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**Design Challenges in
Cooling Water Systems & Plant Layout
at New Nuclear Power Plants**

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Design Challenges in Cooling Water Systems & Plant Layout – New Nuclear Power Plants

➤ New Nuclear Technologies

- ✓ Advanced Boiling Water Reactor (ABWR)
- ✓ Evolutionary Power Reactors (EPR)
- ✓ Advanced Passive 1000 (AP1000)
- ✓ Economically Simplified Boiling Water Reactor (ESBWR)
- ✓ US Advanced Pressurized Water Reactor (US APWR)

➤ Requirements

- ✓ Technical (Ref. Design Control Document)
- ✓ State & local regulations
- ✓ Site environmental requirements
- ✓ Existing site conditions

➤ Cooling Water Systems

- ✓ Circulating Water System
- ✓ Essential Service Water System (Ultimate Heat Sink)

➤ Plant Layout

Design Challenges in Cooling Water Systems – New Nuclear Power Plants

➤ Cooling Water Systems

TYPE OF TECHNOLOGY	CIRCULATING WATER SYSTEM (NON SAFETY SYSTEM)	SERVICE WATER SYSTEM / ULTIMATE HEAT SINK (SAFETY SYSTEM)
ABWR	<ul style="list-style-type: none"> •MULTI PRESSURE CONDENSER •COOLING TOWER OR RESERVOIR •PUMPS, PIPING, VALVES •OPEN LOOP OR CLOSED LOOP COOLING SYSTEM 	<ul style="list-style-type: none"> • SPRAY POND OR COOLING TOWERS • PUMPS, PIPING, VALVES •OPEN LOOP OR CLOSED LOOP COOLING SYSTEM
EPR	<ul style="list-style-type: none"> •MULTI PRESSURE CONDENSER •COOLING TOWER •PUMPS, PIPING, VALVES •CLOSED LOOP COOLING 	<ul style="list-style-type: none"> • COOLING TOWERS • PUMPS, PIPING, VALVES •CLOSED LOOP COOLING SYSTEM
US-APWR	<ul style="list-style-type: none"> •SINGLE OR MULTI PRESSURE CONDENSER •COOLING TOWER •PUMPS, PIPING, VALVES •CLOSED LOOP COOLING 	<ul style="list-style-type: none"> •COOLING TOWERS • PUMPS, PIPING, VALVES •CLOSED LOOP COOLING SYSTEM
AP1000 & ESBWR	<ul style="list-style-type: none"> •MULTI PRESSURE CONDENSER •COOLING TOWER •PUMPS, PIPING, VALVES •CLOSED LOOP COOLING 	NOT APPLICABLE (PASSIVE DESIGN)

Design Challenges in Cooling Water Systems

– New Nuclear Power Plants

- **UNIQUE REGULATORY DIFFERENCES BETWEEN US & OTHER COUNTRIES**
- **US DESIGN**
 - ✓ US CLEAN WATER ACT PRECLUDES THE DESIGN OF “ONCE-THROUGH COOLING WATER SYSTEM” FOR COOLING WATER SYSTEMS
 - ✓ THIS IS MAINLY TO PROTECT AQUATIC LIFE & REGULATE THE DESIGN OF COOLING WATER SYSTEM
 - ✓ RULE 316(b) – INTAKE STRUCTURE REQUIREMENTS
 - ✓ MAKING THE DESIGNS VERY COSTLY
- **DESIGN IN OTHER PARTS OF THE WORLD**
 - ✓ ABOVE REGULATION IS NOT APPLICABLE
 - ✓ “ONCE-THROUGH COOLING WATER SYSTEM” SHOULD BE APPLIED, AS APPROPRIATE

Design Challenges in Cooling Water Systems

- DESIGN & LICENSING BASIS
- LOCATION & ORIENTATION
- WATER TEMPERATURES & DISCHARGE LIMITS
- APPROACH TEMPERATURE
- CYCLES OF CONCENTRATION
- METEOROLOGICAL DATA
 - ✓ WET BULB TEMPERATURE
 - ✓ WIND

Design Challenges / Considerations in Site Plant Layout

- Orientation of the Turbine Island with respect to the water source for Open / Closed Loop Cooling, Cooling Tower, Pond or Reservoir arrangement for CWS
- Location of the Turbine Building (Generator end) to be in close proximity to the switchyard
- Location of the plant switchyard in relation to existing transmission lines and potential transmission interconnection points
- Minimum spacing between units for a two-unit power plant (distance between reactor vessel center line to center line)
- Construction Plot Plan: Location of crane, lay down space, concrete batch plant, modular fabrication, construction offices, potential borrow areas, spoils area, construction access road, parking, etc.
- Establishing site flooding & drainage maps (including site topography)
- Establishing site grade to minimize site cut and fill
- Assessing the plant rock quality and depth (conduct sufficient boring)

Design Challenges / Considerations in Site Plant Layout (Cont'd)

- Identifying any existing below grade structures and/or utilities (water, sewerage, power lines) that could potentially impact plant layout
- Identify overhead limitation—transmission lines and right of way
- Identify plant access roadways during construction phase and when the plant is operating
- Identify supporting structures such as administration building, security building, maintenance building, warehouses, training center, etc.
- Identify security requirements during construction especially if at a site with an operating unit.
- Recommendation is to prepare two site layouts: Design Layout & Construction Layout

Design Challenges in Cooling Water Systems & Plant Layout – New Nuclear Power Plants

➤ SUMMARY

- ✓ EACH OF THE NEW NUCLEAR PLANT TECHNOLOGIES HAVE UNIQUE TECHNICAL REQUIRMENTS FOR COOLING WATER SYSTEMS (Ref: DCD & COMBINED OPERATING LICENSE APPLICATION)
- ✓ PLANT LAYOUT HAS MANY DESIGN & CONSTRUCTION CONSIDERATIONS THAT SHOULD BE CAREFULLY EVALUATED, ESPECIALLY AT EXISTING NUCLEAR SITES
- ✓ ENVIRONMENTAL & STATE / LOCAL REGULATIONS SHOULD BE ADDRESSED DEPENDING ON THE COUNTRY WHERE THE NEW NUCLEAR PLANT WILL BE BUILT