Name: _____ Student ID _____

Prince of Songkla University
Faculty of Engineering

Final Exam, Semester I
Date: September 29, 2009
Subject: 230-334 – Safety
(Safety in Chemical Engineering Operations)

Academic Year: 2009 – 20010
Time: 1:30 – 4:30 PM
Room: S102

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

Instructions: There are a total of 5 parts 14 pages not including the cover sheet. Place your name and the student ID number on every page. This is a CLOSED 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	45	
V	30	
Total	210	

Exam prepared by
Ram Yamsaengsung
September 23, 2009

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 II
Date: February 19, 2009
Subject: 230-334 – Safety
(Safety in Chemical Engineering Operations)

Academic Year: 2008 – 2009
Time: 9:00 – 12:00 PM
Room: A201, A203

CLOSED BOOK SECTION (No books or notes allowed)

I. Fill in the Blanks (35 points)

1. The _____ is responsible for plant operation as is known as a supervisor or superintendent in most US companies.
2. The _____ is usually a chemical engineer who will have to start up and operate the plant (with a new design).
3. The _____ is usually a chemical engineering who draws up the flow sheet of a new plant.
4. The _____ is responsible for investigating technical problems and for transferring laboratory results to plant scale operations.
5. The _____ is the person responsible for mechanical maintenance and knows many of the faults that occur.
6. The five components needed for a dust explosion to are fuel, oxygen, _____, _____, and _____.
7. Experiments can be classified as _____ and _____.
8. 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.
9. Tanks containing _____ have a red band and tanks that contain _____ have yellow band.
10. After spillages, areas should be cleaned and _____ for at least _____ minutes.
11. The _____ will relieve the lab superintendent of the responsibility of main control and direct the shitting down and evacuation of the laboratory.
12. _____ should leave the building immediately upon hearing the fire alarm.
13. Fire fighters, rescuers, first-aid providers are all _____ and will work under the direction of the _____ and later the _____.
14. The first-aid box should be provided in laboratories and should be located near the _____ with a list of trained personnel alongside.
15. The _____ have the responsibility of assisting the orderly evacuation of the building.

16. Upon discovering a major vapor or liquid escape of a hazardous material, persons should _____ and leave immediately.
17. A communicating door must be able to provide fire resistance for at least _____.
18. Metal containers should have about _____ % extra space to allow for liquid expansion.
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.
24. If there are some workers trapped inside the building, the 3 main tasks of emergency services team are _____, _____, and _____.
25. The _____ should be designated in a safe place in the open air where workers evacuating can meet.

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)**

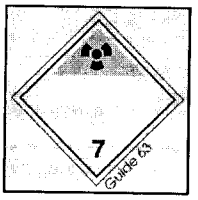
____ Oxidizing agents
____ Harmful, keep away from food stuffs
____ Flammable
____ Can easily combust without external influences
____ Poisonous gas
____ Radioactive material

(a)

(b)

(c)

(d)



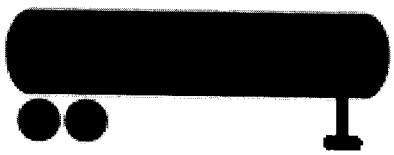
(e)

(f)

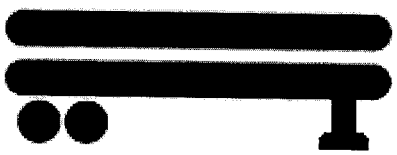
5. What is a Flame Arresters? **(2 points)**

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)**

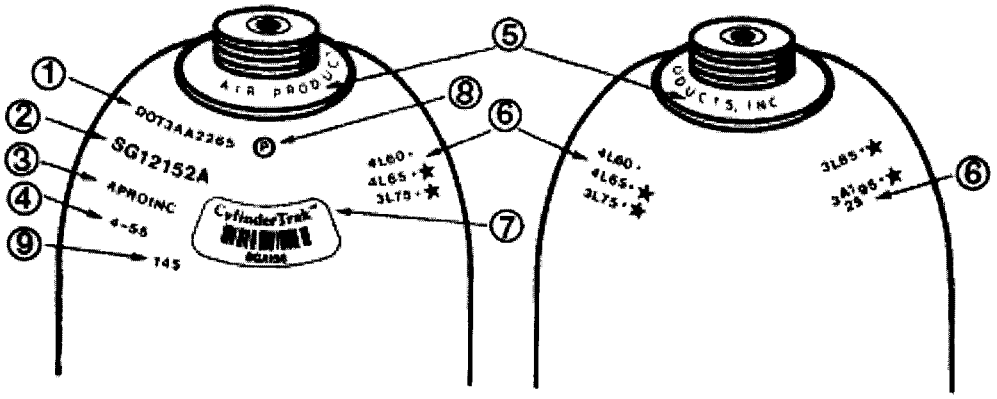


8. What does this symbol represent? What does it generally transport? How is this liquid stored at customers location? **(3 points)**



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. **DOT3AA3000**
2. **SG12152A**
3. **GASINC (Registered Symbol of Gas Inc.)**
4. **6-75**
5. **Department of Chemical Engineering**
6. **9L05 +**
7. **Cylinder Tank Bar Code Label – BGA136**
8. **Cylinder Manufacturer's Inspection marking**
9. **TW 165**

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)** _____	_____	**(d)** _____
		_____	_____	_____
		_____	_____	_____
		(2) Line Leakage	_____	(e) Regular inspection
			_____	
			_____	

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

CCPS CENTER FOR CHEMICAL PROCESS SAFETY
An AIChE Industry Technology Alliance

Process Safety Beacon

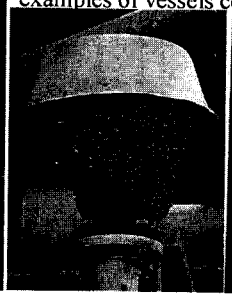
http://www.aiche.org/ccps/safetybeacon.htm
Messages for Manufacturing Personnel

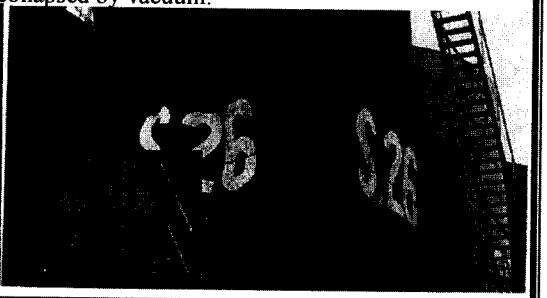
Sponsored by CCPS Supporters

February 2007

Vacuum Hazards - Collapsed Tanks

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 ***internal*** 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.





Did you know?

➢ Engineers calculated that the total force from atmospheric pressure on each panel 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.

What can you do?

➢ 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.

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?

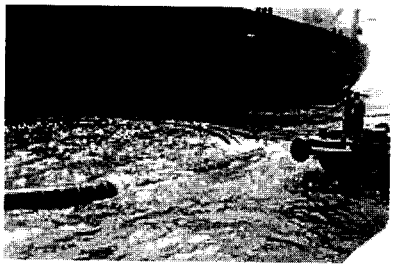
6. Draw a diagram of a typical storage tank and the safety devices that must be installed. **(12 points)**

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

Oil slick threatens Pattaya beaches

By Anchalee Kongrut and Assawin Pakkawan

November 21, 2005



Officials inspect a boom set to contain spilt oil off the coast of Si Racha district, Chon Buri, yesterday. A pipe burst as the tanker Ryuho Maru was unloading, spilling about 50 tonnes of crude oil into the sea. The slick is drifting toward Pattaya. — JERDSAK SANGTHONGCHAROEN

Chon Buri _ An oil slick about 3 km long containing about 100,000 litres of crude could be heading for Pattaya after a pipe on an unloading Japanese oil tanker ruptured yesterday, leading to a large spill. The Ryuho Maru was discharging a load of crude oil from Oman at a buoy about three nautical miles off Udom cove when the accident occurred.

It took about 30 minutes to shut the valve, and by then about 100,000 litres of oil, or a third of the tanker's cargo, had spilled into the sea. The Marine Department has ordered an investigation to establish whether the tanker's crew had mishandled the transfer, or if a faulty pipe was to blame.

The oil was being transferred to the Thai Oil refinery plant in Si Racha district. The tanker threw a floating boom around the slick in a futile attempt to contain its spread. Strong winds and choppy seas pushed the oil slick over the top of the boom and were still hampering clean-up efforts last night.

A Marine Department official said the situation should be under control in a few days. The department would send in the Chontharanurak, a vessel used specifically to battle oil spills. If necessary a second vessel, the Den Suthi, would be dispatched from nearby Samut Prakan.

7.1 How much crude oil was spilled into the sea?

7.2 Where was the tanker heading to?

7.3 What may have caused the accident?

7.4 How will the government treat the oil spill?

IV. CSB Video (45 points)

1. Match the following information with the safety video that it was from? **(35 points)**

(a) Wastewater Plant Explosion in Florida
(b) Explosion and Fire at Formosa PVC in Illinois
(c) Propane Explosion at Ghent, West Virginia
(d) Propylene Fire at Praxair in St. Louis
(e) Blast Waves in Danvers
(f) Explosion at BP Refinery, Texas City
(g) Fire from Ice
(h) Static Explosion

____ 1. Maintenance workers were killed repairing an ethanol storage tank.
____ 2. Control Board Operators worked for 30 straight days at 12 hours shift.
____ 3. A non-conductive naptha solvent tank exploded.
____ 4. Ten thousand pounds of flammable liquid were heated and mixed for more than 8 hours releasing heptane and propanol vapor.
____ 5. Liquid reached a height of 98 ft before noon and overflowed around 1 pm into the relief line and up a blow-down drum.
____ 6. A non-fire proof steel support structure collapsed under intense heat from a jet fire.
____ 7. Pumping of solvent caused air bubbles to enter a storage tank
____ 8. Budget cuts impacted the process safety system leaving 2 operators to oversee major units.
____ 9. When the ice thawed, 4,500 lb/min of propane was released causing a large vapor cloud that ignited at a boiler house
____ 10. A relieve valve set point was too low.
____ 11. The accident had to do with making pizza.
____ 12. Acetylene gas tanks rocketed (shot off) as far as 800 ft.
____ 13. A worker did not know if the reactor was on or off and drained the wrong reactor.
____ 14. An inexperience technician was transferring propane.
____ 15. The level indicator of isomerization unit gave incorrect values, several alarms failed and tower overflowed.
____ 16. One LPG storage sphere was blistered from the intense heat and could have release more than 150,000 gallons of highly-pressurized butane
____ 17. Blast waves woke up sleeping residents on eve of Thanksgiving.
____ 18. Water seeped through a clogged valve and collected in an elbow of a "dead
____ 19. A flame arrester was badly corroded allowing sparks to enter the tank.
____ 20. Supervisor forgot to turn off steam valve.
____ 21. Four workers died because they did evacuate immediately when a pool of flammable liquid was building up.
____ 22. An operator turned the wrong way when he went downstairs to drain water from a reactor.

____ 23. High pressure propane was released from a de-asphalting unit, causing a vapor cloud explosion and a jet fire.
____ 24. A safety plug released liquid fuel when it was opened.
____ 25. An operator bypassed an interlock and released vinyl chloride from a reactor.
____ 26. An explosion occurred at a compressed gas facility.
____ 27. A convenience store/gasoline station exploded.
____ 28. "Hot Work" accident.
____ 29. A hot summer day caused a relief valve to release gas.
____ 30. This accident occurred at a quiet residential neighborhood near Boston.
____ 31. Plastic piping cracked after the tank exploded.
____ 32. Inappropriate instructions and communications between operators of day and night shifts.
____ 33. Water seeped through a clogged valve and collected in an elbow of a "dead leg". The water froze and cracked the piping elbow.
____34. A gap between liquid solvent and level indicator in the storage tank led to a discharge and ignited the vapor cloud.
____ 35. Many of the houses in the residential area had to be rebuilt after a mid-night explosion.

2. From the CSB Video, discuss the causes of the **Blast Waves at Danvers**, how much damage resulted, and how the accident could have been prevented.
(10 points)

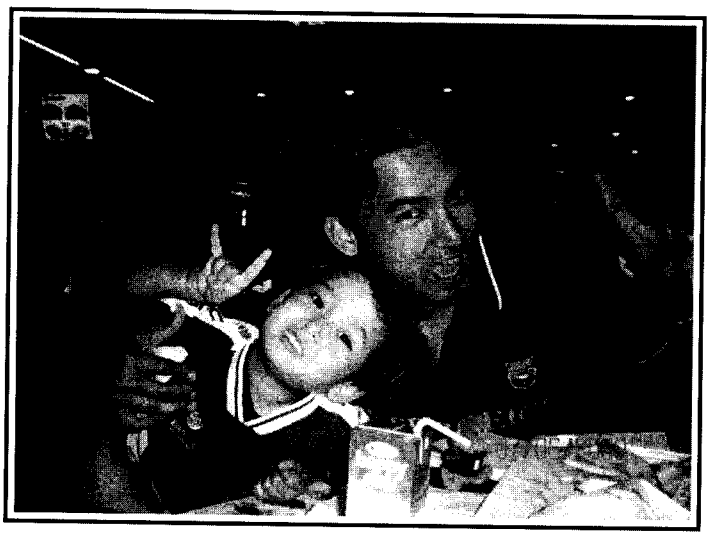
V. Class Presentation – Accidents and Emergencies (30 points)

1. Match the following information with the presentation of class.

(a) Thai Union Rubber (Trang)
(b) ConAgra Foods (USA)
(c) Boon-Leur Fireworks Factory
(d) Starmaker Fireworks Factory in the Philippines
(e) Srinakarind Gas Filling Co. Ltd. (Samutprakarn)
(f) Surapiset Suvarnaphum Liquor (Brandy) Factory
(g) Aditya Birla Chemicals (Thailand) Ltd.
(h) SV Plas Co. Ltd.
(i) Tuna Factory in Phuket

_____ 1. A fire started at a Hood that was used to vent air and trap Dioctyl Phtalate.
_____ 2. Two killed, dozens hurt in Plant Explosion.
_____ 3. Low quality tanks led to explosion.
_____ 4. Factory did not have a license for 10 years.
_____ 5. Explosion broke windows more than 1 km away. Eight dead and more than 70 injured.
_____ 6. May be caused by arson.
_____ 7. Workers allowed product to stay inside dryer too long.
_____ 8. Explosion near Esso Gas Station caused more than 10 million baht in damage.
_____ 9. Children had to be evacuated.
_____10. Explosion caused by static buildup and caught fire at a pump.
_____11. Explosion caused ammonia leak.
_____ 12. Company increased its production for the Loi Krathong Festival.
_____ 13. Storage tank swelled but did not explode.
_____ 14. Carbon monoxide gas tank exploded due to acid corrosion.
_____ 15. Chlorine gas leaked due to clogging or pipe.

2. From your group's presentation on accidents and emergencies, discuss the causes of the accidents, its impact, and ways to prevent it from occurring. Also mention the date and place of the accident. **(10 points)**



Congratulations and have a good vacation!