Experiences with the construction of EPR at Flamanville and Taishan

OECD/ Nuclear Energy Agency

Workshop : ‘’Project and Logistics Management in Nuclear New Build”

NEA Headquarters, Issy-les-Moulineaux
March 11th, 2014

Agenda

- Background
- EPR Projects Status
  - Flamanville 3
  - Taishan 1&2
- Lessons learned
  - Process
  - Examples
  - Early Contractor Involvement

EDF's NUCLEAR FLEET

Powerful, competitive, low CO_2 emissions

The demands of a zero error safety culture

- **EDF Group: the world's No. 1 nuclear power operator**
  - 485.5 TWh generated
  - France: 58 PWRs* at 19 sites
    - 404.9 TWh generated: 74.8% of production
    - €2.7bn invested in maintenance
  - United Kingdom: 14 AGRs**, 1 PWR* at 8 sites
    - 60 TWh generated
  - USA: 5 PWRs* via CENG (49.99% EDF stake) at 3 sites

- **Building the future**
  - 3 PWRs under construction
    - 1 in France: Flamanville
    - 2 in China: Taishan (30% EDF stake)
  - 1 PWR project in the United Kingdom:
    - 2 reactors at Hinkley Point
    - Authorizations granted
    - Design approved by safety authorities
    - Final Investment Decision not yet taken.

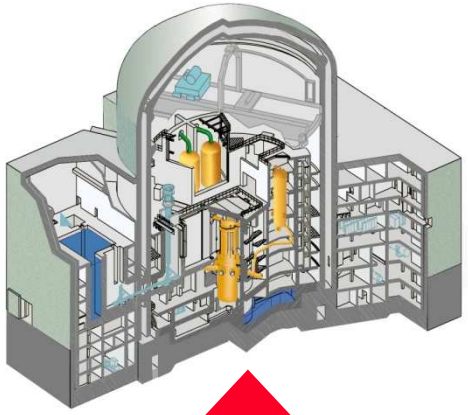
* Pressurized water reactor

** Advanced gas-cooled reactor

EPR = E*uropean (Evolutionary)* P*ressurised water* R*eactor*

Design derived from French N4 and German Konvoi series.

Increase nuclear safety



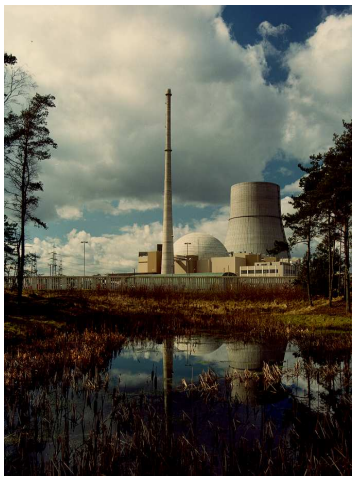
More competitive

EDF-Framatome N4

Evolutionary design concept

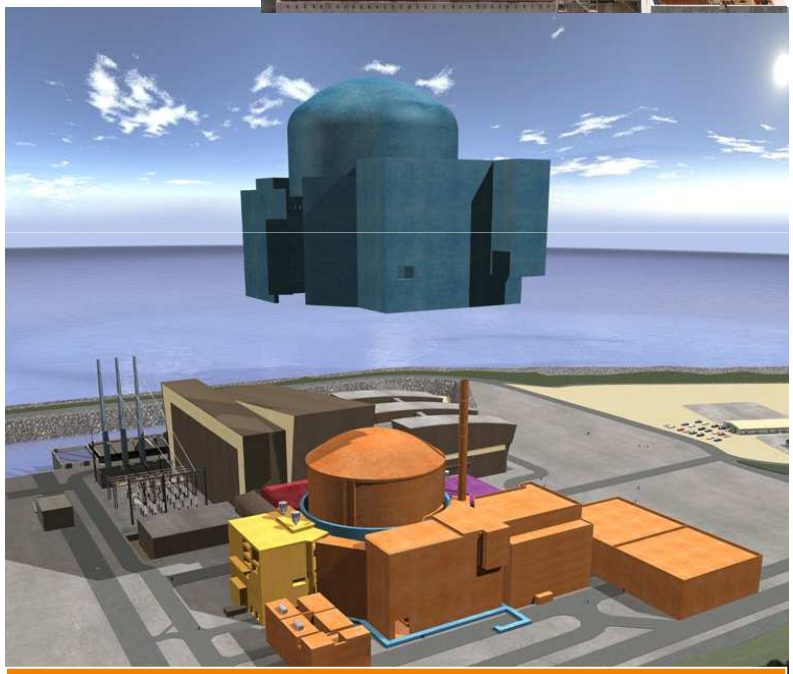
Feedbak of experience
From 58 + 17
reactors in operation

Siemens KONVOI



EPR : some design features to enhance safety

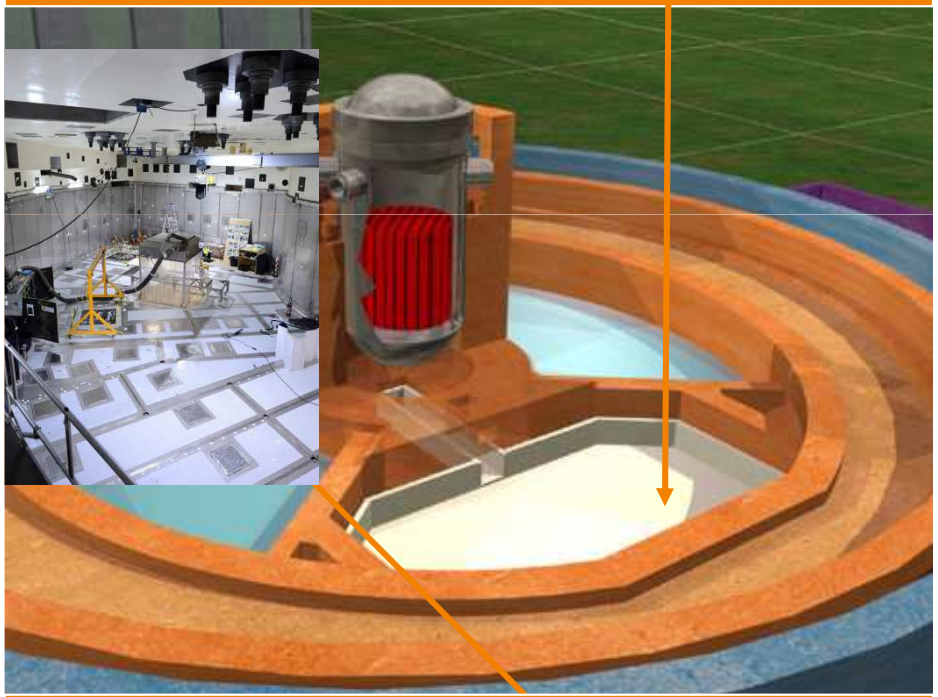
4 independent safety trains



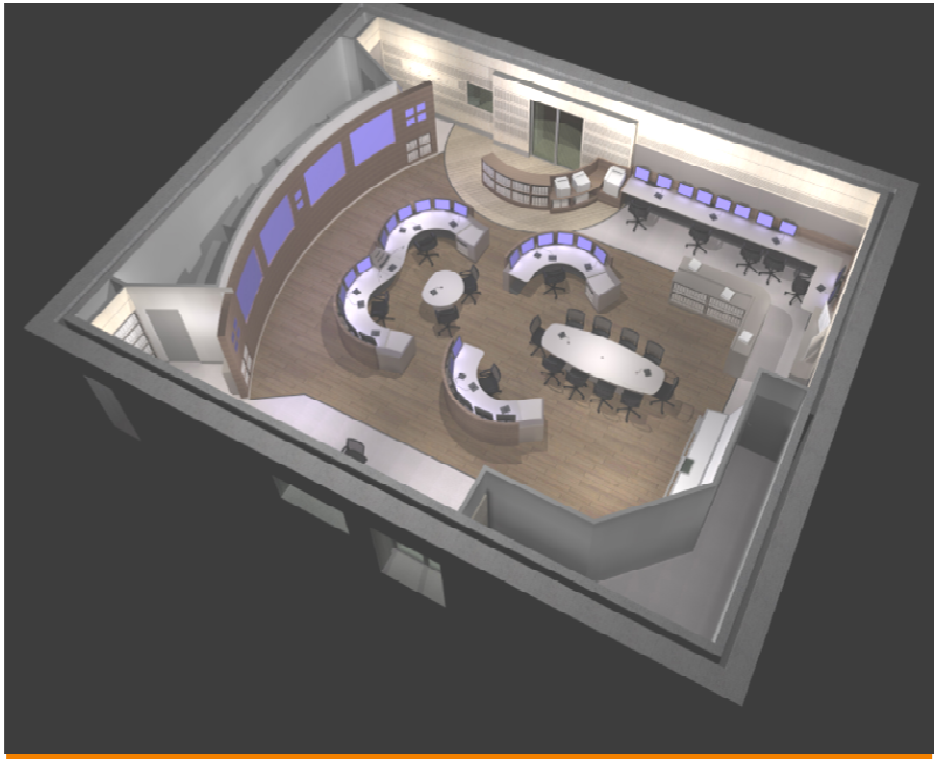
Air Plane Crash shelter
Made with very thick concrete structure

EPR : some design features to enhance safety

Core melt stabilisation system



In-containment water storage + passive cooling system



Digital Instrumentation & Control system Computerised Man Machine Interface

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FLAMANVILLE 3

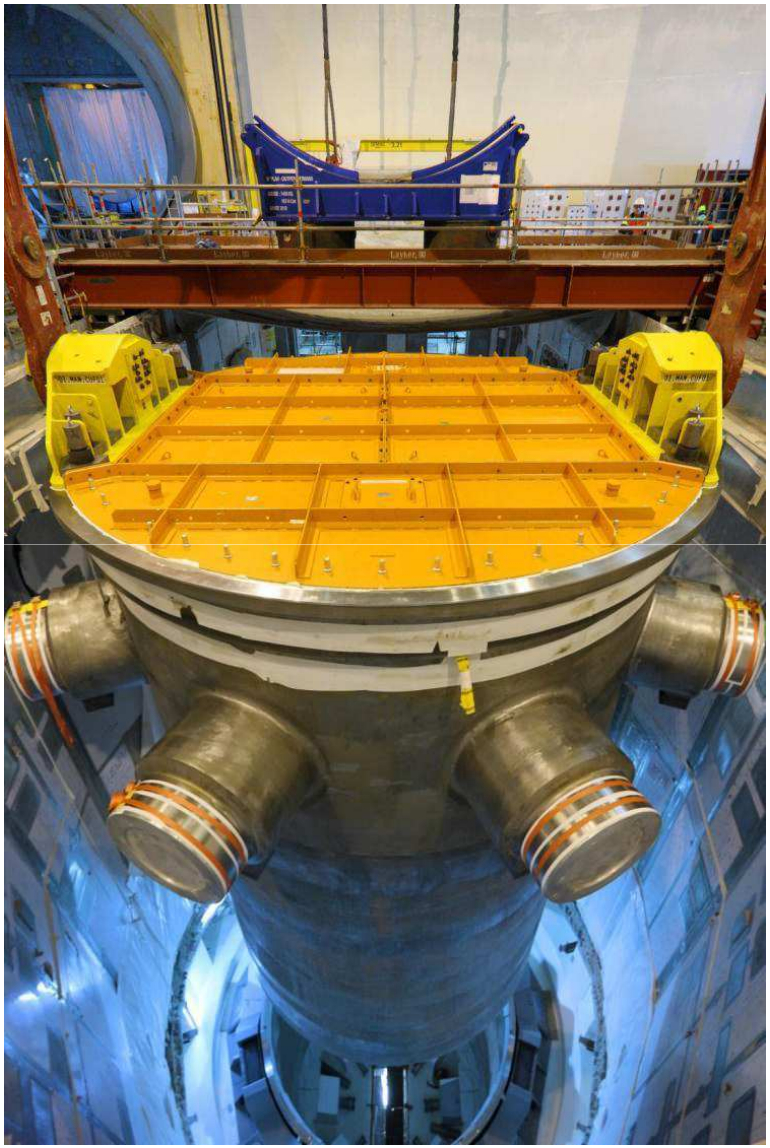
FLAMANVILLE 3

Civil engineering work almost completed.

Prestressing under prepartion.

FLAMANVILLE 3

Electro – Mechanical work :
more than 50 % completed



FLAMANVILLE 3

Conventional Island completed

FLAMANVILLE 3

oCable puling ongoing
oI&C cabinets ongoing
oHV& LV switchboards completed

FLAMANVILLE 3

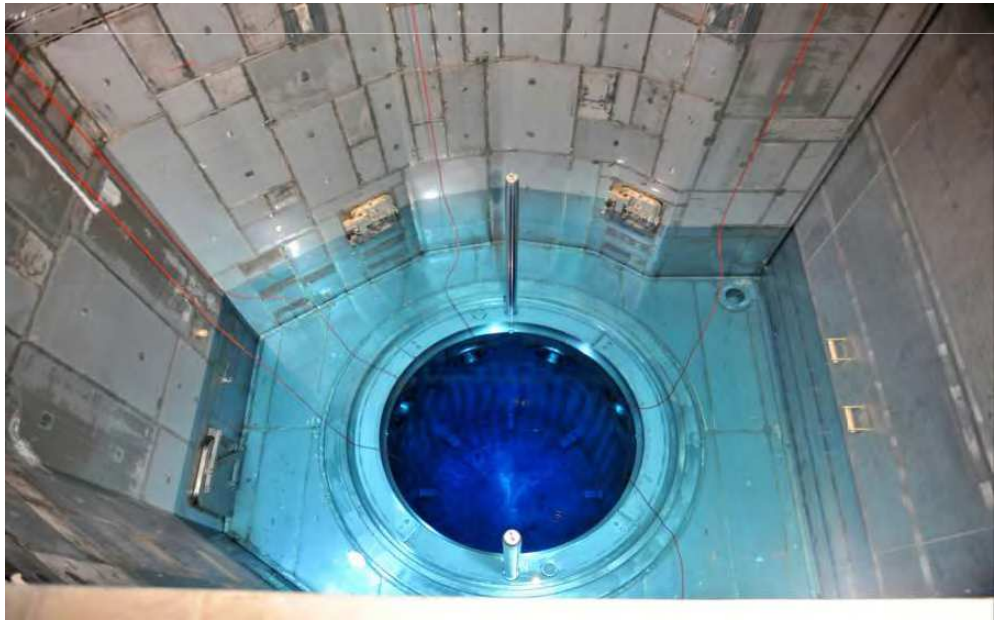
Commissioning under progress

On track to reach the 2016 target.

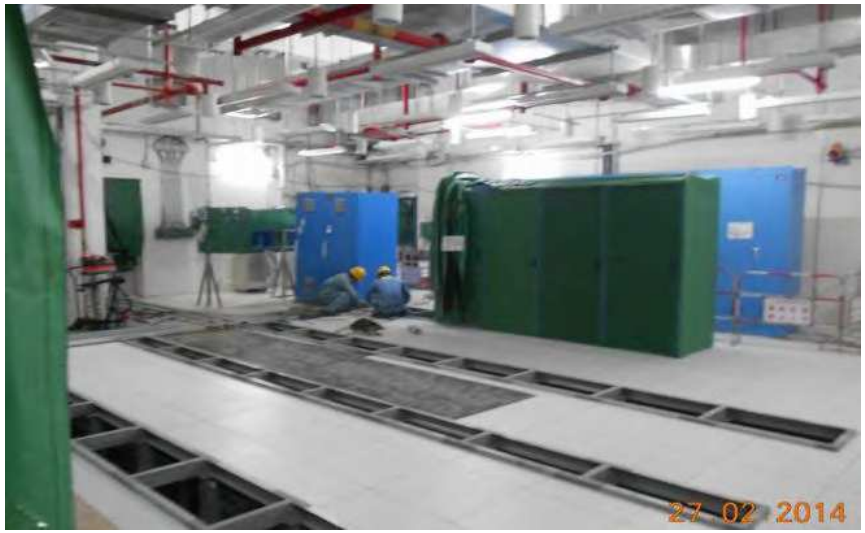
TAISHAN 1&2

TAISHAN 1

TAISHAN 1

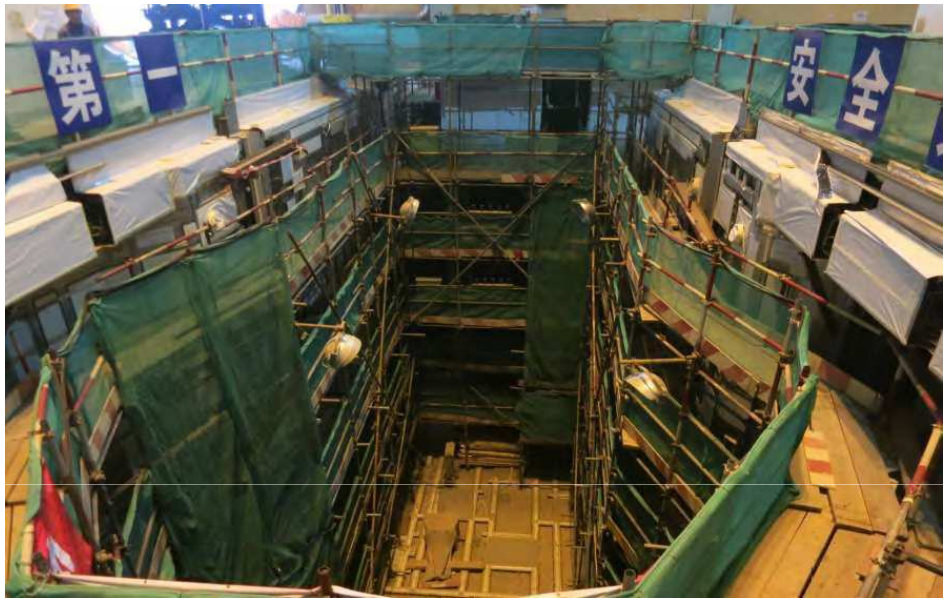


TAISHAN 1



TAISHAN 2

TAISHAN 1&2



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Lessons learned

Goal

Avoid repetition of problems encountered on in-progress EPR Projects

Informed about good practices
and engineering choices

Method

- ❑ Establish a continuous improvement culture across organizations
- ❑ Implement a process which quickly defines, assesses applicability and implements Construction Lessons learned

Users All EPR Projects

Sharing for mutual benefit

Lessons learned :
a continuous improvement process

Lessons learned process :

- Capture Lessons Learned
  - Launch investigation on critical topics (top-down process)
  - Encourage LL implementation in the database (bottom-up process)
- Analyze LL
  - Sorting of LL by leader entities, by impact (cost, schedule, constructability)
  - Analysis (relevance, applicability to other projects)
- Process the LL
  - Appoint a pilot for each LL
  - Launch investigation & action plans
  - Follow-up of actions
  - Implement solution (best practices, issues, know-how)
- Communicate
  - Report
  - Share

Transforms experiences into valuable knowledge

Lessons learned : a continuous improvement process

- **Why ?**
  - To prevent & eliminate difficulties for further projects, offers and ongoing projects: Enhance constructability
  - To reduce and secure cost & time schedule

To improve the performance

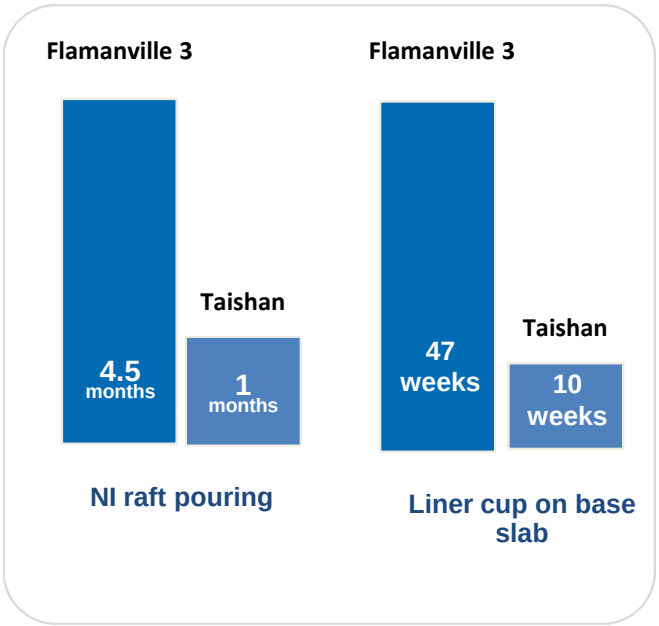
- **How ?**
  - Implement Lessons Learned in the database
  - Redaction of reports, interviews,
  - Missions on site
  - With support of a LL network positioned in key entities

By dedicating people to this task

- **When ?**
  - Day to day
  - Lessons Learned is an ongoing process

Every day

Examples



Flamanville 3

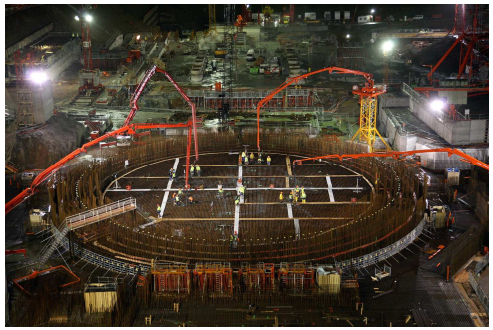
- Issue with the liner containment erection
- Liner le&ading to efficient welding

Taishan 1 & 2

- Reactor raft poured in one step
- CW feedback in order to optimize construction methods

Hinkley Point 1 & 2

- Construction methods => prefabrications
- Early Contractor involvment
- Improvement of mechanicale and elevtrical erection works



HINKLEY POINT C

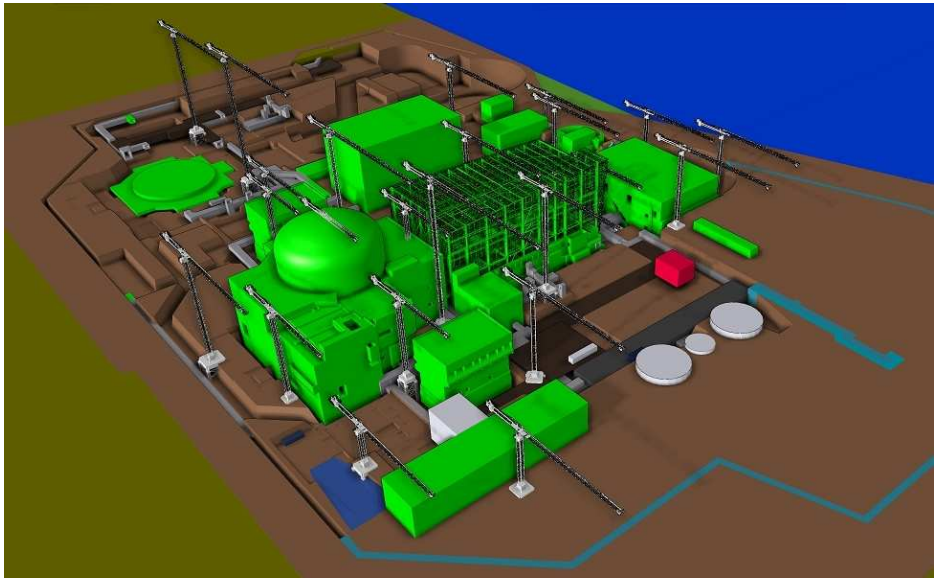
Hinkley Point C project key strengths

Leverage from nuclear and large infrastructure projects	▪ World-class team with significant experience in nuclear projects and large infrastructure projects (2012 Olympics, Heathrow Terminal 5) ▪ Lessons from other EPR projects fully included ▪ Involvement of strategic industrial partners, sharing construction risk
Specific project strengths	▪ Strong project organisation and clear processes ▪ Basic design agreed with UK regulator together with strict change management process ▪ Robust cost model and schedule developed ▪ Constructability and interface management improved by 4D modeling
Alignment through contractual framework	▪ Supply chain aligned to delivery and management of risk ▪ Early contractor involvement improves constructability and interface management

HPC Project

Examples of benefits – pre construction

4D Construction Planning Model



Detailed on site / off site logistics planning:

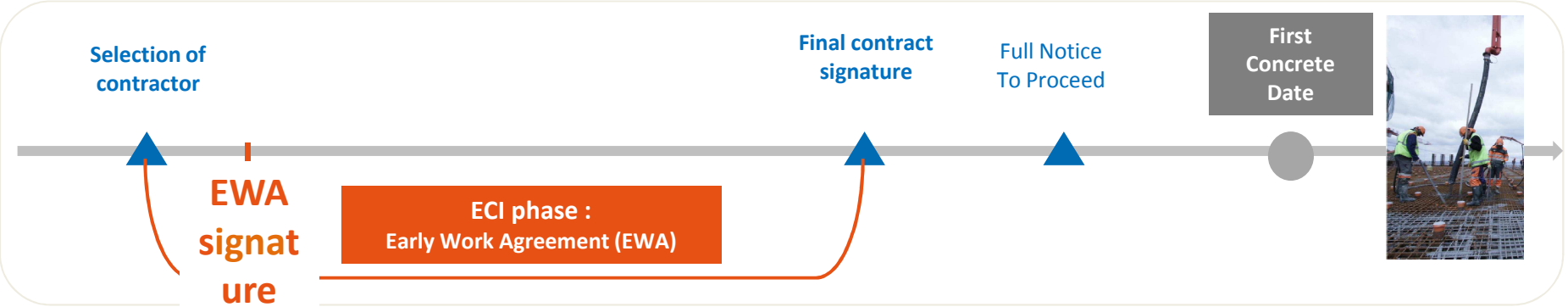
- Monthly time slice
- Cranes; scaffold & access
- Welfare & facilities
- Temporary roads, utilities & works
- Materials handling; lay down & traffic control
- Interfaces between other contracts

New build contracts - Major lessons learned

- Analysis of FA3 main contracts and their management
  - **Significant increase in initial quotation, mostly due to many configuration changes**
  - **Insufficient control of contractual milestones**

- Major areas of improvement, in particular:
  - **A more precise definition of technical scope : engineering studies, equipment/system list, BoQ, erection, etc**
  - **The right moment to sign the final contract: some contracts signed too early compared to detailed design status and works**
  - **Setting up of contractual milestones : notice dates, contract steps (studies, qualification, procurement, manufacturing, erection, tests)**
  - **Cost firming up**

Early contract Involvement (ECI)



- ECI phase : a firming-up phase to conduct early and limited works to get a better level of certainty of contract scope, costs and schedule
  Through an Early Work Agreement (EWA)

- Early Work Agreement may cover the following activities (depending on the Contractor's activities)
  - Critical engineering activities
  - Technical configuration and interface management
  - Project management activities ramp-up
  - Plot plan finalisation / optimisation
  - Site Preparatory work
  - Support to licensing
  - Schedule

Interests of ECI – project & construction aspects

Win-Win approach: an integrated team to set the environment for success

- Entering in a smooth and simplified dialogue with the contractor, working together to prepare the execution of the final contract
- Collaborative work with the contractor to develop a common solution and approach

- Risk management: engineering studies performed before FNTP allowing to reduce critical risks (with high probability and high impact), optimise design and secure planning
  - Reduction and management of changes in configuration with contractor: No work shall be started on construction until specifications, drawings sufficient and configuration enough stable. Freeze of a design reference.
  - Anticipation and clarification of interfaces between lots/contracts
- Appropriation of contractor methods, common development of process and procedures
  - Consider constructor methods at the very beginning of the detailed design phase
  - Integrate innovative methods and tools from contractors mastering their construction specialty (civil works, etc)
  - Improve constructability (pre-fabrication, etc) by considering it in the early engineering phase
  - Optimise delivery process
- Implementation of project management organisation in line with contractors' one and associated preliminary activities to be ready to start construction just after the FNTP

Interests of ECI – contractual aspects

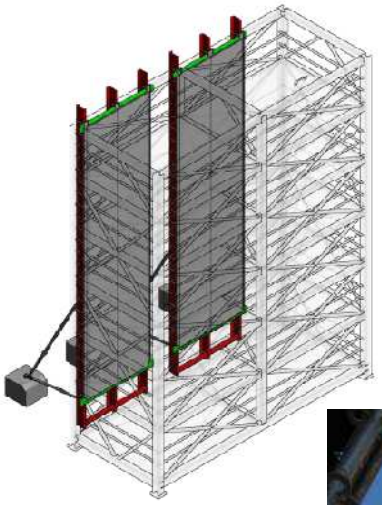
Win-Win approach: an integrated team to set the environment for success

- Entering in a smooth and simplified dialogue with the contractor, working together to prepare the execution of the final contract
- Collaborative work with the contractor to develop a common solution and approach

- Improvement of contract management system and process applying international best practices:
  - Formalisation: contractual exchanges, precise definition of milestones, deliverables, interfaces
  - Tools for contract managers
- Contractual integration of an agreed number of configurations and associated key milestones (in the final contract)
- Cost firm up : from an estimated target price to a final target price. Reduction of contingencies level
- Common work on schedule

ECI - HPC Main Civils Contract

Examples of benefits – pools optimisation



Heavy prefabrication of the pools has been studied in detail.

The pools will be prefabricated and lifted into to position

Significant improvement in schedule

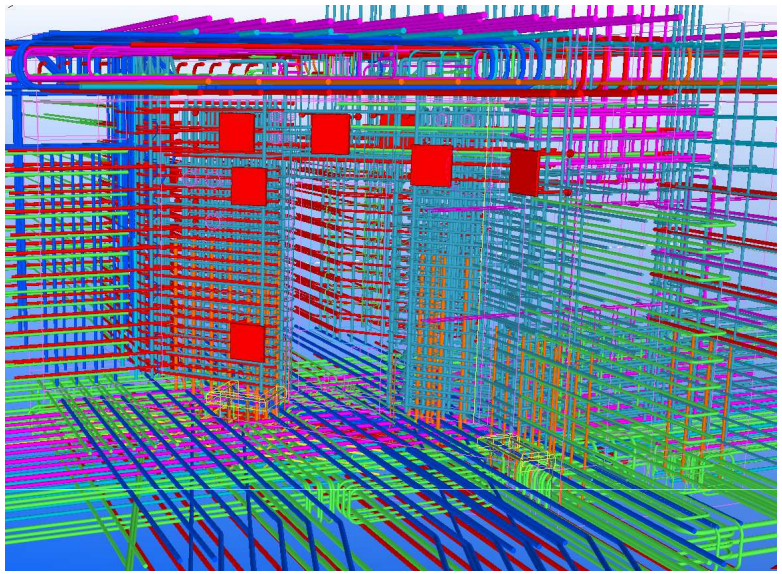
Improvement in safety

Improvement in quality

ECI has identified and developed specific details to enable the prefabrication of the pools

ECI - Main Civils Contract

Examples of benefits – design to build

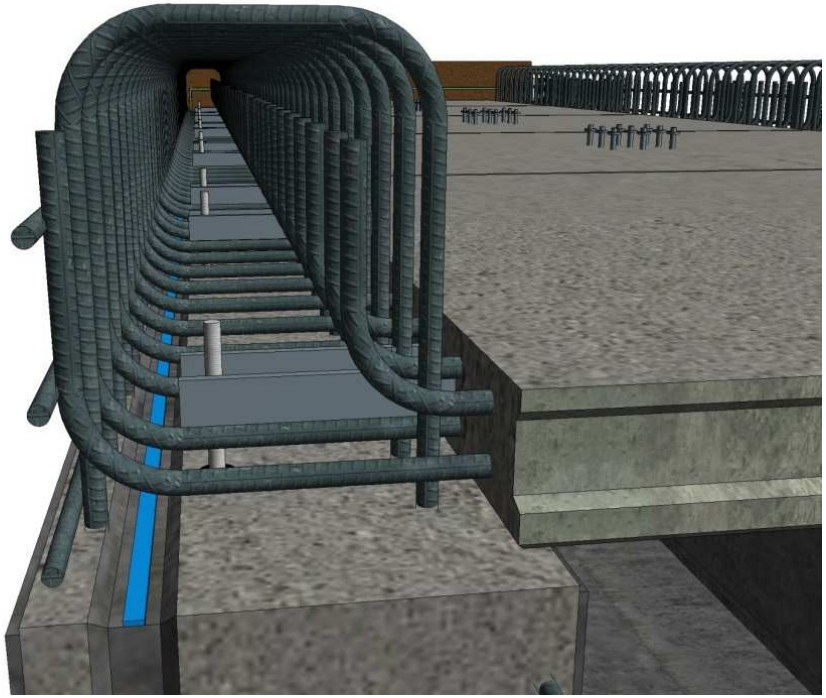


Problems detected and resolved during the design phase giving better certainty on construction programme due to:

- Clash detection of rebar, plates and cast in items
- Construction sequencing and coordination
- Material control on site – lean processes using manufacturing techniques
- Improved quality and productivity

ECI - HPC Main Civils Contract

Examples of benefits – gallery optimisation



Precast concrete roof slab components with structural topping:

- Increases productivity,
- Improved quality with cast in items to be fitted in a factory environment,
- Avoids requirement for false work & propping pus early backfilling,
- Improves safety / reduced working at height.

It's important to carry on the ECI through the key contracts

Thanks for your attention