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NUCLEAR INNOVATION 24 CONFERENCE

Nuclear Solutions

Advanced Reactor Track Opening

NRG Advanced Reactor Activities

NIC 2024
June 5-6, 2024
Amsterdam, Netherlands

MSc Tjark van Staveren

- Tjark van Staveren
- Programme manager materials irradiations at NRG
- 13 years of experience in R&D projects for nuclear materials to support LTO, operation and new reactors
- Contact: +31 6 18725113 / vanstaveren@nrg.eu

Contents

- Advanced reactor track – objectives, organizational matters
- NRG activities in support of Advanced Reactor developments

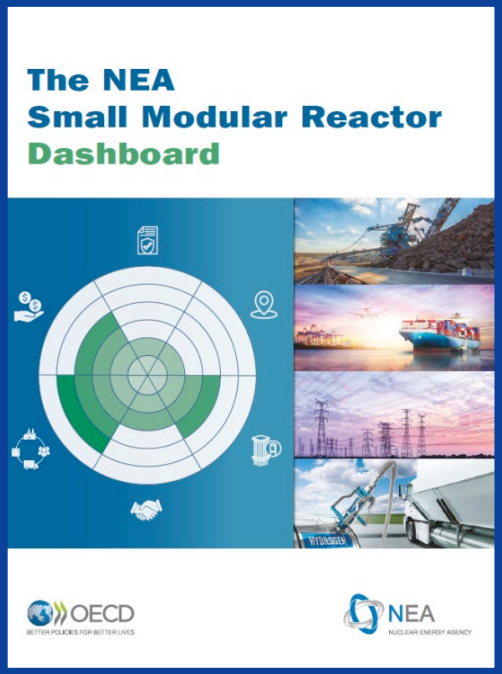
NIC 2024 Programme

- Keynote plenary session 1
- Track 1 – LTO (ageing management and LTO of NPPs)
  - Session 1.1: Regulatory approaches and research
  - Session 1.2: Industry challenges
- Track 2 – New Build
  - Session 2.1: Government
  - Session 2.2: Industry and supply chain
- Track 3 – Advanced Reactors
  - Session 3.1: Reactor developers
  - Session 3.2: Cooperation within the advanced reactor eco-system
- Keynote plenary session 2

www.nuclearinnovationconference.eu/program/program

Advanced reactors, what is happening?

- World-wide efforts by industry, (research) organisations and academia for development of advanced reactors
- Range of private and state-owned organisations around the world develop advanced reactor designs, often in partnership with existing nuclear supply chain
- NEA SMR dashboards report progress on SMRs and advanced reactors working on:
  - Licensing
  - Siting
  - Fuel
  - Engagement
  - Supply chain
  - Financing
- IAEA advanced reactor information system (ARIS) reports 78 advanced reactor and SMR reactor designs)
- But there are quite a few more...



IAEA | ARIS Advanced Reactors Information System

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Time	Advanced reactors
13:00-16:30	**Track 3 – Advanced Reactors, Session 3.1**
13:00-13:30	Track opening: NRG activities in support of Advanced Reactor developments, Tjark van Staveren (NRG, The Netherlands)
13:30-14:00	Fuel cycle development for Molten Salt Reactors, Isabelle Morlaes (ORANO, France)
14:00-14:30	Development of the Thorizon MSR One reactor, Kiki Lauwers (THorizon, NL)
14:30-15:00	**Coffee break**
15:00-15:30	Hermes Reactor Design Overview, Micah Hacket (KAIROS Power, U.S.)
15:30-16:00	Designing for advanced reactors, Jean-Mary Hamy (Framatome, France)
16:00-16:30	Striving to streamline SMR deployment, Eleonora Lambridis (Tractebel, Belgium)
16:30-17:00	Panel session moderated by Tjark van Staveren (NRG, The Netherlands)

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Time	Advanced reactors
9:00-13:30	**Track 3 – Advanced Reactors, Session 3.2**
09:00-09:10	**Opening day 2**
9:10-9:40	IAEA activities in support of advanced reactor developments, Aline des Cloizeaux (IAEA)
9:40-10:10	OECD/NEA and GIF activities to support the transition of Advanced Reactor Technologies from R&D to demonstration and deployment, Brent Wilhelm (OECD/NEA, France)
10:10-10:40	Regulatory framework in the Netherlands for licensing of advanced reactors. Joran de Jong (ANVS, Netherlands)
10:40-11:10	**Coffee break**
11:10-11:40	The SMR-LFR program, an enabler for innovation in nuclear, Pascal de Langhe (SCK CEN, Belgium)
11:40-12:10	EDF Energy perspective on development of advanced reactors in the UK, Jim Reed (EDF Energy, UK)
12:10-12:40	Progress in Developing Nuclear Graphite Grades for HTR and MSR application, Houzheng Wu (SINOSTEEL, China)
12:40-13:40	**Lunch**
13:40-14:10	Assessment of economical and societal impact of the development of molten salt reactors, Anna Menenti (Technopolis, the Netherlands)
14:10-14:40	Panel session moderated by Tjark van Staveren (NRG, The Netherlands)

NIC 2024 – Advanced reactor track organization

- Track leader will introduce speaker
- Speakers have 30 min timeslots
- Max 25 min for presentation + 5 min Q&A
- Track leader keeping time (signal after 20 minutes to conclude)
- Sticky notes to be provided to audience to collect questions
- One junior engineer will provide briefing about Advanced Reactor session topics, discussions and conclusions in plenary session

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Ensuring Nuclear Performance

Advancing Nuclear Medicine

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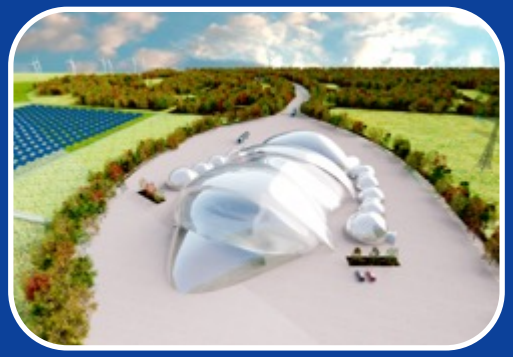

Advanced reactor development

Nuclear new build projects

Operational support

Long term operation

Decommissioning services

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TNO innovation for life

European Commission

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HFR is a multipurpose reactor for medical isotope production and nuclear energy research.

It is in operation since 1961, and operates in 9 ‘cycles’ per year with intermediate maintenance and fuel loading.

High flux in combination with instrumentation allows (accelerated) testing of materials and fuels under controlled conditions

EU DuC = N

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Advanced reactor activities at NRG

- Decades of experience in R&D activities for LWR and advanced reactor concepts (incl. High Temperature Reactors, Lead cooled reactors, Molten Salt Reactors, fusion etc.)
- Utilisation of unique nuclear infrastructure for neutron irradiations in combination with expertise on modelling and (safety) analyses
- R&D activities
  - Sponsored by the Dutch Ministry of Economic Affairs (incl. co-funding of international R&D projects
  - Bilateral activities for industry

Ministry of Economic Affairs of the Netherlands

Material and fuels R&D

- Advanced reactor concepts require assessment of materials and fuels performance for challenging operating conditions
- Fuels and materials performance is established by test irradiations and characterisation during or after neutron irradiation
- Fuel performance, e.g.:
  - Retention of fission products
  - Changes in physical properties
- Materials performance, e.g.:
  - Physical and mechanical properties
  - Interaction with cooling media

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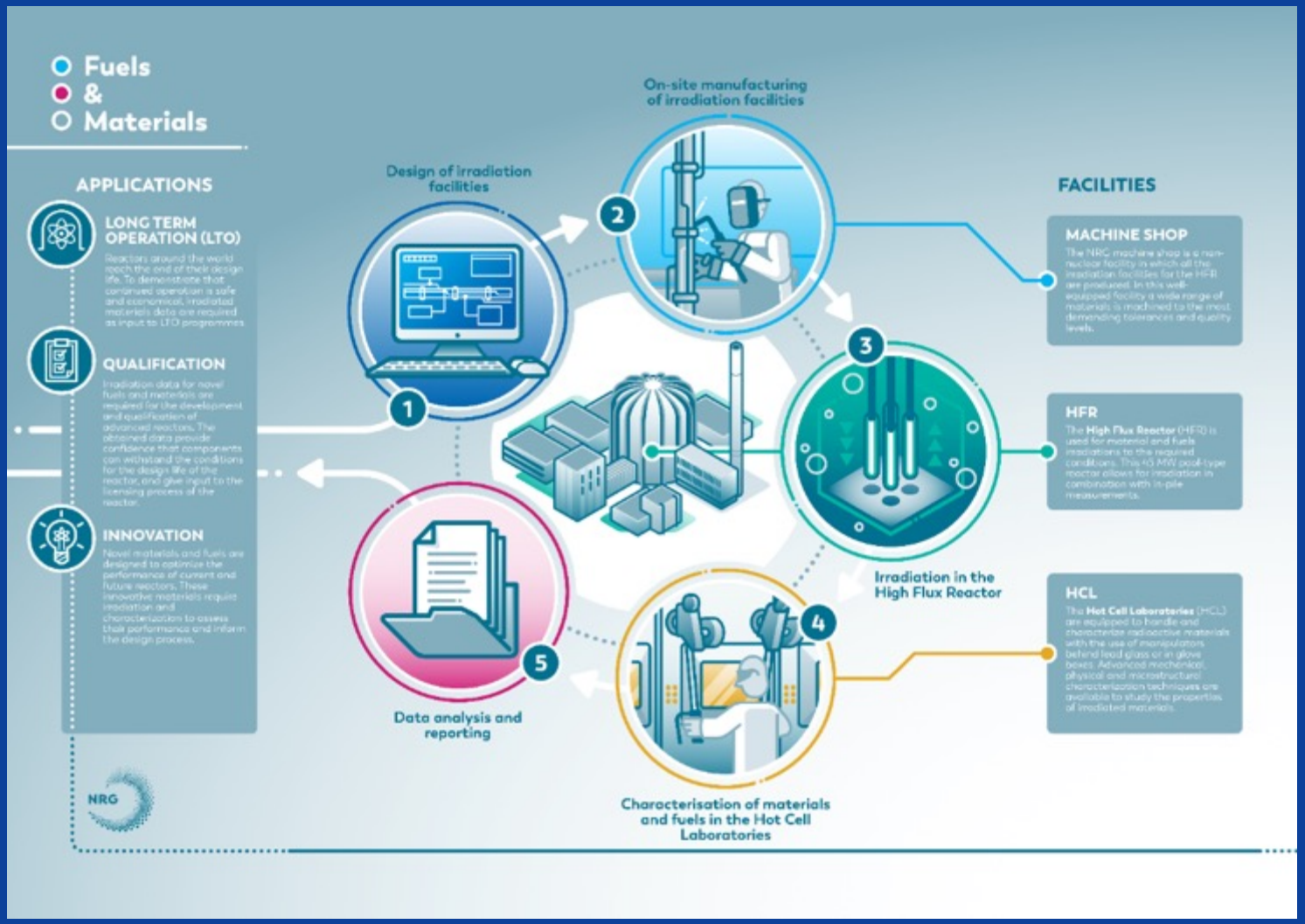
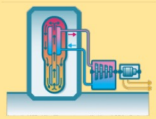
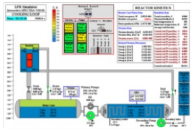
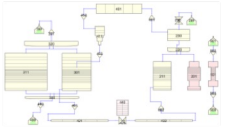
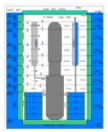
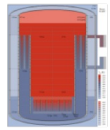
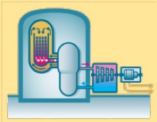
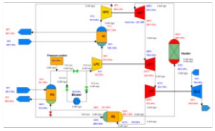
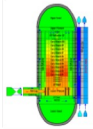
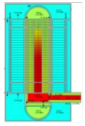
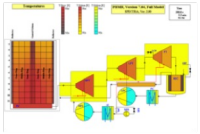
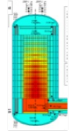
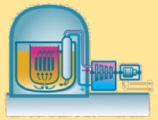
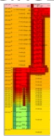
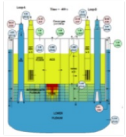
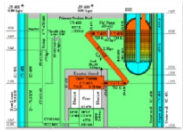
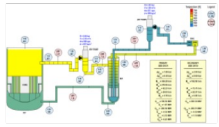
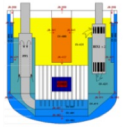
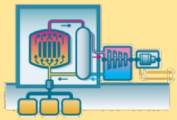
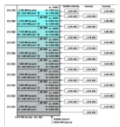
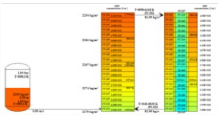
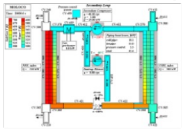
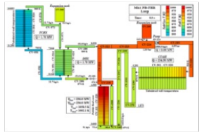
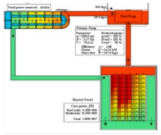


EU DuC = N

Modelling reactor systems

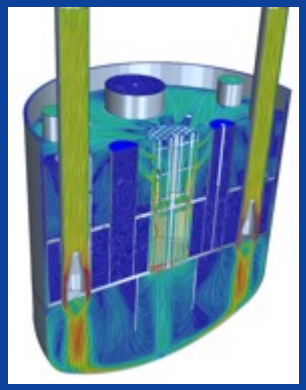
System Thermal Hydraulics codes (e.g. Relap5, TRACE)

Development of SPECTRA code

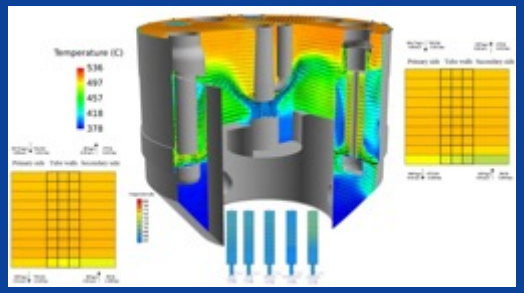
LW SMR 	Low Flux Reactor 	PERSEO 	MASLWR 	Westinghouse SMR 	LDR50 lite 
HTGR 	PBMM 	HTTF 	GEMINI 	PBMR 	HTR-PM 
LMFR 	CIRCE 	ESCAPE 	EBR-II 	FFTF 	Phénix 
MSR 	Static Column 	Standard MSR test 	HFR Facility Design 	Mk1-PB-FHR 	MSRE 

Modelling reactor components

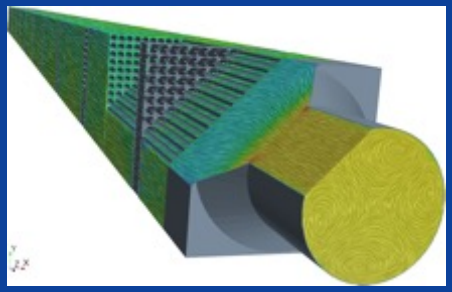
- Application of 3D CFD / FEM
  - Practical engineering increasingly complex geometries and physics to perform safety analyses)
  - High resolution to improve understanding and create reference data (numerical experiment) complementary to real experiments
- Development of tools towards:
  - Multi-phase
  - Multi-scale
  - Multi-physics



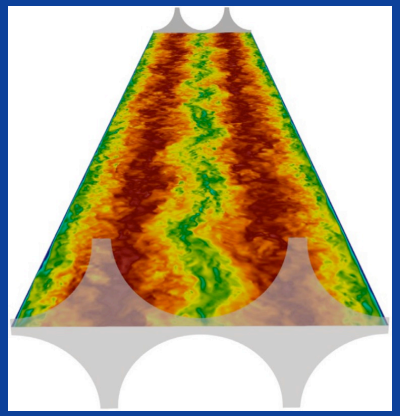
Flow and heat transfer ESCAPE electrical mock-up
practical engineering resolution



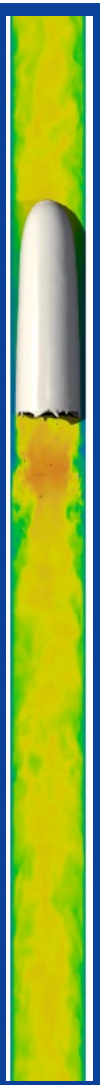
Flow and heat transfer in Phénix
multi-scale simulation (system & component level)



Heat transfer in a fuel assembly
practical engineering resolution



Heat transfer in a sub-channel
high resolution



Taylor bubble in a pipe
high resolution multi-phase

Conclusions

- NRG will continue to support advanced reactor developments in collaboration with international partners
- Existing nuclear infrastructure neutron irradiations will continue to be utilised to enable materials and fuels characterisation while new utilities are developed (PALLAS)
- Looking forward to interact with international experts to exchange thoughts at the Nuclear Innovation Conference 2024!

Thank you for your attention!

Any questions?