loss is not alarming since water in the make-up fluid used will keep the water content above the acceptable safe limits.

Nevertheless, to maintain a safe percentage of water, excessive evaporation should be prevented Tests indicate that this is not a difficult problem if the reservoir temperature is kept below 150 F (65 5 C), as dictated by good operating practice

Producers of each hydraulic fluid approved by the U S Bureau of Mines are required to furnish a method of determining the water content of the fluid during use. Such testing should be done in the manner and at the intervals recommended by the producer Instructions for adding water when such addition is necessary are also available from the producer and should be followed

Design of equipment

Most ordinary hazards from hydraulic fluids can be eliminated through design A factor of safety of at least 8 over normal working pressures is recommended for piping and tubing

Equipment such as flexible tubing, which has a definite life under specific operating conditions, should be replaced at predetermined intervals.

To prevent it from vibrating, piping should be securely fastened to the machine and all machines should be securely anchored to their bases It should be placed where it will not interfere with the adjustment, repair, or replacement of control valves Piping should not be used to support valves or other equipment where vibration might damage the piping Exposed pipes which might be used as steps should be protected with a suitable cover

Hydraulic equipment should be designed to meet the following additional safety requirements

1 Flexible lines should be restrained or confined if their failure might constitute a hazard to personnel
2. The operator should not be required to reach past revolving spindles, moving tools, or moving machine or equipment to reach manual controls.
3. Hydraulic circuits using accumulators should be interlocked to vent or isolate accumulator fluid pressure when the power is shut off Full information for proper servicing without hazard to personnel should be posted on or near the accumulator
4. In hydraulic systems containing flammable fluids and using gas at pressures over 250 psi, nitrogen or other inert gas should be used

Another possible source of injury results when air becomes trapped in the hydraulic lines and creates in effect an air "hammer." This effect has been known to rupture lines or connections with such force that persons have been killed by pieces of flying metal Such accidents can be prevented by proper filling and bleeding of hydraulic systems

Heavy-duty pipe and fittings used to withstand the pressures of hydraulic fluids should be replaced only with pipe or fittings of the same size and grade

Where weight-loaded accumulators are mounted in pits in which servicemen have to work, the pits should have retaining walls or permanent shoring to give safe working space at the bottom

Vibration or recurrent pressure surges can cause the flared end connection of high-pressure welded tubing to pull out of the screwed coupling In this type of installation, welded flanges should be used in place of the flared end connections and the pipe structure should be supported to eliminate vibration from the welded joint

Maintenance

A program of preventive maintenance conducted by men who are thoroughly familiar with hydraulics will do much to prevent accidents A file of all hydraulic circuit diagrams should be established This file is just as much a part of the safety program for maintenance personnel as are the safety rules which follow

1 When questions arise, study the manufacturer's bulletins and safety instructions manual Do not experiment
2 Wear eye protection when doing maintenance work on hydraulic equipment
3 Before doing any maintenance on the equipment, lock the main electrical switch "off" with a padlock, to prevent the machine from starting accidentally.
4. Next, check the hydraulic unit to make certain that the pump is not operating.