Nuclear reactors report time line engineering essay

Engineering

December 1957 – Generation I developed by Duquesne Light Company opened at Shippingport, Pennsylvania, USA1970s – Generation II developed1990s – GE develops first Generation III nuclear reaction called Advanced Boiling Water Reactor (ABWR)Late 1990s– Mitsubishi Heavy Industries develop the Generation III Advanced Pressurized Water Reactor (APWR)September 2001 – Birth of AREVAOctober 2003 – AREVA puts forth design of Generation III+ European Pressurized Reactor (EPR) for FinlandLate 2000s – Mitsubishi Heavy Industries develop Generation III United States Advanced Pressurized Water Reactor (US-APWR)2007 – GE submits Operating License application Generation III+ for Economic Simplified Boiling Water Reactor (ESBWR)2030 – Generation IV is developed

Types of Reactors:

Pressurized Water Reactors

Source: http://www. eia. doe. gov/cneaf/nuclear/page/analysis/nucenviss2. html#_ftn4Moderated and cooled with light water kept liquid in the reactor core with the appropriate pressure under normal operating conditionsMost widely used – 2/3 of the reactors now in service worldwide are PWR’sWill be replaced by European Pressurized Reactor (EPR)

Boiling Water Reactors

Source: http://www. nrc. gov/reading-rm/basic-ref/teachers/03. pdf and http://www. eia. doe. gov/cneaf/nuclear/page/analysis/nucenviss2. html#_ftn4Nuclear reactor moderated and cooled by ordinary waterBrought to boiling point in the core under normal operating conditions to form a steam waterMain Difference: Steam Void Formation – steam pre-separated

by moisture separation, where water droplets are removed before steam enters the steam line. The steam line directs turns the turbine, attached to the electrical generator

Research Reactors

Source: http://www. gao. gov/new. items/d04807. pdf and http://www. eia. doe. gov/cneaf/nuclear/page/analysis/nucenviss2. html#_ftn4Research Community OnlySmaller than nuclear power reactors, they only produce up to 250 megawatts versus a nuclear reactor produces 3, 000 megawattsPurpose: Use highly enriched uranium (HEU) as fuel for the production of medical isotopesUS DOE is attempting to replace HEU with low enriched uranium (LEU) because LEU cannot be used in nuclear weaponsUnited States has 25 Research ReactorsFrance has 5 Research Reactors

Generation I – Generation IV

Generation I

Shippingport Nuclear Reactor – Generation I

Source: http://files. asme. org/ASMEORG/Communities/History/Landmarks/5643. pdfGeneration I developed by Duquesne Light Company opened at Shippingport, Pennsylvania, USA in 1957Specifications : Type Pressurized Water Reactor (PWR)Capacity 60 MW

Dresden Nuclear Reactor – Generation I

Source: http://www. eia. doe. gov/cneaf/nuclear/page/at_a_glance/reactors/dresden. html and http://www.

exeloncorp.

com/ourcompanies/powergen/nuclear/dresden_generating_station.

htmDeveloped by General Electric and opened in 1960 and closed in 1978 and operated by ExelonFirst privately financed nuclear power plantSpecifications : Capacity 210 megawattsTypeBoiling Water Reactor (BWR)

Berkeley Magnox Nuclear Reactor – Generation I

Source: http://www. magnoxsouthsites. com/about-us/our-sites/berkeley/site-historyOpened in 1962 in the United KingdomSpecifications : Capacity276 megawattsLife Span27 years

Generation II

Generation II

Source: In operation in China and Brazil because the generations fit the customers' specific needs in the continuity of their national programsSpecifications: Capacity 1000 MWLife Span20 – 30 years

Generation II Nuclear Reactors

LWR-PWR, BWRCANDUVVER/RBMKAGR

Generation III Reactors

Advanced Boiling Water Reactor (ABWR)

Source: http://gepower.

com/prod_serv/products/nuclear_energy/en/new_reactors/abwr. htmDesigned and built by GEThree plants operating in JapanSpecifications: Capacity 1350 – 1460 MWTypeLight Water Reactor (LWR)Life Span60 years

AP 600

Source: http://www. ap600. westinghousenuclear. com/ and http://www. eia. doe. gov/cneaf/nuclear/page/analysis/nucenviss2. html#_ftn1Designed by Westinghouse but did not sell wellSpecifications: Capacity 600 MWeTypePressurized Water Reactor (PWR)

System 80+

Source: http://www. eia. doe. gov/cneaf/nuclear/page/analysis/nucenviss2. html#_ftn10Built by Westinghouse and provided basis for APR1400Developed in KoreaSpecifications: Capacity1300 MWe

Generation III+ Reactors

European/Evolutionary Pressurized Reactor (EPR)

Source: http://www. areva-np. com/common/liblocal/docs/Brochure/EPR_US_%20May%202005. pdfBid on in Finland in 2003 and made by AREVA100 reactors in service (built 100 of the 303 light water nuclear reactors in service worldwide) – control one third100, 000 MWe of installed powerEPR – large-power pressurized water reactor (PWR) in the range of 1600+ MWe (under construction in Finland, France, and China – in project in the US/UK)only Gen-3 reactor under construction in the worldsignificant performance gain, high level of security, simplified operation/maintenance/reduction in uranium consumption, waste production

Design Specifications of EPR:

Developed by Framatome ANP, AREVA and SiemensSafer, more efficient than PWRThree safety barriers – prevents radioactivity from spreading outside the buildingCore meltdown risk factor decreased by tenIn case of

meltdown (when the reactor reaches a temperature where it cannot properly cool down), the following measures are implemented: Building Spray SystemKeeps the pressure and temperature low to guarantee leak tightness and mechanical resistanceSpecific compartmentCollects any material that may have escapedThick, reinforced concrete shellProtects reactor from external hazards such as aircraft crash1. 3 meter thick walls4 sub-system which are independent of each other and are stored in different roomsEPR – consumes 15% less uranium while generating the same amount of electricityCan be fully or partially loaded with recycled fuel (MOX) to reduce plutonium inventory and increase recycled fuel useMOX – nuclear fuel produced by mixing uranium and plutonium oxideSpecifications: 10% less costOutput: 37% (5% increase)Power: 1600 MW (200 – 500 increase)Life Span: 60 years

ATMEA1 – Mid-Sized Generation III+

Source: http://www. atmea-sas. com/scripts/ATMEA/publigen/content/templates/Show. asp? P= 57&L= ENBuilt by AREVA and Mitsubishi Heavy Industries (MHI)Licensing application ready by end of 2009Specifications: Thermal Output2860 – 3150 MWthElectrical Output1000 – 1150 MWe (Net)TypePressurized Water Reactor(PWR)Operation Cycle Length12 – 24 monthsMOX Loading Available 0 – 100%Design Plant Life60 yearsRegulation ComplianceJapan, Europe and USSevere Accident Mitigation Core catcher and hydrogenrecombiners/ignites, long-term integrity of containmentProvisions for Airplane CrashSafety related buildingsprotected against commercial airplane crash through reinforcement and physical separationSeismic

ConditionAvailable for high seismicareaPublic concerns No long-term emergencyplanning required

SWR (Temporary Name) – Generation III+

Source: http://www. areva. com/servlet/operations/nuclearpower/reactors&services_division/reactors-en. htmlDesigned by AREVASpecifications: Capacity 1250+ MWeTypeCutting-edge boiling water reactor(BWR)Safety Maximum for the use of nuclearpower

Advanced CANDU Reactor (ACR – 1000) – Generation III+

Source: http://www. aecl. ca/Reactors/ACR-1000. htm and http://www. eia. doe. gov/cneaf/nuclear/page/analysis/nucenviss2. html#_ftn4 andDesigned by AECLIn-Service Date: 2016Specifications : Capacity 1200 MWeLife Span60 yearsTypeModified Pressurized Heavy WaterReactor

AP 1000

Source: http://ap1000. westinghousenuclear. com/index. html and http://www. eia. doe. gov/cneaf/nuclear/page/analysis/nucenviss2. html#_ftn4Designed by Westinghouse Electric Company LLCTwo being built in ChinaLarger than the AP600Specifications : Capacity1117 – 1154 MWeTypePressurized Water Reactor (PWR)

Economic Simplified Boiling Water Reactors (ESBWR)

Source: http://gepower. com/prod_serv/products/nuclear_energy/en/new_reactors/esbwr.

htmDesigned by GEPressurized Water Reactor (PWR)Specifications : Capacity 1600 MWeEfficiency36 – 37%Life Span60 Years

APR – 1400

Source: http://www. apr1400. com/index1. jsp and http://www. eia. doe. gov/cneaf/nuclear/page/analysis/nucenviss2. html#_ftn4U. S. System 80+ (formerly Westinghouse)Promoted for development in South KoreaPressurized Water Reactor (PWR)Specifications : Capacity1300 MWe

Customers of Generation III+ AREVA Made Reactors

Source: http://www. areva. com/servlet/operations/nuclearpower/reactors&services_division/reactors-en. htmlFinlandOlkiluoto 3 project – BEHNIND SCHEDULE1 EPR 1600 MWe for TVOImplementation Date: 2012FranceFlamanville Project – BEHIND SCHEDULEEDFDate Began: December 2007ChinaPartnership with China Gunagdoing Nuclear Power Corporation (CGNPC)Construction of 2 EPR nuclear islandsService Until: 2022United StatesUS ERP reactorService Date: 2015United KingdomUnited Kingdom ERPService Date: Pending Regulatory CommissionBulgariaBelene Power PlantCommand control, electrical systems and ventilation systems

Generation IV

Source: http://www. gen-4. org/PDFs/GIF_introduction. pdf

Four Goals:

SustainabilitySafety and ReliabilityEconomicsProliferation resistance and physical protection

Six Systems selected:

Gas-Cooled Fast Reactor (GFR)

Will minimize production of long-lived radioactive wastePlans finalized (no longer under development)Goal is to have experimental technology demonstration reactor in place by 2020Projected Specifications: Size200 – 1200 MWeApplicationElectricity, Hydrogen, ActinideManagement (radioactive elements withatomic numbers 89-103

Lead-Cooled Fast Reactor (LFR)

Still under developmentCompletion date scheduled for 2025Advanced designs expected by 2035Projected Specifications: Size 50 – 1200 MWeApplicationElectricity, Hydrogen Production

Molten Salt Reactor (MSR)

Purpose is to burn up plutonium and minor actinidesPlanning has not begunScoping and screening phase continues until 2011Performance phase set to begin in 2018Projected Specifications: Size1000 MWeApplicationsElectricity, Hydrogen Production, ActinideManagement

Sodium-Cooled Fast Reactor (SFR)

Designed for high-level wastes and management of plutoniumPlans finalized (no longer under development)Projected Specifications: Size300 – 1500 MWeApplicationElectricity, Actinide Management

Supercritical-Water Reactor (SCWR)

Purpose is efficient electricity production with an option for actinide managementPlans finalized (no longer under development)Projected Specifications: Size1500 MWeApplicationElectricity

Very-High-Temperature Reactor (VHTR)

Purpose to supply electricity and process heat to a broad spectrum of high-temperature and energy intensive processesPlans finalized (no longer under development)Projected Specifications: Size250 MWeApplicationElectricity, Hydrogen