

Name: _____ Student ID _____

**Prince of Songkla University
Faculty of Engineering**

Final Exam, Semester I

Date: October 5, 2010

Subject: 230-334 – Safety

(Safety in Chemical Engineering Operations)

Academic Year: 2010 – 2011

Time: 1:30 – 4:30 PM

Room: Robot

ทฤษฎีในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทฤษฎี และพักการเรียน 1 ภาคการศึกษา

Instructions: There are a total of 4 parts 13 pages not including the cover sheet. Place your name and the student ID number on every page. This is a CLOSE BOOK exam. Students are allowed to use only a pen or pencil. No exams are allowed to leave the room.

Points Distribution (For Grader Only)		
Part	Points Value	Score
I	35	
II	50	
III	50	
IV	60	
Total	195	

**Exam prepared by
Ram Yamsaengsung
September 29, 2010**

**PLEASE CHECK TO MAKE SURE THAT
YOU HAVE ALL 14 PAGES OF THE EXAM BEFORE BEGINNING
(not including the cover sheet).
GOOD LUCK!**

Prince of Songkla University
Faculty of Engineering

Final Exam, Semester I

Date: October 5, 2010

Subject: 230-334 – Safety

(Safety in Chemical Engineering Operations)

Academic Year: 2010 – 2011

Time: 1:30 – 4:30 PM

Room: Robot

CLOSED BOOK SECTION (No books or notes allowed)

I. Fill in the Blanks (35 points)

1. The five components needed for a dust explosion to are _____, _____, _____, _____, and _____.
2. Experiments can be classified as _____ and _____.
3. HAZOP is an abbreviation for _____ which is a safety check lists that should be carried out before authorizing work liable to have serious mechanical, flammable, or toxic hazard.
4. Tanks containing _____ have a red band and tanks that contain _____ have yellow band.
5. The _____ will relieve the lab superintendent of the responsibility of main control and direct the shutting down and evacuation of the laboratory.
6. _____ should leave the building immediately upon hearing the fire alarm.
7. Fire fighters, rescuers, first-aid providers are all _____ and will work under the direction of the _____ and later the _____.
8. The _____ is responsible for plant operation as is known as a supervisor or superintendent in most US companies.
9. The _____ is usually a chemical engineer who will have to start up and operate the plant (with a new design).
10. The _____ is usually a chemical engineering who draws up the flow sheet of a new plant.
11. The _____ is responsible for investigating technical problems and for transferring laboratory results to plant scale operations.
12. The _____ is the person responsible for mechanical maintenance and knows many of the faults that occur.
13. After spillages, areas should be cleaned and _____ for at least _____ minutes.
14. The _____ have the responsibility of assisting the orderly evacuation of the building.
15. Upon discovering a major vapor or liquid escape of a hazardous material, persons should _____ and leave immediately.

16. A communicating door must be able to provide fire resistance for at least _____.
17. If there are some workers trapped inside the building, the 3 main tasks of emergency services team are _____, _____, and _____.
18. The _____ should be designated in a safe place in the open air where workers evacuating can meet.
19. The storage of bulk amount of toxic and chemical liquids is preferably stored in _____.
20. The preferred method of stacking drums in the open air is to stack them _____.
21. 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.
22. Steel support should be able to withstand fire (provide resistant for at least _____).
23. An _____ is used to prepare workers for emergencies such as the release of toxic gas.

II. Short Answers (50 points)

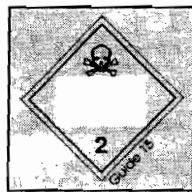
1. Which type of fire is the following: (Type A, B, C, or D) (4 points)
 - ___ Metallic fire such as magnesium
 - ___ Fire involving paper, wood, cloths
 - ___ Electrical Fire
 - ___ Gas or oil fire

2. Name 5 outside resources are generally contacted in cases of laboratory emergencies. (5 points)

3. When an emergency alarm goes-off (toxic gas release), what should personnel/workers do? In case of toxic releases, if the building is located upwind, what should you do? (4 points)

4. Match the following symbol with the description below. (6 points)

- Oxidizing agents
- Harmful, keep away from food stuffs
- Flammable
- Can easily combust without external influences
- Poisonous gas
- Radioactive material



(a)



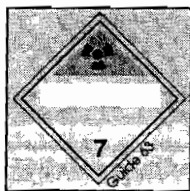
(b)



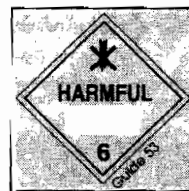
(c)



(d)



(e)



(f)

5. What is a Flame Arresters? (2 points)

6. What is this a symbol of? What type of liquid does it generally store? Give 2 examples of chemicals that are stored in this container? (3 points)



7. What does this symbol represent? What does it generally transport? How is this liquid stored at customers location? (3 points)

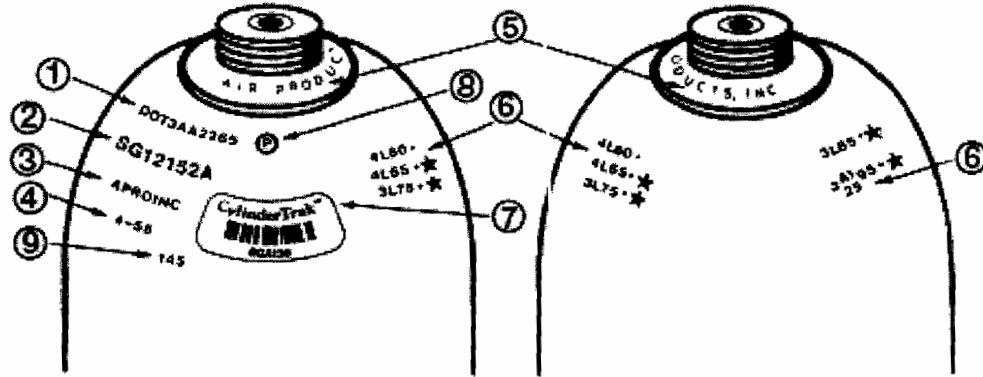


8. What does this symbol represent? What does it generally transport? How is this liquid stored at customers location? (3 points)



9. What is the most common color for a storage cylinder and how often must the tanks be tested? (2 points)

10. Cylinder Identification (8 points)



Use the following information to answer the following questions.

1. DOT3AA3500
2. SG12152A
3. GASINC (Registered Symbol of Gas Inc.)
4. 9-75
5. PTT
6. 10L05 +★
7. Cylinder Tank Bar Code Label – BGA136
8. Cylinder Manufacturer's Inspection marking
9. TW 155

10.1 When was this tank manufactured?

10.2 Who is the current owner of this tank?

10.3 What is the tare weight of this tank?

10.4 What is the working pressure of this tank?

10.5 Who is the original owner of this tank?

10.6 What do the letters SG stand for?

10.7 When was this tank retested? (month and year)

10.8 Does this cylinder meet the requirement for 10-year retest?

11. Discuss 5 reasons why a company does not want any accident to take place?
(5 points)

12. What are the 3 types of major damages that must be considered in assessing the overall risk of accident? (3 points)

13. What are the two risk assessment criteria that are generally used? (2 points)

III. HAZOP and Storage Tank (50 points)

1. List 4 Guide Words and 4 Parameters that are used in HAZOP. (8 points)



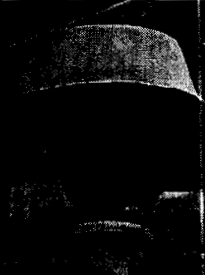
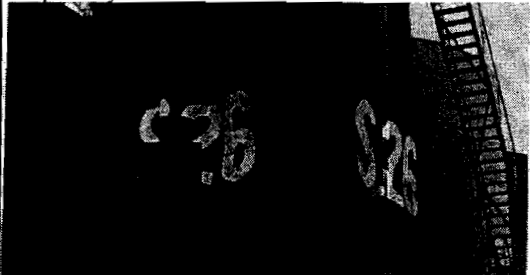
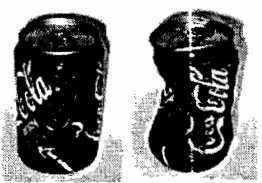
2. If an existing plant must undergo HAZOP, name 6 persons that must be included in the HAZOP team? (6 points)

3. From the HAZOP handout, what do PG, LIC, PIC, RF stand for? (4 points)

4. Conduct a HAZOP analysis of a boiler at an industry (or our ChE dept.). Use the **TWO GUIDE WORDS** and fill out the table. Identify the **Possible Causes**, the **Consequences**, and the **Action Required**. (10 points)

Guide Word	Deviation	Possible Causes	Consequences	Action Required
MORE OF	More Temperature	(1)		(a) (b) (c)
LESS OF	Low Water Level	(1) (2) Line Leakage		(d) (e) Regular inspection

5. Read the PSB article below and answer the following questions? (5 points)

	<p style="text-align: center;">Process Safety Beacon http://www.aiche.org/ccps/safetybeacon.htm Messages for Manufacturing Personnel</p>	<p style="text-align: center;">Sponsored by CCPS Supporters</p>
February 2007		
Vacuum Hazards - Collapsed Tanks		
	<p>The tank on the left collapsed because material was pumped out after somebody had covered the tank vent to atmosphere with a sheet of plastic. Who would ever think that a thin sheet of plastic would be stronger than a large storage tank? But, large storage tanks are designed to withstand only a small amount of <i>internal</i> pressure, not vacuum (external pressure on the tank wall). It is possible to collapse a large tank with a small amount of vacuum, and there are many reports of tanks being collapsed by something as simple as pumping material out while the tank vent is closed or rapid cooling of the tank vapor space from a thunder storm with a closed or blocked tank vent. The tank in the photograph on the right below collapsed because the tank vent was plugged with wax. The middle photograph shows a tank vent which has been blocked by a nest of bees! The February 2002 Beacon shows more examples of vessels collapsed by vacuum.</p>	
		
Did you know?		
<ul style="list-style-type: none"> ➤ Engineers calculated that the total force from atmospheric pressure on <u>each panel</u> of the storage tank in the left photograph was about 60,000 lbs. ➤ The same calculation revealed that the total force on the plastic sheet covering the small tank vent was only about 165 lbs. Obviously this force was not enough to break the plastic, and the tank collapsed. ➤ Many containers can withstand much more internal pressure than external pressure – for example a soda can is quite strong with respect to internal pressure, but it is very easy to crush an empty can. 		<p style="text-align: center;">What can you do?</p> <ul style="list-style-type: none"> ➤ Recognize that vents can be easily blocked by well intended people. They often put plastic bags over tank vents or other openings during maintenance or shutdowns to keep rain out of the tank, or to prevent debris from entering the tank. If you do this, make sure that you keep a list of all such covers and remove them before startup. ➤ Never cover or block the atmospheric vent of an operating tank. ➤ Inspect tank vents routinely for plugging when in fouling service.
<p>AIChE © 2007. All rights reserved. Reproduction for non-commercial, educational purposes is encouraged. However, reproduction for the purpose of resale by anyone other than CCPS is strictly prohibited. Contact us at ccps_beacon@aiiche.org or 212-591-7319</p>		

5.1 What caused the tank on the left to collapse?

5.2 What other things have been known to cover tank vents?

5.3 What is recommended to prevent such an accident?

5.4 Why do operators usually cover tank vents with something like a piece of plastic during maintenance and shut downs? What should they do immediately before start up?

6. Draw a diagram of a typical storage tank and the safety devices that must be installed. What are LC and TC? **(12 points)**

IV. CSB Video and In-Class Accident Presentation (60 points)

1. From the Explosions at the BP Refinery, Texas City, TX, answer the following questions: **(10 points)**
 - 1.1. List 7 causes of the accident. (7 points)

 - 1.2. List 3 ways of preventing the accident. (3 points)

2. From the Fire from Ice incident in Texas, answer the following question. **(10 points)**
 - 2.1. What is a “dead leg”? (2 points)

 - 2.2. Describe the cause of the accident. (3 points)

 - 2.3. Why did the section of the pipeline support 77 feet away fail (collapsed) from the “jet fire”? (2 points)

 - 2.4. List 3 ways of preventing the accident. (3 points)

2. Match the following information with the Presentations from CLASS?
(20 points)

- (a) Mumbai Port Trust, India
- (b) San Bruno Explosion, California, US
- (c) West Atlas Oil Rig, Timor Sea
- (d) Imperial Sugar, Georgia, US
- (e) Refining Factory, Caderayta, Mexico
- (f) Near Industrial Plant, Rural Mississippi
- (g) Abandoned Plastic Plant, Jiangsu, China
- (h) Worthen Industries, New Hampshire, US
- (i) Acetylene Gas Explosion, Dallas, Texas, US
- (j) Gulf Oil Spill, Coast of Louisiana, US

- ___ 1. Spillage of material from a conveyer led to the accident.
- ___ 2. Explosion occurred during a drilling operation as workers attempted to drill to 1000 feet.
- ___ 3. A “prohibited” sign or a “keep out” sign should have been placed in the area.
- ___ 4. Leakage of hydrogen from a compressor led to the explosion.
- ___ 5. Pipe ruptured during refilling of gas and tanks rocketed into nearby highway.
- ___ 6. Chemicals used to produce adhesives, coatings, solvents, and glues helped fuel the explosion.
- ___ 7. Excavation (clearing out) of area led to gas pipe bursting.
- ___ 8. Corroded gas tanks led to the release of the gas and a giant explosion.
- ___ 9. Explosion killed 12 people, injured 300 injured others, and destroyed many nearby buildings.
- ___ 10. Chemicals and surfactants were used to help remove the oil stains in 2010.
- ___ 11. Production shut down led to a loss of 27 L/day of gasoline.
- ___ 12. Dust explosion killed 13 and injured 30 people.
- ___ 13. Smoking teenagers caused the explosion.
- ___ 14. Cleaning workers, fisherman, and environmentalists were interviewed.
- ___ 15. 3,400 barrels of heavy mud was used to plug the oil well.
- ___ 16. Pipeline explosion caused a giant crater, killed 6 people, and injured 50.
- ___ 17. Fire arrestors were recommended to prevent the spreading fire into nearby gas tanks.
- ___ 18. A welding repair caused a large explosion.
- ___ 19. Accident occurred on September 9, 2010 at 6:11 pm.
- ___ 20. Chlorine gas leak killed 3 people and injured 78 others.

2. From the In Class Presentation above, select **TWO** of the presentations and (1) discuss the accident, (2) the possible causes of the accident, (3) consequences from the accident, and (4) recommendations about the accident or how it could have been prevented. **(20 points)**

Case 1:

Case 2:



Congratulations and have a good vacation!