautions. The video records shall be kept for one year after the work is completed and made available for inspection within a reasonable timeframe.

<u>Case 2</u>

Collapse of the accumulated coal ash inside silo

Circumstances

A team of workers was assigned to clear the coal ash, which was generated upon burning of the coal for power generation, accumulated inside a silo of a power station. An aggregate of the coal ash stacked up inside the silo up to at least 3m in height suddenly collapsed. All workers were able to flee from the sliding down of the ash, except one who was buried under it. Other workers attempted to offer rescue before firemen arrived at the scene but to no avail. The worker was certified dead on the spot.

Case Analysis

The causes of accident include:

- Inadequate Safety Awareness
  - No aware of the risk of collapse of the accumulated coal ash in the course of clearing work.
  - Not adopting control measures and using proper monitoring equipment to prevent the over-accumulation of the coal ash inside the silo.
  - Risk assessment for the work in confined space was not carried out.
  - Neither competent person nor standby person was assigned to monitor the

clearing of coal ash work being conducted.

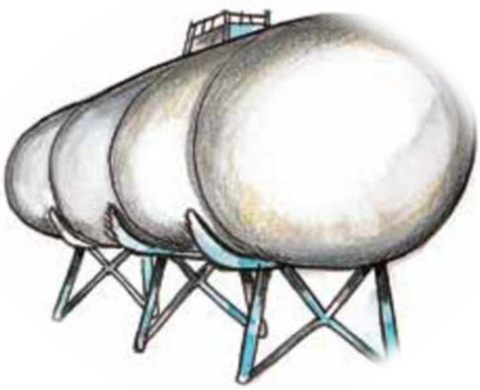
- Inappropriate Emergency Rescue
  - When the worker was found to have been buried by the coal ash, the co-workers were in a desperate bid to offer their assistance to rescue his fellow worker at stake, in spite of the fact that they had neither received proper rescue training nor rescue equipment to take it upon themselves.

- Lack of Continuous Monitoring
  - There was no equipment to continuously monitor the quantity of the accumulated coal ash inside the silo. The workers appointed to work did not have an idea about the dangerous environment where they were subjected to the risk of the falling ash.

- Inadequate Frontline Safety Management and Supervision
  - There was no competent person who had experience in confined space works assigned to check whether the risk associated with the clearing of the coal ash was identified.

Lessons to Learn

- A risk assessment, with recommendations on safety and health, should be conducted by a competent person before work is carried out in a confined space.
- The implementation of permit-to-work system in tandem with the risk assessment of the confined space work. The proprietor or contractor should issue a "permit-to-work certificate" only when all necessary safety measures have been implemented, including all necessary safety precautions specified in the risk assessment.



- Recommendations made by the competent persons and the emergency procedures laid down by the proprietor and contractor should be strictly followed.

- Continuous monitoring of the working condition inside the silo should be maintained while the work is being conducted.

Other Points to Note

- The proprietor or contractor shall ensure that:
  - only certified workers are allowed to enter or work in the confined space.
  - safety precautions shall be taken before work begins and when works is being carried out.
  - the safety precautions shall be effectively maintained while workers are working inside the confined spaces.
  - all workers understand the safe system of work and the emergency rescue procedures formulated and shall provide all necessary rescue equipment for emergency rescue.

- The employees shall:
  - check whether the “risk assessment report” and the related “permit-to-work certificate”, which state that work can be carried out safely, have been displayed in a conspicuous place at the entrance of the confined space.
  - strictly follow safe working procedures and emergency procedures implemented by the proprietor or the contractor
  - make full and proper use of safety equipment provided by the proprietor or contractor.
  - inform the worker stationed outside and get out immediately should any changes in the environment or physical discomfort be noticed.

Discussion

- Common confined spaces in construction sites (e.g. chamber, tank, vat, pit, well, sewer, tunnel, pipe, flue, boiler, pressure receiver, hatch, caisson, shaft, silo, etc.).
- Potential hazards associated with confined space work, including all specified risks.
- Mandatory requirements for persons to work in confined spaces.
- The dangers faced by the personnel conducting rescue operations.
- Difficulties encountered by the parties concerned (including the proprietors

or contractors, the competent persons, the workers who clean the accumulated coal ash inside silo) and their responsibilities.

<u>Case 3</u>

[Training course provider should provide an accident case associated with confined spaces operation (in particular those occurred during the three years preceding the conduct of the course, such as examples involving the use of oxygen-consuming and exhaust-emitting devices like generators in confined spaces, or cases of poisoning caused by the use of volatile chemicals in water tank projects) for case study and analysis in this section]

[Reference can be made to the "Work Safety Alert" provided on the Labour Department's website]

Contents of case study and analysis should include:

Circumstances

- Brief description of the accident case.

Case Analysis

- Analyze the cause of the accident.

Lessons to Learn

- Precautionary measures to be taken to prevent recurrence of the accident.

Other Points to Note

- Points to note for the proprietor or contractor.
- Points to note for the worker.

Discussion

- Common confined spaces in workplaces (e.g. chamber, tank, vat, pit, well, sewer, tunnel, pipe, flue, boiler, pressure receiver, hatch, caisson, shaft, silo, etc.).
- Potential hazards associated with confined space work, including all specified risks.
- Mandatory requirements for persons to work in confined spaces.

- The dangers faced by the personnel conducting rescue operations.
- Difficulties encountered by the parties concerned (including the proprietors or contractors, the competent persons, the workers, etc.) and their responsibilities.

5 Basic Concept of Safe System of Work and Permit-to-work System

[Reference teaching time for Section 5: 135 mins]

5.1 Basic Concept of Safe System of Work

A safe system of work is a formal procedure which results from systematic examination of a task in order to identify all the hazards. It formulates safe methods to ensure that hazards are eliminated or risks minimized.

Steps to a safe system of work:

(1) Risk assessment

- Assess the task and identify the hazards

(2) Method statements

- Formulate safe methods including details of all relevant processes, work procedures, risk control measures, requirements for the associated equipment, and qualifications and training of the workers, etc.
- A permit-to-work system in respect of some high risk work and working environments (such as confined spaces, hot work and work on electrical equipment) should be implemented. The system uses a certificate ("permit-to-work certificate") to set out the work to be done and items to be checked before starting the work and the necessary precautions to be taken to ensure safety and health at work.

(3) Implementation

- Sufficient and suitable steps should be taken to ensure that all safety precautions stated in the risk assessments, permit-to-work systems and method statements are effectively and continuously implemented and maintained.
- Sufficient and necessary information, instruction and training should be provided to all personnel directly or indirectly involved in the work to ensure that they have sufficient knowledge and safety awareness in respect of the work.

(4) Supervision

- An effective monitoring and control system should be established and implemented. A supervisor with sufficient relevant knowledge, experience and safety awareness should be assigned to supervise the work.

(5) Review

- The risk assessments and the associated working arrangements should be regularly reviewed in a timely manner. A review should also be conducted whenever any circumstances during work indicate that the risk assessments and/or the associated working arrangements are no longer valid, or where there has been a significant change in the condition of the work relevant to the assessments and working arrangements. Whenever necessary, a fresh risk assessment should be conducted.

5.2 Safe System of Work and Permit-to-work System for Confined Space Work

A safe system of work should be established by the proprietor or contractor responsible for the space for every operation in a confined space. The system of work should include, but not limited to, the effective implementation of the following:

- The proprietor or contractor shall, as far as reasonably practicable, take alternative measures that can be substituted for workers from entering confined spaces for work.
- to appoint a competent person to carry out risk assessment for work in the confined space and make recommendations on safety and health measures before undertaking the work;
- to ensure that all safety precautions before work begins have been carried out [Reference can be made to section 5.2.1];
- to issue a "permit-to-work certificate" stating that all necessary precautions have been taken and specifying the period during which worker may remain safely in the confined space before a worker enters a confined space [Reference can be made to section 5.2.2];

- The proprietor or contractor should establish and implement an effective system to ensure that all individuals who enter and stay or work inside a confined space have exited the confined space within a specified timeframe.
- to ensure that all safety precautions when work is being undertaken have been carried out and kept effective throughout the confined space work [Reference can be made to section 5.2.3];
- to ensure that no workers other than certified workers enter or work in the confined space;
- The proprietor, contractor and occupier of the workplace should take adequate steps to ensure the confined space within the workplace is well-segregated to avoid trespassing, for example, the confined space should be locked up when left vacant, all entrances of the confined space should be securely controlled, and entry and exit log should be recorded and kept.
- The proprietor or contractor should have a system for access control on the confined space work, recording the workers entering and leaving the confined space clearly and ensuring only relevant workers are allowed to enter the confined space. Common practices include setting up a “tag in/tag out” notice at the entrance of a confined space so that people outside the confined space can easily be aware of workers’ details and the time of entering the confined space. This provides crucial information for the safety supervisory personnel, standby person and rescue team. It helps to check the compliance of the safety requirements and ensures the effective execution of the contingency plan in case of emergency situations.
- to ensure that a person is stationed outside the confined space to maintain communication with the workers inside;
- to ensure the use of an approved breathing apparatus and other necessary personal protective equipment by worker inside the confined space (where the use of approved breathing apparatus is recommended in a risk assessment report, or entry into a confined space for underground pipework is required);
- The proprietor or contractor shall exercise sufficient supervision over confined space work, including recording videos at the entrance and exit of the confined space throughout the entire work period to monitor that relevant personnel have complied with the safety precautions. The video records shall be kept for one year after the work is completed and made available for inspection within a reasonable timeframe. *[Note: The proprietor or*

contractor shall record the video and handle the data collected in accordance with the Personal Data (Privacy) Ordinance (Cap. 486). For details, please refer to the Ordinance, relevant code of practice and publications, e.g. "Guidance on CCTV Surveillance and Use of Drones", etc.]

- to formulate and implement appropriate emergency situations and response procedures to deal with any serious and imminent danger to workers inside the confined space [Reference can be made to section 6]; and
- to provide necessary information, instructions, training and advice to all workers within a confined space or assisting with such work from immediately outside the confined space.

5.2.1 Safety Precautions Before Work Begins

The proprietor or contractor shall, as far as reasonably practicable, take alternative measures that can be substituted for workers from entering confined spaces for work. With the advancement in science and technology, there are many ways to conduct various works within the confined spaces without man-entry e.g. inspecting the internal part of a sewer by remote control monitoring, using suitable equipment and tools to perform sampling and cleaning work from outside of the confined space without requiring workers to enter the confined spaces, etc. Proper planning of work or switching to another work method can reduce the need to work in confined spaces.

A proprietor or contractor should ensure that no worker enters a confined space for work unless safety precautions, including (but not limited to) isolation, purging, air testing, ventilation and using personal protective equipment have been taken before the work begins.

<u>Isolation</u>

- The proprietor or contractor shall, before allowing workers to enter a confined space, ensure that the confined space has been securely and completely isolated and separated from all the other connecting parts so as to prevent any materials which are liable to create a hazard from entering the confined space.
- All isolation points should remain fully secure to ensure that the dangerous materials will not go into the confined space whilst the workers are working

inside.

- The confined space should be isolated from all unnecessary sources of power, e.g. electrical, mechanical, pneumatic, hydraulic, etc., by having them securely locked off, isolated and properly labelled as appropriate to avoid accidental switching of power back to the confined space.
- All pipelines connected to a confined space should be completely shut off or blanked off as appropriate. All connected valves should be fully closed, locked off and properly labelled as appropriate to prevent from being opened without authorization or accidentally.
- Ends of service pipes which are still connected to sources of hazardous gas must be properly sealed (e.g. by means of metal blank or end-cap).
- Any activities outside and in the vicinity of the confined space which may jeopardise the safety or health of workers inside a confined space should not be permitted. Barriers should be erected outside access openings of the confined space, with suitable warning signs and notices displayed.
- The confined space should be isolated from all non-essential sources of heat.
- Effective steps shall be taken to prevent ingress to the confined space of hazardous gas, vapour, dust or fume, or in-rush of mud, water or other free flowing liquids and solids. Openings in a confined space (e.g. drain holes) shall be sealed off if there is any possibility of atmospheric hazards to flow back into the confined space from another area and contaminate it. Regarding in-rush of water, particular attention should be given to the possible sudden changes in water level in drainage facilities due to rainfall in the catchment area, changes in tide levels, sudden discharge of floodwater into the drainage culverts, etc.

Purging

- With regard to the circumstances of a particular confined space, before the proprietor or contractor allows workers to enter into the confined space for work, the confined space shall be adequately purged by suitable method, such as steam cleaning, inert gas purging, forced ventilation, etc. to remove all the hazardous substances contained in the confined space.

Steam cleaning

- Steam-volatile substances in confined spaces could be removed by steam cleaning.

- For removal of corrosive materials, or materials which are not readily volatile, preliminary treatment by repeated washing with water, or with other suitable solvents or appropriate neutralizing agent should be applied prior to steaming.
- The period of steaming should be adequate to remove all the hazardous substances from the confined space thoroughly. The required period should be decided and checked by the person who has been appointed by the proprietor of the industrial undertaking for the steaming work.
- It would be necessary to re-steam where the confined space has been left for more than a few hours after steaming.
- During steaming, adequate outlets for steam and condensate should be provided so that no dangerous pressure should be built up inside the confined space.
- After steaming, adequate air inlets should be provided so that there would not be any vacuum being formed in the confined space by cooling and condensation. To prevent any heat stress problem, sufficient cooling of the confined space to room temperature is essential before allowing workers to enter the space.
- After purging, all liquid remaining in the confined space should be drained away or pumped out as appropriate, and sufficient ventilation should be provided to the confined space.
- Consideration should be given to the potential exposure of workers outside the confined space to hazardous substances carried out by steam cleaning, and effective safety measures should be adopted to prevent workers outside the confined space and nearby workers from coming into contact with these hazardous substances.

Inert gas purging

- To avoid the formation of an explosive mixture with air when a confined space containing flammable gas or vapour is opened up, the confined space may be purged by an inert gas (e.g. nitrogen, carbon dioxide).
- If persons have to enter or approach a confined space in which an inert gas has been purged, the confined space shall be purged again by fresh air so as to provide adequate oxygen into the confined space to support life.

Thereafter, all parts of the air-purged confined space shall then be thoroughly tested against the deficiency of oxygen to make sure that there is adequate oxygen to support life.

- Consideration should be given to the potential exposure of workers outside the confined space to hazardous substances carried out by inert gas purging, and effective safety measures should be adopted to prevent workers outside the confined space and nearby workers from inhaling these hazardous substances.

Air Testing

- Appropriate air testing of a confined space shall be carried out to ensure the absence of any hazardous gas and no deficiency of oxygen before it is certified to be safe to enter.
- Air testing of a confined space should be conducted to decide and specify the related safety precautions necessary to be taken upon entry into such confined space.
- A proprietor or contractor shall prohibit a worker from entering any confined space until initial air testing of the confined space has been properly done from outside, with the test results showing that the environment inside the confined space is safe for entry.
- The air testing should include the testing of the oxygen content and the presence of flammable, toxic or harmful gases, fumes or vapours. Appendix 3 provides information on common atmospheric hazards in confined spaces.
- In selecting appropriate air monitoring equipment for air testing, the types and concentration ranges of atmospheric hazards, as well as parameters such as instrument type, detection range, error, accuracy, resolution, response time, and applicable environment should be considered. It is also essential to consider whether interference could reduce or compromise its detection capabilities.

- All air monitoring equipment should be used in accordance with the operation manual from the manufacturer. All air monitoring equipment should be suitably calibrated and properly maintained as per the recommendations of the manufacturers, with records properly kept.
- All air testing should be carried out with the correct testing methods. Consideration must also be taken to the geometry of the confined space and the physical properties of the gas to be monitored. For instance, air at different levels and locations inside a confined space should be tested since hazardous gases with different densities relative to air may accumulate at different levels and locations of the confined space. (See Figure 1)

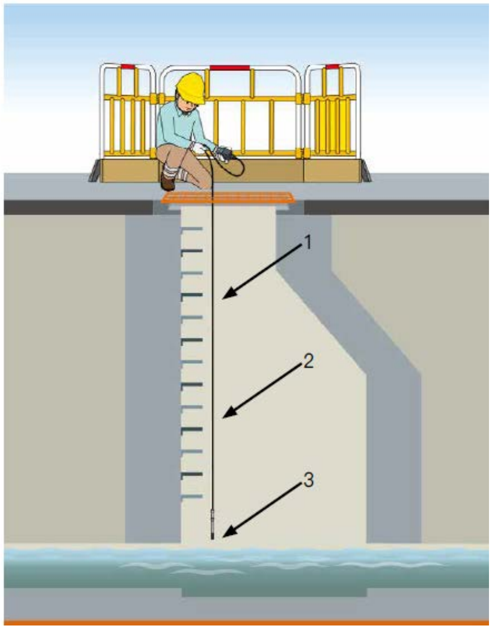


Figure 1: Air at different levels and locations should be tested from the top to the bottom

- Air testing should be carried out outside the confined space, with air samples being drawn out from the confined space by suitable sample probes. It is crucial to ensure that the sampling probe and tubing are not blocked or kinked, and sufficient sampling time should be allowed for testing.
- Additionally, during air testing, appropriate measures should be considered to prevent accidental entry into the confined space, such as using temporary protective nets during testing.
- In case flammable or explosive gases or vapours may be present in the confined space, the air monitoring equipment should be of the explosion-proof type. It should have both audio and visual alarms so that it can quickly alert workers if a hazardous situation exists or is developing in the confined space.
- In general, testing for oxygen should be performed first because most combustible gas testing meters are oxygen-dependent and do not provide reliable readings in an oxygen-deficient atmosphere.

- In a confined space, the percentage of oxygen in air should not be less than 19.5% by volume nor greater than 22% by volume at normal atmospheric pressure.
- The exposure limits for various gases, vapours, dust, or fumes in the air can be referenced from the "Occupational Exposure Limits" listed in the "Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace" published by the Labour Department. For chemicals that do not have established "Occupational Exposure Limits", the exposure limits should be referred to relevant international or national standard, or databases from reliable chemical manufacturers or recognised occupational safety and health professional organisations.

<u>Ventilation</u>

- Adequate supply of respirable air and effective forced ventilation shall be provided inside a confined space. It includes the use of mechanical ventilation to supply an adequate fresh air to workers inside the confined space and prevent atmospheric hazards. In deciding the design and installation of a ventilation system, the following factors should be considered:

    - Foreseeable atmospheric hazards and their risks that may be present or generated;
    - Processes and equipment being used;
    - Potential need to control environmental temperature and/or humidity; and
    - Number of workers and their work locations, and whether ventilation requirements may need to be modified or impose limitations while work is in progress.

- When supplying fresh air, the blower should be carefully positioned to avoid introducing contaminated air into the confined space. (See Figure 2)

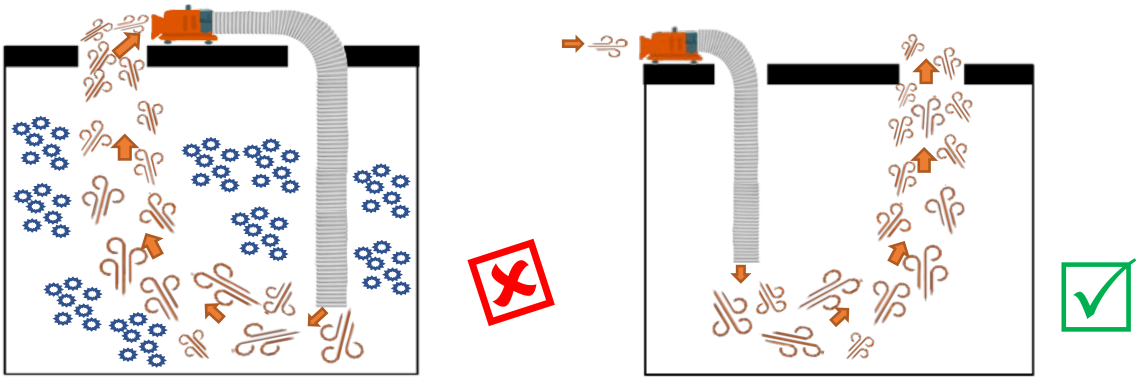


Figure 2: When supplying fresh air, the blower must be carefully positioned to avoid drawing contaminated air into the confined space.

- The provision of ventilation to a confined space should not be considered as an alternative to the use of approved breathing apparatus where the atmosphere inside is likely to cause safety or health hazards to the workers therein.
- Before entering the confined space, it shall be thoroughly purged by means of ventilation. As some hazardous gases (e.g. hydrogen sulphide, etc.) are heavier than air, the air hoses or ducts of fresh air should be directed or extended deep into the confined space. The atmosphere shall be confirmed safe by air testing. When working in confined space, the outlets of the fresh air hoses or ducts should be placed near the work locations of the workers to ensure adequate fresh air. In addition, the removal of air impurities can be facilitated by placing the inlets of the extraction air hoses or ducts near the source of air impurities. Additionally, exhaust device can be installed at the exit or ventilation openings of the confined space to aid in removing impurities and facilitating air exchange. However, it is crucial to consider the positioning of ventilation equipment to avoid short-circuiting and maintain effective air circulation within the confined space. (See Figure 3)

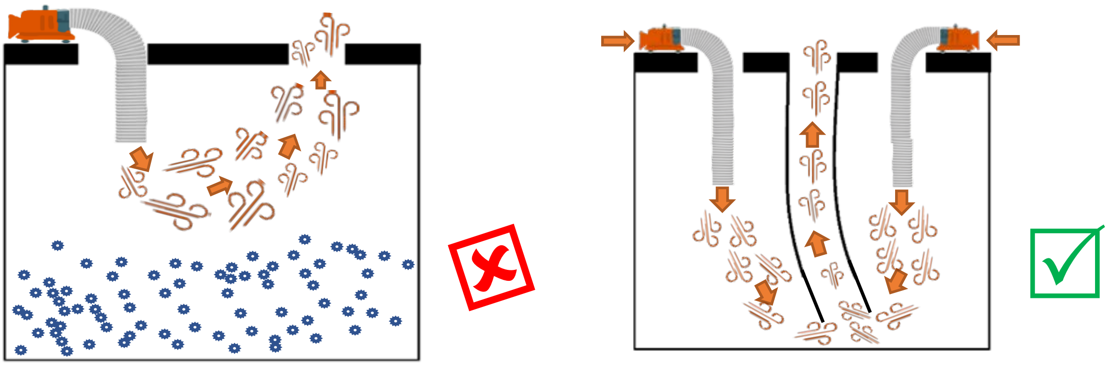


Figure 3: Carefully consider the positioning of ventilation equipment to avoid short-circuiting and maintain effective air circulation within the confined space.

- Certain processes and equipment, such as welding or the use of petrol/diesel-powered devices, can consume oxygen, release atmospheric hazards, and generate heat. Therefore, performing such process or using such equipment in confined space should be avoided if possible. Whenever performing such processes or using such equipment in confined space is unavoidable, adequate forced fresh air should be supplied at the worksite. Exhaust device and hoses or ducts should also be installed near the working location to remove air impurities and hot air effectively. For performing such processes or using such equipment outside the confined space, ingress of the atmospheric hazards or heat in confined space should be avoided.
- Under no circumstances should oxygen be introduced into a confined space which would create a danger of oxygen enrichment in the air.
- Notwithstanding the above, a proprietor or contractor shall also take effective steps to prevent ingress to the confined space of hazardous gas, vapour, dust or fume; and an in-rush into the confined space of free-flowing solid or liquid. In that respect, particular attention has to be paid to any possible ingress, in-rush, spillage or leakage of the substances through the ingress, egress or openings of the confined space from areas or places surrounded.

5.2.2 Permit-to-work System for Confined Space Work

(An example of "permit-to-work certificate" for Entry into Confined Space is attached at Appendix 2)

- The implementation of "permit-to-work system" is an essential part of a safe system of work for confined space work. The proprietor or contractor may set out in a “permit-to-work certificate” the work to be done and items to be checked before entering a confined space and the necessary precautions to be taken to ensure safety and health at work in the confined space.

- The proprietor or contractor should, after receiving a risk assessment report completed by the competent person, verify that the risk assessment report has covered all the matters referred to section 5(2) of the FIU(CS)R. He should then issue a “permit-to-work certificate” to the certified workers engaged in confined space work only when all necessary safety measures have been implemented, including all necessary safety precautions specified in the risk assessment.
- The proprietor, contractor or his authorized person should sign on the “permit-to-work certificate” to confirm that all safety precautions indicated on the certificate have been implemented effectively. The proprietor, contractor or his authorised person should sign the “permit-to-work certificate” to confirm that all safety precautions indicated on the certificate have been implemented effectively. If the proprietor or contractor authorises a person to issue a “permit-to-work certificate”, the person should have sufficient knowledge of working in confined spaces and the safety precautions to be taken. In general, the authorised person should be a competent person as interpreted under the FIU(CS)R. Since the person issuing the “permit-to-work certificate” needs to verify the contents of the risk assessment report as mentioned above, the person being authorised to issue the “permit-to-work certificate” should not be the competent person who completed the risk assessment report. Moreover, the person issuing the “permit-to-work certificate” should also clearly explain the content of the “permit-to-work certificate” to all workers and relevant persons involved in the confined space. Moreover, the person issuing the “permit-to-work certificate” should also clearly explain the content of the certificate to all workers and related persons involved in the confined space. Entry into a confined space for work should be permitted only after the issue of a valid “permit-to-work certificate” by the proprietor or contractor.
- The person responsible for signing and accepting the “permit-to-work certificate” should be the one who is responsible for stationing outside the confined space, that is, the onsite supervisor or the person-in-charge of the

work in the confined space. Such “permit-to-work certificate” should specify the location (the conditions and characteristics of the confined space) and type/nature of work to be done, and state:

- that all necessary safety precautions in relation to the hazards identified in the risk assessment report have been taken; and
- the period during which workers may remain safely in the confined space. In addition, the “permit-to-work certificate” should also include:

(a) results in the risk assessment report completed by the competent person;

(b) effectiveness of the isolation and withdrawal from service;

(c) the amount of sludge or other deposits (if any) after cleaning;

(d) results of the air testing;

(e) whether the nature of work to be done involves underground pipework;

(f) the condition and features of the confined space;

(g) a list of personal protective equipment (“PPE”);

(h) the period during which workers may remain safely in the confined space; and

(i) other safety precautions.

5.2.3 Safety Precautions When Work Is Being Undertaken

- A proprietor or contractor shall ensure that all workers who enter or work in a confined space are certified workers. When allocating work to confined space workers, every step should be taken to ensure that the demands of the work activities do not exceed the workers’ skills and abilities to carry out the work without risks to themselves or others.
- A proprietor or contractor shall provide all necessary equipment to ensure the safety and health of workers working in a confined space. The equipment shall be appropriately selected in respect of their types, purposes, functions and applications. The equipment should also be suitably calibrated, regularly checked and properly maintained, with records properly kept.
- When work is being carried out in a confined space by a certified worker, the proprietor or contractor shall ensure that the relevant risk assessment report, with all its significant findings, is displayed in a conspicuous place at the entrance of the confined space. The related “permit-to-work certificate” shall also be displayed in a conspicuous place at the entrance of the confined space.
- When work is being carried out in a confined space by a certified worker,

standby person must be assigned to station outside the confined space throughout the time of operation to maintain communication with the worker inside.

- The standby person shall be trained on how to maintain communication with those workers inside the confined space and to call for support in case of emergency, including the use of new technology to maintain effective communication with those workers inside the confined space. Additionally, a proprietor or contractor shall provide, to all workers working within a confined space or assisting with such work from immediately outside the confined space, such information, instructions, training and advice as are necessary to ensure the safety and health of all workers in the confined space.
- The standby person shall keep the workers inside the confined space informed of any change in environmental conditions that would adversely affect their safety in the confined space (e.g. heavy rain leading to flooding, emergencies such as fires, spillage of toxic, corrosive or flammable liquids, releasing of hazardous gases, power supply failure, failure of forced ventilation system, etc.).
- On the other hand, the workers inside a confined space shall keep communicating with the standby person, who can quickly summon assistance in the event of a hazardous situation inside the confined space.
- If significant changes or abnormal conditions are observed in the working environment, particularly in air quality, soil conditions, or groundwater levels, or if adverse weather conditions that may pose potential risks to the safety and health of workers are known, work must be immediately suspended, and all workers must be evacuated. Subsequently, a thorough review of risk assessment and related work arrangements must be conducted. Work shall not be resumed unless the site environment is confirmed to be safe.
- A proprietor or contractor shall ensure that the safety precautions, which are taken before work begins in the confined space, continue to be effective whilst the workers remain in the confined space.
- During the continuous or periodic monitoring of the working environment as recommended by the risk assessment, air monitoring equipment should have two levels of alarm systems to alert workers to take appropriate action. Where applicable, workers should wear continuous air monitoring equipment that provides audio and visual alarms to enable workers and standby personnel to

be immediately aware of the danger, evacuate the site as quickly as possible, and arrange rescue. Information on alarm settings for air monitoring in confined spaces is provided in Appendix 3.

- Unless alternative suitable arrangements are made, the standby person shall have sufficient physical strength to be capable of pulling workers out from outside the confined space. The standby person may use mechanical devices to assist him when he is pulling the worker out of the confined space. The standby person should be responsible for contacting emergency rescue teams when necessary. A standby person should be a certified worker or competent person as defined by the FIU(CS)R.

5.3 Critical Control Measures of Work in Confined Spaces

- Before working in a confined space, a competent person shall be appointed to carry out risk assessment and make recommendations. Certified workers shall enter or work in confined spaces only after the issuance of "permit-to-work certificate".
- Before entering the confined space, ensure that the confined space has to be sufficiently purged, cooled and ventilated.
- All pipelines connected to the confined space shall be properly and completely blanked off as appropriate.
- Perform continuous air monitoring to ensure that air of the working environment meets the required standard throughout the work. Each group of workers should individually bring at least one portable air monitoring equipment to conduct continuous air monitoring during work.
- Ensure that any person entering or remaining in that confined space properly wears an approved breathing apparatus and a suitable safety harness, where the use of approved breathing apparatus is recommended in a risk assessment report, or entry into a confined space for underground pipework is required. The safety harness should be connected to a lifeline and the free end of the lifeline should be held by the standby person outside the confined space.
- Formulate and implement proper emergency procedures, including provision of sufficient and suitable rescue equipment and presence of a rescue team that commensurate with the scale of the task.
- Implement effective monitoring and supervision to ensure that the above safety measures are fully implemented and being strictly followed.

- Work team must not begin confined space works unless reasonable steps have been taken to prevent access by unauthorised persons to the confined spaces and adopt a management system to the ingress and egress of confined spaces.
- If someone faints in a confined space, the standby persons/ workers from outside **must remember**:
  - **remain stationed outside the confined space, prevent other workers from entering.**
  - **summon assistance from the rescue team and public emergency services (i.e. Hong Kong Police Force and Fire Services Department).**
  - **brief the rescue personnel on the relevant circumstances of the incident.**
  - **never enter a confined space to try to rescue.**

  [Training course provider can display the Leaflet promoted by Occupational Safety & Health Council "What should the standby persons/ workers from outside do if someone faints in a confined space (Chinese version only)"

  https://www.oshc.org.hk/oshc_data/files/ProfessionalServices/StarScheme/ConfinedSpace/publication_emergency.pdf

6. Emergency Situations and Response Procedures

[Reference teaching time for Section 6: 55mins]

An emergency response plan should be properly formulated, including all the suitable rescue arrangements and the appropriate emergency procedures as described below, and adopted for each entry into a confined space.

Procedures

- A proprietor or contractor shall formulate and implement appropriate procedures to deal with any serious and imminent danger to workers inside a confined space.
- The emergency procedures should include situations that trigger evacuation, such as fire, adverse weather conditions (such as heavy rain), in-rush of large amounts of mud or water, undesirable changes to atmospheric hazards, failure of ventilation or fresh air supply system, and failure of emergency response equipment (such as communication devices, respirators, etc.).
- Typical air monitoring equipment can set different levels of alarms according to the level of atmospheric hazards to remind workers and standby persons whether there are adverse changes in the confined space, so as to determine the corresponding actions that should be taken, including evacuation or arranging rescue. Technical details and recommendations for setting air monitoring alarms are provided in Appendix 3.

Rescue

- A proprietor or contractor should set up arrangements to rescue workers working in a confined space promptly in case of an emergency. Arrangements for emergency rescue will depend on the nature of the confined space, the risks identified and the likely nature of an emergency rescue. Account has to be taken not only of accidents arising from a specified risk, but also of any other accident, for example, incapacitation caused by a fall.
- A rescue team consisting of sufficient number of trained persons, should be readily available. They should readily reach the confined space in time and be able to get the persons inside the confined space out in case of emergency. In general, sufficient rescue personnel and equipment should be arranged on the same worksite or near the confined space.
- As to the number of trained persons required in a rescue team, the factors to

be considered depend on the circumstances of the case, including the nature of work, the hazards inherent in the confined space in relation to the work and work methods proposed, need to be considered depending on the circumstances of the case. In devising an emergency plan, a proprietor or contractor should assess the above factors against the knowledge and experience of the rescue team in such work and recommend the most suitable number of rescue persons required.

- All members of the rescue team shall have been properly and adequately trained in the related emergency rescue procedures, including the detailed particulars of an emergency rescue plan and full knowledge of how to properly use all the rescue equipment specified in section 10(2) of the FIU(CS)R.

Communication

- The proprietor or contractor may, where reasonably practicable, provide video surveillance or body-worn video cameras to workers who need to enter confined spaces. It allows the standby person outside the confined space to monitor the workers' work in real-time and promptly call for rescue when necessary.
- Constant communication between the workers inside a confined space and the standby person shall be maintained throughout the period when the workers are working inside the confined space. An audio and visual alarm system shall be provided for the workers inside the confined space to alert the standby person, and vice versa, in case of emergency.
- Each worker should be equipped with a personal motion-sensing alarm device which can emit audio and visual alarm so that the standby person outside is immediately alerted to arrange for rescue in case the worker inside confined space is unconscious.
- Even in an emergency, the standby person must not enter the confined space. He shall remain stationed outside the confined space and summon assistance from the rescue team and public emergency services (i.e. Hong Kong Police Force and Fire Services Department). He shall brief the rescue personnel on the relevant circumstances of the incident upon their arrival.

Equipment

- Suitable and sufficient rescue equipment, including standby approved breathing apparatus, safety harness, lifelines, reviving apparatus and emergency lighting, and properly trained rescue personnel shall be readily available for rescue purposes at all times when workers are working inside a confined space. Rescue equipment provided shall be appropriate in view of the likely emergencies identified in the risk assessment and be properly maintained. The resuscitation equipment should comply with the latest and recognized international or national standard.

- Where practicable, appropriate lifting equipment, e.g. rescue hoist or winch, split-leg tripod/quadpod with a frame-mounted hoist and one-man access cradle should be available for rescue purposes.
- When continuous monitoring or periodic monitoring of the working environment due to adverse changes in the conditions of a confined space or the work conducted within it is recommended in the risk assessment report, the proprietor or contractor should provide every worker entering the confined space to work such as hand-dug tunnelling or drainage work with a set of emergency escape breathing apparatus and ensure workers to bring with them, unless the worker is using an approved breathing apparatus therein. The proprietor or contractor should ensure adequate supply of respirable air from the emergency escape breathing apparatus to allow workers to escape safely in emergencies. The emergency escape breathing apparatus should comply with the most up-to-date recognised international or national standard.
- The proprietor or contractor should provide adequate information, instructions, training and supervision to the workers to ensure their proper use and wearing of the emergency escape breathing apparatus. The proprietor or contractor should take appropriate steps to ensure the proper functioning of the emergency escape breathing apparatus, such as suitable storage, proper maintenance and regular inspection.

Evacuation

- A proprietor or contractor shall devise an evacuation procedure for prompt evacuation of the workers from the confined space in case of a sudden change in the working or the environmental condition that may cause imminent danger to them.
- If the risk assessment report does not recommend the use of an approved breathing apparatus to work in confined spaces and underground pipework is

not involved, the proprietor or contractor should consider providing workers with emergency escape breathing apparatus based on the working environment of the confined space to allow workers to escape safely in emergencies. However, it should be noted that an emergency escape breathing apparatus is not a substitute for an approved breathing apparatus.

Drills

- Drills for the rescue and emergency procedures should be conducted periodically for testing of the emergency response plan, and for practising the procedures and use of rescue equipment. It is necessary to ensure that all the personnel involved are familiar with the emergency procedures and to enhance their safety awareness and preparedness. In general, the drills should include the following：
  - evacuation drills for all personnel involved. The purpose is to familiarize all the personnel with the emergency procedures, communication systems, escape routes and exits, safe assembly points, personal protective equipment, etc., and to test the effectiveness of emergency procedures and evacuation plans, and the sufficiency and suitability of emergency facilities provided; and
  - rescue drills for emergency rescue team. The purpose is to test the capability of the emergency rescue team in their rescue duties, such as report and command duties, first aid, rescue, use of emergency facilities, etc.

Keep in mind

- If someone faints in a confined space, the standby persons/ workers from outside **must remember**:
  - **remain stationed outside the confined space, prevent other workers from entering.**
  - **summon assistance from the rescue team and public emergency services (i.e. Hong Kong Police Force and Fire Services Department).**
  - **brief the rescue personnel on the relevant circumstances of the incident.**
  - **never enter a confined space to try to rescue.**

[Training course provider can display the Leaflet promoted by Occupational

Safety & Health Council "What should the standby persons/ workers from outside do if someone faints in a confined space (Chinese version only)" https://www.oshc.org.hk/oshc_data/files/ProfessionalServices/StarScheme/ConfinedSpace/publication_emergency.pdf

7. Explanation, Display, Demonstration and Practice on Safety Equipment

[Reference teaching time for Section 7: 215 mins (85 mins in Day 1 and 130 mins in Day 2]

[Training course provider should ensure that the safety equipment used in this section should comply with the requirements of relevant regulations, and recognized international or national standards. In addition, the manufacturers' instruction manuals on the proper use of the safety equipment should be strictly followed.]

7.1 Personal Protective Equipment

- Personal protective equipment (PPE) is intended to be worn or otherwise used by a person at work for protecting the person against one or more hazards to his/her safety or health. Use of PPE is the last resort when controlling the sources of accident is impracticable. PPE should be handled with care and stored properly when standby for use. The equipment should be kept clean and maintained in good condition.
- Employers have duties on guidance, training and supervision with respect to use of PPE. They should ensure that their employees know why and when PPE is used, its maintenance or replacement schedule and limitations.
- PPE should be provided by employers. Employees must wear PPE for the entire period of exposure to hazards.

7.1.1 Safety Helmet [Explain by means of powerpoint or the real object of PPE]

- Wear a safety helmet on a construction site under all circumstances.
- A safety helmet is primarily intended to protect the top of the head from falling objects, striking against objects, and being struck by objects. A safety helmet can reduce the amount of force from an impact.
- A suitable safety helmet should bear appropriate marking indicating the conformity to certain international/national standards such as European Standard.
- A safety helmet should be equipped with a Y-type chin-strip.
- Keep the harness of a safety helmet clean and make sure that it fits well.

- Do not drill any holes on a safety helmet or use it for pounding.

7.1.2 Safety Shoes [Explain by means of powerpoint or the real object of PPE]

- Safety shoes should have steel toe caps, steel soles, slip-proof and water-proof characteristics.

7.1.3 Respiratory Protective Equipment [Explain by means of powerpoint or the real object of PPE]

- Respiratory protective equipment, commonly known as "respirators," can be used to protect users from inhaling contaminants such as dust, gases, or vapours in the air of the workplace. Employers and employees must properly select, use, and maintain respiratory protective equipment.
- Respiratory protective equipment can be broadly divided into two types: air-purifying and air-supplying. Air-purifying respirators filter the contaminated air in the working environment when it is being inhaled by the user. They are applicable to tasks carried out in a working environment where oxygen is not deficient and the levels of contaminants are not very high. Types of air-purifying respiratory protective equipment include: Disposable particulate respirators, half/full-face respirators, and loose-fitting helmet or hood respirators.
- Air-supplying respiratory protective equipment provide uncontaminated air from an independent source for breathing by the user. It includes self-contained breathing apparatus (SCBA) which provides air from a cylinder and the compressed air line breathing apparatus which provides uncontaminated air from a source through a long air hose.

7.1.4 Full Body Harnesses Attached to Independent Lifeline and Fall Arresting Device [Explain by means of powerpoint or the real object of PPE]

- The most suitable way to use a safety harness is to attach its snap-hook to a level higher than the user's waist.
- When falling from height, a full body harness (commonly known as parachute type) could better reduce the downward momentum and protect the user's waist from injury than a general safety belt.

- Before using a safety harness, the following should be checked: any defects on the safety harness, any suitable anchorage, independent lifeline and fall arresting device, and whether the standard is met or not.
- When using a safety harness for fall protection, the safety harness should be attached to a fixed anchorage point or a fall arrester of an independent lifeline.

7.2 Safety and Rescue Equipment

7.2.1 Approved Breathing Apparatus

(Air Line Type Approved Breathing Apparatus
[Explain by means of powerpoint or the real object of PPE] and
Self-contained Type Approved Breathing Apparatus
[Demonstrate using the real object including demonstrations of the procedures for the practice in Section 7.5 and "low pressure test"])

- The risk assessment report prepared by the competent person shall cover the recommendations, having regard to the nature and duration of the work to be performed therein. The competent person shall clearly recommend in the risk assessment report whether the use of approved breathing apparatus is necessary so that the workers can stay in the confined space safely. If the concentration level of the hazardous gases is not sure, appropriate approved breathing apparatus shall be used and the other corresponding safety precautions shall be taken.
- Whenever workers need to enter a confined space to perform underground pipe work, regardless of whether the risk assessment report recommends the use of approved breathing apparatus, the worker must properly wear appropriate approved breathing apparatus and a safety harness properly connected to a lifeline, in accordance with the provisions of Section 9 of the FIU(CS)R.
- Where the use of approved breathing apparatus is recommended in the risk assessment report or a worker has to enter a confined space for underground pipework, the proprietor or contractor shall ensure that any person entering or remaining in that confined space is properly wearing an appropriate approved breathing apparatus with a suitable safety harness. The safety harness should be connected to a lifeline and the free end of the lifeline should be held by the standby person outside the confined space. So far as reasonably

practicable, suitable and adequate mechanical aids should be provided, or lifting devices should be connected. Legal requirement for underground pipework will not be exempted even though safety precautions listed in sections 7 and 8 of the FIU(CS)R have been taken (e.g. every pipe or supply line has been properly blanked off, the confined space has been adequately purged and sufficiently cooled and ventilated, an adequate supply of respirable air and an effective forced ventilation have been provided, etc.).

- Workers in confined spaces must use approved breathing apparatus (applicable when the risk assessment report recommends the use of approved breathing apparatus, or when entering confined spaces for underground pipe work.
- The person using the approved breathing apparatus should have received appropriate training in using of that particular type or model of breathing apparatus. Before each use, the breathing apparatus should be:
  - connected to air cylinder or other appropriate air supply equipment for providing respirable air.
  - properly inspected for any physical damage on all parts and accessories.
  - functionally checked according to the user manual. Check items include “high pressure leak test” (i.e. check the leak of the hoses), “positive pressure test” (i.e. check the positive pressure of the mask), “cylinder pressure test” (i.e. check the pressure of the cylinder), “whistle warning unit test” (i.e. check the function of the whistle), etc.
- The selection of a suitable approved breathing apparatus should depend on the conditions, hazards and air testing results of the confined space, and the work activities to be done inside the confined space.
- All approved breathing apparatuses to be used for entry into and work inside a confined space should well fit the workers and be properly worn.
- Proprietors and contractors should only allow persons who are medically fit for wearing breathing apparatus to use the approved breathing apparatuses for entering into and working in a confined space.
- The service time of self-contained type approved breathing apparatuses should be estimated having regard to the entry time, the consumption rate, the maximum working period, the estimated escape time and other relevant factors.
- All breathing apparatus for use in confined spaces should be properly maintained in clean and good working conditions. Never use defective breathing apparatus. All defective devices should be clearly marked as

"defective" and removed from site.

- The air quality supplied by approved breathing apparatus and air supply device should comply with the most up-to-date recognized international or national standard.
- All approved breathing apparatuses for use in confined spaces should be properly maintained in good working condition.
- Only approved breathing apparatus, that is breathing apparatus which has been approved by the Commissioner for Labour under section 12 of the FIU(CS)R, should be used in connection with confined space work. The name or description of the type of breathing apparatus which has been approved by the Commissioner will be published in the Gazette. The relevant cylinder is also required to be approved by the Director of Fire Services.
- When using breathing apparatus, it must be properly fitted on the wearer's face.
- Breathing apparatus should be cleaned thoroughly after each use.

Self-contained Type Approved Breathing Apparatus

- The service time of self-contained type of approved breathing apparatus should be estimated having regard to the entry time, the consumption rate, the maximum working period, the estimated escape time and other relevant factors.
- Manufacturers' instruction manuals on the proper use of self-contained type approved breathing apparatus should be strictly followed, including:
  - Wearing procedures.
  - Functional tests include "cylinder pressure test" (i.e. check the pressure of the cylinder), "high pressure leak test" (i.e. check the leak of the hoses), "whistle warning unit test" (i.e. check the function of the whistle), "positive pressure test" (i.e. check the positive pressure of the mask), "low pressure test" (i.e. check the leak of the mask), etc.
  - Doffing procedures.

Air Line Type Approved Breathing Apparatus

- For airline type approved breathing apparatus, the air supply rate should be so adjusted that a positive pressure is always maintained inside the facepieces.
- Manufacturers' instruction manuals on the proper use of air line type approved breathing apparatus should be strictly followed, including:
  - Wear procedures.
  - Functional tests include "cylinder pressure test" (i.e. check the pressure

of the cylinder), “high pressure leak test” (i.e. check the leak of the hoses), “whistle warning unit test” (i.e. check the function of the whistle), “positive pressure test” (i.e. check the positive pressure of the mask), “low pressure test” (i.e. check the leak of the mask), etc.

- ■ Doffing procedures.

- To avoid contamination of the supply of air, the following precautions should be taken when using airline type approved breathing apparatus:
  - ■ The air supply equipment should be maintained according to manufacturer’s instructions.
  - ■ The air intake should be properly located to avoid sucking-in of contaminated air such as engine exhaust.
  - ■ The air supply equipment used should be designed for supplying breathing air. Those designed for industrial purposes are not allowed.
  - ■ Air hose which may be oil impregnated or otherwise contaminated should not be used.

7.2.2 Safety Harness, Lifeline and Tripod/Quadpod

[Demonstrate using the real object including demonstration of the procedures for the practice in Section 7.3]

Safety Harness and Lifeline

- Safety rescue harness is connected to a lifeline with the free end held by a person outside the confined space who is capable of pulling the person out of the confined space.
- Safety rescue harness is intended for withdrawal in the event of an accident. It is similar in design to a safety harness and has the D-ring mounted so that the user will remain in an upright position while being lifted with rescue lifeline.
- The safety rescue harness and lifeline should both be of sound construction and be made of suitable materials so that they will be able to withstand the strain imposed on them during emergencies.
- The safety rescue harness and lifeline should be so adjusted and worn that the wearer could be drawn up with head first through any manhole or opening of the confined space.
- Steps should be taken to ensure that the rescue lifelines in use are free from any possible entanglement with, or damaged by, any pipes, fittings, protruding parts, sharp edges or other obstacles inside the confined space.

- Reference should be made to recognized international standards or national standards when selecting safety rescue harnesses and rescue lifelines.

Tripod/Quadpod

- It should be ensured that sufficient number of persons are available outside the confined space for holding the free ends of the lifelines and, as far as practicable, make available suitable and sufficient mechanical aids for lifting and rescue such as split-leg tripod/quadpod with a frame-mounted hoist.
- Manufacturers' instruction manuals on the proper erecting, use, storage and maintenance of tripod/quadpod should be strictly followed.
- Reference should be made to the latest and recognised international or national standards when selecting rescue lifting devices.

7.2.3 Personal Motion-Sensing Alarm Device [Demonstrate using the real object]

- A personal motion-sensing alarm device by which the workers inside the confined space can alert those outside.
- A personal motion-sensing alarm device can emit audio and visual alarm to give out alerting signals to others when the worker remains motionless for a certain duration.
- Manufacturers' instruction manuals on the proper use of personal motion-sensing alarm device should be strictly followed.

7.2.4 Reviving Apparatus / Resuscitator [Demonstrate using the real object]

- Reviving apparatus is an apparatus for reviving an unconscious worker. It is using positive pressure to inflate the lungs of an unconscious person who is not breathing. "Bag-Valve-Mask Resuscitator" is an example of manual operated reviving apparatus.
- Manufacturers' instruction manuals on the proper use of reviving apparatus should be strictly followed.

7.2.5 Air Testing Equipment

(Air Monitoring Equipment [Demonstrate using the real multiple-sensor air monitoring equipment which can display readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide] and Detector

Tubes [Explain by means of powerpoint or the real object])

Direct measuring air testing equipment includes air monitoring equipment and detector tubes. Please refer to Section 9 for information on selecting appropriate air monitoring equipment and how to use it.

Air Monitoring Equipment

- The most common configuration for an air monitoring equipment is one that displays readings on levels of oxygen (O_2), combustible gas (LEL), hydrogen sulphide (H_2S) and carbon monoxide (CO). **One should never assume that the hazardous gases present are limited to these gases.** Confined spaces may contain other hazardous gases. These can originate from various processes like the use or produce hazardous substances, or from residual substances/gases/vapours if the confined spaces are used for chemical storage. Therefore, it is crucial to carefully consider the use of different or additional air monitoring instruments for conducting tests. However, competent persons should first use calibrated direct-reading air monitoring equipment to test the four common gases mentioned above, and then consider other suitable methods to measure other hazardous chemicals when necessary.

Detector Tubes

- Detector tubes are mainly used to measure the concentration of gas or vapour in the air. Different types of detection tubes can directly measure the concentration of different gases or vapors in the air.

7.3 Practice on Use of Safety Harness, Lifeline and Tripod/Quadpod

[Practical Section to be conducted with the use of the real object]

[The training course provider should provide each trainee with ONE set of full body harness]

- Every trainee should use a safety harness, a lifeline and a tripod/quadpod for the hands-on practice.
- Procedures for the practice:
  - Wear the safety harness and then take off the safety harness.
  - Attach the lifeline to the safety harness and then detach the lifeline from the safety harness.

- Mount the safety harness to the hoist of the tripod/quadpod.
- Use the hoist of the tripod/quadpod to raise and lower the safety harness.
- Dismount the safety harness from the hoist of the tripod/quadpod.

7.4 Practice on Use Personal motion-sensing alarm device

[Practical Section to be conducted with the use of the real object]

[The training course provider should provide sufficient number of personal motion-sensing alarm device (at least 2 sets) for hands-on practice and the practical examination.]

- Every trainee should use a personal motion-sensing alarm device for the hands-on practice.
- Procedures for the practice:
  - Turn on the personal motion-sensing alarm device
  - Check if the personal motion-sensing alarm device is fully charged.
  - Carry the personal motion-sensing alarm device
  - Turn off the personal motion-sensing alarm device

7.5 Practice on Use of Approved Breathing Apparatus (Self-contained Type Approved Breathing Apparatus)

[Practical Section to be conducted with the use of the real object]

[The training course provider should provide each trainee with ONE set of air mask (for fitting to compressed air cylinder) and sufficient number of compressed air cylinders (at least 2 sets) for hands-on practice and the practical examination.

[The training course provider should ensure that the self-contained type approved breathing apparatus is clean and hygienic for use]

- Every trainee should use a self-contained type approved breathing apparatus for the hands-on practice.
- Procedures for the practice:
  - Cylinder pressure test (check the pressure of the cylinder).
  - High pressure leak test (check the leak of the hoses).
  - Whistle warning unit test (check the function of the whistle).
  - Wear the whole set of self-contained type approved breathing apparatus and adjust the mask properly.
  - Conduct the low pressure test (check the leak of the mask)

- Open the valve of the air cylinder
- Connect the air hose of the air cylinder to the mask
- Breath normally when wearing the apparatus
- Positive pressure test (check the positive pressure of the mask)
- Take off the whole set of self-contained type approved breathing apparatus
- Turn off gas valve of the air cylinder

8. Risk Assessment

[Reference teaching time for Section 8: 225 mins]

8.1 Principles and Process of Risk Assessment

- The objective of risk assessment and risk control is to provide a means whereby job hazards or potential hazards are identified, evaluated and managed in a way that eliminates them or reduces them to a tolerable level. Safety procedures and risk control measures that are to be taken to prevent the hazards and to control the risks should be developed after risk assessment.
- There are five stages in risk assessment and risk control, namely:
  (1) identification of hazards;
  (2) determination of risk;
  (3) development of safety procedures and risk control measures;
  (4) implementation and maintenance of safety procedures and risk control measures; and
  (5) review of safety procedures and risk control measures.

<u>Hazard identification</u>

- Hazard identification is the process of identifying all situations or events that could give rise to the potential for injury, illness or damage to plant or property. Hazard identification should take into account how things are being done, where they are done and who is doing them, and should also consider how many people are exposed to each hazard identified and for how long.
- The following should be accorded top priority in the hazard identification process:
  - ■ High frequency accidents or near misses
    Jobs with a high frequency of accidents or near misses pose a significant threat to the safety and health of workers and should therefore be given top priority.
  - ■ History of serious accidents causing fatalities
    Jobs that have already produced fatalities, disabling injuries or illnesses, regardless of the frequency, should have a high priority in the hazard identification process.
  - ■ Existence of a potential for serious harm
    Jobs that have the potential to cause serious injury or harm need hazard analysis, even if they have never produced an injury or illness.
  - ■ Introduction of new jobs

Whenever a new job is introduced, a hazard identification process should be conducted before any worker is assigned to it.

- Recent changes in procedures, standards or legislation

  Jobs that have undergone a change in procedure, equipment or materials, and work affected by new regulations or standards will need risk assessment.

- Major methods for identification of hazards include:
  - Direct observation method

    This involves observing an experienced worker with good safety awareness carrying out the work several times. The job steps and the hazards in each of these are recorded.
  - Recall method

    This should be done for jobs that are rarely performed. The method involves inviting the designers, engineers, supervisors and workers involved in the jobs to attend a brainstorming session, during which they would look into the materials, machines and equipment used, and the job steps to identify the hazards inherent in such jobs.
- In order to identify hazards and evaluate their associated risks, it should be in the first place prepare a list of items covering premises, plant, people, procedures and materials use, etc. and gather information about them. When all the necessary information is in hand, the hazards related to work activities can be identified.

Determination of risk

- The risk associated with a hazard is a reflection of the likelihood that the hazard will cause harm and the severity of that harm. The two elements of risk, i.e. likelihood and severity, are independent of each other. The vast majority of hazards are relatively straightforward and requiring only a simple method of risk rating. The method incorporates a judgment as to whether or not a risk is tolerable. Such a method is illustrated as follows:
  - For each hazard identified, ask the question "What if?". Realistically, what is the worst likely outcome (i.e. the potential severity of harm)? Is it a fatality, major injury/permanent disability including permanent ill health, a minor injury, or no injury and only plant damage?
  - For the purpose of determination of risk, the severity of harm can be divided into 3 categories:

(1) Mild:

- accident resulting in mild bodily injury;
- example: eye irritation from dust, cough, etc.

(2) Serious:

- accident causing moderate bodily injury;
- example: fracture, skin ulcer, etc..

(3) Very serious:

- Accident causing immediate danger to life or serious bodily injury;
- Example: gas poisoning, hypoxia, drowning.

■ Make a judgment about the probability or likelihood of harm occurring based on the following table:

Probability/likelihood	**Description**
Very likely	Occurs repeatedly
Possible	Event to be expected
Unlikely	Rather remote, though conceivable

■ Decisions as to whether or not action is needed should then be made by reference to the matrix formed by probability/likelihood and the likely outcome (i.e. severity) which is usually called the Risk Level Estimator. The following table illustrates a Risk Level Estimator:

Risk Level Estimator

	Unlikely	**Possible**	**Very likely**
Very serious	Moderate Risk	High Risk	High Risk
Serious	Low Risk	Moderate Risk	High Risk
Mild	Low Risk	Low Risk	Moderate Risk

■ Action should be taken according to a list of priority. High risks should be accorded the first priority, moderate risks the second priority; low risks the third priority and so on. In deciding whether a risk is tolerable, the proprietor or contractor has to take into account whether the condition is within statutory limits and/or conform to legal or internationally recognised standards. Only when these limits and standards are met and the risk is at, or has been reduced to, the lowest possible level that is reasonably practicable should a risk be considered tolerable.

Development of safety procedures and risk control measures

- Safety procedures and risk control measures are procedures and measures to be put in place to reduce risk to a tolerable level.
- When deciding on safety procedures and risk control measures, the list below should be considered, in the order given. Safety procedures and risk control measures lower down the list should only be used if it can be shown that using a procedure and/or measure higher up the list is not reasonably practicable.
  - List of safety procedures and risk control measures:

(1) Procedures and measures to eliminate hazards at source:
For example, using a non-hazardous substance instead of a hazardous one.

(2) Procedures and measures to reduce hazards at source:
For example, replacing a noisy machine with a quieter one.

(3) Procedures and measures to remove workers from the hazard:
For example, paint spraying by unattended robots.

(4) Procedures and measures to contain hazards by enclosure:
For example, installing sound proofing enclosure for a noisy machine.

(5) Procedures and measures to reduce worker exposure:
For example, reducing exposure to noise by reducing the hours of work.

(6) Procedures and measures to ensure the proper use of personal protective equipment as the last resort:
For example, using hearing protectors for workers operating noisy machines.

Implementing and maintaining safety procedures and risk control measures

- For safety procedures and risk control measures to be implemented effectively and efficiently, they should be as far as practicable developed at the workplace with the participation of all levels of staff. Feedback from people implementing the safety procedures and risk control measures should be encouraged so that improvement to the procedures and measures can be made.

- Maintaining safety procedures and risk control measures requires scheduled inspections and maintenance. It also requires the enforcement of discipline to ensure that people do not tamper with safety procedures and risk control measures (e.g. by removing machine guards).

<u>Review of safety procedures and risk control measures</u>

- Whatever safety procedures and risk control measures are used, they should be reviewed if there is reason to suspect that they are no longer effective, or if there has been a significant change in the matters to which they relate.

  Examples are:
  (1) When information is obtained about a previously unknown design or manufacturing fault, or about a previously unidentified hazard.
  (2) When the design is revised or modified.
  (3) When the system of work associated with the plant is changed.
  (4) When the plant is moved.
  (5) When there is a change to the workplace environment.

  In the circumstances, the risk has to be reassessed and new safety procedures and control measures devised.

8.2 Risk Assessment for Confined Space Work

[An example case with appendix 1 “Risk Assessment Form for Confined Spaces” should be used for demonstration of the process of preparing a risk assessment report]

[This section must be conducted in an interactive manner through discussion with trainees]

- In view of the risk involved, working in confined spaces should be avoided as far as possible.
- Even if workers are in the immediate vicinity of the confined space and perform associated work in that confined space, the proprietor or contractor shall appoint a competent person to assess the reasonably foreseeable risk arising from the work (e.g. releasing of hazardous gases or falling from height, etc.) and make recommendations on measures necessary to ensure the safety and health of workers.
- If it is not reasonably practicable to carry out the work without entering a

confined space, then the proprietor or contractor responsible for the work undertaken in the confined space must appoint a competent person in accordance with section 5(1) of the FIU(CS)R to carry out a risk assessment to identify the hazards likely to be present in the confined space. Basing on the assessment results, the competent person should make recommendations on necessary safety precautions to be taken, before allowing the workers to enter into and work in that space so as to ensure their safety and health.

- The risk assessment should identify the hazards to the workers entering or working in the confined space, and also, others in the close proximity who may be affected by the work to be carried out, taking into account of important factors such as potential sources of inhalation of hazardous gases, vapours, fumes or lack of oxygen, and other hazards inherent in the work, proposed work methods, industrial plants, materials, and the design of the confined space itself. The competent person should consider not only the hazards arising from the confined space, but also those stemming from the other industrial plants, processes and operations in the vicinity, such as inadvertent contact with or damage to the utilities nearby during the work.
- The process of a risk assessment should include a systematic examination and careful consideration of:
  (1) all the work activities required to be done;
  (2) the previous contents in the confined space;
  (3) the methods by which the work could be done;
  (4) the hazards inherent in the confined space in relation to the work; and
  (5) the hazards inherent in the confined space in relation to the method proposed and to the design or construction of the confined space itself (including the layout and location of the confined space).
- Before carrying out the risk assessment:
  (1) all information about the confined space and the work to be done in it should be gathered. For example, there may be information from the engineering drawings, working plans, figures, photos or reports about relevant soil or geological conditions.
  (2) The appointed competent person should conduct site investigation s to have a more thorough knowledge of the location, nature and circumstances of the confined space, particularly its effect on safety and health matters.
- For identifying all the possible hazards which may be present in the confined space and evaluating fully the extent of all those associated risks, the risk

assessment shall cover the following aspects:

(1) the work method to be used and the plant and materials to be used in work activities;
(2) whether or not there is any hazardous gas, vapour, dust or fume present;
(3) whether or not there is any deficiency in oxygen;
(4) the possibility of ingress of hazardous gas, vapour, dust or fume;
(5) the possibility of sludge or other deposits being present that are liable to give off hazardous gas, vapour, dust or fume;
(6) the possibility of in-rush of free flowing solid or liquid;
(7) the possibility of fire or explosion in the confined space; and
(8) the possibility of loss of consciousness of a certified worker arising from an increase in body temperature.

- The risk assessment report shall also cover the following:
  (1) the recommendations on the measures required, including whether or not the use of approved breathing apparatus is necessary, having regard to the nature and duration of the work to be performed therein; and
  (2) the period during which workers may remain safely in the confined space.
- Where sludge or other deposits are present, and a competent person considers that there is a possibility that they will give off hazardous gas, vapour, dust or fume, he shall recommend the use of an approved breathing apparatus. It should be noted that if there are sludge or other deposits present, it is generally very likely for the trapped or dissolved gases such as, hydrogen sulphide, to be released during confined space work, especially drainage works.
- A competent person, in evaluating the extent of the risks in a confined space, shall recommend the use of suitable monitoring equipment and specify how the equipment shall be used if he deems that there is a substantial likelihood of environmental changes occurring in the confined space during work that would increase the risks associated with the hazards.
- The size and number of access and egress points of a confined space:
  (1) should be assessed individually taking into the account of the activities to be carried out and the number of people involved.
  (2) due consideration should be given to the possible difficulties for access to and rescue from the confined space when determining the locations of manholes or openings to vessels, tanks, etc.
  (3) there may be occasions when access and egress are so tortuous that temporary openings are needed. Different criteria should be applied

when determining manhole dimensions for a confined space that extends over a significant length or height (such as sewers, pipes, culverts, small tunnels or shafts). Measures to improve access pathways, such as structural alterations to the confined space, could be considered. If the distance between manholes on drainages is considerably long, it may affect both the degree of natural ventilation and the efficiency of rescue operations.

- The recommendations on the necessary safety measures must include whether the use of approved breathing apparatus is necessary so that the workers can safely stay inside the confined space. When there is any doubt about atmospheric hazards, suitable and approved breathing apparatus must be used and the other necessary safety precautions must be taken accordingly.
- When workers enter a confined space to carry out underground pipework, there may be additional hazards, particularly atmospheric hazards. Therefore, a proprietor or contractor and a competent person should determine whether the work involving entry into the confined space relates to underground pipework. If underground pipework is involved, the workers must properly wear an approved breathing apparatus and use a suitable safety harness connected to a lifeline in accordance with section 9 of the FIU(CS)R.
- When making recommendations regarding a confined space work, an important consideration is how the worker can be safely rescued from the confined space in case of emergency.
- During the risk assessment, if the competent person considers that the working environment may change adversely, he must recommend continuous monitoring or periodic monitoring of the working environment. The purpose of air monitoring is to ensure that the ventilation is adequate and that the atmosphere hazards inside the confined space are within an acceptable level. The requirement for testing, retesting and monitoring must be determined by the competent person.
- In case it is possible that flammable or explosive gases or vapours would be present in the confined space, the equipment for atmospheric monitoring of the gases or vapours should be of the explosion proof type. It should have both visual and audible alarms so that it can alert workers if a hazardous situation exists or is developing in the confined space.
- All the monitoring equipment used in connection with the atmospheric monitoring should be properly maintained and be calibrated periodically as per the recommendation of the manufacturer or supplier for accurate testing

functions.

- For precautions on air testing and monitoring and exposure limits for air impurities, please refer to Appendix 3 and the “Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace” and “Air Monitoring in the Workplace” published by the Labour Department.
- When there is any circumstance indicating that the risk assessment is no longer valid or work arrangement has significantly changed, the work must be stopped. All workers must be evacuated immediately and the risk assessment should be reviewed. Workers must not enter the relevant confined space unless the work environment is confirmed to be safe.
- The risk assessment for confined space work should be repeated whenever necessary. The proprietor or contractor shall appoint a competent person to carry out a fresh risk assessment and make recommendations whenever there has been a significant change in the conditions of the confined space or of the work activities therein to which the previous assessment relates, or where there is reason to suspect that such change may occur, and that the change is likely to affect the safety and health of the workers therein. Such changes may include, e.g. for sewers, the increase in the level of sewage or storm-water due to sudden rainfall, the increase in tide level, the evolution of toxic gas due to disturbance of sludge or deposits in the place, etc. Risk assessment should also be repeated if there is any reason to suspect that the previous assessment is no longer valid.
- The risk assessment and related work arrangements should be reviewed regularly and in a timely manner. When carrying out long-term projects inside confined space, even in the absence of significant changes, the proprietor or contractor should conduct regular reviews (e.g., at least once a month) of the work environment and processes to ensure that the risk assessment and recommendations remain valid.
- A competent person shall record all significant assessment results in the risk assessment report, which includes (but not limited to) the hazards identified, the necessary safety precautions to be taken, the type and the number of workers being affected, the period during which workers may remain safely in the confined space and the relevant personal particulars of the competent person who was responsible for carrying out the risk assessment.
- The competent person must make available the risk assessment reports and recommendations to the proprietor or contractor within a reasonable time after the request for the reports and recommendations was made by the

proprietor or contractor, but it must be given before the proprietor or contractor allows the workers to enter into the confined space.

- The completed risk assessment report for confined space work shall be submitted to the proprietor or contractor of the industrial undertaking for his consideration for the issue of a "permit-to-work certificate" before the confined space work is carried out.
- After the risk assessment has pointed out the hazards and relevant recommendations on safety precautions, the proprietor or contractor shall verify that such risk assessment report covers all matters referred to in section 5(2) of the FIU(CS)R, and formulate the method statement for the confined space works.
- The method statement should record details of all relevant processes, work procedures, safety precautions, relevant equipment, workers' qualifications and training requirements, etc., and include the implementation of a permit-to-work system.
- There may be other work-related hazards for working in confined spaces arising out of, for example, electricity, welding, dangerous substances, noise and dust, etc. The competent person should recommend necessary safety precautions for work to be carried out in confined space having regard to the usually restrictive, and sometimes electrically conductive, nature of a confined space.
- The competent person appointed to carry out risk assessment should assist the proprietor or contractor in assessing whether the confined space work is an underground pipework to ensure compliance with section 9(b) of the FIU(CS)R, i.e. where a person has to enter a confined space for underground pipework, the proprietor or contractor should ensure that a person entering or remaining in that confined space is properly wearing an approved breathing apparatus, and the person is wearing a suitable safety harness connected to a lifeline so that the person can be pulled out of the confined space in an emergency. To assess whether a work is an underground pipework, factors to be considered include (1) whether the work is conducted inside a confined space; (2) whether the aforesaid confined space is underground; and (3) whether the work involves any pipework which would have specified risk associated with atmospheric hazard.

8.3 Points should be noted when conducting drainage works in confined spaces

To assist competent person to have a detailed grasp of the risk assessment of drainage works, following are the points should be noted when conducting risk assessment for confined space (drainage works):

8.3.1 To determine whether a work is an underground pipework

- Typical underground pipework includes (1) workers are required to enter any underground drains or their associated manholes that may pose atmospheric hazards, which have been classified as confined spaces, to carry out inspection or maintenance of drainage works, etc.; or (2) workers are required to enter any underground confined spaces that may pose atmospheric hazards for inspection or maintenance work of pipes. We must note that whether the nature of a confined space work is underground pipework or not can, under no circumstances, be changed by taking any control measures. The competent person appointed to carry out risk assessment should assist the proprietor or contractor in assessing whether the confined space work is an underground pipework to ensure compliance with section 9(b) of the FIU(CS)R.

8.3.2 Collection of all relevant information of the drainage works

- The competent person appointed to carry out risk assessment should understand the work methods to be employed, the plant and materials to be used, and the physical layout and surrounding environment of the drainage worksite. This can be done by conducting an on-site survey and studying the relevant information of the underground facilities, drawings and work plans.
- The competent person should identify and assess all the potential atmospheric hazards that may exist before the work begins as well as those that may emerge in the course of the work. Even if hazardous gases, fumes and vapours may not be present initially, they may be released while the work is in progress inside the drainage. For example, if sludge or sewage containing hydrogen sulphide is disturbed, the hydrogen sulphide gas will be released quickly and accumulated in the confined space to hazardous levels. Also, sudden ingress of hazardous gases to newly built drainage from existing sewers is not uncommon.

8.3.3 Determination of the presence of sludge or other deposits

- The competent person is required to assess the presence of sludge or other deposits in the confined space. When there is a possibility that the sludge or deposits will give off hazardous gas, vapour, dust or fume, the competent person should recommend the use of approved breathing apparatus. When there are sludge or deposits present in the drainage works site, the trapped or dissolved hazardous gases such as hydrogen sulphide are very likely to be released due to disturbance of the sludge, sediment or sewage during work, thus increasing the risk of gas poisoning. In this circumstance, the competent person must recommend the use of approved breathing apparatus by workers in the risk assessment, and recommend the use of suitable air monitoring equipment (should be explosion-proof type) for continuous air monitoring in the confined space until everyone leaves the confined space. The preferred method of continuous air monitoring is carrying suitable air monitoring equipment by certified workers working inside confined spaces.

8.3.4 Assessment of atmospheric hazards

- Air monitoring in confined space should be conducted by a person with appropriate training and experience, e.g. competent persons including registered safety officers with at least one year of experience in air monitoring in confined spaces, occupational hygienists, etc. Air monitoring includes pre-entry air testing and air monitoring during the work.
  - The competent person shall recommend continuous air monitoring if the risk assessment shows that there could be adverse changes in atmospheric conditions.
  - The competent person shall state in the recommendation whether the use of approved breathing apparatus is necessary and the period within which workers may safely remain in the confined space.
- Air monitoring does not end with the pre-entry test. Since atmospheric conditions within a drainage workspace can change rapidly, it is necessary to perform continuous air monitoring to ensure that the air quality remains acceptable throughout the work. Each group of workers (at the same working location) should bring alone with at least one portable air monitoring equipment to conduct continuous air monitoring during drainage work. The equipment should be checked to ensure that it is calibrated, functioning properly and with sufficient power to operate before the workers enter the drainage.
- A “re-entry” test should be conducted if the workers have temporarily left the space. In fact, “re-entry” testing and pre-entry testing should be performed in

exactly the same manner and should be considered equally important. In case the alarm of the air monitoring equipment is activated or any other indication of danger is observed, workers should leave the work space immediately according to the emergency procedures.

- Please note the following important points on the use of air monitoring equipment:
  - Only properly maintained and calibrated equipment should be used for air testing. Unscientific methods such as throwing a flame down the manhole, and observing the presence of living organisms or the colour of the manhole are unreliable.
  - The most common configuration for a multiple-sensor air monitoring equipment is one that can show the readings of oxygen, combustible gases, hydrogen sulphide and carbon monoxide. Never assume that the hazardous gases present in the drainage are limited to these gases. Different or additional air monitoring equipment is required for other hazardous gases (e.g. chlorine) that may be present in the drainage.
  - The proper functioning of the air monitoring equipment should be tested before use according to the manufacturer's instructions, i.e. functional or bump/challenge test.
  - The atmosphere in the drainage should, as far as practicable, be tested by using remote probes and sampling lines connected to direct-reading instruments placed outside the drainage.
  - The atmosphere around the working position of the person carrying out the air monitoring should be tested first to ensure his safety and health during the air monitoring.
  - In general, testing for oxygen should be performed first because some gas sensors are oxygen dependent and could give unreliable readings in oxygen deficient situations. Even though it may still be sufficient for survival, any depletion of oxygen should be further investigated.
  - Testing of the atmosphere inside the drainage should be done from the top to the bottom of the confined space, preferably at about 1-metre intervals. Sampling for a few minutes at each location is required as there will be a time lag for the gas to be pumped from the sampling probe to the monitoring equipment.
  - Record the results with the time and location of the atmospheric monitoring in the risk assessment.
  - Air monitoring must be conducted again when there is any potential

change in the atmospheric conditions.

8.4 Exercises in Preparation of Risk Assessment Report

[This section must be conducted in an interactive manner through discussion with trainees]

[Risk assessment reports completed by trainees should be collected and checked to facilitate the interactive discussion]

[Model answers of risk assessment reports should be provided to trainees to facilitate the interactive discussion]

- Exercises：Every trainee should prepare one to two risk assessment reports.

- Cases for the exercises:

    - The accident cases associated with confined spaces operation (in particular those occurred during the three years preceding the conduct of the course)

    or

    - The accident cases associated with confined spaces operation published by Labour Department (e.g. “Poisoning in manhole sewer” and “Poisoning in metal duct” in “Brief Analysis of Site Accident Cases”, etc.).

9. Air Testing Procedures and Points to Note

[Reference teaching time for Section 9: 35 mins]

[Demonstrate using the real multiple-sensor air monitoring equipment which can display readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide. The demonstration should include the test for the proper functioning of the air monitoring equipment, i.e. the functional or bump test, before use according to the manufacturer's instructions.]

9.1 Select appropriate air monitoring equipment and usage methods

During the risk assessment, if the competent person considers that the working environment may change adversely, he must recommend continuous monitoring or periodic monitoring of the working environment. The purpose of air monitoring is to ensure that the ventilation is adequate and that the atmosphere hazards inside the confined space are within an acceptable level. The requirement for testing, retesting and monitoring must be determined by the competent person.

Using direct-reading equipment, including air monitoring devices and detector tubes, is a simpler and quicker way to conduct air monitoring in confined spaces.

Air Monitoring Equipment

- The most common configuration for an air monitoring equipment is one that displays readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide. One should never assume that the hazardous gases present are limited to these gases. Confined spaces may contain other hazardous gases. These can originate from various processes like the use or produce hazardous substances, or from residual substances/gases/vapours if the confined spaces are used for chemical storage. Therefore, it is crucial to carefully consider the use of different or additional air monitoring instruments for conducting tests.
- Continuous air monitoring equipment are suitable for continuous air monitoring.
- Air monitoring equipment have audio-visual alarms to alert workers to take appropriate actions.

Detector Tubes

- Detector tubes are primarily used to measure the concentration of gases or vapours in the air. Different types of detector tubes can directly measure the concentration of various gases or vapuors in the air. For example, if toluene is volatilized from the use of organic solvents, a detector tube for toluene can be used to directly measure its concentration in the air.

9.2 Air Testing Procedures

Air testing should be conducted by a person with appropriate training and experience.

<u>Pre-entry Air testing</u>

- The atmosphere in the confined space should, as far as practicable, be tested by using remote sampling probes and sampling lines connected to direct-reading equipment (e.g. detector tubes and air monitoring equipment) placed outside the confined space.
- The manufacturers' instruction manuals on the proper use of air testing equipment should be strictly followed including the proper functioning of the equipment should be tested, i.e. to conduct functional or bump test, before use according to the manufacturer's instructions. Only properly maintained and calibrated equipment should be used for air testing.
- The atmosphere around the working position of the person carrying out air testing should be tested first to ensure his safety and health during air testing.
- In general, testing for oxygen should be performed first because some gas sensors are oxygen-dependent and may give unreliable readings in oxygen-deficient situations. Even though it may still be sufficient for survival, any depletion of oxygen should be further investigated.
- As the hazardous gas may not be evenly distributed (e.g. manhole and hand-dug tunnel), air testing should be performed from the top to the front end of the confined space to cover different positions and different depths of the confined space. Sampling for a few minutes at each location is required as there will be a time lag for the gas to be pumped from the sampling probe to the air testing equipment through the sampling line.
    - Manhole: testing of the atmosphere inside the manhole should be done from the top to the bottom of the space, preferably at about 1-metre intervals. It is because different gases will float at different levels of the manhole according to their relative density to air. For example, methane is lighter than air and therefore it will be at the top of the manhole; hydrogen sulphide is heavier than air and it will be at the

bottom and carbon monoxide is similar to air.

- Hand-dug tunnel: air testing should be performed from the top to the front end of the hand-dug tunnel to cover different positions of the hand-dug tunnel and different depths of the shaft pit. If it is not feasible to horizontally extend the sampling probe and sampling line connected to the air testing equipment to the front end of the hand-dug tunnel, remote control type air testing equipment at different and suitable locations (including different working locations and the excavation face) in the tunnel should be placed.

- The results should be recorded with the time and location of the air testing in the risk assessment.
- Air testing must be conducted again when there is any potential change in the atmospheric conditions.

Air monitoring during work

- During the risk assessment, if the competent person considers that there is a known possibility of adverse changes of working conditions, he should recommend a continuous monitoring or periodical monitoring of the working environment.
- For examples, atmospheric conditions within the drainage system and the hand-dug tunnel can change rapidly or contaminants may be produced during work processes; therefore, it is necessary to perform continuous air monitoring to ensure that the air quality remains acceptable throughout the work. Portable type multi-gas continuous air monitoring equipment with an audio-visual alarm should be provided to each worker for continuous air monitoring. In case the alarm of air monitoring equipment is activated or any other indication of danger is observed, workers must leave the confined space immediately according to the emergency procedure.
- Each team of workers (at the same work location) should carry at least one portable air monitoring device for drainage work, allowing them to continuously monitor the air while working. The device should be checked before entering the sewer to ensure it is calibrated, functioning properly, and has sufficient battery power. (See Figure 4)

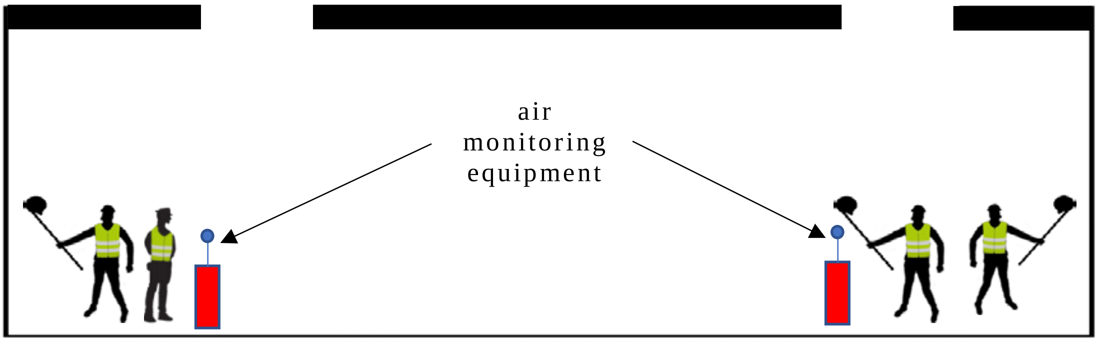


Figure 4. Portable air monitoring equipment should be equipped by at least one person in a group (at the same working location) or placed in same vicinity of the group of workers

- A re-entry test should be conducted before any worker re-enters the confined space if all the workers have temporarily left the confined space. In fact, re-entry test and pre-entry test should be performed in exactly the same manner and should be considered to be equally important.

9.3 Points to note for using air testing equipment

Air Monitoring Equipment

- Proper air monitoring equipment should be selected with respect to the gas or vapour to be tested. For example, the air monitoring equipment equipped with multiple sensors to measure the levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide.
- The air monitoring equipment should be of the explosion-proof type and should have an audio-visual alarm device.
- Read and follow the manufacturer's instructions when using the air monitoring equipment, including the proper maintenance and calibration for the equipment, etc.
- The sensors of the air monitoring equipment should be checked to ensure that they are properly installed and has not yet expired.
- The remaining battery level of the air monitoring equipment should be checked.
- The proper functioning of the air monitoring equipment should be tested, i.e. to conduct functional or bump test, before use according to the manufacturer's instructions.
- In general, testing for oxygen should be performed first because some air monitoring equipment is oxygen-dependent and may give unreliable readings

in oxygen-deficient situations.

- The air monitoring equipment should have an audio-visual alarm device which would alert workers when any indication of danger is detected.
- The air monitoring equipment is suitable for continuous air monitoring.
- The air monitoring equipment should have a two-level alarm system to alert workers to take appropriate actions correspondingly. Level 1 Alarm is a warning level indicating that there is a threat of atmospheric hazards, but the situation of worker is still safe. Action should be taken to determine the cause of the threat and implement appropriate remedial measures. Under normal circumstances, when reaching Level 2 Alarm level, it indicates the atmospheric hazards pose risks to the workers, the emergency procedures should be activated, and the workers should be evacuated immediately.

Flammable or Explosive Substances in Air

- The alarm for the presence of flammable or explosive gases is generally set using the Lower Explosive Limit (LEL). Level 1 Alarm (Warning) for the lower explosive limit should be set at 5% LEL, and Level 2 Alarm (Evacuation) should be set at 10% LEL. If a flammable or explosive substance has toxic/harmful properties simultaneously, the lower concentration of the two shall be used as the criterion for setting the alarm. For example, hydrogen sulphide must set the alarm at the concentration of its toxicity.

Toxic or Harmful Chemicial Substances in Air

- The setting of alarm levels for toxic or harmful chemicals in the air should make reference to the Occupational Exposure Limits if underground pipework is not involved and an approved breathing apparatus is not required as indicated in the risk assessment report. In this connection, the alarm levels for toxic or harmful chemicals in the air should be set as follows:

Level 1 Alarm§	Half of Occupational Exposure Limit - Short-Term Exposure Limit *[or 1.5 times of Occupational Exposure Limit - Time-Weighted Average¶]*
Level 2 Alarm§	Occupational Exposure Limit - Short-Term Exposure Limit *[or 3 times of Occupational Exposure Limit - Time-Weighted Average¶]*

§ Alarm settings for measuring instruments should be rounded down to the nearest integer.

¶ Only applicable to chemicals for which OEL-STEL have not been established.

Excessive Level of Oxygen or Oxygen Deficiency in Air

- There are about 21% by volume of oxygen in air under normal atmospheric pressure. A decrease in the percentage of oxygen in air can result in an oxygen-deficient environment, which can asphyxiate workers. Conversely, a high percentage of oxygen in air increases the risk of causing fires and explosions. Therefore, alarm thresholds for oxygen content in air (measured by volume) are set at 19.5% and 22% to warn workers of oxygen deficiency or excessive oxygen level environments respectively. Whenever the oxygen content alarm is activated, immediate evacuation should be carried out.

- The alarm levels for some common hazardous gases that can be encountered in confined spaces are recommended as follows:

For workers without using approved breathing apparatus to enter confined spaces	CH_4	H_2S	CO
Level 1 Alarm	5% LEL	7ppm	37ppm
Level 2 Alarm	10% LEL	15ppm	75ppm

Detector Tubes

- Proper detector tube should be selected with respect to the gas or vapour to be tested. Make sure the tube has not yet expired.
- Read and follow the manufacturer’s instructions when using the detector tube.
- Some of the detector tubes are subjected to cross-interference, hence it is important that instructions provided by the manufacturer should be referred to before using detector tubes.
- The pump to be connected to the detector tube should be checked to ensure that it is in good working order.
- The tips of the tube should be broken carefully since glass splinters may come off. The opened tube should be handled with care to avoid being injured by the sharp edges of the tips.
- Insert the opened detector tube into the pump with the arrow mark pointing towards the pump.
- Detector tube is operated by connecting an unsealed tube to a pump. By operating the pump, air is drawn into the tube. If the relevant gas or vapour is present, the purpose made chemicals in the tube will react to give a colour

change. The concentration of the gas or vapour is measured by the length or the intensity of the colour change.

- The detector tubes are not suitable for continuous air monitoring.

10. Practice on Use of Multiple-Sensor Air Monitoring Equipment

[Reference teaching time for Section 10: 90 mins (60 minutes on the first day, 30 minutes on the second day]

[Practical Section to be conducted with the use of the real object of multiple-sensor air monitoring equipment which can display readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide]

[The training course provider should provide sufficient number of continuous air monitoring equipment (at least 2 sets) for hands-on practice and the practical examination.]

- Trainees are divided into groups (maximum of four trainees per group) to use a multiple-sensor air monitoring equipment for the hands-on practice.
- Every trainee should use a continuous air monitoring equipment for the hands-on practice.
- Procedures for the practice:
  - Check if the air monitoring equipment is available and intact
  - Start up the air monitoring equipment
  - Take the readings on levels of oxygen, carbon monoxide, hydrogen sulphide and flammable gases in the classroom and read the readings

  - **Simulation of safe situation**

  Each trainee should complete the following procedures on his own (other group members observe and learn the procedures at the same time):

  - Connect the sampling probe and hose to the air monitoring equipment.
  - Switch on the air monitoring equipment.
  - Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
  - Switch off the air monitoring equipment.

  - **Simulation of hazardous situation**

  Either procedures A or B should be completed by each group (every group members should participate in the procedures). Each trainee should complete the procedure B on his own (other group members observe and learn the procedures at the same time):

Procedure A

- Connect the sampling probe and hose to the air monitoring equipment.

- Switch on the air monitoring equipment.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- Put the sampling probe into a container (e.g. a plastic ziplock bag) containing alcohol wipes.
- Wait the audio-visual alarm of the air monitoring equipment to be activated.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- Take out the sampling probe from the container and observe the changes of the readings displayed on the air monitoring equipment.
- Press the reset button of the air monitoring equipment to turn off the audio-visual alarm or wait the air monitoring equipment back to normal automatically (i.e. the audio-visual alarm is stopped).
- Switch off the air monitoring equipment.

(Remarks: Adequate measures should be taken to ensure the fire safety of the training premises during the conduct of the simulation.)

Procedure B

- Connect the sampling probe and hose to the air monitoring equipment.
- Switch on the air monitoring equipment.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- Exhale to a plastic ziplock bag or a container several times to simulate the oxygen deficient environment.
- Put the sampling probe into the plastic ziplock bag or the container.
- Wait the audio-visual alarm of the air monitoring equipment to be activated.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- Take out the sampling probe from the plastic ziplock bag or the container, and observe the changes of the readings displayed on the air monitoring equipment.
- Press the reset button of the air monitoring equipment to turn off the audio-visual alarm or wait the gas monitor back to normal automatically (i.e. the audio-visual alarm is stopped).
- Switch off the air monitoring equipment.

(Remarks: Adequate measures should be taken to ensure that all training activities conducted are safe and without risks to health, e.g. the hygienic arrangements for exhaling to a plastic ziplock bag or a container.)

- Every trainee shall be able to tell the locations where air testing is required in confined space (such as **manhole, shaft and tunnel)** and the measuring time required for those locations.
  - **manhole, shaft**: from the top to the front end of the confined space to cover different positions and different depths of the confined space;
  - **Tunnel**: In addition to conducting air tests at different depths in the tunnel, air tests must also be conducted horizontally at different locations in the tunnel;
  - Sampling for a few minutes at each location is required.

11. Application of Safe System of Work and Permit-to-work System

[Reference teaching time for Section 11: 130 mins]

11.1 Overview of Application of Safe System of Work and Permit-to-work System

[The example at Appendix 2 should be used for demonstration of the process of preparing a "permit-to-work certificate"]

[This section must be conducted in an interactive manner through discussion with trainees]

"Permit-to-work" system reminds the proprietor or contractor to ensure that all foreseeable hazards and associated risks have been considered in advance and that all the necessary safety precautions are clearly defined and have been effectively taken. The following paragraphs give a brief framework of the system.

Contents

- The proprietor or contractor of a confined space should issue to the workers a "permit-to-work certificate" before allowing them to enter into or work in the confined space.
- The "permit-to-work certificate" should record the following:
  (1) the findings in the risk assessment report completed by the competent person;
  (2) the effectiveness of the isolation and withdrawal from service;
  (3) the amount of sludge or other deposits (if any) after cleaning;
  (4) the results of the air testing;
  (5) the nature of work to be done;
  (6) the conditions and features of the confined space;
  (7) list of personal protective equipment;
  (8) the period during which workers may remain safely in the confined; and
  (9) the other relevant information [Reference can be made to the example of "permit-to-work certificate" at Appendix 2].

Procedures

- The proprietor or contractor of the confined space work, after receiving a risk assessment report completed by a competent person, shall verify that the report has covered all the matters referred to in section 5(2) of the FIU(CS)R. The proprietor or contractor should determine to issue a "permit-to-work certificate" only when all necessary safety measures have been implemented, including all necessary safety precautions specified in the risk assessment.

- The "permit-to-work certificate" should be properly signed for confirmation that all safety precautions indicated on the certificate have been implemented effectively by the proprietor or contractor or persons authorized by him. The items in the certificate should be written in permanent ink or otherwise so as to be indelible.
- The person responsible for signing and accepting the "permit-to-work certificate" should be the one who is responsible for stationing outside the confined space, that is, the onsite supervisor or the person-in-charge of the work in the confined space. The signer should read and fully understand the content of the "permit-to-work certificate" and undertake the work in accordance with all the conditions laid down in the certificate.
- The contents of the "permit-to-work certificate" should be clearly explained to all the workers and persons involved in the confined space work.
- All the safety requirements, necessary precautions and relevant conditions or limitations stated in the "permit-to-work certificate" should be strictly observed and followed by all the workers and persons involved in the confined space work.
- The "permit-to-work certificate" should be displayed conspicuously at the entrance of the confined space.
- A "permit-to-work certificate" should be properly cancelled when the work activities in the confined space to which it refers have been completed and the confined space is clear of workers, equipment and spare material.
- When work in the confined space was completed, the "permit-to-work certificate" should be returned to the proprietor or contractor by the person to whom it was issued. This person should sign a declaration that all personnel and equipment have been removed from the site, and the personnel have been warned that the confined space is no longer safe for entry.
- A proprietor or contractor should check that the work covered by the "permit-to-work certificate" has been properly completed. He should then sign a final confirmation of cancellation of the certificate to confirm that the work activities in the confined space have been completed and that another certificate will be required for entering the confined space again. Effective measures should be taken to ensure that no worker would enter the confined space during the period when the completed "permit-to-work certificate" is being delivered to the proprietor or contractor for proper cancellation.

- The records of all risk assessment report and “permit-to-work certificates” should be properly maintained for one year after the certificates have been cancelled and be available for inspection.

11.2 Exercise in Preparation of “Permit-to-work Certificate”

[The example of “permit-to-work certificate” at Appendix 2 should be used for the exercise]

[This section must be conducted in an interactive manner through discussion with trainees]

[“permit-to-work certificate” completed by trainees should be collected and checked to facilitate the interactive discussion]

[Model answers of “permit-to-work certificate” should be provided to trainees to facilitate the interactive discussion]

- Exercise：Every trainee should prepare one “permit-to-work certificate”.

- Cases for the exercise:

  - The accident cases associated with confined spaces operation (in particular those occurred during the three years preceding the conduct of the course)

    or

  - The accident cases associated with confined spaces operation published by Labour Department (e.g. “Poisoning in manhole sewer” and “Poisoning in metal duct” in “Brief Analysis of Site Accident Cases”, etc.).

12. Practical Examination

The practical examination consists of proper use of personal motion-sensing alarm device, approved breathing apparatus (self-contained type) and continuous air monitoring equipment. For the assessment items of the practical examination, please refer to Score Sheet in **Annex 9**.

Risk Assessment Form for Confined Spaces

Appendix 1

Location of work : ____________________

Description of work : ____________________

Main Contractor/Proprietor : ____________________

Subcontractor (if applicable) : ____________________

Name of Competent Person : ____________________

Certificate No. : ____________________ Validity Period : ________(Year) ______ (Month) ______ (Day)

Add a ✔ to appropriate boxes

1.	Contents of Risk Assessment		
1.1	☐ This work falls under the provisions of section 3 of the Factories and Industrial Undertakings (Confined Spaces) Regulation, as it involves work performed within a confined space or in close proximity to a confined space, and is related to work conducted within a confined space. Work methods to be adopted in the confined space works[1] : ____________________ Plant to be used in the confined space works[1] : ____________________ Materials to be used in the confined space works[1] : ____________________ (If the work does not involve any worker entering the confined space[1], the following measures shall be taken to ensure that no workers enter the confined space : ____________________ ____________________)		
	Assessment Items	**Result(s)**	**Safety Precautions Required**
1.2	Is the confined space works an **underground pipework** as described in section 9(b) of the Factories and Industrial Undertakings (Confined Spaces) Regulation?	☐ Yes	☐ Ensure that any person entering or remaining in that particular confined space is properly (i) wearing a suitable approved breathing apparatus; and (ii) wearing a suitable safety harness connected to a lifeline. ☐ Monitor the air in the confined space continuously until everyone has left the confined space.
		☐ No (Reasons provided as follows : ____________ ____________ ____________)	____________________ ____________________ ____________________
1.3	Is there any **hazardous** gas, vapour, dust or fume, or **deficiency of oxygen** present in the confined space?	☐ Yes	☐ Ensure that any person entering or remaining in that particular confined space is properly (i) wearing a suitable approved breathing apparatus; and (ii) wearing a suitable safety harness connected to a lifeline. ☐ Monitor the air in the confined space continuously until everyone has left the confined space.
		☐ No (Reasons provided as follows : ____________ ____________ ____________)	____________________ ____________________ ____________________

[1] The Competent Person should obtain information of work methods, plant and materials to be used for the particular confined space works from the Main Contractor/ Subcontractor/ Proprietor in order to complete the risk assessment. The Main Contractor/ Subcontractor / Proprietor shall ensure the risk assessment report is displayed in a conspicuous place at the entrance of the confined space.

	Assessment Items	Consequence [2]	Likelihood [2]	Risk [2]	Safety Precautions Required
1.4	Ingress of hazardous gas, vapour, dust or fume to the confined space	☐ Very Serious (3) ☐ Serious (2)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	__________ __________ __________
				☐ Moderate risk (3-4)	__________ __________ __________
				☐ Low risk (<=2)	__________ __________ __________
1.5	Are there any **sludge or other deposits being present** that are **liable to give off hazardous gas, vapour, dust or fume** in the confined space?			☐ High risk (>=6)	☐ Ensure that any person entering or remaining in that particular confined space is properly (i) wearing a suitable approved breathing apparatus; and (ii) wearing a suitable safety harness connected to a lifeline. ☐ Monitor the air in the confined space continuously until everyone has left the confined space.
	☐ **Yes, sludge or other deposits are present** in the confined space. *Unless the sludge and other deposits are completely removed and purged, otherwise if there are sludge or other deposits present, it is generally very likely for the trapped or dissolved gases such as hydrogen sulphide to be released in confined space work, in particular drainage works.*	☐ Very Serious (3) ☐ Serious (2)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ Moderate risk (3-4)	__________ __________ __________
				☐ Low risk (<=2)	__________ __________ __________ __________
	☐ **No, sludge or other deposits are not present** in the confined space.	(Reasons provided as follows : __________ __________ __________)			

[2] Regarding the definitions of 'severity of consequences', 'likelihood of occurrence' and 'risk rating' please refer to the risk rating table in the final section of this assessment form.

	Assessment Items	Consequence [2]	Likelihood [2]	Risk [2]	Safety Precautions Required
1.6	**In-rush** into the confined space of free flowing solid or liquid	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	
1.7	**A fire or explosion** in the confined space	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	
1.8	The **ambient temperature** in the confined space that may lead to loss of consciousness of a certified worker arising from an increase in body temperature	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	
1.9	**Change in the environment** leading to an increased risk of the above hazards during the course of the work in the confined space	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	

[2] Regarding the definitions of 'severity of consequences', 'likelihood of occurrence' and 'risk rating' please refer to the risk rating table in the final section of this assessment form.

	Assessment Items	Consequence [2]	Likelihood [2]	Risk [2]	Safety Precautions Required
1.10	**Risk of worker falling from height** during the course of the work in the confined space or its proximity	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	______ ______ ______
				☐ Moderate risk (3-4)	______ ______ ______ ______
				☐ Low risk (<=2)	______ ______ ______
1.11	Others (please specify: ______ ______)	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	______ ______ ______
				☐ Moderate risk (3-4)	______ ______ ______ ______
				☐ Low risk (<=2)	______ ______ ______
1.12	Others (please specify: ______ ______)	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	______ ______ ______
				☐ Moderate risk (3-4)	______ ______ ______ ______
				☐ Low risk (<=2)	______ ______ ______
1.13	Period during which certified workers may remain safely in the confined space: ________hour(s)				

[2] Regarding the definitions of 'severity of consequences', 'likelihood of occurrence' and 'risk rating' please refer to the risk rating table in the final section of this assessment form.

2	**Safety precautions must be taken when entering and working into the confined space** —— Apart from the aforementioned safety precautions required with respect to the risk assessment, the proprietor or contractor must ensure that all the following safety precautions are taken before allowing certified workers to work in confined spaces:
	☐ Every piece of mechanical equipment in the confined space, which is liable to cause danger, has been disconnected from its power source, with warning notice displayed and its power source locked out;
	☐ Every pipe or supply line whose contents are liable to create a hazard has been properly blanked off;
	☐ The confined space has been tested to ensure the absence of any hazardous gas and no deficiency of oxygen;
	☐ The confined space has been adequately purged and sufficiently cooled and ventilated, having regard to the circumstances of the particular confined space, to ensure that it is a safe workplace;
	☐ An adequate supply of respirable air and an effective forced ventilation have been provided inside the confined space;
	☐ Effective steps have been taken to prevent - (i) an ingress to the confined space of hazardous gas, vapour, dust or fume; and (ii) an in-rush into the confined space of free flowing solid or liquid;
	☐ Before entering and working in the confined space, the following air testing of the confined space has been conducted with appropriate air monitoring equipment of explosion-proof design: ☐ Oxygen ☐ LEL ☐ Hydrogen sulphide ☐ Carbon monoxide ☐ Others : ________________; ☐ Continuous air monitoring has to be conducted until everyone has left the confined space;
	☐ Formulated appropriate emergency procedures to deal with any serious and imminent danger to workers inside the confined space, including the provision of a sufficient supply of the following items in a satisfactory condition (and keeping them readily available) (a) approved breathing apparatus; (b) suitable apparatus for reviving an unconscious worker; (c) vessels containing oxygen or air; (d) safety harnesses and ropes; and (e) an audio and visual alarm by which the workers inside the confined space can alert those outside;
	☐ The emergency rescue team is composed of a sufficient number of trained personnel who are ready to carry out emergency procedures in case of accident. All members of the emergency rescue team have been properly and adequately trained in the related emergency rescue procedures, including the details of the emergency rescue plan and full knowledge on how to properly use all the rescue equipment;
	☐ Instructions, training and advice are provided to all workers within a confined space or assisting with such work from immediately outside the confined space to ensure the safety and health of all workers, including posting up or displaying a clearly visible warning sign in a conspicuous place at the entrance to the confined space, indicating the specified hazards and safety precautions taken in the confined space;
	☐ All necessary equipment is provided to ensure the safety and health of workers in the confined space, including the provision of suitable air monitoring equipment of explosion-proof design for continuous air monitoring if necessary;
	☐ Only certified workers are allowed to enter or work in the confined space;
	☐ At least one "Standby Person" is stationed outside the confined space to maintain communication with the workers inside the confined space;
	☐ The risk assessment report and the Permit-to-work Certificate shall be displayed in a conspicuous place at the entrance of the confined space; and
	☐ The safety precautions listed above are effective continuously while the workers remain in the confined space.
	☐ Other safety precautions: ________________________________

I confirmed that I have at least one year of relevant experience, after obtaining registration as Safety Officer or the certificate as Competent Person, in assessing risk to the safety and health of workers working in confined spaces, and have been appointed by the above-mentioned Main Contractor/ Subcontractor/Proprietor to be the competent person to carry out an assessment in the aforesaid confined space works in accordance with section 5(1) of the Factories and Industrial Undertakings (Confined Spaces) Regulation.

I confirmed that, the true to the best of my knowledge and belief, the risk of the working condition in the confined space was assessed according to the requirements of section 5(6) of the Factories and Industrial Undertakings (Confined Spaces) Regulation, and recommendations of control measures were made under the section with respect to the safety and health of workers working in the confined space.

Signature of the Competent Person
conducted the above risk assessment : ______________________

Name : ______________________

Date and time : ______________________

Receipt of the risk assessment report

Recipient signature : ______________________

Name : ______________________

Post : ______________________

Date and time : ______________________

Risk Assessment Table

Likelihood / Consequence	Unlikely (1) (Rather remote, though conceivable)	Possible (2) (Event to be expected)	Very likely (3) (Occurs repeatedly)
Very serious (3) Accident causing immediate danger to life or serious bodily injury (Example: gas poisoning, hypoxia, drowning)	(3) Moderate Risk	(6) High Risk	(9) High Risk
Serious (2) Accident causing moderate bodily injury (Example: fracture, skin ulcer, etc.)	(2) Low Risk	(4) Moderate Risk	(6) High Risk
Mild (1) Accident resulting in mild bodily injury (Example: eye irritation from dust, cough)	(1) Low Risk	(2) Low Risk	(3) Moderate Risk

Pink	High Risk
Yellow	Moderate Risk
Green	Low Risk

Appendix 2

Permit-to-work Certificate

A Template of "Permit-to-work Certificate" for Entry into Confined Space

Location of work : ______________________________

Description of work : ______________________________

Main Contractor/Proprietor : ______________________________

Name of the Competent Person appointed : ____________________

Date and time of risk assessment : ____________________

Date & time for entry to the confined space : ________(Year) _____ (Month) _____ (Day) from _____ *am/pm (Time)

This permit-to-work certificate is valid until : ________(Year) _____ (Month) _____ (Day) _____*am/pm (Time)

* Please delete if not applicable

Workers				
	Certified Worker			
	Maximum duration that certified workers are allowed to stay in the confined space : _____ Hour(s)			
	Name	Reference No. of Certificate	Validity Period	Signature
	Standby Person			
	Name	Date of training	Responsibility	Signature
			✓ Maintain communication with the workers inside the confined space, and call for support in case of emergency; ✓ Brief the rescue personnel of the relevant circumstances of the incident upon their arrival in case of emergency; ✓ Even in case of emergency, the standby person should not enter the confined space.	
	Onsite Rescue Personnel			
	Name	Date received training for rescue in emergency	Responsibility	Signature
			✓ Familiar with the details of the emergency rescue plan; ✓ Know how to properly operate all rescue equipment provided.	

Add a ✔ to appropriate boxes ☐

Underground Pipework
☐ This confined space work is underground pipework as described in section 9(b) of the Factories and Industrial Undertakings (Confined Spaces) Regulation, and therefore contractor / proprietor has to ☐ Ensure that any person entering or remaining in that particular confined space is properly i. wearing a suitable approved breathing apparatus; and ii. wearing a suitable safety harness connected to a lifeline. ☐ Use appropriate air monitoring equipment of explosion-proof design to monitor the air in the confined space continuously until everyone has left the confined space; and ____________________ ____________________
☐ This confined space work is **NOT underground pipework** as described in section 9(b) of the Factories and Industrial Undertakings (Confined Spaces) Regulation with the reason(s) stated as follows: ____________________ ____________________
Remarks : Must choose one out of the two options above

Isolation Measures		
	Signature	Date & time
☐ Normal services in the confined space have been suspended.		
☐ All unnecessary sources of power (Electrical/ Mechanical/ Pneumatic/ Hydraulic/ Others: __________) have been isolated.		
☐ All pipelines connected to the confined space have been completely shut off or blanked off		
☐ The ends of all service pipes connected to hazardous gas sources have been sealed.		
☐ Non-essential heat sources have been isolated.		
☐ Other sources of danger have been isolated (please specify ________).		
☐ All isolated or closed connections have been locked off and properly labelled to prevent from being opened without authorisation or accidentally.		

Purging and Ventilation Control Measures		
	Signature	Date & time
☐ The confined space has been purged/cleaned adequately. (Method : ____________________)		
☐ All hazardous substances stored inside the confined space have been removed.		
☐ Adequate respirable air and effective forced ventilation have been provided.		

Add a ✔ to appropriate boxes ☐

Air Testing Results
Testing Date (YYYY/MM/DD) : ______________________ Model of air monitoring equipment : __________________ Serial number of air monitoring equipment : ____________ Calibration Expiry Date (YYYY/MM/DD) : _______________
Testing Location : ________________________________ Testing Time : __________*am/pm ☐ O_2 : __________ % ☐ LEL(Percentage) : __________ % ☐ H_2S : __________ ppm ☐ CO : __________ ppm ☐ ______________________
Testing Location : ________________________________ Testing Time : __________*am/pm ☐ O_2 : __________ % ☐ LEL(Percentage) : __________ % ☐ H_2S : __________ ppm ☐ CO : __________ ppm ☐ ______________________
Testing Location : ________________________________ Testing Time : __________*am/pm ☐ O_2 : __________ % ☐ LEL(Percentage) : __________ % ☐ H_2S : __________ ppm ☐ CO : __________ ppm ☐ ______________________
☐ After the air testing, I confirm that there is no hazardous gas and no oxygen-deficient situation in this confined space. Responsible person for conducting the air testing Name : ______________________ Signature : ______________________

Add a ✔ to appropriate boxes ☐

Safety Precautions for Entry into the Confined Space
☐ Every piece of mechanical equipment in the confined space, which is liable to cause danger, has been disconnected from its power source, with warning notice displayed and its power source locked out;
☐ Every pipe or supply line whose contents are liable to create a hazard has been properly blanked off;
☐ The confined space has been tested to ensure the absence of any hazardous gas and no deficiency of oxygen;
☐ The confined space has been adequately purged and sufficiently cooled and ventilated, having regard to the circumstances of the particular confined space, to ensure that it is a safe workplace;
☐ An adequate supply of respirable air and an effective forced ventilation have been provided inside the confined space;
☐ Effective steps have been taken to prevent - (i) an ingress to the confined space of hazardous gas, vapour, dust or fume; and (ii) an in-rush into the confined space of free flowing solid or liquid;
☐ Formulated appropriate emergency procedures to deal with any serious and imminent danger to workers inside the confined space, including the provision of a sufficient supply of the following items in a satisfactory condition (and keeping them readily available): (a) approved breathing apparatus; (b) suitable apparatus for reviving an unconscious worker; (c) vessels containing oxygen or air; (d) safety harnesses and ropes; and (e) an audio and visual alarm by which the workers inside the confined space can alert those outside;
☐ The emergency rescue team is composed of a sufficient number of trained personnel who are ready to carry out emergency procedures in case of accident. All members of the emergency rescue team have been properly and adequately trained in the related emergency rescue procedures, including the details of the emergency rescue plan and full knowledge on how to properly use all the rescue equipment;
☐ Instructions, training and advice are provided to all workers within a confined space or assisting with such work from immediately outside the confined space to ensure the safety and health of all workers, including posting up or displaying a clearly visible warning sign in a conspicuous place at the entrance to the confined space, indicating the specified hazards and safety precautions taken in the confined space;
☐ All necessary equipment is provided to ensure the safety and health of workers in the confined space, including the provision of suitable air monitoring equipment of explosion proof design for continuous air monitoring if necessary;
☐ Only certified worker is allowed to enter or work in the confined space;
☐ At least one "Standby Person" is stationed outside the confined space to maintain communication with the workers inside the confined space;
☐ The risk assessment report and this permit-to-work certificate should be displayed in a conspicuous place at the entrance of the confined space;
☐ The safety precautions listed above are effective continuously while the workers remain in the confined space;
☐ Video recording at the entrance and exit of the confined space throughout the entire work period is arranged to monitor that relevant personnel have complied with the safety precautions.

Add a ✔ to appropriate boxes ☐

Emergency Rescue Equipment Provided

☐ Approved breathing apparatus : ____________ set

☐ Apparatus for reviving an unconscious worker : ____________ set

☐ Vessels containing oxygen or air : ____________ set

☐ Safety harnesses and ropes : ____________ set

☐ Audio and visual alarm by which the workers inside the confined space can alert those outside : ____________ set

☐ Other relevant emergency rescue equipment, including : ☐ Tripods and winches; ☐ ______________________________

☐ I confirm that the above emergency rescue equipment is sufficient with satisfactory condition and are readily available.

List of Protective Equipment Provided

General

☐ Forced ventilation device : ____________ set

☐ Continuous air monitoring equipment : ____________ set

☐ Walkie-talkie (explosion-proof design) : ____________ set

☐ Shield : ____________ set

☐ Lighting device : ____________ set

☐ Others (Please specify) : ______________________________

Personal Protective Equipment

☐ Approved breathing apparatus : ____________ set (excluding for emergency use)

☐ Audio and visual alarm : ____________ set

☐ Protective clothing : ____________ piece

☐ Head, Hand & Foot Protection : ____________ piece

☐ Life Lines & Harness : ____________ set

☐ Eye Protection : ____________ set

☐ Ear Protection : ____________ set

☐ Others (Please specify) : ______________________________

Declaration by the Proprietor/Contractor or Authorised Representative

Permit-to-work Certificate

I am the proprietor/ contractor/ authorised representative* of the confined space work mentioned above. I confirm that the risk assessment report by the competent person mentioned above covers all matters stated in section 5(2) of the Factories and Industrial Undertakings (Confined Spaces) Regulation, and I certify that all necessary safety precautions in accordance with the risk assessment report have been taken, and I hereby, issue this Permit-to-work Certificate.

This permit-to-work certificate is valid until (Date & Time):

_________(Year) ______(Month)______ (Day) ______ *am/pm (Time)

Signature : ___________________________

Name : ___________________________

Post : ___________________________

Date & time : ___________________________

* Please delete if not applicable

Receipt of Permit-to-work Certificate

(To be filled by the supervisor or person in-charge of the work)

I have read and understood the content of the Permit-to work Certificate, and shall undertake to work in accordance with all the conditions laid down in this certificate.

Signature : ___________________________

Name : ___________________________

Post : ___________________________

Date & time : ___________________________

Proof of Completion

(To be filled by the supervisor or person in-charge of the work)

I confirm that the confined space work mentioned above has been completed and that all assigned persons, materials and equipment have been withdrawn from the site, the personnel have been warned that the confined space is no longer safe for entry and I hereby sign to confirm.

Signature : ___________________________

Name : ___________________________

Post : ___________________________

Date & time : ___________________________

Cancellation of Permit-to-work Certificate

I am the proprietor/ contractor/ authorised representative* of the confined space work mentioned above. I hereby sign to confirm the cancellation of this Permit-to-work Certificate. I understand that a new permit-to-work certificate will be required if work is to be continued.

Signature : ___________________________

Name : ___________________________

Post : ___________________________

Date & time : ___________________________

* Please delete if not applicable

Setting Up Air Monitoring Alarm

Appendix 3

1. Working in confined space can pose risks to the safety and health of workers, including atmospheric hazards. Typical situations that cause loss of consciousness or ability to escape due to atmospheric hazards include: (1) concentrations of flammable or explosive gases or vapours, etc. exceeding their Lower Explosive Limit (LEL), (2) concentrations of toxic or harmful substances in the air exceeding their Occupational Exposure Limit (OEL) or Immediately Dangerous to Life or Health (IDLH) concentrations, and (3) the air becoming oxygen-enriched or deficient. For detailed information on common hazardous gases/chemicals in confined spaces and occupational hygiene standards, please refer to paragraphs 11 to 16 below.

2. Examples of possible atmospheric hazards in confined spaces include:
   - Fire or chemical spill happens in confined spaces;
   - Failure of the ventilation or fresh air supply systems in confined spaces;
   - Fire or chemical spillage happens outside confined spaces, which could affect the quality of fresh air intake;
   - Disturbance of the sewage, sediment, or sludge can release the trapped or dissolved hydrogen sulphide gas, etc., thus rising the concentration of the hazardous gases in the air rapidly; and
   - Use of volatile chemicals in confined spaces, etc.

3. A number of hazardous gases, such as carbon monoxide, are colourless and odourless. On the other hand, some hazardous gases like hydrogen sulphide may have an unpleasant smell at low concentrations, but such smell disappears at higher concentrations due to olfactory fatigue. It can be very wrong and dangerous if workers think they can recognise the presence of hazardous gases by scent. In certain situations, competent person may recommend continuous monitoring or periodic monitoring of the working environment. Workers should be equipped with continuous air monitoring equipment that provides audio and visual alarms, where applicable, in order to immediately alert the workers and standby persons the imminent situations regarding the air quality and presence of hazardous gases in confined spaces, and activate evacuation or arrange rescue as soon as possible.

4. The air monitoring equipment should have a two-level alarm system to alert workers to take appropriate actions correspondingly. Level 1 Alarm is a warning level indicating that there is a threat of atmospheric hazards, but the situation of worker is still safe. Action should be taken to determine the cause of the threat and implement appropriate remedial measures. Under normal circumstances, when

reaching Level 2 Alarm level, it indicates the atmospheric hazards pose risks to the workers, the emergency procedures should be activated, and the workers should be evacuated immediately.

Flammable or Explosive Substances in Air

5. The alarm for the presence of flammable or explosive gases is generally set using the Lower Explosive Limit (LEL). Level 1 Alarm (Warning) for the lower explosive limit should be set at 5% LEL, and Level 2 Alarm (Evacuation) should be set at 10% LEL. If a flammable or explosive substance has toxic/harmful properties simultaneously, the lower concentration of the two shall be used as the criterion for setting the alarm. For example, hydrogen sulphide must set the alarm at the concentration of its toxicity.

Toxic or Harmful Chemcial Substances in Air

6. The setting of alarm levels for toxic or harmful chemicals in the air should make reference to the Occupational Exposure Limits if underground pipework is not involved and an approved breathing apparatus is not required as indicated in the risk assessment report. In this connection, the alarm levels for toxic or harmful chemicals in the air should be set as follows:

Level 1 Alarm§	Half of Occupational Exposure Limit - Short-Term Exposure Limit *[or 1.5 times of Occupational Exposure Limit - Time-Weighted Average¶]*
Level 2 Alarm§	Occupational Exposure Limit - Short-Term Exposure Limit *[or 3 times of Occupational Exposure Limit - Time-Weighted Average¶]*

§ Alarm settings for measuring instruments should be rounded down to the nearest integer.

¶ Only applicable to chemicals for which OEL-STEL have not been established.

7. In normal circumstances, properly worn approved breathing apparatus can provide a good protection to workers against atmospheric hazards but it is not entirely fail-safe. When workers are using approved breathing apparatus to enter confined spaces, it is a prudent approach to set Level 1 Alarm at half of IDLH concentration of the toxic or harmful chemical substance and Level 2 Alarm at the corresponding IDLH. For example, Level 1 and Level 2 Alarms for hydrogen sulphide gas can be set at 50ppm and 100ppm respectively.

8. Under the Factories and Industrial Undertakings Ordinance, it shall be the duty of every proprietor to ensure the provision and maintenance of a working environment for the proprietor’s workers that is, so far as is reasonably practicable, safe, and without risks to health. In this regard, the proprietor should eliminate or substitute the atmospheric hazards and/or implement vigorous and robust engineering control measures to reduce the level of hazardous gases to below IDLH as far as possible

rather than relying heavily on the use of personal protective equipment ("PPE"). The use of PPE should always be regarded as the last resort in the hierarchy of control measures, and is a supplement to, not in lieu of, effective engineering control measures and safe system of work. In rare circumstances where elimination or substitution is not possible and vigorous and robust engineering control measures adopted cannot reduce the level of hazardous gases below IDLH, the proprietor should consult occupational health professionals, in addition to the competent person appointed, to review the work situation and to develop and fully implement a written respiratory protection programme with required worksite-specific procedures and elements for required respirator use which is commensurate with the respiratory protection standards, 29 CFR 1910.134, required by the Occupational Safety and Health Administration, U.S. Department of Labor, to ensure the safety and health of the certified workers working in such high risk situation.

Excessive Level of Oxygen or Oxygen Deficiency in Air

9. There are about 21% by volume of oxygen in air under normal atmospheric pressure. A decrease in the percentage of oxygen in air can result in an oxygen-deficient environment, which can asphyxiate workers. Conversely, a high percentage of oxygen in air increases the risk of causing fires and explosions. Therefore, alarm thresholds for oxygen content in air (measured by volume) are set at 19.5% and 22% to warn workers of oxygen deficiency or excessive oxygen level environments respectively. Whenever the oxygen content alarm is activated, immediate evacuation should be carried out.

Setting Air Monitoring Alarm

10. The alarm levels for some common hazardous gases that can be encountered in confined spaces are recommended as follows:

For workers without using approved breathing apparatus to enter confined spaces	CH_4	H_2S	CO
Level 1 Alarm	5% LEL	7ppm	37ppm
Level 2 Alarm	10% LEL	15ppm	75ppm

Common Hazardous Gas in Confined Space and Occupational Safety and Hygiene Standards

11. Lower Explosive Limit (LEL) – LEL is the lowest concentration of a substance that will produce a flash fire or explosion when an ignition source (flame, spark, etc.) is present and is expressed in percent of vapour or gas in the air by volume.

12. "Occupational Exposure Limit (OEL)" refers to the airborne concentration(s) of

individual chemical substances that represent levels that are regarded to impose no adverse health effects to nearly all workers on exposures by the route of inhalation. “Occupational Exposure Limit - Time - Weighted Average (OEL-TWA)” refers to the time-weighted average concentration of a chemical substance over an eight-hour working day for a five-day workweek, to which nearly all workers can be exposed day after day without adverse health effects. “Occupational Exposure Limit - Short-Term Exposure Limit (OEL-STEL)” refers to the 15-minute time-weighted average of the airborne concentration of a chemical substance. A list of OEL for chemical substances can be found in the “Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace” published by the Labour Department.

13. Under the situation of Immediately Dangerous to Life or Health (IDLH) concentrations, there will be an immediate or delayed threat to life, or it may cause irreversible health effects or impairment of the ability to escape. For IDLH concentrations, please refer to the values developed by the Ministry of Health of the People’s Republic of China or the National Institute for Occupational Safety and Health (NIOSH) of the United States of America.

14. Hydrogen Sulphide (H_2S) is a deadly gas with a distinctive “rotten egg” odour that can be detected at very low concentrations. At concentrations above 100 ppm, hydrogen sulphide has a paralysing effect on the sense of smell. Even at lower concentrations, hydrogen sulphide can affect the olfactory nerve, and workers cannot detect the changes in concentrations. It can be produced and accumulated in confined spaces such as septic tanks, manholes or sewers. Hydrogen sulphide is heavier than air and thus settles in lower part of the confined space such as the bottom of manholes or sewers.

Hydrogen Sulphide (in ppm)	Effect/ Exposure Limit
Less than 1	Smells like rotten eggs
10	OEL-TWA
15	OEL-STEL
50-100	Paralysis of the olfactory nerve, irritation to the eye and respiratory tract, and inhalation may result in lung oedema that causes death
100	IDLH

15. Carbon Monoxide (CO) is a lethal colourless and odourless gas. Carbon monoxide is a product of incomplete combustion. When gasoline/diesel generators or other fuel-driven tools are used in inadequately ventilated workplaces, oxygen can also be consumed, and carbon monoxide can be produced and accumulated.

Carbon Monoxide (in ppm)	Effect/ Exposure Limit
25	OEL-TWA
350	Confusion, fainting on exertion and collapse
1200	IDLH

16. Methane (CH_4) is commonly generated when organic matter is decomposed by various bacterial processes. It is a colourless, odourless, extremely flammable and explosive gas that can cause fire and explosion. The accumulation of methane in a poorly ventilated area will displace normal air and result in an oxygen-deficient environment. Typical air monitoring equipment for confined spaces does not directly measure methane concentration. Instead, users can determine the presence of methane through the oxygen concentration and LEL. Methane is lighter than air and thus will accumulate in the upper part of the confined space.

Occupational Safety and Health Branch
Labour Department

Annex 6

Course Contents for Safety Training Course for Top-Up to Competent Persons of Confined Spaces Operation

Course Contents for

Safety Training Course for Top-Up to

Competent Persons of Confined Spaces Operation

Section 4(2) of the Factories and Industrial Undertakings

(Confined Spaces) Regulation

Occupational Safety and Health Branch
Labour Department

The Course Contents are prepared by
The Occupational Safety and Health Branch
Labour Department

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Information on the services offered by the Labour Department and on major labour legislation can also be found by visiting our Home Page in the Internet.

Contents

1. Introduction to Arrangements of the Course

[Reference teaching time for Section 1: 10 mins]

1.1 Training Venue, Training Equipment and Examination Requirements

- To introduce briefly about the training venue, training equipment and the examination requirements

1.2 Introduction to the Course Contents

- To introduce briefly about the course structure and contents

1.3 Objectives of the Course

Under the Factories and Industrial Undertakings (Confined Spaces) Regulation (Chapter 59AE) (hereinafter referred as the FIU(CS)R), a proprietor or contractor responsible for a confined space work shall appoint a competent person to carry out an assessment of the working conditions in the confined space and make recommendations on measures to be taken in relation to safety and health of workers while working in that space. Being a competent person, the person shall has attained the age of 18 years; and who is a registered safety officer or has successfully completed the relevant training course to prepare risk assessment reports and been issued with a relevant certificate recognized by the Commissioner for Labour; as well as having one year's relevant post-registration or post-training experience.

Upon successfully completing the course and passing the examination, the trainee should be issued with a certificate in a format to be specified by the Commissioner. At the end of the course, the trainees should be able to:

- Describe the basic legal requirements prescribed under relevant safety legislation applicable to confined spaces;
- Describe the nature and potential harmful effects of hazards that are likely to be present when working in confined spaces;
- Conduct a risk assessment, make recommendations on measures to be taken and prepare an appropriate report pertaining to working in confined spaces;
- Devise a safe system of work as a follow-on action from the risk assessment report, the system of work must include measures to minimize the risk of

injuries arising from the hazards;

- Describe possible emergency situations arising from working in confined spaces, appropriate response procedures and limitations of such procedures;
- Describe the types, principles, operations, purposes and limitations of safety equipment to be used when working in confined spaces;
- Familiarize and practise the correct and proper use of safety equipment to be used when working in confined spaces; and
- Describe past accidents (including causes and related preventive measures) associated with working in confined spaces. The accidents should include alarming and/or serious nature ones.

2. Risk Assessment

[Reference teaching time for Section 2: 225 mins]

2.1 Principles and Process of Risk Assessment

- The objective of risk assessment and risk control is to provide a means whereby job hazards or potential hazards are identified, evaluated and managed in a way that eliminates them or reduces them to a tolerable level. Safety procedures and risk control measures that are to be taken to prevent the hazards and to control the risks should be developed after risk assessment.
- There are five stages in risk assessment and risk control, namely:
  (1) identification of hazards;
  (2) determination of risk;
  (3) development of safety procedures and risk control measures;
  (4) implementation and maintenance of safety procedures and risk control measures; and
  (5) review of safety procedures and risk control measures.

<u>Hazard identification</u>

- Hazard identification is the process of identifying all situations or events that could give rise to the potential for injury, illness or damage to plant or property. Hazard identification should take into account how things are being done, where they are done and who is doing them, and should also consider how many people are exposed to each hazard identified and for how long.
- The following should be accorded top priority in the hazard identification process:
  - ■ High frequency accidents or near misses
    Jobs with a high frequency of accidents or near misses pose a significant threat to the safety and health of workers and should therefore be given top priority.
  - ■ History of serious accidents causing fatalities
    Jobs that have already produced fatalities, disabling injuries or illnesses, regardless of the frequency, should have a high priority in the hazard identification process.
  - ■ Existence of a potential for serious harm
    Jobs that have the potential to cause serious injury or harm need hazard

analysis, even if they have never produced an injury or illness.

- Introduction of new jobs

  Whenever a new job is introduced, a hazard identification process should be conducted before any worker is assigned to it.

- Recent changes in procedures, standards or legislation

  Jobs that have undergone a change in procedure, equipment or materials, and work affected by new regulations or standards will need risk assessment.

- Major methods for identification of hazards include:
  - Direct observation method

    This involves observing an experienced worker with good safety awareness carrying out the work several times. The job steps and the hazards in each of these are recorded.

  - Recall method

    This should be done for jobs that are rarely performed. The method involves inviting the designers, engineers, supervisors and workers involved in the jobs to attend a brainstorming session, during which they would look into the materials, machines and equipment used, and the job steps to identify the hazards inherent in such jobs.

- In order to identify hazards and evaluate their associated risks, it should be in the first place prepare a list of items covering premises, plant, people, procedures and materials used, etc. and gather information about them. When all the necessary information is in hand, the hazards related to work activities can be identified.

Determination of risk

- The risk associated with a hazard is a reflection of the likelihood that the hazard will cause harm and the severity of that harm. The two elements of risk, i.e. likelihood and severity, are independent of each other. The vast majority of hazards are relatively straightforward and requiring only a simple method of risk rating. The method incorporates a judgment as to whether or not a risk is tolerable. Such a method is illustrated as follows:
  - For each hazard identified, ask the question "What if?". Realistically, what is the worst likely outcome (i.e. the potential severity of harm)? Is it a fatality, major injury/permanent disability including permanent ill health,

a minor injury, or no injury and only plant damage?

- For the purpose of determination of risk, the severity of harm can be divided into 3 categories:

(1) Mild:
  - accident resulting in mild bodily injury;
  - example: eye irritation from dust, cough, etc.

(2) Serious Harmful:
  - accident causing moderate bodily injury;
  - example: fracture, skin ulcer, etc..

(3) Very serious:
  - Accident causing immediate danger to life or serious bodily injury;
  - Example: gas poisoning, hypoxia, drowning.

- Make a judgment about the probability or likelihood of harm occurring based on the following table:

Probability/likelihood	Description
Very likely	Occurs repeatedly
Possible	Event to be expected
Unlikely	Rather remote, though conceivable

- Decisions as to whether or not action is needed should then be made by reference to the matrix formed by probability/likelihood and the likely outcome (i.e. severity) which is usually called the Risk Level Estimator. The following table illustrates a Risk Level Estimator:

Risk Level Estimator

	Unlikely	**Possible**	**Very likely**
Very serious	Moderate Risk	High Risk	High Risk
Serious	Low Risk	Moderate Risk	High Risk
Mild	Low Risk	Low Risk	Moderate Risk

- Action should be taken according to a list of priority. High risks should be accorded the first priority, moderate risks the second priority; low risks the third priority and so on. In deciding whether a risk is tolerable, the proprietor or contractor has to take into account whether the condition is within statutory limits and/or conform to legal or internationally recognised standards. Only when these limits and standards are met and the risk is at, or has been reduced to, the lowest possible level that is reasonably practicable should a risk be considered tolerable.

<u>Development of safety procedures and risk control measures</u>

- Safety procedures and risk control measures are procedures and measures to be put in place to reduce risk to a tolerable level.
- When deciding on safety procedures and risk control measures, the list below should be considered, in the order given. Safety procedures and risk control measures lower down the list should only be used if it can be shown that using a procedure and/or measure higher up the list is not reasonably practicable.
  - List of safety procedures and risk control measures:

(1) Procedures and measures to eliminate hazards at source:
For example, using a non-hazardous substance instead of a hazardous one.

(2) Procedures and measures to reduce hazards at source:
For example, replacing a noisy machine with a quieter one.

(3) Procedures and measures to remove workers from the hazard:
For example, paint spraying by unattended robots.

(4) Procedures and measures to contain hazards by enclosure:
For example, installing sound proofing enclosure for a noisy machine.

(5) Procedures and measures to reduce worker exposure:
For example, reducing exposure to noise by reducing the hours of work.

(6) Procedures and measures to ensure the proper use of personal protective equipment as the last resort:

For example, using hearing protectors for workers operating noisy machines.

Implementing and maintaining safety procedures and risk control measures

- For safety procedures and risk control measures to be implemented effectively and efficiently, they should be as far as practicable developed at the workplace with the participation of all levels of staff. Feedback from people implementing the safety procedures and risk control measures should be encouraged so that improvement to the procedures and measures can be made.
- Maintaining safety procedures and risk control measures requires scheduled inspections and maintenance. It also requires the enforcement of discipline to ensure that people do not tamper with safety procedures and risk control measures (e.g. by removing machine guards).

Review of safety procedures and risk control measures

- Whatever safety procedures and risk control measures are used, they should be reviewed if there is reason to suspect that they are no longer effective, or if there has been a significant change in the matters to which they relate.

  Examples are:

  (1) When information is obtained about a previously unknown design or manufacturing fault, or about a previously unidentified hazard.
  (2) When the design is revised or modified.
  (3) When the system of work associated with the plant is changed.
  (4) When the plant is moved.
  (5) When there is a change to the workplace environment.

  In the circumstances, the risk has to be reassessed and new safety procedures and control measures devised.

2.2 Risk Assessment for Confined Space Work

[An example case with appendix 1 “Risk Assessment Form for Confined Spaces” should be used for demonstration of the process of preparing a risk assessment report]

[This section must be conducted in an interactive manner through discussion with trainees]

- In view of the risk involved, working in confined spaces should be avoided as far as possible.
- Even if workers are in the immediate vicinity of the confined space and perform associated work in that confined space, the proprietor or contractor shall appoint a competent person to assess the reasonably foreseeable risk arising from the work (e.g. releasing of hazardous gases or falling from height, etc.) and make recommendations on measures necessary to ensure the safety and health of workers.
- If it is not reasonably practicable to carry out the work without entering a confined space, then the proprietor or contractor responsible for the work under taken in the confined space must appoint a competent person in accordance with section 5(1) of the FIU(CS)R to carry out a risk assessment to identify the hazards likely to be present in the confined space. Basing on the assessment results, the competent person should make recommendations on necessary safety precautions to be taken, before allowing the workers to enter into and work in that space so as to ensure their safety and health.
- The risk assessment should identify the hazards to the workers entering or working in the confined space, and also, others in the close proximity who may be affected by the work to be carried out, taking into account of important factors such as potential sources of inhalation of hazardous gases, vapours, fumes or lack of oxygen, and other hazards inherent in the work, proposed work methods, industrial plants, materials, and the design of the confined space itself. The competent person should consider not only the hazards arising from the confined space, but also those stemming from the other industrial plants, processes and operations in the vicinity, such as inadvertent contact with or damage to the utilities nearby during the work.
- The process of a risk assessment should include a systematic examination and careful consideration of:
  (1) all the work activities required to be done;
  (2) the previous contents in the confined space;
  (3) the methods by which the work could be done;
  (4) the hazards inherent in the confined space in relation to the work; and

(5) the hazards inherent in the confined space in relation to the method proposed and to the design or construction of the confined space itself (including the layout and location of the confined space).

- Before carrying out the risk assessment:
  (1) all information about the confined space and the work to be done in it should be gathered. For example, there may be information from the engineering drawings, working plans, figures, photos or reports about relevant soil or geological conditions.
  (2) The appointed competent person should conduct site investigation to have a more thorough knowledge of the location nature and circumstances of the confined space, particularly, its effect on safety and health matters.
- For identifying all the possible hazards which may be present in the confined space and evaluating fully the extent of all those associated risks, the risk assessment shall cover the following aspects:
  (1) the work method to be used and the plant and materials to be used in work activities;
  (2) whether or not there is any hazardous gas, vapour, dust or fume present;
  (3) whether or not there is any deficiency in oxygen;
  (4) the possibility of ingress of hazardous gas, vapour, dust or fume;
  (5) the possibility of sludge or other deposits being present that are liable to give off hazardous gas, vapour, dust or fume;
  (6) the possibility of in-rush of free flowing solid or liquid;
  (7) the possibility of fire or explosion in the confined space; and
  (8) the possibility of loss of consciousness of a certified worker arising from an increase in body temperature.
- The risk assessment report shall also cover the following:
  (1) the recommendations on the measures required, including whether or not the use of approved breathing apparatus is necessary, having regard to the nature and duration of the work to be performed therein; and
  (2) the period during which workers may remain safely in the confined space.
- Where sludge or other deposits are present, and a competent person considers that there is a possibility that they will give off hazardous gas, vapour, dust or fume, he shall recommend the use of an approved breathing apparatus. It should be noted that if there are sludge or other deposits present, it is

generally very likely for the trapped or dissolved gases such as, hydrogen sulphide, to be released during confined space work, especially drainage works.

- A competent person, in evaluating the extent of the risks in a confined space, shall recommend the use of suitable monitoring equipment and specify how the equipment shall be used if he deems that there is a substantial likelihood of environmental changes occurring in the confined space during work that would increase the risks associated with the hazards.
- The size and number of access and egress points of a confined space:
  (1) should be assessed individually taking into the account of the activities to be carried out and the number of people involved.
  (2) due consideration should be given to the possible difficulties for access to and rescue from the confined space when determining the locations of manholes or openings to vessels, tanks, etc.
  (3) there may be occasions when access and egress are so tortuous that temporary openings are needed. Different criteria should be applied when determining manhole dimensions for a confined space that extends over a significant length or height (such as sewers, pipes, culverts, small tunnels or shafts). Measures to improve access pathways, such as structural alterations to the confined space could be considered. If the distance between manholes on drainages is considerably long, it may affect both the degree of natural ventilation and the efficiency of rescue operations.
- The recommendations on the necessary safety measures must include whether the use of approved breathing apparatus is necessary so that the workers can safely stay inside the confined space. When there is any doubt about atmospheric hazards, suitable and approved breathing apparatus must be used and the other necessary safety precautions must be taken accordingly.
- When workers enter a confined space to carry out underground pipework, there may be additional hazards, particularly atmospheric hazards. Therefore, a proprietor or contractor and a competent person should determine whether the work involving entry into the confined space relates to underground pipework. If underground pipework is involved, the workers must properly wear an approved breathing apparatus and use a suitable safety harness connected to a lifeline in accordance with section 9 of the FIU(CS)R.

- When making recommendations regarding a confined space work, an important consideration is how the worker can be safely rescued from the confined space in case of emergency.
- During the risk assessment, if the competent person considers that the working environment may change adversely, he must recommend continuous monitoring or periodic monitoring of the working environment. The purpose of air monitoring is to ensure that the ventilation is adequate and that the atmosphere hazards inside the confined space are within an acceptable level. The requirement for testing, retesting and monitoring must be determined by the competent person.
- In case it is possible that flammable or explosive gases or vapours would be present in the confined space, the equipment for atmospheric monitoring of the gases or vapours should be of the explosion proof type. It should have both visual and audible alarms so that it can alert workers if a hazardous situation exists or is developing in the confined space.
- All the monitoring equipment used in connection with the atmospheric monitoring should be properly maintained and be calibrated periodically as per the recommendation of the manufacturer or supplier for accurate testing functions.
- For precautions on air testing and monitoring and exposure limits for air impurities, please refer to Appendix 5 and the “Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace” and “Air Monitoring in the Workplace” published by the Labour Department.
- When there is any circumstance indicating that the risk assessment is no longer valid or work arrangement has significantly changed, the work must be stopped. All workers must be evacuated immediately and the risk assessment should be reviewed. Workers must not enter the relevant confined space unless the work environment is confirmed to be safe.
- The risk assessment for confined space work should be repeated whenever necessary. The proprietor or contractor shall appoint a competent person to carry out a fresh risk assessment and make recommendations whenever there has been a significant change in the conditions of the confined space or of the work activities therein to which the previous assessment relates, or where there is reason to suspect that such change may occur, and that the change is likely to affect the safety and health of the workers therein. Such changes may

include, e.g. for sewers, the increase in the level of sewage or storm-water due to sudden rainfall, the increase in tide level, the evolution of toxic gas due to disturbance of sludge or deposits in the place, etc. Risk assessment should also be repeated if there is any reason to suspect that the previous assessment is no longer valid.

- The risk assessment and related work arrangements should be reviewed regularly and in a timely manner. When carrying out long-term projects inside confined space, even in the absence of significant changes, the proprietor or contractor should conduct regular reviews (e.g., at least once a month) of the work environment and processes to ensure that the risk assessment and recommendations remain valid.
- A competent person shall record all significant assessment results in the risk assessment report, which includes (but not limited to) the hazards identified, the necessary safety precautions to be taken, the type and the number of workers being affected, the period during which workers may remain safely in the confined space and the relevant personal particulars of the competent person who was responsible for carrying out the risk assessment.
- The competent person must make available the risk assessment reports and recommendations to the proprietor or contractor within a reasonable time after the request for the reports and recommendations was made by the proprietor or contractor, but it must be given before the proprietor or contractor allows the workers to enter into the confined space.
- The completed risk assessment report for confined space work shall be submitted to the proprietor or contractor of the industrial undertaking for his consideration for the issue of a “permit-to-work certificate” before the confined space work is carried out.
- After the risk assessment has pointed out the hazards and relevant recommendations on safety precautions, the proprietor or contractor shall verify that such risk assessment report covers all matters referred to in section 5(2) of the FIU(CS)R, and formulate the method statement for the confined space works.
- The method statement should record details of all relevant processes, work procedures, safety precautions, relevant equipment, workers’ qualifications and training requirements, etc., and include the implementation of a permit-to-work system.

- There may be other work-related hazards for working in confined spaces arising out of, for example, electricity, welding, dangerous substances, noise and dust, etc. The competent person should recommend necessary safety precautions for work to be carried out in confined space having regard to the usually restrictive, and sometimes electrically conductive, nature of a confined space.
- The competent person appointed to carry out risk assessment should assist the proprietor or contractor in assessing whether the confined space work is an underground pipework to ensure compliance with section 9(b) of the FIU(CS)R, i.e. where a person has to enter a confined space for underground pipework, the proprietor or contractor should ensure that a person entering or remaining in that confined space is properly wearing an approved breathing apparatus, and the person is wearing a suitable safety harness connected to a lifeline so that the person can be pulled out of the confined space in an emergency. To assess whether a work is an underground pipework, factors to be considered include (1) whether the work is conducted inside a confined space; (2) whether the aforesaid confined space is underground; and (3) whether the work involves any pipework which would have specified risk associated with atmospheric hazard.

2.3 Points should be noted when conducting drainage works in confined spaces

To assist competent person to have a detailed grasp of the risk assessment of drainage works, following are the points should be noted when conducting risk assessment for confined space (drainage works):

2.3.1 To determine whether a work is an underground pipework

- Typical underground pipework includes (1) workers are required to enter any underground drains or their associated manholes that may pose atmospheric hazards, which have been classified as confined spaces, to carry out inspection or maintenance of drainage works, etc.; or (2) workers are required to enter any underground confined spaces that may pose atmospheric hazards for inspection or maintenance work of pipes. We must note that whether the nature of a confined space work is underground pipework or not can, under no circumstances, be changed by taking any control measures. The competent person appointed to carry out risk assessment should assist the proprietor or contractor in assessing whether the confined space work is an underground pipework to ensure compliance with section 9(b) of the FIU(CS)R.

2.3.2 Collection of all relevant information of the drainage works

- The competent person appointed to carry out risk assessment should understand the work methods to be employed, the plant and materials to be used, and the physical layout and surrounding environment of the drainage worksite. This can be done by conducting an on-site survey and studying the relevant information of the underground facilities, drawings and work plans.
- The competent person should identify and assess all the potential atmospheric hazards that may exist before the work begins as well as those that may emerge in the course of the work. Even if hazardous gases, fumes and vapours may not be present initially, they may be released while the work is in progress inside the drainage. For example, if sludge or sewage containing hydrogen sulphide is disturbed, the hydrogen sulphide gas will be released quickly and accumulated in the confined space to hazardous levels. Also, sudden ingress of hazardous gases to newly built drainage from existing sewers is not uncommon.

2.3.3 Determination of the presence of sludge or other deposits

- The competent person is required to assess the presence of sludge or other deposits in the confined space. When there is a possibility that the sludge or deposits will give off hazardous gas, vapour, dust or fume, the competent person should recommend the use of approved breathing apparatus. When there are sludge or deposits present in the drainage works site, the trapped or dissolved hazardous gases such as hydrogen sulphide are very likely to be released due to disturbance of the sludge, sediment or sewage during work, thus increasing the risk of gas poisoning. In this circumstance, the competent person must recommend the use of approved breathing apparatus by workers in the risk assessment, and recommend the use of suitable air monitoring equipment (should be explosion-proof type) for continuous air monitoring in the confined space until everyone leaves the confined space. The preferred method of continuous air monitoring is carrying suitable air monitoring equipment by certified workers working inside confined spaces.

2.3.4 Assessment of atmospheric hazards

- Air monitoring in confined space should be conducted by a person with appropriate training and experience, e.g. competent persons including registered safety officers with at least one year of experience in air monitoring in confined spaces, occupational hygienists, etc. Air monitoring includes pre-entry air testing and air monitoring during the work.
  - The competent person shall recommend continuous air monitoring if the risk assessment shows that there could be adverse changes in atmospheric conditions.
  - The competent person shall state in the recommendation whether the use of approved breathing apparatus is necessary and the period within which workers may safely remain in the confined space.
- Air monitoring does not end with the pre-entry test. Since atmospheric conditions within a drainage workspace can change rapidly, it is necessary to perform continuous air monitoring to ensure that the air quality remains acceptable throughout the work. Each group of workers (at the same working location) should bring alone with at least one portable air monitoring equipment to conduct continuous air monitoring during drainage work. The equipment should be checked to ensure that it is calibrated, functioning properly and with sufficient power to operate before the workers enter the drainage.
- A "re-entry" test should be conducted if the workers have temporarily left the space. In fact, "re-entry" testing and pre-entry testing should be performed in exactly the same manner and should be considered equally important. In case the alarm of the air monitoring equipment is activated or any other indication of danger is observed, workers should leave the work space immediately according to the emergency procedures.
- Please note the following important points on the use of air monitoring equipment:
  - Only properly maintained and calibrated equipment should be used for air testing. Unscientific methods such as throwing a flame down the manhole, and observing the presence of living organisms or the colour of the manhole are unreliable.
  - The most common configuration for a multiple-sensor air monitoring

equipment is one that can show the readings of oxygen, combustible gases, hydrogen sulphide and carbon monoxide. Never assume that the hazardous gases present in the drainage are limited to these gases. Different or additional air monitoring equipment is required for other hazardous gases (e.g. chlorine) that may be present in the drainage.

- The proper functioning of the air monitoring equipment should be tested before use according to the manufacturer's instructions, i.e. functional or bump/challenge test.
- The atmosphere in the drainage should, as far as practicable, be tested by using remote probes and sampling lines connected to direct-reading instruments placed outside the drainage.
- The atmosphere around the working position of the person carrying out the air monitoring should be tested first to ensure his safety and health during the air monitoring.
- In general, testing for oxygen should be performed first because some gas sensors are oxygen dependent and could give unreliable readings in oxygen deficient situations. Even though it may still be sufficient for survival, any depletion of oxygen should be further investigated.
- Testing of the atmosphere inside the drainage should be done from the top to the bottom of the confined space, preferably at about 1-metre intervals. Sampling for a few minutes at each location is required as there will be a time lag for the gas to be pumped from the sampling probe to the monitoring equipment.
- Record the results with the time and location of the atmospheric monitoring in the risk assessment.
- Air monitoring must be conducted again when there is any potential change in the atmospheric conditions.

2.4 Exercises in Preparation of Risk Assessment Report

[This section must be conducted in an interactive manner through discussion with trainees]

[Risk assessment reports completed by trainees should be collected and checked to facilitate the interactive discussion]

[Model answers of risk assessment reports should be provided to trainees to facilitate the interactive discussion]

- Exercises：Every trainee should prepare one to two risk assessment reports.

- Cases for the exercises:

  - The accident cases associated with confined spaces operation (in particular those occurred during the three years preceding the conduct of the course)

    or

  - The accident cases associated with confined spaces operation published by Labour Department (e.g. “Poisoning in manhole sewer” and “Poisoning in metal duct” in “Brief Analysis of Site Accident Cases”, etc.).

3. Air Testing Procedures and Points to Note

[Reference teaching time for Section 3: 35 mins]

[Demonstrate using the real multiple-sensor air monitoring equipment which can display readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide. The demonstration should include the test for the proper functioning of the air monitoring equipment, i.e. the functional or bump test, before use according to the manufacturer's instructions.]

3.1 Select appropriate air monitoring equipment and usage methods

During the risk assessment, if the competent person considers that the working environment may change adversely, he must recommend continuous monitoring or periodic monitoring of the working environment. The purpose of air monitoring is to ensure that the ventilation is adequate and that the atmosphere hazards inside the confined space are within an acceptable level. The requirement for testing, retesting and monitoring must be determined by the competent person.

Using direct-reading equipment, including air monitoring devices and detector tubes, is a simpler and quicker way to conduct air monitoring in confined spaces.

<u>Air Monitoring Equipment</u>

- The most common configuration for an air monitoring equipment is one that displays readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide. One should never assume that the hazardous gases present are limited to these gases. Confined spaces may contain other hazardous gases. These can originate from various processes like the use or produce hazardous substances, or from residual substances/gases/vapours if the confined spaces are used for chemical storage. Therefore, it is crucial to carefully consider the use of different or additional air monitoring instruments for conducting tests.
- Continuous air monitoring equipment are suitable for continuous air monitoring.
- Air monitoring equipment have audio-visual alarms to alert workers to take appropriate actions.

Detector Tubes

- Detector tubes are primarily used to measure the concentration of gases or vapours in the air. Different types of detector tubes can directly measure the concentration of various gases or vapuors in the air. For example, if toluene is volatilized from the use of organic solvents, a detector tube for toluene can be used to directly measure its concentration in the air.

3.2 Air Testing Procedures

Air testing should be conducted by a person with appropriate training and experience.

Pre-entry Air testing

- The atmosphere in the confined space should, as far as practicable, be tested by using remote sampling probes and sampling lines connected to direct-reading equipment (e.g. detector tubes and air monitoring equipment) placed outside the confined space.
- The manufacturers' instruction manuals on the proper use of air testing equipment should be strictly followed including the proper functioning of the equipment should be tested, i.e. to conduct functional or bump test, before use according to the manufacturer's instructions. Only properly maintained and calibrated equipment should be used for air testing.
- The atmosphere around the working position of the person carrying out air testing should be tested first to ensure his safety and health during air testing.
- In general, testing for oxygen should be performed first because some gas sensors are oxygen-dependent and may give unreliable readings in oxygen-deficient situations. Even though it may still be sufficient for survival, any depletion of oxygen should be further investigated.
- As the hazardous gas may not be evenly distributed (e.g. manhole and hand-dug tunnel), air testing should be performed from the top to the front end of the confined space to cover different positions and different depths of the confined space. Sampling for a few minutes at each location is required as there will be a time lag for the gas to be pumped from the sampling probe to the air testing equipment through the sampling line.
  - Manhole: testing of the atmosphere inside the manhole should be done from the top to the bottom of the space, preferably at about 1-metre

intervals. It is because different gases will float at different levels of the manhole according to their relative density to air. For example, methane is lighter than air and therefore it will be at the top of the manhole; hydrogen sulphide is heavier than air and it will be at the bottom and carbon monoxide is similar to air.

  - Hand-dug tunnel: air testing should be performed from the top to the front end of the hand-dug tunnel to cover different positions of the hand-dug tunnel and different depths of the shaft pit. If it is not feasible to horizontally extend the sampling probe and sampling line connected to the air testing equipment to the front end of the hand-dug tunnel, remote control type air testing equipment at different and suitable locations (including different working locations and the excavation face) in the tunnel should be placed.

- The results should be recorded with the time and location of the air testing in the risk assessment.
- Air testing must be conducted again when there is any potential change in the atmospheric conditions.

Air monitoring during work

- During the risk assessment, if the competent person considers that there is a known possibility of adverse changes of working conditions, he should recommend a continuous monitoring or periodical monitoring of the working environment.
- For examples, atmospheric conditions within the drainage system and the hand-dug tunnel can change rapidly or contaminants may be produced during work processes; therefore, it is necessary to perform continuous air monitoring to ensure that the air quality remains acceptable throughout the work. Portable type multi-gas continuous air monitoring equipment with an audio-visual alarm should be provided to each worker for continuous air monitoring. In case the alarm of air monitoring equipment is activated or any other indication of danger is observed, workers must leave the confined space immediately according to the emergency procedure.
- Each team of workers (at the same work location) should carry at least one portable air monitoring device for drainage work, allowing them to continuously monitor the air while working. The device should be checked

before entering the sewer to ensure it is calibrated, functioning properly, and has sufficient battery power. (See Figure 1)

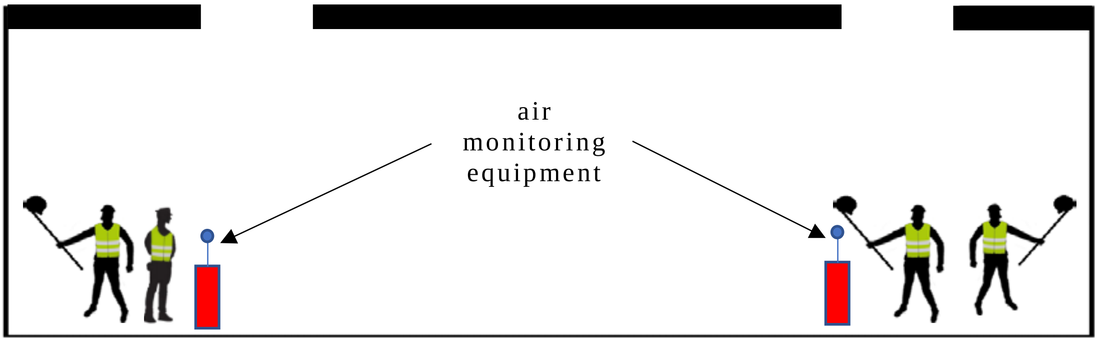

Figure 1. Portable air monitoring equipment should be equipped by at least one person in a group (at the same working location) or placed in same vicinity of the group of workers

- A re-entry test should be conducted before any worker re-enters the confined space if all the workers have temporarily left the confined space. In fact, re-entry test and pre-entry test should be performed in exactly the same manner and should be considered to be equally important.

3.3 Points to note for using air testing equipment

Air Monitoring Equipment

- Proper air monitoring equipment should be selected with respect to the gas or vapour to be tested. For example, the air monitoring equipment equipped with multiple sensors to measure the levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide.
- The air monitoring equipment should be of the explosion-proof type and should have an audio-visual alarm device.
- Read and follow the manufacturer’s instructions when using the air monitoring equipment, including the proper maintenance and calibration for the equipment, etc.
- The sensors of the air monitoring equipment should be checked to ensure that they are properly installed and has not yet expired.
- The remaining battery level of the air monitoring equipment should be checked.

- The proper functioning of the air monitoring equipment should be tested, i.e. to conduct functional or bump test, before use according to the manufacturer's instructions.
- In general, testing for oxygen should be performed first because some air monitoring equipment is oxygen-dependent and may give unreliable readings in oxygen-deficient situations.
- The air monitoring equipment should have an audio-visual alarm device which would alert workers when any indication of danger is detected.
- The air monitoring equipment is suitable for continuous air monitoring.
- The air monitoring equipment should have a two-level alarm system to alert workers to take appropriate actions correspondingly. Level 1 Alarm is a warning level indicating that there is a threat of atmospheric hazards, but the situation of worker is still safe. Action should be taken to determine the cause of the threat and implement appropriate remedial measures. Under normal circumstances, when reaching Level 2 Alarm level, it indicates the atmospheric hazards pose risks to the workers, the emergency procedures should be activated, and the workers should be evacuated immediately.

Flammable or Explosive Substances in Air

- The alarm for the presence of flammable or explosive gases is generally set using the Lower Explosive Limit (LEL). Level 1 Alarm (Warning) for the lower explosive limit should be set at 5% LEL, and Level 2 Alarm (Evacuation) should be set at 10% LEL. If a flammable or explosive substance has toxic/harmful properties simultaneously, the lower concentration of the two shall be used as the criterion for setting the alarm. For example, hydrogen sulphide must set the alarm at the concentration of its toxicity.

Toxic or Harmful Chemicial Substances in Air

- The setting of alarm levels for toxic or harmful chemicals in the air should make reference to the Occupational Exposure Limits if underground pipework is not involved and an approved breathing apparatus is not required as indicated in the risk assessment report. In this connection, the alarm levels for toxic or harmful chemicals in the air should be set as follows:

Level 1 Alarm§	Half of Occupational Exposure Limit - Short-Term Exposure Limit *[or 1.5 times of Occupational Exposure Limit - Time-Weighted Average¶]*
Level 2 Alarm§	Occupational Exposure Limit - Short-Term Exposure Limit *[or 3 times of Occupational Exposure Limit - Time-Weighted Average¶]*

§ Alarm settings for measuring instruments should be rounded down to the nearest integer.

¶ Only applicable to chemicals for which OEL-STEL have not been established.

Excessive Level of Oxygen or Oxygen Deficiency in Air

- There are about 21% by volume of oxygen in air under normal atmospheric pressure. A decrease in the percentage of oxygen in air can result in an oxygen-deficient environment, which can asphyxiate workers. Conversely, a high percentage of oxygen in air increases the risk of causing fires and explosions. Therefore, alarm thresholds for oxygen content in air (measured by volume) are set at 19.5% and 22% to warn workers of oxygen deficiency or excessive oxygen level environments respectively. Whenever the oxygen content alarm is activated, immediate evacuation should be carried out.

- The alarm levels for some common hazardous gases that can be encountered in confined spaces are recommended as follows:

For workers without using approved breathing apparatus to enter confined spaces	CH_4	H_2S	CO
Level 1 Alarm	5% LEL	7ppm	37ppm
Level 2 Alarm	10% LEL	15ppm	75ppm

Detector Tubes

- Proper detector tube should be selected with respect to the gas or vapour to be tested. Make sure the tube has not yet expired.
- Read and follow the manufacturer's instructions when using the detector tube.
- Some of the detector tubes are subjected to cross-interference, hence it is important that instructions provided by the manufacturer should be referred to before using detector tubes.
- The pump to be connected to the detector tube should be checked to ensure that it is in good working order.

- The tips of the tube should be broken carefully since glass splinters may come off. The opened tube should be handled with care to avoid being injured by the sharp edges of the tips.
- Insert the opened detector tube into the pump with the arrow mark pointing towards the pump.
- Detector tube is operated by connecting an unsealed tube to a pump. By operating the pump, air is drawn into the tube. If the relevant gas or vapour is present, the purpose made chemicals in the tube will react to give a colour change. The concentration of the gas or vapour is measured by the length or the intensity of the colour change.
- The detector tubes are not suitable for continuous air monitoring.

4. Practice on Use of Multiple-Sensor Air Monitoring Equipment

[Reference teaching time for Section 4: 90 mins]

[Practical Section to be conducted with the use of the real object of multiple-sensor air monitoring equipment which can display readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide]

[The training course provider should provide sufficient number of continuous air monitoring equipment (at least 2 sets) for hands-on practice and the practical examination.]

- Trainees are divided into groups (maximum of four trainees per group) to use a multiple-sensor air monitoring equipment for the hands-on practice.
- Every trainee should use a continuous air monitoring equipment for the hands-on practice.
- Procedures for the practice:
  - Check if the air monitoring equipment is available and intact
  - Start up the air monitoring equipment
  - Take the readings on levels of oxygen, carbon monoxide, hydrogen sulphide and flammable gases in the classroom and read the readings

  - **Simulation of safe situation**

  Each trainee should complete the following procedures on his own (other group members observe and learn the procedures at the same time):

  - ➢ Connect the sampling probe and hose to the air monitoring equipment.
  - ➢ Switch on the air monitoring equipment.
  - ➢ Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
  - ➢ Switch off the air monitoring equipment.

  - **Simulation of hazardous situation**

  Either procedures A or B should be completed by each group (every group members should participate in the procedures). Each trainee should complete the procedure B on his own (other group members observe and learn the procedures at the same time):

Procedure A

- Connect the sampling probe and hose to the air monitoring equipment.
- Switch on the air monitoring equipment.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- Put the sampling probe into a container (e.g. a plastic ziplock bag) containing alcohol wipes.
- Wait the audio-visual alarm of the air monitoring equipment to be activated.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- Take out the sampling probe from the container and observe the changes of the readings displayed on the air monitoring equipment.
- Press the reset button of the air monitoring equipment to turn off the audio-visual alarm or wait the air monitoring equipment back to normal automatically (i.e. the audio-visual alarm is stopped).
- Switch off the air monitoring equipment.

(Remarks: Adequate measures should be taken to ensure the fire safety of the training premises during the conduct of the simulation.)

Procedure B

- Connect the sampling probe and hose to the air monitoring equipment.
- Switch on the air monitoring equipment.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- Exhale to a plastic ziplock bag or a container several times to simulate the oxygen deficient environment.
- Put the sampling probe into the plastic ziplock bag or the container.
- Wait the audio-visual alarm of the air monitoring equipment to be activated.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- Take out the sampling probe from the plastic ziplock bag or the container, and observe the changes of the readings displayed on the air monitoring equipment.
- Press the reset button of the air monitoring equipment to turn off the

audio-visual alarm or wait the air monitoring equipment back to normal automatically (i.e. the audio-visual alarm is stopped).

- ➢ Switch off the air monitoring equipment.

(Remarks: Adequate measures should be taken to ensure that all training activities conducted are safe and without risks to health, e.g. the hygienic arrangements for exhaling to a plastic ziplock bag or a container.)

- Every trainee shall be able to tell the locations where air testing is required in the confined space (such as **manhole, shaft and tunnel)** and the measuring time required for those locations.
  - **manhole, shaft**: from the top to the front end of the confined space to cover different positions and different depths of the confined space;
  - **Tunnel**: In addition to conducting air tests at different depths in the tunnel, air tests must also be conducted horizontally at different locations in the tunnel;
  - Sampling for a few minutes at each location is required.

5. Practice on Safety Equipment

[Reference teaching time for Section 5: 120 mins (90 mins in Day 1 and 30 mins in Day 2)]

[Training course provider should ensure that the safety equipment used in this section should comply with the requirements of relevant regulations, and recognized international or national standards. In addition, the manufacturers' instruction manuals on the proper use of the safety equipment should be strictly followed.]

5.1 Practice on Use of Safety Harness, Lifeline and Tripod/Quadpod

[Practical Section to be conducted with the use of the real object]

[The training course provider should provide each trainee with ONE set of full body harness]

- Every trainee should use a safety harness, a lifeline and a tripod/quadpod for the hands-on practice.
- Procedures for the practice:
  - Wear the safety harness and then take off the safety harness.
  - Attach the lifeline to the safety harness and then detach the lifeline from the safety harness.
  - Mount the safety harness to the hoist of the tripod/quadpod.
  - Use the hoist of the tripod/quadpod to raise and lower the safety harness.
  - Dismount the safety harness from the hoist of the tripod/quadpod.

5.2 Practice on Use Personal motion-sensing alarm device

[Practical Section to be conducted with the use of the real object]

[The training course provider should provide sufficient number of personal motion-sensing alarm device (at least 2 sets) for hands-on practice and the practical examination.]

- Every trainee should use a personal motion-sensing alarm device for the hands-on practice.
- Procedures for the practice:
  - Turn on the personal motion-sensing alarm device
  - Check if the personal motion-sensing alarm device is fully charged. Tell

the checking result to Examiner

- Carry the personal motion-sensing alarm device
- Turn off the personal motion-sensing alarm device

5.3 Practice on Use of Approved Breathing Apparatus (Self-contained Type Approved Breathing Apparatus)

[Practical Section to be conducted with the use of the real object]

[The training course provider should provide each trainee with ONE set of air mask (for fitting to compressed air cylinder) and sufficient number of compressed air cylinders (at least 2 sets) for hands-on practice and the practical examination.

[The training course provider should ensure that the self-contained type approved breathing apparatus is clean and hygienic for use]

- Every trainee should use a self-contained type approved breathing apparatus for the hands-on practice.
- Procedures for the practice:
  - Cylinder pressure test (check the pressure of the cylinder).
  - High pressure leak test (check the leak of the hoses).
  - Whistle warning unit test (check the function of the whistle).
  - Wear the whole set of self-contained type approved breathing apparatus and adjust the mask properly.
  - Conduct the low pressure test (check the leak of the mask)
  - Open the valve of the air cylinder
  - Connect air hose of the air cylinder to the mask
  - Breath normally when wearing the apparatus
  - Positive pressure test (check the positive pressure of the mask)
  - Take off the whole set of self-contained type approved breathing apparatus
  - Turn off gas valve of the air cylinder

6. Application of Safe System of Work and Permit-to-work System

[Reference teaching time for Section 5: 160 mins]

6.1 Overview of Application of Safe System of Work and Permit-to-work System

[The example at Appendix 2 should be used for demonstration of the process of preparing a "permit-to-work certificate"]

[This section must be conducted in an interactive manner through discussion with trainees]

"Permit-to-work" system reminds the proprietor or contractor to ensure that all foreseeable hazards and associated risks have been considered in advance and that all the necessary safety precautions are clearly defined and have been effectively taken. The following paragraphs give a brief framework of the system.

<u>Contents</u>

- The proprietor or contractor of a confined space should issue to the workers "permit-to-work certificate" before allowing them to enter into or work in the confined space.
- The "permit-to-work certificate" should record the following:
  (1) the findings in the risk assessment report completed by the competent person;
  (2) the effectiveness of the isolation and withdrawal from service;
  (3) the amount of sludge or other deposits (if any) after cleaning;
  (4) the results of the air testing;
  (5) the nature of work to be done;
  (6) the conditions and features of the confined space;
  (7) list of personal protective equipment;
  (8) the period during which workers may remain safely in the confined; and
  (9) the other relevant information. [Reference can be made to the example of "permit-to-work certificate" at Appendix 2]

<u>Procedures</u>

- The proprietor or contractor of the confined space work, after receiving a risk assessment report completed by a competent person, shall verify that the report has covered all the matters referred to in section 5(2) of the FIU(CS)R. The proprietor or contractor should determine to issue a “permit-to-work certificate” only when all necessary safety measures have been implemented, including all necessary safety precautions specified in the risk assessment.

- The “permit-to-work certificate” should be properly signed for confirmation that all safety precautions indicated on the certificate have been implemented effectively by the proprietor or contractor or persons authorized by him. The items in the certificate should be written in permanent ink or otherwise so as to be indelible.
- The person responsible for signing and accepting the “permit-to-work certificate” should be the one who is responsible for stationing outside the confined space, that is, the onsite supervisor or the person-in-charge of the work in the confined space. The signer should read and fully understand the content of the “permit-to-work certificate” and undertake the work in accordance with all the conditions laid down in the certificate.
- The contents of the “permit-to-work certificate” should be clearly explained to all the workers and persons involved in the confined space work.
- All the safety requirements, necessary precautions and relevant conditions or limitations stated in the “permit-to-work certificate” should be strictly observed and followed by all the workers and persons involved in the confined space work.
- The “permit-to-work certificate” should be displayed conspicuously at the entrance of the confined space.
- A “permit-to-work certificate” should be properly cancelled when the work activities in the confined space to which it refers have been completed and the confined space is clear of workers, equipment and spare material.
- When work in the confined space was completed, the “permit-to-work certificate” should be returned to the proprietor or contractor by the person to whom it was issued. This person should sign a declaration that all personnel and equipment have been removed from the site, and the personnel have been warned that the confined space is no longer safe for entry.
- A proprietor or contractor should check that the work covered by the “permit-to-work certificate” has been properly completed. He should then sign a final confirmation of cancellation of the certificate to confirm that the work activities in the confined space have been completed and that another

certificate will be required for entering the confined space again. Effective measures should be taken to ensure that no worker would enter the confined space during the period when the completed "permit-to-work certificate" is being delivered to the proprietor or contractor for proper cancellation.

- The records of all risk assessment report and "permit-to-work certificates" should be properly maintained for one year after the certificates have been cancelled and be available for inspection.

6.2 Exercise in Preparation of "Permit-to-work Certificate"

[The example of "permit-to-work certificate" at Appendix 2 should be used for the exercise]

[This section must be conducted in an interactive manner through discussion with trainees]

["permit-to-work certificate" completed by trainees should be collected and checked to facilitate the interactive discussion]

[Model answers of "permit-to-work certificate" should be provided to trainees to facilitate the interactive discussion]

- Exercise：Every trainee should prepare one "permit-to-work certificate".

- Cases for the exercise:

  - The accident cases associated with confined spaces operation (in particular those occurred during the three years preceding the conduct of the course)

    or

  - The accident cases associated with confined spaces operation published by Labour Department (e.g. "Poisoning in manhole sewer" and "Poisoning in metal duct" in "Brief Analysis of Site Accident Cases", etc.).

7. Practical Examination

The practical examination consists of proper use of personal motion-sensing alarm device, approved breathing apparatus (self-contained type) and continuous air monitoring equipment. For the assessment items of the practical examination, please refer to the Score Sheet in **Annex 9**.

Risk Assessment Form for Confined Spaces

Appendix 1

Location of work : ______

Description of work : ______

Main Contractor/Proprietor : ______

Subcontractor (if applicable) : ______

Name of Competent Person : ______

Certificate No. : ______ Validity Period : ______(Year) ______ (Month) ______ (Day)

Add a ✔ to appropriate boxes

1.	Contents of Risk Assessment		
1.1	☐ This work falls under the provisions of section 3 of the Factories and Industrial Undertakings (Confined Spaces) Regulation, as it involves work performed within a confined space or in close proximity to a confined space, and is related to work conducted within a confined space. Work methods to be adopted in the confined space works[1] : ______ Plant to be used in the confined space works[1] : ______ Materials to be used in the confined space works[1] : ______ (If the work does not involve any worker entering the confined space[1], the following measures shall be taken to ensure that no workers enter the confined space : ______ ______)		
	Assessment Items	**Result(s)**	**Safety Precautions Required**
1.2	Is the confined space works an **underground pipework** as described in section 9(b) of the Factories and Industrial Undertakings (Confined Spaces) Regulation?	☐ Yes	☐ Ensure that any person entering or remaining in that particular confined space is properly (i) wearing a suitable approved breathing apparatus; and (ii) wearing a suitable safety harness connected to a lifeline. ☐ Monitor the air in the confined space continuously until everyone has left the confined space.
		☐ No (Reasons provided as follows : ______ ______ ______)	______ ______ ______
1.3	Is there any **hazardous** gas, vapour, dust or fume, or **deficiency of oxygen** present in the confined space?	☐ Yes	☐ Ensure that any person entering or remaining in that particular confined space is properly (i) wearing a suitable approved breathing apparatus; and (ii) wearing a suitable safety harness connected to a lifeline. ☐ Monitor the air in the confined space continuously until everyone has left the confined space.
		☐ No (Reasons provided as follows : ______ ______ ______)	______ ______ ______

[1] The Competent Person should obtain information of work methods, plant and materials to be used for the particular confined space works from the Main Contractor/ Subcontractor/ Proprietor in order to complete the risk assessment. The Main Contractor/ Subcontractor / Proprietor shall ensure the risk assessment report is displayed in a conspicuous place at the entrance of the confined space.

	Assessment Items	Consequence [2]	Likelihood [2]	Risk [2]	Safety Precautions Required
1.4	**Ingress** of hazardous gas, vapour, dust or fume to the confined space	☐ Very Serious (3) ☐ Serious (2)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	__________ __________ __________
				☐ Moderate risk (3-4)	__________ __________ __________
				☐ Low risk (<=2)	__________ __________ __________
1.5	Are there any **sludge or other deposits being present** that are **liable to give off hazardous gas, vapour, dust or fume** in the confined space?			☐ High risk (>=6)	☐ Ensure that any person entering or remaining in that particular confined space is properly (i) wearing a suitable approved breathing apparatus; and (ii) wearing a suitable safety harness connected to a lifeline. ☐ Monitor the air in the confined space continuously until everyone has left the confined space.
	☐ **Yes, sludge or other deposits are present** in the confined space. *Unless the sludge and other deposits are completely removed and purged, otherwise if there are sludge or other deposits present, it is generally very likely for the trapped or dissolved gases such as hydrogen sulphide to be released in confined space work, in particular drainage works.*	☐ Very Serious (3) ☐ Serious (2)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)		
				☐ Moderate risk (3-4)	__________ __________ __________
				☐ Low risk (<=2)	__________ __________ __________ __________
	☐ **No, sludge or other deposits are not present** in the confined space.	(Reasons provided as follows : __________ __________ __________)			

[2] Regarding the definitions of 'severity of consequences', 'likelihood of occurrence' and 'risk rating' please refer to the risk rating table in the final section of this assessment form.

	Assessment Items	Consequence [2]	Likelihood [2]	Risk [2]	Safety Precautions Required
1.6	**In-rush** into the confined space of free flowing solid or liquid	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	
1.7	**A fire or explosion** in the confined space	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	
1.8	The **ambient temperature** in the confined space that may lead to loss of consciousness of a certified worker arising from an increase in body temperature	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	
1.9	**Change in the environment** leading to an increased risk of the above hazards during the course of the work in the confined space	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	

[2] Regarding the definitions of 'severity of consequences', 'likelihood of occurrence' and 'risk rating' please refer to the risk rating table in the final section of this assessment form.

	Assessment Items	Consequence [2]	Likelihood [2]	Risk [2]	Safety Precautions Required
1.10	**Risk of worker falling from height** during the course of the work in the confined space or its proximity	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	____________ ____________ ____________
				☐ Moderate risk (3-4)	____________ ____________ ____________
				☐ Low risk (<=2)	____________ ____________ ____________
1.11	Others (please specify: ____________ ____________)	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	____________ ____________ ____________
				☐ Moderate risk (3-4)	____________ ____________ ____________
				☐ Low risk (<=2)	____________ ____________ ____________
1.12	Others (please specify: ____________ ____________)	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	____________ ____________ ____________
				☐ Moderate risk (3-4)	____________ ____________ ____________
				☐ Low risk (<=2)	____________ ____________ ____________
1.13	Period during which certified workers may remain safely in the confined space: ________hour(s)				

[2] Regarding the definitions of 'severity of consequences', 'likelihood of occurrence' and 'risk rating' please refer to the risk rating table in the final section of this assessment form.

2	**Safety precautions must be taken when entering and working into the confined space** —— Apart from the aforementioned safety precautions required with respect to the risk assessment, the proprietor or contractor must ensure that all the following safety precautions are taken before allowing certified workers to work in confined spaces:
	☐ Every piece of mechanical equipment in the confined space, which is liable to cause danger, has been disconnected from its power source, with warning notice displayed and its power source locked out;
	☐ Every pipe or supply line whose contents are liable to create a hazard has been properly blanked off;
	☐ The confined space has been tested to ensure the absence of any hazardous gas and no deficiency of oxygen;
	☐ The confined space has been adequately purged and sufficiently cooled and ventilated, having regard to the circumstances of the particular confined space, to ensure that it is a safe workplace;
	☐ An adequate supply of respirable air and an effective forced ventilation have been provided inside the confined space;
	☐ Effective steps have been taken to prevent - (i) an ingress to the confined space of hazardous gas, vapour, dust or fume; and (ii) an in-rush into the confined space of free flowing solid or liquid;
	☐ Before entering and working in the confined space, the following air testing of the confined space has been conducted with appropriate air monitoring equipment of explosion-proof design: ☐ Oxygen ☐ LEL ☐ Hydrogen sulphide ☐ Carbon monoxide ☐ Others : ________________; ☐ Continuous air monitoring has to be conducted until everyone has left the confined space;
	☐ Formulated appropriate emergency procedures to deal with any serious and imminent danger to workers inside the confined space, including the provision of a sufficient supply of the following items in a satisfactory condition (and keeping them readily available) (a) approved breathing apparatus; (b) suitable apparatus for reviving an unconscious worker; (c) vessels containing oxygen or air; (d) safety harnesses and ropes; and (e) an audio and visual alarm by which the workers inside the confined space can alert those outside;
	☐ The emergency rescue team is composed of a sufficient number of trained personnel who are ready to carry out emergency procedures in case of accident. All members of the emergency rescue team have been properly and adequately trained in the related emergency rescue procedures, including the details of the emergency rescue plan and full knowledge on how to properly use all the rescue equipment;
	☐ Instructions, training and advice are provided to all workers within a confined space or assisting with such work from immediately outside the confined space to ensure the safety and health of all workers, including posting up or displaying a clearly visible warning sign in a conspicuous place at the entrance to the confined space, indicating the specified hazards and safety precautions taken in the confined space;
	☐ All necessary equipment is provided to ensure the safety and health of workers in the confined space, including the provision of suitable air monitoring equipment of explosion-proof design for continuous air monitoring if necessary;
	☐ Only certified workers are allowed to enter or work in the confined space;
	☐ At least one "Standby Person" is stationed outside the confined space to maintain communication with the workers inside the confined space;
	☐ The risk assessment report and the Permit-to-work Certificate shall be displayed in a conspicuous place at the entrance of the confined space; and
	☐ The safety precautions listed above are effective continuously while the workers remain in the confined space.
	☐ Other safety precautions: ________________

I confirmed that I have at least one year of relevant experience, after obtaining registration as Safety Officer or the certificate as Competent Person, in assessing risk to the safety and health of workers working in confined spaces, and have been appointed by the above-mentioned Main Contractor/ Subcontractor/Proprietor to be the competent person to carry out an assessment in the aforesaid confined space works in accordance with section 5(1) of the Factories and Industrial Undertakings (Confined Spaces) Regulation.

I confirmed that, the true to the best of my knowledge and belief, the risk of the working condition in the confined space was assessed according to the requirements of section 5(6) of the Factories and Industrial Undertakings (Confined Spaces) Regulation, and recommendations of control measures were made under the section with respect to the safety and health of workers working in the confined space.

Signature of the Competent Person conducted the above risk assessment : ______________________

Name : ______________________

Date and time : ______________________

Receipt of the risk assessment report

Recipient signature : ______________________

Name : ______________________

Post : ______________________

Date and time : ______________________

Risk Assessment Table

Consequence \ Likelihood	Unlikely (1) (Rather remote, though conceivable)	Possible (2) (Event to be expected)	Very likely (3) (Occurs repeatedly)
Very serious (3) Accident causing immediate danger to life or serious bodily injury (Example: gas poisoning, hypoxia, drowning)	(3) Moderate Risk	(6) High Risk	(9) High Risk
Serious (2) Accident causing moderate bodily injury (Example: fracture, skin ulcer, etc.)	(2) Low Risk	(4) Moderate Risk	(6) High Risk
Mild (1) Accident resulting in mild bodily injury (Example: eye irritation from dust, cough)	(1) Low Risk	(2) Low Risk	(3) Moderate Risk

(pink)	High Risk
(yellow)	Moderate Risk
(green)	Low Risk

Appendix 2

Permit-to-work Certificate

A Template of "Permit-to-work Certificate" for Entry into Confined Space

Location of work : ____

Description of work : ____

Main Contractor/Proprietor : ____

Name of the Competent Person appointed : __________________________

Date and time of risk assessment : __________________________

Date & time for entry to the confined space : ________(Year) ______ (Month) ______ (Day) from ______ *am/pm (Time)

This permit-to-work certificate is valid until : ________(Year) ______ (Month) ______ (Day) ______*am/pm (Time)

* Please delete if not applicable

Workers				
	Certified Worker			
	Maximum duration that certified workers are allowed to stay in the confined space : ______ Hour(s)			
	Name	Reference No. of Certificate	Validity Period	Signature
	Standby Person			
	Name	Date of training	Responsibility	Signature
			✓ Maintain communication with the workers inside the confined space, and call for support in case of emergency; ✓ Brief the rescue personnel of the relevant circumstances of the incident upon their arrival in case of emergency; ✓ Even in case of emergency, the standby person should not enter the confined space.	
	Onsite Rescue Personnel			
	Name	Date received training for rescue in emergency	Responsibility	Signature
			✓ Familiar with the details of the emergency rescue plan; ✓ Know how to properly operate all rescue equipment provided.	

Add a ✔ to appropriate boxes ☐

Underground Pipework
☐ This confined space work is underground pipework as described in section 9(b) of the Factories and Industrial Undertakings (Confined Spaces) Regulation, and therefore contractor / proprietor has to ☐ Ensure that any person entering or remaining in that particular confined space is properly i. wearing a suitable approved breathing apparatus; and ii. wearing a suitable safety harness connected to a lifeline. ☐ Use appropriate air monitoring equipment of explosion-proof design to monitor the air in the confined space continuously until everyone has left the confined space; and ______________________________ ______________________________
☐ This confined space work is **NOT underground pipework** as described in section 9(b) of the Factories and Industrial Undertakings (Confined Spaces) Regulation with the reason(s) stated as follows: ______________________________ ______________________________
Remarks : Must choose one out of the two options above

Isolation Measures		
	Signature	Date & time
☐ Normal services in the confined space have been suspended.		
☐ All unnecessary sources of power (Electrical/ Mechanical/ Pneumatic/ Hydraulic/ Others: ____________) have been isolated.		
☐ All pipelines connected to the confined space have been completely shut off or blanked off		
☐ The ends of all service pipes connected to hazardous gas sources have been sealed.		
☐ Non-essential heat sources have been isolated.		
☐ Other sources of danger have been isolated (please specify __________).		
☐ All isolated or closed connections have been locked off and properly labelled to prevent from being opened without authorisation or accidentally.		

Purging and Ventilation Control Measures		
	Signature	Date & time
☐ The confined space has been purged/cleaned adequately. (Method : ____________________________)		
☐ All hazardous substances stored inside the confined space have been removed.		
☐ Adequate respirable air and effective forced ventilation have been provided.		

Add a ✓ to appropriate boxes ☐

Air Testing Results
Testing Date (YYYY/MM/DD) : ____________ Model of air monitoring equipment : ____________ Serial number of air monitoring equipment : ____________ Calibration Expiry Date (YYYY/MM/DD) : ____________
Testing Location : ____________ Testing Time : ____________*am/pm ☐ O_2 : ____________ % ☐ LEL(Percentage) : ____________ % ☐ H_2S : ____________ ppm ☐ CO : ____________ ppm ☐ ____________
Testing Location : ____________ Testing Time : ____________*am/pm ☐ O_2 : ____________ % ☐ LEL(Percentage) : ____________ % ☐ H_2S : ____________ ppm ☐ CO : ____________ ppm ☐ ____________
Testing Location : ____________ Testing Time : ____________*am/pm ☐ O_2 : ____________ % ☐ LEL(Percentage) : ____________ % ☐ H_2S : ____________ ppm ☐ CO : ____________ ppm ☐ ____________
☐ After the air testing, I confirm that there is no hazardous gas and no oxygen-deficient situation in this confined space. Responsible person for conducting the air testing Name : ____________ Signature : ____________

Add a ✔ to appropriate boxes ☐

Safety Precautions for Entry into the Confined Space
☐ Every piece of mechanical equipment in the confined space, which is liable to cause danger, has been disconnected from its power source, with warning notice displayed and its power source locked out;
☐ Every pipe or supply line whose contents are liable to create a hazard has been properly blanked off;
☐ The confined space has been tested to ensure the absence of any hazardous gas and no deficiency of oxygen;
☐ The confined space has been adequately purged and sufficiently cooled and ventilated, having regard to the circumstances of the particular confined space, to ensure that it is a safe workplace;
☐ An adequate supply of respirable air and an effective forced ventilation have been provided inside the confined space;
☐ Effective steps have been taken to prevent - (i) an ingress to the confined space of hazardous gas, vapour, dust or fume; and (ii) an in-rush into the confined space of free flowing solid or liquid;
☐ Formulated appropriate emergency procedures to deal with any serious and imminent danger to workers inside the confined space, including the provision of a sufficient supply of the following items in a satisfactory condition (and keeping them readily available): (a) approved breathing apparatus; (b) suitable apparatus for reviving an unconscious worker; (c) vessels containing oxygen or air; (d) safety harnesses and ropes; and (e) an audio and visual alarm by which the workers inside the confined space can alert those outside;
☐ The emergency rescue team is composed of a sufficient number of trained personnel who are ready to carry out emergency procedures in case of accident. All members of the emergency rescue team have been properly and adequately trained in the related emergency rescue procedures, including the details of the emergency rescue plan and full knowledge on how to properly use all the rescue equipment;
☐ Instructions, training and advice are provided to all workers within a confined space or assisting with such work from immediately outside the confined space to ensure the safety and health of all workers, including posting up or displaying a clearly visible warning sign in a conspicuous place at the entrance to the confined space, indicating the specified hazards and safety precautions taken in the confined space;
☐ All necessary equipment is provided to ensure the safety and health of workers in the confined space, including the provision of suitable air monitoring equipment of explosion proof design for continuous air monitoring if necessary;
☐ Only certified worker is allowed to enter or work in the confined space;
☐ At least one "Standby Person" is stationed outside the confined space to maintain communication with the workers inside the confined space;
☐ The risk assessment report and this permit-to-work certificate should be displayed in a conspicuous place at the entrance of the confined space;
☐ The safety precautions listed above are effective continuously while the workers remain in the confined space;
☐ Video recording at the entrance and exit of the confined space throughout the entire work period is arranged to monitor that relevant personnel have complied with the safety precautions.

Add a ✔ to appropriate boxes ☐

Emergency Rescue Equipment Provided
☐ Approved breathing apparatus : ____________ set
☐ Apparatus for reviving an unconscious worker : ____________ set
☐ Vessels containing oxygen or air : ____________ set
☐ Safety harnesses and ropes : ____________ set
☐ Audio and visual alarm by which the workers inside the confined space can alert those outside : ____________ set
☐ Other relevant emergency rescue equipment, including : ☐ Tripods and winches; ☐ ______________________________
☐ I confirm that the above emergency rescue equipment is sufficient with satisfactory condition and are readily available.

List of Protective Equipment Provided
<u>General</u>
☐ Forced ventilation device : ____________ set
☐ Continuous air monitoring equipment : ____________ set
☐ Walkie-talkie (explosion-proof design) : ____________ set
☐ Shield : ____________ set
☐ Lighting device : ____________ set
☐ Others (Please specify) : ____
<u>Personal Protective Equipment</u>
☐ Approved breathing apparatus : ____________ set (excluding for emergency use)
☐ Audio and visual alarm : ____________ set
☐ Protective clothing : ____________ piece
☐ Head, Hand & Foot Protection : ____________ piece
☐ Life Lines & Harness : ____________ set
☐ Eye Protection : ____________ set
☐ Ear Protection : ____________ set
☐ Others (Please specify) : ____

Declaration by the Proprietor/Contractor or Authorised Representative
Permit-to-work Certificate I am the proprietor/ contractor/ authorised representative* of the confined space work mentioned above. I confirm that the risk assessment report by the competent person mentioned above covers all matters stated in section 5(2) of the Factories and Industrial Undertakings (Confined Spaces) Regulation, and I certify that all necessary safety precautions in accordance with the risk assessment report have been taken, and I hereby, issue this Permit-to-work Certificate. This permit-to-work certificate is valid until (Date & Time): _________(Year) ______(Month)______ (Day) ______ *am/pm (Time) Signature : ___________________________ Name : ___________________________ Post : ___________________________ Date & time : ___________________________ * Please delete if not applicable
Receipt of Permit-to-work Certificate (To be filled by the supervisor or person in-charge of the work) I have read and understood the content of the Permit-to work Certificate, and shall undertake to work in accordance with all the conditions laid down in this certificate. Signature : ___________________________ Name : ___________________________ Post : ___________________________ Date & time : ___________________________
Proof of Completion (To be filled by the supervisor or person in-charge of the work) I confirm that the confined space work mentioned above has been completed and that all assigned persons, materials and equipment have been withdrawn from the site, the personnel have been warned that the confined space is no longer safe for entry and I hereby sign to confirm. Signature : ___________________________ Name : ___________________________ Post : ___________________________ Date & time : ___________________________
Cancellation of Permit-to-work Certificate I am the proprietor/ contractor/ authorised representative* of the confined space work mentioned above. I hereby sign to confirm the cancellation of this Permit-to-work Certificate. I understand that a new permit-to-work certificate will be required if work is to be continued. Signature : ___________________________ Name : ___________________________ Post : ___________________________ Date & time : ___________________________ * Please delete if not applicable

Setting Up Air Monitoring Alarm

Appendix 3

1. Working in confined space can pose risks to the safety and health of workers, including atmospheric hazards. Typical situations that cause loss of consciousness or ability to escape due to atmospheric hazards include: (1) concentrations of flammable or explosive gases or vapours, etc. exceeding their Lower Explosive Limit (LEL), (2) concentrations of toxic or harmful substances in the air exceeding their Occupational Exposure Limit (OEL) or Immediately Dangerous to Life or Health (IDLH) concentrations, and (3) the air becoming oxygen-enriched or deficient. For detailed information on common hazardous gases/chemicals in confined spaces and occupational hygiene standards, please refer to paragraphs 11 to 16 below.

2. Examples of possible atmospheric hazards in confined spaces include:
   - Fire or chemical spill happens in confined spaces;
   - Failure of the ventilation or fresh air supply systems in confined spaces;
   - Fire or chemical spillage happens outside confined spaces, which could affect the quality of fresh air intake;
   - Disturbance of the sewage, sediment, or sludge can release the trapped or dissolved hydrogen sulphide gas, etc., thus rising the concentration of the hazardous gases in the air rapidly; and
   - Use of volatile chemicals in confined spaces, etc.

3. A number of hazardous gases, such as carbon monoxide, are colourless and odourless. On the other hand, some hazardous gases like hydrogen sulphide may have an unpleasant smell at low concentrations, but such smell disappears at higher concentrations due to olfactory fatigue. It can be very wrong and dangerous if workers think they can recognise the presence of hazardous gases by scent. In certain situations, competent person may recommend continuous monitoring or periodic monitoring of the working environment. Workers should be equipped with continuous air monitoring equipment that provides audio and visual alarms, where applicable, in order to immediately alert the workers and standby persons the imminent situations regarding the air quality and presence of hazardous gases in confined spaces, and activate evacuation or arrange rescue as soon as possible.

4. The air monitoring equipment should have a two-level alarm system to alert workers to take appropriate actions correspondingly. Level 1 Alarm is a warning level indicating that there is a threat of atmospheric hazards, but the situation of worker

is still safe. Action should be taken to determine the cause of the threat and implement appropriate remedial measures. Under normal circumstances, when reaching Level 2 Alarm level, it indicates the atmospheric hazards pose risks to the workers, the emergency procedures should be activated, and the workers should be evacuated immediately.

Flammable or Explosive Substances in Air

5. The alarm for the presence of flammable or explosive gases is generally set using the Lower Explosive Limit (LEL). Level 1 Alarm (Warning) for the lower explosive limit should be set at 5% LEL, and Level 2 Alarm (Evacuation) should be set at 10% LEL. If a flammable or explosive substance has toxic/harmful properties simultaneously, the lower concentration of the two shall be used as the criterion for setting the alarm. For example, hydrogen sulphide must set the alarm at the concentration of its toxicity.

Toxic or Harmful Chemcial Substances in Air

6. The setting of alarm levels for toxic or harmful chemicals in the air should make reference to the Occupational Exposure Limits if underground pipework is not involved and an approved breathing apparatus is not required as indicated in the risk assessment report. In this connection, the alarm levels for toxic or harmful chemicals in the air should be set as follows:

Level 1 Alarm§	Half of Occupational Exposure Limit - Short-Term Exposure Limit *[or 1.5 times of Occupational Exposure Limit - Time-Weighted Average¶]*
Level 2 Alarm§	Occupational Exposure Limit - Short-Term Exposure Limit *[or 3 times of Occupational Exposure Limit - Time-Weighted Average¶]*

§ Alarm settings for measuring instruments should be rounded down to the nearest integer.

¶ Only applicable to chemicals for which OEL-STEL have not been established.

7. In normal circumstances, properly worn approved breathing apparatus can provide a good protection to workers against atmospheric hazards but it is not entirely fail-safe. When workers are using approved breathing apparatus to enter confined spaces, it is a prudent approach to set Level 1 Alarm at half of IDLH concentration of the toxic or harmful chemical substance and Level 2 Alarm at the corresponding IDLH. For example, Level 1 and Level 2 Alarms for hydrogen sulphide gas can be set at 50ppm and 100ppm respectively.

8. Under the Factories and Industrial Undertakings Ordinance, it shall be the duty of every proprietor to ensure the provision and maintenance of a working environment for the proprietor's workers that is, so far as is reasonably practicable, safe, and without risks to health. In this regard, the proprietor should eliminate or substitute the atmospheric hazards and/or implement vigorous and robust engineering control measures to reduce the level of hazardous gases to below IDLH as far as possible rather than relying heavily on the use of personal protective equipment ("PPE"). The use of PPE should always be regarded as the last resort in the hierarchy of control measures, and is a supplement to, not in lieu of, effective engineering control measures and safe system of work. In rare circumstances where elimination or substitution is not possible and vigorous and robust engineering control measures adopted cannot reduce the level of hazardous gases below IDLH, the proprietor should consult occupational health professionals, in addition to the competent person appointed, to review the work situation and to develop and fully implement a written respiratory protection programme with required worksite-specific procedures and elements for required respirator use which is commensurate with the respiratory protection standards, 29 CFR 1910.134, required by the Occupational Safety and Health Administration, U.S. Department of Labor, to ensure the safety and health of the certified workers working in such high risk situation.

Excessive Level of Oxygen or Oxygen Deficiency in Air

9. There are about 21% by volume of oxygen in air under normal atmospheric pressure. A decrease in the percentage of oxygen in air can result in an oxygen-deficient environment, which can asphyxiate workers. Conversely, a high percentage of oxygen in air increases the risk of causing fires and explosions. Therefore, alarm thresholds for oxygen content in air (measured by volume) are set at 19.5% and 22% to warn workers of oxygen deficiency or excessive oxygen level environments respectively. Whenever the oxygen content alarm is activated, immediate evacuation should be carried out.

Setting Air Monitoring Alarm

10. The alarm levels for some common hazardous gases that can be encountered in confined spaces are recommended as follows:

For workers without using approved breathing apparatus to enter confined spaces	CH_4	H_2S	CO
Level 1 Alarm	5% LEL	7ppm	37ppm
Level 2 Alarm	10% LEL	15ppm	75ppm

Common Hazardous Gas in Confined Space and Occupational Safety and Hygiene Standards

11. Lower Explosive Limit (LEL) – LEL is the lowest concentration of a substance that will produce a flash fire or explosion when an ignition source (flame, spark, etc.) is present and is expressed in percent of vapour or gas in the air by volume.

12. "Occupational Exposure Limit (OEL)" refers to the airborne concentration(s) of individual chemical substances that represent levels that are regarded to impose no adverse health effects to nearly all workers on exposures by the route of inhalation. "Occupational Exposure Limit - Time - Weighted Average (OEL-TWA)" refers to the time-weighted average concentration of a chemical substance over an eight-hour working day for a five-day workweek, to which nearly all workers can be exposed day after day without adverse health effects. "Occupational Exposure Limit - Short-Term Exposure Limit (OEL-STEL)" refers to the 15-minute time-weighted average of the airborne concentration of a chemical substance. A list of OEL for chemical substances can be found in the "Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace" published by the Labour Department.

13. Under the situation of Immediately Dangerous to Life or Health (IDLH) concentrations, there will be an immediate or delayed threat to life, or it may cause irreversible health effects or impairment of the ability to escape. For IDLH concentrations, please refer to the values developed by the Ministry of Health of the People's Republic of China or the National Institute for Occupational Safety and Health (NIOSH) of the United States of America.

14. Hydrogen Sulphide (H_2S) is a deadly gas with a distinctive "rotten egg" odour that can be detected at very low concentrations. At concentrations above 100 ppm, hydrogen sulphide has a paralysing effect on the sense of smell. Even at lower concentrations, hydrogen sulphide can affect the olfactory nerve, and workers cannot detect the changes in concentrations. It can be produced and accumulated in confined spaces such as septic tanks, manholes or sewers. Hydrogen sulphide is heavier than air and thus settles in lower part of the confined space such as the bottom of manholes or sewers.

Hydrogen Sulphide (in ppm)	Effect/ Exposure Limit
Less than 1	Smells like rotten eggs
10	OEL-TWA
15	OEL-STEL

50-100	Paralysis of the olfactory nerve, irritation to the eye and respiratory tract, and inhalation may result in lung oedema that causes death
100	IDLH

15. Carbon Monoxide (CO) is a lethal colourless and odourless gas. Carbon monoxide is a product of incomplete combustion. When gasoline/diesel generators or other fuel-driven tools are used in inadequately ventilated workplaces, oxygen can also be consumed, and carbon monoxide can be produced and accumulated.

Carbon Monoxide (in ppm)	Effect/ Exposure Limit
25	OEL-TWA
350	Confusion, fainting on exertion and collapse
1200	IDLH

16. Methane (CH_4) is commonly generated when organic matter is decomposed by various bacterial processes. It is a colourless, odourless, extremely flammable and explosive gas that can cause fire and explosion. The accumulation of methane in a poorly ventilated area will displace normal air and result in an oxygen-deficient environment. Typical air monitoring equipment for confined spaces does not directly measure methane concentration. Instead, users can determine the presence of methane through the oxygen concentration and LEL. Methane is lighter than air and thus will accumulate in the upper part of the confined space.

Occupational Safety and Health Branch
Labour Department

Annex 7

Course Contents for Safety Training Revalidation Course for Competent Persons of Confined Spaces Operation

Course Contents for

Safety Training Revalidation Course for

Competent Persons of Confined Spaces Operation

Section 4(2) of the Factories and Industrial Undertakings

(Confined Spaces) Regulation

Occupational Safety and Health Branch
Labour Department

The Course Contents are prepared by
The Occupational Safety and Health Branch
Labour Department

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Information on the services offered by the Labour Department and on major labour legislation can also be found by visiting our Home Page in the Internet.

Contents

1. Introduction to Arrangements of the Course

[Reference teaching time for Section 1: 5 mins]

1.1 Training Venue, Training Equipment and Examination Requirements

- To introduce briefly about the training venue, training equipment and the examination requirements

1.2 Introduction to the Course Contents

- To introduce briefly about the course structure and contents

1.3 Objectives of the Course

Under the Factories and Industrial Undertakings (Confined Spaces) Regulation (Chapter 59AE) (hereinafter referred as the FIU(CS)R), a proprietor or contractor responsible for a confined space work shall appoint a competent person to carry out an assessment of the working conditions in the confined space and make recommendations on measures to be taken in relation to safety and health of workers while working in that space. Being a competent person, the person shall has attained the age of 18 years; and who is a registered safety officer or has successfully completed the relevant training course to prepare risk assessment reports and been issued with a relevant certificate recognized by the Commissioner for Labour; as well as having one year's relevant post-registration or post-training experience.

2. Relevant Occupational Safety and Health Legislation Applicable to Confined Spaces

[Reference teaching time for Section 2: 30 mins]

2.1 Occupational Safety and Health Ordinance and Subsidiary Legislation (Chapter 509)

Purposes

- To ensure the safety and health of employees when they are at work
- To prescribe the occupational safety and health measures
- To improve the safety and health standards applicable to workplaces
- To improve the safety and health aspects of working environments of employees

Coverage

- This ordinance covers almost all workplaces - places where employees work, including offices, department stores, supermarkets, hospitals, construction sites, etc.
- However, there are a few exceptions, including places where only self-employed persons work and domestic premises where the only employees are domestic servants.
- Every employer must, so far as reasonably practicable, ensure the safety and health at work of all his employees.

Subsidiary Regulations include:

- Occupational Safety and Health Regulation
- Occupational Safety and Health (Display Screen Equipment) Regulation

2.2 Factories and Industrial Undertakings Ordinance and Subsidiary Legislation (Chapter 59)

- Provide for the safety and health protection to workers in the industrial sector
- Coverage
  - factories
  - construction sites

- catering establishments
- cargo and container handling undertakings
- repair workshops and other industrial workplaces

- **General Duties of Proprietors**

  Every proprietor of an industrial undertaking must, so far as is reasonably practicable, ensure the safety and health at work of all persons employed by him. The matters to which that duty extends include:
  - providing and maintaining plant and work systems that do not endanger safety or health;
  - making arrangements for ensuring safety and health in connection with the use, handling, storage or transport of plant or substances;
  - providing all necessary information, instruction, training, and supervision for ensuring safety and health;
  - providing and maintaining all parts of the workplace and means of access to and egress from the workplace that is safe and without risk to health; and
  - providing and maintaining a working environment that is safe and without risk to health.

- **General Duties of Persons Employed**
  - every person employed at an industrial undertaking must take reasonable care for the safety and health of himself and others; and
  - co-operate with the proprietor of an industrial undertaking to enable any duty or requirement for securing the safety and health of persons employed at the industrial undertaking to be performed or complied with.

Subsidiary Legislation under the Factories and Industrial Undertakings Ordinance:

Under the Factories and Industrial Undertakings Ordinance (hereinafter referred as the FIUO), there are subsidiary regulations covering various aspects of hazardous work activities in factories, building and engineering construction sites, catering establishments, cargo and container handling and other industrial workplaces. The subsidiary regulations prescribe detailed safety and health standards on work situations, plant and machinery, processes and substances.

Subsidiary Regulations include Factories and Industrial Undertakings Regulations, Construction Sites (Safety) Regulations, FIU(CS)R, Factories and Industrial Undertakings (Lifting Appliances and Lifting Gear) Regulations, Factories and Industrial Undertakings (Electricity) Regulations, Factories and Industrial Undertakings (Loadshifting Machinery) Regulation, Factories and Industrial Undertakings (Gas Welding and Flame Cutting) Regulation, Factories and Industrial Undertakings (Safety Management) Regulation, etc.

2.2.1 Factories and Industrial Undertakings (Confined Spaces) Regulation

Application

The FIU(CS)R applies to work in an industrial undertaking that takes place:

- within a "confined space"; and
- within the immediate vicinity of, and is associated with work occurring within, a "confined space".

"confined space" means any place in which, by virtue of its enclosed nature, there arises a reasonably foreseeable **"specified risk"**, and without limiting the generality of the foregoing, includes any chamber, tank, vat, pit, well, sewer, tunnel, pipe, flue, boiler, pressure receiver, hatch, caisson, shaft or silo in which such risk arises.

"specified risk" means a risk of:

(a) serious injury to any person at work arising from a fire or explosion;

(b) the loss of consciousness of any person at work arising from an increase in body temperature;

(c) the loss of consciousness or asphyxiation of any person at work arising from gas, fume, vapour or the lack of oxygen;

(d) the drowning of any person at work arising from an increase in the level of liquid; or

(e) the asphyxiation of any person at work arising from a free flowing solid or the inability to reach a respirable environment due to entrapment by a free flowing solid.

For the purpose of Code of Practice for Safety and Health at Work in Confined Spaces,

- “risk” (危險) expresses the likelihood that the harm from a particular hazard is realised and the severity of the harm.
- “hazard” (危害) is something with the potential to cause harm (this includes any atmospheric hazards, hazards from in-rush of mud or water, hazards from machines, substances or job methods, and other aspects of work in a confined space).
- “atmospheric hazard” (空氣危害) refers to the presence of gases, vapours, dusts, fumes, smoke or oxygen-deficient air in a confined space, which potentially causes harm to the safety and health of persons staying in the confined space.

Duties of a proprietor or contractor

- **Risk assessment and recommendations**
  - appoint a “competent person” to carry out risk assessment for work in confined space and make recommendations on safety and health measures before undertaking the work.
  - appoint a “competent person” to carry out fresh assessment and make recommendations whenever there has been a significant change in the conditions of the confined space or of the work activities or whenever there is any reason to suspect that such change likely to affect the safety and health of workers working therein may occur.

“competent person” means a person:

(a) who has attained the age of 18 years;

(b) who is either:

(1) a safety officer registered under the Factories and Industrial Undertakings (Safety Officers and Safety Supervisors) Regulations; or

(2) a person who holds a certificate issued by a person whom the Commissioner for Labour has authorized to certify persons as being competent to prepare risk assessment reports; and

(c) who has at least one year's relevant experience, after obtaining the registration or certification referred to in paragraph (b)(1) or (2), in assessing risk to the safety and health of workers working in confined spaces.

- **Compliance with risk assessment report and certification**
  - verify the "risk assessment report" submitted by the competent person.
  - issue a certificate (i.e. permit-to-work certificate) stating that all necessary safety precautions in relation to the hazards identified in the "risk assessment report" have been taken and the period during which workers may remain safely in the confined space before allowing workers enter the confined space for the first time.
  - ensure no worker enters or remains in a confined space unless all recommendations in the "risk assessment report" have been complied with.
  - keep the "permit-to-work certificate" and "risk assessment report" for one year after work in the confined space has been completed and make them available, on request, to an occupational safety officer.

"risk assessment report" is a written report which contains the assessment and recommendations carried out by a competent person for the work in confined space. It identifies the hazards likely to be present in the confined space, evaluates the extent of the risks arising from such hazards and, without limiting the foregoing, covers the following:

(a) the work method to be used and the plant and materials to be used in work activities;

(b) whether or not there is any hazardous gas, vapour, dust or fume present or there is any deficiency in oxygen;

(c) the possibility of:

  (1) ingress of hazardous gas, vapour, dust or fume;

  (2) sludge or other deposits being present that are liable to give off hazardous gas, vapour, dust or fume;

  (3) in-rush of free flowing solid or liquid;

  (4) a fire or explosion in the confined space; and

  (5) loss of consciousness of a certified worker arising from an increase in body temperature;

(d) recommendations on the measures required, including whether or not the use of approved breathing apparatus is necessary;

(e) the period during which workers may remain safely in the confined space; and

(f) recommendation on use of such monitoring equipment if there is a substantial likelihood of a change in the environment leading to an increased risk from the aforementioned possible hazards in the course of work.

Template of the "Risk Assessment Form for Confined Spaces" is attached in Appendix 1.

- **Safety precautions**

  - Before allowing workers enter a confined space for the first time:

(a) disconnect and lock out power source to mechanical equipment which is liable to cause danger inside the confined space;

(b) blank off pipe or supply line whose contents are liable to create a hazard;

(c) test to ensure absence of any hazardous gas and no deficiency of oxygen in the confined space;

(d) purge, cool and ventilate the confined space to ensure it is a safe workplace;

(e) provide adequate respirable air and effective forced ventilation inside the confined space; and

(f) prevent ingress of hazardous gas, vapour, dust, fume and in-rush of free flowing solid or liquid into the confined space.

  - When work is being carried out in a confined space:

(a) ensure only "certified workers" enter or work in the confined space;

(b) ensure a "standby person" is stationed outside the confined space to maintain communication with the workers inside and adopt emergency response;

(c) ensure the risk assessment report and related "permit-to-work certificate" are displayed in a conspicuous place at the entrance of the confined space; and

(d) ensure the safety precautions undertaken continue to be effective.

"certified worker" means a person:

(a) who has attained the age of 18 years; and

(b) who holds a certificate issued by a person whom the Commissioner for Labour has authorized to certify workers as being competent to work in a confined space.

"**standby person**" means when there is a certified worker working in the confined space, another worker, namely the "standby person", shall be assigned by the proprietor or contractor to be stationed outside the confined space to maintain communication with the worker inside the confined space and be responsible for contacting the emergency rescue team when necessary. Standby person shall have sufficient physical strength to be capable of pulling workers out of the confined space. The "standby person" may use mechanical devices to assist him when he is pulling the worker out of the confined space. In addition, the "standby person" should be a certified worker or competent person as defined in the FIU(CS)R.

- **Use of personal protective equipment**
  - ensure the person entering a confined space or remaining therein has worn an "approved breathing apparatus" of a type that gives appropriate protection given the nature of the confined space:

(a) for "underground pipework"; or

(b) where the risk assessment report recommends the use of "approved breathing apparatus".

  - ensure the person who uses an "approved breathing apparatus" is also wearing a safety harness connected to a lifeline with the free end held by a person outside who is capable of pulling him out of the confined space.

"approved breathing apparatus" used in confined space work shall be of a type approved by the Commissioner for Labour. Notice of approval of these apparatus will be published in the Gazette. [Reference can be made to the "approved breathing apparatus" list provided by the Labour Department's website]

"underground pipework" in confined space means work in a confined space, which meets the definition of a confined space in the FIU(CS)R and the underground pipework as set out in section 9 of the Regulation. When assessing whether a particular job constitutes "underground pipework" under section 9 of the FIU(CS)R, the following determining factors should be considered:

(a) whether the work is performed within a confined space as interpreted under section 2 of the FIU(CS)R;

(b) whether the aforementioned confined space is located underground; and

(c) whether the work involves any pipework which would have specified risk associated with atmospheric hazard.

Typical underground pipework includes (1) workers are required to enter any underground drains or their associated manholes, which may have atmospheric hazards and have been classified as confined spaces, to carry out inspection or maintenance of drainage works, etc.; or (2) workers are required to enter any underground confined spaces for inspection or maintenance work of pipes.

- **Emergency procedures**
  - formulate and implement emergency procedures to deal with any serious and imminent danger to workers inside confined space.
  - provide and keep readily available in satisfactory condition sufficient supply of:

(a) approved breathing apparatus;

(b) reviving apparatus;

(c) vessels containing oxygen or air;

(d) safety harnesses and ropes; and

(e) audio and visual alarm (such as personal motion-sensing alarm device) for alerting others outside confined space.

  - ensure sufficient number of persons who know how to use the safety equipment including above items (a) to (e) are present when work is taking place in confined space.

- **Provision of information, instructions, etc.**
  - provide all workers working within a confined space and those outside assisting in such work with information, instructions, training and advice as are necessary to ensure safety and health of workers.
  - provide all necessary equipment to ensure safety and health of workers.

- The relevant information or instructions to be given to the workers should be easily comprehensible by the workers or other relevant personnel, taking into account their knowledge and experience. Such information or instructions could be in written form, symbols, diagrams, notices or any other forms as appropriate, so long as they can be clearly understood by the workers and are suitable to the confined space work concerned. (Please see Warning Notice Samples (Sample 1 and Sample 2)).

危險 Danger

- 本密閉空間非常可能含有具危害性的氣體，可令人中毒、窒息或死亡。
- 任何人沒有配戴認可呼吸器具或沒有配戴適當並與救生繩連接的安全吊帶，嚴禁進入。
- This confined space probably contains hazardous gases which can cause poisoning, asphyxiation or death to any person.
- No entry is allowed by any person without wearing an approved breathing apparatus or without wearing a suitable safety harness connected to a lifeline.

Warning Notice (Sample 1)

危險 Danger

- 本密閉空間的工程是屬於地底喉管工作，任何進入或在其內逗留的人必須已妥當地配戴認可呼吸器具；及已配戴適當並與救生繩連接的安全吊帶，讓該人在緊急情況時可被拉出該密閉空間。
- The works in this confined space are underground pipework. Anyone entering or staying inside must be properly wearing an approved breathing apparatus; and wearing a suitable safety harness connected to a lifeline so that the person can be pulled out of it in case of emergency.

Warning Notice (Sample 2)

Duties of a competent person

- carry out an assessment of the working conditions of a confined space covering all the aspects specified under the FIU(CS)R.
- make recommendations on measures in relation to safety and health of workers while working in that space.
- submit the assessment report with recommendations to the proprietor or contractor within a reasonable period of time.
- should not make a risk assessment report which is to his knowledge false as to a material particular.

Duties of a certified worker

- observe emergency procedures implemented by the proprietor or contractor.
- observe instructions and advice and attend training provided by the proprietor or contractor.
- make full and proper use of, and forthwith report to the proprietor or

contractor of any fault or defect in, any safety equipment or emergency facilities.

2.2.2 Construction Sites (Safety) Regulations

These regulations control the construction, maintenance, use and operation of hoists, scaffolds and working platforms. There are also provisions for the use of personal protective equipment for protection against falling of person, falling objects and drowning in a construction site. There are miscellaneous safety requirements such as prevention of inhalation of dust and fumes, protection of eyes and the provision of first aid facilities.

Under this regulation, at least one person trained in first aid should be employed on site, where 30 to 99 workmen are employed on a site. Adequate ventilation shall be provided to prevent workmen from inhaling dust or fumes arising from grinding, cleaning, spraying, mixing or working of any material which causes dust or fumes to be given off of a character and extent likely to be injurious to the health of workmen employed in work. Suitable and adequate lighting necessary to secure workmen's safety shall be provided. Drinking water must be provided to workers.

2.2.3 Factories and Industrial Undertakings (Safety Management) Regulation

The proprietor and contractor covered by the Regulation shall implement a safety management system which consists of 14 elements. The proprietor and contractor are required to carry out safety audit or safety review as the case may be of their safety management system.

2.3 Code of Practice

The Code of Practice (hereinafter referred as the Code) is approved and issued by the Commissioner for Labour under Section 7A of the FIUO. It provides a practical guidance to proprietors of industrial undertakings and the employees for compliance with the requirements under the provisions of the Sections 6A and 6B of the FIUO concerning the general duties of proprietor and employee. It is important to note that compliance with the Code does not of itself confer immunity from legal obligations.

The Code has a special legal status. Although failure to observe any guidance contained in the Code is not in itself an offence that failure may be taken by a court in criminal proceedings as a relevant factor in determining whether or not a person has breached any of the provisions of the regulations to which the guidance relates.

Codes of practice that are often used include:

- Code of Practice for Safety and Health at Work in Confined Spaces
- Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace
- Code of Practice: Safety and Health at Work for Gas Welding and Flame Cutting
- Code of Practice: Safety and Health at Work for Manual Electric Arc Welding

3. Basic Concept of a Confined Space and Common Potential Hazards

[Reference teaching time for Section 3: 40 mins]

3.1 Basic Concept of a Confined Space [Playing Video: Manhole]

Work in confined spaces can kill or cause injuries in any industries, ranging from those involving complex plant through to simple storage. Those victims include not only people working in the confined space but also those who try to rescue them without proper training and equipment.

Under the FIU(CS)R, **“confined space”** means any place in which, by virtue of its enclosed nature, there arises a reasonably foreseeable **“specified risk”**, and without limiting the generality of the foregoing, includes any chamber, tank, vat, pit, well, sewer, tunnel, pipe, flue, boiler, pressure receiver, hatch, caisson, shaft or silo in which such risk arises.

The major hazards associated with the entry into or working in confined spaces arise through the combination of the confined nature of the place of work and the possible presence of substances or conditions which, taken together, could lead to the **“specified risks”** which threaten the safety and health of workers entering or staying in the confined space.

3.2 Common Potential Hazards in Confined Spaces

3.2.1 Flammable or Explosive Atmosphere

Flammable or explosive atmosphere is the mixture of oxygen in air and flammable gas, vapour or combustible dust of concentration within the flammable range. Flammable or explosive atmosphere will burn or explode in the presence of an ignition source such as sparks from welding or portable electric tool.

Flammable gas and vapour may arise from residues of flammable substances, using of flammable substances or chemical reaction (e.g. generation of methane).

Combustible dust may arise from crops (e.g. flour), chemicals, plastic particle, pharmaceuticals and metal powder.

3.2.2 Fire

Burning, welding, gas cutting and other hot work are inherently hazardous. They not only create hazards of fire, but also lead to emission of toxic gas, vapour, dust or fume, causing deficiency of oxygen, raising the atmospheric temperature, etc.

Hot work should be prohibited in confined space work as far as practicable. However, when hot work is necessary, a hot work permit system should be drawn up detailing the precautionary measures to be taken. For example:

- All electrical plant, equipment and tools that are likely to give off sparks or become hot should not be installed or used in areas where combustible substances exist.
- The quantity of gas cylinders stored should be kept to a minimum as far as practicable.
- All combustible substances in the proximity should be removed, and all workpieces should be checked to ensure that no residues of any combustible substances left on them.
- Continuous monitoring of the atmospheric temperature and air quality, and good ventilation should be maintained.
- Devise a fire emergency plan in writing so that all workers can respond quickly and correctly in case of fire.
- Proper fire-fighting installations (e.g. fire blanket and suitable water and foam type extinguishers) should be provided and maintained. **Never use carbon dioxide gas or dry powder type fire extinguishers in confined spaces.** Except for those are marked in accordance with international standards to indicate that they are suitable for use on live electrical equipment, ordinary water and foam-type fire extinguishers cannot be used on fires of electrical origin.
- The access to the fire-fighting equipment and emergency escape route should be kept free from obstruction.

3.2.3 Hazardous Gas, Vapour or Fume

Hazardous gases may be present naturally in confined spaces. However, some may arise from the work being carried out. The enclosed nature of the workspace may increase the danger, as hazardous gases can accumulate in the work area and their concentrations in air can rise rapidly.

Typical sources of hazardous gases present in confined spaces (e.g. sewers, manholes and pits of the drainage system) include the following:

- Decomposition of organic matters will generate methane and/or hydrogen sulphide. Hydrogen sulphide, being very soluble in water, often dissolves in sewage and can be trapped within sediment and sludge in sewers as gas pockets. Disturbing the sewage, sediment or sludge can release the trapped or dissolved gas.
- Leaks from underground fuel tanks, gas utility pipes, connected sewer systems or contaminated land, such as landfills, may enter the work area.
- Hazardous gases, fumes and vapours can be generated due to work or equipment nearby being improperly performed or isolated. For examples,
    - leaks from pipes which are connected to the confined space;
    - the use of generators and fuel-driven tools that can consume the oxygen and generate carbon monoxide;
    - hazardous gases, fumes and vapours released from the chemical substances being discharged into underground drains in industrial areas; or
    - welding or the use of volatile solvents, adhesives, etc, that can generate hazardous gases, fumes or vapours.

A number of hazardous gases, such as carbon monoxide, are colourless and odourless. On the other hand, some hazardous gases like hydrogen sulphide may have an unpleasant smell at low concentrations but such smell disappears at higher concentrations due to olfactory fatigue. It can be very dangerous if drainage workers think they can easily recognize the presence of toxic gases by smell.

Hazardous gases of different densities may accumulate at different levels and locations in the confined space. Gases heavier than air will fall in the lower part of the confined space, while gases lighter than air will accumulate in the upper part of the confined space.

Hydrogen sulphide, carbon monoxide and methane are the most common hazardous gases found in confined spaces (e.g. sewers, manholes and pits of the drainage system). The characteristics of these hazardous gases are listed below:

Hazardous gas	**OEL-TWA (ppm)**	**IDLH (ppm)**	**Relative density (air=1.0)**	**LEL/UEL**	**Remarks**
Hydrogen Sulphide (H_2S)	10	100	1.2	4.3% / 45.5%	Rotten egg smell; Olfactory fatigue, coma and death by suffocation at high concentrations
Carbon Monoxide (CO)	25	1,200	1.0	12.5% / 75%	Colourless and odourless; Confusion, coma and death by suffocation at high concentrations
Methane (CH_4)	---	---	0.6	5.3% / 15%	Colourless and odourless; Displace air causing asphyxiation and death

Note:
ppm – Parts per Million
OEL–TWA – Occupational Exposure Limit - Time-Weighted Average
IDLH – Immediately Dangerous to Life or Health Concentration
Relative density – <1.0 means lighter than air; > 1.0 means heavier than air
LEL/UEL – Lower Explosive Limit / Upper Explosive Limit

- Hydrogen sulphide (H_2S)
  - Hydrogen sulphide is a deadly gas with a distinctive "rotten egg" odour that can be detected at very low concentrations. At concentrations above 100 ppm, hydrogen sulphide has a paralysing effect on the sense of smell. Even at lower concentrations, hydrogen sulphide can affect the olfactory nerve and workers cannot detect the changes in concentrations. Therefore, it is very dangerous to rely on the smell to detect the presence of hydrogen sulphide by smelling. As sewage is very often present in a drainage system, workers overcome by hydrogen sulphide could be easily killed by drowning.

- Carbon monoxide (CO)
  - The lethal colourless and odourless gas, carbon monoxide, is given off when charcoal is burnt in poorly ventilated areas. Similarly, it is produced when gasoline/diesel generators or other fuel-driven tools are used in inadequately ventilated workplaces.
- Methane (CH_4)
  - Methane is commonly generated when organic matter is decomposed by a variety of bacterial processes. It is a colourless, extremely flammable and explosive gas that can cause fire and explosion. The accumulation of methane in a poorly ventilated area will displace normal air and result in an oxygen-deficient environment.

Apart from gases, hazardous fumes or vapours can be generated from the work, e.g. welding or the use of adhesives, paints, volatile or flammable solvents, etc.

Residues left in tanks, vessels, etc. can also give off hazardous gases, vapours or fumes.

3.2.4 Hazards of Excess Oxygen or Oxygen Deficiency in the Environment

The percentage of oxygen in air in a confined space should not be less than 19.5% by volume nor greater than 22% by volume at normal atmospheric pressure.

Cause of excess oxygen includes:

- Excess of oxygen in the environment due to leaking of oxygen supply may cause fires and explosion.

Causes of oxygen deficiency include:

- Oxygen consumption caused by chemical reactions:
  - Welding, cutting by oxy-acetylene, rusting (e.g. inside steel tanks and vessels when rust forms), naked flame operations, fermentation and mould growth.

- Displacement of oxygen:
  - The accumulation of methane in a poorly ventilated area will displace normal air and result in an oxygen-deficient environment.
  - A confined space which has been purged by an inert gas (e.g. nitrogen and carbon dioxide).
- Absorption of oxygen:
  - A reaction between the soils and the oxygen in the atmosphere, resulting in the oxygen being used up by the soil ingredients.
  - A reaction between the goods stored and the oxygen in the atmosphere, resulting in the oxygen being used up.

3.2.5 Heat

Without taking appropriate protective measures, workers prolongedly working under a hot environment may cause heat rashes, heat cramps, heat exhaustion and even heat stroke. The problem may be aggravated if impermeable protective clothing is worn when undertaking heavy work or working in an enclosed area with a strong heat source, poor ventilation and high humidity. Examples that lead to hot working conditions include performing underground work, hot work and using machines that give out heat, etc.

The best strategy to prevent heat stress is to avoid heavy manual work in hot environment. It is worthwhile to consider whether the work can be accomplished by mechanical means or done in cooler parts of a day or season. Heat stress can be reduced by providing blowing fans, adequate cool potable water to replace water loss from sweating and sufficient rest breaks.

If an employer believes that the employees are facing high levels of heat stress while working, he may measure the Wet Bulb Globe Temperature (WBGT) index at the workplace as the basis for assessing the heat stress of employees and formulating necessary preventive measures including risk management, control strategy and provision of personal protective equipment. The method for evaluation of heat stress using WBGT index can be referred to the National Standard.

3.2.6 An Increase in the Level of Liquid or a Free Flowing Solid

Drowning of workers arising from an increase in the level of liquid includes:

- Sudden changes in water level in sewers due to rainfall in the catchment area, changes in tide levels, sudden discharge of floodwater into the drainage culverts.
- In-rush of underground water in hand-dug tunnel.

Asphyxiation of workers arising from a free flowing solid includes:

- Free flowing solids such as grain and concrete which can partially solidify or "bridge" in silos. They can collapse unexpectedly when disturbed and press against workers resulting in asphyxiation.
- In-rush of soil in hand-dug tunnel.

3.2.7 Dust

Processes involving drilling, breaking and crushing of rocks will generate silica dust. Besides, dry cement for use in processes such as grouting, concreting, transporting and tipping of spoil could produce excessive dust.

Exposure to excessive silica dust for prolonged period can lead to silicosis - a disease with lung fibrosis causing difficulty in breathing. The risk of suffering from silicosis is high in the confined spaces with poor ventilation such as the construction of hand-dug tunnels.

To reduce the workers' exposure to silicosis, control measures such as using water suppression to reduce the dust level, applying local exhaust system at source to effectively remove dust, etc. should be taken. If, and only if, the dust level cannot be adequately controlled by any combination of the measures mentioned above, appropriate and adequate respiratory protective equipment ("RPE") should be provided to the workers and ensure that the RPE is properly worn.

3.2.8 Use of Machinery Hazards

If a dangerous part of a machine is not properly guarded, a worker could be hurt by the dangerous part due to entanglement, shearing, crushing, trapping or cutting. Do not use machines (such as saw, grinder and drill) unless their dangerous parts have been effectively guarded.

3.2.9 Biological Hazards

The workers in confined spaces (e.g. sewers, manholes and pits of the drainage system) may be exposed to biological hazard from the bite of rodents or pests. Infection from bacteria or virus is not impossible if the workplace has been contaminated.

Measures to protect workers from biological hazards include remind workers of the importance of good personal hygiene, tidy up the workplaces and inform workers of the importance of first aid treatment to prevent infection through wounds.

3.2.10 Noise Hazards

High noise level in the work environment can distract concentration, cause difficulties in oral communication and even cause accidents. Long term exposure to excessive noise can cause permanent hearing damage. Construction plant, such as drillers and rock breakers, frequently create very loud noise level.

Engineering control measures should first be adopted to reduce the noise at the source. Such measures include the use of machines with less noise, installation of anti-vibration materials, etc. If it is not possible to reduce the noise to an acceptable level, approved ear protectors (ear muffs or ear plugs) must be worn.

3.2.11 Radiation Hazards

Radiation produced when using radioactive equipment, such as laser, and conducting welding in confined spaces may hurt workers' eyes.

3.2.12 Work-above-ground Hazards

Potential hazards arising from work-above-ground in confined spaces include:

- Workers falling from locations of work-above-ground, including working platforms, scaffolds or other workplaces.
- Falling objects from the working platform hitting workers below.
- Toppling of the power-operated elevating work platform.

3.2.13 Electrical Hazards

Common sources of electric hazard associated with confined space work included underground power cables, electrical plant, equipment and tools involved in the work. For the confined spaces with humid environment, prevention of electric shock is of paramount importance. To eliminate the hazards, the following should be ensured:

- Except for the water pumps, ventilation blowers and arc welding equipment, the rated voltage of all portable electrical tools and the power supply within the confined space should not exceed 110V a.c.
- The power supplying circuitry used should be provided with a suitable residual current device to prevent electric shock.
- All electrical plant, equipment and tools should be designed to be adequately waterproof, dustproof, explosion-proof (where applicable) and double-insulated/earthed to prevent any harmful effects caused by ingress of water and dust.
- All electrical plant, equipment, tools and exposed utilities should be properly located and protected, and regularly checked and maintained.

3.2.14 Hazards from Manual Handling Operations

The working environment of a confined space is generally narrow and working in such an environment is very physical demanding. Especially if personal protective equipment is worn, performing manual handling operations would become even more difficult. Incorrect manual handling operations involving awkward posture, incorrect application of bodily force, prolonged or frequently repetitive motions, jerky motion or unexpected movements and pressure, etc. can lead to injuries such as strain and sprain, damage to the back and intervertebral discs.

3.2.15 Insufficient Lighting

Good lighting helps us to see and to recognise hazards. Adequate and suitable lighting shall be provided for entry and work in a confined space.

3.2.16 Other Hazards

The entrances of some confined spaces are located on footpaths or roads (e.g. sewers, manholes and pits of the drainage system). Workers who access to and egress from the entrances may be in danger of being knocked down by cars. Also, passersby may be in danger of falling into such confined spaces from the entrances. Vehicular access and pedestrian access should be separated as far as practicable. Traffic should be controlled through gates, barriers, traffic signs, speed and height limits etc. Steps should be taken to ensure sufficient illumination to the roads. Appropriate banksmen should be appointed to direct traffic if in need. Road closures or traffic diversion arrangements should be implemented when necessary.

Workers may inhale the fibers of asbestos during renovation/demolition works or boiler chipping works etc. Assessment for asbestos work should be conducted by a person who is qualified by training and experience to make the assessment in accordance with the Factories and Industrial Undertakings (Asbestos) Regulation and suitable steps should be taken to prevent workers from exposing to asbestos.

4. Case Study and Analysis of Common Serious Accidents

[Reference teaching time for Section 4: 45 mins]

[This section must be conducted in an interactive manner through discussion with trainees]

Workplace accidents not only cause sufferings to the victims and their families, but also result in financial losses arising from stoppage of work, insurance claims, medical and rehabilitation expenses, etc.

In fact, most of the workplace accidents are preventable. Very often, they share common scenarios and causes. These scenarios and causes should be properly understood in order that lessons are learnt and suitable measures implemented to prevent recurrence of such accidents.

4.1 Case Analysis of Serious Confined Space Accidents

<u>Case 1</u>

Poisoning in manhole sewer

Circumstances

A team of workers had to clear an underground sewer which was about 2 metres in diameter. An air test was conducted before commencement of work. The result indicated that the environment was safe. Also, an air blower was provided at the top of the manhole to blow fresh air into the sewer. When the work was close to completion, the workers removed the air blower. A worker fell unconscious when entering the sewer for final clean-up, and so did the other workers during the rescue as they did not wear any breathing apparatus when going inside.

Case Analysis

The causes of accident include:

- Inadequate Safety Awareness
  - In an enclosed space, if there is sludge or other deposits present, it is likely to be a confined space operation. Particularly in sewer works, the process can release accumulated or dissolved gases such as hydrogen sulphide. Without a proper assessment of the potential presence of harmful gases, vapours, dust, or fumes from the sludge or other deposits, the risk assessment report also lacks recommendations for the use of approved breathing apparatus.
  - not aware of the risk of sudden ingress of toxic gases because there was no continuous air monitoring.
  - lack of a standby person stationing outside the manhole for communication and appropriate emergency response.
  - disregard the risk of sudden ingress of toxic gases as a result of the engineering work.
  - ignore the risks of toxic gases that may be generated when conducting drainage work in a poorly ventilated environment.
  - the effluent in the sewer produced toxic gases. Toxic gases accumulated more easily in the absence of an air blower.
- Performing Underground Pipework Improperly
  - The proprietor or contractor and the competent person did not determine whether the confined space entry work involves underground pipe work, nor did they correctly classify the relevant drainage works as underground pipework, and therefore failed to ensure, as required in section 9 of the FIU(CS)R, properly wearing approved breathing apparatus and wearing a suitable safety harness connected to a lifeline to enable the person to be pulled out of the confined space in an emergency.
- Inappropriate Emergency Rescue
  - when a worker was found unconscious inside a drainage, the co-workers often instinctively entered the drainage immediately in an effort to rescue the worker even though they neither had proper rescue equipment nor proper training. As a result, the co-workers were also succumbed to the

gas poisoning.

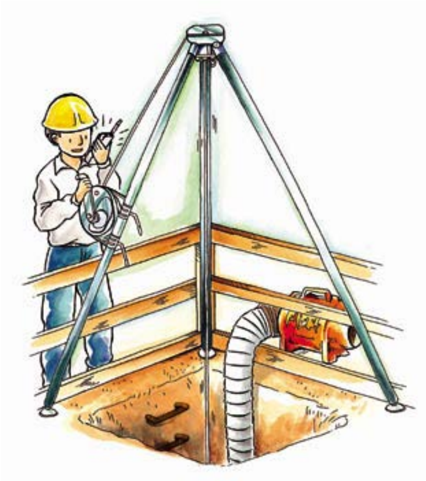
- Lack of Continuous Air Monitoring
  - the air composition in drains could be changed rapidly due to work processes, activities, or other environmental factors. For example, hazardous gases dissolved inside sludge might be released when it was disturbed and therefore the concentrations of hazardous gases in air could rise rapidly. Since workers did not monitor the air composition continuously, it was difficult for workers to determine the presence of hazardous gas or oxygen deficiency in the working environment. This situation would lead to severe consequences.
- Inadequate Safety Management and Supervision
  - the proprietor or contractor or their authorized persons did not verify the hazard assessment report, nor did they check whether underground pipes were working, whether continuous air monitoring was required, and whether workers needed to wear approved breathing apparatuses, etc.
  - failure to implement appropriate access controls for confined space work.
  - the proprietor or contractor did not assign persons with relevant confined space experience as "safety supervisory personnel".

    "safety supervisory personnel" means a person responsible for supervising and guiding the occupational safety and health issues related to confined space work. It would be desirable if the safety supervisory personnel is a competent person as defined in the FIU(CS)R or a registered safety officer.

Lessons to Learn

- The proprietor or contractor shall take alternative measures that can be substituted for workers from entering confined spaces for work. With the advancement in science and technology, there are many ways to conduct various works within the confined spaces without man-entry e.g. inspecting the internal part of a sewer by remote control monitoring, using suitable equipment and tools to perform sampling and cleaning work from outside of the confined space without requiring workers to enter the confined spaces.

- A risk assessment, with recommendations on safety and health, should be conducted by a competent person before work is carried out in a confined space. [Reference can be made to Appendix 1 - "Risk Assessment Form for Confined Space"]



- The implementation of permit-to-work system to tie in with the risk assessment of the confined space work. The proprietor or contractor should issue a "permit-to-work certificate" only when all necessary safety measures have been implemented, including all necessary safety precautions specified in the risk assessment. [Reference can be made to Appendix 2 - "Permit-to-work Certificate" for Entry into Confined Space]

- Recommendations made by the competent person and emergency procedures laid down by the proprietor or contractor should be strictly followed.

- Suitable mechanical ventilation and continuous air monitoring should be maintained while work is being conducted inside a sewer.

- Workers without proper safety training and not wearing protective equipment should not be allowed to enter a confined space to work or to carry out a rescue operation. The workers should:
    - wear suitable and approved breathing apparatus.
    - wear a safety harness connected to a lifeline, with the free end of the lifeline held by the worker staying outside for immediate rescue.
    - equip with audio and visual alarm devices (i.e. personal motion-sensing alarm devices and continuous air monitoring devices) and communication devices to keep in touch with the worker stationed outside.

Other Points to Note

- The proprietor or contractor shall ensure that:
  - only certified workers are allowed to enter or work in the confined space.
  - safety precautions shall be taken before work begins and when work is being carried out (e.g. conducting air testing, continuous air monitoring and using suitable ventilation equipment, etc.).
  - the safety precautions shall be effectively maintained (e.g. providing suitable ventilation equipment and continuous monitoring of the air quality inside the sewer, etc.) while workers are working inside the confined spaces.
  - any person entering the confined space should be wearing suitable approved breathing apparatus and suitable safety harness connected to lifeline (where the use of approved breathing apparatus is recommended in a risk assessment report, or entry into a confined space for underground pipework is required).
  - all workers understand the safe system of work and the emergency rescue procedures formulated and shall provide all necessary rescue equipment for emergency rescue.
- The employees shall:
  - check whether the "risk assessment report" and the related "permit-to-work certificate", which state that work can be carried out safely, have been displayed in a conspicuous place at the entrance of the confined space.
  - strictly follow safe working procedures and emergency procedures implemented by the proprietor or the contractor (e.g. wearing approved breathing apparatus, use of rescue equipment and protective equipment, etc.).
  - make full and proper use of safety equipment provided by the proprietor or contractor.
  - inform the worker stationed outside and get out immediately should any

changes in the environment or physical discomfort be noticed.

Discussion

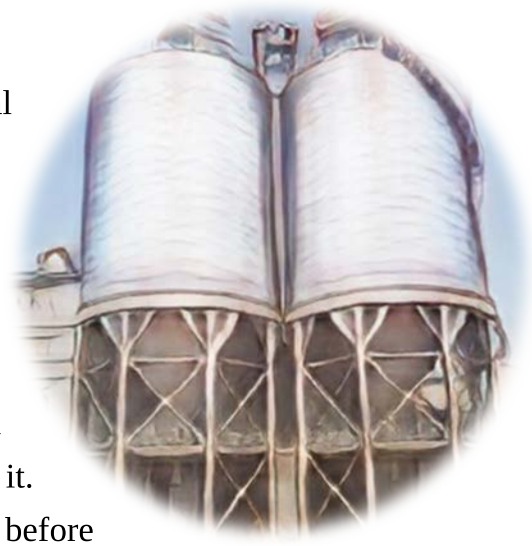
- Common confined spaces in construction sites (e.g. chamber, tank, vat, pit, well, sewer, tunnel, pipe, flue, boiler, pressure receiver, hatch, caisson, shaft, silo, etc.).
- Potential hazards associated with confined space work, including all specified risks, in particular, the atmospheric hazards of underground sewers and their connected manholes.
- Entering underground sewers and their connected manholes is considered underground pipe work as described in Section 9(b) of the FIU(CS)R. Anyone entering or staying in these spaces must properly wear approved respiratory protective equipment and a suitable safety harness connected to a lifeline, so that they can be pulled out of the confined space in an emergency.
- Underground sewers and their connected manholes contain sludge or other deposits that can emit hazardous gases, vapours, dusts, or fumes. Continuous monitoring of the air in the confined space is required until everyone has exited the confined space.
- All members of the rescue team shall have been properly and adequately trained in the related emergency rescue procedures, including the detailed particulars of an emergency rescue plan and full knowledge of how to properly use all the rescue equipment specified in section 10(2) of the FIU(CS)R.
- Even if workers are in the immediate vicinity of the confined space and perform associated work in that confined space, the proprietor or contractor shall appoint a competent person to assess the reasonably foreseeable risk arising from the work (e.g. releasing of hazardous gases or falling from height, etc.) and make recommendations on measures necessary to ensure the safety and health of workers.
- The proprietor or contractor shall exercise sufficient supervision over confined space work, including recording videos at the entrance and exit of the confined space throughout the entire work period to monitor that relevant

personnel have complied with the safety precautions. The video records shall be kept for one year after the work is completed and made available for inspection within a reasonable timeframe.

<u>Case 2</u>

Collapse of the accumulated coal ash inside silo

Circumstances



A team of workers was assigned to clear the coal ash, which was generated upon burning of the coal for power generation, accumulated inside a silo of a power station. An aggregate of the coal ash stacked up inside the silo up to at least 3m in height suddenly collapsed. All workers were able to flee from the sliding down of the ash, except one who was buried under it. Other workers attempted to offer rescue before firemen arrived at the scene but to no avail. The worker was certified dead on the spot.

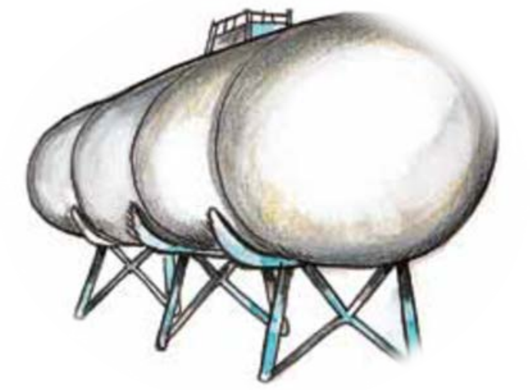
Case Analysis

The causes of accident include:

- Inadequate Safety Awareness
  - No aware of the risk of collapse of the accumulated coal ash in the course of clearing work.
  - Not adopting control measures and using proper monitoring equipment to prevent the over-accumulation of the coal ash inside the silo.
  - Risk assessment for the work in confined space was not carried out.
  - Neither competent person nor standby person was assigned to monitor the clearing of coal ash work being conducted.

- Inappropriate Emergency Rescue

- When the worker was found to have been buried by the coal ash, the co-workers were in a desperate bid to offer their assistance to rescue his fellow worker at stake, in spite of the fact that they had neither received proper rescue training nor rescue equipment to take it upon themselves.



- Lack of Continuous Monitoring
  - There was no equipment to continuously monitor the quantity of the accumulated coal ash inside the silo. The workers appointed to work did not have an idea about the dangerous environment where they were subjected to the risk of the falling ash.

- Inadequate Frontline Safety Management and Supervision
  - There was no competent person who had experience in confined space works assigned to check whether the risk associated with the clearing of the coal ash was identified.

Lessons to Learn

- A risk assessment, with recommendations on safety and health, should be conducted by a competent person before work is carried out in a confined space.
- The implementation of permit-to-work system in tandem with the risk assessment of the confined space work. The proprietor or contractor should issue a “permit-to-work certificate” only when all necessary safety measures have been implemented, including all necessary safety precautions specified in the risk assessment.
- Recommendations made by the competent persons and the emergency procedures laid down by the proprietor and contractor should be strictly

followed.

- Continuous monitoring of the working condition inside the silo should be maintained while the work is being conducted.

Other Points to Note

- The proprietor or contractor shall ensure that:
  - only certified workers are allowed to enter or work in the confined space.
  - safety precautions shall be taken before work begins and when works is being carried out.
  - the safety precautions shall be effectively maintained while workers are working inside the confined spaces.
  - all workers understand the safe system of work and the emergency rescue procedures formulated and shall provide all necessary rescue equipment for emergency rescue.
- The employees shall:
  - check whether the "risk assessment report" and the related "permit-to-work certificate", which state that work can be carried out safely, have been displayed in a conspicuous place at the entrance of the confined space.
  - strictly follow safe working procedures and emergency procedures implemented by the proprietor or the contractor.
  - make full and proper use of safety equipment provided by the proprietor or contractor.
  - inform the worker stationed outside and get out immediately should any changes in the environment or physical discomfort be noticed.

Discussion

- Common confined spaces in construction sites (e.g. chamber, tank, vat, pit, well, sewer, tunnel, pipe, flue, boiler, pressure receiver, hatch, caisson, shaft, silo, etc.).

- Potential hazards associated with confined space work, including all specified risks.
- Mandatory requirements for persons to work in confined spaces.
- The dangers faced by the personnel conducting rescue operations.
- Difficulties encountered by the parties concerned (including the proprietors or contractors, the competent persons, the workers who clean the accumulated coal ash inside silo) and their responsibilities.

<u>Case 3</u>

[Training course provider should provide an accident case associated with confined spaces operation (in particular those occurred during the three years preceding the conduct of the course, such as examples involving the use of oxygen-consuming and exhaust-emitting devices like generators in confined spaces, or cases of poisoning caused by the use of volatile chemicals in water tank projects) for case study and analysis in this section]

[Reference can be made to the "Work Safety Alert" provided on the Labour Department's website]

Contents of case study and analysis should include:

Circumstances

- Brief description of the accident case.

Case Analysis

- Analyze the cause of the accident.

Lessons to Learn

- Precautionary measures to be taken to prevent recurrence of the accident.

Other Points to Note

- Points to note for the proprietor or contractor.
- Points to note for the worker.

Discussion

- Common confined spaces in workplaces (e.g. chamber, tank, vat, pit, well, sewer, tunnel, pipe, flue, boiler, pressure receiver, hatch, caisson, shaft, silo, etc.).
- Potential hazards associated with confined space work, including all specified risks.
- Mandatory requirements for persons to work in confined spaces.
- The dangers faced by the personnel conducting rescue operations.
- Difficulties encountered by the parties concerned (including the proprietors or contractors, the competent persons, the workers, etc.) and their responsibilities.

5 Basic Concept of Safe System of Work and Permit-to-work System

[Reference teaching time for Section 5: 70 mins]

5.1 Basic Concept of Safe System of Work

A safe system of work is a formal procedure which results from systematic examination of a task in order to identify all the hazards. It formulates safe methods to ensure that hazards are eliminated or risks minimized.

Steps to a safe system of work:

(1) Risk assessment

- Assess the task and identify the hazards

(2) Method statements

- Formulate safe methods including details of all relevant processes, work procedures, risk control measures, requirements for the associated equipment, and qualifications and training of the workers, etc.

- A permit-to-work system in respect of some high risk work and working environments (such as confined spaces, hot work and work on electrical equipment) should be implemented. The system uses a certificate ("permit-to-work certificate") to set out the work to be done and items to be checked before starting the work and the necessary precautions to be taken to ensure safety and health at work.

(3) Implementation

- Sufficient and suitable steps should be taken to ensure that all safety precautions stated in the risk assessments, permit-to-work systems and method statements are effectively and continuously implemented and maintained.

- Sufficient and necessary information, instruction and training should be provided to all personnel directly or indirectly involved in the work to ensure that they have sufficient knowledge and safety awareness in respect of the work.

(4) Supervision

- An effective monitoring and control system should be established and implemented. A supervisor with sufficient relevant knowledge, experience and safety awareness should be assigned to supervise the work.

(5) Review

- The risk assessments and the associated working arrangements should be regularly reviewed in a timely manner. A review should also be conducted whenever any circumstances during work indicate that the risk assessments and/or the associated working arrangements are no longer valid, or where there has been a significant change in the condition of the work relevant to the assessments and working arrangements. Whenever necessary, a fresh risk assessment should be conducted.

5.2 Safe System of Work and Permit-to-work System for Confined Space Work

A safe system of work should be established by the proprietor or contractor responsible for the space for every operation in a confined space. The system of work should include, but not limited to, the effective implementation of the following:

- The proprietor or contractor shall, as far as reasonably practicable, take alternative measures that can be substituted for workers from entering confined spaces for work.
- to appoint a competent person to carry out risk assessment for work in the confined space and make recommendations on safety and health measures before undertaking the work;
- to ensure that all safety precautions before work begins have been carried out

[Reference can be made to section 5.2.1];

- to issue a "permit-to-work certificate" stating that all necessary precautions have been taken and specifying the period during which worker may remain safely in the confined space before a worker enters a confined space [Reference can be made to section 5.2.2];

- The proprietor or contractor should establish and implement an effective system to ensure that all individuals who enter and stay or work inside a confined space have exited the confined space within a specified timeframe.

- to ensure that all safety precautions when work is being undertaken have been carried out and kept effective throughout the confined space work [Reference can be made to section 5.2.3];
- to ensure that no workers other than certified workers enter or work in the confined space;
- The proprietor, contractor and occupier of the workplace should take adequate steps to ensure the confined space within the workplace is well-segregated to avoid trespassing, for example, the confined space should be locked up when left vacant, all entrances of the confined space should be securely controlled, and entry and exit log should be recorded and kept.
- The proprietor or contractor should have a system for access control on the confined space work, recording the workers entering and leaving the confined space clearly and ensuring only relevant workers are allowed to enter the confined space. Common practices include setting up a "tag in/tag out" notice at the entrance of a confined space so that people outside the confined space can easily be aware of workers' details and the time of entering the confined space. This provides crucial information for the safety supervisory personnel, standby person and rescue team. It helps to check the compliance of the safety requirements and ensures the effective execution of the contingency plan in case of emergency situations.

- to ensure that a person is stationed outside the confined space to maintain communication with the workers inside;

- to ensure the use of an approved breathing apparatus and other necessary personal protective equipment by worker inside the confined space (where the use of approved breathing apparatus is recommended in a risk assessment report, or entry into a confined space for underground pipework is required);

- The proprietor or contractor shall exercise sufficient supervision over confined space work, including recording videos at the entrance and exit of the confined space throughout the entire work period to monitor that relevant personnel have complied with the safety precautions. The video records shall be kept for one year after the work is completed and made available for inspection within a reasonable timeframe. *[Note: The proprietor or contractor shall record the video and handle the data collected in accordance with the Personal Data (Privacy) Ordinance (Cap. 486). For details, please refer to the Ordinance, relevant code of practice and publications, e.g. "Guidance on CCTV Surveillance and Use of Drones", etc.]*

- to formulate and implement appropriate emergency situations and response procedures to deal with any serious and imminent danger to workers inside the confined space [Reference can be made to section 6]; and

- to provide necessary information, instructions, training and advice to all workers within a confined space or assisting with such work from immediately outside the confined space.

5.2.1 Safety Precautions Before Work Begins

The proprietor or contractor shall, as far as reasonably practicable, take alternative measures that can be substituted for workers from entering confined spaces for work. With the advancement in science and technology, there are many ways to conduct various works within the confined spaces without man-entry e.g. inspecting the internal part of a sewer by remote control monitoring, using suitable equipment and tools to perform sampling and cleaning work from outside of the confined space without requiring workers to enter the confined spaces, etc. Proper planning of work or switching to another work method can reduce the need to work in confined spaces.

A proprietor or contractor should ensure that no worker enters a confined space for work unless safety precautions including (but not limited to) isolation, purging, air testing, ventilation and using personal protective equipment have been taken before the work begins.

Isolation

- The proprietor or contractor shall, before allowing workers to enter a confined space, ensure that the confined space has been securely and completely isolated and separated from all the other connecting parts so as to prevent any materials which are liable to create a hazard from entering the confined space.
- All isolation points should remain fully secure to ensure that the dangerous materials will not go into the confined space whilst the workers are working inside.
- The confined space should be isolated from all unnecessary sources of power, e.g. electrical, mechanical, pneumatic, hydraulic, etc., by having them securely locked off, isolated and properly labelled as appropriate to avoid accidental switching of power back to the confined space.
- All pipelines connected to a confined space should be completely shut off or blanked off as appropriate. All connected valves should be fully closed, locked off and properly labelled as appropriate to prevent from being opened without authorization or accidentally.
- Ends of service pipes which are still connected to sources of hazardous gas must be properly sealed (e.g. by means of metal blank or end-cap).
- Any activities outside and in the vicinity of the confined space which may jeopardise the safety or health of workers inside a confined space should not be permitted. Barriers should be erected outside access openings of the confined space, with suitable warning signs and notices displayed.
- The confined space should be isolated from all non-essential sources of heat.
- Effective steps shall be taken to prevent ingress to the confined space of hazardous gas, vapour, dust or fume, or in-rush of mud, water or other free flowing liquids and solids. Openings in a confined space (e.g. drain holes) shall be sealed off if there is any possibility of atmospheric hazards to flow back into the confined space from another area and contaminate it. Regarding in-rush of water, particular attention should be given to the possible sudden changes in water level in drainage facilities due to rainfall in the catchment

area, changes in tide levels, sudden discharge of floodwater into the drainage culverts, etc.

Purging

- With regard to the circumstances of a particular confined space, before the proprietor or contractor allows workers to enter into the confined space for work, the confined space shall be adequately purged by suitable method, such as steam cleaning, inert gas purging, forced ventilation, etc. to remove all the hazardous substances contained in the confined space.

  Steam cleaning

  - Steam-volatile substances in confined spaces could be removed by steam cleaning.
  - For removal of corrosive materials, or materials which are not readily volatile, preliminary treatment by repeated washing with water, or with other suitable solvents or appropriate neutralizing agent should be applied prior to steaming.
  - The period of steaming should be adequate to remove all the hazardous substances from the confined space thoroughly. The required period should be decided and checked by the person who has been appointed by the proprietor of the industrial undertaking for the steaming work.
  - It would be necessary to re-steam where the confined space has been left for more than a few hours after steaming.
  - During steaming, adequate outlets for steam and condensate should be provided so that no dangerous pressure should be built up inside the confined space.
  - After steaming, adequate air inlets should be provided so that there would not be any vacuum being formed in the confined space by cooling and condensation. To prevent any heat stress problem, sufficient cooling of the confined space to room temperature is essential before allowing workers to enter the space.
  - After purging, all liquid remaining in the confined space should be drained away or pumped out as appropriate, and sufficient ventilation should be provided to the confined space.
  - Consideration should be given to the potential exposure of workers

outside the confined space to hazardous substances carried out by steam cleaning, and effective safety measures should be adopted to prevent workers outside the confined space and nearby workers from coming into contact with these hazardous substances.

Inert gas purging

- To avoid the formation of an explosive mixture with air when a confined space containing flammable gas or vapour is opened up, the confined space may be purged by an inert gas (e.g. nitrogen, carbon dioxide).
- If persons have to enter or approach a confined space in which an inert gas has been purged, the confined space shall be purged again by fresh air so as to provide adequate oxygen into the confined space to support life. Thereafter, all parts of the air-purged confined space shall then be thoroughly tested against the deficiency of oxygen to make sure that there is adequate oxygen to support life.
- Consideration should be given to the potential exposure of workers outside the confined space to hazardous substances carried out by inert gas purging, and effective safety measures should be adopted to prevent workers outside the confined space and nearby workers from inhaling these hazardous substances..

Air Testing

- Appropriate air testing of a confined space shall be carried out to ensure the absence of any hazardous gas and no deficiency of oxygen before it is certified to be safe to enter.

- Air testing of a confined space should be conducted to decide and specify the related safety precautions necessary to be taken upon entry into such confined space.

- A proprietor or contractor shall prohibit a worker from entering any confined space until initial air testing of the confined space has been properly done from outside, with the test results showing that the environment inside the confined space is safe for entry.

- The air testing should include the testing of the oxygen content and the presence of flammable, toxic or harmful gases, fumes or vapours. Appendix 3 provides information on common atmospheric hazards in confined spaces.

- In selecting appropriate air monitoring equipment for air testing, the types and concentration ranges of atmospheric hazards, as well as parameters such as instrument type, detection range, error, accuracy, resolution, response time, and applicable environment should be considered. It is also essential to consider whether interference could reduce or compromise its detection capabilities.

- All air monitoring equipment should be used in accordance with the operation manual from the manufacturer. All air monitoring equipment should be suitably calibrated and properly maintained as per the recommendations of the manufacturers, with records properly kept.

- All air testing should be carried out with the correct testing methods. Consideration must also be taken to the geometry of the confined space and the physical properties of the gas to be monitored. For instance, air at different levels and locations inside a confined space should be tested since hazardous gases with different densities relative to air may accumulate at different levels and locations of the confined space. (See Figure 1)

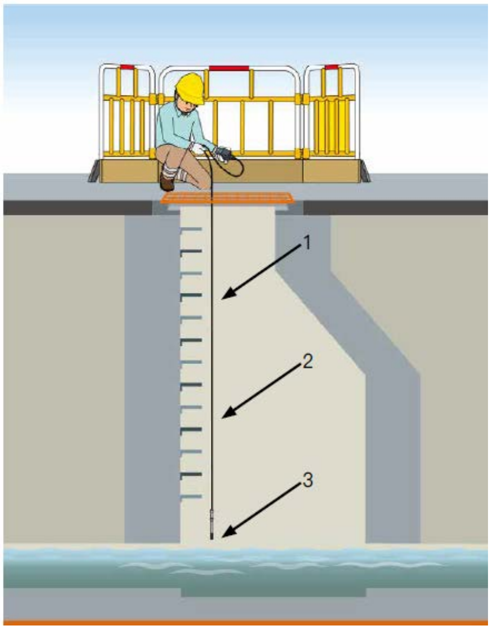


Figure 1: Air at different levels and locations should be tested from the top to the bottom

- Air testing should be carried out outside the confined space, with air samples being drawn out from the confined space by suitable sample probes. It is crucial to ensure that the sampling probe and tubing are not blocked or kinked, and sufficient sampling time should be allowed for testing.

- Additionally, during air testing, appropriate measures should be considered to prevent accidental entry into the confined space, such as using temporary protective nets during testing.

- In case flammable or explosive gases or vapours may be present in the confined space, the air monitoring equipment should be of the explosion-proof type. It should have both audio and visual alarms so that it can quickly alert workers if a hazardous situation exists or is developing in the confined space.

- In general, testing for oxygen should be performed first because most combustible gas testing meters are oxygen dependent and do not provide reliable readings in an oxygen deficient atmosphere.

- In a confined space, the percentage of oxygen in air should not be less than 19.5% by volume nor greater than 22% by volume at normal atmospheric pressure.

- The exposure limits for various gases, vapours, dust, or fumes in the air can be referenced from the "Occupational Exposure Limits" listed in the "Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace" published by the Labour Department. For chemicals that do not have established "Occupational Exposure Limits", the exposure limits should be referred to relevant international or national standard, or databases from reliable chemical manufacturers or recognised occupational safety and health professional organisations.

Ventilation

- Adequate supply of respirable air and effective forced ventilation shall be provided inside a confined space. It includes the use of mechanical ventilation to supply an adequate fresh air to workers inside the confined space and prevent atmospheric hazards. In deciding the design and installation of a ventilation system, the following factors should be considered:
  - Foreseeable atmospheric hazards and their risks that may be present or generated;
  - Processes and equipment being used;
  - Potential need to control environmental temperature and/or humidity;

and

- Number of workers and their work locations, and whether ventilation requirements may need to be modified or impose limitations while work is in progress.

- When supplying fresh air, the blower should be carefully positioned to avoid introducing contaminated air into the confined space. (See Figure 2)

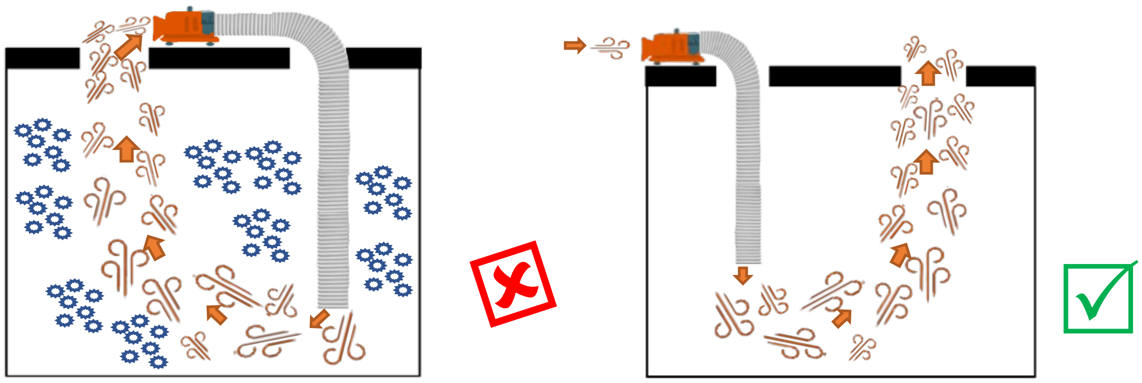


Figure 2: When supplying fresh air, the blower must be carefully positioned to avoid drawing contaminated air into the confined space.

- The provision of ventilation to a confined space should not be considered as an alternative to the use of approved breathing apparatus where the atmosphere inside is likely to cause safety or health hazards to the workers therein.

- Before entering the confined space, it shall be thoroughly purged by means of ventilation. As some hazardous gases (e.g. hydrogen sulphide, etc.) are heavier than air, the air hoses or ducts of fresh air should be directed or extended deep into the confined space. The atmosphere shall be confirmed safe by air testing. When working in confined space, the outlets of the fresh air hoses or ducts should be placed near the work locations of the workers to ensure adequate fresh air. In addition, the removal of air impurities can be facilitated by placing the inlets of the extraction air hoses or ducts near the source of air impurities. Additionally, exhaust device can be installed at the exit or ventilation openings of the confined space to aid in removing impurities and facilitating air exchange. However, it is crucial to consider the positioning of ventilation equipment to avoid short-circuiting and maintain effective air circulation within the confined space. (See Figure 3)

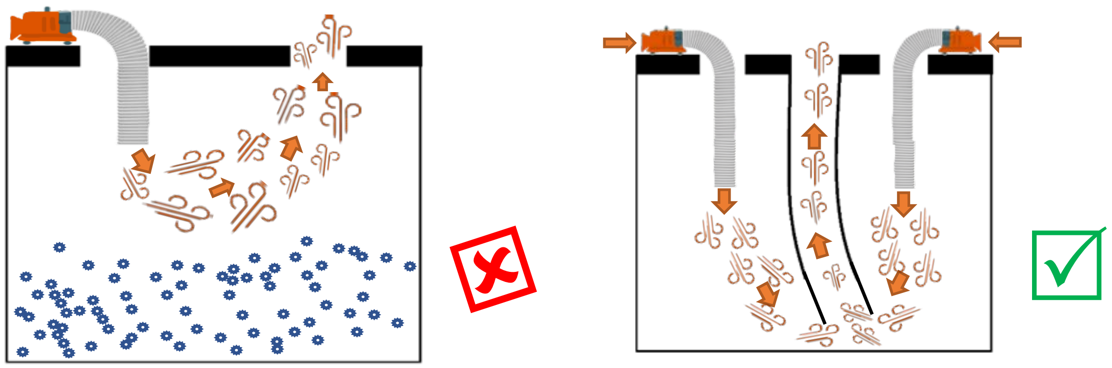


Figure 3: Carefully consider the positioning of ventilation equipment to avoid short-circuiting and maintain effective air circulation within the confined space.

- Certain processes and equipment, such as welding or the use of petrol/diesel-powered devices, can consume oxygen, release atmospheric hazards, and generate heat. Therefore, performing such process or using such equipment in confined space should be avoided if possible. Whenever performing such processes or using such equipment in confined space is unavoidable, adequate forced fresh air should be supplied at the worksite. Exhaust device and hoses or ducts should also be installed near the working location to remove air impurities and hot air effectively. For performing such processes or using such equipment outside the confined space, ingress of the atmospheric hazards or heat in confined space should be avoided.

- Under no circumstances should oxygen be introduced into a confined space which would create a danger of oxygen enrichment in the air.

- Notwithstanding the above, a proprietor or contractor shall also take effective steps to prevent ingress to the confined space of hazardous gas, vapour, dust or fume; and an in-rush into the confined space of free flowing solid or liquid. In that respect, particular attention has to be paid to any possible ingress, in-rush, spillage or leakage of the substances through the ingress, egress or openings of the confined space from areas or places surrounded.

5.2.2 Permit-to-work System for Confined Space Work

(An example of “permit-to-work certificate” for Entry into Confined Space is attached at Appendix 2)

- The implementation of “permit-to-work system” is an essential part of a safe system of work for confined space work. The proprietor or contractor may set out in a “permit-to-work certificate” the work to be done and items to be checked before entering a confined space and the necessary precautions to be taken to ensure safety and health at work in the confined space.
- The proprietor or contractor should, after receiving a risk assessment report completed by the competent person, verify that the risk assessment report has covered all the matters referred to section 5(2) of the FIU(CS)R . He should then issue a “permit-to-work certificate” to the certified workers engaged in confined space work only when all necessary safety measures have been implemented, including all necessary safety precautions specified in the risk assessment.
- The proprietor, contractor or his authorized person should sign on the “permit-to-work certificate” to confirm that all safety precautions indicated on the certificate have been implemented effectively. The proprietor, contractor or his authorised person should sign the “permit-to-work certificate” to confirm that all safety precautions indicated on the certificate have been implemented effectively. If the proprietor or contractor authorises a person to issue a “permit-to-work certificate”, the person should have sufficient knowledge of working in confined spaces and the safety precautions to be taken. In general, the authorised person should be a competent person as interpreted under the FIU(CS)R. Since the person issuing the “permit-to-work certificate” needs to verify the contents of the risk assessment report as mentioned above, the person being authorised to issue the “permit-to-work certificate” should not be the competent person who completed the risk assessment report. Moreover, the person issuing the “permit-to-work certificate” should also clearly explain the content of the “permit-to-work certificate” to all workers and relevant persons involved in the confined space. Moreover, the person issuing the “permit-to-work certificate” should also clearly explain the content of the certificate to all workers and related persons involved in the confined space. Entry into a

confined space for work should be permitted only after the issue of a valid "permit-to-work certificate" by the proprietor or contractor.

- The person responsible for signing and accepting the "permit-to-work certificate" should be the one who is responsible for stationing outside the confined space, that is, the onsite supervisor or the person-in-charge of the work in the confined space. Such "permit-to-work certificate" should specify the location (the conditions and characteristics of the confined space) and type/nature of work to be done, and state:
  - that all necessary safety precautions in relation to the hazards identified in the risk assessment report have been taken; and
  - the period during which workers may remain safely in the confined space.

  In addition, the "permit-to-work certificate" should also include:

  (a) results in the risk assessment report completed by the competent person;
  (b) effectiveness of the isolation and withdrawal from service;
  (c) the amount of sludge or other deposits (if any) after cleaning;
  (d) results of the air testing;
  (e) whether the nature of work to be done involves underground pipework;
  (f) the condition and features of the confined space;
  (g) a list of personal protective equipment ("PPE");
  (h) the period during which workers may remain safely in the confined space; and
  (i) other safety precautions.

5.2.3 Safety Precautions When Work Is Being Undertaken

- A proprietor or contractor shall ensure that all workers who enter or work in a confined space are certified workers. When allocating work to confined space workers, every step should be taken to ensure that the demands of the work activities do not exceed the workers' skills and abilities to carry out the work without risks to themselves or others.

- A proprietor or contractor shall provide all necessary equipment to ensure the safety and health of workers working in a confined space. The equipment shall be appropriately selected in respect of their types, purposes, functions and applications. The equipment should also be suitably calibrated, regularly checked and properly maintained, with records properly kept.

- When work is being carried out in a confined space by a certified worker, the proprietor or contractor shall ensure that the relevant risk assessment report, with all its significant findings, is displayed in a conspicuous place at the entrance of the confined space. The related "permit-to-work certificate" shall also be displayed in a conspicuous place at the entrance of the confined space.
- When work is being carried out in a confined space by a certified worker, standby person must be assigned to station outside the confined space throughout the time of operation to maintain communication with the worker inside.
- The standby person shall be trained on how to maintain communication with those workers inside the confined space and to call for support in case of emergency, including the use of new technology to maintain effective communication with those workers inside the confined space. Additionally, a proprietor or contractor shall provide, to all workers working within a confined space or assisting with such work from immediately outside the confined space, such information, instructions, training and advice as are necessary to ensure the safety and health of all workers in the confined space.
- The standby person shall keep the workers inside the confined space informed of any change in environmental conditions that would adversely affect their safety in the confined space (e.g. heavy rain leading to flooding, emergencies such as fires, spillage of toxic, corrosive or flammable liquids, releasing of hazardous gases, power supply failure, failure of forced ventilation system, etc.).
- On the other hand, the workers inside a confined space shall keep communicating with the standby person , who can quickly summon assistance in the event of a hazardous situation inside the confined space.
- If significant changes or abnormal conditions are observed in the working environment, particularly in air quality, soil conditions, or groundwater levels, or if adverse weather conditions that may pose potential risks to the safety and health of workers are known, work must be immediately suspended, and all workers must be evacuated. Subsequently, a thorough review of risk assessment and related work arrangements must be conducted. Work shall

not be resumed unless the site environment is confirmed to be safe.

- A proprietor or contractor shall ensure that the safety precautions, which are taken before work begins in the confined space, continue to be effective whilst the workers remain in the confined space.

- During the continuous or periodic monitoring of the working environment as recommended by the risk assessment, air monitoring equipment should have two levels of alarm systems to alert workers to take appropriate action. Where applicable, workers should wear continuous air monitoring equipment that provides audio and visual alarms to enable workers and standby personnel to be immediately aware of the danger, evacuate the site as quickly as possible, and arrange rescue. Information on alarm settings for air monitoring in confined spaces is provided in Appendix 3.
- Unless alternative suitable arrangements are made, the standby person shall have sufficient physical strength to be capable of pulling workers out from outside the confined space. The standby person may use mechanical devices to assist him when he is pulling the worker out of the confined space. The standby person should be responsible for contacting emergency rescue teams when necessary. A standby person should be a certified worker or competent person as defined by the FIU(CS)R.

5.3 Critical Control Measures of Work in Confined Spaces

- Before working in a confined space, a competent person shall be appointed to carry out risk assessment and make recommendations. Certified workers shall enter or work in confined spaces only after the issuance of "permit-to-work certificate".
- Before entering the confined space, ensure that the confined space has to be sufficiently purged, cooled and ventilated.
- All pipelines connected to the confined space shall be properly and completely blanked off as appropriate.
- Perform continuous air monitoring to ensure that the atmospheric environment meets the required standard throughout the work. Each group of workers should individually bring at least one portable air monitoring equipment to conduct continuous air monitoring during work.
- Ensure that any person entering or remaining in that confined space properly

wears an approved breathing apparatus and a suitable safety harness, where the use of approved breathing apparatus is recommended in a risk assessment report, or entry into a confined space for underground pipework is required. The safety harness should be connected to a lifeline and the free end of the lifeline should be held by the standby person outside the confined space.

- Formulate and implement proper emergency procedures, including provision of sufficient and suitable rescue equipment and presence of a rescue team that commensurate with the scale of the task.
- Implement effective monitoring and supervision to ensure that the above safety measures are fully implemented and being strictly followed.
- Work team must not begin confined space works unless reasonable steps have been taken to prevent access by unauthorised persons to the confined spaces and adopt a management system to the ingress and egress of confined spaces.
- If someone faints in a confined space, the standby persons/ workers from outside **must remember**:
  - **remain stationed outside the confined space, prevent other workers from entering.**
  - **summon assistance from the rescue team and public emergency services (i.e. Hong Kong Police Force and Fire Services Department).**
  - **brief the rescue personnel on the relevant circumstances of the incident.**
  - **never enter a confined space to try to rescue.**

[Training course provider can display the Leaflet promoted by Occupational Safety & Health Council "What should the standby persons/ workers from outside do if someone faints in a confined space (Chinese version only)"

https://www.oshc.org.hk/oshc_data/files/ProfessionalServices/StarScheme/ConfinedSpace/publication_emergency.pdf

6. Emergency Situations and Response Procedures

[Reference teaching time for Section 6: 45 mins]

An emergency response plan should be properly formulated, including all the suitable rescue arrangements and the appropriate emergency procedures as described below, and adopted for each entry into a confined space.

Procedures

- A proprietor or contractor shall formulate and implement appropriate procedures to deal with any serious and imminent danger to workers inside a confined space.
- The emergency procedures should include situations that trigger evacuation, such as fire, adverse weather conditions (such as heavy rain), in-rush of large amounts of mud or water, undesirable changes to atmospheric hazards, failure of ventilation or fresh air supply system, and failure of emergency response equipment (such as communication devices, respirators, etc.).
- Typical air monitoring equipment can set different levels of alarms according to the level of atmospheric hazards to remind workers and standby persons whether there are adverse changes in the confined space, so as to determine the corresponding actions that should be taken, including evacuation or arranging rescue. Technical details and recommendations for setting air monitoring alarms are provided in Appendix 3.

Rescue

- A proprietor or contractor should set up arrangements to rescue workers working in a confined space promptly in case of an emergency. Arrangements for emergency rescue will depend on the nature of the confined space, the risks identified and the likely nature of an emergency rescue. Account has to be taken not only of accidents arising from a specified risk, but also any other accident, for example, incapacitation caused by a fall.

- A rescue team consisting of sufficient number of trained persons, should be readily available. They should readily reach the confined space in time and be able to get the persons inside the confined space out in case of emergency.

In general, sufficient rescue personnel and equipment should be arranged on the same worksite or near the confined space.

- As to the number of trained persons required in a rescue team, the factors to be considered depend on the circumstances of the case, including the nature of work, the hazards inherent in the confined space in relation to the work and work methods proposed, need to be considered depending on the circumstances of the case. In devising an emergency plan, a proprietor or contractor should assess the above factors against the knowledge and experience of the rescue team in such work and recommend the most suitable number of rescue persons required.
- All members of the rescue team shall have been properly and adequately trained in the related emergency rescue procedures, including the detailed particulars of an emergency rescue plan and full knowledge of how to properly use all the rescue equipment specified in section 10(2) of the FIU(CS)R.

Communication

- The proprietor or contractor may, where reasonably practicable, provide video surveillance or body-worn video cameras to workers who need to enter confined spaces. It allows the standby person outside the confined space to monitor the workers' work in real-time and promptly call for rescue when necessary.
- Constant communication between the workers inside a confined space and the standby person shall be maintained throughout the period when the workers are working inside the confined space. An audio and visual alarm system shall be provided for the workers inside the confined space to alert the standby person, and vice versa, in case of emergency.
- Each worker should be equipped with a personal motion-sensing alarm device which can emit audio and visual alarm so that the standby person outside is immediately alerted to arrange for rescue in case the worker inside confined space is unconscious.
- Even in an emergency, the standby person must not enter the confined space. He shall remain stationed outside the confined space and summon assistance

from the rescue team and public emergency services (i.e. Hong Kong Police Force and Fire Services Department). He shall brief the rescue personnel on the relevant circumstances of the incident upon their arrival.

Equipment

- Suitable and sufficient rescue equipment, including standby approved breathing apparatus, safety harness, lifelines, reviving apparatus and emergency lighting, and properly trained rescue personnel shall be readily available for rescue purposes at all times when workers are working inside a confined space. Rescue equipment provided shall be appropriate in view of the likely emergencies identified in the risk assessment and be properly maintained. The resuscitation equipment should comply with the latest and recognized international or national standard.

- Where practicable, appropriate lifting equipment, e.g. rescue hoist or winch, split-leg tripod/quadpod with a frame-mounted hoist and one-man access cradle should be available for rescue purposes.
- When continuous monitoring or periodic monitoring of the working environment due to adverse changes in the conditions of a confined space or the work conducted within it is recommended in the risk assessment report, the proprietor or contractor should provide every worker entering the confined space to work such as hand-dug tunnelling or drainage work with a set of emergency escape breathing apparatus and ensure workers to bring with them, unless the worker is using an approved breathing apparatus therein. The proprietor or contractor should ensure adequate supply of respirable air from the emergency escape breathing apparatus to allow workers to escape safely in emergencies. The emergency escape breathing apparatus should comply with the most up-to-date recognised international or national standard.
- The proprietor or contractor should provide adequate information, instructions, training and supervision to the workers to ensure their proper use and wearing of the emergency escape breathing apparatus. The proprietor or contractor should take appropriate steps to ensure the proper functioning of the emergency escape breathing apparatus, such as suitable storage, proper maintenance and regular inspection.

Evacuation

- A proprietor or contractor shall devise an evacuation procedure for prompt evacuation of the workers from the confined space in case of a sudden change in the working or the environmental condition that may cause imminent danger to them .
- If the risk assessment report does not recommend the use of an approved breathing apparatus to work in confined spaces and underground pipework is not involved, the proprietor or contractor should consider providing workers with emergency escape breathing apparatus based on the working environment of the confined space to allow workers to escape safely in emergencies. However, it should be noted that an emergency escape breathing apparatus is not a substitute for an approved breathing apparatus.

Drills

- Drills for the rescue and emergency procedures should be conducted periodically for testing of the emergency response plan, and for practising the procedures and use of rescue equipment. It is necessary to ensure that all the personnel involved are familiar with the emergency procedures and to enhance their safety awareness and preparedness. In general, the drills should include the following：

  - evacuation drills for all personnel involved. The purpose is to familiarize all the personnel with the emergency procedures, communication systems, escape routes and exits, safe assembly points, personal protective equipment, etc., and to test the effectiveness of emergency procedures and evacuation plans, and the sufficiency and suitability of emergency facilities provided; and

  - rescue drills for emergency rescue team. The purpose is to test the capability of the emergency rescue team in their rescue duties, such as report and command duties, first aid, rescue, use of emergency facilities, etc.

Keep in mind

- If someone faints in a confined space, the standby persons/ workers from outside **must remember**:

- **remain stationed outside the confined space, prevent other workers from entering.**
- **summon assistance from the rescue team and public emergency services (i.e. Hong Kong Police Force and Fire Services Department).**
- **brief the rescue personnel on the relevant circumstances of the incident.**
- **never enter a confined space to try to rescue.**

[Training course provider can display the Leaflet promoted by Occupational Safety & Health Council “What should the standby persons/ workers from outside do if someone faints in a confined space (Chinese version only)”
https://www.oshc.org.hk/oshc_data/files/ProfessionalServices/StarScheme/ConfinedSpace/publication_emergency.pdf

7. Explanation, Display, Demonstration and Practice on Safety Equipment

[Reference teaching time for Section 7: 215 mins]

[Training course provider should ensure that the safety equipment used in this section should comply with the requirements of relevant regulations, and recognized international or national standards. In addition, the manufacturers' instruction manuals on the proper use of the safety equipment should be strictly followed.]

7.1 Personal Protective Equipment

- Personal protective equipment (PPE) is intended to be worn or otherwise used by a person at work for protecting the person against one or more hazards to his/her safety or health. Use of PPE is the last resort when controlling the sources of accident is impracticable. PPE should be handled with care and stored properly when standby for use. The equipment should be kept clean and maintained in good condition.

- Employers have duties on guidance, training and supervision with respect to use of PPE. They should ensure that their employees know why and when PPE is used, its maintenance or replacement schedule and limitations.

- PPE should be provided by employers. Employees must wear PPE for the entire period of exposure to hazards.

7.1.1 Safety Helmet **[Explain by means of powerpoint or the real object of PPE]**

- Wear a safety helmet on a construction site under all circumstances.

- A safety helmet is primarily intended to protect the top of the head from falling objects, striking against objects, and being struck by objects. A safety helmet can reduce the amount of force from an impact.

- A suitable safety helmet should bear appropriate marking indicating the conformity to certain international/national standards such as European Standard.

- A safety helmet should be equipped with a Y-type chin-strip.

- Keep the harness of a safety helmet clean and make sure that it fits well.
- Do not drill any holes on a safety helmet or use it for pounding.

7.1.2 Safety Shoes [Explain by means of powerpoint or the real object of PPE]

- Safety shoes should have steel toe caps, steel soles, slip-proof and water-proof characteristics.

7.1.3 Respiratory Protective Equipment [Explain by means of powerpoint or the real object of PPE]

- Respiratory protective equipment, commonly known as "respirators," can be used to protect users from inhaling contaminants such as dust, gases, or vapours in the air of the workplace. Employers and employees must properly select, use, and maintain respiratory protective equipment.
- Respiratory protective equipment can be broadly divided into two types: air-purifying and air-supplying. Air-purifying respirators filter the contaminated air in the working environment when it is being inhaled by the user. They are applicable to tasks carried out in a working environment where oxygen is not deficient and the levels of contaminants are not very high. Types of air-purifying respiratory protective equipment include: Disposable particulate respirators, half/full-face respirators, and loose-fitting helmet or hood respirators.
- Air-supplying respiratory protective equipment provide uncontaminated air from an independent source for breathing by the user. It includes self-contained breathing apparatus (SCBA) which provides air from a cylinder and the compressed air line breathing apparatus which provides uncontaminated air from a source through a long air hose.

7.1.4 Full Body Harnesses Attached to Independent Lifeline and Fall Arresting Device [Explain by means of powerpoint or the real object of PPE]

- The most suitable way to use a safety harness is to attach its snap-hook to a level higher than the user's waist.

- When falling from height, a full body harness (commonly known as parachute type) could better reduce the downward momentum and protect the user's waist from injury than a general safety belt.
  - Before using a safety harness, the following should be checked: any defects on the safety harness, any suitable anchorage, independent lifeline and fall arresting device, and whether the standard is met or not.
  - When using a safety harness for fall protection, the safety harness should be attached to a fixed anchorage point or a fall arrester of an independent lifeline.

7.2 Safety and Rescue Equipment

7.2.1 Approved Breathing Apparatus

(Air Line Type Approved Breathing Apparatus
[Explain by means of powerpoint or the real object of PPE] and
Self-contained Type Approved Breathing Apparatus
[Demonstrate using the real object including demonstrations of the procedures for the practice in Section 7.5 and "low pressure test"])

- The risk assessment report prepared by the competent person shall cover the recommendations, having regard to the nature and duration of the work to be performed therein. The competent person shall clearly recommend in the risk assessment report whether the use of approved breathing apparatus is necessary so that the workers can stay in the confined space safely. If the concentration level of the hazardous gases is not sure, appropriate approved breathing apparatus shall be used and the other corresponding safety precautions shall be taken.
- Whenever workers need to enter a confined space to perform underground pipe work, regardless of whether the risk assessment report recommends the use of approved breathing apparatus, the worker must properly wear appropriate approved breathing apparatus and a safety harness properly connected to a lifeline, in accordance with the provisions of Section 9 of the FIU(CS)R.
- Where the use of approved breathing apparatus is recommended in the risk assessment report or a worker has to enter a confined space for underground pipework, the proprietor or contractor shall ensure that any person entering or remaining in that confined space is properly wearing an appropriate

approved breathing apparatus with a suitable safety harness. The safety harness should be connected to a lifeline and the free end of the lifeline should be held by the standby person outside the confined space. So far as reasonably practicable, suitable and adequate mechanical aids should be provided, or lifting devices should be connected. Legal requirement for underground pipework will not be exempted even though safety precautions listed in sections 7 and 8 of the FIU(CS)R have been taken (e.g. every pipe or supply line has been properly blanked off, the confined space has been adequately purged and sufficiently cooled and ventilated, an adequate supply of respirable air and an effective forced ventilation have been provided, etc.).

- Workers in confined spaces must use approved breathing apparatus (applicable when the risk assessment report recommends the use of approved breathing apparatus, or when entering confined spaces for underground pipe work.
- The person using the approved breathing apparatus should have received appropriate training in using of that particular type or model of breathing apparatus. Before each use, the breathing apparatus should be:
    - connected to air cylinder or other appropriate air supply device for providing respirable air.
    - properly inspected for any physical damage on all parts and accessories; and
    - functionally checked according to the user manual. Check items include “high pressure leak test” (i.e. check the leak of the hoses), “positive pressure test” (i.e. check the positive pressure of the mask), “cylinder pressure test” (i.e. check the pressure of the cylinder), “whistle warning unit test” (i.e. check the function of the whistle), etc.
- The selection of a suitable approved breathing apparatus should depend on the conditions, hazards and air testing results of the confined space, and the work activities to be done inside the confined space.
- All approved breathing apparatuses to be used for entry into and work inside a confined space should well fit the workers and be properly worn.
- Proprietors and contractors should only allow persons who are medically fit for wearing breathing apparatus to use the approved breathing apparatuses for entering into and working in a confined space.
- The service time of self-contained type approved breathing apparatuses

should be estimated having regard to the entry time, the consumption rate, the maximum working period, the estimated escape time and other relevant factors.

- All breathing apparatus for use in confined spaces should be properly maintained in clean and good working conditions. Never use defective breathing apparatus. All defective devices should be clearly marked as “defective” and removed from site.
- The air quality supplied by approved breathing apparatus and air supply device should comply with the most up-to-date recognized international or national standard.
- All approved breathing apparatuses for use in confined spaces should be properly maintained in good working condition.
- Only approved breathing apparatus, that is breathing apparatus which has been approved by the Commissioner for Labour under section 12 of the FIU(CS)R, should be used in connection with confined space work. The name or description of the type of breathing apparatus which has been approved by the Commissioner will be published in the Gazette. The relevant cylinder is also required to be approved by the Director of Fire Services.
- When using breathing apparatus, it must be properly fitted on the wearer’s face.
- Breathing apparatus should be cleaned thoroughly after each use.

Self-contained Type Approved Breathing Apparatus

- The service time of self-contained type of approved breathing apparatus should be estimated having regard to the entry time, the consumption rate, the maximum working period, the estimated escape time and other relevant factors.
- Manufacturers’ instruction manuals on the proper use of self-contained type approved breathing apparatus should be strictly followed, including:
  - Wearing procedures.
  - Functional tests include “cylinder pressure test” (i.e. check the pressure of the cylinder), “high pressure leak test” (i.e. check the leak of the hoses),

“whistle warning unit test” (i.e. check the function of the whistle), “positive pressure test” (i.e. check the positive pressure of the mask), “low pressure test” (i.e. check the leak of the mask), etc.

- Doffing procedures.

Air Line Type Approved Breathing Apparatus

- For airline type approved breathing apparatus, the air supply rate should be so adjusted that a positive pressure is always maintained inside the facepieces.
- Manufacturers’ instruction manuals on the proper use of air line type approved breathing apparatus should be strictly followed, including:
  - Wearing procedures.
  - Functional tests include “cylinder pressure test” (i.e. check the pressure of the cylinder), “high pressure leak test” (i.e. check the leak of the hoses), “whistle warning unit test” (i.e. check the function of the whistle), “positive pressure test” (i.e. check the positive pressure of the mask), “low pressure test” (i.e. check the leak of the mask), etc.
  - Doffing procedures.
- To avoid contamination of the supply of air, the following precautions should be taken when using airline type approved breathing apparatus:
  - The air supply equipment should be maintained according to manufacturer’s instructions.
  - The air intake should be properly located to avoid sucking-in of contaminated air such as engine exhaust.
  - The air supply equipment used should be designed for supplying breathing air. Those designed for industrial purposes are not allowed.
  - Air hose which may be oil impregnated or otherwise contaminated should not be used.

7.2.2 Safety Harness, Lifeline and Tripod/Quadpod

[Demonstrate using the real object including demonstration of the procedures for the practice in Section 7.3]

Safety Harness and Lifeline

- Safety rescue harness is connected to a lifeline with the free end held by a person outside the confined space who is capable of pulling the person out of the confined space.
- Safety rescue harness is intended for withdrawal in the event of an accident. It is similar in design to a safety harness and has the D-ring mounted so that the user will remain in an upright position while being lifted with rescue lifeline.
- The safety rescue harness and lifeline should both be of sound construction and be made of suitable materials so that they will be able to withstand the strain imposed on them during emergencies.
- The safety rescue harness and lifeline should be so adjusted and worn that the wearer could be drawn up with head first through any manhole or opening of the confined space.
- Steps should be taken to ensure that the rescue lifelines in use are free from any possible entanglement with, or damaged by, any pipes, fittings, protruding parts, sharp edges or other obstacles inside the confined space.
- Reference should be made to recognized international standards or national standards when selecting safety rescue harnesses and rescue lifelines.

Tripod/Quadpod

- It should be ensured that sufficient number of persons are available outside the confined space for holding the free ends of the lifelines and, as far as practicable, make available suitable and sufficient mechanical aids for lifting and rescue such as split-leg tripod/quadpod with a frame-mounted hoist.
- Manufacturers' instruction manuals on the proper erecting, use, storage and maintenance of tripod/quadpod should be strictly followed.
- Reference should be made to the latest and recognised international or national standards when selecting rescue lifting devices.

7.2.3 Personal Motion-Sensing Alarm Device [Demonstrate using the real object]

- A personal motion-sensing alarm device by which the workers inside the confined space can alert those outside.
- A personal motion-sensing alarm device can emit audio and visual alarm to give out alerting signals to others when the worker remains motionless for a certain duration.
- Manufacturers' instruction manuals on the proper use of personal motion-sensing alarm device should be strictly followed.

7.2.4 Reviving Apparatus / Resuscitator [Demonstrate using the real object]

- Reviving apparatus is an apparatus for reviving an unconscious worker. It is using positive pressure to inflate the lungs of an unconscious person who is not breathing. "Bag-Valve-Mask Resuscitator" is an example of manual operated reviving apparatus.
- Manufacturers' instruction manuals on the proper use of reviving apparatus should be strictly followed.

7.2.5 Air Testing Equipment

Air Monitoring Equipment [Demonstrate using the real multiple-sensor air monitoring equipment which can display readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide] and Detector Tubes [Explain by means of powerpoint or the real object]

Direct measuring air testing equipment includes detector tubes and air monitoring equipment and detector tubes. Please refer to Section 9 for information on selecting appropriate air monitoring equipment and how to use it.

Air Monitoring Equipment

- The most common configuration for an air monitoring equipment is one that displays readings on levels of oxygen (O_2), combustible gas (LEL), hydrogen sulphide (H_2S) and carbon monoxide (CO). **One should never assume that the hazardous gases present are limited to these gases.** Confined spaces may contain other hazardous gases. These can originate from various processes like the use or produce hazardous substances, or from residual substances/gases/vapours if the confined spaces are used for chemical storage. Therefore, it is crucial to carefully consider the use of different or additional air monitoring instruments for conducting tests. However, competent persons should first use calibrated direct-reading air monitoring equipment to test the four common gases mentioned above, and then consider other suitable methods to measure other hazardous chemicals when necessary.

Detector Tubes

- Detector tubes are mainly used to measure the concentration of gas or vapuor in the air. Different types of detection tubes can directly measure the concentration of different gases or vapors in the air.

7.3 Practice on Use of Safety Harness, Lifeline and Tripod/Quadpod

[Practical Section to be conducted with the use of the real object]

[The training course provider should provide each trainee with ONE set of full body harness]

- Every trainee should use a safety harness, a lifeline and a tripod/quadpod for the hands-on practice.
- Procedures for the practice:
  - Wear the safety harness and then take off the safety harness.
  - Attach the lifeline to the safety harness and then detach the lifeline from the safety harness.
  - Mount the safety harness to the hoist of the tripod/quadpod.
  - Use the hoist of the tripod/quadpod to raise and lower the safety harness.
  - Dismount the safety harness from the hoist of the tripod/quadpod.

7.4 Practice on Use Personal motion-sensing alarm device

[Practical Section to be conducted with the use of the real object]

[The training course provider should provide sufficient number of personal motion-sensing alarm device (at least 2 sets) for hands-on practice and the practical examination.]

- Every trainee should use a personal motion-sensing alarm device for the hands-on practice.
- Procedures for the practice:
  - Turn on the personal motion-sensing alarm device
  - Check if the personal motion-sensing alarm device is fully charged.
  - Carry the personal motion-sensing alarm device
  - Turn off the personal motion-sensing alarm device

7.5 Practice on Use of Approved Breathing Apparatus (Self-contained Type Approved Breathing Apparatus)

[Practical Section to be conducted with the use of the real object]

[The training course provider should provide each trainee with ONE set of air mask (for fitting to compressed air cylinder) and sufficient number of compressed air cylinders (at least 2 sets) for hands-on practice and the practical examination.

[The training course provider should ensure that the self-contained type approved breathing apparatus is clean and hygienic for use]

- Every trainee should use a self-contained type approved breathing apparatus for the hands-on practice.
- Procedures for the practice:
  - Cylinder pressure test (check the pressure of the cylinder).
  - High pressure leak test (check the leak of the hoses).
  - Whistle warning unit test (check the function of the whistle).
  - Wear the whole set of self-contained type approved breathing apparatus and adjust the mask properly.
  - Conduct the low pressure test (check the leak of the mask)
  - Open the valve of the air cylinder.
  - Connect the air hose of the air cylinder to the mask.
  - Breath normally when wearing the apparatus.
  - Positive pressure test (check the positive pressure of the mask).
  - Take off the whole set of self-contained type approved breathing apparatus.

- Turn off gas valve of the air cylinder

8. Risk Assessment

[Reference teaching time for Section 8: 145 mins]

8.1 Principles and Process of Risk Assessment

- The objective of risk assessment and risk control is to provide a means whereby job hazards or potential hazards are identified, evaluated and managed in a way that eliminates them or reduces them to a tolerable level. Safety procedures and risk control measures that are to be taken to prevent the hazards and to control the risks should be developed after risk assessment.

- There are five stages in risk assessment and risk control, namely:

  (1) identification of hazards;

  (2) determination of risk;

  (3) development of safety procedures and risk control measures;

  (4) implementation and maintenance of safety procedures and risk control measures; and

  (5) review of safety procedures and risk control measures.

<u>Hazard identification</u>

- Hazard identification is the process of identifying all situations or events that could give rise to the potential for injury, illness or damage to plant or property. Hazard identification should take into account how things are being done, where they are done and who is doing them, and should also consider how many people are exposed to each hazard identified and for how long.

- The following should be accorded top priority in the hazard identification process:

  - High frequency accidents or near misses
  - History of serious accidents causing fatalities
  - Existence of a potential for serious harm
  - Introduction of new jobs
  - Recent changes in procedures, standards or legislation

- Major methods for identification of hazards include:
  - Direct observation method

    This involves observing an experienced worker with good safety awareness carrying out the work several times. The job steps and the hazards in each of these are recorded.

  - Recall method

    This should be done for jobs that are rarely performed. The method involves inviting the designers, engineers, supervisors and workers involved in the jobs to attend a brainstorming session, during which they would look into the materials, machines and equipment used, and the job steps to identify the hazards inherent in such jobs.

- In order to identify hazards and evaluate their associated risks, it should be in the first place prepare a list of items covering premises, plant, people and procedures and materials use, etc. and gather information about them. When all the necessary information is in hand, the hazards related to work activities can be identified.

<u>Determination of risk</u>

- The risk associated with a hazard is a reflection of the likelihood that the hazard will cause harm and the severity of that harm. The two elements of risk, i.e. likelihood and severity, are independent of each other. The vast majority of hazards are relatively straightforward and requiring only a simple method of risk rating. The method incorporates a judgment as to whether or not a risk is tolerable. Such a method is illustrated as follows:
  - For each hazard identified, ask the question "What if?". Realistically, what is the worst likely outcome (i.e. the potential severity of harm)? Is it a fatality, major injury/permanent disability including permanent ill health, a minor injury, or no injury and only plant damage?
  - For the purpose of determination of risk, the severity of harm can be divided into 3 categories:

(1) Mild:
  - accident resulting in mild bodily injury;
  - example: eye irritation from dust, cough, etc.

(2) Serious:

- accident causing moderate bodily injury;
- example: fracture, skin ulcer, etc..

(3) Very serious:

- Accident causing immediate danger to life or serious bodily injury;
- Example: gas poisoning, hypoxia, drowning.

■ Make a judgment about the probability or likelihood of harm occurring based on the following table:

Probability/likelihood	Description
Very likely	Occurs repeatedly
Possible	Event to be expected
Unlikely	Rather remote, though conceivable

■ Decisions as to whether or not action is needed should then be made by reference to the matrix formed by probability/likelihood and the likely outcome (i.e. severity) which is usually called the Risk Level Estimator. The following table illustrates a Risk Level Estimator:

Risk Level Estimator

	Unlikely	Possible	Very likely
Very serious	Moderate Risk	High Risk	High Risk
Serious	Low Risk	Moderate Risk	High Risk
Mild	Low Risk	Low Risk	Moderate Risk

■ Action should be taken according to a list of priority. High risks should be accorded the first priority, moderate risks the second priority; low risks the third priority and so on. In deciding whether a risk is tolerable, the proprietor or contractor has to take into account whether the condition is within statutory limits and/or conform to legal or internationally recognised standards. Only when these limits and standards are met and the risk is at, or has been reduced to, the lowest possible level that is reasonably practicable should a risk be considered tolerable.

<u>Development of safety procedures and risk control measures</u>

- Safety procedures and risk control measures are procedures and measures to be put in place to reduce risk to a tolerable level.
- When deciding on safety procedures and risk control measures, the list below should be considered, in the order given. Safety procedures and risk control measures lower down the list should only be used if it can be shown that using a procedure and/or measure higher up the list is not reasonably practicable.
  - List of safety procedures and risk control measures:

(1) Procedures and measures to eliminate hazards at source:
For example, using a non-hazardous substance instead of a hazardous one.

(2) Procedures and measures to reduce hazards at source:
For example, replacing a noisy machine with a quieter one.

(3) Procedures and measures to remove workers from the hazard:
For example, paint spraying by unattended robots.

(4) Procedures and measures to contain hazards by enclosure:
For example, installing sound proofing enclosure for a noisy machine.

(5) Procedures and measures to reduce worker exposure:
For example, reducing exposure to noise by reducing the hours of work.

(6) Procedures and measures to ensure the proper use of personal protective equipment as the last resort:
For example, using hearing protectors for workers operating noisy machines.

<u>Implementing and maintaining safety procedures and risk control measures</u>

- For safety procedures and risk control measures to be implemented effectively and efficiently, they should be as far as practicable developed at the workplace with the participation of all levels of staff. Feedback from people implementing the safety procedures and risk control measures should be encouraged so that improvement to the procedures and measures can be made.

- Maintaining safety procedures and risk control measures requires scheduled inspections and maintenance. It also requires the enforcement of discipline to ensure that people do not tamper with safety procedures and risk control measures (e.g. by removing machine guards).

Review of safety procedures and risk control measures

- Whatever safety procedures and risk control measures are used, they should be reviewed if there is reason to suspect that they are no longer effective, or if there has been a significant change in the matters to which they relate.

  Examples are:
  (1) When information is obtained about a previously unknown design or manufacturing fault, or about a previously unidentified hazard.
  (2) When the design is revised or modified.
  (3) When the system of work associated with the plant is changed.
  (4) When the plant is moved.
  (5) When there is a change to the workplace environment.

  In the circumstances, the risk has to be reassessed and new safety procedures and control measures devised.

8.2 Risk Assessment for Confined Space Work

[An example case with appendix 1 "Risk Assessment Form for Confined Spaces" should be used for demonstration of the process of preparing a risk assessment report]

[This section must be conducted in an interactive manner through discussion with trainees]

- In view of the risk involved, working in confined spaces should be avoided as far as possible.

- Even if workers are in the immediate vicinity of the confined space and perform associated work in that confined space, the proprietor or contractor shall appoint a competent person to assess the reasonably foreseeable risk arising from the work (e.g. releasing of hazardous gases or falling from height, etc.) and make recommendations on measures necessary to ensure the safety and health of workers.

- If it is not reasonably practicable to carry out the work without entering a confined space, then the proprietor or contractor responsible for the work undertaken in the confined space must appoint a competent person in accordance with section 5(1) of the FIU(CS)R to carry out a risk assessment to identify the hazards likely to be present in the confined space. Basing on the assessment results, the competent person should make recommendations on necessary safety precautions to be taken, before allowing the workers to enter into and work in that space so as to ensure their safety and health.
- The risk assessment should identify the hazards to the workers entering or working in the confined space, and also, others in the close proximity who may be affected by the work to be carried out, taking into account of important factors such as potential sources of inhalation of hazardous gases, vapours, fumes or lack of oxygen, and other hazards inherent in the work, proposed work methods, industrial plants, materials, and the design of the confined space itself. The competent person should consider not only the hazards arising from the confined space, but also those stemming from the other industrial plants, processes and operations in the vicinity, such as inadvertent contact with or damage to the utilities nearby during the work.
- The process of a risk assessment should include a systematic examination and careful consideration of:

  (1) all the work activities required to be done;

  (2) the previous contents in the confined space;

  (3) the methods by which the work could be done;

  (4) the hazards inherent in the confined space in relation to the work; and

  (5) the hazards inherent in the confined space in relation to the method proposed and to the design or construction of the confined space itself (including the layout and location of the confined space).

- Before carrying out the risk assessment:

(1) all information about the confined space and the work to be done in it should be gathered. For example, there may be information from the engineering drawings, working plans, figures, photos or reports about relevant soil or geological conditions.

(2) The appointed competent person should conduct site investigation to have a more thorough knowledge of the location, nature and circumstances of the confined space, particularly its effect on safety and health matters.

- For identifying all the possible hazards which may be present in the confined space and evaluating fully the extent of all those associated risks, the risk assessment shall cover the following aspects:

(1) the work method to be used and the plant and materials to be used in work activities;

(2) whether or not there is any hazardous gas, vapour, dust or fume present;

(3) whether or not there is any deficiency in oxygen;

(4) the possibility of ingress of hazardous gas, vapour, dust or fume;

(5) the possibility of sludge or other deposits being present that are liable to give off hazardous gas, vapour, dust or fume;

(6) the possibility of in-rush of free flowing solid or liquid;

(7) the possibility of fire or explosion in the confined space; and

(8) the possibility of loss of consciousness of a certified worker arising from an increase in body temperature.

- The risk assessment report shall also cover the following:

(1) the recommendations on the measures required, including whether or not the use of approved breathing apparatus is necessary, having regard to the nature and duration of the work to be performed therein; and

(2) the period during which workers may remain safely in the confined space.

- Where sludge or other deposits are present, and a competent person considers that there is a possibility that they will give off hazardous gas, vapour, dust or fume, he shall recommend the use of an approved breathing apparatus. It should be noted that if there are sludge or other deposits present, it is generally very likely for the trapped or dissolved gases such as, hydrogen sulphide, to be released during confined space work, especially drainage works.

- A competent person, in evaluating the extent of the risks in a confined space, shall recommend the use of suitable monitoring equipment and specify how the equipment shall be used if he deems that there is a substantial likelihood of environmental changes occurring in the confined space during work that would increase the risks associated with the hazards.

- The size and number of access and egress points of a confined space:

  (1) should be assessed individually taking into the account of the activities to be carried out and the number of people involved.

  (2) due consideration should be given to the possible difficulties for access to and rescue from the confined space when determining the locations of manholes or openings to vessels, tanks, etc..

  (3) there may be occasions when access and egress are so tortuous that temporary openings are needed. Different criteria should be applied when determining manhole dimensions for a confined space that extends over a significant length or height (such as sewers, pipes, culverts, small tunnels or shafts). Measures to improve access pathways, such as structural alterations to the confined space, could be considered. If the distance between manholes on drainages is considerably long, it may affect both the degree of natural ventilation and the efficiency of rescue operations.

- The recommendations on the necessary safety measures must include whether the use of approved breathing apparatus is necessary so that the workers can safely stay inside the confined space. When there is any doubt about atmospheric hazards, suitable and approved breathing apparatus must be used and the other necessary safety precautions must be taken accordingly.

- When workers enter a confined space to carry out underground pipework, there may be additional hazards, particularly atmospheric hazards. Therefore, a proprietor or contractor and a competent person should determine whether the work involving entry into the confined space relates to underground pipework. If underground pipework is involved, the workers must properly wear an approved breathing apparatus and use a suitable safety harness connected to a lifeline in accordance with section 9 of the FIU(CS)R.

- When making recommendations regarding a confined space work, an important consideration is how the worker can be safely rescued from the confined space in case of emergency.

- During the risk assessment, if the competent person considers that the working environment may change adversely, he must recommend continuous monitoring or periodic monitoring of the working environment. The purpose of air monitoring is to ensure that the ventilation is adequate and that the atmosphere hazards inside the confined space are within an acceptable level. The requirement for testing, retesting and monitoring must be determined by the competent person.

- In case it is possible that flammable or explosive gases or vapours would be present in the confined space, the equipment for atmospheric monitoring of the gases or vapours should be of the explosion proof type. It should have both visual and audible alarms so that it can alert workers if a hazardous situation exists or is developing in the confined space.
- All the monitoring equipment used in connection with the atmospheric monitoring should be properly maintained and be calibrated periodically as per the recommendation of the manufacturer or supplier for accurate testing functions.
- For precautions on air testing and monitoring and exposure limits for air impurities, please refer to Appendix 3 and the "Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace" and "Air Monitoring in the Workplace" published by the Labour Department.

- When there is any circumstance indicating that the risk assessment is no longer valid or work arrangement has significantly changed, the work must be stopped. All workers must be evacuated immediately and the risk assessment should be reviewed. Workers must not enter the relevant confined space unless the work environment is confirmed to be safe.

- The risk assessment for confined space work should be repeated whenever necessary. The proprietor or contractor shall appoint a competent person to carry out a fresh risk assessment and make recommendations whenever there has been a significant change in the conditions of the confined space or of the work activities therein to which the previous assessment relates, or where there is reason to suspect that such change may occur, and that the change is likely to affect the safety and health of the workers therein. Risk assessment should also be repeated if there is any reason to suspect that the previous assessment is no longer valid.

- The risk assessment and related work arrangements should be reviewed regularly and in a timely manner. When carrying out long-term projects inside confined space, even in the absence of significant changes, the proprietor or contractor should conduct regular reviews (e.g., at least once a month) of the work environment and processes to ensure that the risk assessment and recommendations remain valid.
- A competent person shall record all significant assessment results in the risk assessment report, which includes (but not limited to) the hazards identified, the necessary safety precautions to be taken, the type and the number of workers being affected, the period during which workers may remain safely in the confined space and the relevant personal particulars of the competent person who was responsible for carrying out the risk assessment.
- The competent person must make available the risk assessment reports and recommendations to the proprietor or contractor within a reasonable time after the request for the reports and recommendations was made by the proprietor or contractor, but it must be given before the proprietor or contractor allows the workers to enter into the confined space.
- The completed risk assessment report for confined space work shall be submitted to the proprietor or contractor of the industrial undertaking for his consideration for the issue of a "permit-to-work certificate" before the confined space work is carried out.
- After the risk assessment has pointed out the hazards and relevant recommendations on safety precautions, the proprietor or contractor shall verify that such risk assessment report covers all matters referred to in section 5(2) of the FIU(CS)R, and formulate the method statement for the confined space works.
- The method statement should record details of all relevant processes, work procedures, safety precautions, relevant equipment, workers' qualifications and training requirements, etc., and include the implementation of a permit-to-work system.
- There may be other work-related hazards for working in confined spaces arising out of, for example, electricity, welding, dangerous substances, noise

and dust, etc. The competent person should recommend necessary safety precautions for work to be carried out in confined space having regard to the usually restrictive, and sometimes electrically conductive, nature of a confined space.

- The competent person appointed to carry out risk assessment should assist the proprietor or contractor in assessing whether the confined space work is an underground pipework to ensure compliance with section 9(b) of the FIU(CS)R, i.e. where a person has to enter a confined space for underground pipework, the proprietor or contractor should ensure that a person entering or remaining in that confined space is properly wearing an approved breathing apparatus, and the person is wearing a suitable safety harness connected to a lifeline so that the person can be pulled out of the confined space in an emergency. To assess whether a work is an underground pipework, factors to be considered include (1) whether the work is conducted inside a confined space; (2) whether the aforesaid confined space is underground; and (3) whether the work involves any pipework which would have specified risk associated with atmospheric hazard.

8.3 Points should be noted when conducting drainage works in confined spaces

To assist competent person to have a detailed grasp of the risk assessment of drainage works, following are the points should be noted when conducting risk assessment for confined space (drainage works):

8.3.1 To determine whether a work is an underground pipework

- Typical underground pipework includes (1) workers are required to enter any underground drains or their associated manholes that may pose atmospheric hazards, which have been classified as confined spaces, to carry out inspection or maintenance of drainage works, etc.; or (2) workers are required to enter any underground confined spaces that may pose atmospheric hazards for inspection or maintenance work of pipes. We must note that whether the nature of a confined space work is underground pipework or not can, under no circumstances, be changed by taking any control measures. The competent person appointed to carry out risk assessment should assist the proprietor or contractor in assessing whether the confined space work is an underground pipework to ensure compliance with section 9(b) of the FIU(CS)R.

8.3.2 Collection of all relevant information of the drainage works

- The competent person appointed to carry out risk assessment should understand the work methods to be employed, the plant and materials to be used, and the physical layout and surrounding environment of the drainage worksite. This can be done by conducting an on-site survey and studying the relevant information of the underground facilities, drawings and work plans.
- The competent person should identify and assess all the potential atmospheric hazards that may exist before the work begins as well as those that may emerge in the course of the work. Even if hazardous gases, fumes and vapours may not be present initially, they may be released while the work is in progress inside the drainage. For example, if sludge or sewage containing hydrogen sulphide is disturbed, the hydrogen sulphide gas will be released quickly and accumulated in the confined space to hazardous levels. Also, sudden ingress of hazardous gases to newly built drainage from existing sewers is not uncommon.

8.3.3 Determination of the presence of sludge or other deposits

- The competent person is required to assess the presence of sludge or other deposits in the confined space. When there is a possibility that the sludge or deposits will give off hazardous gas, vapour, dust or fume, the competent person should recommend the use of approved breathing apparatus. When there are sludge or deposits present in the drainage works site, the trapped or dissolved hazardous gases such as hydrogen sulphide are very likely to be released due to disturbance of the sludge, sediment or sewage during work, thus increasing the risk of gas poisoning. In this circumstance, the competent person must recommend the use of approved breathing apparatus by workers in the risk assessment, and recommend the use of suitable air monitoring equipment (should be explosion-proof type) for continuous air monitoring in the confined space until everyone leaves the confined space. The preferred method of continuous air monitoring is carrying suitable air monitoring equipment by certified workers working inside confined spaces.

8.3.4 Assessment of atmospheric hazards

- Air monitoring in confined space should be conducted by a person with appropriate training and experience, e.g. competent persons including registered safety officers with at least one year of experience in air monitoring in confined spaces, occupational hygienists, etc. Air monitoring includes pre-entry air testing and air monitoring during the work.

  - The competent person shall recommend continuous air monitoring if the risk assessment shows that there could be adverse changes in atmospheric conditions.
  - The competent person shall state in the recommendation whether the use of approved breathing apparatus is necessary and the period within which workers may safely remain in the confined space.

- Air monitoring does not end with the pre-entry test. Since atmospheric conditions within a drainage workspace can change rapidly, it is necessary to perform continuous air monitoring to ensure that the air quality remains acceptable throughout the work. Each group of workers (at the same working location) should bring alone with at least one portable air monitoring equipment to conduct continuous air monitoring during drainage work. The equipment should be checked to ensure that it is calibrated, functioning properly and with sufficient power to operate before the workers enter the drainage.
- A “re-entry” test should be conducted if the workers have temporarily left the space. In fact, “re-entry” testing and pre-entry testing should be performed in exactly the same manner and should be considered equally important. In case the alarm of the air monitoring equipment is activated or any other indication of danger is observed, workers should leave the work space immediately according to the emergency procedures.
- Please note the following important points on the use of air monitoring equipment:
  - Only properly maintained and calibrated equipment should be used for air testing. Unscientific methods such as throwing a flame down the manhole, and observing the presence of living organisms or the colour of the manhole are unreliable.
  - The most common configuration for a multiple-sensor air monitoring equipment is one that can show the readings of oxygen, combustible gases, hydrogen sulphide and carbon monoxide. Never assume that the hazardous gases present in the drainage are limited to these gases. Different or additional air monitoring equipment is required for other hazardous gases (e.g. chlorine) that may be present in the drainage.

- The proper functioning of the air monitoring equipment should be tested before use according to the manufacturer's instructions, i.e. functional or bump/challenge test.
- The atmosphere in the drainage should, as far as practicable, be tested by using remote probes and sampling lines connected to direct-reading instruments placed outside the drainage.
- The atmosphere around the working position of the person carrying out the air monitoring should be tested first to ensure his safety and health during the air monitoring.
- In general, testing for oxygen should be performed first because some gas sensors are oxygen dependent and could give unreliable readings in oxygen deficient situations. Even though it may still be sufficient for survival, any depletion of oxygen should be further investigated.
- Testing of the atmosphere inside the drainage should be done from the top to the bottom of the confined space, preferably at about 1-metre intervals. Sampling for a few minutes at each location is required as there will be a time lag for the gas to be pumped from the sampling probe to the monitoring equipment.
- Record the results with the time and location of the atmospheric monitoring in the risk assessment.
- Air monitoring must be conducted again when there is any potential change in the atmospheric conditions.

8.4 Exercises in Preparation of Risk Assessment Report

[This section must be conducted in an interactive manner through discussion with trainees]

[Risk assessment reports completed by trainees should be collected and checked to facilitate the interactive discussion]

[Model answers of risk assessment reports should be provided to trainees to facilitate the interactive discussion]

- Exercises：Every trainee should prepare one to two risk assessment reports.

- Cases for the exercises:

    - The accident cases associated with confined spaces operation (in particular those occurred during the three years preceding the conduct of the course)

or

- The accident cases associated with confined spaces operation published by Labour Department (e.g. “Poisoning in manhole sewer” and “Poisoning in metal duct” in “Brief Analysis of Site Accident Cases”, etc.).

9. Air Testing Procedures and Points to Note

[Reference teaching time for Section 9: 35 mins]

[Demonstrate using the real multiple-sensor air monitoring equipment which can display readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide. The demonstration should include the test for the proper functioning of the air monitoring equipment, i.e. the functional or bump test, before use according to the manufacturer's instructions.]

9.1 Select appropriate air monitoring equipment and usage methods

During the risk assessment, if the competent person considers that the working environment may change adversely, he must recommend continuous monitoring or periodic monitoring of the working environment. The purpose of air monitoring is to ensure that the ventilation is adequate and that the atmosphere hazards inside the confined space are within an acceptable level. The requirement for testing, retesting and monitoring must be determined by the competent person.

Using direct-reading equipment, including air monitoring devices and detector tubes, is a simpler and quicker way to conduct air monitoring in confined spaces.

<u>Air Monitoring Equipment</u>

- The most common configuration for an air monitoring equipment is one that displays readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide. One should never assume that the hazardous gases present are limited to these gases. Confined spaces may contain other hazardous gases. These can originate from various processes like the use or produce hazardous substances, or from residual substances/gases/vapours if the confined spaces are used for chemical storage. Therefore, it is crucial to carefully consider the use of different or additional air monitoring instruments for conducting tests.
- Continuous air monitoring equipment are suitable for continuous air monitoring.
- Air monitoring equipment have audio-visual alarms to alert workers to take appropriate actions.

<u>Detector Tubes</u>

- Detector tubes are primarily used to measure the concentration of gases or vapours in the air. Different types of detector tubes can directly measure the concentration of various gases or vapuors in the air. For example, if toluene is volatilized from the use of organic solvents, a detector tube for toluene can be used to directly measure its concentration in the air.

9.2 Air Testing Procedures

Air testing should be conducted by a person with appropriate training and experience.

<u>Pre-entry Air testing</u>

- The atmosphere in the confined space should, as far as practicable, be tested by using remote sampling probes and sampling lines connected to direct-reading equipment (e.g. detector tubes and air monitoring equipment) placed outside the confined space.

- The manufacturers' instruction manuals on the proper use of air testing equipment should be strictly followed including the proper functioning of the equipment should be tested, i.e. to conduct functional or bump test, before use according to the manufacturer's instructions. Only properly maintained and calibrated equipment should be used for air testing.

- The atmosphere around the working position of the person carrying out air testing should be tested first to ensure his safety and health during air testing.

- In general, testing for oxygen should be performed first because some gas sensors are oxygen-dependent and may give unreliable readings in oxygen-deficient situations. Even though it may still be sufficient for survival, any depletion of oxygen should be further investigated.

- As the hazardous gas may not be evenly distributed (e.g. manhole and hand-dug tunnel), air testing should be performed from the top to the front end of the confined space to cover different positions and different depths of the confined space. Sampling for a few minutes at each location is required as there will be a time lag for the gas to be pumped from the sampling probe to the air testing equipment through the sampling line.

    - ■ Manhole: testing of the atmosphere inside the manhole should be done from the top to the bottom of the space, preferably at about 1-metre intervals. It is because different gases will float at different levels of the manhole according to their relative density to air. For example, methane is lighter than air and therefore it will be at the top of the manhole; hydrogen sulphide is heavier than air and it will be at the bottom; and carbon monoxide is similar to air.

  - Hand-dug tunnel: air testing should be performed from the top to the front end of the hand-dug tunnel to cover different positions of the hand-dug tunnel and different depths of the shaft pit. If it is not feasible to horizontally extend the sampling probe and sampling line connected to the air testing equipment to the front end of the hand-dug tunnel, remote control type air testing equipment at different and suitable locations (including different working locations and the excavation face) in the tunnel should be placed.

- The results should be recorded with the time and location of the air testing in the risk assessment.
- Air testing must be conducted again when there is any potential change in the atmospheric conditions.

<u>Air monitoring during work</u>

- During the risk assessment, if the competent person considers that there is a known possibility of adverse changes of working conditions, he should recommend a continuous monitoring or periodical monitoring of the working environment.
- For examples, atmospheric conditions within the drainage system and the hand-dug tunnel can change rapidly or contaminants may be produced during work processes; therefore, it is necessary to perform continuous air monitoring to ensure that the air quality remains acceptable throughout the work. Portable type multi-gas continuous air monitoring equipment with an audio-visual alarm should be provided to each worker for continuous air monitoring. In case the alarm of air monitoring equipment is activated or any other indication of danger is observed, workers must leave the confined space immediately according to the emergency procedure.

- Each team of workers (at the same work location) should carry at least one portable air monitoring device for drainage work, allowing them to continuously monitor the air while working. The device should be checked before entering the sewer to ensure it is calibrated, functioning properly, and has sufficient battery power. (See Figure 4)

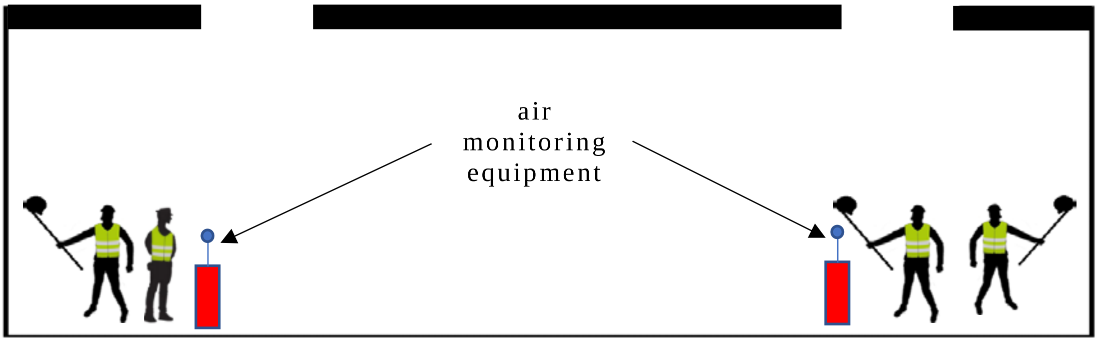


Figure 4. Portable air monitoring equipment should be equipped by at least one person in a group (at the same working location) or placed in same vicinity of the group of workers

- A re-entry test should be conducted before any worker re-enters the confined space if all the workers have temporarily left the confined space. In fact, re-entry test and pre-entry test should be performed in exactly the same manner and should be considered to be equally important.

9.3 Points to note for using air testing equipment

Air Monitoring Equipment

- Proper air monitoring equipment should be selected with respect to the gas or vapour to be tested. For example, the air monitoring equipment equipped with multiple sensors to measure the levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide.
- The air monitoring equipment should be of the explosion-proof type and should have an audio-visual alarm device.
- Read and follow the manufacturer's instructions when using the air monitoring equipment, including the proper maintenance and calibration for the equipment, etc.
- The sensors of the air monitoring equipment should be checked to ensure that they are properly installed and has not yet expired.

- The remaining battery level of the air monitoring equipment should be checked.
- The proper functioning of the air monitoring equipment should be tested, i.e. to conduct functional or bump test, before use according to the manufacturer’s instructions.
- In general, testing for oxygen should be performed first because some air monitoring equipment is oxygen-dependent and may give unreliable readings in oxygen-deficient situations.
- The air monitoring equipment should have an audio-visual alarm device which would alert workers when any indication of danger is detected.
- The air monitoring equipment is suitable for continuous air monitoring.
- The air monitoring equipment should have a two-level alarm system to alert workers to take appropriate actions correspondingly. Level 1 Alarm is a warning level indicating that there is a threat of atmospheric hazards, but the situation of worker is still safe. Action should be taken to determine the cause of the threat and implement appropriate remedial measures. Under normal circumstances, when reaching Level 2 Alarm level, it indicates the atmospheric hazards pose risks to the workers, the emergency procedures should be activated, and the workers should be evacuated immediately.

Flammable or Explosive Substances in Air

- The alarm for the presence of flammable or explosive gases is generally set using the Lower Explosive Limit (LEL). Level 1 Alarm (Warning) for the lower explosive limit should be set at 5% LEL, and Level 2 Alarm (Evacuation) should be set at 10% LEL. If a flammable or explosive substance has toxic/harmful properties simultaneously, the lower concentration of the two shall be used as the criterion for setting the alarm. For example, hydrogen sulphide must set the alarm at the concentration of its toxicity.

Toxic or Harmful Chemicial Substances in Air

- The setting of alarm levels for toxic or harmful chemicals in the air should make reference to the Occupational Exposure Limits if underground pipework is not involved and an approved breathing apparatus is not required as indicated in the risk assessment report. In this connection, the alarm levels for toxic or harmful chemicals in the air should be set as follows:

Level 1 Alarm§	Half of Occupational Exposure Limit - Short-Term Exposure Limit *[or 1.5 times of Occupational Exposure Limit - Time-Weighted Average¶]*
Level 2 Alarm§	Occupational Exposure Limit - Short-Term Exposure Limit *[or 3 times of Occupational Exposure Limit - Time-Weighted Average¶]*

§ Alarm settings for measuring instruments should be rounded down to the nearest integer.

¶ Only applicable to chemicals for which OEL-STEL have not been established.

Excessive Level of Oxygen or Oxygen Deficiency in Air

- There are about 21% by volume of oxygen in air under normal atmospheric pressure. A decrease in the percentage of oxygen in air can result in an oxygen-deficient environment, which can asphyxiate workers. Conversely, a high percentage of oxygen in air increases the risk of causing fires and explosions. Therefore, alarm thresholds for oxygen content in air (measured by volume) are set at 19.5% and 22% to warn workers of oxygen deficiency or excessive oxygen level environments respectively. Whenever the oxygen content alarm is activated, immediate evacuation should be carried out.

- The alarm levels for some common hazardous gases that can be encountered in confined spaces are recommended as follows:

For workers without using approved breathing apparatus to enter confined spaces	CH_4	H_2S	CO
Level 1 Alarm	5% LEL	7ppm	37ppm
Level 2 Alarm	10% LEL	15ppm	75ppm

Detector Tubes

- Proper detector tube should be selected with respect to the gas or vapour to be tested. Make sure the tube has not yet expired.
- Read and follow the manufacturer's instructions when using the detector tube.
- Some of the detector tubes are subjected to cross-interference, hence it is important that instructions provided by the manufacturer should be referred to before using detector tubes.
- The pump to be connected to the detector tube should be checked to ensure that it is in good working order.
- The tips of the tube should be broken carefully since glass splinters may come

off. The opened tube should be handled with care to avoid being injured by the sharp edges of the tips.

- Insert the opened detector tube into the pump with the arrow mark pointing towards the pump.
- Detector tube is operated by connecting an unsealed tube to a pump. By operating the pump, air is drawn into the tube. If the relevant gas or vapour is present, the purpose made chemicals in the tube will react to give a colour change. The concentration of the gas or vapour is measured by the length or the intensity of the colour change.
- The detector tubes are not suitable for continuous air monitoring.

10. Practice on Use of Multiple-Sensor Air Monitoring Equipment

[Reference teaching time for Section 10: 75 mins]

[Practical Section to be conducted with the use of the real object of multiple-sensor air monitoring equipment which can display readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide]

[The training course provider should provide sufficient number of continuous air monitoring equipment (at least 2 sets) for hands-on practice and the practical examination.]

- Trainees are divided into groups (maximum of four trainees per group) to use a multiple-sensor air monitoring equipment for the hands-on practice.
- Every trainee should use a continuous air monitoring equipment for the hands-on practice.
- Procedures for the practice:
  - Check if the air monitoring equipment is available and intact
  - Start up the air monitoring equipment
  - Take the readings on levels of oxygen, carbon monoxide, hydrogen sulphide and flammable gases in the classroom and read the readings

  - **<u>Simulation of hazardous situation</u>**

Either procedures A or B should be completed by each group (every group members should participate in the procedures). Each trainee should complete the procedure B on his own (other group members observe and learn the procedures at the same time):

<u>Procedure A</u>

- ➢ Connect the sampling probe and hose to the air monitoring equipment.
- ➢ Switch on the air monitoring equipment.
- ➢ Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- ➢ Put the sampling probe into a container (e.g. a plastic ziplock bag) containing alcohol wipes.
- ➢ Wait the audio-visual alarm of the air monitoring equipment to be

activated.

- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- Take out the sampling probe from the container and observe the changes of the readings displayed on the air monitoring equipment.
- Press the reset button of the air monitoring equipment to turn off the audio-visual alarm or wait the air monitoring equipment back to normal automatically (i.e. the audio-visual alarm is stopped).
- Switch off the air monitoring equipment.

(Remarks: Adequate measures should be taken to ensure the fire safety of the training premises during the conduct of the simulation.)

<u>Procedure B</u>

- Connect the sampling probe and hose to the air monitoring equipment.
- Switch on the air monitoring equipment.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- Exhale to a plastic ziplock bag or a container several times to simulate the oxygen deficient environment.
- Put the sampling probe into the plastic ziplock bag or the container.
- Wait the audio-visual alarm of the air monitoring equipment to be activated.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the air monitoring equipment.
- Take out the sampling probe from the plastic ziplock bag or the container, and observe the changes of the readings displayed on the air monitoring equipment.
- Press the reset button of the air monitoring equipment to turn off the audio-visual alarm or wait the air monitoring equipment back to normal automatically (i.e. the audio-visual alarm is stopped).

- Switch off the air monitoring equipment.

(Remarks: Adequate measures should be taken to ensure that all training activities conducted are safe and without risks to health, e.g. the hygienic arrangements for exhaling to a plastic ziplock bag or a container.)

- Every trainee should be able to tell the locations where air testing is required in confined space (such as **manhole, shaft and tunnel)** and the measuring time required for those locations.
  - **manhole, shaft**: from the top to the front end of the confined space to cover different positions and different depths of the confined space.
  - **Tunnel**: In addition to conducting air tests at different depths in the tunnel, air tests must also be conducted horizontally at different locations in the tunnel.
  - Sampling for a few minutes at each location is required.

11. Application of Safe System of Work and Permit-to-work System

[Reference teaching time for Section 11: 130 mins]

11.1 Overview of Application of Safe System of Work and Permit-to-work System

[The example at Appendix 2 should be used for demonstration of the process of preparing a "permit-to-work certificate"]

[This section must be conducted in an interactive manner through discussion with trainees]

"Permit-to-work" system reminds the proprietor or contractor to ensure that all foreseeable hazards and associated risks have been considered in advance and that all the necessary safety precautions are clearly defined and have been effectively taken. The following paragraphs give a brief framework of the system.

<u>Contents</u>

- The proprietor or contractor of a confined space should issue to the workers a "permit-to-work certificate" before allowing them to enter into or work in the confined space.
- The "permit-to-work certificate" should record the following:

  (1) the findings in the risk assessment report completed by the competent person;
  (2) the effectiveness of the isolation and withdrawal from service;
  (3) the amount of sludge or other deposits (if any) after cleaning;
  (4) the results of the air testing;
  (5) the nature of work to be done;
  (6) the conditions and features of the confined space;
  (7) list of personal protective equipment;
  (8) the period during which workers may remain safely in the confined; and
  (9) the other relevant information. [Reference can be made to the example of "permit-to-work certificate" at Appendix 2]

<u>Procedures</u>

- The proprietor or contractor of the confined space work, after receiving a risk assessment report completed by a competent person, shall verify that the report has covered all the matters referred to in section 5(2) of the FIU(CS)R. The proprietor or contractor should determine to issue a "permit-to-work certificate" only when all necessary safety measures have been implemented, including all necessary safety precautions specified in the risk assessment.

- The "permit-to-work certificate" should be properly signed for confirmation that all safety precautions indicated on the certificate have been implemented effectively by the proprietor or contractor or persons authorized by him. The items in the certificate should be written in permanent ink or otherwise so as to be indelible.
- The person responsible for signing and accepting the "permit-to-work certificate" should be the one who is responsible for stationing outside the confined space, that is, the onsite supervisor or the person-in-charge of the work in the confined space. The signer should read and fully understand the content of the "permit-to-work certificate" and undertake the work in accordance with all the conditions laid down in the certificate.
- The contents of the "permit-to-work certificate" should be clearly explained to all the workers and persons involved in the confined space work.
- All the safety requirements, necessary precautions and relevant conditions or limitations stated in the "permit-to-work certificate" should be strictly observed and followed by all the workers and persons involved in the confined space work.
- The "permit-to-work certificate" should be displayed conspicuously at the entrance of the confined space.
- A "permit-to-work certificate" should be properly cancelled when the work activities in the confined space to which it refers have been completed and the confined space is clear of workers, equipment and spare material.
- When work in the confined space was completed, the "permit-to-work certificate" should be returned to the proprietor or contractor by the person to whom it was issued. This person should sign a declaration that all personnel and equipment have been removed from the site, and the personnel have been warned that the confined space is no longer safe for entry.
- A proprietor or contractor should check that the work covered by the "permit-to-work certificate" has been properly completed. He should then sign a final

confirmation of cancellation of the certificate to confirm that the work activities in the confined space have been completed and that another certificate will be required for entering the confined space again. Effective measures should be taken to ensure that no worker would enter the confined space during the period when the completed "permit-to-work certificate" is being delivered to the proprietor or contractor for proper cancellation.

- The records of all risk assessment report and "permit-to-work certificates" should be properly maintained for one year after the certificates have been cancelled and be available for inspection.

11.2 Exercise in Preparation of "Permit-to-work Certificate"

[The example of "permit-to-work certificate" at Appendix 2 should be used for the exercise]

[This section must be conducted in an interactive manner through discussion with trainees]

["permit-to-work certificate" completed by trainees should be collected and checked to facilitate the interactive discussion]

[Model answers of "permit-to-work certificate" should be provided to trainees to facilitate the interactive discussion]

- Exercise：Every trainee should prepare one "permit-to-work certificate".
- Cases for the exercise:
  - The accident cases associated with confined spaces operation (in particular those occurred during the three years preceding the conduct of the course)

    or

  - The accident cases associated with confined spaces operation published by Labour Department (e.g. "Poisoning in manhole sewer" and "Poisoning in metal duct" in "Brief Analysis of Site Accident Cases", etc.).

12. Practical Examination

The practical examination consists of proper use of personal motion-sensing alarm device, approved breathing apparatus (self-contained type) and continuous air monitoring equipment. For the assessment items of the practical examination, please refer to the Score Sheet in **Annex 9**.

Risk Assessment Form for Confined Spaces

Appendix 1

Location of work : ______________________________

Description of work : ______________________________

Main Contractor/Proprietor : ______________________________

Subcontractor (if applicable) : ______________________________

Name of Competent Person : ______________________________

Certificate No. : ______________ Validity Period : ________(Year) ______ (Month) ______ (Day)

Add a ✓ to appropriate boxes

1.	Contents of Risk Assessment		
1.1	☐ This work falls under the provisions of section 3 of the Factories and Industrial Undertakings (Confined Spaces) Regulation, as it involves work performed within a confined space or in close proximity to a confined space, and is related to work conducted within a confined space. Work methods to be adopted in the confined space works[1] : ______________ Plant to be used in the confined space works[1] : ______________ Materials to be used in the confined space works[1] : ______________ (If the work does not involve any worker entering the confined space[1], the following measures shall be taken to ensure that no workers enter the confined space : ______________ ______________)		
	Assessment Items	**Result(s)**	**Safety Precautions Required**
1.2	Is the confined space works an **underground pipework** as described in section 9(b) of the Factories and Industrial Undertakings (Confined Spaces) Regulation?	☐ Yes	☐ Ensure that any person entering or remaining in that particular confined space is properly (i) wearing a suitable approved breathing apparatus; and (ii) wearing a suitable safety harness connected to a lifeline. ☐ Monitor the air in the confined space continuously until everyone has left the confined space.
		☐ No (Reasons provided as follows : ______________ ______________ ______________)	______________ ______________ ______________
1.3	Is there any **hazardous** gas, vapour, dust or fume, or **deficiency of oxygen** present in the confined space?	☐ Yes	☐ Ensure that any person entering or remaining in that particular confined space is properly (i) wearing a suitable approved breathing apparatus; and (ii) wearing a suitable safety harness connected to a lifeline. ☐ Monitor the air in the confined space continuously until everyone has left the confined space.
		☐ No (Reasons provided as follows : ______________ ______________ ______________)	______________ ______________ ______________

[1] The Competent Person should obtain information of work methods, plant and materials to be used for the particular confined space works from the Main Contractor/ Subcontractor/ Proprietor in order to complete the risk assessment. The Main Contractor/ Subcontractor / Proprietor shall ensure the risk assessment report is displayed in a conspicuous place at the entrance of the confined space.

	Assessment Items	Consequence [2]	Likelihood [2]	Risk [2]	Safety Precautions Required
1.4	**<u>Ingress</u>** of hazardous gas, vapour, dust or fume to the confined space	☐ Very Serious (3) ☐ Serious (2)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	____ ____ ____
				☐ Moderate risk (3-4)	____ ____ ____
				☐ Low risk (<=2)	____ ____ ____
1.5	Are there any **<u>sludge or other deposits being present</u>** that are **<u>liable to give off hazardous gas, vapour, dust or fume</u>** in the confined space?			☐ High risk (>=6)	☐ Ensure that any person entering or remaining in that particular confined space is properly (i) wearing a suitable approved breathing apparatus; and (ii) wearing a suitable safety harness connected to a lifeline. ☐ Monitor the air in the confined space continuously until everyone has left the confined space.
	☐ **Yes, sludge or other deposits are present** in the confined space. *Unless the sludge and other deposits are completely removed and purged, otherwise if there are sludge or other deposits present, it is generally very likely for the trapped or dissolved gases such as hydrogen sulphide to be released in confined space work, in particular drainage works.*	☐ Very Serious (3) ☐ Serious (2)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ Moderate risk (3-4)	____ ____ ____
				☐ Low risk (<=2)	____ ____ ____ ____
	☐ **No, sludge or other deposits are not present** in the confined space.	(Reasons provided as follows : ____ ____ ____)			

[2] Regarding the definitions of 'severity of consequences', 'likelihood of occurrence' and 'risk rating' please refer to the risk rating table in the final section of this assessment form.

	Assessment Items	Consequence [2]	Likelihood [2]	Risk [2]	Safety Precautions Required
1.6	**In-rush** into the confined space of free flowing solid or liquid	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	
1.7	**A fire or explosion** in the confined space	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	
1.8	The **ambient temperature** in the confined space that may lead to loss of consciousness of a certified worker arising from an increase in body temperature	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	
1.9	**Change in the environment** leading to an increased risk of the above hazards during the course of the work in the confined space	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	
				☐ Moderate risk (3-4)	
				☐ Low risk (<=2)	

[2] Regarding the definitions of 'severity of consequences', 'likelihood of occurrence' and 'risk rating' please refer to the risk rating table in the final section of this assessment form.

	Assessment Items	Consequence [2]	Likelihood [2]	Risk [2]	Safety Precautions Required
1.10	**Risk of worker falling from height** during the course of the work in the confined space or its proximity	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	____________ ____________ ____________
				☐ Moderate risk (3-4)	____________ ____________ ____________
				☐ Low risk (<=2)	____________ ____________ ____________
1.11	Others (please specify: ____________ ____________)	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	____________ ____________ ____________
				☐ Moderate risk (3-4)	____________ ____________ ____________
				☐ Low risk (<=2)	____________ ____________ ____________
1.12	Others (please specify: ____________ ____________)	☐ Very Serious (3) ☐ Serious (2) ☐ Mild (1)	☐ Very likely (3) ☐ Possible (2) ☐ Unlikely (1)	☐ High risk (>=6)	____________ ____________ ____________
				☐ Moderate risk (3-4)	____________ ____________ ____________
				☐ Low risk (<=2)	____________ ____________ ____________
1.13	Period during which certified workers may remain safely in the confined space: ________hour(s)				

[2] Regarding the definitions of 'severity of consequences', 'likelihood of occurrence' and 'risk rating' please refer to the risk rating table in the final section of this assessment form.

2	**Safety precautions must be taken when entering and working into the confined space** —— Apart from the aforementioned safety precautions required with respect to the risk assessment, the proprietor or contractor must ensure that all the following safety precautions are taken before allowing certified workers to work in confined spaces:
	☐ Every piece of mechanical equipment in the confined space, which is liable to cause danger, has been disconnected from its power source, with warning notice displayed and its power source locked out;
	☐ Every pipe or supply line whose contents are liable to create a hazard has been properly blanked off;
	☐ The confined space has been tested to ensure the absence of any hazardous gas and no deficiency of oxygen;
	☐ The confined space has been adequately purged and sufficiently cooled and ventilated, having regard to the circumstances of the particular confined space, to ensure that it is a safe workplace;
	☐ An adequate supply of respirable air and an effective forced ventilation have been provided inside the confined space;
	☐ Effective steps have been taken to prevent - (i) an ingress to the confined space of hazardous gas, vapour, dust or fume; and (ii) an in-rush into the confined space of free flowing solid or liquid;
	☐ Before entering and working in the confined space, the following air testing of the confined space has been conducted with appropriate air monitoring equipment of explosion-proof design: ☐ Oxygen ☐ LEL ☐ Hydrogen sulphide ☐ Carbon monoxide ☐ Others : ________________; ☐ Continuous air monitoring has to be conducted until everyone has left the confined space;
	☐ Formulated appropriate emergency procedures to deal with any serious and imminent danger to workers inside the confined space, including the provision of a sufficient supply of the following items in a satisfactory condition (and keeping them readily available) (a) approved breathing apparatus; (b) suitable apparatus for reviving an unconscious worker; (c) vessels containing oxygen or air; (d) safety harnesses and ropes; and (e) an audio and visual alarm by which the workers inside the confined space can alert those outside;
	☐ The emergency rescue team is composed of a sufficient number of trained personnel who are ready to carry out emergency procedures in case of accident. All members of the emergency rescue team have been properly and adequately trained in the related emergency rescue procedures, including the details of the emergency rescue plan and full knowledge on how to properly use all the rescue equipment;
	☐ Instructions, training and advice are provided to all workers within a confined space or assisting with such work from immediately outside the confined space to ensure the safety and health of all workers, including posting up or displaying a clearly visible warning sign in a conspicuous place at the entrance to the confined space, indicating the specified hazards and safety precautions taken in the confined space;
	☐ All necessary equipment is provided to ensure the safety and health of workers in the confined space, including the provision of suitable air monitoring equipment of explosion-proof design for continuous air monitoring if necessary;
	☐ Only certified workers are allowed to enter or work in the confined space;
	☐ At least one "Standby Person" is stationed outside the confined space to maintain communication with the workers inside the confined space;
	☐ The risk assessment report and the Permit-to-work Certificate shall be displayed in a conspicuous place at the entrance of the confined space; and
	☐ The safety precautions listed above are effective continuously while the workers remain in the confined space.
	☐ Other safety precautions: ________________________________

I confirmed that I have at least one year of relevant experience, after obtaining registration as Safety Officer or the certificate as Competent Person, in assessing risk to the safety and health of workers working in confined spaces, and have been appointed by the above-mentioned Main Contractor/ Subcontractor/Proprietor to be the competent person to carry out an assessment in the aforesaid confined space works in accordance with section 5(1) of the Factories and Industrial Undertakings (Confined Spaces) Regulation.

I confirmed that, the true to the best of my knowledge and belief, the risk of the working condition in the confined space was assessed according to the requirements of section 5(6) of the Factories and Industrial Undertakings (Confined Spaces) Regulation, and recommendations of control measures were made under the section with respect to the safety and health of workers working in the confined space.

Signature of the Competent Person
conducted the above risk assessment : ____________________________

Name : ____________________________

Date and time : ____________________________

Receipt of the risk assessment report

Recipient signature : ____________________________

Name : ____________________________

Post : ____________________________

Date and time : ____________________________

Risk Assessment Table

Likelihood / Consequence	Unlikely (1) (Rather remote, though conceivable)	Possible (2) (Event to be expected)	Very likely (3) (Occurs repeatedly)
Very serious (3) Accident causing immediate danger to life or serious bodily injury (Example: gas poisoning, hypoxia, drowning)	(3) Moderate Risk	(6) High Risk	(9) High Risk
Serious (2) Accident causing moderate bodily injury (Example: fracture, skin ulcer, etc.)	(2) Low Risk	(4) Moderate Risk	(6) High Risk
Mild (1) Accident resulting in mild bodily injury (Example: eye irritation from dust, cough)	(1) Low Risk	(2) Low Risk	(3) Moderate Risk

Pink	High Risk
Yellow	Moderate Risk
Green	Low Risk

Appendix 2

Permit-to-work Certificate

A Template of "Permit-to-work Certificate" for Entry into Confined Space

Location of work : ______________________________

Description of work : ______________________________

Main Contractor/Proprietor : ______________________________

Name of the Competent Person appointed : ______________________

Date and time of risk assessment : ______________________

Date & time for entry to the confined space : ________(Year) _____ (Month) _____ (Day) from _____ *am/pm (Time)

This permit-to-work certificate is valid until : ________(Year) _____ (Month) _____ (Day) _____*am/pm (Time)

* Please delete if not applicable

Workers			
Certified Worker			
Maximum duration that certified workers are allowed to stay in the confined space : _____ Hour(s)			
Name	Reference No. of Certificate	Validity Period	Signature
Standby Person			
Name	Date of training	Responsibility	Signature
		✓ Maintain communication with the workers inside the confined space, and call for support in case of emergency; ✓ Brief the rescue personnel of the relevant circumstances of the incident upon their arrival in case of emergency; ✓ Even in case of emergency, the standby person should not enter the confined space.	
Onsite Rescue Personnel			
Name	Date received training for rescue in emergency	Responsibility	Signature
		✓ Familiar with the details of the emergency rescue plan; ✓ Know how to properly operate all rescue equipment provided.	

Add a ✔ to appropriate boxes ☐

Underground Pipework
☐ This confined space work is <u>underground pipework</u> as described in section 9(b) of the Factories and Industrial Undertakings (Confined Spaces) Regulation, and therefore contractor / proprietor has to ☐ Ensure that any person entering or remaining in that particular confined space is properly i. wearing a suitable approved breathing apparatus; and ii. wearing a suitable safety harness connected to a lifeline. ☐ Use appropriate air monitoring equipment of explosion-proof design to monitor the air in the confined space continuously until everyone has left the confined space; and __________ __________
☐ This confined space work is **<u>NOT underground pipework</u>** as described in section 9(b) of the Factories and Industrial Undertakings (Confined Spaces) Regulation with the reason(s) stated as follows: __________ __________
Remarks : Must choose one out of the two options above

Isolation Measures		
	Signature	Date & time
☐ Normal services in the confined space have been suspended.		
☐ All unnecessary sources of power (Electrical/ Mechanical/ Pneumatic/ Hydraulic/ Others: __________) have been isolated.		
☐ All pipelines connected to the confined space have been completely shut off or blanked off		
☐ The ends of all service pipes connected to hazardous gas sources have been sealed.		
☐ Non-essential heat sources have been isolated.		
☐ Other sources of danger have been isolated (please specify _________).		
☐ All isolated or closed connections have been locked off and properly labelled to prevent from being opened without authorisation or accidentally.		

Purging and Ventilation Control Measures		
	Signature	Date & time
☐ The confined space has been purged/cleaned adequately. (Method : ____________________)		
☐ All hazardous substances stored inside the confined space have been removed.		
☐ Adequate respirable air and effective forced ventilation have been provided.		

Add a ✔ to appropriate boxes ☐

Air Testing Results
Testing Date (YYYY/MM/DD) : ____________________ Model of air monitoring equipment : ________________ Serial number of air monitoring equipment : ____________ Calibration Expiry Date (YYYY/MM/DD) : ______________
Testing Location : ______________________________ Testing Time : __________*am/pm ☐ O_2 : __________ % ☐ LEL(Percentage) : __________ % ☐ H_2S : __________ ppm ☐ CO : __________ ppm ☐ ____________________
Testing Location : ______________________________ Testing Time : __________*am/pm ☐ O_2 : __________ % ☐ LEL(Percentage) : __________ % ☐ H_2S : __________ ppm ☐ CO : __________ ppm ☐ ____________________
Testing Location : ______________________________ Testing Time : __________*am/pm ☐ O_2 : __________ % ☐ LEL(Percentage) : __________ % ☐ H_2S : __________ ppm ☐ CO : __________ ppm ☐ ____________________
☐ After the air testing, I confirm that there is no hazardous gas and no oxygen-deficient situation in this confined space. Responsible person for conducting the air testing Name : ____________________ Signature : ____________________

Add a ✔ to appropriate boxes ☐

Safety Precautions for Entry into the Confined Space
☐ Every piece of mechanical equipment in the confined space, which is liable to cause danger, has been disconnected from its power source, with warning notice displayed and its power source locked out;
☐ Every pipe or supply line whose contents are liable to create a hazard has been properly blanked off;
☐ The confined space has been tested to ensure the absence of any hazardous gas and no deficiency of oxygen;
☐ The confined space has been adequately purged and sufficiently cooled and ventilated, having regard to the circumstances of the particular confined space, to ensure that it is a safe workplace;
☐ An adequate supply of respirable air and an effective forced ventilation have been provided inside the confined space;
☐ Effective steps have been taken to prevent - (i) an ingress to the confined space of hazardous gas, vapour, dust or fume; and (ii) an in-rush into the confined space of free flowing solid or liquid;
☐ Formulated appropriate emergency procedures to deal with any serious and imminent danger to workers inside the confined space, including the provision of a sufficient supply of the following items in a satisfactory condition (and keeping them readily available): (a) approved breathing apparatus; (b) suitable apparatus for reviving an unconscious worker; (c) vessels containing oxygen or air; (d) safety harnesses and ropes; and (e) an audio and visual alarm by which the workers inside the confined space can alert those outside;
☐ The emergency rescue team is composed of a sufficient number of trained personnel who are ready to carry out emergency procedures in case of accident. All members of the emergency rescue team have been properly and adequately trained in the related emergency rescue procedures, including the details of the emergency rescue plan and full knowledge on how to properly use all the rescue equipment;
☐ Instructions, training and advice are provided to all workers within a confined space or assisting with such work from immediately outside the confined space to ensure the safety and health of all workers, including posting up or displaying a clearly visible warning sign in a conspicuous place at the entrance to the confined space, indicating the specified hazards and safety precautions taken in the confined space;
☐ All necessary equipment is provided to ensure the safety and health of workers in the confined space, including the provision of suitable air monitoring equipment of explosion proof design for continuous air monitoring if necessary;
☐ Only certified worker is allowed to enter or work in the confined space;
☐ At least one "Standby Person" is stationed outside the confined space to maintain communication with the workers inside the confined space;
☐ The risk assessment report and this permit-to-work certificate should be displayed in a conspicuous place at the entrance of the confined space;
☐ The safety precautions listed above are effective continuously while the workers remain in the confined space;
☐ Video recording at the entrance and exit of the confined space throughout the entire work period is arranged to monitor that relevant personnel have complied with the safety precautions.

Add a ✔ to appropriate boxes ☐

Emergency Rescue Equipment Provided
☐ Approved breathing apparatus : ____________ set
☐ Apparatus for reviving an unconscious worker : ____________ set
☐ Vessels containing oxygen or air : ____________ set
☐ Safety harnesses and ropes : ____________ set
☐ Audio and visual alarm by which the workers inside the confined space can alert those outside : ____________ set
☐ Other relevant emergency rescue equipment, including : ☐ Tripods and winches; ☐ ______________________________
☐ I confirm that the above emergency rescue equipment is sufficient with satisfactory condition and are readily available.

List of Protective Equipment Provided
General
☐ Forced ventilation device : ____________ set
☐ Continuous air monitoring equipment : ____________ set
☐ Walkie-talkie (explosion-proof design) : ____________ set
☐ Shield : ____________ set
☐ Lighting device : ____________ set
☐ Others (Please specify) : ______________________________
Personal Protective Equipment
☐ Approved breathing apparatus : ____________ set (excluding for emergency use)
☐ Audio and visual alarm : ____________ set
☐ Protective clothing : ____________ piece
☐ Head, Hand & Foot Protection : ____________ piece
☐ Life Lines & Harness : ____________ set
☐ Eye Protection : ____________ set
☐ Ear Protection : ____________ set
☐ Others (Please specify) : ______________________________

Declaration by the Proprietor/Contractor or Authorised Representative

Permit-to-work Certificate

I am the proprietor/ contractor/ authorised representative* of the confined space work mentioned above. I confirm that the risk assessment report by the competent person mentioned above covers all matters stated in section 5(2) of the Factories and Industrial Undertakings (Confined Spaces) Regulation, and I certify that all necessary safety precautions in accordance with the risk assessment report have been taken, and I hereby, issue this Permit-to-work Certificate.

This permit-to-work certificate is valid until (Date & Time):

_________(Year) ______(Month)______ (Day) ______ *am/pm (Time)

Signature : ____________________________

Name : ____________________________

Post : ____________________________

Date & time : ____________________________

* Please delete if not applicable

Receipt of Permit-to-work Certificate

(To be filled by the supervisor or person in-charge of the work)

I have read and understood the content of the Permit-to work Certificate, and shall undertake to work in accordance with all the conditions laid down in this certificate.

Signature : ____________________________

Name : ____________________________

Post : ____________________________

Date & time : ____________________________

Proof of Completion

(To be filled by the supervisor or person in-charge of the work)

I confirm that the confined space work mentioned above has been completed and that all assigned persons, materials and equipment have been withdrawn from the site, the personnel have been warned that the confined space is no longer safe for entry and I hereby sign to confirm.

Signature : ____________________________

Name : ____________________________

Post : ____________________________

Date & time : ____________________________

Cancellation of Permit-to-work Certificate

I am the proprietor/ contractor/ authorised representative* of the confined space work mentioned above. I hereby sign to confirm the cancellation of this Permit-to-work Certificate. I understand that a new permit-to-work certificate will be required if work is to be continued.

Signature : ____________________________

Name : ____________________________

Post : ____________________________

Date & time : ____________________________

* Please delete if not applicable

Appendix 3

Setting Up Air Monitoring Alarm

1. Working in confined space can pose risks to the safety and health of workers, including atmospheric hazards. Typical situations that cause loss of consciousness or ability to escape due to atmospheric hazards include: (1) concentrations of flammable or explosive gases or vapours, etc. exceeding their Lower Explosive Limit (LEL), (2) concentrations of toxic or harmful substances in the air exceeding their Occupational Exposure Limit (OEL) or Immediately Dangerous to Life or Health (IDLH) concentrations, and (3) the air becoming oxygen-enriched or deficient. For detailed information on common hazardous gases/chemicals in confined spaces and occupational hygiene standards, please refer to paragraphs 11 to 16 below.

2. Examples of possible atmospheric hazards in confined spaces include:
   - Fire or chemical spill happens in confined spaces;
   - Failure of the ventilation or fresh air supply systems in confined spaces;
   - Fire or chemical spillage happens outside confined spaces, which could affect the quality of fresh air intake;
   - Disturbance of the sewage, sediment, or sludge can release the trapped or dissolved hydrogen sulphide gas, etc., thus rising the concentration of the hazardous gases in the air rapidly; and
   - Use of volatile chemicals in confined spaces, etc.

3. A number of hazardous gases, such as carbon monoxide, are colourless and odourless. On the other hand, some hazardous gases like hydrogen sulphide may have an unpleasant smell at low concentrations, but such smell disappears at higher concentrations due to olfactory fatigue. It can be very wrong and dangerous if workers think they can recognise the presence of hazardous gases by scent. In certain situations, competent person may recommend continuous monitoring or periodic monitoring of the working environment. Workers should be equipped with continuous air monitoring equipment that provides audio and visual alarms, where applicable, in order to immediately alert the workers and standby persons the imminent situations regarding the air quality and presence of hazardous gases in confined spaces, and activate evacuation or arrange rescue as soon as possible.

4. The air monitoring equipment should have a two-level alarm system to alert workers to take appropriate actions correspondingly. Level 1 Alarm is a warning level indicating that there is a threat of atmospheric hazards, but the situation of worker is still safe. Action should be taken to determine the cause of the threat and implement appropriate remedial measures. Under normal circumstances, when

reaching Level 2 Alarm level, it indicates the atmospheric hazards pose risks to the workers, the emergency procedures should be activated, and the workers should be evacuated immediately.

Flammable or Explosive Substances in Air

5. The alarm for the presence of flammable or explosive gases is generally set using the Lower Explosive Limit (LEL). Level 1 Alarm (Warning) for the lower explosive limit should be set at 5% LEL, and Level 2 Alarm (Evacuation) should be set at 10% LEL. If a flammable or explosive substance has toxic/harmful properties simultaneously, the lower concentration of the two shall be used as the criterion for setting the alarm. For example, hydrogen sulphide must set the alarm at the concentration of its toxicity.

Toxic or Harmful Chemcial Substances in Air

6. The setting of alarm levels for toxic or harmful chemicals in the air should make reference to the Occupational Exposure Limits if underground pipework is not involved and an approved breathing apparatus is not required as indicated in the risk assessment report. In this connection, the alarm levels for toxic or harmful chemicals in the air should be set as follows:

Level 1 Alarm§	Half of Occupational Exposure Limit - Short-Term Exposure Limit *[or 1.5 times of Occupational Exposure Limit - Time-Weighted Average¶]*
Level 2 Alarm§	Occupational Exposure Limit - Short-Term Exposure Limit *[or 3 times of Occupational Exposure Limit - Time-Weighted Average¶]*

§ Alarm settings for measuring instruments should be rounded down to the nearest integer.

¶ Only applicable to chemicals for which OEL-STEL have not been established.

7. In normal circumstances, properly worn approved breathing apparatus can provide a good protection to workers against atmospheric hazards but it is not entirely fail-safe. When workers are using approved breathing apparatus to enter confined spaces, it is a prudent approach to set Level 1 Alarm at half of IDLH concentration of the toxic or harmful chemical substance and Level 2 Alarm at the corresponding IDLH. For example, Level 1 and Level 2 Alarms for hydrogen sulphide gas can be set at 50ppm and 100ppm respectively.

8. Under the Factories and Industrial Undertakings Ordinance, it shall be the duty of every proprietor to ensure the provision and maintenance of a working environment for the proprietor’s workers that is, so far as is reasonably practicable, safe, and without risks to health. In this regard, the proprietor should eliminate or substitute

the atmospheric hazards and/or implement vigorous and robust engineering control measures to reduce the level of hazardous gases to below IDLH as far as possible rather than relying heavily on the use of personal protective equipment ("PPE"). The use of PPE should always be regarded as the last resort in the hierarchy of control measures, and is a supplement to, not in lieu of, effective engineering control measures and safe system of work. In rare circumstances where elimination or substitution is not possible and vigorous and robust engineering control measures adopted cannot reduce the level of hazardous gases below IDLH, the proprietor should consult occupational health professionals, in addition to the competent person appointed, to review the work situation and to develop and fully implement a written respiratory protection programme with required worksite-specific procedures and elements for required respirator use which is commensurate with the respiratory protection standards, 29 CFR 1910.134, required by the Occupational Safety and Health Administration, U.S. Department of Labor, to ensure the safety and health of the certified workers working in such high risk situation.

Excessive Level of Oxygen or Oxygen Deficiency in Air

9. There are about 21% by volume of oxygen in air under normal atmospheric pressure. A decrease in the percentage of oxygen in air can result in an oxygen-deficient environment, which can asphyxiate workers. Conversely, a high percentage of oxygen in air increases the risk of causing fires and explosions. Therefore, alarm thresholds for oxygen content in air (measured by volume) are set at 19.5% and 22% to warn workers of oxygen deficiency or excessive oxygen level environments respectively. Whenever the oxygen content alarm is activated, immediate evacuation should be carried out.

Setting Air Monitoring Alarm

10. The alarm levels for some common hazardous gases that can be encountered in confined spaces are recommended as follows:

For workers without using approved breathing apparatus to enter confined spaces	CH_4	H_2S	CO
Level 1 Alarm	5% LEL	7ppm	37ppm
Level 2 Alarm	10% LEL	15ppm	75ppm

Common Hazardous Gas in Confined Space and Occupational Safety and Hygiene Standards

11. Lower Explosive Limit (LEL) – LEL is the lowest concentration of a substance that will produce a flash fire or explosion when an ignition source (flame, spark, etc.) is present and is expressed in percent of vapour or gas in the air by volume.

12. “Occupational Exposure Limit (OEL)” refers to the airborne concentration(s) of individual chemical substances that represent levels that are regarded to impose no adverse health effects to nearly all workers on exposures by the route of inhalation. “Occupational Exposure Limit - Time - Weighted Average (OEL-TWA)” refers to the time-weighted average concentration of a chemical substance over an eight-hour working day for a five-day workweek, to which nearly all workers can be exposed day after day without adverse health effects. “Occupational Exposure Limit - Short-Term Exposure Limit (OEL-STEL)” refers to the 15-minute time-weighted average of the airborne concentration of a chemical substance. A list of OEL for chemical substances can be found in the “Code of Practice on Control of Air Impurities (Chemical Substances) in the Workplace” published by the Labour Department.

13. Under the situation of Immediately Dangerous to Life or Health (IDLH) concentrations, there will be an immediate or delayed threat to life, or it may cause irreversible health effects or impairment of the ability to escape. For IDLH concentrations, please refer to the values developed by the Ministry of Health of the People’s Republic of China or the National Institute for Occupational Safety and Health (NIOSH) of the United States of America.

14. Hydrogen Sulphide (H_2S) is a deadly gas with a distinctive “rotten egg” odour that can be detected at very low concentrations. At concentrations above 100 ppm, hydrogen sulphide has a paralysing effect on the sense of smell. Even at lower concentrations, hydrogen sulphide can affect the olfactory nerve, and workers cannot detect the changes in concentrations. It can be produced and accumulated in confined spaces such as septic tanks, manholes or sewers. Hydrogen sulphide is heavier than air and thus settles in lower part of the confined space such as the bottom of manholes or sewers.

Hydrogen Sulphide (in ppm)	Effect/ Exposure Limit
Less than 1	Smells like rotten eggs
10	OEL-TWA
15	OEL-STEL
50-100	Paralysis of the olfactory nerve, irritation to the eye and respiratory tract, and inhalation may result in lung oedema that causes death
100	IDLH

15. Carbon Monoxide (CO) is a lethal colourless and odourless gas. Carbon monoxide is a product of incomplete combustion. When gasoline/diesel generators or other fuel-driven tools are used in inadequately ventilated workplaces, oxygen can also

be consumed, and carbon monoxide can be produced and accumulated.

Carbon Monoxide (in ppm)	Effect/ Exposure Limit
25	OEL-TWA
350	Confusion, fainting on exertion and collapse
1200	IDLH

16. Methane (CH_4) is commonly generated when organic matter is decomposed by various bacterial processes. It is a colourless, odourless, extremely flammable and explosive gas that can cause fire and explosion. The accumulation of methane in a poorly ventilated area will displace normal air and result in an oxygen-deficient environment. Typical air monitoring equipment for confined spaces does not directly measure methane concentration. Instead, users can determine the presence of methane through the oxygen concentration and LEL. Methane is lighter than air and thus will accumulate in the upper part of the confined space.

Occupational Safety and Health Branch
Labour Department

Annex 8

Answer Sheet for Safety Training Course for Competent Persons

Answer Sheet
for Safety Training Course for Competent Persons (Part 1)

Name of Course Provider : ______________________________

Class Ref. (TRC1): ____________________ **Examination Paper Code :** ____________________

Date of Examination : ____________________ **Examination Start Time :** ____________________

Name of Trainee : ______________________________ **Mark :** ____________________

Instructions to Trainees

1. Answer 10 multiple-choice questions in 15 minutes. Each question carries 10 marks. The passing mark of the examination is 100.
2. Tick only ONE answer box on the answer sheet for each question. Otherwise no marks will be awarded.
3. Please initial next to your final answer whenever amendment is made.
4. The "law" referred in the questions means the Factories and Industrial Undertakings Ordinance, the Occupational Safety and Health Ordinance and their subsidiary regulations.
5. The questions are worded in simple language and difficult legal terms are avoided.
6. If you have any questions, please raise your hand and ask the examiner or invigilator.

Question	Answer				Question	Answer			
	A	B	C	D		A	B	C	D
1					6				
2					7				
3					8				
4					9				
5					10				

Please tick only one box to denote if the trainee has used the question paper reading service and also if it is read in English.

Not required		Read in English		Read in language other than English	

Signature of Trainee : ______________________________ **Date:** ____________________

Name and Signature of Invigilator : ______________________________ **Date:** ____________________

Answer Sheet
for Safety Training Course for Competent Persons (Part 2)

Name of Course Provider : ____________________

Class Ref. (TRC1): ____________________ **Examination Paper Code :** ____________________

Date of Examination : ____________________ **Examination Start Time :** ____________________

Name of Trainee : ____________________ **Mark :** ____________________

Instructions to Trainees

1. **Answer 20 multiple-choice questions in 30 minutes. Each question carries 5 marks. The passing mark of the examination is 75.**
2. **Tick only ONE answer box on the answer sheet for each question. Otherwise no marks will be awarded.**
3. **Please initial next to your final answer whenever amendment is made.**
4. **The "law" referred in the questions means the Factories and Industrial Undertakings Ordinance, the Occupational Safety and Health Ordinance and their subsidiary regulations.**
5. **The questions are worded in simple language and difficult legal terms are avoided.**
6. **If you have any questions, please raise your hand and ask the examiner or invigilator.**

Question	Answer A	B	C	D	Question	Answer A	B	C	D
1					11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Please tick only one box to denote if the trainee has used the question paper reading service and also if it is read in English.

Not required	☐	Read in English	☐	Read in language other than English	☐

Signature of Trainee : ____________________ **Date:** ____________________

Name and Signature of Invigilator : ____________________ **Date:** ____________________

Annex 9

Score Sheet for Practical Examination of Safety Training Course for Competent Persons of Confined Spaces Operation

Score Sheet for Practical Examination of

Safety Training Course for Competent Persons of Confined Spaces Operation

Name of Course Provider :			
Class Ref. :			
Date of Examination :		Examination Start/End Time :	/
Name of Trainee :		Practical Examination Result :	Passed / Failed

Examiner must give relevant instructions to each trainee on each assessment item to be carried out.

Trainees must correctly complete all the following assessment items within the time allowed for each assessment item in order to pass the practical examination according to the Examiner's instructions. Each trainee must wear a safety harness correctly before taking the practical examination and keep wearing the harness until the trainee has completed the practical examination.

	Assessment items (Time allowed 2 minutes)		
1	**Checking the personal motion-sensing alarm device and approved breathing apparatus (self-contained type) before use**	**Correctly completed**	**Failed**
	A. Check whether the personal motion-sensing alarm device and the approved breathing apparatus (self-contained type) are available and intact, and report the checking result to the Examiner.		

	Assessment items (Time allowed 2 minutes)		
2	**Wearing Personal motion-sensing alarm device**	**Correctly completed**	**Failed**
	A. Turn on the personal motion-sensing alarm device		
	B. Check whether the personal motion-sensing alarm device is fully charged, and report the checking result to the Examiner.		
	C. Wear the personal motion-sensing alarm device		
	D. Turn off the personal motion-sensing alarm device		

Signature of Examiner： ______________________ Signature of Trainee： ______________________

	Assessment items (Time allowed 4 minutes)		
3	**Matters to do before wearing the approved breathing apparatus (self-contained type)**	**Correctly completed**	**Failed**
	A. Conduct compressed air cylinder pressure test (check the pressure of the cylinder) and report the readings to the Examiner		
	B. Conduct high pressure leak test (check the leak of the hoses)		
	C. Conduct whistle warning unit test (check the function of the whistle)		

	Assessment items (Time allowed 6 minutes)		
4	**Wearing the whole set of approved breathing apparatus (self-contained type)**	**Correctly completed**	**Failed**
	A. Wear the mask		
	B. Adjust the mask properly		
	C. Conduct the low pressure test (check the leak of the mask)		
	D. Open the valve of the air cylinder		
	E. Connect the mask to the air cylinder		
	F. Breath normally when wearing the approved breathing apparatus		
	G. Conduct the positive pressure test (check the positive pressure of the mask)		

	Assessment items (Time allowed 2 minutes)		
5	**Doffing the whole set of approved breathing apparatus (self-contained type)**	**Correctly completed**	**Failed**
	A. Doff the whole set of approved breathing apparatus		
	B. Turn off gas valve of the air cylinder		

Signature of Examiner： ______________________ Signature of Trainee： ______________________

	Assessment items (Time allowed 4 minutes)		
6	**Checking the air monitoring equipment before use**	**Correctly completed**	**Failed**
	A. Check whether the air monitoring equipment is available and intact, and report the checking result to the Examiner.		
	B. Start up the air monitoring equipment		
	C. Take the readings on levels of oxygen, carbon monoxide, hydrogen sulphide and flammable gases in the examination room and report the readings to the Examiner		

	Assessment items (Time allowed 2 minutes)		
7	**Simulation of hazardous situation**	**Correctly completed**	**Failed**
	A. Exhale to a plastic ziplock bag or container several times to simulate the oxygen deficient environment. Put the sampling probe into the plastic ziplock bag or container. Take the readings on levels of oxygen, carbon monoxide, hydrogen sulphide and flammable gases in the plastic ziplock bag or container and report the readings to the Examiner		
	B. Turn off the air monitoring equipment		
	C. Report the Examiner the locations where air testing is required in the confined space like **manhole, shaft Tunnel** and the measuring time required for each location (**manhole, shaft**: from the top to the front end of the confined space to cover different positions and different depths of the confined space. Sampling for a few minutes at each location is required; **Tunnel**: In addition to conducting air tests at different depths in the tunnel, air tests must also be conducted horizontally at different locations in the tunnel. Sampling for a few minutes at each location is required)		

Name and Signature of Examiner：

____

Signature of Trainee：

____

Name & Signature of Invigilator：

____

Annex 10

Assessment Instructions for Practical Examination of Safety Training Course for Competent Persons of Confined Spaces Operation

Assessment Instructions for Practical Examination of Safety Training Course for Competent Persons of Confined Spaces Operation

Instructions to Trainees

- **Trainees must correctly complete all the following assessment items within the time allowed for each assessment item in order to pass the practical examination according to the Examiner's instructions.**
- **Each trainee must wear a safety harness correctly before taking the practical examination and keep wearing the harness until the trainee has completed the practical examination.**
- **If you have any questions, please raise your hand and ask the Examiner or Invigilator.**

1. Checking personal motion-sensing alarm device and approved breathing apparatus (self-contained type) (Time allowed 2 minutes)

- report the Examiner whether all kinds of equipment are available and whether they are intact

2. Wearing personal motion-sensing alarm device (Time allowed 2 minutes)

- properly turn on the device
- check whether the device is fully charged, and report the checking result to the Examiner

- properly wear the device
- properly turn off the device

3. Matters to do before wearing the approved breathing apparatus (self-contained type) (Time allowed 4 minutes)

- check the air pressure in cylinder and report the readings to the Examiner
- check the leak of the hoses
- check the function of the whistle

4. Wearing the whole set of approved breathing apparatus (self-contained type) (Time allowed 6 minutes)

- wear the mask and adjust the mask properly
- check the leak of the mask
- open the valve of the air cylinder
- connect the mask to the air cylinder and breath normally
- check the positive pressure of the mask

5. Doffing the whole set of approved breathing apparatus (self-contained type) (Time allowed 2 minutes)

- doff the whole set of approved breathing apparatus and turn off gas valve of the air cylinder

6. **Checking continuous air monitoring equipment before use (Time allowed 4 minutes)**
   - check whether the equipment is available and intact, and report the checking result to the Examiner
   - start up the equipment
   - take the readings on levels of oxygen, carbon monoxide, hydrogen sulphide and combustible gas in the examination room and report the readings to the Examiner

7. **Simulation of hazardous situation (Time allowed 2 minutes)**
   - exhale to a plastic ziplock bag or container several times to simulate the oxygen deficient environment. Put the sampling probe into the plastic ziplock bag or container. Take the readings on levels of oxygen, carbon monoxide, hydrogen sulphide and combustible gas in the bag or container and report the readings to the Examiner
   - turn off the air monitoring equipment

- report the Examiner the locations where air testing is required in the confined space like manhole, shaft, tunnel and the measuring time required for each location

Occupational Safety and Health Branch
Labour Department