

	Nuclear Regulatory Commission	
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Rejected:		Stricken:

SNCR00026
Corrected on: March 11, 2009
Originally Filed on: January 9, 2009

Dry Cooling Presentation
By James W. Cuchens

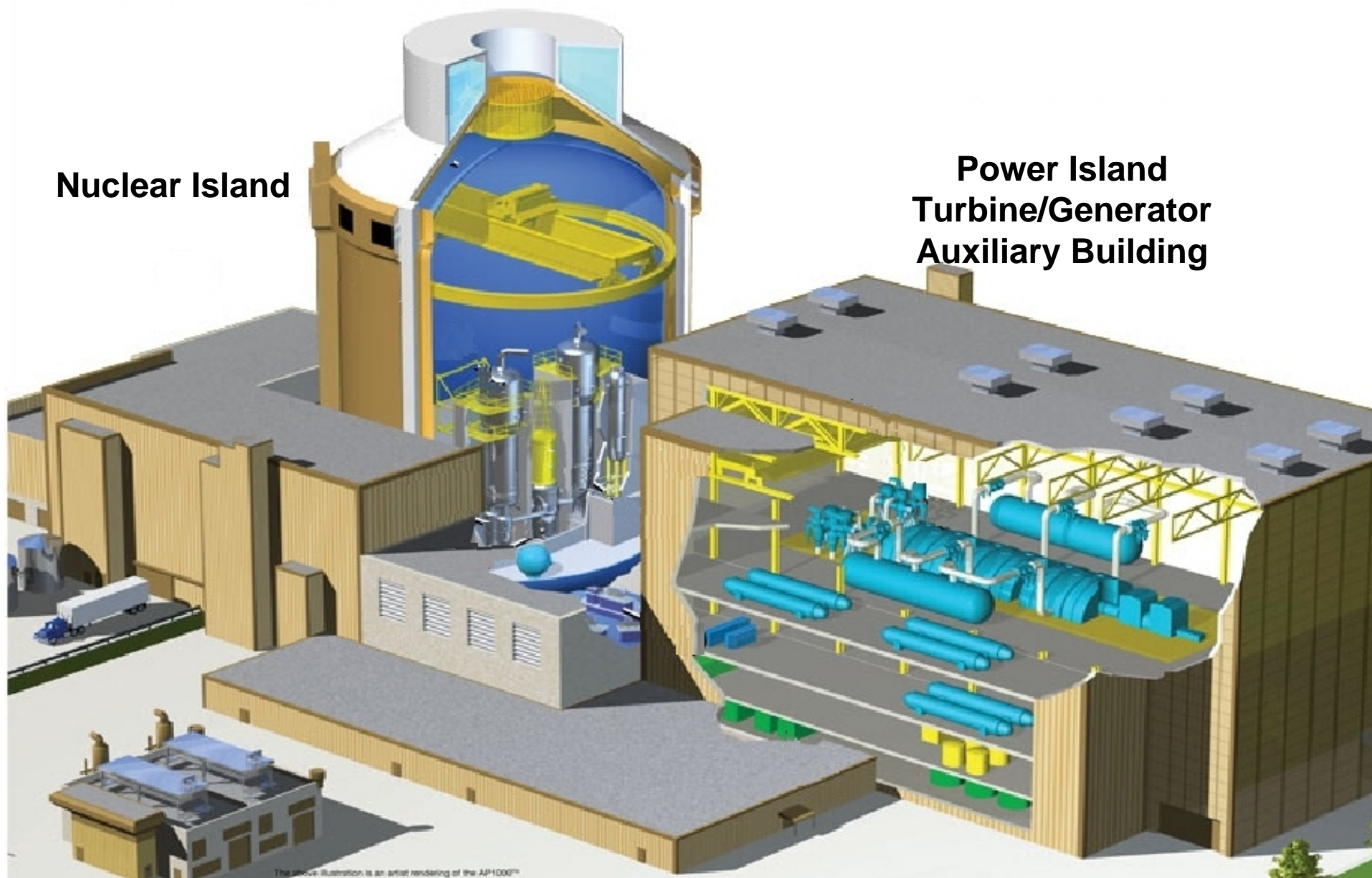
AP1000™ Standardized Nuclear Plant Concept (Westinghouse AP1000)



Westinghouse Electric Company LLC

Nuclear Island

**Power Island
Turbine/Generator
Auxiliary Building**



The above illustration is an artist rendering of the AP1000™.



at a Glance

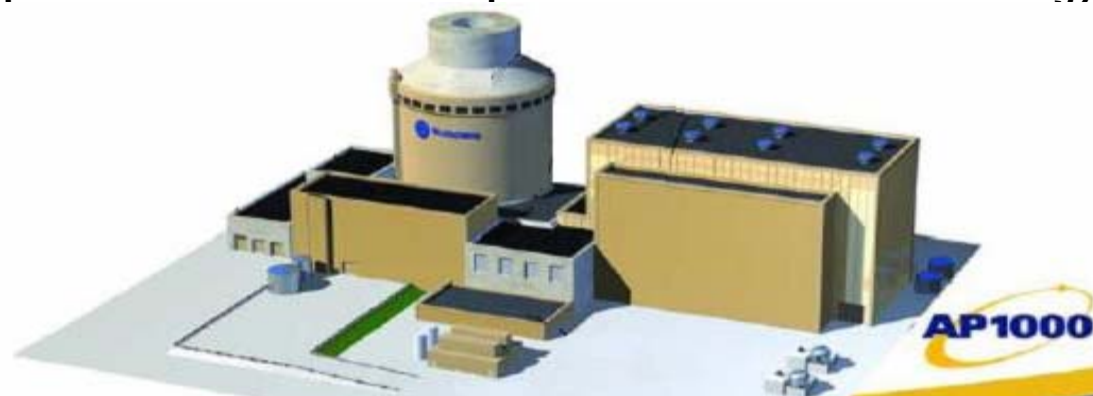
The AP1000 is a standardized unit design that has a net electrical output of 1117 megawatt electric (MWe). The AP1000 received Final Design Approval from the U.S. NRC in September 2004, and Design Certification in December 2005. The AP1000 is the first and only Generation III+ reactor to receive such certification from the NRC.

Simplified Plant Design

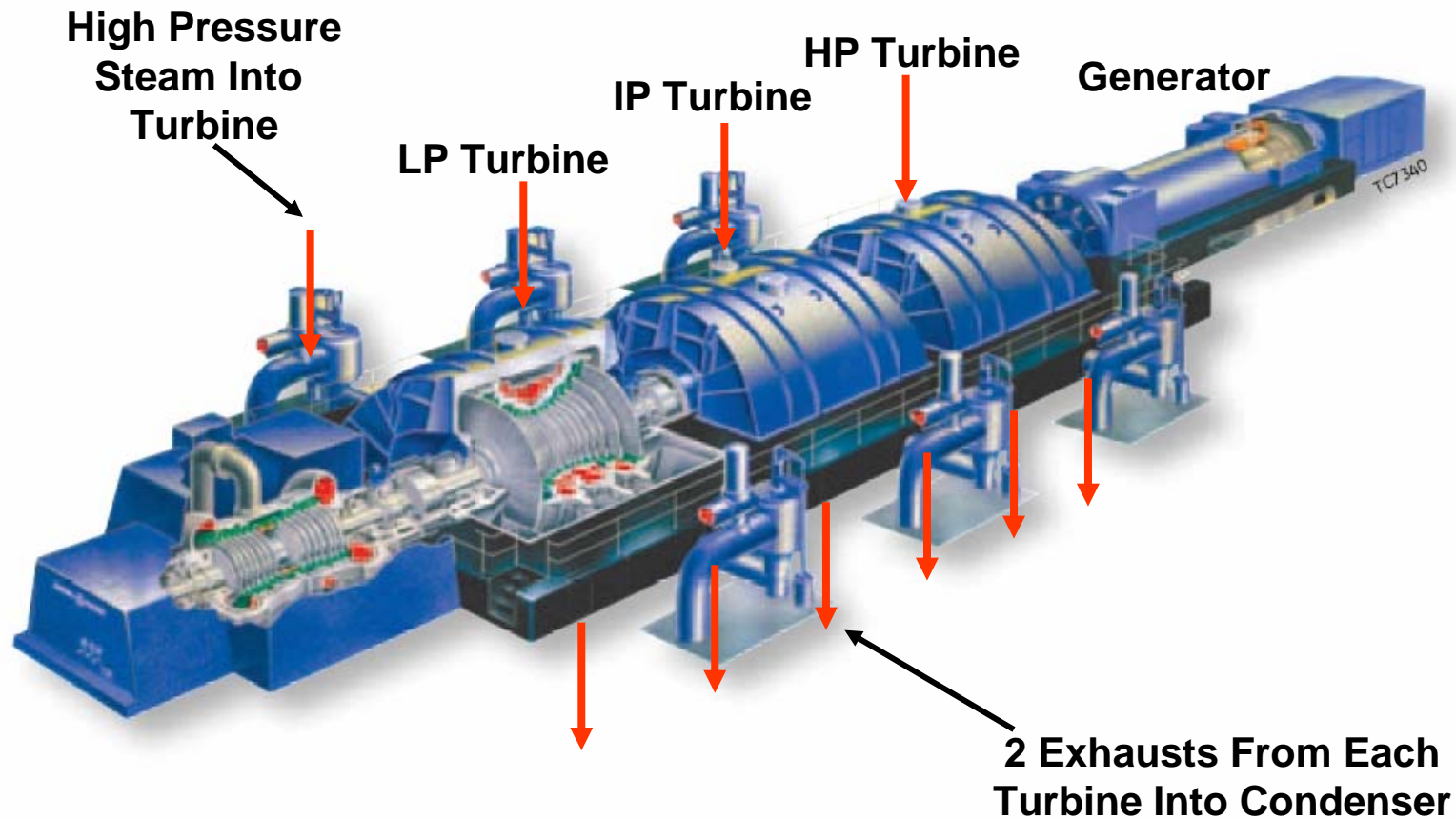
Simplification of the AP1000 unit design include safety systems, normal operating systems, control room, construction techniques, and instrumentation and control systems which will be easier and less expensive to build, operate, and maintain. Plant simplifications yield fewer components, cable, and seismic building volume, all of which contribute to considerable savings in capital investment, and lower operation and maintenance costs.

The Technology

The AP1000 is comprised of components (Nuclear Island and Power Island) that incorporate design improvements distilled from 50 years of successful operating nuclear power plant experience. As such, the turbine generator design represents the most efficient plant based on current technology.

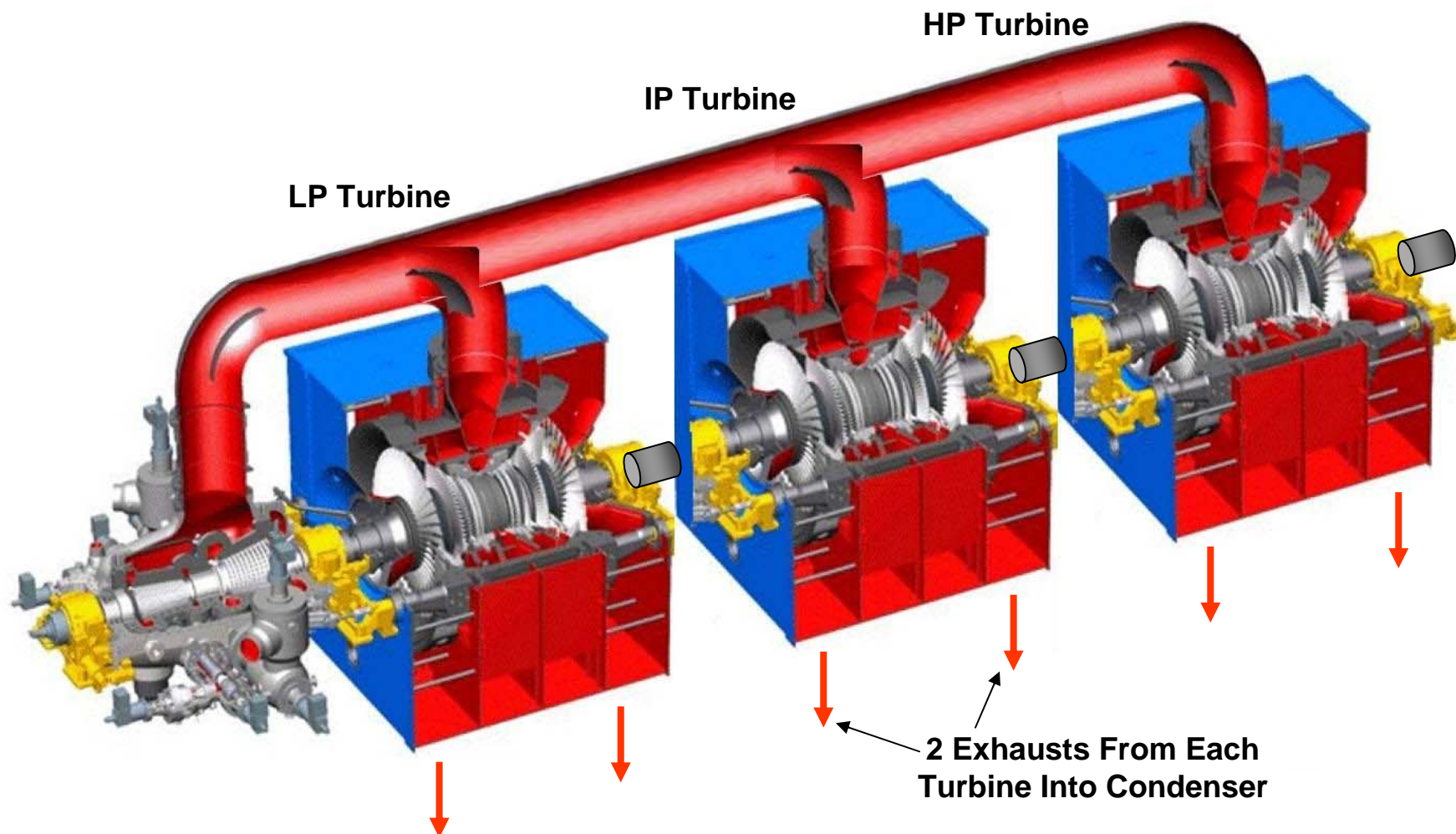


6-Flow Turbine Configuration GE Series N or Westinghouse TC6F Turbine



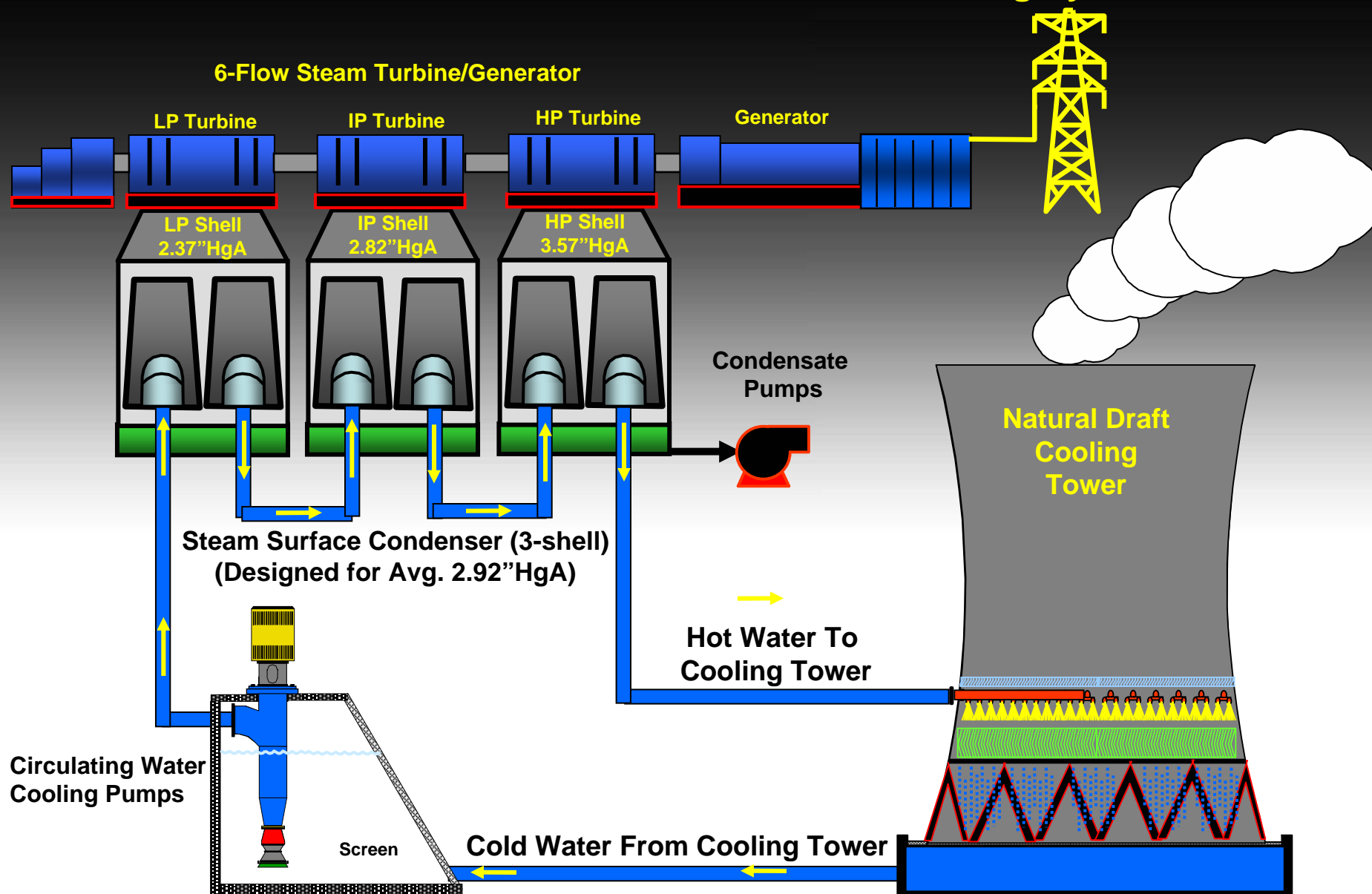
**Note: All current standardized Westinghouse or GE employ 6-flow turbines
Viable Operating Range = 0.0 to 5.0 "HgA (+,-) Vacuum/Backpressure**

6-Flow Turbine Configuration GE Series N or Westinghouse TC6F Turbine

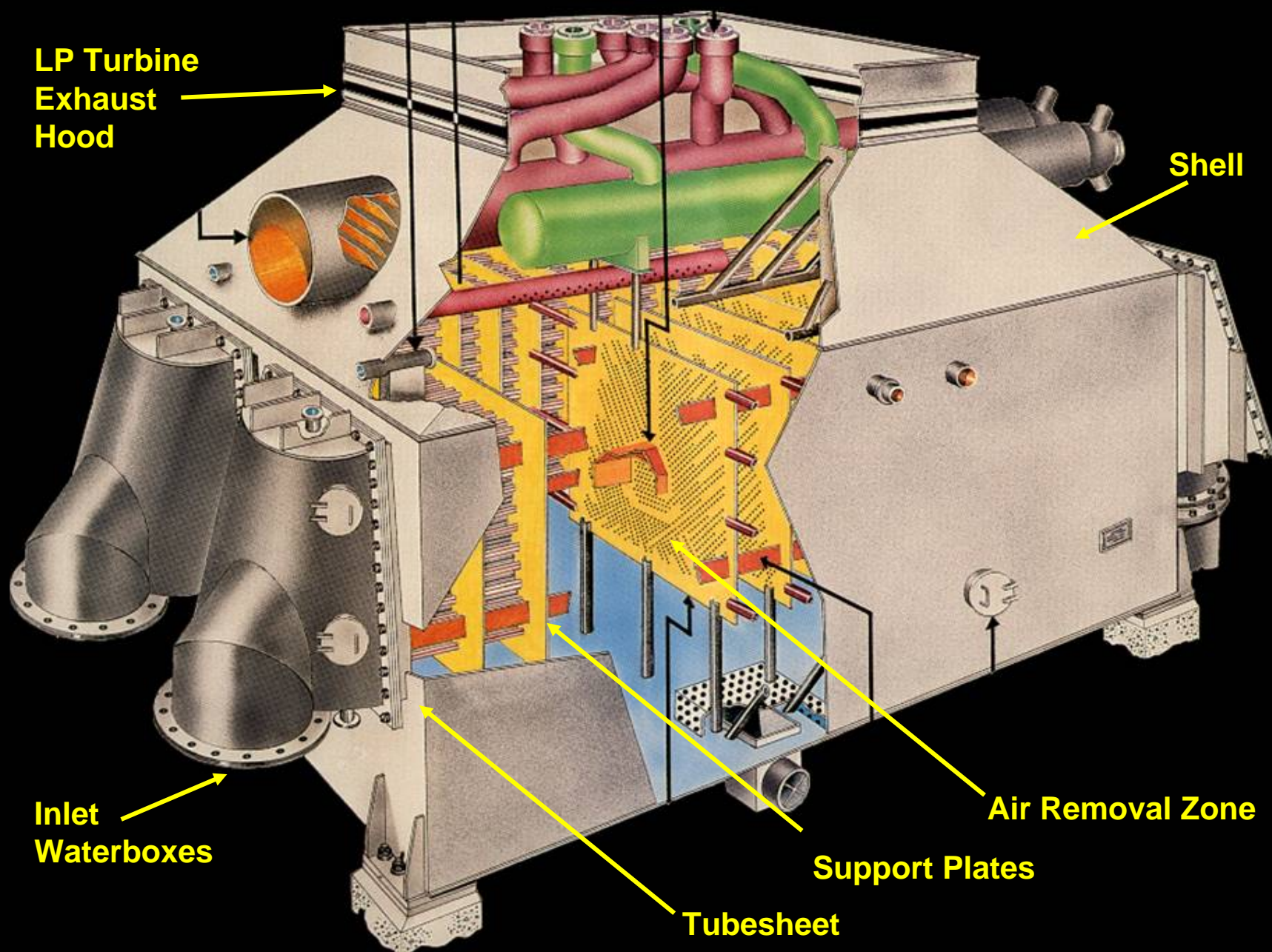


**Note: All current standardized Westinghouse or GE employ 6-flow turbines
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AP1000 Turbine W/Steam Condenser & Wet Cooling System



Typical Steam Surface Condenser



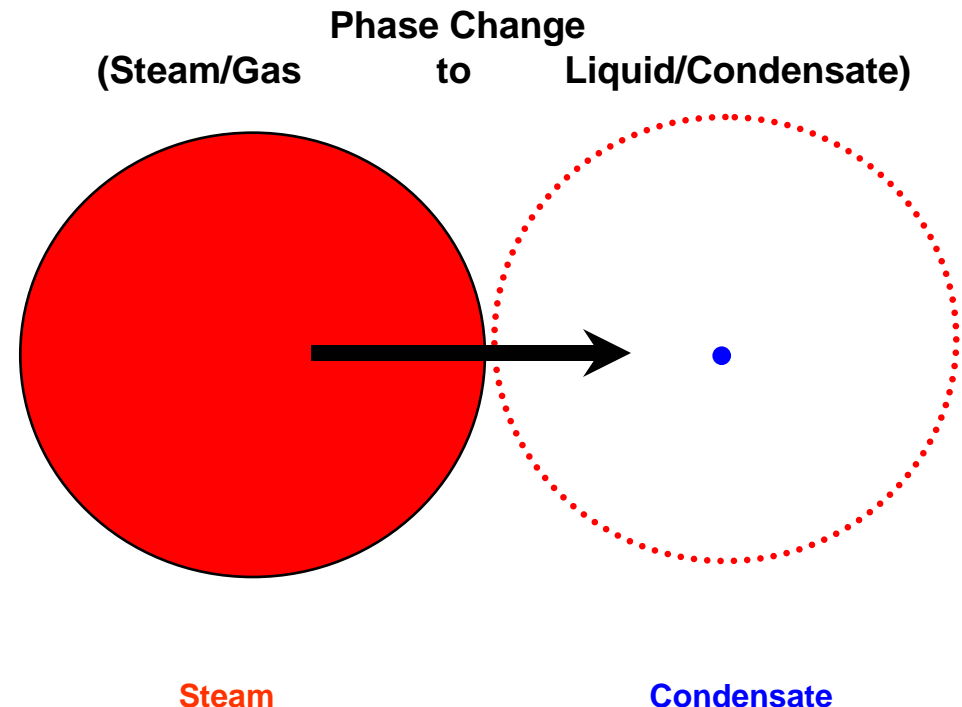
What Happens Inside A Steam Surface Condenser

Steam Condensation & Resultant Backpressure

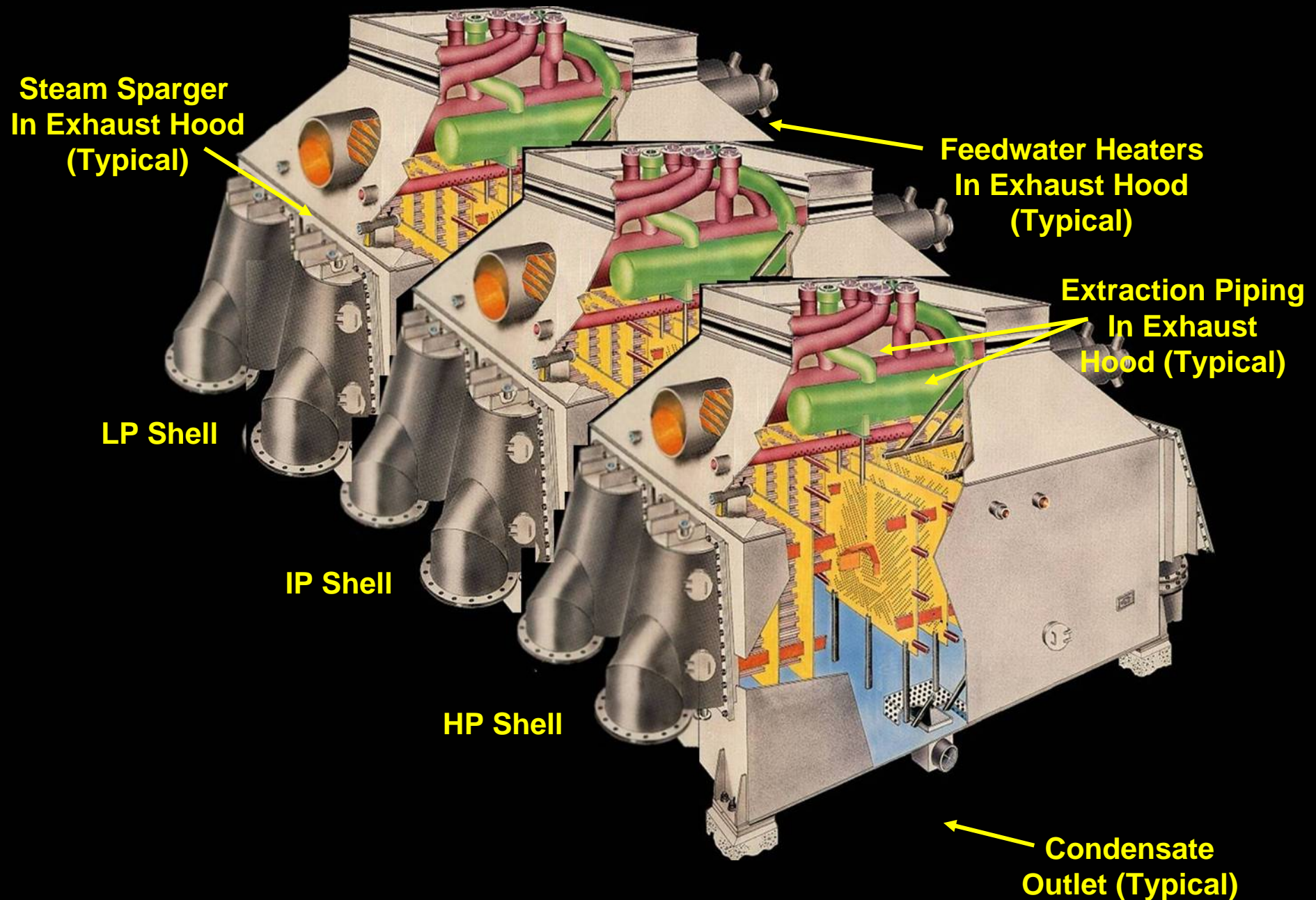
Water flowing inside the condenser tubes condenses steam flowing across the outside surface of the tubes. When steam is condensed to become a liquid, it requires a significantly less amount of space and/or volume. In doing so, it creates a vacuum which is often referred to as backpressure inside a steam condenser and turbine exhaust. Typically, the lower the backpressure (or vacuum), the better turbine performance will be (similar to a car's performance when you remove tennis balls stuck in the car's exhaust pipes).

The Vacuum Effect

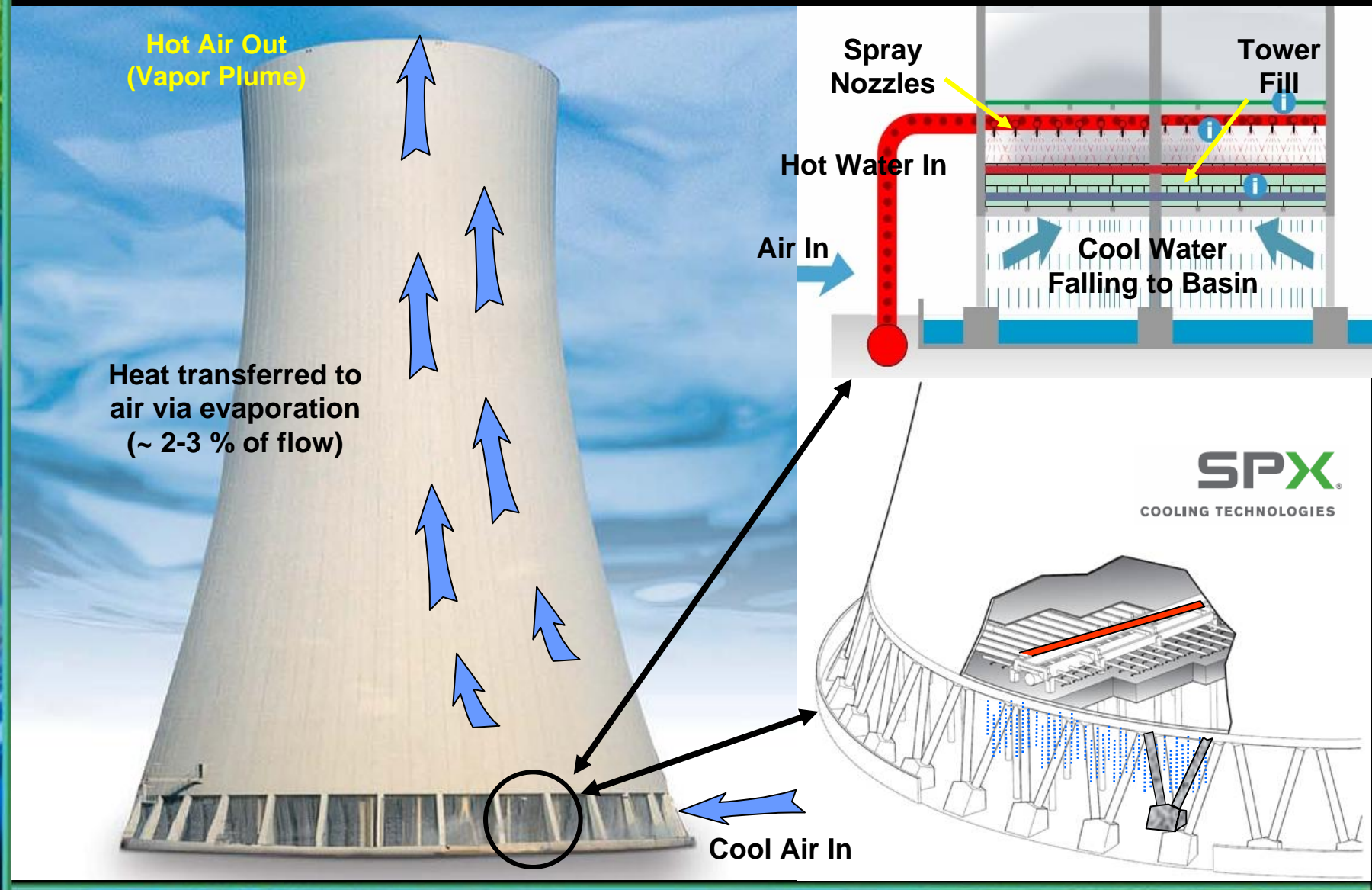
- Imagine **1 lb** of saturated **steam** at 2"HgA. Its occupied volume is **339 ft³**.
- Now imagine this steam is condensed in to **1 lb** of **condensate** (saturated liquid) that occupies a volume of **0.016 ft³**.
- The occupied volume reduces more than 21,000 times!
- Condensing itself Creates Vacuum!



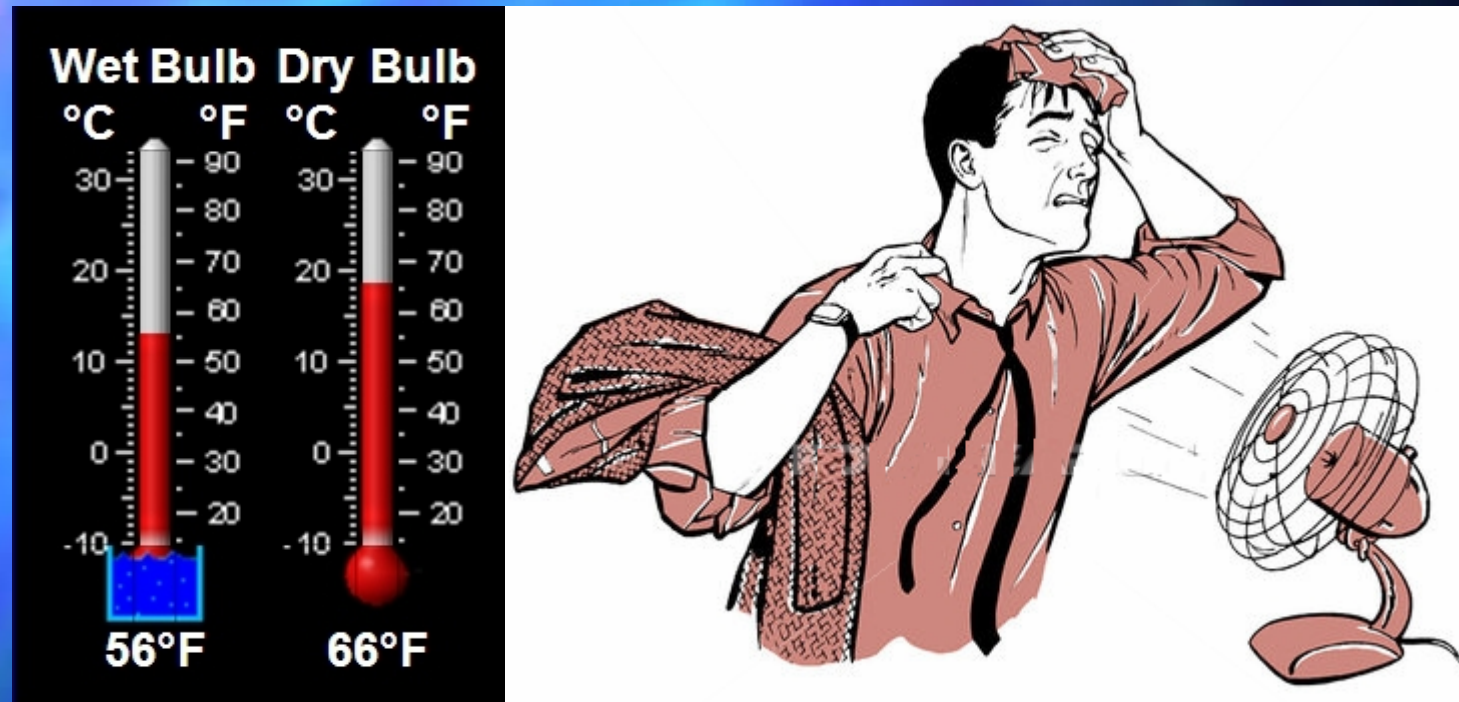
Steam Surface Condenser (Triple Pressure -3 Shell for AP1000)



Natural Draft Cooling Tower Design



Fundamentals of Evaporative Cooling (Natural Draft Cooling Tower)



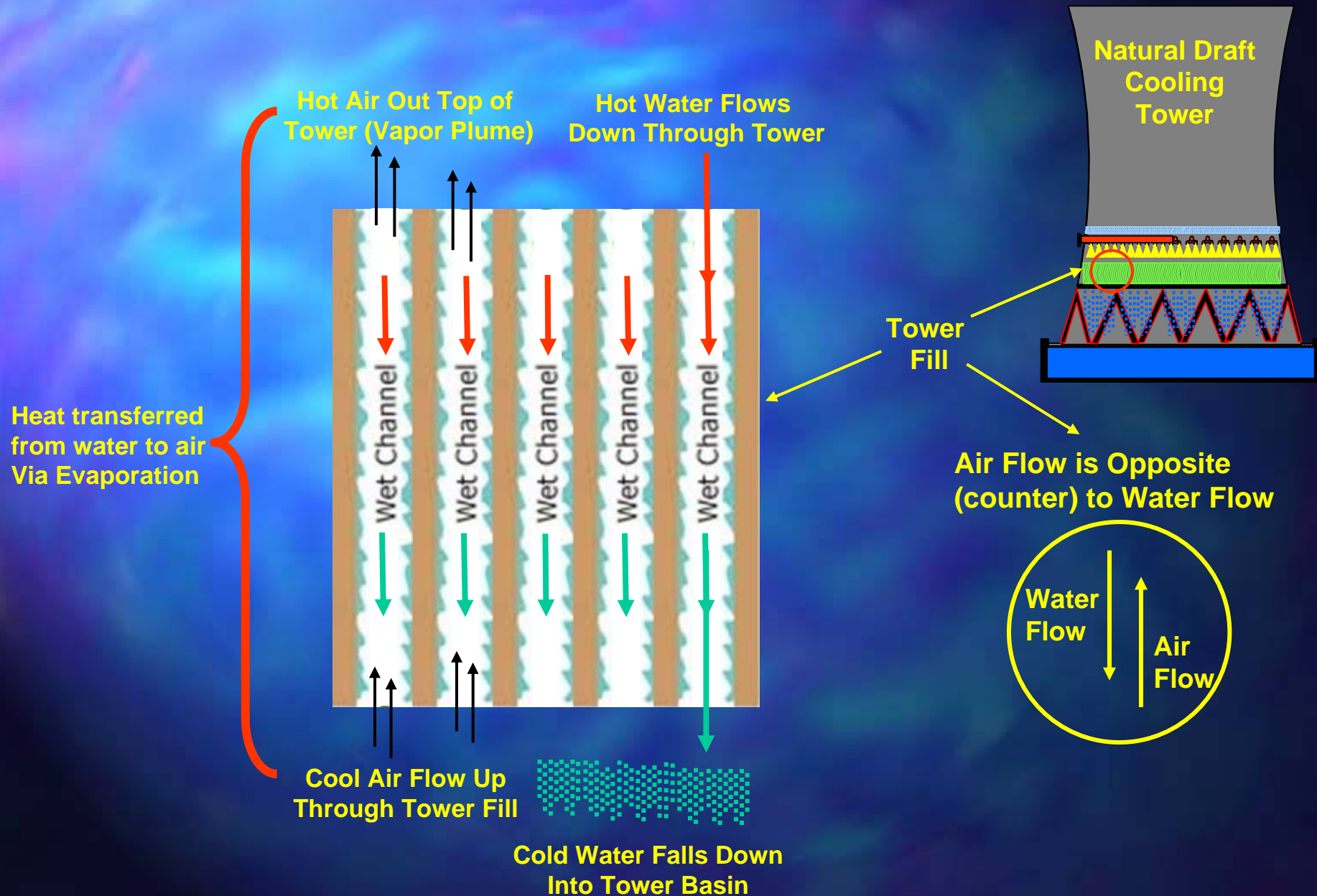
Wet-bulb Temperature = Temperature at which evaporation occurs

Wet-bulb Temperature Typically Less Than Dry-bulb (ambient) temperature

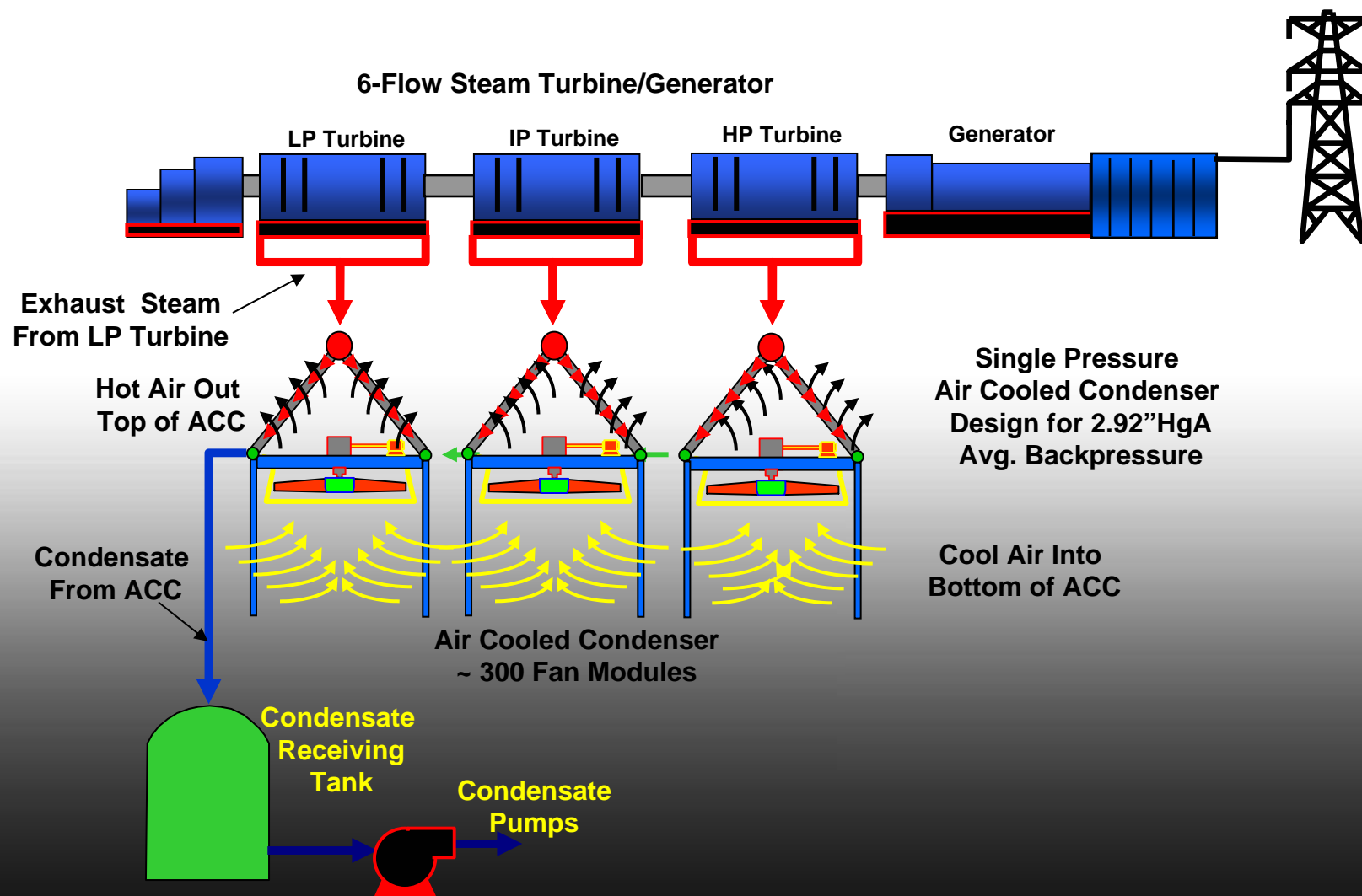
i.e. @ 95.0 Deg.F Ambient Dry-bulb & 50 % Humidity, Wetbulb ~ 78.0 Deg.F

The human body maintains a basic minimum rate of heat production at about 250 Btu/hr during sleep, the heat equivalent of about 75 watts, and about 400 Btu/hr (120 watts) when awake but sedentary. As bodily activity increases, the rate of oxidation of food, with its attendant release of energy, must increase. The level of heat production for light work will be about 650 Btu/hr (190 watts), the extreme value for heavy work, about 2400 Btu/hr (700 watts).

What Happens Inside A Natural Draft Cooling Tower

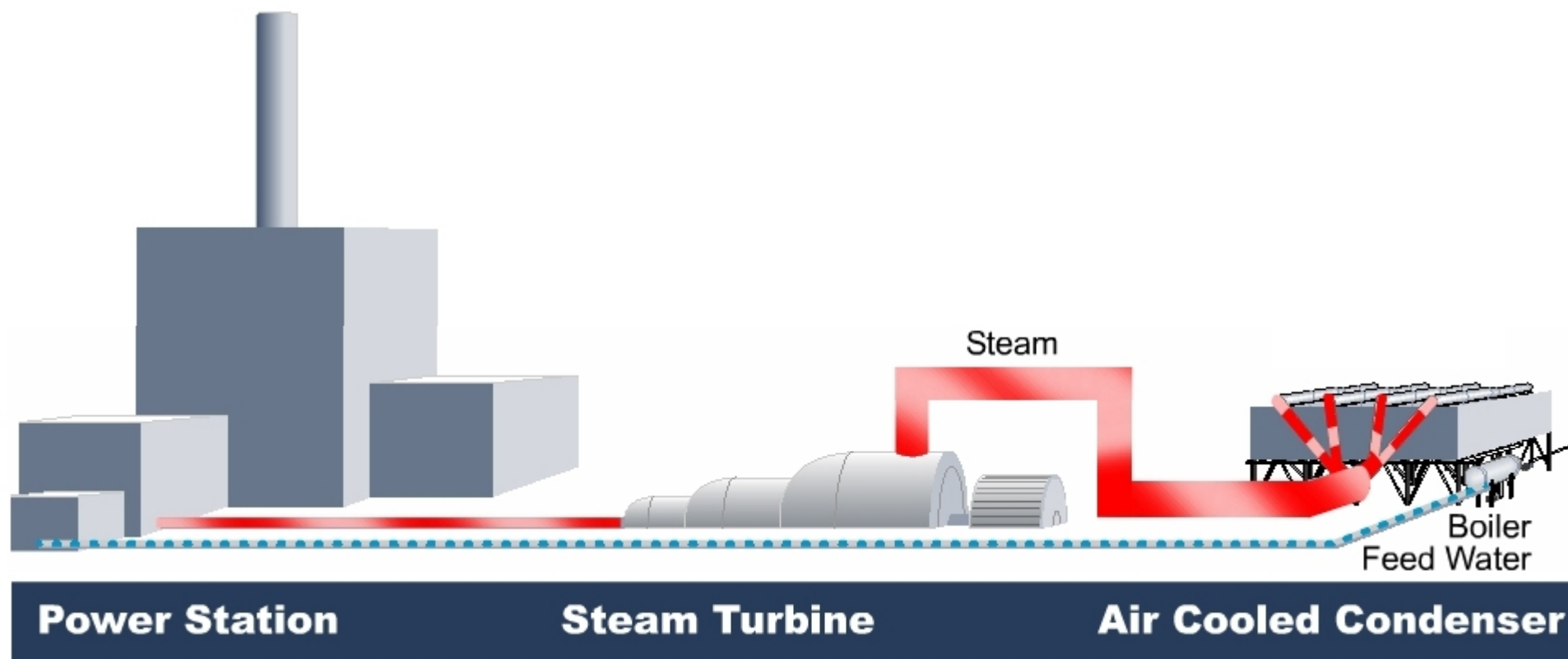


AP1000 Turbine Cycle W/Air Cooled Condenser

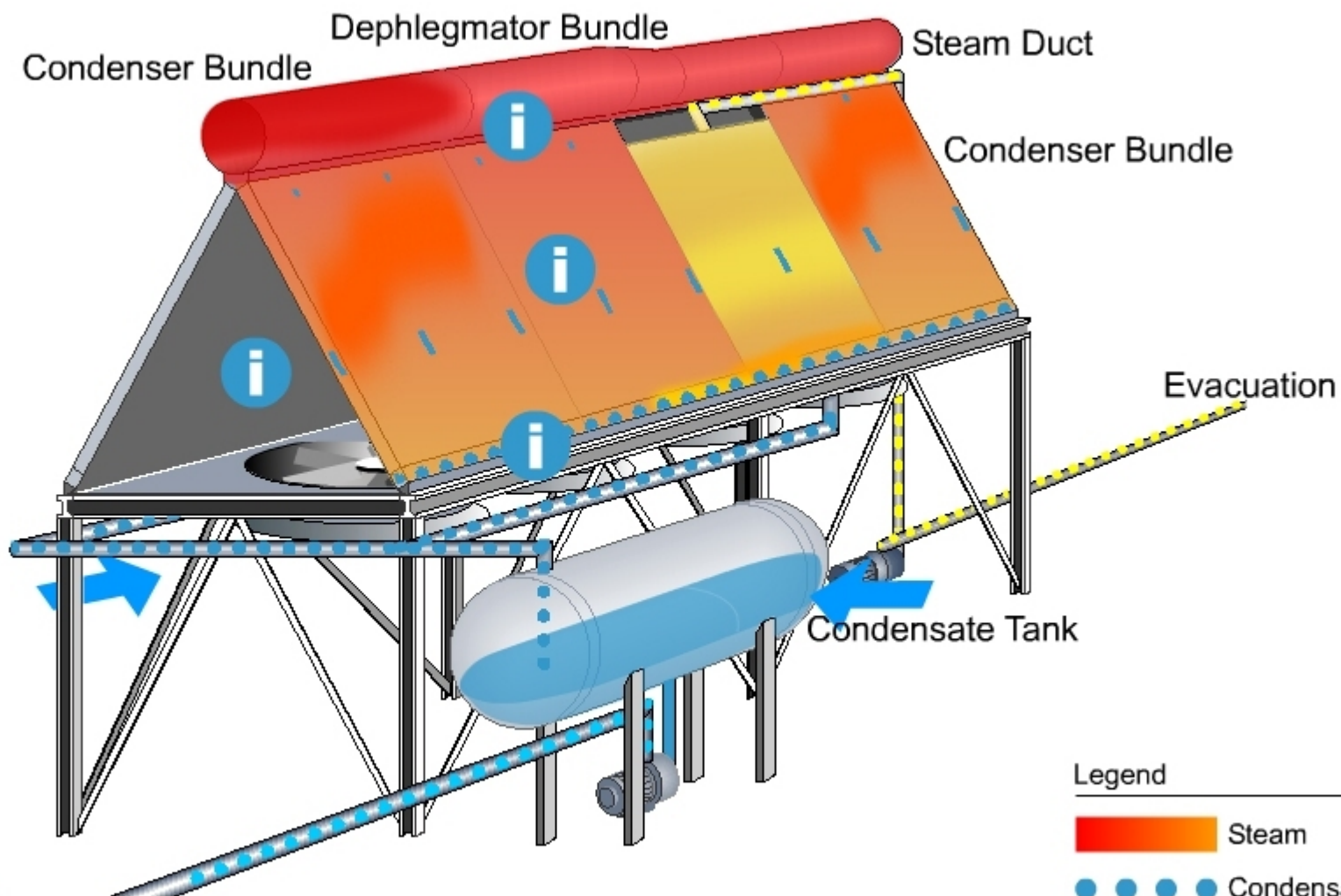


Air Cooled Condenser (Single Pressure) Configuration

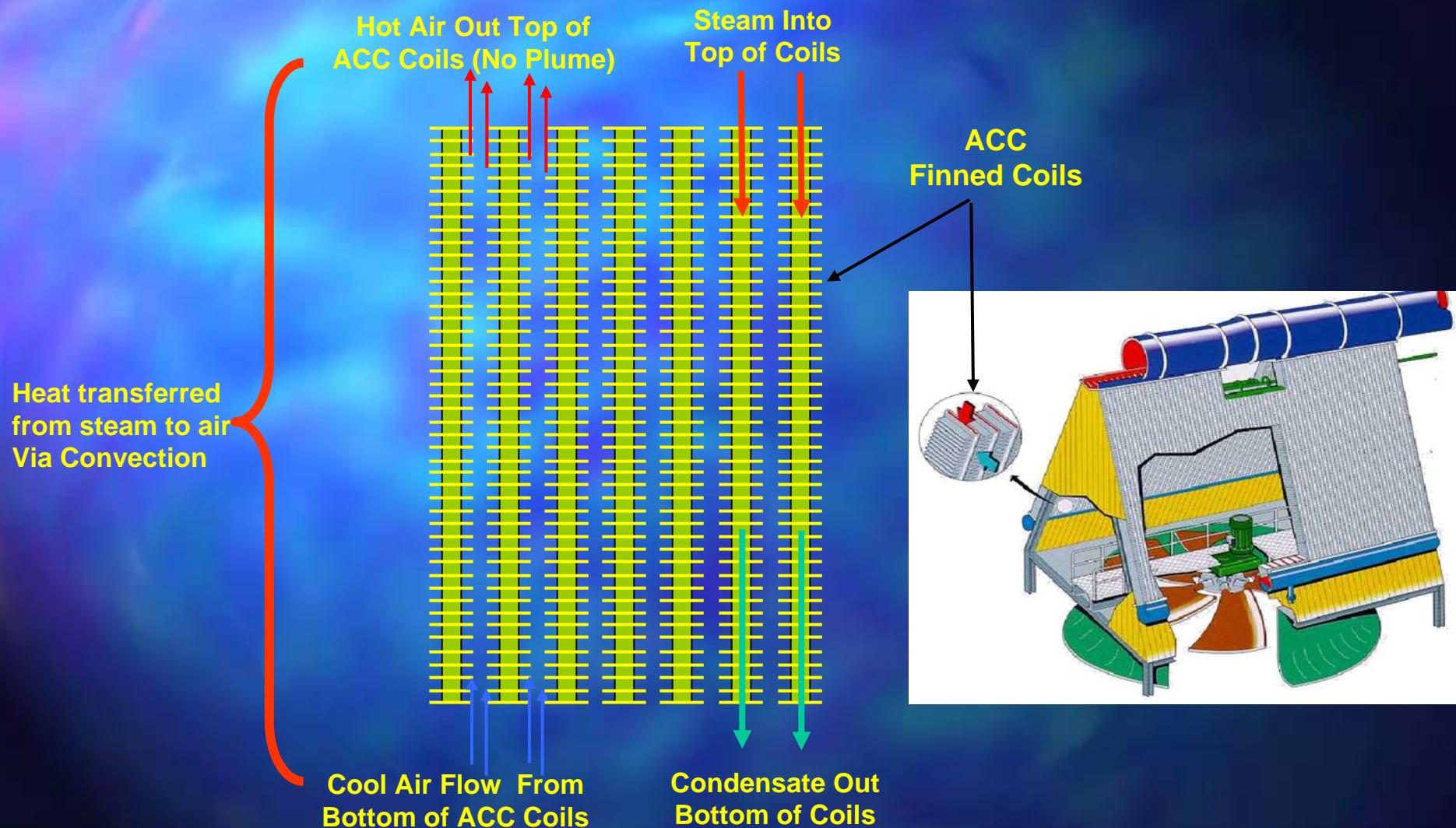
Power Station W/ Air-Cooled Condenser



Air-Cooled Condenser



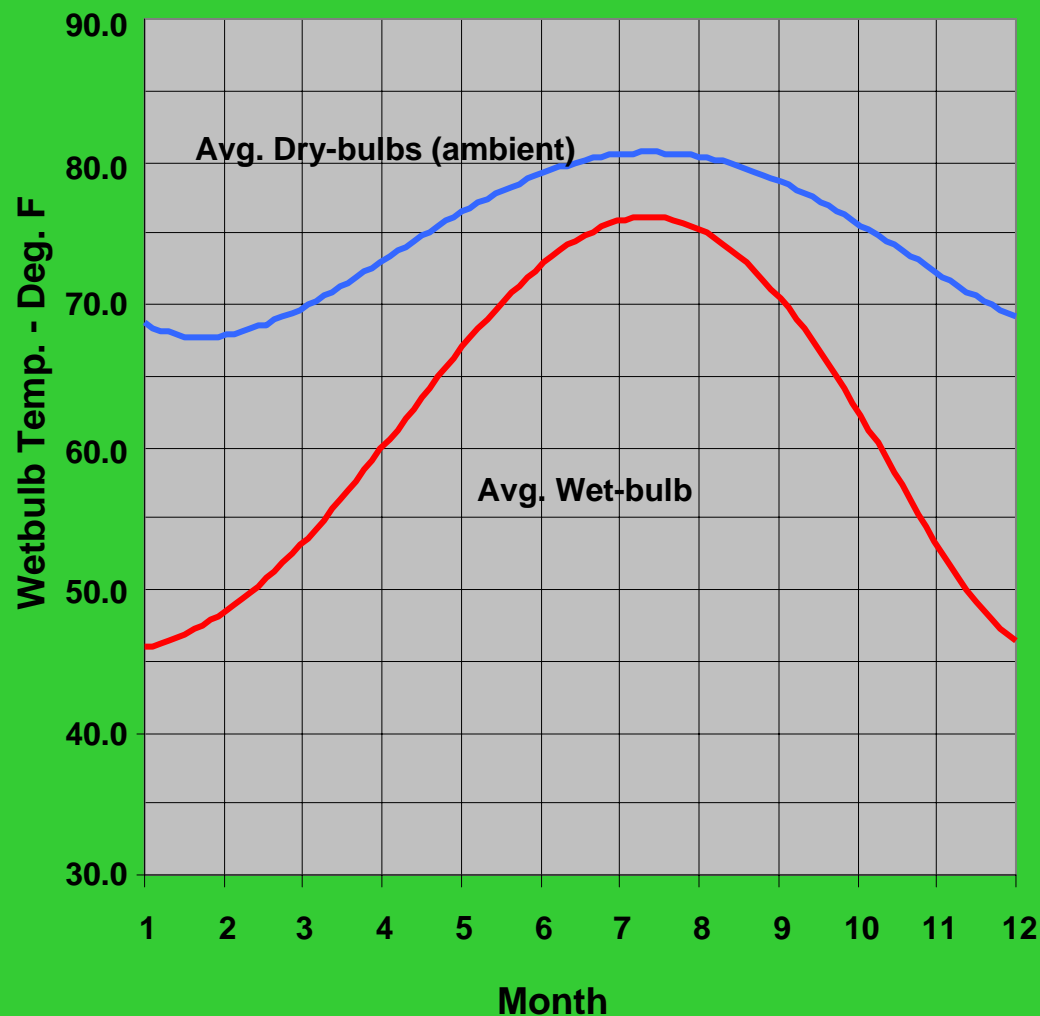
What Happens Inside An Air-Cooled Condenser



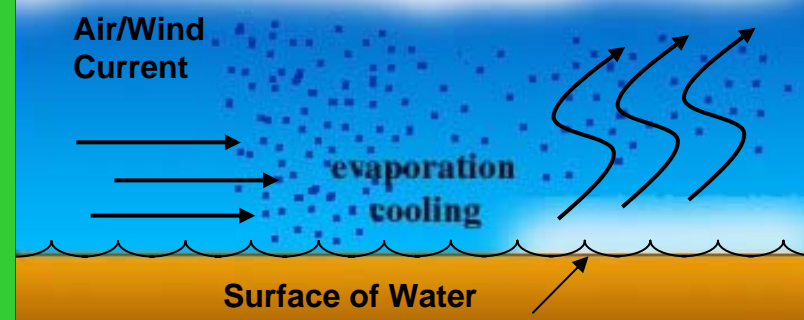
Steam Condensation & Resultant Backpressure = f (drybulb & ACC surface area)
Metal-to-Air Heat Transfer (Forced Convection)

Performance Drivers for Evaporative Cooling (W/Cooling Tower) Versus Dry Cooling (Air Cooled Condenser)

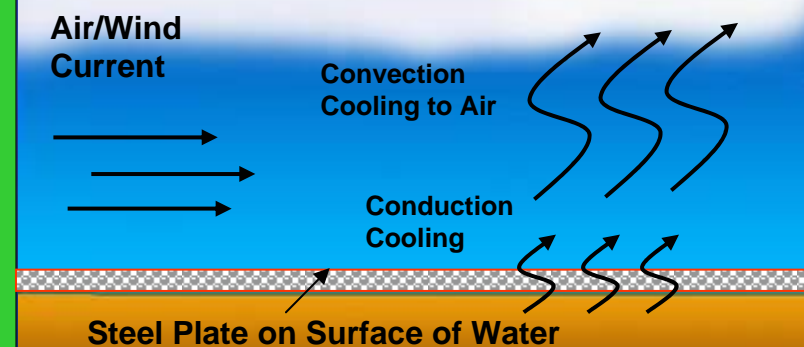
Monthly Dry-bulb Versus Wet-bulb Temp. - Deg. F



Evaporative Cooling @ Wet-bulb Temperature
(as in Cooling Tower)



Convective Dry Cooling @ Dry-bulb Temperature
(as on ACC)

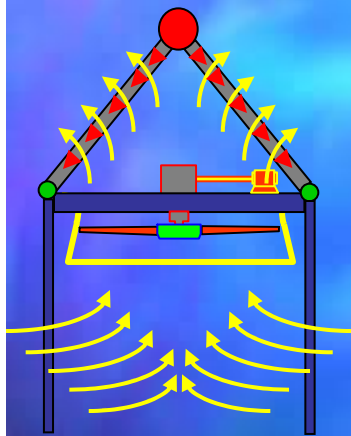


Typical 500 Mw Combined Cycle ACC Installation (240 Mw Steam Turbine)



Note: Turbine/Condenser Design backpressure ~ 10.0"Hga @ 112 Deg.F Ambient

Proximity Issues – Restricted Perimeter Air-Inlet Zones

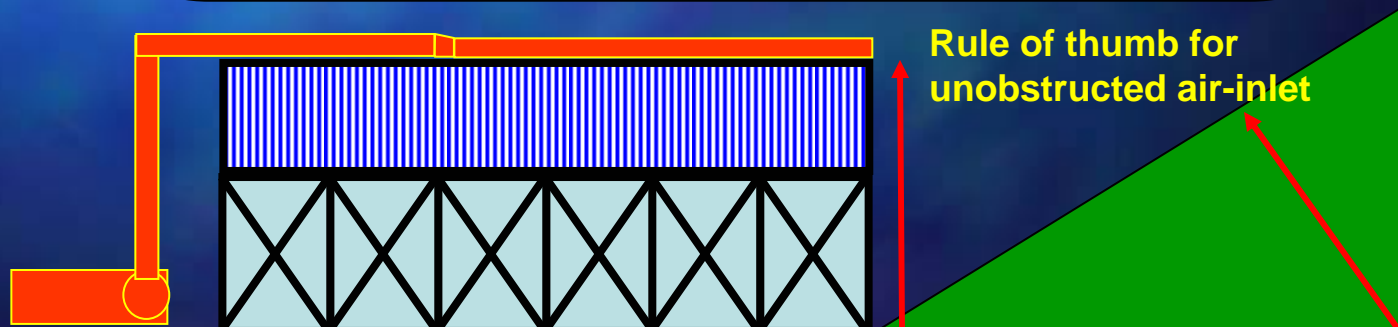


Comparative Height
(ACC Vs Cooling Tower)



RESTRICTED PERIMETER

1. No-build zones to avoid air-inlet interference
2. To provide maintenance access



ACC Design/Layout Considerations

~ 30 ' Steam Duct
From Turbine
Exhaust to ACC

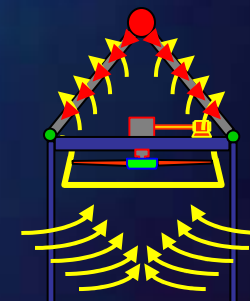
Football Field
160'x360'

~ 324' (+,-)

~ 270

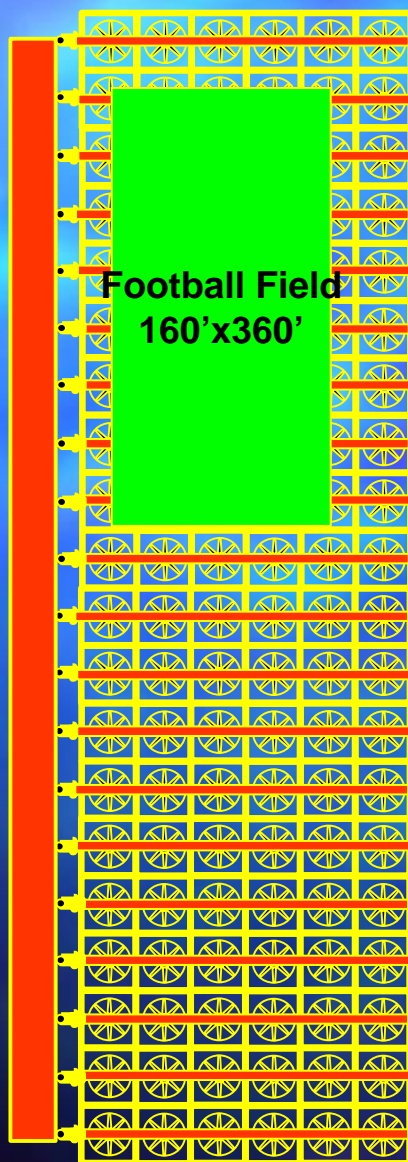
~ 110 - 120 '

~ 70 '

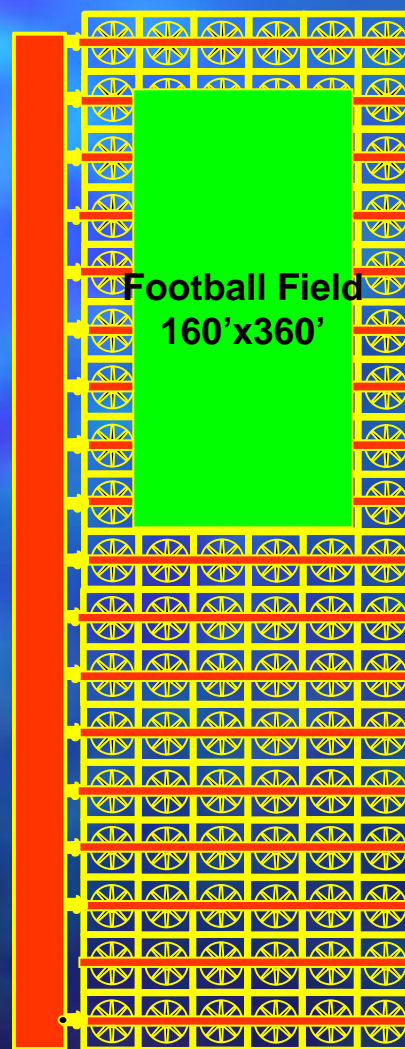


**AP1000 Plant - ACC Size & Layout Requirements
Designed For 2.92"HgA @ 95 Deg. Ambient
324 Modules (54 x 6 Module Array Configuration)**

LP Shell 6x20 (120 Modules)



IP Shell 6x18 (108 Modules)



HP Shell 6x16 (96 Modules)

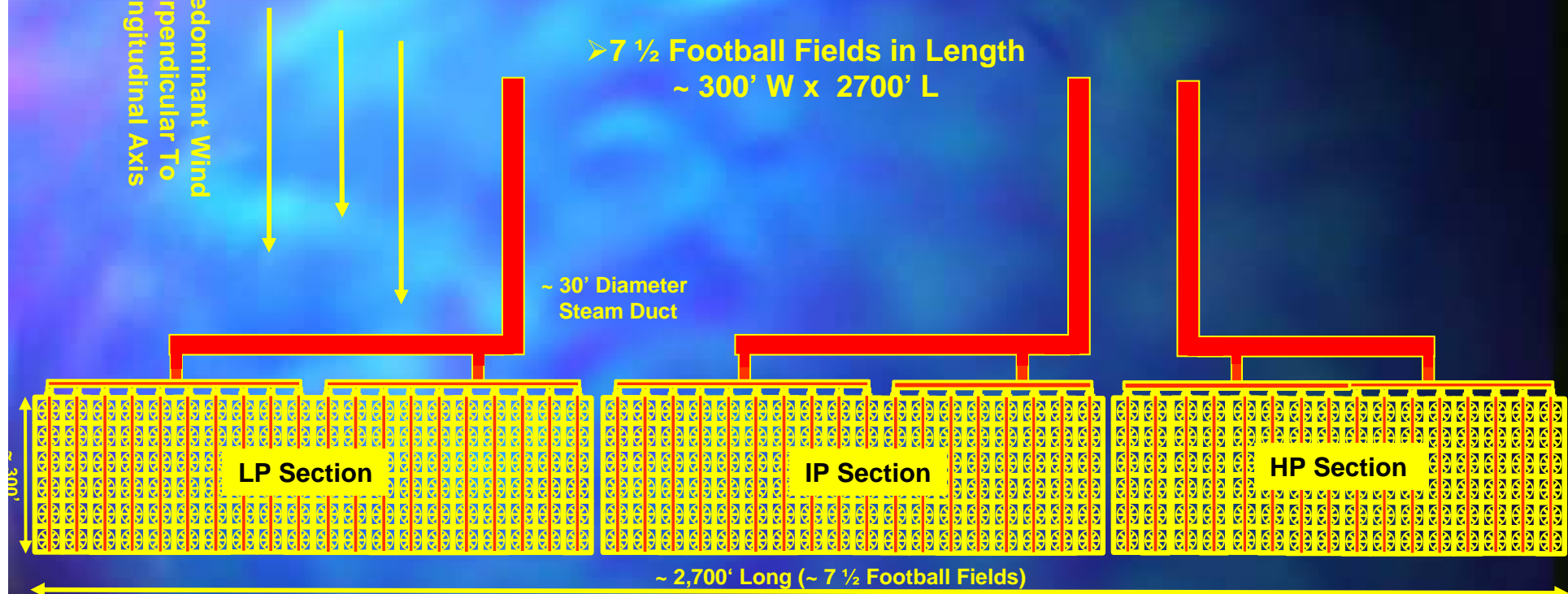


AP1000 ACC CONDENSER
DESIGNED FOR 2.92" HgA @ 95 Deg. Ambient
324 Modules
54 x 6 Module Array Configuration

➤ **7 ½ Football Fields in Length**
~ 300' W x 2700' L

Predominant Wind
 Perpendicular To
 Longitudinal Axis

~ 30' Diameter
 Steam Duct

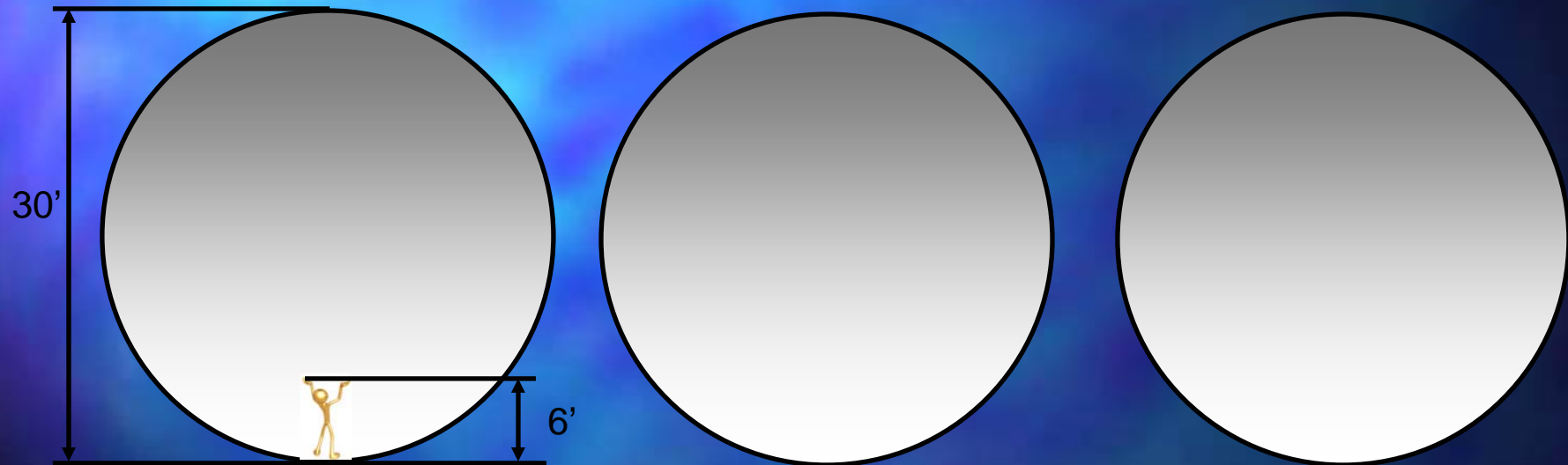


Football Field 160'x360'	Football Field	Football Field	Football Field	Football Field	Football Field	Football Field	1/2 Football Field
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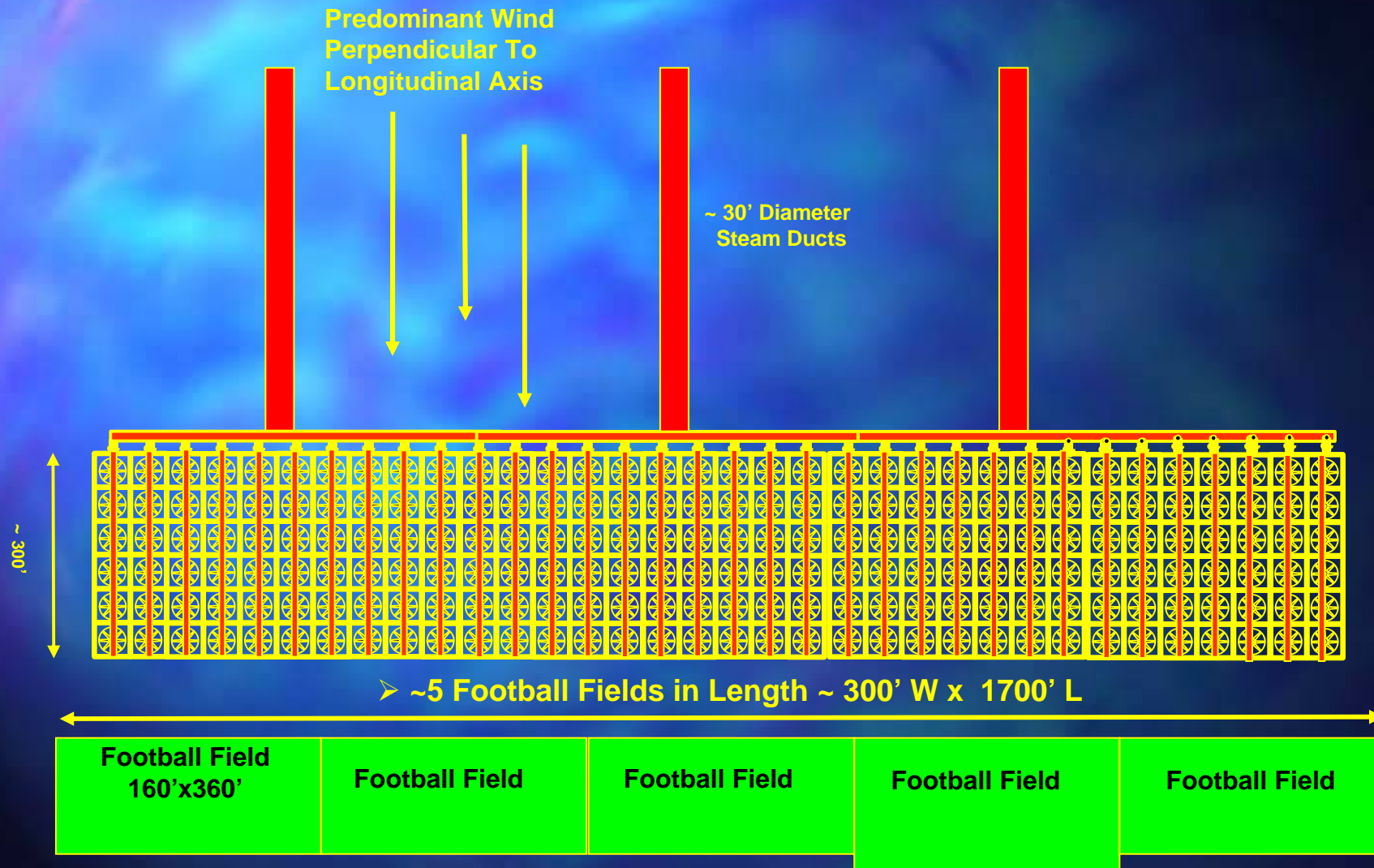
Design Backpressure @ ACC (steam turbine backpressure = ACC + Duct Losses)
ACC Backpressure Design Not Recommended due to performance limitations and reliability)

Required Size for ACC Steam Ducts for an AP1000 Unit

(Average Height Man Shown for Scale)



AP1000 ACC CONDENSER
DESIGNED FOR 4.5" HgA @ 95 Deg. Ambient
204 Modules (34 x 6 Module Array Configuration)



Design Backpressure @ ACC (steam turbine backpressure = ACC + Duct Losses)

ACC Backpressure Design Not Recommended due to performance limitations and reliability)

**ACC Designed For 2.92" HgA @ 95 Deg. Ambient
Modules (54 x 6 Module Array Configuration)**

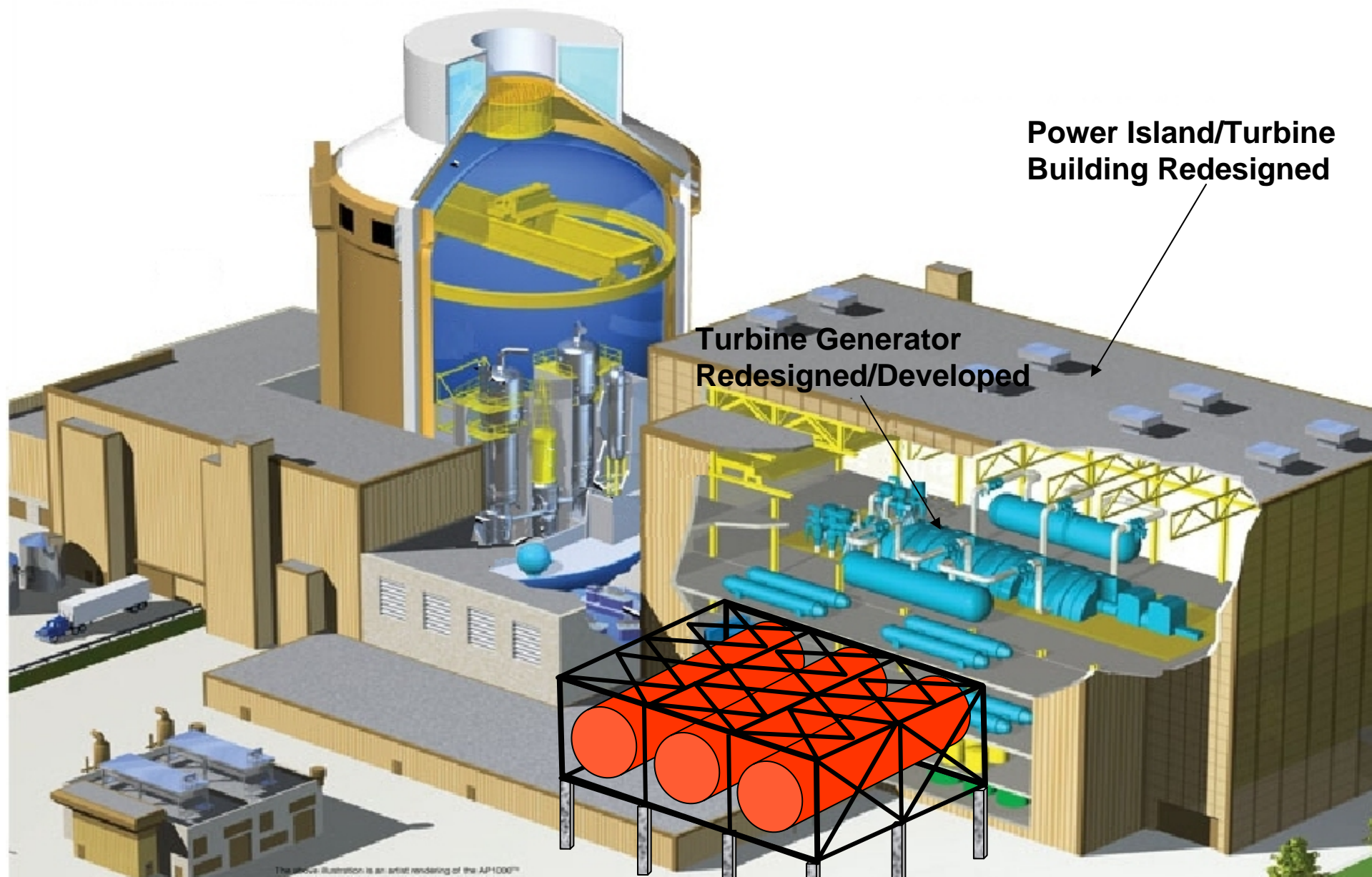
**AP1000 ACC Designed for 4.5" HgA @ 95 Deg. Ambient
204 Modules (34 x 6 Module Array Configuration)**



7 ½ Football Fields in Length (~ 300' W x 2700' L) —————→
←————— ➤ ~5 Football Fields in Length ~ 300' W x 1700' L —————→



ACC Impact on AP1000 Standardized Unit Design



The above illustration is an artist rendering of the AP1000®.