Realisation of the PALLAS Reactor.
Experiences and lessons learned

Jan van der Marel, Technical Director PALLAS Reactor, 6 June 2024

PALLAS NRG

Who am I?

- 30 years of experience in engineering, consultancy and project management, of which 10 years in the nuclear industry
- PALLAS Reactor Project: Technical Project Director responsible for
  - Engineering and Commissioning
  - Quality Safety and Licensing
- Nuon / Vattenfall
  - Director Engineering new build projects
  - Project Manager life time extension Velsen 24, Velsen 25 and IJmond power plants.
  - Technical Project manager new build Hemweg 9 and Diemen 33 gas power plants
- Education: Master of Business in Energy Systems. TU Delft
- Jacobs:
  - Project Manager / Consultant energy and utilities projects
- Comprimo / Nucon
  - Nuclear I&C and process engineer
- Education: Applied Physics, TU Delft

Content

Realisation of the PALLAS isotope production reactor.
Experience and lessons learned for NPP's

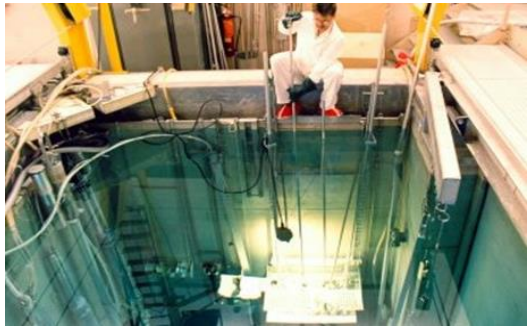
1. The PALLAS reactor objectives and status
2. 4 area's of experience and lessons learned
   - Design
   - Licensing
   - Project Organisation and Contracting
   - Financing, and (political) decision making
3. Conclusion of 'top level' lessons learned

PALLAS reactor - PALLAS isotope production facility

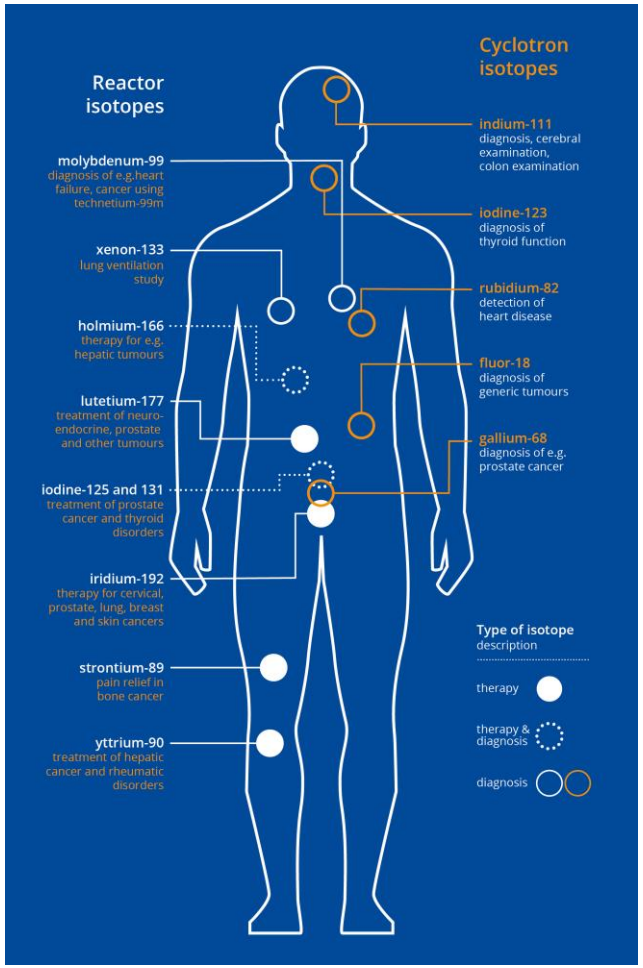
Supported by the Dutch Government

Secure supply of medical isotopes

Key nuclear infrastructure



Driver of local economy



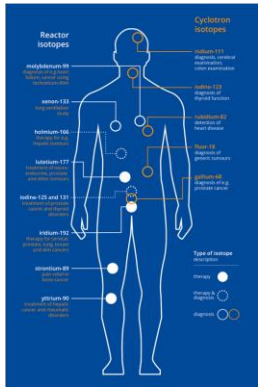
"Ensure security of supply of medical isotopes in Europe, support maintaining nuclear knowledge in The Netherlands, provide high level jobs in the region of North Holland by realizing the PALLAS-reactor, the NHC and building the organisations to operate both facilities,"

Preparatory phases and realisation PALLAS-reactor

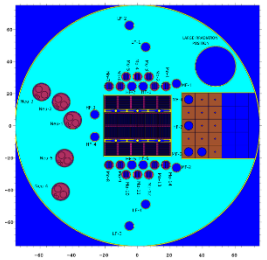
2013 -2014	2015 -2016	2017 -2018	2019 -2020	2022	2023		~ 2030
Project start-up	Scoping	Tendering	Basic design	Detailed design	Construction	Commissioning	Start-up

HFR – PALLAS transition phase

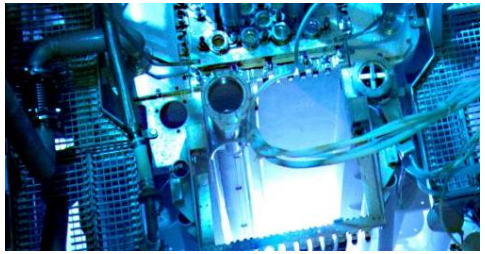
Reactor Project structured approach



Safe Commercial Operation

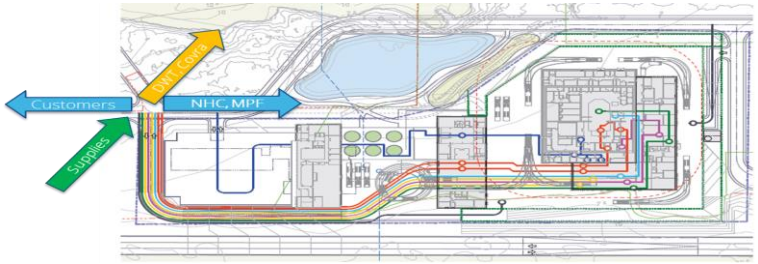


Requirements
&
Guaranteed
performances



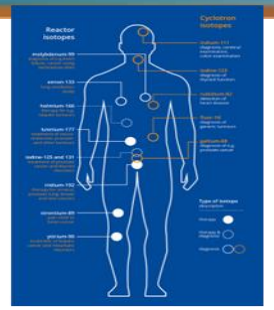
Performance test

Basic Design,
PSAR,
Capability reports



Commissioning

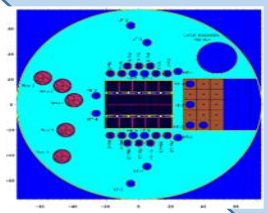
Reactor Project; Systems Engineering



Validate

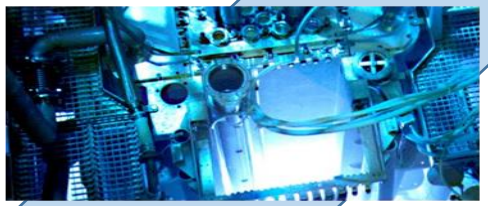
Safe Commercial Operation

Verify



Requirements & Guaranteed performances

Validate

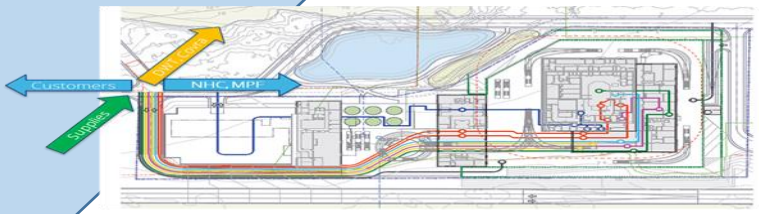


Performance test

Verify

Basic Design, PSAR, Capability reports

Validate



Commissioning

Basic design / Technical Baseline

System integration test

Detailed design

Integration tests

Specification of components

Component tests

Realisation

Verification

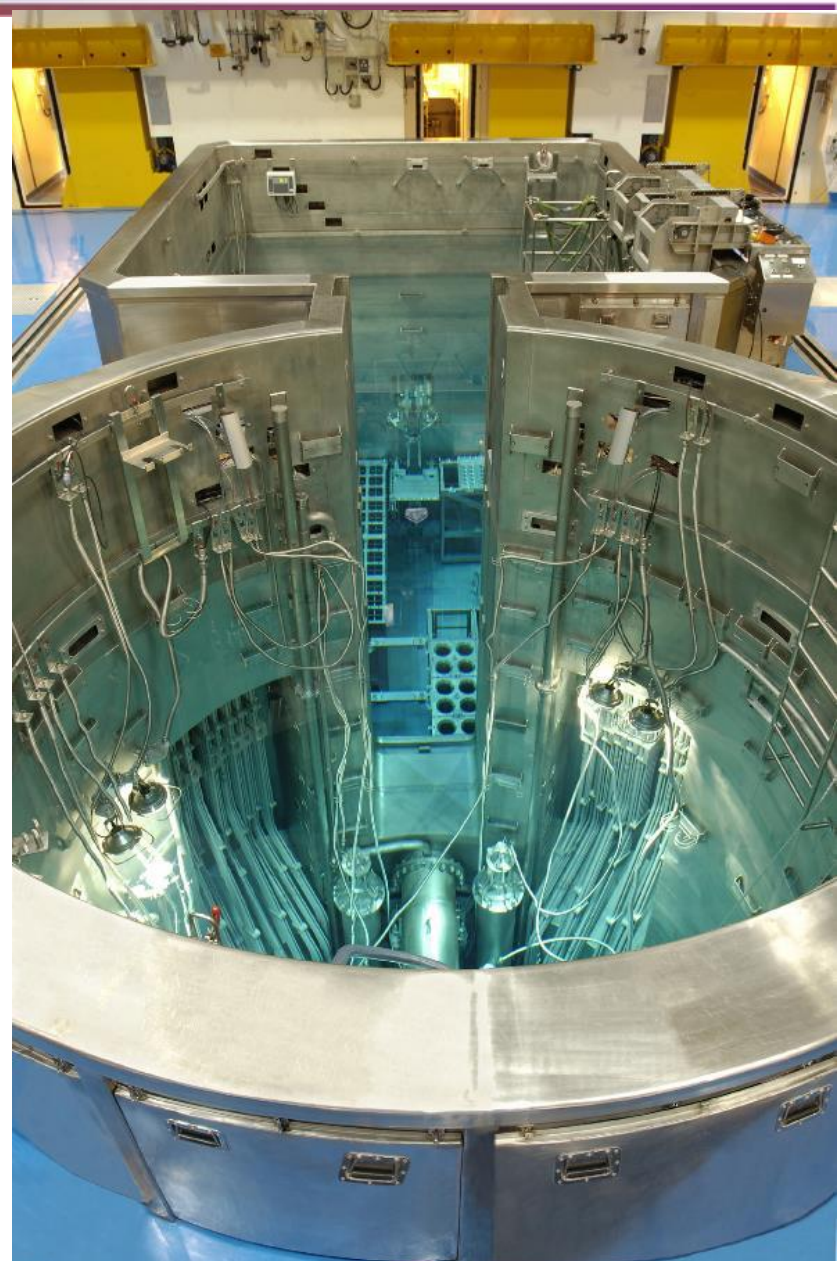
Validation

10 years of PALLAS

Assignment to develop the PALLAS reactor replacing the HFR.

Objectives

	Short Story
1. Develop the design	√
2. Obtain the licences	√
3. Develop the business case	√
4. Obtain financing	√



10 years of PALLAS

Assignment to develop the PALLAS reactor replacing the HFR.

Objectives:

1. Develop the design
2. Obtain the licences
3. Develop the BC
4. Obtain financing

Long Story

Challenges

Culture

Successes

Set backs

Reviews

Changes of Strategy

Milestones achieved

Hard work and extra hours

Developing Organisation

PALLAS has many lessons learned

Status PALLAS Reactor

Design

- Basic Design completed
- Detailed design started 2023
- Intermediate Design Review June 24

Licensing

- All licenses granted
- PSAR approved and nuclear construction license in place

Organisation

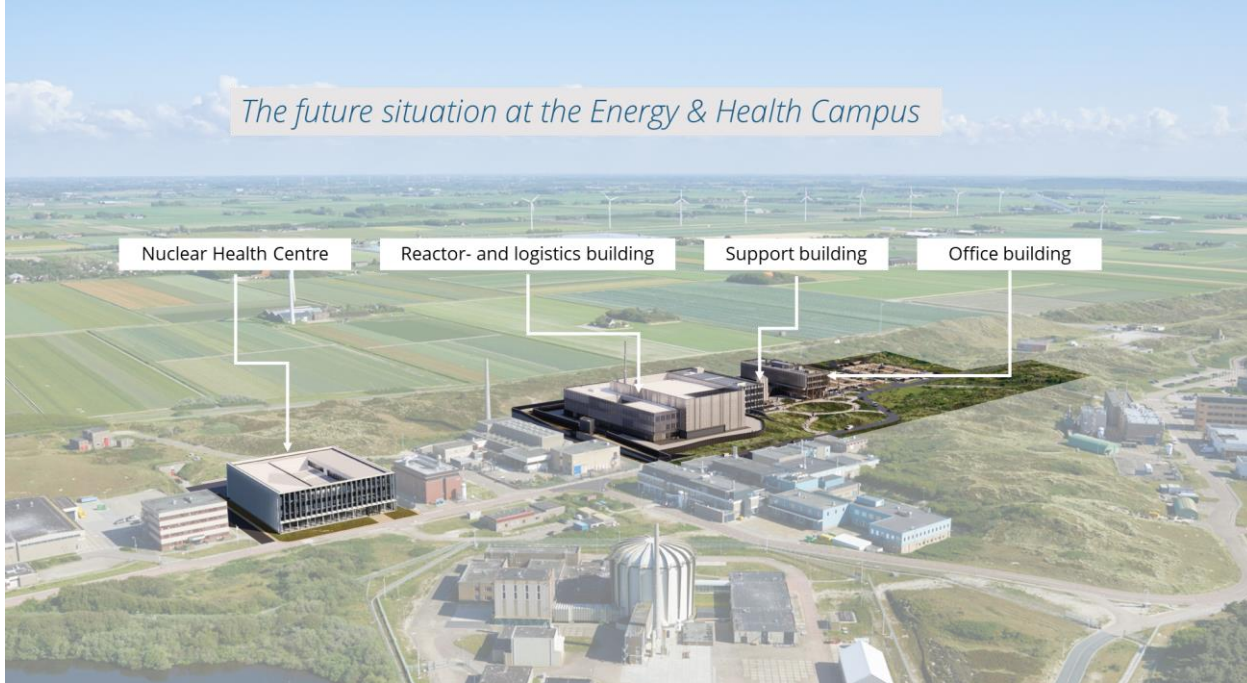
- Main contracts in place for execution
- Joint project organisation in preparation for execution

Financing

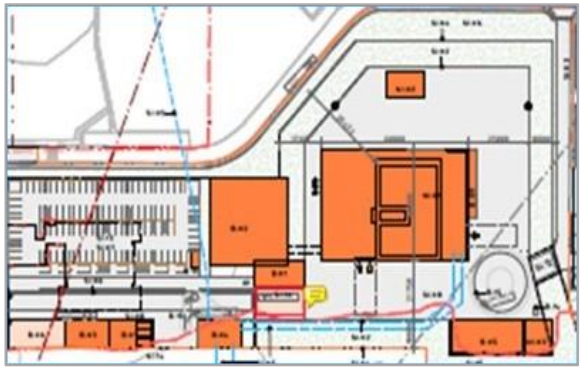
- Financing in place based on Business Case and Basic Design

Construction

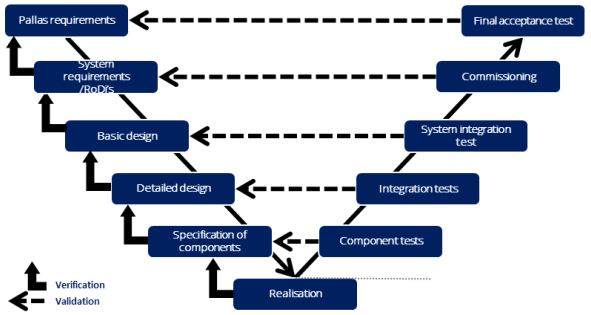
- Lay down area completed
- Pit and Foundation in progress
- Nuclear Island and cooling water system construction in preparation

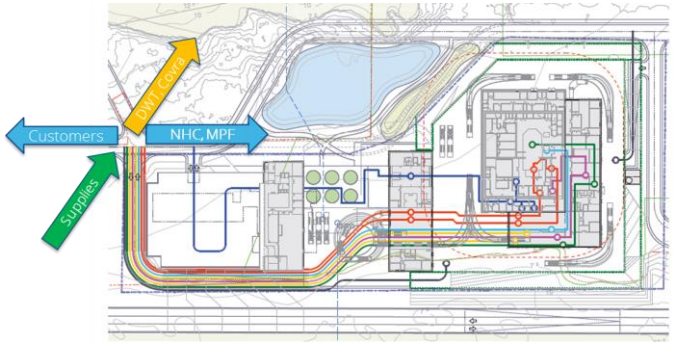


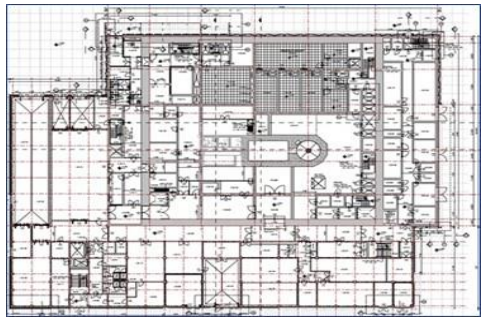
Develop PALLAS reactor; Design Perspective



Systems Engineering







Research Reactor

2017 — User requirements defined

Integrated design for reactor production

Integrated Design Site Layout

Integrated Design Building Layout

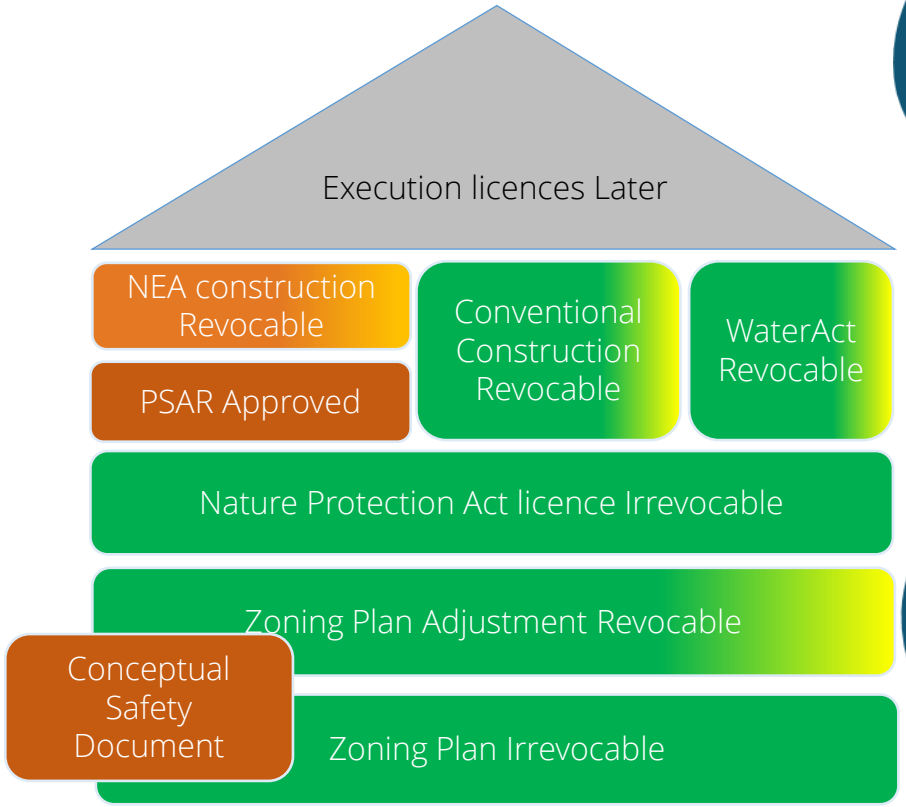
Integrated Design for Production, Waste and Radiation Protection

2022 — PALLAS becomes Design Authority
Detailed Design Started

Medical Isotope Production Plant

Structured Approach
based on
Systems Engineering
with
Collaborative Integrated Design
steps from
Research Reactor
to a
Isotope Production Plant

Develop PALLAS Organisation; Safety & Licensing Perspective



Research Reactor

2017

Dutch Safety Requirements

EIA
Zoning plan

Conceptual Safety Document

Zoning plan Adjustment

PSAR

Nature Protection act (Nitrogen!)

PSAR approved

EIA
WaterAct licence
Conventional Construction Licence

2022

NEA Granted

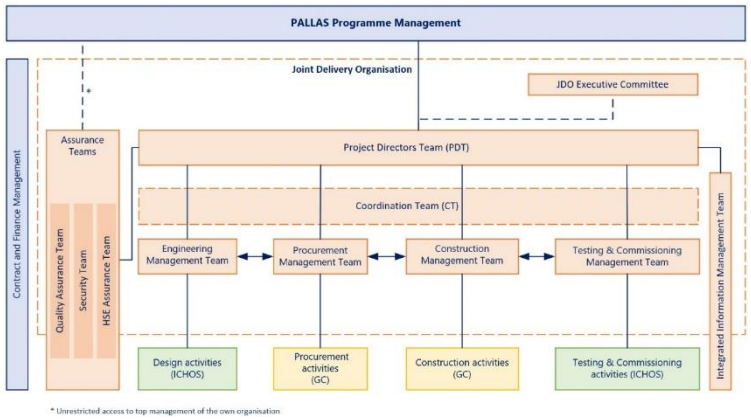
2023

Licensed Medical Isotope Production Plant

Cooperative Regulator Approach
leading to
Structured Licensing
Process of the a
Licensed Nuclear Isotope Prod. Plant

Develop PALLAS Organisation & Contracting Perspective

PALLAS & ICHOS



Joint Delivery Organisation

ICHOS PALLAS FCC

Research Reactor

2017

User requirements defined

EPCM/EPC Contract with ICHOS

Conceptual Design and Basic Design under EPCM

Construction Company left ICHOS

PALLAS from Contract Management to Delivery Organisation

Pit & Foundation construction started

2023

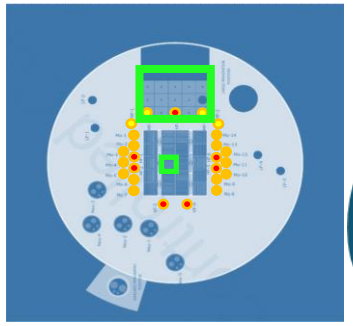
FCC selected as General Contractor; NEC4 contract

Joint Delivery Approach
leading to
Structured Licensing
Process of the a
Constructing Nuclear Isotope Prod. Plant

Constructing a Medical Isotope Production Plant

Develop PALLAS Organisation; Business Case & Financing Perspective

Irradiation positions and # hot cells.



Capability Reports

Safety
Production
Reliability
Supply chain
Operations and Maintenance

PALLAS reactor design aligned with business case

Research Reactor

2017 Assignment for private financing.

Conceptual Design; Value Engineering

Therapeutic isotopes

Letters of Intent from Investors

Shifting towards Public Financing

Ministry of Health investor

Investment Decision!

2023 PALLAS + NRG

Commercial Isotope Production Plant

Structured BC development
aligned with
Reactor Design
in
cooperation with financers
results in
Commercial Nuclear Isotope Prod. Plant

10 years of PALLAS; Develop Nuclear New Build Organisation

Develop 'from scratch' an organisation that:

- Has all the attributes and "**Safety Culture**" of a capable nuclear organisation
- Is a **Nuclear Licensee** having a NEA for Construction
- Can demonstrate **Compliance** to the legal framework
- Has **Contracts** in place to design and execute the PALLAS reactor
- Is capable to manage the contracts and the work: "**Intelligent Customer**"
- 'Owns' the "**Safety Case**"
- Can fulfil the role of "**Design Authority**"
- Is capable to apply a "**Graded Approach**"
- Has the support "**draagvlak**" from local, regional and national stakeholders

=> Is realizing the first new nuclear reactor in NL since NPP Borssele mid 70's

That is quite a Journey!!

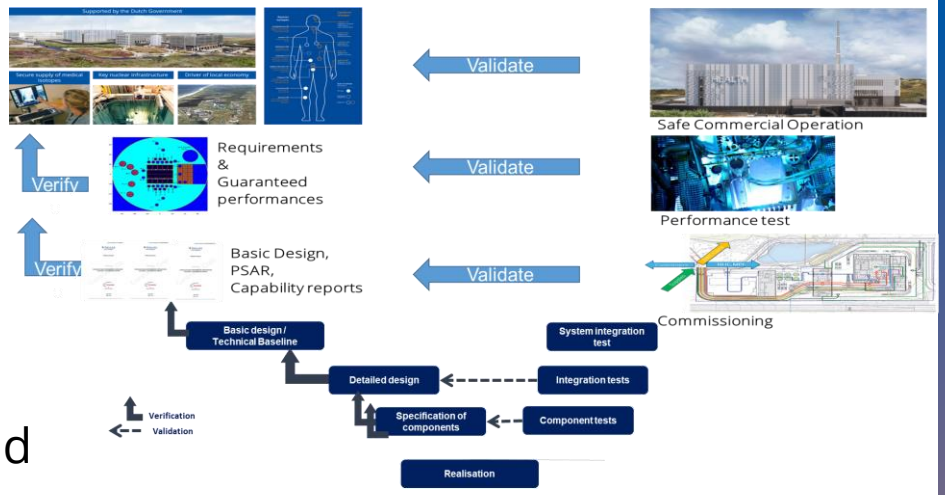
PALLAS has done this in the period 2014-2024

Top Lessons Learned

Structured approach

Demonstrate:

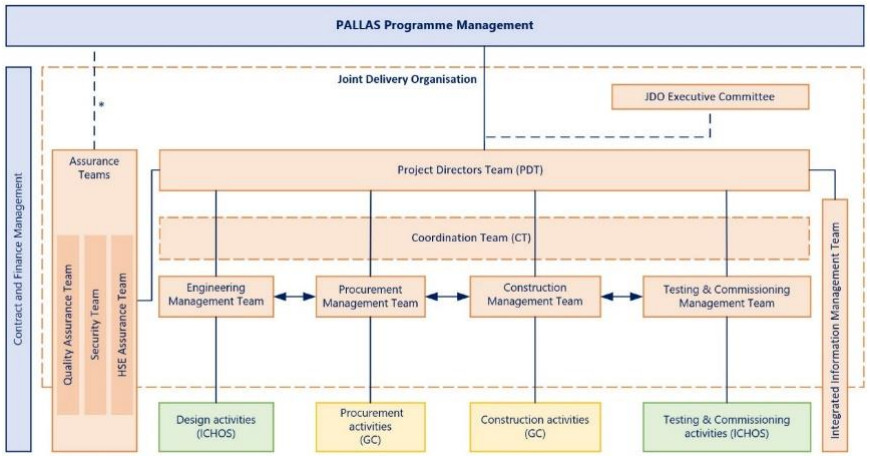
- Design compliant to top level requirements
- Compliant to (nuclear) safety regulations
- Supporting business case
- Quality in manufacturing and construction



Collaborative approach

Solve challenges together:

- Within PALLAS
- With financers
- With regulators
- With contractors



Key Success Factors

We maintain a strong safety culture

We care about the health and wellbeing of everyone involved in the PALLAS Programme. We invest in and help each other to maintain a strong safety culture. Our goal is zero incidents and accidents in both delivery and during operation.

We are one team that owns the whole programme

The PALLAS Programme will be delivered across organisational and disciplinary boundaries. We are not just individual parts with their own roles and responsibilities working in collaboration with each other; everyone sees the whole and truly acts in its service. No sub-optimization, but 'best for project' in everything we do.

We stick to the agreed scope

The PALLAS Programme has a clear assignment, translated into an agreed scope and quality requirements, that we are confident will deliver the benefits described in the business case. We focus on delivering the agreed scope and quality as soon as possible with minimal (only unavoidable) changes.

We will not start construction and commissioning until we are ready

We want to avoid a major risk of delay in large construction projects: rework during the construction or commissioning phase. Through good collaborative preparation and management and based on a well thought out and approved plan, we will only commit to construction and commissioning when we are sure we are ready.

We can demonstrate that we deliver quality

We must deliver the quality required to ensure safe operation of the reactor. Moreover, we must be able to demonstrate that quality has been delivered.

We have strong stakeholder management and clear governance

PALLAS is a unique, one of a kind programme that requires regular, proactive and effective communication with all stakeholders as well as clearly defined and agreed roles and responsibilities.

The current situation at the Energy & Health Campus