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

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### Inquiry

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

Occupational Safety Officer (Training)
Occupational Safety and Health Training Centre
Occupational Safety and Health Branch, Labour Department
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Tsuen Wan, New Territories

Tel.: 2940 7054 or 2940 7807
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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 with validity time not less than 2 years 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 have at least two years of practical experience directly involving working in confined spaces.

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 atmospheric testing equipment and rescue equipment (such as tripod and audio and visual 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 16 hours in 2 whole days (8 hours per day, but excluding break between half-day sessions or lunch time) and it should include hands-on sessions of about four hours on the practice of safety equipment, an examination session of 30 minutes and a total of not
more than 30 minutes recess time per day.

6.2 A TCP should ensure that the minimum course duration of top-up course should be 8 hours (break between half-day sessions or lunch time not included) and it should include a hands-on session of about one hour on the practice of safety equipment, an examination session of 30 minutes and a total of not more than 30 minutes recess time.

6.3 A TCP should ensure that the minimum course duration of revalidation course should be 12 hours in 2 whole days (8 hours in first day and 4 hours in second day, but excluding break between half-day sessions or lunch time) and it should include hands-on session of about three hours on the practice of safety equipment, an examination session of 30 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.

6.4 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 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 6.5, 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:

10.2.1 Full and Revalidation Courses:
- Minimum one set of Safety Harness, Lifeline and Tripod/Quadpod;
- Minimum two sets of Self-contained Type Approved Breathing Apparatus; and
- Minimum one multiple-sensor gas monitor which can display readings on levels of oxygen, combustible gas,
hydrogen sulphide and carbon monoxide.

10.2.2 Top-up Course:
- Minimum one multiple-sensor gas monitor which can display readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide.

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 examination papers used are issued and specified by LD.

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

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

11.5 Time allowed for the examination is 30 minutes and the passing mark is 75%.

12. Validity period of certificate

12.1 A TCP should ensure that the validity period of combined certificate of CP and CW issued is 3 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—
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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

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**

<table>
<thead>
<tr>
<th>HKID/Passport No. (TRT1)</th>
<th>Name of trainee (TRT2)</th>
<th>Class Ref. (TRC1)</th>
<th>Name of Trainer (TRC2)</th>
<th>Date of Course completion (TRC3)</th>
<th>Certificate Effective Date (TRT3)</th>
<th>Certificate Expiry Date (TRT4)</th>
<th>Certificate Serial No. (TRT5)</th>
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## Annex 1

### Qualifications of a CP Course Trainer (theory session)

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<th>Qualifications</th>
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<td>A person possessing at least any one of the following qualifications and experience from (i) to (v)</td>
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<td><strong>Academic Qualifications</strong></td>
<td><strong>Experience</strong></td>
</tr>
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<td>(i) A Registered Safety Officer under the Factories and Industrial Undertakings (Safety Officers and Safety Supervisors) Regulations.</td>
<td>At least two (2) years of practical experience directly involving working in confined spaces. or</td>
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<tr>
<td>(ii) A recognized degree or post-graduate diploma in occupational safety and health, or equivalent, and with a cumulative total of <strong>not less than one</strong> (1) year of experience directly involving occupational safety and health related work.</td>
<td>At least two (2) years of practical experience directly involving working in confined spaces. or</td>
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<tr>
<td>(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 <strong>not less than one</strong> (1) year of experience directly involving occupational safety and health related work.</td>
<td>At least two (2) years of practical experience directly involving working in confined spaces. or</td>
</tr>
<tr>
<td>(iv) A recognized certificate, diploma or higher diploma in occupational safety and health, and with a cumulative total of <strong>not less than two</strong> (2) years of experience directly involving occupational safety and health related work, <strong>one (1) year of such experience must be obtained after the academic qualification.</strong></td>
<td>At least two (2) years of practical experience directly involving working in confined spaces. or</td>
</tr>
<tr>
<td>(v) A recognized certificate in construction safety and with a cumulative total of <strong>not less than two</strong> (2) years of experience directly involving occupational safety and health related work, <strong>one (1) year of such experience must be obtained after the academic qualification.</strong></td>
<td>At least two (2) years of practical experience directly involving working in confined spaces.</td>
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## Annex 2

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

#### Day 1

<table>
<thead>
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<th>Section</th>
<th>Topic &amp; Content</th>
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<td>1</td>
<td>Introduction to Arrangements of the Course</td>
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<td>2</td>
<td>Relevant Occupational Safety and Health Legislation Applicable to Confined Spaces</td>
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<tr>
<td>3</td>
<td>Basic Concept of a Confined Space and Common Potential Hazards</td>
<td>60</td>
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<td>4</td>
<td>Case Study and Analysis of Common Serious Accidents</td>
<td>60</td>
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<td>5</td>
<td>Basic Concept of Safe System of Work and Permit-to-work System</td>
<td>75</td>
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<td><strong>Break between Half-day Sessions or Lunch Break</strong></td>
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<td>5</td>
<td>Basic Concept of Safe System of Work and Permit-to-work System <em>(continued)</em></td>
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<td>6</td>
<td>Emergency Situations and Response Procedures</td>
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<td>7</td>
<td>Explanation, Display, Demonstration and Practice on Safety Equipment</td>
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Lesson Plan for Safety Training Course for Competent Persons of Confined Spaces Operation

Day 2

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<td>8</td>
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<td><strong>Break between Half-day Sessions or Lunch Break</strong></td>
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<tr>
<td>9</td>
<td>Atmospheric Testing Procedures and Points to Note</td>
<td>35</td>
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<tr>
<td>10</td>
<td>Practice on Use of Multiple-Sensor Gas Monitor</td>
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<tr>
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<td><strong>Recess</strong></td>
<td>15</td>
</tr>
<tr>
<td>11</td>
<td>Application of Safe System of Work and Permit-to-work System</td>
<td>75</td>
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<tr>
<td>12</td>
<td>Conclusion of the Course</td>
<td>5</td>
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<td>13</td>
<td>Written Examination</td>
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<td>14</td>
<td>Review of the Examination Paper After the Examination</td>
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## Annex 3

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

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<th>Topic &amp; Content</th>
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<td>Risk Assessment</td>
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<tr>
<td>2</td>
<td>Risk Assessment (continued)</td>
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<td></td>
<td><strong>Break between Half-day Sessions or Lunch Break</strong></td>
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<tr>
<td>3</td>
<td>Atmospheric Testing Procedures and Points to Note</td>
<td>35</td>
</tr>
<tr>
<td>4</td>
<td>Practice on Use of Multiple-Sensor Gas Monitor</td>
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<tr>
<td>5</td>
<td>Application of Safe System of Work and Permit-to-work System</td>
<td>75</td>
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<tr>
<td>6</td>
<td>Conclusion of the Course</td>
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<td>7</td>
<td>Written Examination</td>
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<td>8</td>
<td>Review of the Examination Paper After the Examination</td>
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# Annex 4

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

### Day 1

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<tr>
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<td>1</td>
<td>Introduction to Arrangements of the Course</td>
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<tr>
<td>2</td>
<td>Relevant Occupational Safety and Health Legislation Applicable to Confined Spaces</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>Basic Concept of a Confined Space and Common Potential Hazards</td>
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<td>4</td>
<td>Case Study and Analysis of Common Serious Accidents</td>
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<td></td>
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<td>Basic Concept of Safe System of Work and Permit-to-work System</td>
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<td>Risk Assessment</td>
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**Break between Half-day Sessions or Lunch Break**

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<th>Section</th>
<th>Topic &amp; Content</th>
<th>Time (Minutes)</th>
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<td></td>
<td><strong>Recess</strong></td>
<td>15</td>
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<tr>
<td>9</td>
<td>Application of Safe System of Work and Permit-to-work System</td>
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**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

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<td>Review of the Examination Paper After the Examination</td>
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<td><strong>Total Time of Day 2 [Class+Exam+Review]</strong></td>
<td><strong>240</strong> (4 Hrs)</td>
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- Total Time of Day 2: 240 minutes (4 hours)
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 Factories and Industrial Undertakings
(Confined Spaces) Regulation
The Course Contents are prepared by
The Occupational Safety and Health Branch
Labour Department

This Edition June 2019

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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.
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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), 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, shopping arcades, 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 Factories and Industrial Undertakings Ordinance:**

Under the Factories and Industrial Undertakings Ordinance, 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
Subsidiary Regulations include Factories and Industrial Undertakings Regulations, Construction Sites (Safety) Regulations, Factories and Industrial Undertakings (Confined Spaces) Regulation, 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

Factories and Industrial Undertakings (Confined Spaces) Regulation 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.

**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 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 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.
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 person is stationed outside the confined space to maintain communication with the workers inside;
(c) ensure the risk assessment report and related 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 workers” 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.

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.

- **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 for alerting others outside confined space.
  - ensure sufficient number of persons who know how to use the safety equipment 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 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.

**Duties of a competent person**

- carry out an assessment of the working conditions of a confined space covering all the aspects specified under the F&IU (Confined Spaces) Regulation.
- 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 (Loadshifting Machinery) Regulation**

Loadshifting machines used in the industrial undertakings are operated by a person who has attended the age of 18 years and holds a valid certificate. Fork-lift trucks used in industrial undertakings; bulldozers, loaders, excavators,
trucks or lorries, compactors, dumpers, graders, locomotives, and scrapers used on construction site are within the ambit of the Regulation. However, the Regulation does not apply to the operator of a truck or lorry who holds a valid driving licence under the Road Traffic Ordinance (Cap. 374).

2.2.4 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 Factories and Industrial Undertakings Ordinance, Chapter 59 of the Laws of Hong Kong (hereinafter referred as 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 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: Safety and Health at Work in Confined Spaces
- 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 Factories and Industrial Undertakings (Confined Spaces) Regulation, “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, such as 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, buildings, building voids, some enclosed rooms (particularly plant rooms) and compartments within them, including some cellars and interiors of machines, plant or vehicles and other places such as open-topped tanks and vats, wells,
hatches, caissons, shafts, closed and unventilated or inadequately ventilated rooms or constructions during their manufacture, may by reason of its construction, location or contents give rise to the “specified risks”.

Some places may, due to the work to be undertaken or a change in the condition inside the space or a change in the degree of enclosure or confinement, give rise to a “specified risk”.

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.
- Proper fire-fighting installations (e.g. suitable fire extinguishers and fire blanket) should be provided and maintained, and 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.
- Use of generators and fuel-driven tools in poorly ventilated areas may use up oxygen and generate carbon monoxide.

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.

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:

- **Hydrogen sulphide (H₂S)**
  - 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 more reliable method for detecting hydrogen sulphide is by using a calibrated gas detector. 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 a confined space should not be less than 19.5% by volume nor greater than 23% 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 moulding.

- 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.

### 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 cuitry 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 electrical 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 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.
4. Case Study and Analysis of Common Serious Accidents

[Reference teaching time for Section 4: 60 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

Case 1
Poisoning in manhole sewer

Circumstances
A team of workers had to clear a sewer which was about 2 metres in diameter. A 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:
• The effluent in the sewer produced toxic gases. Toxic gases accumulated more easily in the absence of an air blower.
• There was no continuous monitoring for the air quality inside the sewer, the worker was not aware that the toxic gases had accumulated to a dangerous level.
• The worker did not wear approved breathing apparatus while at work.
• The workers taking part in the rescue did not wear any safety equipment.

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.
• 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 warning 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 atmospheric testing and providing 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 approved breathing apparatus (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 certificate (permit-to-work), 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.
- 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 removed the ventilating blower, the worker who entered the manhole for final clean-up and the workers who rushed into the manhole for the rescue operation) and their responsibilities.

Case 2
Poisoning in metal duct

Circumstances
A polishing worker was poisoned by the carbon monoxide produced by a portable diesel generator operating in a metal duct which was over 100 metres in length and 2.2 metres in diameter while he was polishing the internal surface of the duct alone.

Case Analysis
The causes of accident include:
- An enormous amount of poisonous carbon monoxide was produced when the fuel generator was in operation.
- Poor air ventilation inside the metal duct had resulted in the accumulation of carbon monoxide.
- Risk assessment for the work in confined space was not carried out.
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.
- Recommendations made by the competent person and the emergency procedures laid down by the proprietor or contractor should be strictly followed.
- Fuel-powered machines shall be placed outside the metal duct to prevent carbon monoxide from accumulating inside the metal duct.
- Suitable mechanical ventilation and continuous air monitoring should be maintained while work is being conducted inside a metal duct.

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 atmospheric testing and providing 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 metal pipe, etc.) while workers are working inside the confined spaces.
  - any person entering the confined space should be wearing approved breathing apparatus (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 certificate (permit-to-work), 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.
- 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 entered the metal duct for work) and their responsibilities.

Case 3

[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) for case study and analysis in this section]

[Reference can be made to the “Safety Alert” provided by 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: 75 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:
- 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 (*references should be made to section 5.2.1*);
- to issue a certificate (“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 (*references should be made to section 5.2.2*);
- to ensure that all safety precautions when work is being undertaken have
been carried out and kept effective throughout the confined space work (references should be made to section 5.2.3);

- to ensure that no workers other than certified workers enter or work in the confined space;
- 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);
- to formulate and implement appropriate emergency situations and response procedures to deal with any serious and imminent danger to workers inside the confined space (references should be made to section 6); and
- to provide necessary 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

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

Isolation

- The proprietor or contractor should, 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 a confined space.
- All the points of isolation should remain fully secure to ensure that the dangerous materials will not go into the confined space whilst the workers are working in it.
- 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 being opened without authorization or accidentally.

- Ends of service pipes which are still connected to sources of dangerous fume should be properly sealed by means of, e.g. metal blank, end-cap.

- No work which may jeopardize the safety of workers inside a confined space should be permitted to be carried out outside and in the vicinity of the confined space. Barriers should be erected outside access openings of the confined space, with suitable warning signs and notices displayed. This is particularly important for floor openings, where hazards may arise from liquid spills, e.g. flammable liquid, solvents, or from sparks created by cutting or welding in the vicinity.

- Openings in a confined space (e.g. drain holes) should be sealed off if there is any possibility of hazardous gases or vapours backing up from another area and contaminating the confined space.

- The confined space should be isolated from all non-essential sources of heat.

- Effective steps should be taken to prevent an 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. Regarding in-rush of water, particular attention should be given to the possible 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, etc.

**Purging**

- Having regard to the circumstances of a particular confined space, before the proprietor or contractor allows workers to enter into and work in a confined space, the confined space should 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 thoroughly remove all the dangerous materials from the confined space. 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 should not be any vacuum being caused 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.
- When purging has been completed, all liquid remaining in the confined space should be drained away or pumped out as appropriate, and manholes should be opened to allow ventilation.

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 which has been purged by an inert gas, the confined space should 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 should then be thoroughly tested against the deficiency of oxygen to make sure that there is adequate oxygen to support life.
Atmospheric Testing

- Atmospheric testing of a confined space should be carried out as appropriate before it is certified as being safe to enter.
- Atmospheric testing of a confined space should be done for the purposes of deciding and specifying the related safety precautions necessary to be taken upon entry into such a confined space.
- A proprietor or contractor should prohibit a worker from entering into the confined space until initial testing of the atmosphere of the confined space has been properly done from outside, with the testing results showing that the atmosphere inside the confined space is safe for entry.
- The atmospheric testing should include the testing of the oxygen content, the presence of flammable, toxic or harmful gases, fumes or vapours. Hazardous gases commonly found in confined spaces such as sewers, include carbon monoxide (CO), hydrogen sulphide (H₂S), methane (CH₄) and other flammable gases.
- All atmospheric testing should be carried out by means of suitable testing equipment with correct testing methods. For instance, air at different levels and locations inside a confined space should be tested since dangerous gases with different densities relative to air may accumulate at different levels and locations of the confined space.
- Atmospheric testing should be made outside the confined space, with air samples being drawn out by suitable sample probes.
- The gas testing equipment used in atmospheric air testing should be of the explosion proof type.
- In general, testing for oxygen should be performed first because most combustible gas testing meters are oxygen dependent and does not provide reliable readings in an oxygen deficient atmosphere.
- All testing meters and equipment should be properly and correctly used for the purpose of atmospheric testing for confined space. The manufacturers’ instruction manuals on the proper use of those meters and equipment should be strictly followed. All testing meters and equipment should be suitably calibrated and properly maintained as per the recommendations of the equipment manufacturers, with records properly kept.
- The percentage of oxygen in a confined space should not be less than 19.5%
by volume nor greater than 23% by volume at normal atmospheric pressure.

- For the exposure limits of various dangerous gases, reference should be made to the publications made by the Labour Department, the Health and Safety Executive (HSE) of the UK, the American Conference of Governmental Industrial Hygienists’ (ACGIH) and other relevant authorities on occupational exposure limits.

**Ventilation**

- Adequate and effective ventilation should be maintained for supplying sufficient respirable fresh air for workers inside a confined space. In that respect, forced ventilation may be required instead of natural ventilation.
- In deciding the ventilation air exchange rate, it should take into account that some work tasks, e.g. gas welding, consume oxygen and some tasks, e.g. paint spraying, contaminate the atmosphere. It would be required to provide adequate air change to remove the hazardous substances evolved and maintain sufficient fresh air supply while work is in progress.
- The provision of ventilation to a confined space should not be considered as an alternative to the use of breathing apparatus where the atmosphere inside is likely to cause safety or health hazards to the workers therein.
- In all cases of forced ventilation to supply fresh air into a confined space, the air-line or trunking should be introduced or extended to the bottom of the confined space, for removal of gases or vapours heavier than air and for effective air circulation.
- Under no circumstances should oxygen be introduced into a confined space which would create a danger of oxygen enrichment in the atmosphere.
- Notwithstanding the above, a proprietor or contractor should also take effective steps to prevent an 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...
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 F&IU (Confined Spaces) Reg. He may then issue a “Permit-to-work certificate” to the certified workers engaged in confined space work.

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. 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) results of cleaning and purging of facilities in the confined space;
  (d) results of the atmospheric testing;
  (e) a list of personal protective equipment (“PPE”); and
  (f) other safety precautions.

5.2.3 Safety Precautions When Work Is Being Undertaken

- A proprietor or contractor should 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 should provide all necessary equipment to ensure
the safety and health of workers working in a confined space. The equipment should be properly 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 should ensure that the relevant risk assessment report, with all its significant findings, are displayed in a conspicuous place at the entrance of the confined space. The related certificate should 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, another worker (the “standby person”) should be assigned to station outside the confined space throughout the time of operation to maintain communication with the worker inside.

- The standby person should be trained on how to maintain communication with those workers working inside the confined space.

- The standby person should 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 dangerous gases, power supply failure, failure of forced ventilation system, etc.).

- Similarly the workers inside a confined space should keep the standby person informed should any dangerous situations arise inside the confined space so that the standby person can call for assistance.

- A proprietor or contractor should 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.
6. Emergency Situations and Response Procedures

[Reference teaching time for Section 6: 30 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 should formulate and implement appropriate procedures to deal with any serious and imminent danger to workers inside a confined space.

**Rescue**
- A proprietor or contractor should set up arrangements for rescue of workers working in a confined space 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 after 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.
- As to the number of trained persons required in a rescue team, several factors, 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 should have been properly and adequately trained in the related emergency rescue procedures, including the detailed particulars of an emergency rescue plan and full knowledge on how to properly use all those rescue equipment.

**Communication**
• Communication between the workers inside a confined space and the standby person should be maintained throughout the period when the workers are working inside the confined space. An audio and visual alarm system should be provided for the workers inside the confined space to alert the standby person, and vice versa, in case of emergency.

• Even in case of emergency, the standby person should not enter the confined space. He should remain stationed outside the confined space and summon assistance of the rescue team and public emergency services (i.e. the Police and the Fire Services). He should stay outside the confined space and brief the rescue personnel of the relevant circumstances of the incident upon their arrival.

**Equipment**
• Suitable and sufficient rescue equipment, including standby approved breathing apparatus, safety harness, life-lines, reviving apparatus and emergency lighting, and properly trained rescue personnel should be readily available for rescue purposes at all times when workers are working inside a confined space. Rescue equipment provided should be appropriate in view of the likely emergencies identified in the risk assessment and be properly maintained. For the use of resuscitators, reference should be made to 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.

**Evacuation**
• A proprietor or contractor should devise an evacuation procedure for prompt evacuation from the confined space in case of a sudden change in the working or the environmental condition that may cause imminent danger to the workers working in a confined space.

**Drills**
• Drills for the rescue and emergency procedures should be conducted periodically for testing of the emergency response plan, and for practicing the procedures and use of rescue equipment.
7. Explanation, Display, Demonstration and Practice on Safety Equipment

[Reference teaching time for Section 7: 180 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 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 Breathing Apparatus [Explain by means of powerpoint or the real object of PPE]

• Protect workers against dust, fibres, hazardous gases and fumes and prevent workers from oxygen deficiency.
• Types of breathing apparatus include: disposable cartridge respirators; full-face/half-face respirators; air-supplied hoods; self-contained respirators.
• The worker inside the confined space should use an approved breathing apparatus (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).
• When using breathing apparatus, it must be properly fitted on the wearer’s face.
• Breathing apparatus should be cleaned thoroughly after each use.

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 belt 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 belt, the following should be checked: any defects on the safety belt, any suitable anchorage, independent lifeline and fall arresting device, and whether the standard is met or not.
  ■ When using a safety belt for fall protection, the safety belt 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 7.4 and “low pressure test”]

- Only approved breathing apparatus, that is breathing apparatus which has been approved by the Commissioner for Labour under section 12 of Factories and Industrial Undertakings (Confined Spaces) Regulation, 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 pursuant to regulations 64 and 66 of Dangerous Goods (General) Regulations.

- An air-supplying respiratory protective equipment provides uncontaminated air from an independent source for breathing by the user. It includes the self-contained breathing apparatus (i.e. Self-contained Type) which provides air from a gas cylinder, and the compressed air line breathing apparatus (i.e. Air Line Type) which provides uncontaminated air from a source through a long hose.

- The person using the approved breathing apparatus should have received appropriate training in the use of that particular type or model of equipment.

- The selection of a suitable approved breathing apparatus should depend upon the conditions, hazards, testing results of the confined space, and the work activities to be done inside the confined space.

- All approved breathing apparatus to be used for entry into and work inside a confined space should well fit the workers and be properly worn.

- Only those who are medically fit for using approved breathing apparatus should be allowed to use approved breathing apparatus for entering into and working in a confined space.
The quality of the breathing air supplied by an approved breathing apparatus should comply with the most up-to-date recognized international or national standard.

All the approved breathing apparatus for use in confined spaces should be properly maintained in good working conditions.

Before each use, the approved breathing apparatus should be:
- connected to a cylinder, a pump or a compressor to provide breathable air. Care should be taken to ensure that the air compressor used for filling air cylinders or supplying air to airline type breathing apparatus is specially designed for providing breathable air, suitably maintained and properly located to avoid intake from contaminated air sources.
- inspected for any sign of physical damage on all parts and accessories.
- functionally checked according to the user manual.
- kept in clean and good conditions. Defective equipment should be clearly marked “defective” and removed from site for maintenance. Never use defective breathing apparatus.

**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:
  - 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.
  - Unload 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.
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 recognized international standards or national standards when selecting rescue lifting devices.

7.2.3 Audio and Visual Alarm [Demonstrate using the real object]
- An audio and visual alarm by which the workers inside the confined space can alert those outside.
- An audio and visual alarm (with motion sensor) to give out alerting signals to others when the worker remains motionless for a certain duration.
- Manufacturers’ instruction manuals on the proper use of audio and visual alarm 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 Atmospheric Testing Equipment
(Detector Tubes [Explain by means of powerpoint or the real object] and Gas Monitor [Demonstrate using the real multiple-sensor gas monitor which can display readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide])
Direct measuring atmospheric testing equipment includes detector tubes and gas monitor.

**Detector Tubes**
- Detector tubes are one of the most commonly used methods for air monitoring. They are fairly simple to use and are mainly used for determination of the concentrations of gas or vapour in the air. Different types of tubes are available for detecting different gas or vapour.
- 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.
- Detector tubes have a limited shelf life and some of them are subjected to cross-interference, hence it is important that instructions provided by the manufacturer should be referred to before using detector tubes. In addition, detector tubes are not suitable for continuous air monitoring.

**Gas Monitor**
- The most common configuration for a multiple-sensor gas monitor 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. Different or additional air monitoring instruments are required for other hazardous gases that may be present in the confined spaces such as drainage.
- Only properly maintained and calibrated equipment should be used for atmospheric testing.
- The gas monitor should be of the explosion-proof type.
- The proper functioning of the gas monitor 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 gas sensors are oxygen-dependent and may give unreliable readings in oxygen-deficient situations.
• The gas monitor should have an audio-visual alarm device which would alert workers when any indication of danger is detected.
• The gas monitor is suitable for continuous air monitoring.

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

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

• 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 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 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.
  ■ Normal breathing.
  ■ Positive pressure test (check the positive pressure of the mask).
  ■ Take off the whole set of self-contained type approved breathing apparatus.
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.

Hazard Identification

- 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.
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 and procedures, 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. Slightly harmful:
   Examples are:
   - superficial injuries; minor cuts and bruises; eye irritation from dust;
   - nuisance and irritation (e.g. headaches); ill-health leading to temporary discomfort.

2. Harmful:
   Examples are:
   - lacerations; burns; concussions; serious sprains; minor fractures;
   - deafness; dermatitis; asthma; work related upper limb disorders; ill-health leading to permanent minor disability.

3. Extremely harmful:
   Examples are:
   - amputations; major fractures; poisonings; multiple injuries; fatal injuries;
   - occupational cancer; other severe life shortening diseases; acute fatal diseases.

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

<table>
<thead>
<tr>
<th>Probability/likelihood</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likely/frequent</td>
<td>Occurs repeatedly/event only to be expected</td>
</tr>
<tr>
<td>Unlikely</td>
<td>Rather remote, though conceivable</td>
</tr>
<tr>
<td>Highly unlikely</td>
<td>So unlikely that probability is close to zero</td>
</tr>
</tbody>
</table>

If the judgment is "highly unlikely", this needs to be subject to particularly rigorous scrutiny as, in reality, this is a relatively rare situation.
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:

<table>
<thead>
<tr>
<th>Risk Level Estimator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Slightly harmful</td>
</tr>
<tr>
<td>Highly unlikely</td>
</tr>
<tr>
<td>Unlikely</td>
</tr>
<tr>
<td>Likely</td>
</tr>
<tr>
<td>Harmful</td>
</tr>
<tr>
<td>Trivial risk</td>
</tr>
<tr>
<td>Minor risk</td>
</tr>
<tr>
<td>Moderate risk</td>
</tr>
<tr>
<td>Substantial risk</td>
</tr>
<tr>
<td>Extreme risk</td>
</tr>
<tr>
<td>Extremely harmful</td>
</tr>
</tbody>
</table>

Action should be taken according to a list of priority. Extreme risks should be accorded the first priority, substantial risks the second priority; moderate 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).

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.

8.1.1 Risk Assessment for Confined Space Work
[An example case 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.
- 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 should appoint a competent person to carry out a risk assessment to identify the hazards likely to be present in the confined space, and to recommend necessary 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, for example, to the workers in the vicinity who could be affected by the work to be undertaken. The hazards to be considered should include not only those arising from the materials and substances present, or likely to be present in the confined space concerned, its previous uses and the work to be done, but also those which may be present by its proximity to other plants, processes and operations.
- 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 taken 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) Where necessary, a proper site investigation should be arranged to the actual spot of the confined space so as to have a more thorough knowledge about the nature and circumstances, in particular 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 should 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 should 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
The size and number of access and egress points:

1. should be assessed individually dependent upon the activities to be carried out and the number of people involved.
2. to determine the locations of manholes or openings to vessels, tanks, etc., due consideration should be given to the possible difficulties for access to and rescue from the confined space.
3. there may be occasions when access and egress is so tortuous that temporary openings may be needed. Different criteria should be applied when determining manhole dimensions for a confined space that extends over a significant length or height, as in the case of sewers, pipes, culverts, small tunnels or shafts. Measures to improve access such as structural alterations to the confined space could be considered. The spacing of manholes on sewers and the absence of such access over considerable lengths may affect both the degree of natural ventilation and the efficiency to rescue.

The recommendations on the necessary safety measures should include whether the use of approved breathing apparatus is necessary so as to render the confined space safe for workers to stay inside. When there is any doubt as to the possible concentration level of the harmful atmosphere in a confined space, suitable and approved breathing apparatus should be used and the other necessary safety precautions should be taken accordingly.

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 there is a known possibility of adverse changes of working conditions, he should recommend a continuous monitoring or periodical monitoring of the working environment. The purpose is to ensure that the ventilation is adequate and that the atmosphere remains safe for working inside the confined space. The exact testing, retesting and monitoring requirement should 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.

- 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.

- All the significant findings of a risk assessment should be recorded by the competent person in a risk assessment report, including:
  (1) the hazards identified;
  (2) the necessary safety precautions to be taken;
  (3) the type and the number of workers being affected;
  (4) the period during which workers may remain safely in the confined space; and
  (5) the particulars of the competent person who has carried out the risk assessment.

- The competent person should 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 should be submitted to the proprietor or contractor of the industrial undertaking for his consideration for the issue of a certificate before the confined space work is
carried out.

- 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.

8.2 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. Atmospheric Testing Procedures and Points to Note

[Reference teaching time for Section 9: 35 mins]

[Demonstrate using the real multiple-sensor gas monitor 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 gas monitor, i.e. the functional or bump test, before use according to the manufacturer’s instructions.]

9.1 Atmospheric Testing Procedures

- Atmospheric testing should be conducted by a person with appropriate training and experience. It includes pre-entry atmospheric testing and atmospheric monitoring during work by atmospheric monitoring equipment.

Pre-entry atmospheric 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 gas monitor) placed outside the confined space.

- The manufacturers’ instruction manuals on the proper use of atmospheric 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 atmospheric testing.

- The atmosphere around the working position of the person carrying out atmospheric testing should be tested first to ensure his safety and health during atmospheric 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), atmospheric 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 atmospheric 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; carbon monoxide is slightly lighter than air and it will stay near the released position.

- **Hand-dug tunnel:** Atmospheric 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 atmospheric testing equipment to the front end of the hand-dug tunnel, remote control type atmospheric 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 atmospheric testing in the risk assessment.

- Atmospheric testing must be conducted again when there is any potential change in the atmospheric conditions.

**Atmospheric 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 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.

- 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.

### 9.2 Points to note for using atmospheric testing equipment

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

**Gas Monitor**

- Proper gas monitor should be selected with respect to the gas or vapour to be tested. For example, the gas monitor equipped with multiple sensors to measure the levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide.
- The gas monitor 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 gas monitor,
including the proper maintenance and calibration for the equipment, etc.

- The sensors of the gas monitor should be checked to ensure that they are properly installed and has not yet expired.
- The remaining battery level of the gas monitor should be checked.
- The proper functioning of the gas monitor should be tested, i.e. to conduct functional or bump test, before use according to the manufacturer’s instructions.
- The gas monitor is suitable for continuous air monitoring.
10. Practice on Use of Multiple-Sensor Gas Monitor

[Reference teaching time for Section 10: 70 mins]

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

- Trainees are divided into groups (maximum of four trainees per group) to use a multiple-sensor gas monitor for the hands-on practice.

**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 gas monitor.
  - Switch on the gas monitor.
  - Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
  - Switch off the gas monitor.

**Simulation of hazardous situation**

- Either procedures A or B should be completed by each group (every group members should participate in the procedures):

  **Procedure A**
  - Connect the sampling probe and hose to the gas monitor.
  - Switch on the gas monitor.
  - Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
  - Put the sampling probe into a container (e.g. a plastic ziplock bag) containing alcohol wipes.
  - Wait the audio-visual alarm of the gas monitor to be activated.
  - Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
  - Take out the sampling probe from the container and observe the changes of the readings displayed on the gas monitor.
  - Press the reset button of the gas monitor 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 gas monitor.

(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 gas monitor.
- Switch on the gas monitor.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
- 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 gas monitor to be activated.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
- Take out the sampling probe from the plastic ziplock bag or the container, and observe the changes of the readings displayed on the gas monitor.
- Press the reset button of the gas monitor 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 gas monitor.

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

[Reference teaching time for Section 11: 75 mins]

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

[The example at Appendix 1 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 atmospheric testing;
  5. the nature of work to be done;
  6. the conditions and features of the confined space;
  7. the period during which workers may remain safely in the confined; and
  8. the other relevant information (references should be made to the example of “Permit-to-work certificate” at Appendix 1).

Procedures

- The proprietor or contractor of the confined space work, after receiving a
risk assessment report completed by a competent person, should determine to issue a “Permit-to-work certificate”.

- The “Permit-to-work certificate” should be properly signed for confirmation by the proprietor or contractor or persons authorized by him. The items in the certificate should be written in ink or otherwise so as to be indelible.
- 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.
- If the work has not yet been completed by the expiry of the “Permit-to-work certificate”, an extension of the certificate is required.
  - The proprietor or contractor or persons authorized by him should visit the confined space and satisfy himself (by testing if necessary) that the conditions have not materially altered since he first issued the certificate. If the conditions have materially altered, the proprietor or contractor should cause the competent person to re-assess the situation, specify what further precautions are required to ensure the safety and health of the workers and state in the “Permit-to-work certificate” the extended time of expiry.
- In case extension of time of the certificate is required, application for extension of time should be made before the certificate is expired. In no way should blanket approval be given beforehand or retrospectively.
- 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 “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 1 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.).
An example of Permit-to-work Certificate for Entry into Confined Space

<table>
<thead>
<tr>
<th>Location of Work</th>
<th>Description of Work</th>
<th>Contractor/Proprietor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Workers Assigned: (Names and Identification)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workers:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Standby Persons:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Date & Time of Entry to the Confined Space:

Date & Time of Expiry of the Certificate:

<table>
<thead>
<tr>
<th>Work Involved</th>
<th>Associated Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
<td>4.</td>
</tr>
</tbody>
</table>

Other Hazards Expected/Identified:

1.                          
2.                          
3.                          
4.                          
5.                          

**Isolation Checklist**:

<table>
<thead>
<tr>
<th>Normal service in the confined space suspended</th>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| All inlets and outlets isolated/blanked off   |        |             |
| ☐                                             |        |             |

| All power isolated (electrical/mechanical/hydraulic/others) |        |             |
| ☐                                                           |        |             |

| Heat source isolated |        |             |
| ☐                       |        |             |

| Other source of danger isolated (specify) |        |             |
| ☐                                         |        |             |

**Cleaning & Purging**:

<table>
<thead>
<tr>
<th>Purging &amp; Cleaning (method: )</th>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Inspection & Check |        |             |
| ☐                      |        |             |
### Atmospheric Testing:

<table>
<thead>
<tr>
<th></th>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen content ( %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flammable gases test (result :</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxic/Harmful gases test (result :</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (specify)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Fire Precautions:

<table>
<thead>
<tr>
<th></th>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Personal Safety Protection:

<table>
<thead>
<tr>
<th></th>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilation Requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respirators</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clothing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head, Hand &amp; Foot Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shields</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life Lines &amp; Harness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye/Ear Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (specify)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Other Safety Precautions:

- Communication between workers and standby person (equipment and methods):
  

- Evacuation Procedures:
  

- Continuous Monitoring/Periodical Monitoring (equipment and methods)
  

### Remarks:

-
Authorization:
(to be completed by the proprietor/contractor, or his authorized representatives)

I certify that I have personally checked all the above conditions and satisfied myself that all the above particulars are correct or have been implemented. I certify that:

(a) ☐ the confined space is safe for entry without breathing apparatus.
    ☐ to enter the confined space, approved breathing apparatus must be worn.

(b) ☐ continuous monitoring is required.
    ☐ periodical monitoring is required.
    ☐ no foreseeable changes in the environment during the course of work, monitoring is not required.

(c) the necessary safety precautions for entering into the confined space are:

________________________________________________________________________

(d) date & time of expiry of the certificate:

________________________________________________________________________

(e) all workers are certified workers.

Other remarks & limitations:

________________________________________________________________________

________________________________________________________________________

Signed by: __________________________
Position: __________________________
Date & Time: _______________________

Acceptance of Certificate:
(to be completed by the supervisor or the person-in-charge of the work)

I have read and understood this certificate and shall undertake to work in accordance with all the conditions laid down in it.

Signed by: __________________________
Position: __________________________
Date & Time: _______________________

Request for Extension of Time of the Certificate:
(to be completed by the supervisor or the person-in-charge of the work)

The work has not been completed as scheduled and permission to continue is requested.

Signed by: __________________________
Position: __________________________
Date & Time: _______________________

3/4
**Extension of Certificate:**

*(to be completed by the proprietor/contractor, or his authorized representatives)*

I have re-assessed and re-examined the confined space detailed above, and confirm that this certificate can be extended to expire _______________ subject to:

(a) further safety precautions:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

(b) remarks & limitations:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Signed by: ____________________________
Position: ____________________________
Date & Time: _______________________

**Completion of Work:**

*(to be completed by the supervisor or the person-in-charge of the work)*

The work has been completed and all persons under my supervision, materials and equipment had been withdrawn.

Signed by: ____________________________
Position: ____________________________
Date & Time: _______________________

**Cancellation of Certificate:**

*(to be completed by the proprietor/contractor, or his authorized representatives)*

(a) This Permit-to-work certificate is now cancelled; and

(b) a new Permit-to-work certificate will be required if work is to be continued.

Signed by: ____________________________
Position: ____________________________
Date & Time: _______________________

4/4
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 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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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), 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 have 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: 215 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.

Hazard identification

- 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 and procedures, 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. **Slightly harmful:**
   - Examples are:
     - superficial injuries; minor cuts and bruises; eye irritation from dust;
     - nuisance and irritation (e.g. headaches); ill-health leading to temporary discomfort.

2. **Harmful:**
   - Examples are:
     - lacerations; burns; concussions; serious sprains; minor fractures;
     - deafness; dermatitis; asthma; work related upper limb disorders; ill-health leading to permanent minor disability.

3. **Extremely harmful:**
   - Examples are:
     - amputations; major fractures; poisonings; multiple injuries; fatal injuries;
     - occupational cancer; other severe life shortening diseases; acute fatal diseases.

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

<table>
<thead>
<tr>
<th>Probability/likelihood</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likely/frequent</td>
<td>Occurs repeatedly/event only to be expected</td>
</tr>
<tr>
<td>Unlikely</td>
<td>Rather remote, though conceivable</td>
</tr>
<tr>
<td>Highly unlikely</td>
<td>So unlikely that probability is close to zero</td>
</tr>
</tbody>
</table>

If the judgment is "highly unlikely", this needs to be subject to particularly rigorous scrutiny as, in reality, this is a relatively rare situation.

- 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**

<table>
<thead>
<tr>
<th>Highly unlikely</th>
<th>Slightly harmful</th>
<th>Harmful</th>
<th>Extremely harmful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trivial risk</td>
<td>Minor risk</td>
<td>Moderate risk</td>
<td></td>
</tr>
<tr>
<td>Unlikely</td>
<td>Minor risk</td>
<td>Moderate risk</td>
<td>Substantial risk</td>
</tr>
<tr>
<td>Likely</td>
<td>Moderate risk</td>
<td>Substantial risk</td>
<td>Extreme risk</td>
</tr>
</tbody>
</table>

Action should be taken according to a list of priority. Extreme risks should be accorded the first priority, substantial risks the second priority; moderate 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 soundproofing 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.

2.1.1 Risk Assessment for Confined Space Work
[An example case 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.
- 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 should appoint a competent person to carry out a risk assessment to identify the hazards likely to be present in the confined space, and to recommend necessary 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, for example, to the workers in the vicinity who could be affected by the work to be undertaken. The hazards to be considered should include not only those arising from the materials and substances present, or likely to be present in the confined space concerned, its previous uses and the work to be done, but also those which may be present by its proximity to other plants, processes and operations.
- 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 taken 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) where necessary, a proper site investigation should be arranged to the
  actual spot of the confined space so as to have a more thorough
  knowledge about the nature and circumstances, in particular its effect
  on safety and health matters.

● **For identifying all the possible hazards which may be present in the**
cl **confined space and evaluating fully the extent of all those associated risks,**
c **the risk assessment should 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 should 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
The size and number of access and egress points:

1. should be assessed individually dependent upon the activities to be carried out and the number of people involved.

2. To determine the locations of manholes or openings to vessels, tanks, etc., due consideration should be given to the possible difficulties for access to and rescue from the confined space.

3. there may be occasions when access and egress is so tortuous that temporary openings may be needed. Different criteria should be applied when determining manhole dimensions for a confined space that extends over a significant length or height, as in the case of sewers, pipes, culverts, small tunnels or shafts. Measures to improve access such as structural alterations to the confined space could be considered. The spacing of manholes on sewers and the absence of such access over considerable lengths may affect both the degree of natural ventilation and the efficiency to rescue.

The recommendations on the necessary safety measures should include whether the use of approved breathing apparatus is necessary so as to render the confined space safe for workers to stay inside. When there is any doubt as to the possible concentration level of the harmful atmosphere in a confined space, suitable and approved breathing apparatus should be used and the other necessary safety precautions should be taken accordingly.

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 there is a known possibility of adverse changes of working conditions, he should recommend a continuous monitoring or periodical monitoring of the working environment. The purpose is to ensure that the ventilation is adequate and that the atmosphere remains safe for working inside the confined space. The exact testing, retesting and monitoring requirement should 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.

- 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.

- All the significant findings of a risk assessment should be recorded by the competent person in a risk assessment report, including:
  (1) the hazards identified;
  (2) the necessary safety precautions to be taken;
  (3) the type and the number of workers being affected;
  (4) the period during which workers may remain safely in the confined space; and
  (5) the particulars of the competent person who has carried out the risk assessment.

- The competent person should 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 should be submitted to the proprietor or contractor of the industrial undertaking for his consideration for the issue of a certificate before the confined space work is
carried out.

- 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.

### 2.2  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. Atmospheric Testing Procedures and Points to Note

[Reference teaching time for Section 3: 35 mins]

[Demonstrate using the real multiple-sensor gas monitor 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 gas monitor, i.e. the functional or bump test, before use according to the manufacturer’s instructions.]

3.1 Atmospheric Testing Procedures

- Atmospheric testing should be conducted by a person with appropriate training and experience. It includes pre-entry atmospheric testing and atmospheric monitoring during work by atmospheric monitoring equipment.

**Pre-entry atmospheric 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 gas monitor) placed outside the confined space.

- The manufacturers’ instruction manuals on the proper use of atmospheric 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 atmospheric testing.

- The atmosphere around the working position of the person carrying out atmospheric testing should be tested first to ensure his safety and health during atmospheric 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), atmospheric 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 atmospheric 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; carbon monoxide is slightly lighter than air and it will stay near the released position.

- **Hand-dug tunnel**: atmospheric 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 atmospheric testing equipment to the front end of the hand-dug tunnel, remote control type atmospheric 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 atmospheric testing in the risk assessment.
- Atmospheric testing must be conducted again when there is any potential change in the atmospheric conditions.

**Atmospheric 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 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.

- 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.

### 3.2 Points to note for using atmospheric testing equipment

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

#### Gas Monitor

- Proper gas monitor should be selected with respect to the gas or vapour to be tested. For example, the gas monitor equipped with multiple sensors to measure the levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide.
- The gas monitor 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 gas monitor,
including the proper maintenance and calibration for the equipment, etc.

- The sensors of the gas monitor should be checked to ensure that they are properly installed and has not yet expired.
- The remaining battery level of the gas monitor should be checked.
- The proper functioning of the gas monitor should be tested, i.e. to conduct functional or bump test, before use according to the manufacturer’s instructions.
- The gas monitor is suitable for continuous air monitoring.
4. Practice on Use of Multiple-Sensor Gas Monitor

[Reference teaching time for Section 4: 70 mins]

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

- Trainees are divided into groups (maximum of four trainees per group) to use a multiple-sensor gas monitor for the hands-on practice.

**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 gas monitor.
  - Switch on the gas monitor.
  - Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
  - Switch off the gas monitor.

**Simulation of hazardous situation**
- Either procedures A or B should be completed by each group (every group members should participate in the procedures):

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

- Switch off the gas monitor.

(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 gas monitor.
- Switch on the gas monitor.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
- 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 gas monitor to be activated.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
- Take out the sampling probe from the plastic ziplock bag or the container, and observe the changes of the readings displayed on the gas monitor.
- Press the reset button of the gas monitor 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 gas monitor.

(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.)
5. Application of Safe System of Work and Permit-to-work System

[Reference teaching time for Section 5: 75 mins]

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

[The example at Appendix 1 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 “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 atmospheric testing;
  5. the nature of work to be done;
  6. the conditions and features of the confined space;
  7. the period during which workers may remain safely in the confined; and
  8. the other relevant information (references should be made to the example of “Permit-to-work certificate” at Appendix 1).

**Procedures**

- The proprietor or contractor of the confined space work, after receiving a risk assessment report completed by a competent person, should determine
to issue a “Permit-to-work certificate”.

- The “Permit-to-work certificate” should be properly signed for confirmation by the proprietor or contractor or persons authorized by him. The items in the certificate should be written in ink or otherwise so as to be indelible.
- 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.
- If the work has not yet been completed by the expiry of the “Permit-to-work certificate”, an extension of the certificate is required.
  - The proprietor or contractor or persons authorized by him should visit the confined space and satisfy himself (by testing if necessary) that the conditions have not materially altered since he first issued the certificate. If the conditions have materially altered, the proprietor or contractor should cause the competent person to re-assess the situation, specify what further precautions are required to ensure the safety and health of the workers and state in the “Permit-to-work certificate” the extended time of expiry.
- In case extension of time of the certificate is required, application for extension of time should be made before the certificate is expired. In no way should blanket approval be given beforehand or retrospectively.
- 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 “Permit-to-work certificates” should be properly maintained for one year after the certificates have been cancelled and be available for inspection.

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

[The example of “Permit-to-work Certificate” at Appendix 1 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.).
### Appendix 1

An example of Permit-to-work Certificate for Entry into Confined Space

<table>
<thead>
<tr>
<th>(1) Location of Work :</th>
<th></th>
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<tbody>
<tr>
<td></td>
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<table>
<thead>
<tr>
<th>(2) Description of Work :</th>
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<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>(3) Contractor/Proprietor :</th>
<th></th>
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<tbody>
<tr>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>(4) Workers Assigned : (Names and Identification)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Workers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Standby Persons</td>
<td></td>
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<td></td>
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</tbody>
</table>

| (5) Date&Time of Entry to the Confined Space: |  |
|                                               |  |

| (6) Date&Time of Expiry of the Certificate : |  |
|                                              |  |

<table>
<thead>
<tr>
<th>Work Involved</th>
<th>Associated Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
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<tr>
<td>2.</td>
<td>2.</td>
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<tr>
<td>3.</td>
<td>3.</td>
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<td>4.</td>
<td>4.</td>
</tr>
</tbody>
</table>

**Other Hazards Expected/Identified :**

| 1. |  |
| 2. |  |
| 3. |  |
| 4. |  |
| 5. |  |

**Isolation Checklist :**

<table>
<thead>
<tr>
<th>Normal service in the confined space suspended</th>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>All inlets and outlets isolated/blanked off</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All power isolated (electrical/mechanical/hydraulic/others)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat source isolated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other source of danger isolated (specify)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cleaning & Purging :**

<table>
<thead>
<tr>
<th>Purging &amp; Cleaning (method : )</th>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection &amp; Check</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Atmospheric Testing:

<table>
<thead>
<tr>
<th>Test</th>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen content (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flammable gases test (result:)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxic/Harmful gases test (result:)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (specify)</td>
<td></td>
<td></td>
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</tbody>
</table>

### Fire Precautions:

<table>
<thead>
<tr>
<th>Precaution</th>
<th>Signed</th>
<th>Date &amp; Time</th>
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<tbody>
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</table>

### Personal Safety Protection:

<table>
<thead>
<tr>
<th>Protection</th>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilation Requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respirators</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clothing</td>
<td></td>
<td></td>
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<tr>
<td>Head, Hand &amp; Foot Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shields</td>
<td></td>
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<tr>
<td>Life Lines &amp; Harness</td>
<td></td>
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<tr>
<td>Lighting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye/Ear Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (specify)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Other Safety Precautions:

- Communication between workers and standby person (equipment and methods):
  
- Evacuation Procedures:
  
- Continuous Monitoring/Periodical Monitoring (equipment and methods):
  
### Remarks:

---

2/4
Authorization :
(to be completed by the proprietor/contractor, or his authorized representatives)

I certify that I have personally checked all the above conditions and satisfied myself that all the above particulars are correct or have been implemented. I certify that:

(a) ☐ the confined space is safe for entry without breathing apparatus.
    ☐ to enter the confined space, approved breathing apparatus must be worn.

(b) ☐ continuous monitoring is required.
    ☐ periodical monitoring is required.
    ☐ no foreseeable changes in the environment during the course of work, monitoring is not required.

(c) the necessary safety precautions for entering into the confined space are:

(d) date & time of expiry of the certificate:

(e) all workers are certified workers.

Other remarks & limitations:

Signed by:
Position:
Date & Time:

Acceptance of Certificate:
(to be completed by the supervisor or the person-in-charge of the work)

I have read and understood this certificate and shall undertake to work in accordance with all the conditions laid down in it.

Signed by:
Position:
Date & Time:

Request for Extension of Time of the Certificate:
(to be completed by the supervisor or the person-in-charge of the work)

The work has not been completed as scheduled and permission to continue is requested.

Signed by:
Position:
Date & Time:
Extension of Certificate:
(to be completed by the proprietor/contractor, or his authorized representatives)
I have re-assessed and re-examined the confined space detailed above, and confirm that this certificate can be extended to expire ___________ subject to:
(a) further safety precautions:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

(b) remarks & limitations:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Signed by: __________________________
Position: __________________________
Date & Time: ______________________

Completion of Work:
(to be completed by the supervisor or the person-in-charge of the work)
The work has been completed and all persons under my supervision, materials and equipment had been withdrawn.

Signed by: __________________________
Position: __________________________
Date & Time: ______________________

Cancellation of Certificate:
(to be completed by the proprietor/contractor, or his authorized representatives)
(a) This Permit-to-work certificate is now cancelled; and
(b) a new Permit-to-work certificate will be required if work is to be continued.

Signed by: __________________________
Position: __________________________
Date & Time: ______________________
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 Factories and Industrial Undertakings
(Confined Spaces) Regulation
The Course Contents are prepared by
The Occupational Safety and Health Branch
Labour Department

This Edition June 2019

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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), 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: 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, shopping arcades, 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 Factories and Industrial Undertakings Ordinance:**
Under the Factories and Industrial Undertakings Ordinance, 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, Factories and Industrial Undertakings (Confined Spaces) Regulation, 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

Factories and Industrial Undertakings (Confined Spaces) Regulation 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.

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 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 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.
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 person is stationed outside the confined space to maintain communication with the workers inside;
(c) ensure the risk assessment report and related 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 workers” 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.

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
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.

- 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 for alerting others outside confined space.
  - ensure sufficient number of persons who know how to use the safety equipment 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 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.

Duties of a competent person

- carry out an assessment of the working conditions of a confined space covering all the aspects specified under the F&IU (Confined Spaces) Regulation.
- 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 (Loadshifting Machinery) Regulation**

Loadshifting machines used in the industrial undertakings are operated by a person who has attended the age of 18 years and holds a valid certificate.
Fork-lift trucks used in industrial undertakings; bulldozers, loaders, excavators, trucks or lorries, compactors, dumpers, graders, locomotives, and scrapers used on construction site are within the ambit of the Regulation. However, the Regulation does not apply to the operator of a truck or lorry who holds a valid driving licence under the Road Traffic Ordinance (Cap. 374).

2.2.4 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 Factories and Industrial Undertakings Ordinance, Chapter 59 of the Laws of Hong Kong (hereinafter referred as 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 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: Safety and Health at Work in Confined Spaces
- 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 Factories and Industrial Undertakings (Confined Spaces) Regulation, “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 work pieces 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.
- Proper fire-fighting installations (e.g. suitable fire extinguishers and fire blanket) should be provided and maintained, and 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.

- Use of generators and fuel-driven tools in poorly ventilated areas may use up oxygen and generate carbon monoxide.

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. The most common hazardous gases found in confined spaces are listed below:

- Hydrogen sulphide (H₂S)
  - 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 (CH₄)

- 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 a confined space should not be less than 19.5% by volume nor greater than 23% 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 moulding.
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. Heat stress can be reduced by providing blowing fans, adequate cool potable water to replace water loss from sweating and sufficient rest breaks.

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 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.
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

Case 1

Poisoning in manhole sewer

Circumstances

A team of workers had to clear a sewer which was about 2 metres in diameter. A 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:

- The effluent in the sewer produced toxic gases. Toxic gases accumulated more easily in the absence of an air blower.
- There was no continuous monitoring for the air quality inside the sewer, the worker was not aware that the toxic gases had accumulated to a dangerous level.
- The worker did not wear approved breathing apparatus while at work.
- The workers taking part in the rescue did not wear any safety equipment.

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.
- 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 warning 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 atmospheric testing and providing 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 approved breathing apparatus (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 certificate (permit-to-work), 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.

- 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 removed the ventilating blower, the worker who entered the manhole for final clean-up and the workers who rushed into the manhole for the rescue operation) and their responsibilities.

**Case 2**

**Poisoning in metal duct**

**Circumstances**

A polishing worker was poisoned by the carbon monoxide produced by a portable diesel generator operating in a metal duct which was over 100 metres in length and 2.2
metres in diameter while he was polishing the internal surface of the duct alone.

**Case Analysis**

The causes of accident include:

- An enormous amount of poisonous carbon monoxide was produced when the fuel generator was in operation.
- Poor air ventilation inside the metal duct had resulted in the accumulation of carbon monoxide.
- Risk assessment for the work in confined space was not carried out.

**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.
- Recommendations made by the competent person and the emergency procedures laid down by the proprietor or contractor should be strictly followed.
- Fuel-powered machines shall be placed outside the metal duct to prevent carbon monoxide from accumulating inside the metal duct.
- Suitable mechanical ventilation and continuous air monitoring should be maintained while work is being conducted inside a metal duct.

**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 atmospheric testing and providing 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 metal pipe, etc.) while workers are working inside the confined spaces.

 any person entering the confined space should be wearing approved breathing apparatus (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 certificate (permit-to-work), 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.
- 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 entered the metal duct for work) and their responsibilities.

Case 3

[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) for case study and analysis in this section]

[Reference can be made to the “Safety Alert” provided by 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: 60 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:

- 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 (references should be made to section 5.2.1);

- to issue a certificate (“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 confined space (references should be made to section 5.2.2);

- to ensure that all safety precautions when work is being undertaken have been carried out and kept effective throughout the confined space work (references should be made to section 5.2.3);

- to ensure that no workers other than certified workers enter or work in the confined space;

- 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);

- to formulate and implement appropriate emergency situations and response procedures to deal with any serious and imminent danger to workers inside the confined space (references should be made to section 6); and

- to provide necessary 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

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

Isolation

- The proprietor or contractor should, 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 a confined space.

- All the points of isolation should remain fully secure to ensure that the dangerous materials will not go into the confined space whilst the workers are working in it.

- 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 being opened without authorization or accidentally.

- Ends of service pipes which are still connected to sources of dangerous fume should be properly sealed by means of, e.g. metal blank, end-cap.

- No work which may jeopardize the safety of workers inside a confined space should be permitted to be carried out outside and in the vicinity of the confined space. Barriers should be erected outside access openings of the confined space, with suitable warning signs and notices displayed. This is particularly important for floor openings, where hazards may arise from liquid spills, e.g. flammable liquid, solvents, or from sparks created by cutting or welding in the vicinity.

- Openings in a confined space (e.g. drain holes) should be sealed off if there is any possibility of hazardous gases or vapours backing up from another area and contaminating the confined space.

- The confined space should be isolated from all non-essential sources of heat.

- Effective steps should be taken to prevent an 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. Regarding in-rush of water, particular attention should be given to the possible 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, etc.

**Purging**

- Having regard to the circumstances of a particular confined space, before the proprietor or contractor allows workers to enter into and work in a confined space, the confined space should 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 thoroughly remove all the dangerous materials from the confined space. 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 should not be any vacuum being caused 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.
- When purging has been completed, all liquid remaining in the confined space should be drained away or pumped out as appropriate, and manholes should be opened to allow ventilation.
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 which has been purged by an inert gas, the confined space should 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 should then be thoroughly tested against the deficiency of oxygen to make sure that there is adequate oxygen to support life.

Atmospheric Testing

- Atmospheric testing of a confined space should be carried out as appropriate before it is certified as being safe to enter.

- Atmospheric testing of a confined space should be done for the purposes of deciding and specifying the related safety precautions necessary to be taken upon entry into such a confined space.

- A proprietor or contractor should prohibit a worker from entering into the confined space until initial testing of the atmosphere of the confined space has been properly done from outside, with the testing results showing that the atmosphere inside the confined space is safe for entry.

- The atmospheric testing should include the testing of the oxygen content, the presence of flammable, toxic or harmful gases, fumes or vapours. Hazardous gases commonly found in confined spaces such as sewers, include carbon monoxide (CO), hydrogen sulphide (H₂S), methane (CH₄) and other flammable gases.

- All atmospheric testing should be carried out by means of suitable testing equipment with correct testing methods. For instance, air at different levels and locations inside a confined space should be tested since dangerous gases with different densities relative to air may accumulate at different levels and locations of the confined space.

- Atmospheric testing should be made outside the confined space, with air samples being drawn out by suitable sample probes.
The gas testing equipment used in atmospheric air testing should be of the explosion proof type.

In general, testing for oxygen should be performed first because most combustible gas testing meters are oxygen dependent and does not provide reliable readings in an oxygen deficient atmosphere.

All testing meters and equipment should be properly and correctly used for the purpose of atmospheric testing for confined space. The manufacturers’ instruction manuals on the proper use of those meters and equipment should be strictly followed. All testing meters and equipment should be suitably calibrated and properly maintained as per the recommendations of the equipment manufacturers, with records properly kept.

The percentage of oxygen in a confined space should not be less than 19.5% by volume nor greater than 23% by volume at normal atmospheric pressure.

For the exposure limits of various dangerous gases, reference should be made to the publications made by the Labour Department, the Health and Safety Executive (HSE) of the UK, the American Conference of Governmental Industrial Hygienists’ (ACGIH) and other relevant authorities on occupational exposure limits.

### Ventilation

Adequate and effective ventilation should be maintained for supplying sufficient respirable fresh air for workers inside a confined space. In that respect, forced ventilation may be required instead of natural ventilation.

In deciding the ventilation air exchange rate, it should take into account that some work tasks, e.g. gas welding, consume oxygen and some tasks, e.g. paint spraying, contaminate the atmosphere. It would be required to provide adequate air change to remove the hazardous substances evolved and maintain sufficient fresh air supply while work is in progress.

The provision of ventilation to a confined space should not be considered as an alternative to the use of breathing apparatus where the atmosphere inside is likely to cause safety or health hazards to the workers therein.

In all cases of forced ventilation to supply fresh air into a confined space,
the air-line or trunking should be introduced or extended to the bottom of
the confined space, for removal of gases or vapours heavier than air and for
effective air circulation.

- Under no circumstances should oxygen be introduced into a confined space
  which would create a danger of oxygen enrichment in the atmosphere.

- Notwithstanding the above, a proprietor or contractor should also take
effective steps to prevent an 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 1)

- 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 F&IU (Confined
Spaces) Reg. He may then issue a “Permit-to-work certificate” to the
certified workers engaged in confined space work.

- 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.
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) results of cleaning and purging of facilities in the confined space;
(d) results of the atmospheric testing;
(e) a list of personal protective equipment (“PPE”); and
(f) other safety precautions.

5.2.3 Safety Precautions When Work Is Being Undertaken

- A proprietor or contractor should 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 should provide all necessary equipment to ensure the safety and health of workers working in a confined space. The equipment should be properly 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 should ensure that the relevant risk assessment report, with all its significant findings, are displayed in a conspicuous place at the entrance of the confined space. The related certificate should 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, another worker (the “standby person”) should be assigned to station outside the confined space throughout the time of operation to maintain communication with the worker inside.

- The standby person should be trained on how to maintain communication with those workers working inside the confined space.
• The standby person should 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 dangerous gases, power supply failure, failure of forced ventilation system, etc.).

• Similarly the workers inside a confined space should keep the standby person informed should any dangerous situations arise inside the confined space so that the standby person can call for assistance.

• A proprietor or contractor should 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.
6. **Risk Assessment**

[Reference teaching time for Section 6: 110 mins]

6.1 **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.

**Hazard identification**

- 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 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. Slightly harmful, examples are superficial injuries, minor cuts and bruises, etc.
2. Harmful, examples are lacerations, serious sprains, minor fractures, etc.
3. Extremely harmful, examples are amputations, major fractures, fatal injuries, etc.

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

<table>
<thead>
<tr>
<th>Probability/likelihood</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Likely/frequent</td>
<td>Occurs repeatedly/event only to be expected</td>
</tr>
<tr>
<td>Unlikely</td>
<td>Rather remote, though conceivable</td>
</tr>
<tr>
<td>Highly unlikely</td>
<td>So unlikely that probability is close to zero</td>
</tr>
</tbody>
</table>

If the judgment is "highly unlikely", this needs to be subject to particularly rigorous scrutiny as, in reality, this is a relatively rare situation.

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:

<table>
<thead>
<tr>
<th></th>
<th>Slightly harmful</th>
<th>Harmful</th>
<th>Extremely harmful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly unlikely</td>
<td>Trivial risk</td>
<td>Minor risk</td>
<td>Moderate risk</td>
</tr>
<tr>
<td>Unlikely</td>
<td>Minor risk</td>
<td>Moderate risk</td>
<td>Substantial risk</td>
</tr>
<tr>
<td>Likely</td>
<td>Moderate risk</td>
<td>Substantial risk</td>
<td>Extreme risk</td>
</tr>
</tbody>
</table>

Action should be taken according to a list of priority. Extreme risks
should be accorded the first priority, substantial risks the second priority; moderate 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 soundproofing 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.
6.1.1 Risk Assessment for Confined Space Work

[An example case 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.

- 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 should appoint a competent person to carry out a risk assessment to identify the hazards likely to be present in the confined space, and to recommend necessary 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, for example, to the workers in the vicinity who could be affected by the work to be undertaken. The hazards to be considered should include not only those arising from the materials and substances present, or likely to be present in the confined space concerned, its previous uses and the work to be done, but also those which may be present by its proximity to other plants, processes and operations.

- 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 taken 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) where necessary, a proper site investigation should be arranged to the actual spot of the confined space so as to have a more thorough knowledge about the nature and circumstances, in particular 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 should 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 should 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.
The size and number of access and egress points:

(1) should be assessed individually dependent upon the activities to be carried out and the number of people involved.

(2) To determine the locations of manholes or openings to vessels, tanks, etc., due consideration should be given the possible difficulties for access to and rescue from the confined space.

(3) there may be occasions when access and egress is so tortuous that temporary openings may be needed. Different criteria should be applied when determining manhole dimensions for a confined space that extends over a significant length or height, as in the case of sewers, pipes, culverts, small tunnels or shafts. Measures to improve access such as structural alterations to the confined space could be considered. The spacing of manholes on sewers and the absence of such access over considerable lengths may affect both the degree of natural ventilation and the efficiency to rescue.

The recommendations on the necessary safety measures should include whether the use of approved breathing apparatus is necessary so as to render the confined space safe for workers to stay inside. When there is any doubt as to the possible concentration level of the harmful atmosphere in a confined space, suitable and approved breathing apparatus should be used and the other necessary safety precautions should be taken accordingly.

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 there is a known possibility of adverse changes of working conditions, he should recommend a continuous monitoring or periodical monitoring of the working environment. The purpose is to ensure that the ventilation is adequate and that the atmosphere remains safe for working inside the confined space. The exact testing, retesting and monitoring requirement should 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.

- 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.

- All the significant findings of a risk assessment should be recorded by the competent person in a risk assessment report, including:
  (1) the hazards identified;
  (2) the necessary safety precautions to be taken;
  (3) the type and the number of workers being affected;
  (4) the period during which workers may remain safely in the confined space; and
  (5) the particulars of the competent person who has carried out the risk assessment.

- The competent person should 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 should be submitted to the proprietor or contractor of the industrial undertaking for his consideration for the issue of a certificate before the confined space work is carried out.

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.

6.2 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 risk assessment report.

- 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.).
7. Atmospheric Testing Procedures and Points to Note

[Reference teaching time for Section 7: 30 mins]

[Demonstrate using the real multiple-sensor gas monitor 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 gas monitor, i.e. the functional or bump test, before use according to the manufacturer’s instructions.]

7.1 Atmospheric Testing Procedures

- Atmospheric testing should be conducted by a person with appropriate training and experience. It includes pre-entry atmospheric testing and atmospheric monitoring during work by atmospheric monitoring equipment.

**Pre-entry atmospheric 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 gas monitor) placed outside the confined space.

- The manufacturers’ instruction manuals on the proper use of atmospheric 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 atmospheric testing.

- The atmosphere around the working position of the person carrying out atmospheric testing should be tested first to ensure his safety and health during atmospheric 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), atmospheric 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 atmospheric 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; carbon monoxide is slightly lighter than air and it will stay near the released position.

- **Hand-dug tunnel**: atmospheric 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 atmospheric testing equipment to the front end of the hand-dug tunnel, remote control type atmospheric 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 atmospheric testing in the risk assessment.

- Atmospheric testing must be conducted again when there is any potential change in the atmospheric conditions.

**Atmospheric 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 example, 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 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.

• 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.

7.2 Points to note for using atmospheric testing equipment

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

Gas Monitor
• Proper gas monitor should be selected with respect to the gas or vapour to
be tested. For example, the gas monitor equipped with multiple sensors to measure the levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide.

- The gas monitor 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 gas monitor, including the proper maintenance and calibration for the equipment, etc.
- The sensors of the gas monitor should be checked to ensure that they are properly installed and has not yet expired.
- The remaining battery level of the gas monitor should be checked.
- The proper functioning of the gas monitor should be tested, i.e. to conduct functional or bump test, before use according to the manufacturer’s instructions.
- The gas monitor is suitable for continuous air monitoring.
8. Practice on Use of Multiple-Sensor Gas Monitor

[Reference teaching time for Section 8: 30 mins]

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

- Trainees are divided into groups (maximum of four trainees per group) to use a multiple-sensor gas monitor for the hands-on practice.

Simulation of hazardous situation

- Either procedures A or B should be completed by each group (every group members should participate in the procedures):

Procedure A

- Connect the sampling probe and hose to the gas monitor.
- Switch on the gas monitor.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
- Put the sampling probe into a container (e.g. a plastic ziplock bag) containing alcohol wipes.
- Wait the audio-visual alarm of the gas monitor to be activated.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
- Take out the sampling probe from the container and observe the changes of the readings displayed on the gas monitor.
- Press the reset button of the gas monitor 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 gas monitor.

(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 gas monitor.
- Switch on the gas monitor.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
- 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 gas monitor to be activated.
- Take readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide from the gas monitor.
- Take out the sampling probe from the plastic ziplock bag or the container, and observe the changes of the readings displayed on the gas monitor.
- Press the reset button of the gas monitor 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 gas monitor.

(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.)

[Reference teaching time for Section 9: 65 mins]

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

[The example at Appendix 1 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 atmospheric testing;
  5. the nature of work to be done;
  6. the conditions and features of the confined space;
  7. the period during which workers may remain safely in the confined; and
  8. the other relevant information (references should be made to the example of “Permit-to-work certificate” at Appendix 1).

Procedures

- The proprietor or contractor of the confined space work, after receiving a
risk assessment report completed by a competent person, should determine to issue a “Permit-to-work certificate”.

- The “Permit-to-work certificate” should be properly signed for confirmation by the proprietor or contractor or persons authorized by him. The items in the certificate should be written in ink or otherwise so as to be indelible.

- 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.

- If the work has not yet been completed by the expiry of the “Permit-to-work certificate”, an extension of the certificate is required.
  - If the conditions have materially altered, the proprietor or contractor should cause the competent person to re-assess the situation, specify what further precautions are required to ensure the safety and health of the workers and state in the “Permit-to-work certificate” the extended time of expiry.

- In case extension of time of the certificate is required, application for extension of time should be made before the certificate is expired. In no way should blanket approval be given beforehand or retrospectively.

- 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 “Permit-to-work certificates” should be properly maintained for one year after the certificates have been cancelled and be available for inspection.

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

[The example of “Permit-to-work Certificate” at Appendix 1 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.).
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 should formulate and implement appropriate procedures to deal with any serious and imminent danger to workers inside a confined space.

**Rescue**

- A proprietor or contractor should set up arrangements for rescue of workers working in a confined space 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 after 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.

- As to the number of trained persons required in a rescue team, several factors, 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 should have been properly and adequately trained in the related emergency rescue procedures, including the detailed particulars of an emergency rescue plan and full knowledge on how to
properly use all those rescue equipment.

**Communication**

- Communication between the workers inside a confined space and the standby person should be maintained throughout the period when the workers are working inside the confined space. An audio and visual alarm system should be provided for the workers inside the confined space to alert the standby person, and vice versa, in case of emergency.

- Even in case of emergency, the standby person should not enter the confined space. He should remain stationed outside the confined space and summon assistance of the rescue team and public emergency services (i.e. the Police and the Fire Services). He should stay outside the confined space and brief the rescue personnel of the relevant circumstances of the incident upon their arrival.

**Equipment**

- Suitable and sufficient rescue equipment, including standby approved breathing apparatus, safety harness, life-lines, reviving apparatus and emergency lighting, and properly trained rescue personnel should be readily available for rescue purposes at all times when workers are working inside a confined space. Rescue equipment provided should be appropriate in view of the likely emergencies identified in the risk assessment and be properly maintained. For the use of resuscitators, reference should be made to 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.

**Evacuation**

- A proprietor or contractor should devise an evacuation procedure for prompt evacuation from the confined space in case of a sudden change in the working or the environmental condition that may cause imminent
danger to the workers working in a confined space.

**Drills**

- Drills for the rescue and emergency procedures should be conducted periodically for testing of the emergency response plan, and for practicing the procedures and use of rescue equipment.
11. Explanation, Display, Demonstration and Practice on Safety Equipment

[Reference teaching time for Section 11: 180 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.]

11.1 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.

11.1.1 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 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.

11.1.2 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.

11.1.3 Breathing Apparatus [Explain by means of powerpoint or the real object of PPE]

- Protect workers against dust, fibres, hazardous gases and fumes and prevent workers from oxygen deficiency.

- Types of breathing apparatus include: disposable cartridge respirators; full-face/half-face respirators; air-supplied hoods; self-contained respirators.

- The worker inside the confined space should use an approved breathing apparatus (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).

- When using breathing apparatus, it must be properly fitted on the wearer’s face.

- Breathing apparatus should be cleaned thoroughly after each use.

11.1.4 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 belt 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 belt, the following should be checked: any defects on the safety belt, any suitable anchorage, independent lifeline and fall arresting device, and whether the standard is met or not.

When using a safety belt for fall protection, the safety belt should be attached to a fixed anchorage point or a fall arrester of an independent lifeline.

11.2 Safety and Rescue Equipment

11.2.1 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 11.4 and “low pressure test”]

- Only approved breathing apparatus, that is breathing apparatus which has been approved by the Commissioner for Labour under section 12 of Factories and Industrial Undertakings (Confined Spaces) Regulation, 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 pursuant to regulations 64 and 66 of Dangerous Goods (General) Regulations.

- An air-supplying respiratory protective equipment provides uncontaminated air from an independent source for breathing by the user. It includes the self-contained breathing apparatus (i.e. Self-contained Type) which provides air from a gas cylinder, and the compressed air line breathing apparatus (i.e. Air Line Type) which provides uncontaminated air from a source through a long hose.

- The person using the approved breathing apparatus should have received appropriate training in the use of that particular type or model of equipment.

- The selection of a suitable approved breathing apparatus should depend upon the conditions, hazards, testing results of the confined space, and the work activities to be done inside the confined space.
● All approved breathing apparatus to be used for entry into and work inside a confined space should well fit the workers and be properly worn.

● Only those who are medically fit for using approved breathing apparatus should be allowed to use approved breathing apparatus for entering into and working in a confined space.

● The quality of the breathing air supplied by an approved breathing apparatus should comply with the most up-to-date recognized international or national standard.

● All the approved breathing apparatus for use in confined spaces should be properly maintained in good working conditions.

● Before each use, the approved breathing apparatus should be:
  ■ connected to a cylinder, a pump or a compressor to provide breathable air. Care should be taken to ensure that the air compressor used for filling air cylinders or supplying air to airline type breathing apparatus is specially designed for providing breathable air, suitably maintained and properly located to avoid intake from contaminated air sources.
  ■ inspected for any sign of physical damage on all parts and accessories.
  ■ functionally checked according to the user manual.
  ■ kept in clean and good conditions. Defective equipment should be clearly marked “defective” and removed from site for maintenance. Never use defective breathing apparatus.

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:
  ■ 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.

Unload 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.
- 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.

11.2.2 Safety Harness, Lifeline and Tripod/Quadpod

[Demonstrate using the real object including demonstration of the procedures for the practice in Section 11.3]

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 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 in the event of an accident.

- 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 ensure 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 recognized international standards or national standards when selecting rescue lifting devices.

### 11.2.3 Audio and Visual Alarm [Demonstrate using the real object]

- An audio and visual alarm by which the workers inside the confined space can alert those outside.

- An audio and visual alarm (with motion sensor) to give out alerting signals to others when the worker remains motionless for a certain duration.

- Manufacturers’ instruction manuals on the proper use of audio and visual
alarm should be strictly followed.

11.2.4 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.

11.2.5 Atmospheric Testing Equipment

(Detector Tubes [Explain by means of powerpoint or the real object] and Gas Monitor [Demonstrate using the real multiple-sensor gas monitor which can display readings on levels of oxygen, combustible gas, hydrogen sulphide and carbon monoxide])

Direct measuring atmospheric testing equipment includes detector tubes and gas monitor.

Detector Tubes

- Detector tubes are mainly used for determination of the concentrations of gas or vapour in the air. Different types of tubes are available for detecting different gas or vapour.

- 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.

- Detector tubes have a limited shelf life and some of them are subjected to cross-interference, hence it is important that instructions provided by the manufacturer should be referred to before using detector tubes. In addition, detector tubes are not suitable for continuous air monitoring.
Gas Monitor

- The most common configuration for a multiple-sensor gas monitor 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. Different or additional air monitoring instruments are required for other hazardous gases that may be present in the confined spaces such as drainage.

- Only properly maintained and calibrated equipment should be used for atmospheric testing.

- The gas monitor should be of the explosion-proof type.

- The proper functioning of the gas monitor 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 gas sensors are oxygen-dependent and may give unreliable readings in oxygen-deficient situations.

- The gas monitor should have an audio-visual alarm device which would alert workers when any indication of danger is detected.

- The gas monitor is suitable for continuous air monitoring.

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

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

- 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.

11.4 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 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.
  - Normal breathing.
  - Positive pressure test (check the positive pressure of the mask).
  - Take off the whole set of self-contained type approved breathing apparatus.
Appendix 1

An example of Permit-to-work Certificate for Entry into Confined Space

<table>
<thead>
<tr>
<th>Location of Work</th>
<th>Description of Work</th>
<th>Contractor/Proprietor</th>
<th>Workers Assigned (Names and Identification)</th>
<th>Standby Persons</th>
</tr>
</thead>
</table>

| Date & Time of Entry to the Confined Space: |

| Date & Time of Expiry of the Certificate: |

<table>
<thead>
<tr>
<th>Work Involved</th>
<th>Associated Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
<td>4.</td>
</tr>
</tbody>
</table>

Other Hazards Expected/Identified:

| 1. |
| 2. |
| 3. |
| 4. |
| 5. |

Isolation Checklist:

<table>
<thead>
<tr>
<th>Normal service in the confined space suspended</th>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>All inlets and outlets isolated/blanked off</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All power isolated (electrical/mechanical/hydraulic/others)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat source isolated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other source of danger isolated (specify)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cleaning & Purging:

<table>
<thead>
<tr>
<th>Purging &amp; Cleaning (method: )</th>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection &amp; Check</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Atmospheric Testing :

<table>
<thead>
<tr>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Oxygen content ( %)</td>
<td></td>
</tr>
<tr>
<td>☐ Flammable gases test (result : )</td>
<td></td>
</tr>
<tr>
<td>☐ Toxic/Harmful gases test (result : )</td>
<td></td>
</tr>
<tr>
<td>☐ Other (specify)</td>
<td></td>
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</tbody>
</table>

### Fire Precautions :

<table>
<thead>
<tr>
<th>Signed</th>
<th>Date &amp; Time</th>
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<tbody>
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</tbody>
</table>

### Personal Safety Protection :

<table>
<thead>
<tr>
<th>Signed</th>
<th>Date &amp; Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Ventilation Requirements</td>
<td></td>
</tr>
<tr>
<td>☐ Respirators</td>
<td></td>
</tr>
<tr>
<td>☐ Clothing</td>
<td></td>
</tr>
<tr>
<td>☐ Head, Hand &amp; Foot Protection</td>
<td></td>
</tr>
<tr>
<td>☐ Shields</td>
<td></td>
</tr>
<tr>
<td>☐ Life Lines &amp; Harness</td>
<td></td>
</tr>
<tr>
<td>☐ Lighting</td>
<td></td>
</tr>
<tr>
<td>☐ Eye/Ear Protection</td>
<td></td>
</tr>
<tr>
<td>☐ Other (specify)</td>
<td></td>
</tr>
</tbody>
</table>

### Other Safety Precautions :

Communication between workers and standby person (equipment and methods) :

Evacuation Procedures :

Continuous Monitoring/Periodical Monitoring (equipment and methods)

### Remarks :


Authorization:
(to be completed by the proprietor/contractor, or his authorized representatives)
I certify that I have personally checked all the above conditions and satisfied myself that all the above particulars are correct or have been implemented. I certify that:

(a) □ the confined space is safe for entry without breathing apparatus.
    □ to enter the confined space, approved breathing apparatus must be worn.

(b) □ continuous monitoring is required.
    □ periodical monitoring is required.
    □ no foreseeable changes in the environment during the course of work, monitoring is not required.

(c) the necessary safety precautions for entering into the confined space are:

(d) date & time of expiry of the certificate:

(e) all workers are certified workers.
Other remarks & limitations:

Signed by: __________________________
Position: __________________________
Date & Time: __________________________

Acceptance of Certificate:
(to be completed by the supervisor or the person-in-charge of the work)
I have read and understood this certificate and shall undertake to work in accordance with all the conditions laid down in it.

Signed by: __________________________
Position: __________________________
Date & Time: __________________________

Request for Extension of Time of the Certificate:
(to be completed by the supervisor or the person-in-charge of the work)
The work has not been completed as scheduled and permission to continue is requested.

Signed by: __________________________
Position: __________________________
Date & Time: __________________________
Extension of Certificate:
(to be completed by the proprietor/contractor, or his authorized representatives)
I have re-assessed and re-examined the confined space detailed above, and confirm that this certificate can be extended to expire ___________ subject to:
(a) further safety precautions:

(b) remarks & limitations:

Signed by:
Position:
Date & Time:

Completion of Work:
(to be completed by the supervisor or the person-in-charge of the work)
The work has been completed and all persons under my supervision, materials and equipment had been withdrawn.

Signed by:
Position:
Date & Time:

Cancellation of Certificate:
(to be completed by the proprietor/contractor, or his authorized representatives)
(a) This Permit-to-work certificate is now cancelled; and
(b) a new Permit-to-work certificate will be required if work is to be continued.

Signed by:
Position:
Date & Time:
Annex 8

Answer Sheet for Safety Training Course for Competent Persons
Instructions to Trainees
1. The examination paper consists of 20 multiple choice questions. Each correct answer carries 5 marks. Please answer all questions.
2. The passing mark of the examination is 75. The examination must be finished in 30 minutes.
3. Please read the questions carefully and put a tick in the answer box you choose for the question.
4. If you tick more than one answer box for one question, no marks will be awarded.
5. Please initial next to your final answer whenever amendment is made.
6. If you have any questions, please raise your hand and ask the examiner or invigilator.

Question | Answer | Question | Answer
--- | --- | --- | ---
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: _________________