

Name: _____ Student ID _____

**Prince of Songkla University
Faculty of Engineering**

Exam: Mid-Term, Semester II

Academic Year: 2008 – 2009

Date: December 24, 2008

Time: 1:30 – 4:30 PM

Subject: 230-334 – Safety

Room: A400

(Safety in Chemical Engineering Operations)

ทฤษฎีในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทฤษฎี และพักการเรียน 1 ภาคการศึกษา

Instructions: There are a total of 4 parts 8 pages (not including the cover sheet). Place your name and the student ID number on every page. Students are allowed to use only a pen or pencil and an English dictionary (Talking Dictionary is permitted). No exams are allowed to leave the room.

Points Distribution (For Grader Only)		
Part	Points Value	Score
I	35	
II	30	
III	35	
IV	45	
Total	145	

**Exam prepared by
Ram Yamsaengsung
December 17, 2008**

**PLEASE CHECK TO MAKE SURE THAT
YOU HAVE ALL 8 PAGES OF THE EXAM BEFORE BEGINNING
(not including the cover sheet).
GOOD LUCK!**

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Closed Book Exam (No books or notes allowed)

I. Fill in the blanks (35 points)

1. The _____ appoints the laboratory safety officer and is usually the head of the department.
2. The _____ acts as the secretary of the laboratory safety committee.
3. The _____ is responsible for arranging inspection of the storage materials. The inspection should be conducted every _____.
4. The _____ ensures that equipment used in work under their direction is of safe design and construction.
5. The safety policy of the Department of Chemical Engineering must be signed by the _____.
6. To produce a fire, it is necessary to have _____, _____, and _____. This is also known as _____.
7. If organic solvents are used for cleaning equipment, the work (cleaning) should be done in a _____.
8. _____ are highly toxic by ingestion and are rapidly absorbed by the skin producing intensive burns.
9. A signature on behalf of the _____ must be present on the safety policy.
10. In a well design facility, the equipment should only take up about _____ % of the entire floor space.
11. An inflammation of the skin that causes an allergic reaction is called _____.
12. _____ should be worn when working with toxic and _____ chemicals.
13. The sudden release of vacuum is called _____.
14. Phenol, Cresol, and Xylenol are very dangerous _____.
15. For high pressure equipment, the safety devices that must be installed include _____, _____, and _____.
16. Metal containers should have about _____ % extra space to allow for liquid expansion.
17. The storage of bulk amount of toxic and chemical liquids is preferably stored in _____.
18. The preferred method of stacking drums in the open air is to stack them _____.

19. LPG is an abbreviation for _____ and must be stored in properly designed vessels, in which at least _____ unfilled space must be allowed to prevent the development of dangerous pressure.
20. The five components needed for a dust explosion to are _____, _____, _____, _____, and _____.
21. Steep support should be able to withstand fire (provide resistant for at least _____).
22. Red bands on gas cylinders mean _____ while yellow bands mean _____.

II. Shorts Answers (30 points)

1. List 2 different methods for treating the effluents leaving the facility. **(2 points)**

2. Name 5 things that must be included in a general safety policy. **(5 points)**

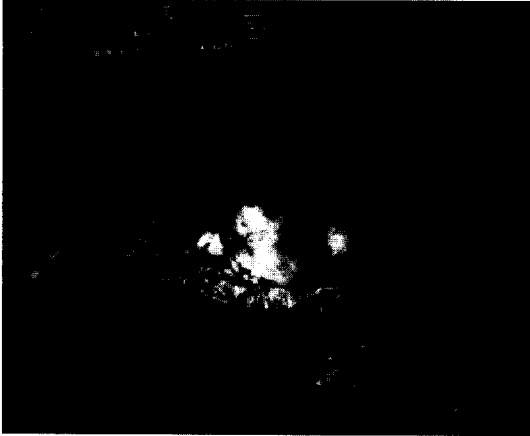
3. Name 4 major dangers from electrical hazards. **(4 points)**

4. With long term exposure to toxic hazards, what are the damages that may be caused to the body? **(2 points)**

5. What are the 2 types of human indiscipline mentioned that could cause hazards to others? **(2 points)**

6. List 5 emergency facilities (or equipment) that must be listed in the labs?
(5 points)

7. Read the article below and answer the following questions? (10 points)

<u>Overfilling Tanks – What Happened?</u>		September 2006
	<p>On Sunday December 11, 2005, gasoline (petrol) was being pumped into a storage tank at the Buncefield Oil Storage Depot in Hertfordshire, England. At about 1:30 AM a stock check of the tanks showed nothing abnormal. From about 3 AM, the level gauge in one of the tanks recorded no change in reading, even though flow was continuing at a rate of about 550 cu. meters/hour (2400 US gallons/minute). Calculations show that the tank would have been full at about 5:20 AM, and that it would then overflow. Pumping continued and the excess gasoline overflowed from the top of the tank and cascaded down the sides, forming a liquid pool and a cloud of flammable gasoline vapor. At about 6:00 AM the cloud ignited and the first explosion occurred, followed by additional explosions and a fire which engulfed 20 storage tanks. Fortunately there were no fatalities, but 43 people were injured. 2000 people were evacuated, there was significant damage to property in the area, and a major highway was closed. The fires burned for several days, destroying most of the site and releasing large clouds of black smoke which impacted the environment over a large area.</p>	
<p><i>Photograph courtesy of Royal Chiltern Air Support Unit</i></p>		

7.1 What caused the accident? (1 point)

7.2 Where did the accident take place? (1 point)

7.3 When and what type of explosion took place? (2 point)

7.4 How many people were injured and evacuated? (2 point)

7.5 What should have been done to prevent the accident? (4 points)

III. CSB Video (35 points)

1. Match the following information with the safety video that it was from?
(20 points)

- (a) Reactive Hazards
- (b) Explosion at BP Refinery, Texas City
- (c) Death in the Oil Field
- (d) Fire from Ice
- (e) Static Explosion

- ___ 1. High pressure propane was released from a de-asphalting unit, causing a vapor cloud explosion and a jet fire.
- ___ 2. Maintenance workers were killed when they tried to clean out plastics from a waste tank
- ___ 3. Inappropriate instructions and communications between operators of day and night shifts.
- ___ 4. Pumping of solvent caused air bubbles to enter a storage tank
- ___ 5. Highly toxic gas was released due to improper scale-up of process
- ___ 6. Water seeped through a clogged valve and collected in an elbow of a “dead leg”. The water froze and cracked the piping elbow.
- ___ 7. A gap between liquid solvent and level indicator in the storage tank led to a discharge and ignited the vapor cloud
- ___ 8. A ladder was used as a platform during “Hot Work” operation.
- ___ 9. The level indicator of isomerization unit gave incorrect values, several alarms failed and tower overflowed.
vapor cloud that ignited at a boiler house
- ___ 10. One LPG storage sphere was blistered from the intense heat and could have release more than 150,000 gallons of highly-pressurized butane
- ___ 11. Control Board Operators worked for 30 straight days at 12 hours shift.
- ___ 12. Three maintenance workers were killed during a welding operation
- ___ 13. A 12% increase in production caused a runaway reaction leading to the release of acrylic vapor clouds and a violent explosion
- ___ 14. A non-conductive naphtha solvent tank exploded
- ___ 15. A lid acetylene torch was inserted into a storage tank to test for the presence of hydrocarbons.
- ___ 16. Liquid reached a height of 98 ft before noon and overflowed around 1 pm into the relief line and up a blow-down drum.
- ___ 17. A non-fire proof steel support structure collapsed under intense heat from a jet fire.
- ___ 18. Slow decomposition took place releasing large amount of gas and increasing the internal pressure inside of a waste storage tank
- ___ 19. Budget cuts impacted the process safety system leaving 2 operators to oversee major units.
- ___ 20. When the ice thawed, 4,500 lb/min of propane was released causing a large

2. From the BP Refinery Texas City Accident Video, discuss the causes that led to the accident, how much damage resulted, and how the accident could have been prevented, including suggestions from the Chemical and Safety Hazards Investigation Board (CSB).
(15 points)

IV. Discussions (45 points)

1. Using the attached diagram of a typical R&D facility layout (Fig.1), write where the following should be located: the service vehicles, the parking space for the employees and visitors, the office area, the workshops, store area, low hazards materials, high hazards materials, laboratory, control equipment, high hazard experimental area, and restricted area. **(12 points)**

See attached diagram for solution.

2. Name 10 types of hazards that are found in our Chemical Engineering Department. Give specific examples of each (i.e. the slippery, greasy floor of the vacuum frying unit is a hazard). An example cannot be used more than once. Also give one way to prevent each hazard from occurring. **(15 points)**

3. From the Lab Layout assignment, list at least **two potential dangers** in each lab, and **two suggestions** recommended in your report to make it safer. **There were 6 labs presented. (18 points)**



MERRY CHRISTMAS AND HAPPY NEW YEAR KRUB!

CONGRATULATIONS! END OF EXAM!

Designing R&D Facilities

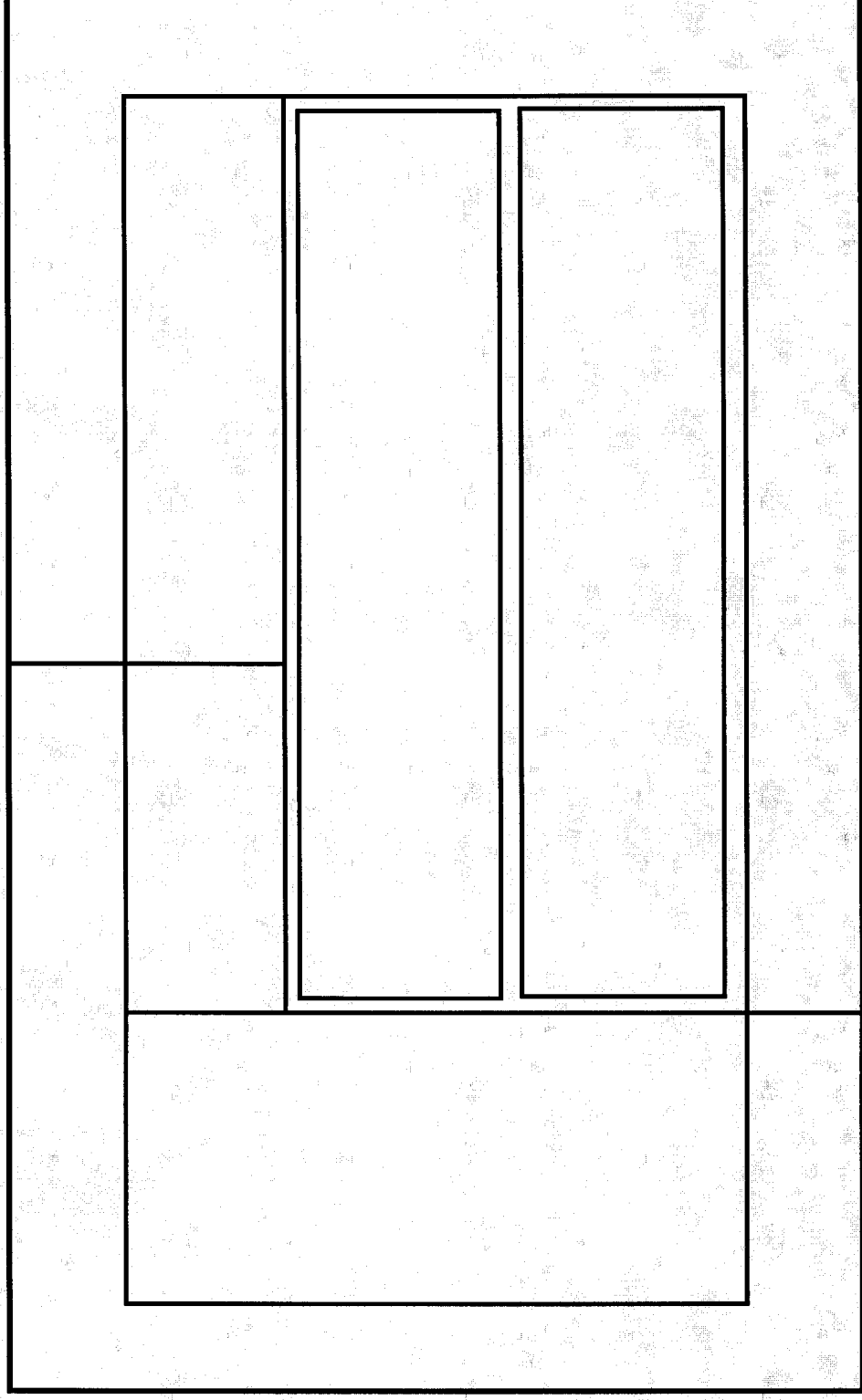


Fig. 1: Typical R&D facility layout