



Safety of Nuclear Energy in Hungary

by

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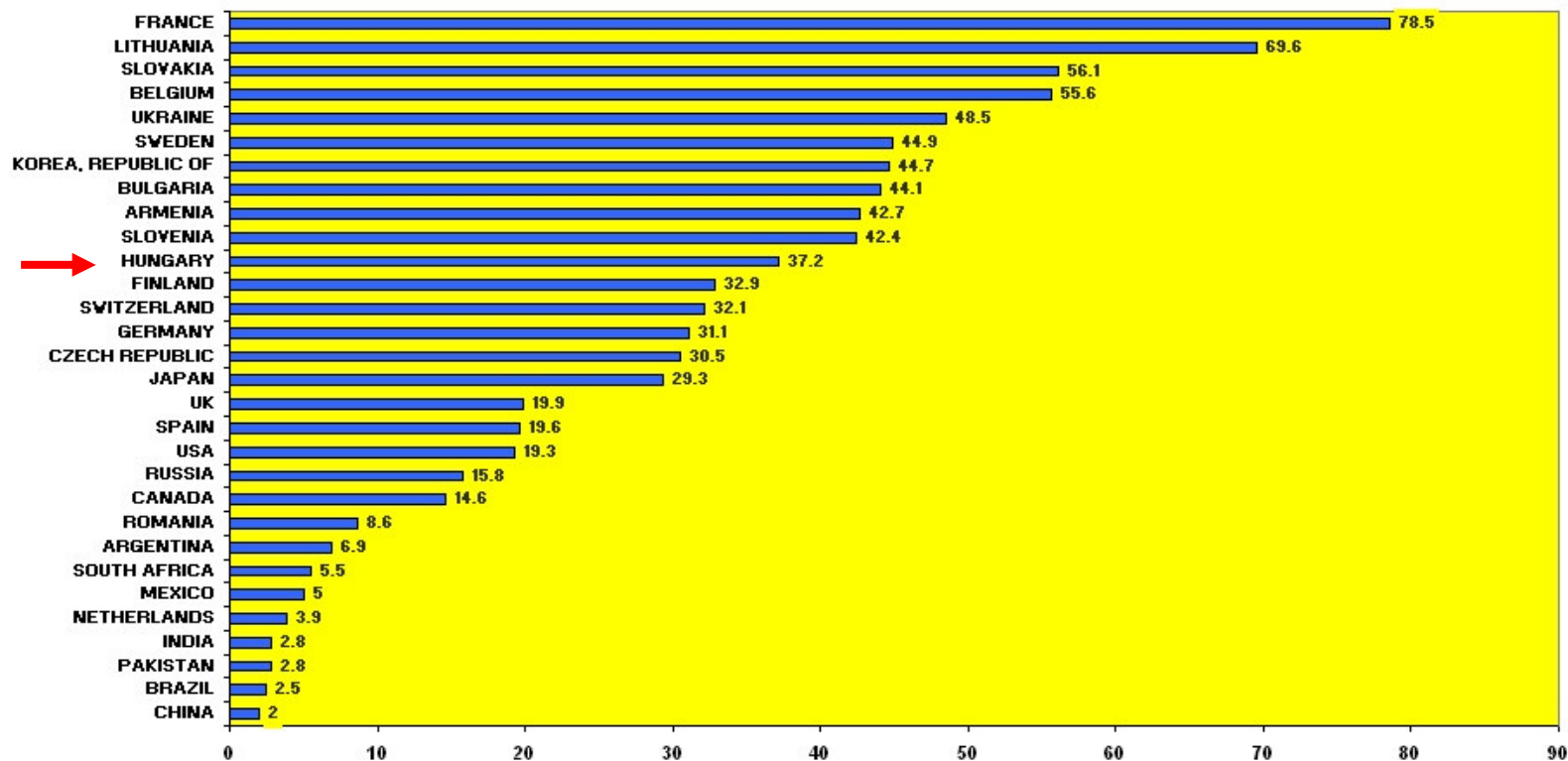
- ➔ Need for nuclear energy
- ➔ Components of nuclear safety
- ➔ Fission Product Barriers
- ➔ Engineered Safety Systems
- ➔ Safety Design Principles
- ➔ Defense in depth
- ➔ International system of nuclear safety
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Nuclear Energy Worldwide*

Number of Reactors in Operation Worldwide (as of 20 of September 2006)



Nuclear Share in Electricity Generation in 2005



Energy Production in the EU*

Share of Total Primary Energy Supply* in 2003

Euro

IEA Energy Statistics

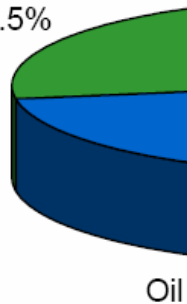
Statistics on the Web: <http://www.iea.org/statist/index.htm>

Evolution of Electricity Generation by Fuel from 1992 to 2003

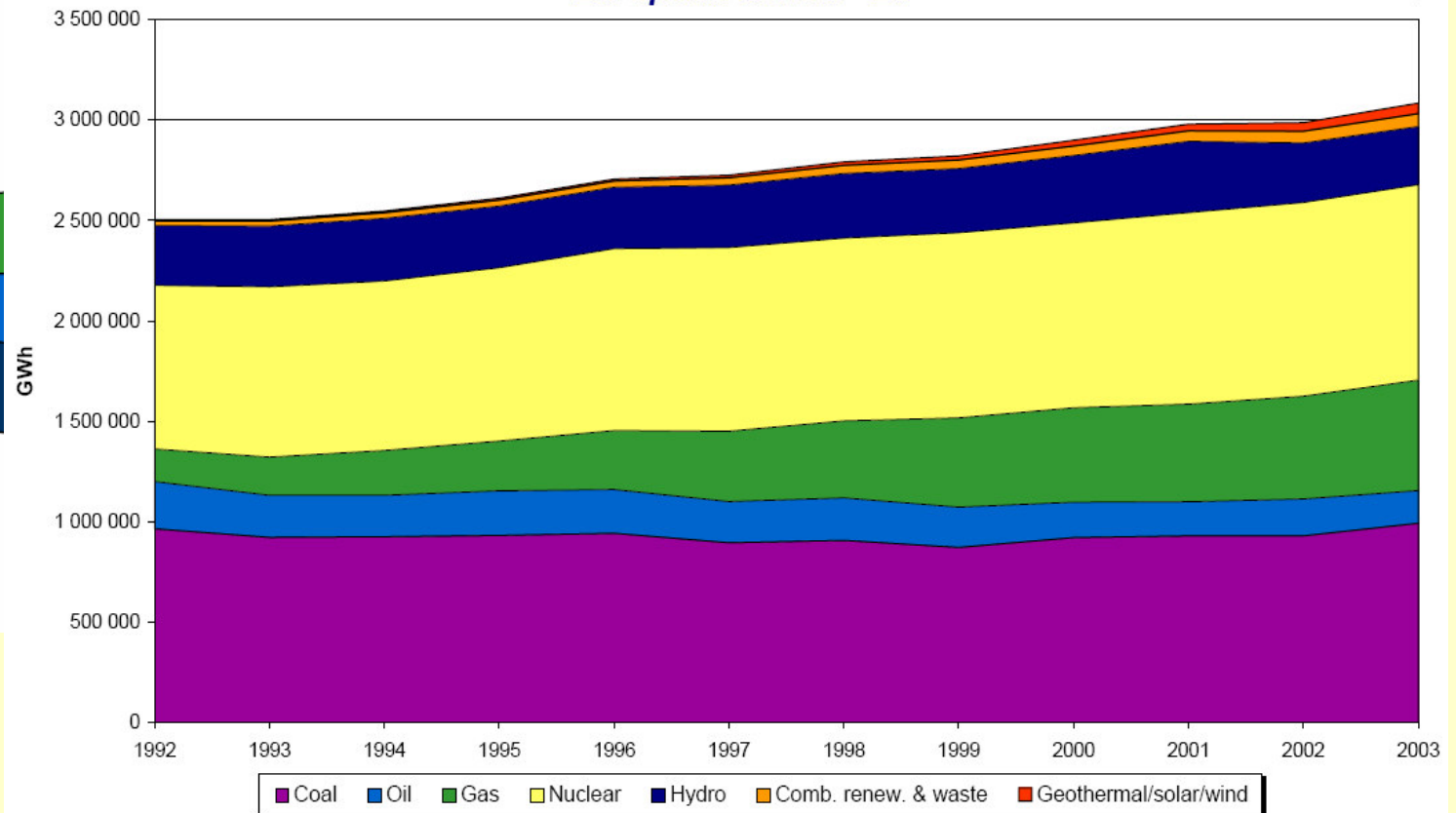
European Union - 25



Gas 23.5%



Oil



* IEA



Components of Nuclear Safety

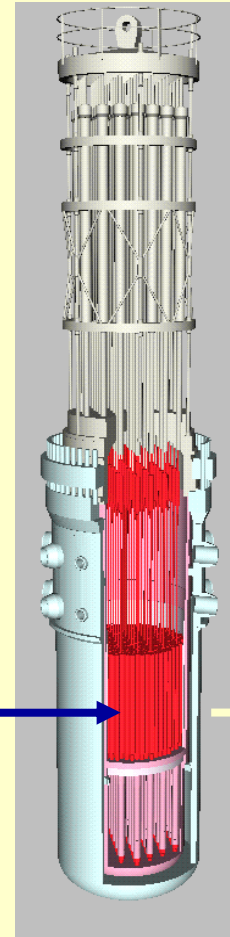
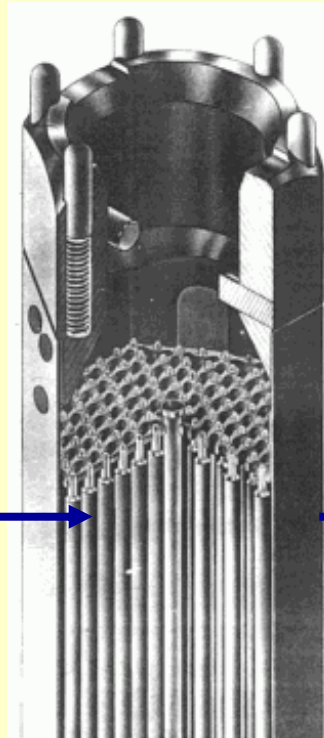
- ➔ Technological components
 - ➔ Barriers of radiological release
 - ➔ Engineered Safety Systems
 - ➔ Defense in depth
- ➔ Institutional components
 - ➔ International constituents
 - ➔ National constituents

First and second barriers – the fuel elements

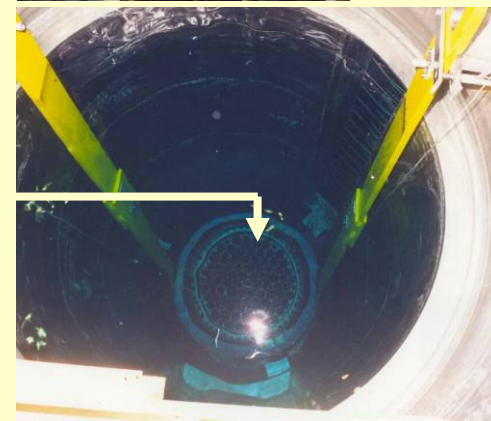
1st: fuel pellets
(UO_2 ceramics)



2nd: fuel assembly
(126 fuel pins with metal cladding)



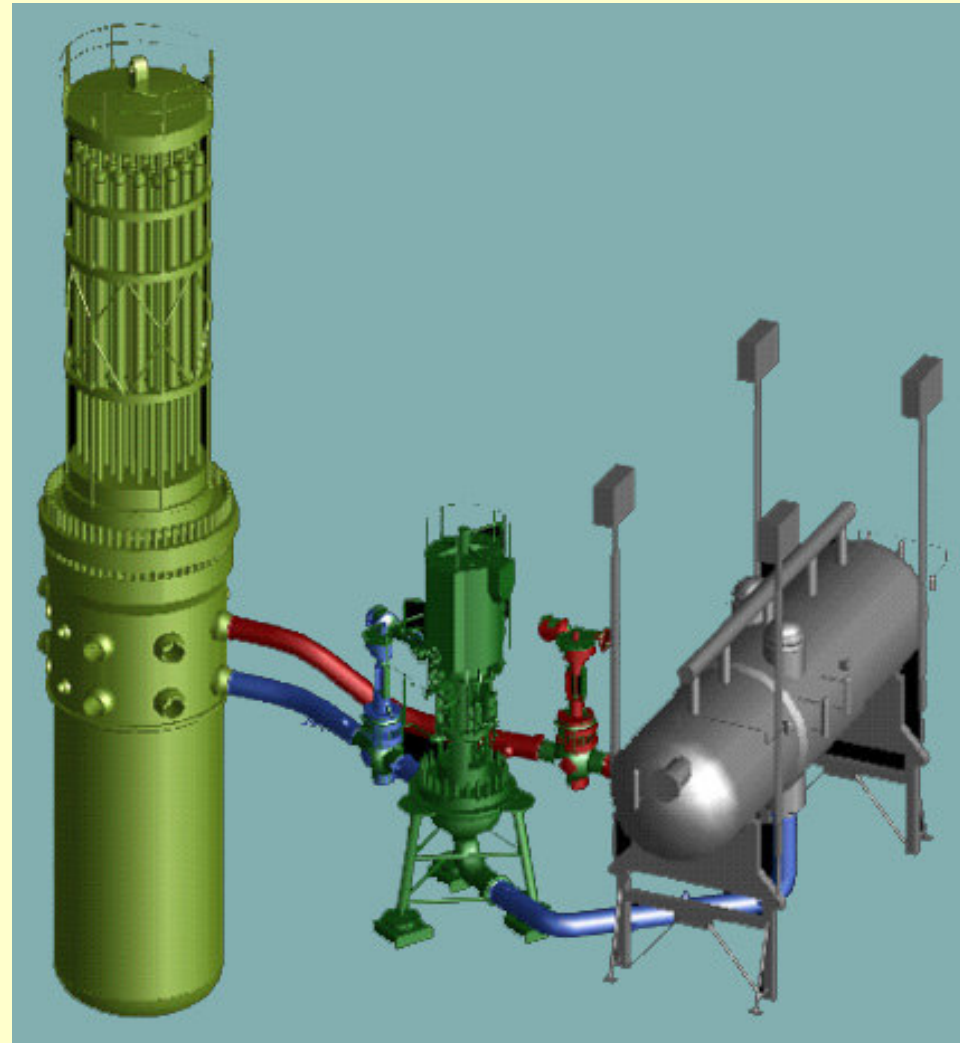
Reactor vessel



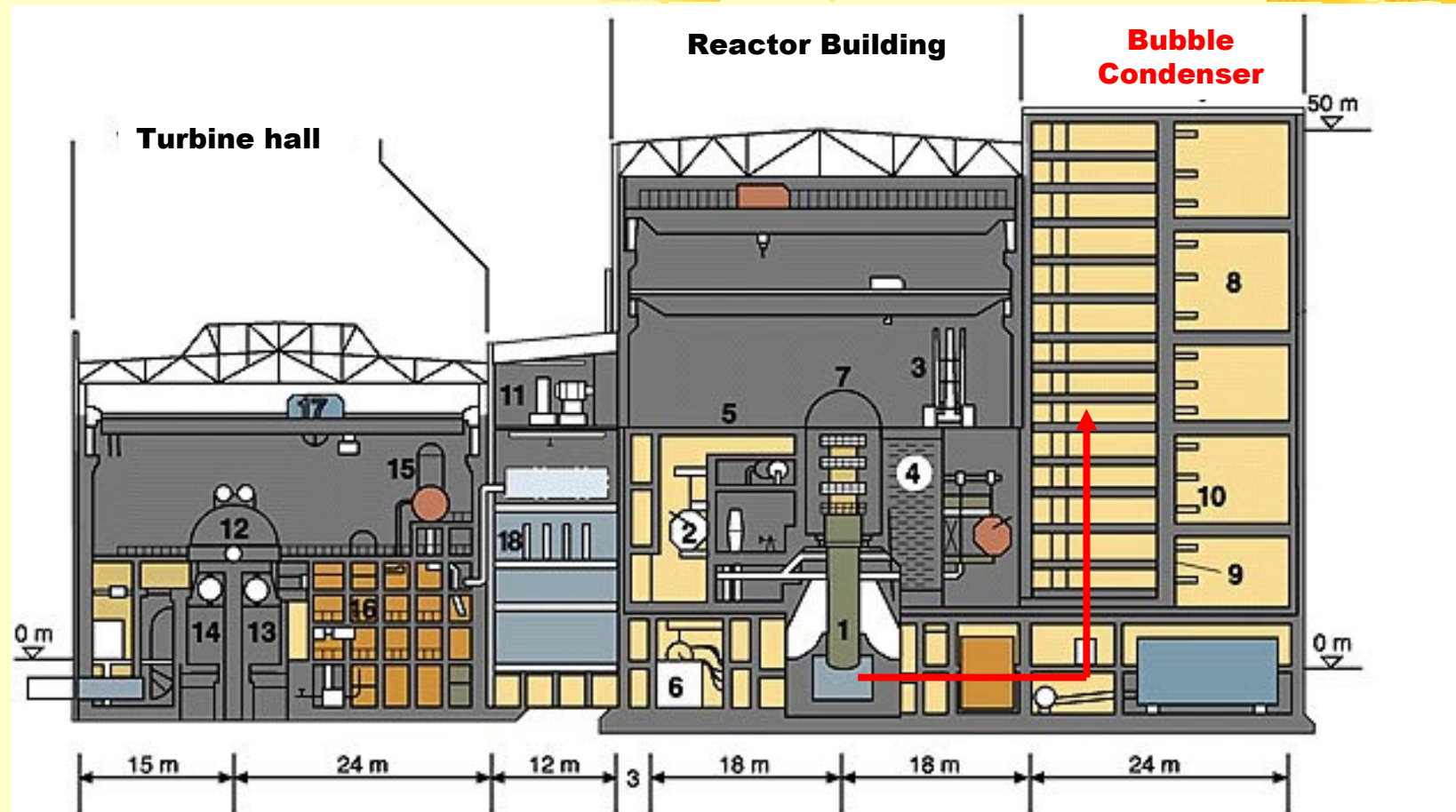
Reactor (with 349 assemblies)

Third barrier – the primary circuit

- ➔ Cooling the fuel
- ➔ Transporting heat to steam generator
- ➔ Retaining radioactivity released from leaking fuel



Fourth barrier – the containment



Condensing and collecting radioactive steam released from the PC



Engineered Safety Systems

Critical Safety Functions

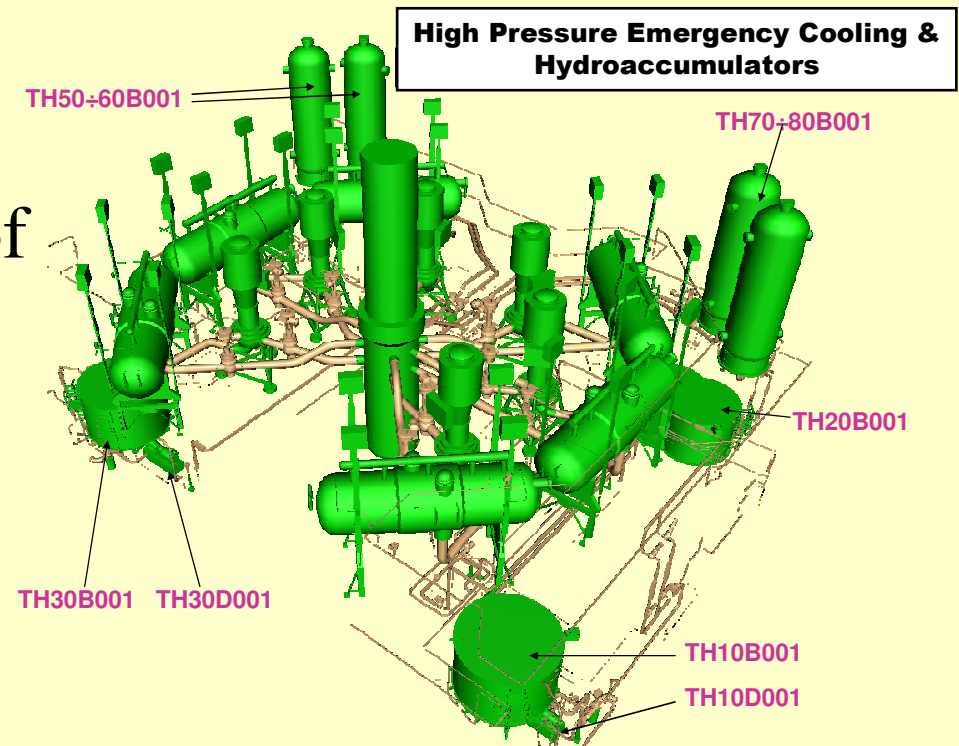
- Subcriticality (controlled chain reaction)
- Core cooling (heat removal from the fuel)
- Primary circuit cooling (heat removal from the reactor)
- Integrity of primary circuit (no leak of cooling water)
- Containment integrity (no radiation leak)

Related Safety Systems



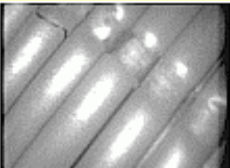

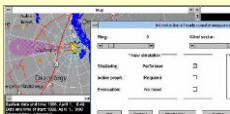
- 37 control rods (neutron absorbers)
- Redundant emergency cooling systems and primary water reserves
- Steam generator water reserves, diverse routes to ultimate heat sink
- Reactor vessel and primary circuit control
- Pressure control: passive condenser, sprinklers

Safety Design Principles

- ➔ Redundancy of safety systems (typically 3 x)
- ➔ Diversity (different types of redundant systems)
- ➔ Multiple voting algorithms (typically 2 out of 3)
- ➔ Defense in depth (see below)



Defense in depth*

Level	Objective	Essential means
	1 Prevention of abnormal operation and failures	Conservative design, high quality
	2 Control of abnormal operation and detection of failures	Control-, limiting and protection systems, surveil.
	3 Control of accidents within the design basis	Engineered safety features and accident procedures
	4 Control of sever plant cond.s, mitigation of severe accidents	Complementary measures and accident management
	5 Mitigation of radiological consequences of large releases	Off-site emergency response



International system of nuclear safety

- ➔ **International Atomic Energy Agency (IAEA)**: safety document system (fundamentals, standards, requirements, recommendations, guides); Safety Conventions; Agreements; Reviews and Services
- ➔ **Western European Regulators' Association (WENRA)**: reference levels – European requirements based on IAEA standards
- ➔ **OECD Nuclear Energy Agency (NEA)**: Committees and Working Groups for coordinated research
- ➔ **Multilateral initiatives**: VVER Forum - WGs on selected safety issues; EUROSAFE – German - French cooperative research, Quadrilateral agreement by CZ, HU, SK, SL, Bilateral agreements





National system of nuclear safety

- ➔ **Legal background:** Atomic Act, Nuclear Safety Codes (Gov. Decree), related legal instruments
- ➔ **Institutional background:** *Nuclear Safety Authority* (HAEA NSD): independent, authorized (licensing, inspection, enforcement, assessment), trained, open
- ➔ **Technical background:** *Technical and operational documents:* Procedures, TechSpec, Guides
- ➔ **Scientific background:** Network of Technical Support Organisations (Academic and University R&D, enterprises), international cooperation



THANK YOU FOR YOUR ATTENTION



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