U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Cooling Water Systems

AP1000 Technology Section 6.2

HRTD Human Resources Training & Development

Learning Objectives:

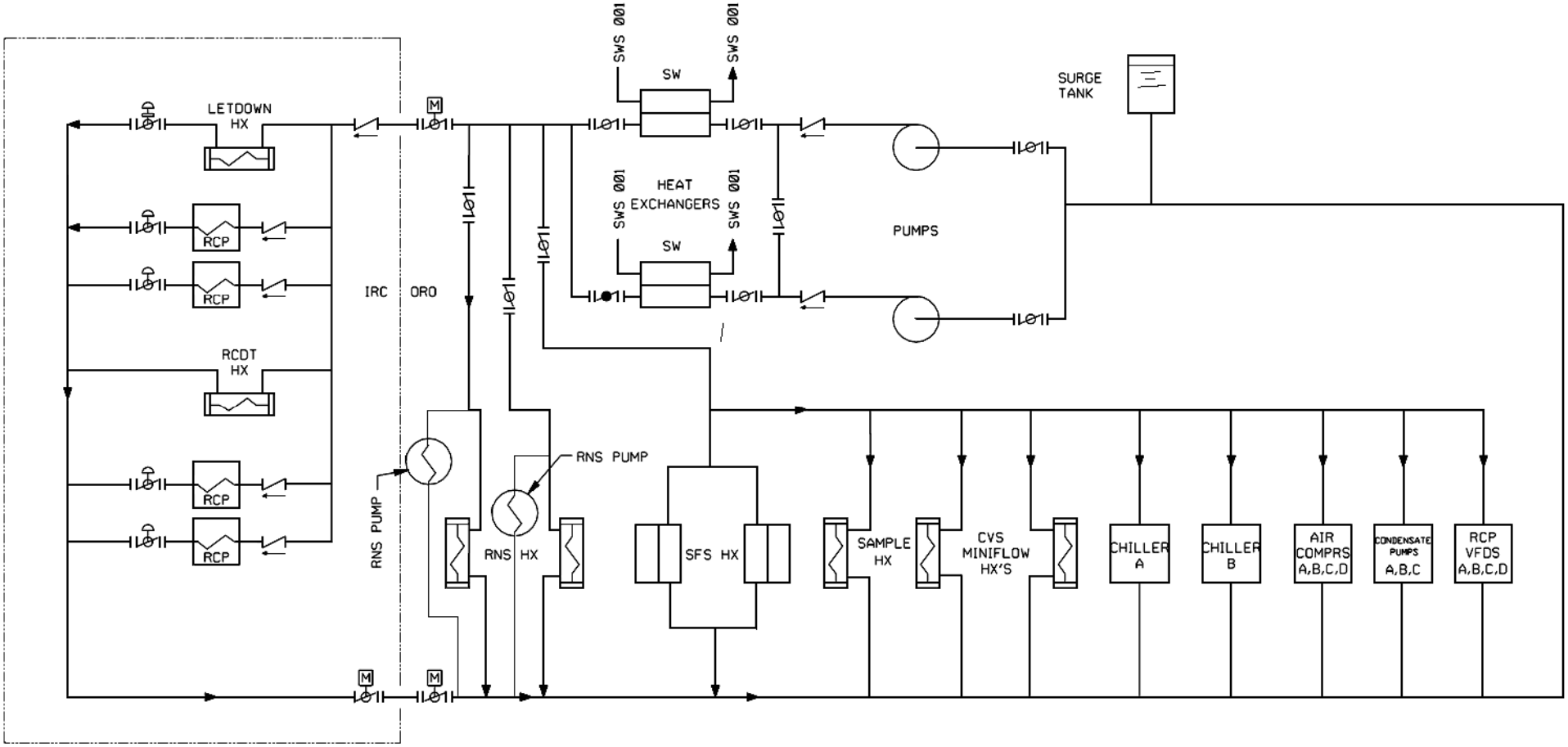
1. State the purpose of the following AP1000 Cooling Water Systems.
   a. Component Cooling Water System (CCS)
   b. Service Water System (SWS)
   c. Spent Fuel Cooling System
   d. Turbine Building Closed Cooling Water System
   e. Condenser Circulating Water System

2. Describe the major differences between the AP1000 and current operating Westinghouse plants Cooling Water Systems.

Component Cooling Water System (CCS)

Purpose

- CCS is a non-safety, closed loop system that transfers heat from various plant components to the service water system (SWS) during normal operation.
- It removes core decay heat and sensible heat for normal reactor shutdown and cooldown.
- It provides a barrier to the release of radioactivity between the plant components being cooled that handle radioactive fluid and the environment.
- It provides a barrier against leakage of SWS fluid into primary containment and reactor systems.


LETDOWN HX
RCP
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RCDT HX
IRC
ORO
RNS PUMP
RNS PUMP
RNS HX
SW
SWS 100
SWS 100
HEAT EXCHANGERS
SWS 100
SWS 100
SW
SFS HX
SAMPLE HX
CVS MINIFLOW HX'S
PUMPS
SURGE TANK
CHILLER A
CHILLER B
AIR COMPRS A,B,C,D
CONDENSATE PUMPS A,B,C
RCP VFDS A,B,C,D

CCS Normal Operations

- Cools primary plant equipment needed for full-power operation
- Cools plant equipment used to attain cold shutdown conditions
  - RCPs, RNS heat exchangers and pumps, CVCS pump coolers
- Cools SFS heat exchanger

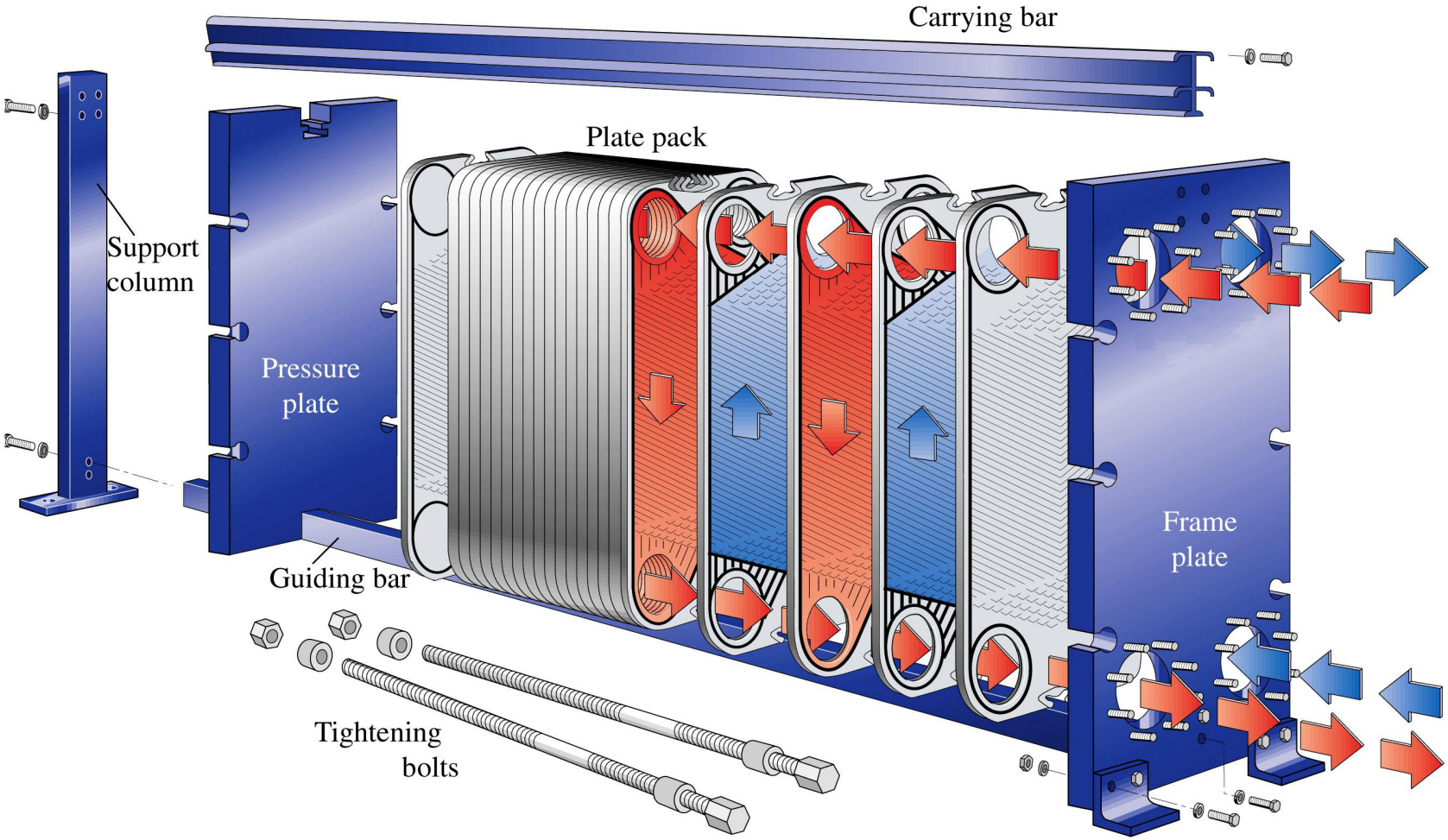
Reactor Coolant Pumps

- Primary heat load during normal plant operations
  - Canned motor pumps are less efficient – produce a much higher heat load on CCS
- RCPs can accept 110°F for limited periods of time
- Auto isolation of CCS to containment on high RCP bearing water temp. reactor & RCP trip
  - Protects CCS from potential leakage through an external heat exchanger tube rupture

CCS Heat Exchanger

- Plate type heat exchangers
  - Initial cost ~70% less than shell and tube HX
  - Plate HX occupies half the space of shell and tube HX
  - Plate HX's capacity can quickly be changed by adding or removing plates
  - Pressure drop across a plate HX is generally lower permitting use of smaller pumps
- CCS water is maintained at a higher pressure than the SWS to prevent leakage

Plate Type Heat Exchanger



Loss of CCS

- Loss of normal AC power
  - CCS pumps are automatically loaded on the standby diesel (non-safety related)

- Loss of Component Cooling Water
  - Fire Protection System can provide the source of cooling water for a RNS heat exchanger and a RNS pump

Service Water System

Purpose

- Supplies cooling water to remove heat from the nonsafety-related CCS heat exchangers.

SWS Pumps

- 2 Vertical, centrifugal, constant speed, electric motor-driven pumps

- Powered from the normal ac power system and are backed by the standby DG power

SWS Normal Operations

- Provides cooling water at a max temp of 93.5°F to the CCS exchanger in service.
- One SWS pump normally in service.
- The standby SWS pump auto starts if the operating pump should fail.

Cooling Tower

- Standard AP1000 design uses a counterflow, induced draft tower divided into two cells
- Each cell utilizes one fan
- Depending on the plant site chosen may or may not utilize this arrangement

Spent Fuel Cooling System

Purpose

- Non-safety-related system
- Designed to remove decay heat from the fuel pool
- Circulates water through filters & demineralizers to maintain fuel pool water purity
- The safety-related function of cooling and shielding the fuel is performed by the water in the pool.

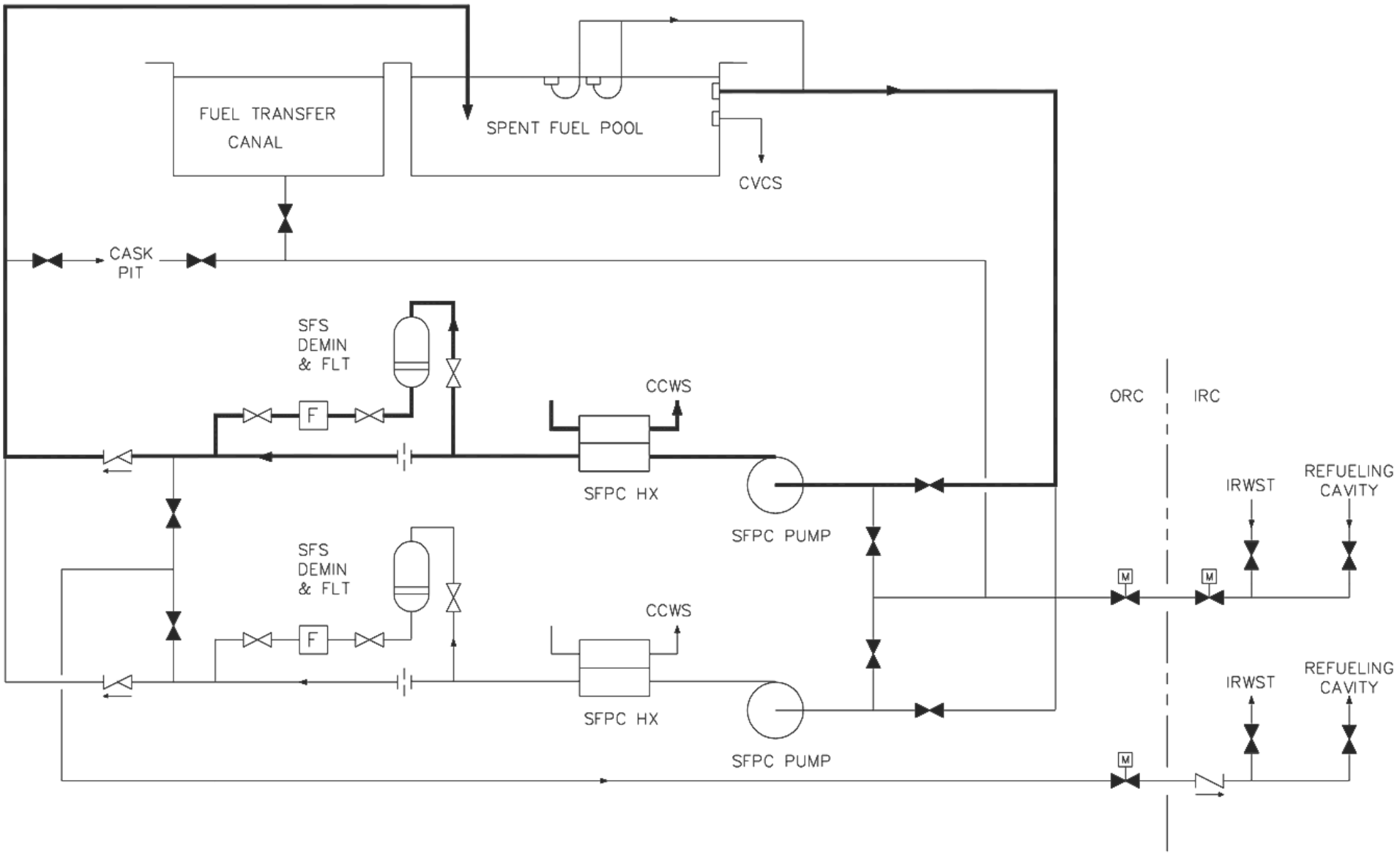

FUEL TRANSFER
CANAL
SPENT FUEL POOL
CVCS
CASK
PIT
SFS
DEMIN
& FLT
F
CCWS
SFPC HX
SFPC PUMP
ORC
IRC
IRWST
REFUELING
CAVITY
M

Figure 6.2-2

Refueling Ops

- **For fuel shuffling (partial core off-load), both SFP heat exchangers are used to maintain the SFP water temp < 120°F.**

- **With a full core off-load and 10 years accumulation of spent fuel in the pool, both SFP heat exchangers and one RNS heat exchanger are used to maintain the SFP water temp < 120°F.**

Loss of Power

- **The SFP cooling system pumps can be manually loaded on the onsite standby DGs.**

- **SFP makeup for long term station blackout can be provided through seismically qualified safety-related makeup connections from the passive containment cooling system .**

Turbine Building Closed Cooling Water System

Purpose

- Provides chemically treated, demineralized cooling water for the removal of heat from nonsafety-related heat exchangers in the turbine building.

Description

- Two 100-percent capacity pumps, three 50-percent capacity heat exchangers (connected in parallel), and one surge tank.

- Heat is removed from the heat exchangers by the circulating water system.

Condenser Circulating Water System

Purpose

Supplies cooling water to remove heat from:

- the main condensers,
- the turbine building closed cooling water system (TCS) heat exchangers, and
- the condenser vacuum pump seal water heat exchangers

Description

- Three 33-1/3-percent-capacity circulating water pumps, one hyperbolic natural draft cooling tower, and associated piping, valves, and instrumentation.

- Depending on plant site selection a cooling tower may or may not be utilized.

Questions?

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Which one of the following is the Ultimate Heat Sink for the AP1000?

a) Service Water System

b) Lake, River, Ocean, or other body of water used by the Condenser Circulating Water System

c) Component Cooling Water System

d) The surrounding environment (via passive containment cooling system)

Which one of the following is the largest heat load on the CCS during normal power operations?

a) Spent Fuel Cooling Heat Exchanger

b) Reactor Coolant Pump Motors

c) Main Feedwater Pump Motors

d) Containment Coolers

With a full core off-load and 10 years accumulation of spent fuel in the pool, which one of the following describes the required cooling arrangement for the SFP?

a) **One SFP heat exchanger and one RNS heat exchanger are required.**

b) **One SFP heat exchanger and two RNS heat exchangers are required.**

c) **Both SFP heat exchangers and one RNS heat exchanger are required.**

a) **One SFP heat exchanger is required.**