Мониторинг на радиоактивното замърсяване в градска среда

Йордан Янков, Nucleon Consulting Ltd

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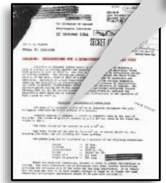
HTGRs Leverages Proven Technology with Novel Flexibility

Continuous innovation to improve safety and economics (capital cost and operating cost) with a focus on simplicity, reliability, flexibility

USA



1944
ORNL

UK

1966-1975
Dragon

USA

1966-1974
Peach Bottom

Germany

1967-1988
AVR

USA

1967-1988
Fort St. Vrain

Germany

1986-1989
THTR

Japan

1998-Present
HTTR

China

2000-Present
HTR-10

USA

NGNP

2005 – Present

USA

2009 – Present

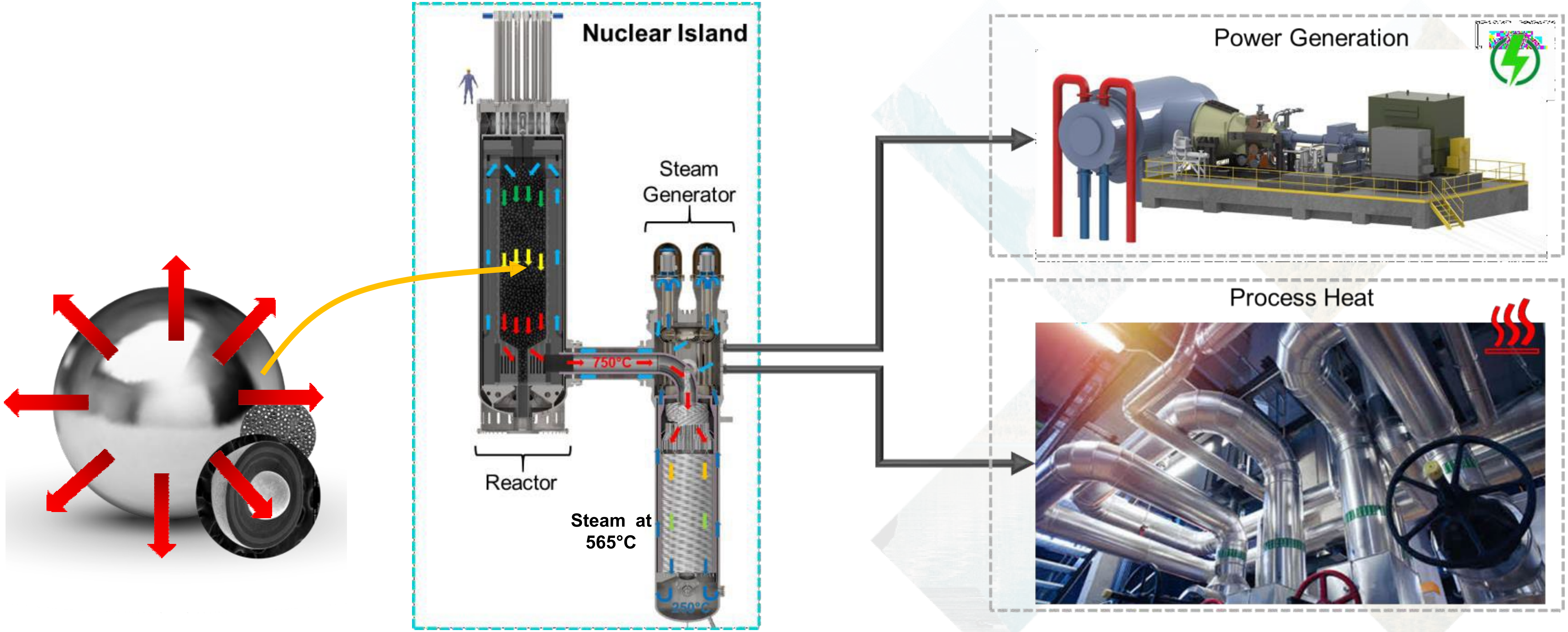
HTGR - First SMR Deployment this decade

IAEA-TECDOC-1645

The HTGR is the SMR reactor technology nearest deployment

In the USA: More than $750 million U.S. DOE investment, including development and testing of the safest fuel – UCO TRISO coated particles

The "Xe-100"- Innovative and Flexible



HTGR vs Light Water Reactor (LWR) Small Modular Reactor (SMR)

Intrinsic Safety

- Strong negative temperature coefficient + Low core power density
- Graphite has a large heat capacity
- Helium is chemically inert and transparent to neutrons (no activation)
- Small excess reactivity due to continuous refueling

TRISO-X Fuel

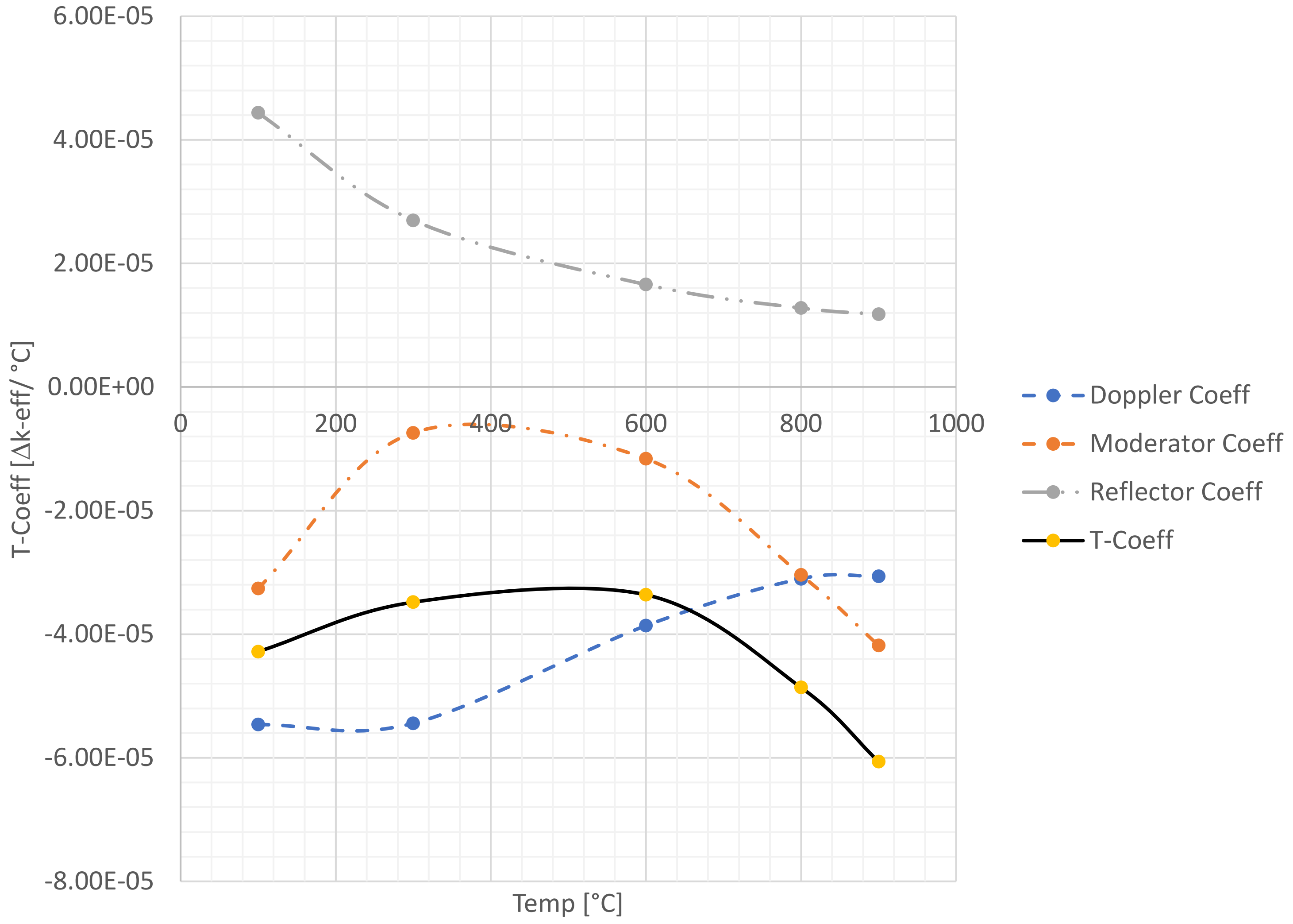
- Proliferation Resistant
- Core melt scenario excluded
- Simplified waste disposal, no spent fuel pools

High Temp Heat

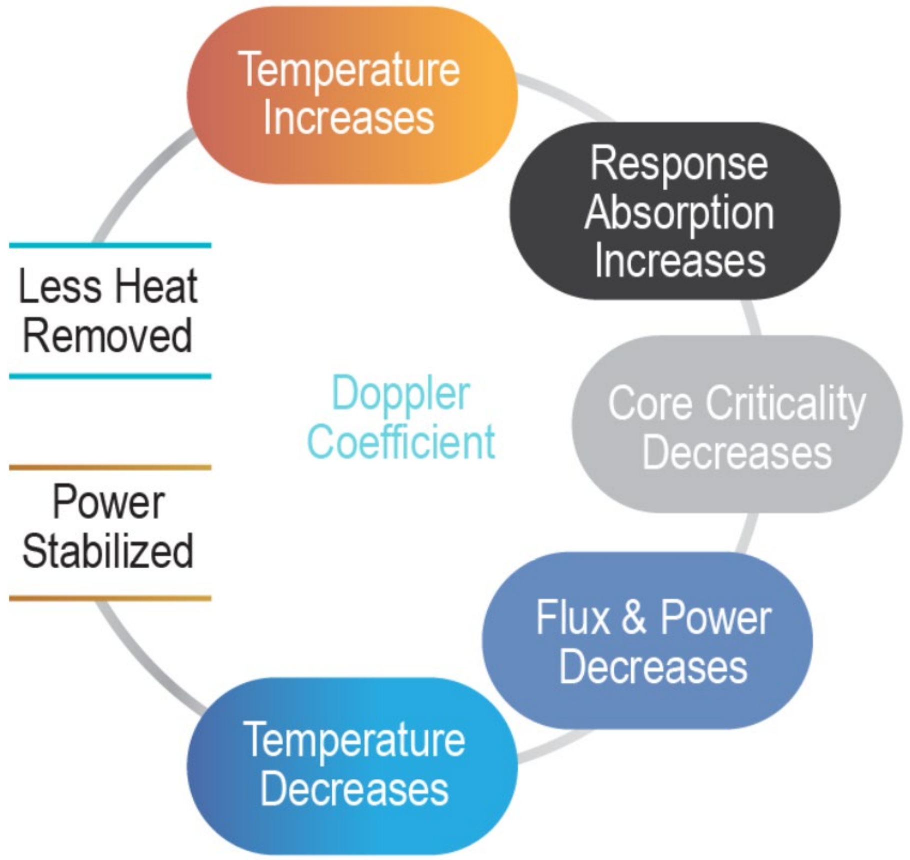
- More Efficient 40% vs 33%
- Super heated steam 565°C/16.5 MPa
- Numerous Process Heat Applications
- Hydrogen Production

200 MW … Thermal
80 MW … Electric O
750°C … Helium Ter
6 MPa … Helium Pre
565°C … Steam Tem
16.5 MPa … Steam Pressure

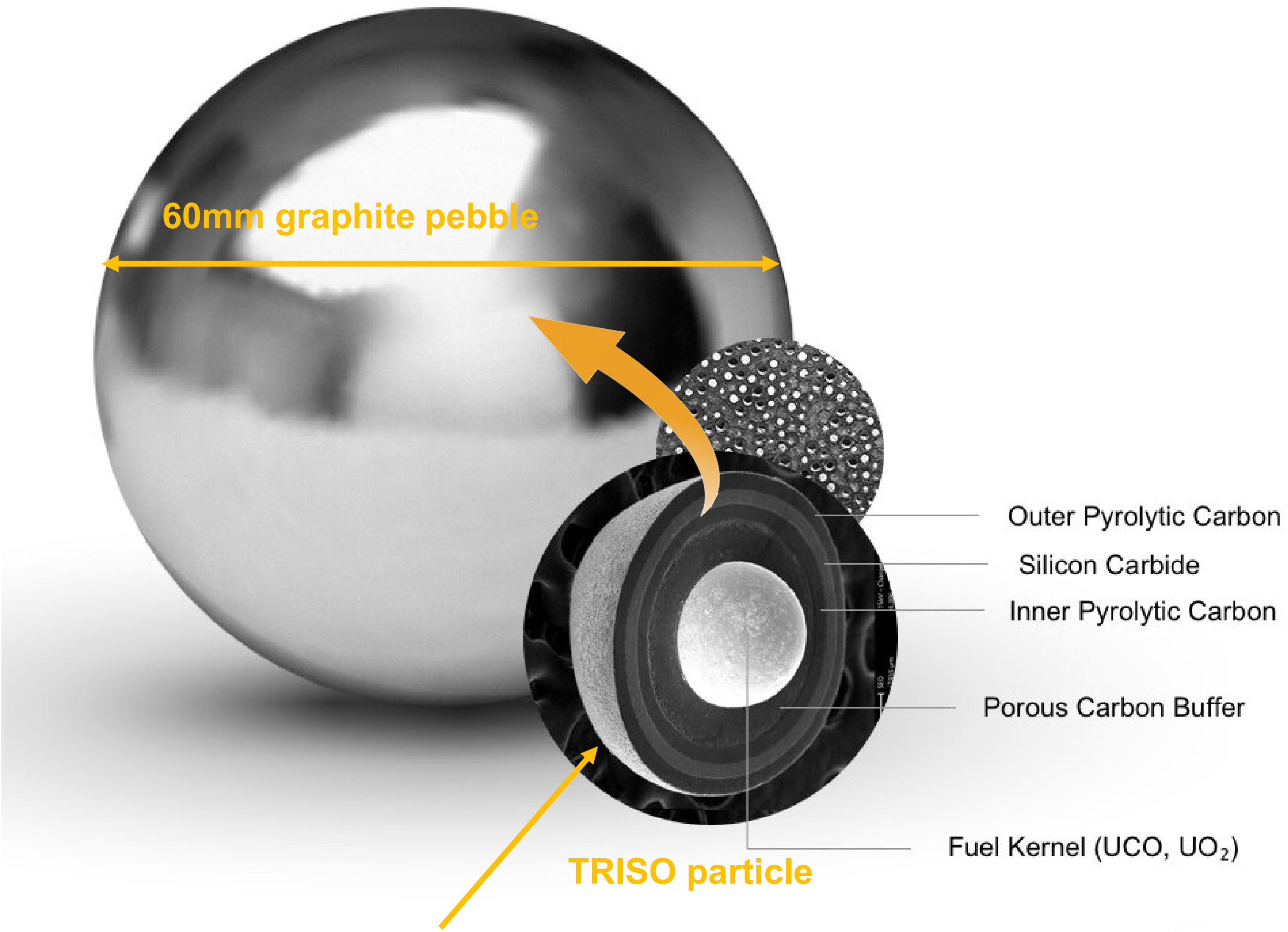
Xe-100: Strong Negative Temperature Coefficient



Schematic of the Xe-100 Self-Regulatory Behaviour



What makes our design Special?



These ~ 1mm particles retain 99.999% of the radionuclides

It All Starts With The Fuel!

- TRISO (tri-structural-isotropic) particle fuel has a proven pedigree – more that 30 years of operational and fuel fabrication experience
- Tested to 1,800°C – remains safe and cannot melt even without active cooling
- Burnup to 168,000 MW/t – this is 4 times higher than existing reactors and significantly improves overall economics
- Each pebble contains approximately 19,000 TRISO fuel particles – This is equivalent to 19,000 independent miniature containment vessels – these particles replace the need for many complex safety systems that are required in traditional reactors
- Excellent long-term robustness (thousands of years) which provides excellent spent fuel containment after use

How is this different ?

Retaining the fission products within the fuel without requiring complex safety systems helps engineers to simply the design, this reduces licensing complexity, system cost and construction times.

TRISO-based Fuel Comparison

TRISO-coated Fuel

15.5% U-235 Enrichment

Average burnup per fuel element is 168,000 MWd/t_{HM}

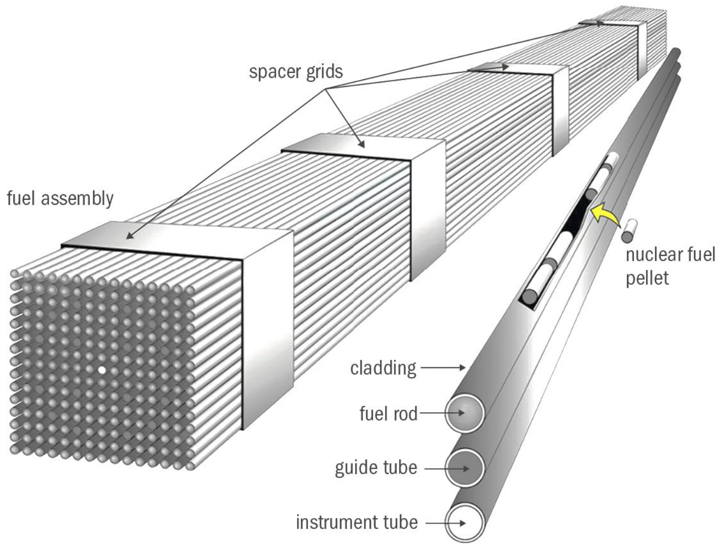
19,000 thousand HALEU particles per pebble (6 cm)

224,000 pebbles per reactor

Graphite pebbles cannot melt

Decay heat per fuel element (1%) is 8 watt

Spent fuel is air-cooled



https://physicsworld.com/wp-content/uploads/2021/02/Allen-fig1.png

Fuel Pellets

5-6% U-235 Enrichment

Average burnup achieved per fuel element is 45,000 MWd/t_{HM}

18 million pellets per reactor, bundled in assemblies

Fuel can melt in extreme cases and Zirconium cladding reacts to create hydrogen

Decay heat per fuel element (1%) is 2.175 kW

Spent fuel must be cooled down in spent fuel pools for years before being air-cooled

Selected parameters of PWR and HTGR reactors

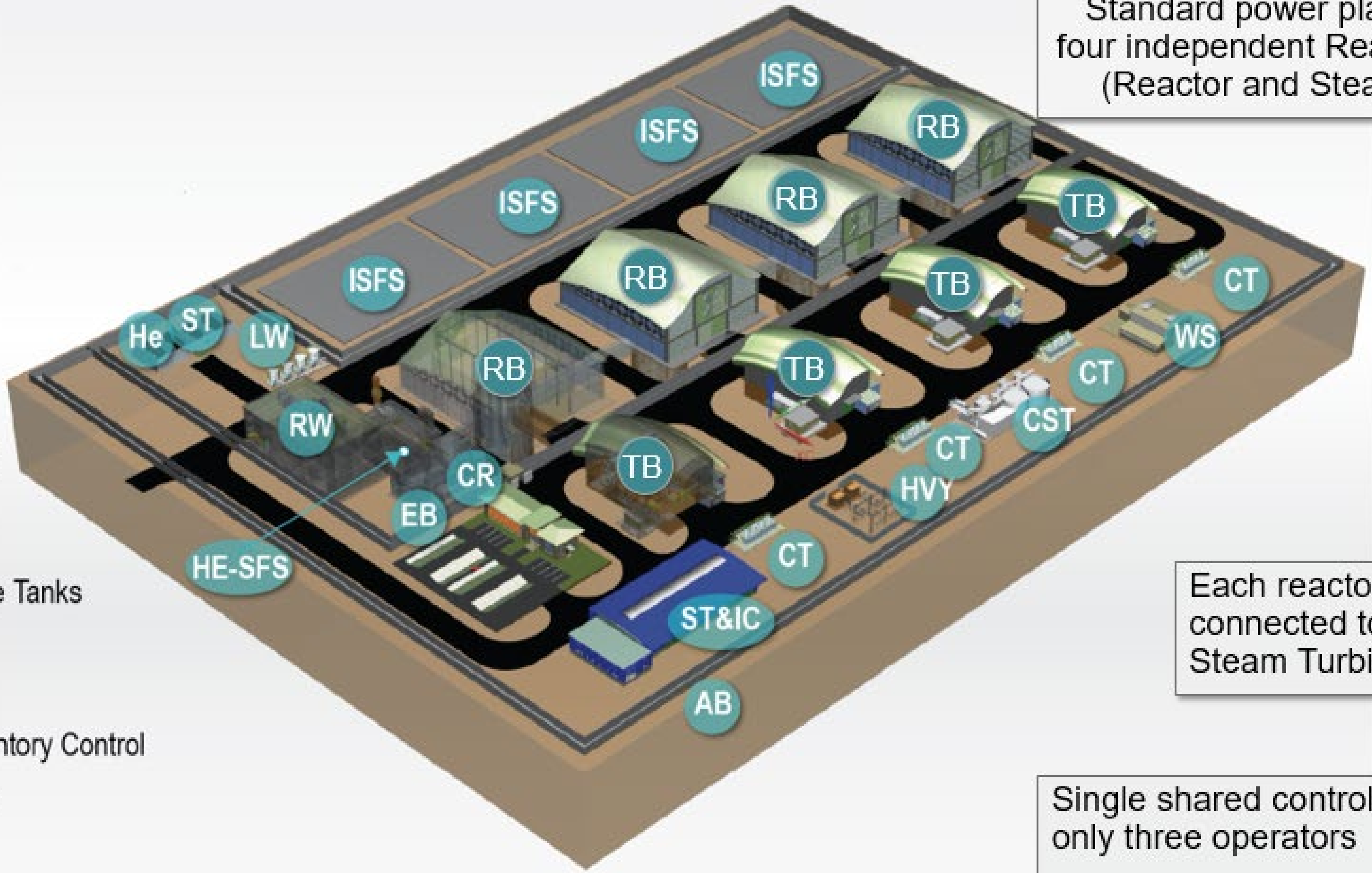
	PWR	HTGR
U enrichment (%)	3.0–4.2 (avg.)	14–20 (avg.)
U3O8 consumption (MT/GWY)	181 (avg.)	246 (avg.)
Burn-up (GWd/MT)	33–50	83–167
Discharged HM (MT/GWY)	21.4 (avg.)	5.4 (avg.)
Discharged Pu-239 (kg/GWY)	171 (avg.)	43 (avg.)

Status of Simulator Development

Phase 2: 4 Reactor x 4 Turbine Thin Slice Operator Training Simulator Completed

Standard Technology Offering (4-Reactor Plant)

RB: Reactor Building
TB: Turbine Building
AB: Admin Building
HVY: High Voltage Yard
CR: Control Room
EB: Electrical Building
CT: Cooling Towers
HE-SFS: High Energy Spent Fuel Storage
ISFS: Intermediate Spent Fuel Storage
WS: Work Shop
CST: Condensate Storage Tanks
HeST: Helium storage
LW: Liquid waste
ST&IC: Stores and - Inventory Control
RW: Rad. Waste Building



Standard power plant consists of four independent Reactor Modules (Reactor and Steam Generator)

Each reactor module is connected to its own Steam Turbine/Generator

Single shared control room with only three operators


Благодаря за вниманието
NUCLEON
office@nucleon-consulting
+359 896 86 1042