

Licensing of New Build Reactors in the UK – Part 1



Keith Ardron
UK Licensing Manager ,
AREVA NP UK



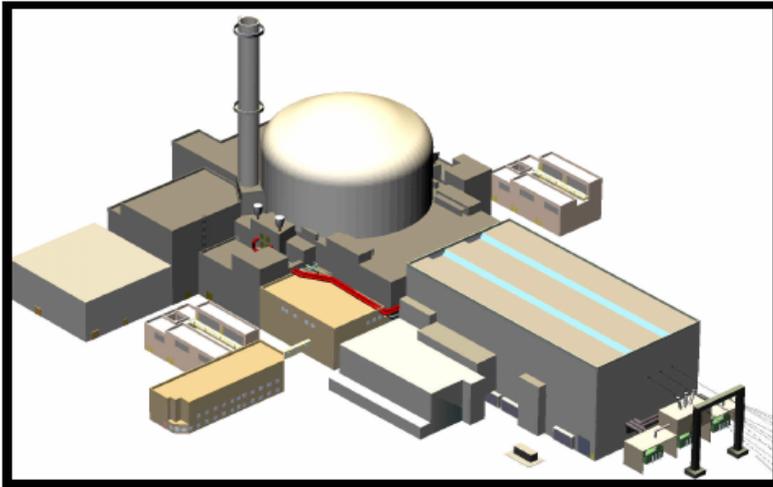
Imperial College – Nuclear Thermalhydraulics Course: February 2014

Contents



- ▶ **Role of Safety Authorities & Technical Support Organisations**
- ▶ **Application of International Rules and Frameworks**
- ▶ **Structure of a Safety Report & Standard Rules and Practices**
 - ◆ **Deterministic analysis of accidents**
 - ◆ **Probabilistic analysis of risk**

New Build Reactors in the UK – the EPR



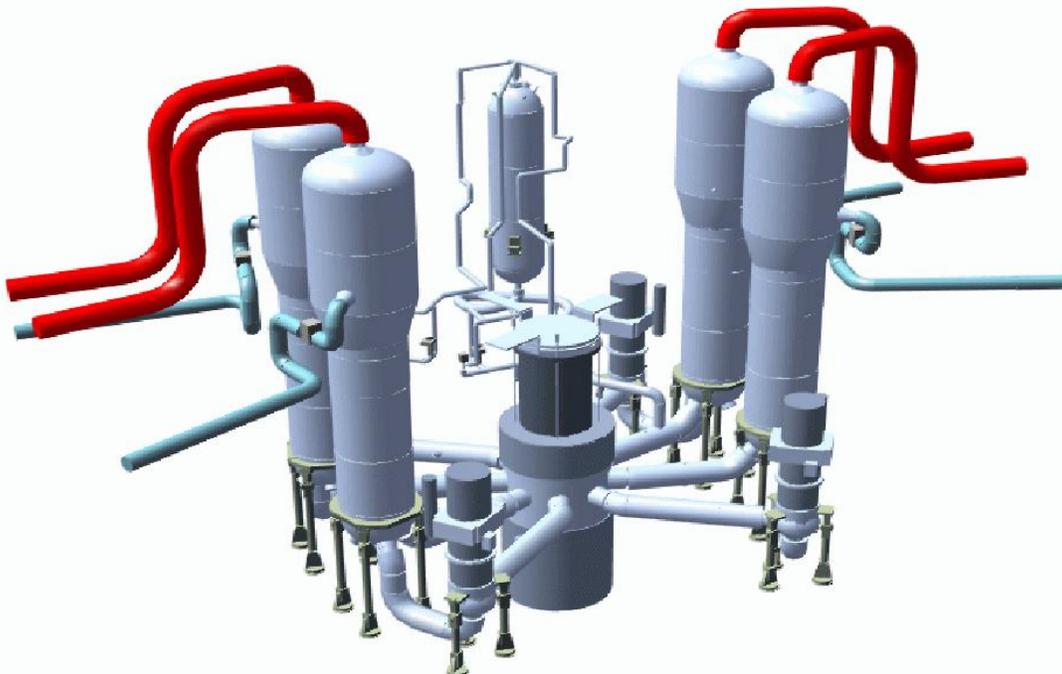
40 EPR units could supply 100% of UK demand

AREVA NP

Imperial College NTEC 2014 - p.3



EPR Nuclear Steam Supply System (NSSS)



AREVA NP

Imperial College NTEC 2014 - p.4



EPR and the UK GDA Process

- ▶ EPR is Generation 3+ PWR design - evolutionary development of the most modern French and German PWRs (N4 and Konvoi designs). UK EPR output = 1650MW(e). One unit = 3.5% UK Electricity Demand.
- ▶ EDF and AREVA submitted the UK EPR design to the UK Regulators for “Generic Design Assessment (GDA)” in 2007. GDA Design Acceptance granted in 2012.
- ▶ UK EPR is the only reactor design to achieve GDA Design Acceptance so far. Process just started for ABWR
- ▶ EDF-led consortium plans to construct 2 EPR units at Hinkley Point. May be followed by 2 units at Sizewell.
- ▶ Detailed ‘site specific’ safety report still needed by UK regulators before start of reactor construction

AREVA NP

Imperial College NTEC 2014 - p.5



Flamanville 3 – UK EPR Prototype – September 2013



AREVA NP

Imperial College NTEC 2014 - p.6





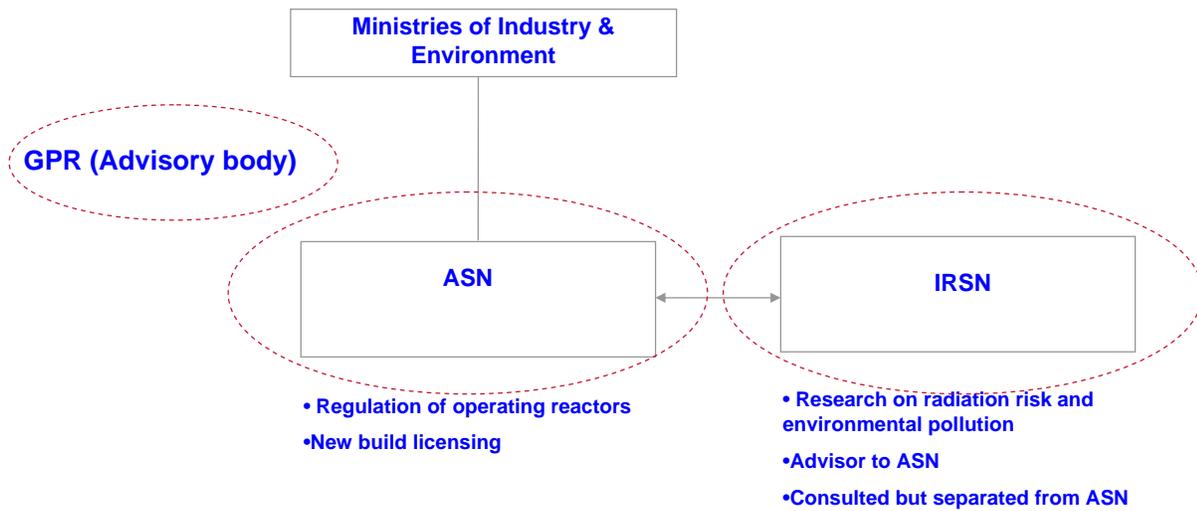
- ▶ **Role of Safety Authorities & Technical Support Organisations**
- ▶ Licensing Practices in different countries
- ▶ Application of International Rules and Frameworks
- ▶ Structure of a Safety Report & Standard Rules and Practices

Nuclear Energy: Role of Safety Authority



- ▶ **Safety Authorities are national governmental organisations, usually reporting to a government Ministry or Department**
- ▶ **In most countries the SA is supported by a dedicated Technical Support Organisation who help define design and operational safety principles and review submissions from license applicants**
- ▶ **Oversight committee of independent experts often used to advise SA on complex safety issues (GPR in France, RSK in Germany, ACRS in US)**
- ▶ **Safety Authority role:**
 - ◆ To devise rules for the safe design and operation of nuclear plants
 - ◆ To assess design and safety documentation to confirm that rules and quality standards have been correctly applied
 - ◆ To grant authorisation for construction, fuel load and plant operation of new plants
 - ◆ To monitor construction and operation, to show that design and operating rules are being complied with. To approve safety significant modifications to physical plant or operating procedures.

Safety Authority – French Model

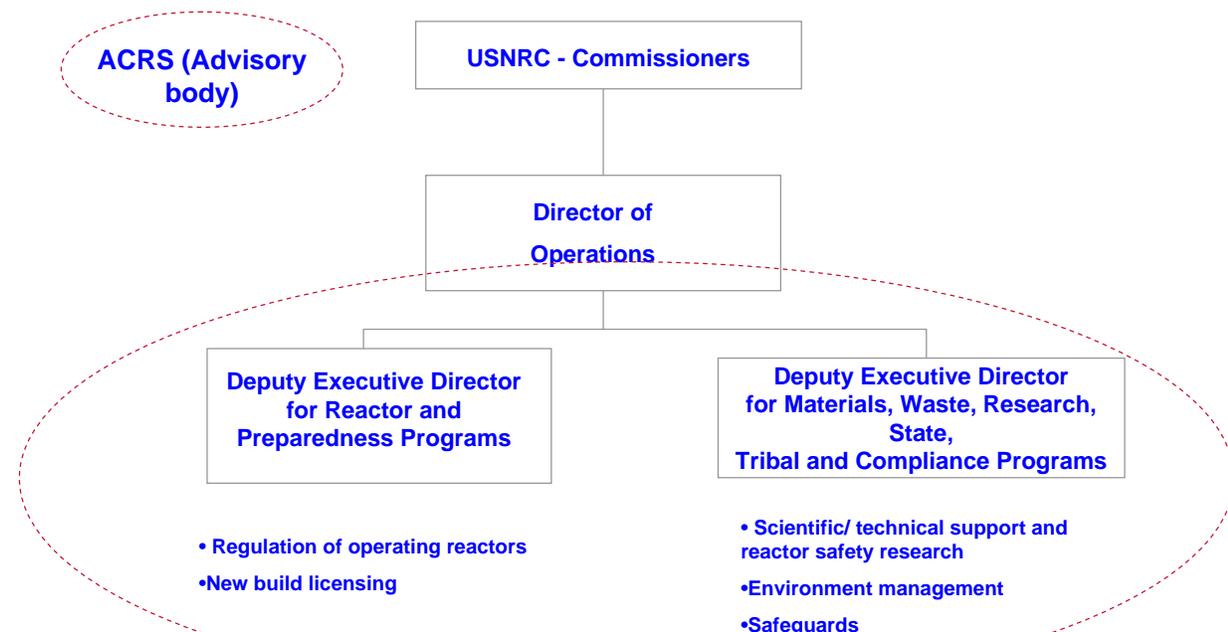


AREVA NP

Imperial College NTEC 2014 - p.9



Safety Authority – US Model

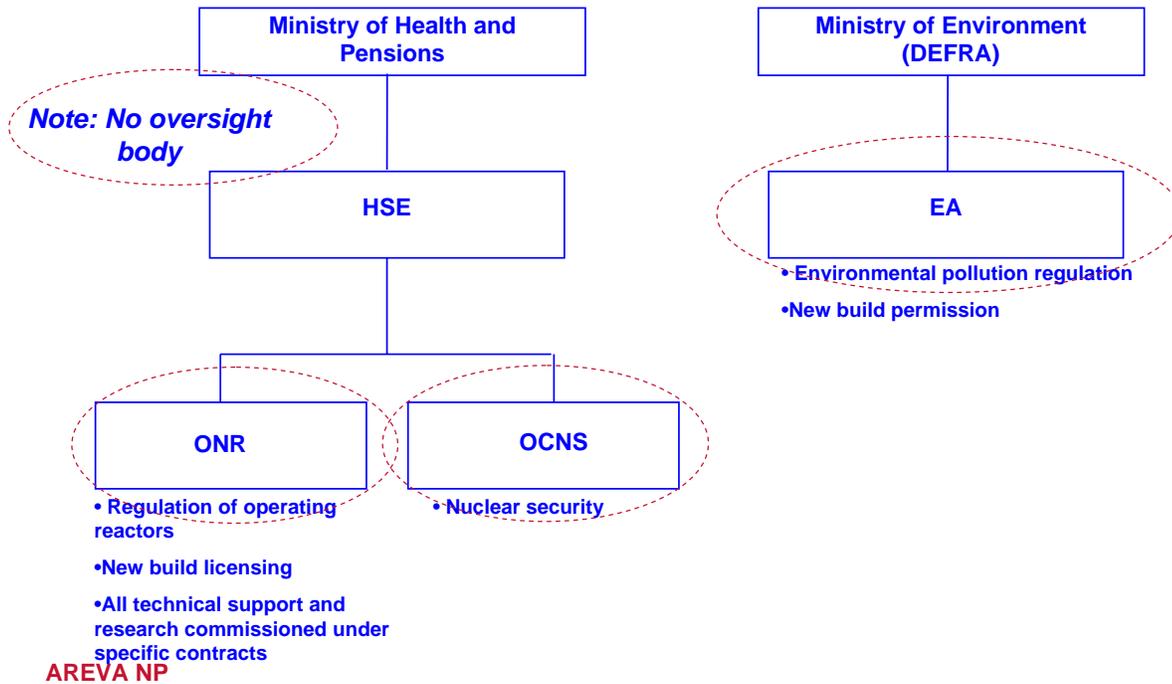


AREVA NP

Imperial College NTEC 2014 - p.10



Safety Authority- UK Model

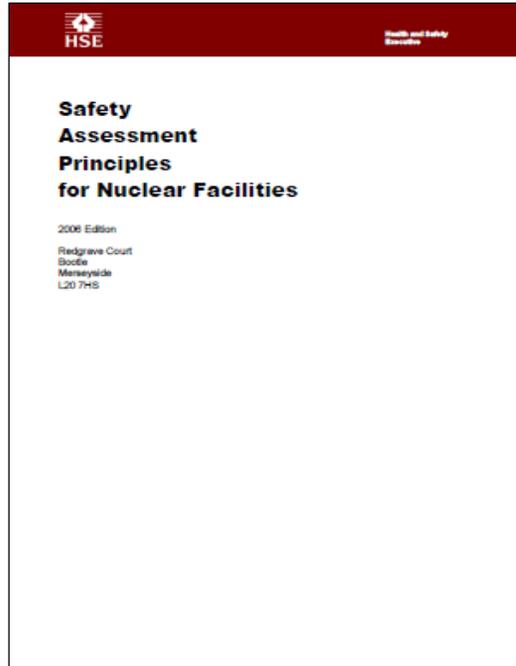


UK Approach to Regulation of Civil Nuclear Industry



- ▶ Very limited specific UK legislation exists relating to design, construction and operation of nuclear installations
- ▶ UK regulatory approach based on **PRINCIPLES & GOALS** rather than **LEGALLY ENFORCABLE REGULATIONS** as used in countries such as France and US
- ▶ Principle of ALARP overrides other requirements
- ▶ Licensees expected to develop own principles/rules/guidelines for design, construction, operation and decommissioning of their facilities
- ▶ HSE/ONR is small regulator by international standards (~220 inspectors) with no dedicated Technical Support Organisation. Its role is to approve licensee's **own rules** and to monitor **compliance**
- ▶ ONR has developed **Safety Assessment Principles (SAPs)** for assessing licensee submissions relating to nuclear safety

HSE/ONR Safety Assessment Principles (SAPs)



AREVA NP

Imperial College NTEC 2014 - p.13



Contents of HSE/ONR SAPs (1/2)



	FOREWORD	1
INTRODUCTION		1
FUNDAMENTAL PRINCIPLES		41
FP – Fundamental principles (FP.1 to FP.8)		42
LEADERSHIP AND MANAGEMENT FOR SAFETY		43
MS – Leadership and management for safety (MS.1 to MS.4)		47
THE REGULATORY ASSESSMENT OF SAFETY CASES		70
SC – Safety cases (SC.1 to SC.8)		81
THE REGULATORY ASSESSMENT OF SITING		103
ST – Siting (ST.1 to ST.7)		108
ENGINEERING PRINCIPLES		131
EKP – Key principles (EKP.1 to EKP.5)		135
ECS – Safety classification and standards (ECS.1 to ECS.5)		148
EQU – Equipment qualification (EQU.1)		161
EDR – Design for reliability (EDR.1 to EDR.4)		169
ERL – Reliability claims (ERL.1 to ERL.4)		175
ECM – Commissioning (ECM.1)		181
EMT – Maintenance, inspection and testing (EMT.1 to EMT.8)		186
EAD – Aging and degradation (EAD.1 to EAD.5)		193
ELO – Layout (ELO.1 to ELO.4)		204
EHA – External and internal hazards (EHA.1 to EHA.17)		210
EPS – Pressure systems (EPS.1 to EPS.5)		233
EMC – Integrity of metal components and structures (EMC.1 to EMC.34)		248
ECE – Civil engineering (ECE.1 to ECE.24)		281
EGR – Graphite components and structures (EGR.1 to EGR.15)		306
ESS – Safety systems (ESS.1 to ESS.27)		335
ESR – Control and instrumentation of safety-related systems (ESR.1 to ESR.10)		364

AREVA NP

Imperial College NTEC 2014 - p.14



Contents of HSE/ONR SAPs (2/2)



EES – Essential services (EES.1 to EES.9).....	370
EHF – Human factors (EHF.1 to EHF.10).....	375
ENM – Control of nuclear matter (ENM.1 to ENM.8).....	392
ECV – Containment and ventilation (ECV.1 to ECV.10).....	422
ERC – Reactor core (ERC.1 to ERC.4).....	439
EHT – Heat transport systems (EHT.1 to EHT.5).....	458
ECR – Criticality safety (ECR.1 to ECR.2).....	470
RADIATION PROTECTION.....	476
RP – Radiation protection (RP.1 to RP.6).....	479
FAULT ANALYSIS.....	496
FA – Fault analysis (FA.1 to FA.24).....	503
NUMERICAL TARGETS AND LEGAL LIMITS.....	568
NT – Numerical targets and legal limits (NT.1 to NT.2).....	582
ACCIDENT MANAGEMENT AND EMERGENCY PREPAREDNESS.....	639
AM – Accident management and emergency preparedness (AM.1).....	640
RADIOACTIVE WASTE MANAGEMENT.....	646
RW – Radioactive waste management (RW.1 to RW.7).....	650
DECOMMISSIONING.....	684
DC – Decommissioning (DC.1 to DC.8).....	686
CONTROL AND REMEDIATION OF RADIOACTIVELY CONTAMINATED LAND.....	740
RL – Strategies for radioactively contaminated land (RL.1 to RL.8).....	742

AREVA NP

Imperial College NTEC 2014 - p.15



SAPs Discussion



- ▶ SAPs are often detailed and may be demanding. In many cases wording is open to different interpretations
- ▶ SAPs may be interpreted differently by different ONR inspectors
- ▶ SAPs not legal requirements, but in practice compliance may be necessary to achieve a license for a nuclear activity
- ▶ Many key SAPs are unique to UK (e.g. probabilistic numerical targets for risks to public and workers, ALARP requirement etc) – sometimes no equivalent requirement in IAEA standards and guides
- ▶ SAPs can be prescriptive but achieving compliance may be rather unpredictable
- ▶ Unpredictability of outcomes can lead to uncertainty and delay in planning of nuclear projects

AREVA NP

Imperial College NTEC 2014 - p.16



Principle of ALARP (As Low as Reasonably Practicable) (1/3)



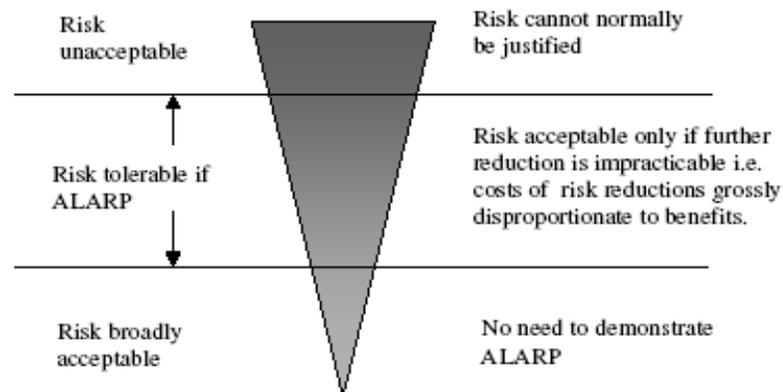
- ▶ ALARP principle adopted in 1970s for risk to public (off-site) and workers (on-site) from operation of Nuclear Power Plants. Requirement came from 1974 Health and Safety at Work Act.
- ▶ HSE 1988 report “Tolerability of Risk from Nuclear Power Stations” (TOR) states that:
 - ◆ a risk of death due to radiation from a power plant of 1 in 10^6 /yr would be acceptable for most people (1% of risk from background radiation or 1% of risk from fatal road accident)
 - ◆ a risk of death above of 1 in 10^4 /yr due to radiation from a power plant would be unacceptable
 - ◆ in intermediate region, risk could be acceptable if it is ALARP – i.e. cost in time and effort of reducing the risk was disproportionate

AREVA NP

Imperial College NTEC 2014 - p.17



Principle of ALARP (As Low as Reasonably Practicable) (2/3)



AREVA NP

Imperial College NTEC 2014 - p.18



Principle of ALARP (As Low as Reasonably Practicable) (3/3)



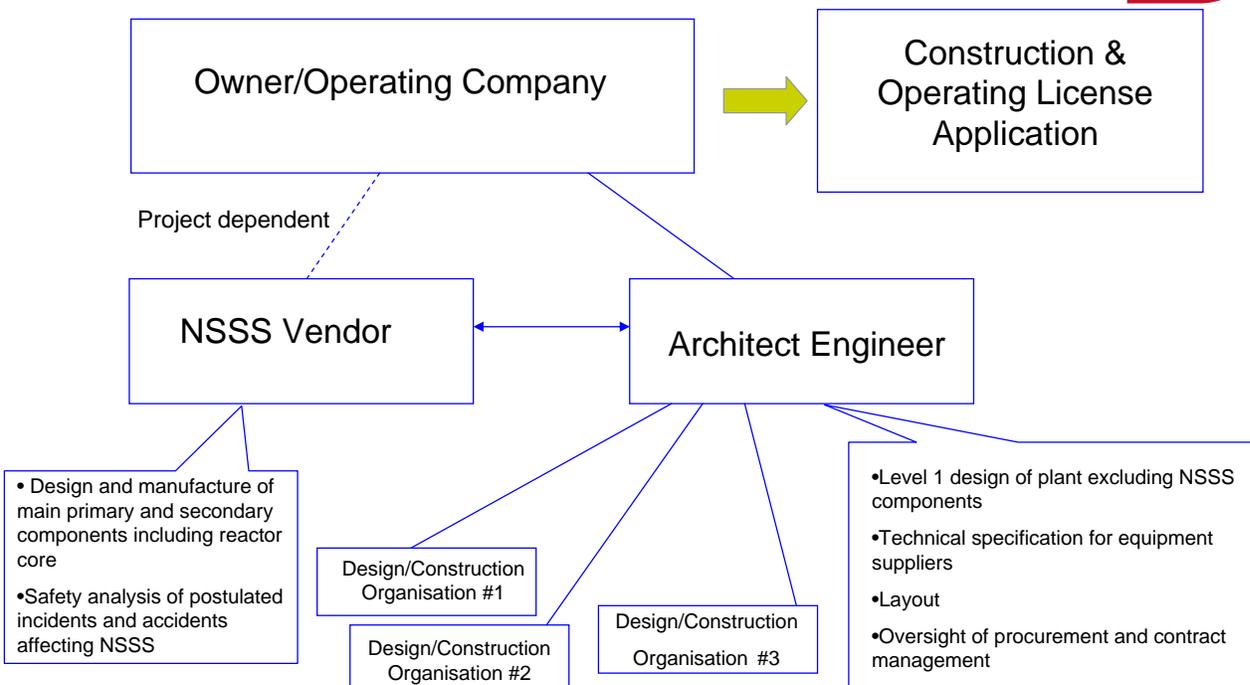
- ▶ **Demonstration that risks are ALARP is considered a legal duty for nuclear operators in UK**
- ▶ **To show ALARP, must show that cost and difficulty of further safety improvements is grossly disproportionate to the reduction in risk achieved**
- ▶ **Cost benefit analysis often used to support ALARP claims**

AREVA NP

Imperial College NTEC 2014 - p.19



License Applicant Organisation

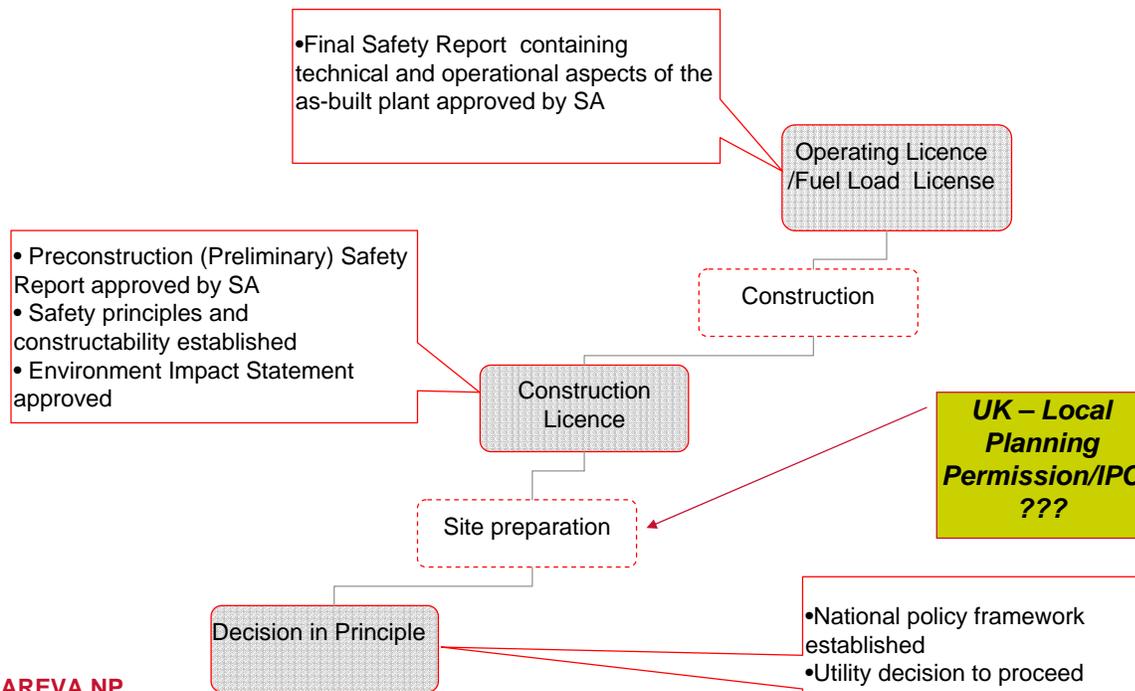


AREVA NP

Imperial College NTEC 2014 - p.20



Typical Licensing Steps in Nuclear Build Programme



AREVA NP

Imperial College NTEC 2014 - p.21



Contents

- ▶ Role of Safety Authorities & Technical Support Organisations
- ▶ **Application of International Rules and Frameworks**
- ▶ Structure of a Safety Report & Standard Rules and Practices
 - ◆ Deterministic analysis of accidents
 - ◆ Probabilistic analysis of risk

AREVA NP

Imperial College NTEC 2014 - p.22



International Framework



- ▶ National safety bodies are autonomous but national regulations for design, construction and operation of Nuclear Plants *generally* comply with standard international practices
- ▶ International bodies have published rules and guidelines for the safety of NPPs which are widely referenced e.g.
 - ◆ International Atomic Energy Agency (UN). Standards and guides for reactor design, construction and operation
 - ◆ European Utilities Group – Guidelines for design of next generation of LWRs in Europe
 - ◆ Western European Regulators Group – Regulatory framework for design and operation of reactors in Europe
- ▶ National safety bodies often benchmark their regulations against these standards. However most countries impose additional specific rules which go beyond international norms
- ▶ ***Nuclear safety regulation has not yet achieved international standardisation as achieved in other safety critical industries (e.g. global aircraft industry)***