1. PCBs are regulated under which law? List PCB classifications with concentrations.
2. Describe the disposal requirements for transformers, capacitors, containers, and liquids. Is manifesting required for PCB disposal?
3. Detail the spill reporting requirements for PCB spills.
4. Which law studied this term is the most burdensome to environmental managers and why?

**Use the following scenario to answer questions 5, 6, and 7. Give detailed answers.**

**Introduction**

Fabricating printed wiring boards (PWB) involves a variety of different processes that are

divided into two categories: dry and wet fabrication. Dry fabrication is composed of drilling,

routing, and imaging; whereas wet fabrication is composed of scrubbing, developing, plating,

and etching. This study focuses only on the wet processes and the associated problems relative to

environmental stewardship. This shop had much to learn about environmental responsibility and natural resource conservation. The past processes of the shop were not a deliberate "nose-thumbing" attitude toward the environment and natural resources; but rather it was brought about by lack of knowledge and awareness. All of the chemicals involved in wet processing are hazardous to some degree. These hazards revolve around the properties of the chemicals. For example, strong mineral acids are extremely corrosive and the vapors readily degrade most metals on contact. Inhalation of these vapors can cause a range of problems such as slight respiratory irritation, pulmonary edema, and death. All these hazards can be reduced or even eliminated from the work place by engineering and administrative controls. Engineering controls include proper ventilation and material substitution. Administrative controls include Standard Operating Procedures (SOP) and training. Personal protective equipment (PPE) is used when the hazard hasn't been eliminated from the workplace.

**Past Operation Practices**

**Processing**

The processes of environmental concern were electroless copper deposition, electrolytic copper

plating, and electrolytic tin/lead or solder plating. All of the plating shop rinses consisted of tap

water overflow that were discharged directly into an Industrial Sewer System (ISS). The initial

processing flow rates were approximately 2,000 gallons/hour. Contained within this substantial

rinse discharge were regulated materials (i.e., copper, tin, lead, and formaldehyde).

Scrubbing and deburring equipment used to process PWB panels was plumbed to discharge

directly into the ISS. This discharge was approximately 12 gallons/minute and contained copper

particles along with fibrous material from the scrubber wheels.

The photoresist developer and stripper used in the imaging process were also plumbed to

discharge directly into the ISS with approximately 6 gallons/minute of outflow. Alkaline effluent

in the imaging process contained residual organic material in solution and suspended particles.

Temperature control was a critical parameter in many of the steps involved in fabricating PWBs.

Maintaining predetermined temperature parameters was accomplished with tap water circulation.

All of the cooling water was discharged into the ISS. There were no recycling steps practiced.

The etchers, developer, lamination press, and vapor degreasers required tap water cooling to

control the temperature. During normal operations, approximately 8,000 gallons of noncontact

cooling water was used weekly. (Water usage fluctuated depending on the temperature of the

ground water.)

**Hazardous Materials**

Materials used in the wet fabrication processes are hazardous. The chemicals employed can be

categorized into three groups: oxidizers, corrosives, and toxins.

1. Oxidizers are materials that readily oxidize substances with which they come into contact. An example is chlorine gas, which was used to regenerate an etching system. The etchant was chemically reduced as copper was removed from the PWB panel. Chlorine gas was used to reoxidize the etchant and restore etching ability.

2. Corrosive materials include acids, bases, and halogens. Each of these materials could cause corrosion on substances with which they come into contact. (An example of this is the effect that strong mineral acid vapors have on metals and respiratory systems.)

3. Toxins include toxic materials, irritants, carcinogens, and asphyxiants. These materials are known to have an adverse effect on humans. Most of the chemicals used in the fabrication of PWBs possessed one or more of these undesirable properties. Since there was a great concern for protecting the personnel exposed to these substances, it was extremely important that the PPE be properly used. The solution employed to etch copper without destroying the tin/lead plated pattern was chrome trioxide and sulfuric acid. The etching solution was heated to 120oF in a conveyorized spray module and was used until spent. Waste products were then transferred into drums, labeled, manifested, and sent to waste disposal. (The main component, chrome trioxide, is a known carcinogen and exposure to this compound has been documented to cause lung cancer.)

The solvent used to remove dryfilm photoresist was methylene chloride, a suspected carcinogen.

Removal was accomplished by placing a large solvent-resistant tray in an open sink and adding

solvent. A number of panels were then placed in the solution and allowed to soak for several

minutes. During this dwell time, the photoresist blistered and floated free of the panel surface.

The panels were then withdrawn from the tray and held under running water to rinse the residual

solvent into the Domestic Sewer System (DSS). A liquid photoimagable resist was used to fabricate fine line circuitry. This resist was a xylenebased material formulated with hotosensitive compounds. The resist was applied by pumping the compound onto a set of rollers which, in turn, was deposited onto the panels being processed. After each use, the equipment had to be cleaned by wiping the soiled areas with xylene. (Xylene is a chemical suspected of damaging bone marrow, thus causing anemia.).

As California was experiencing a 7-year drought a hard look was taken into operation practices.

1. Describe how you would manage this waste stream. Be specific in approaches and include personnel aspects. What law regulates this material?
2. Describe some waste minimization techniques that could be used for this waste stream. Keep in mind that water is scarce.
3. What HW characteristics do the materials used in this process have?