Evaluation of 15m cycles on Paks NPP VVER-440 units

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MVM Paks NPP

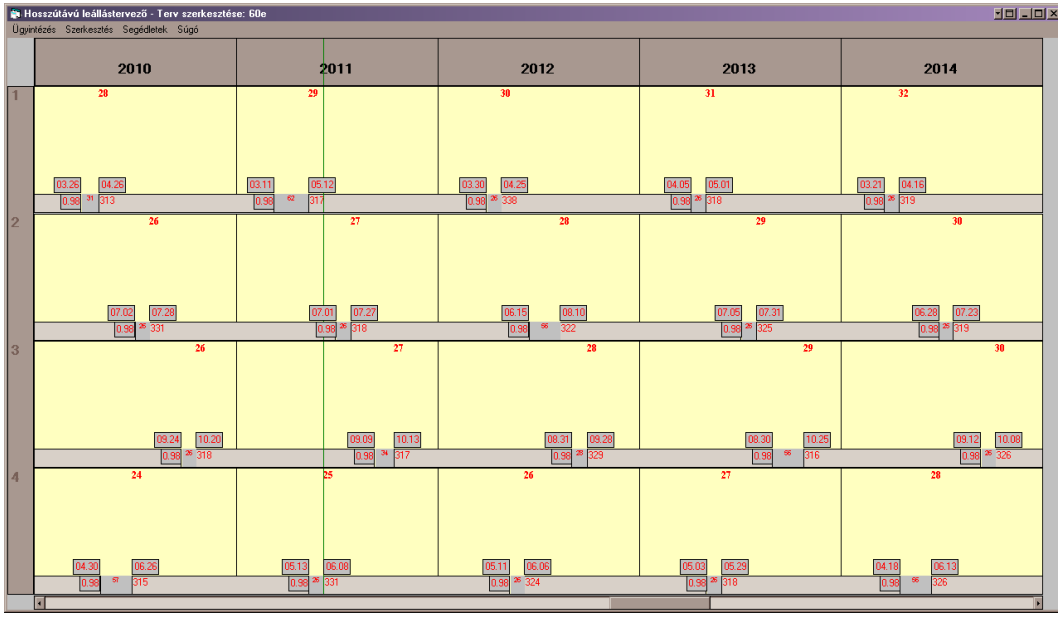
Paks history : power uprate and new fuel

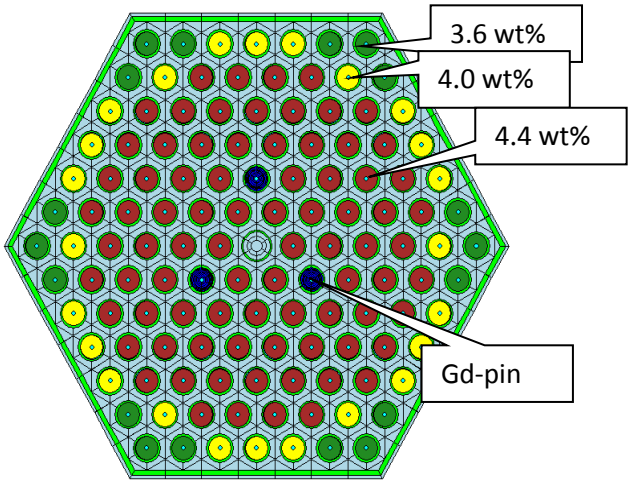
Power uprate of Units to 1485 MWth (108%) : 2006-2009

Introduction of higher enriched (4.2%) fuel with Gd BP : 2009-

Up to 2014 :

Annual cycles, outages in summer period





End of 2010 :
How to continue

Investigation of new possibilities for Paks NPP application :

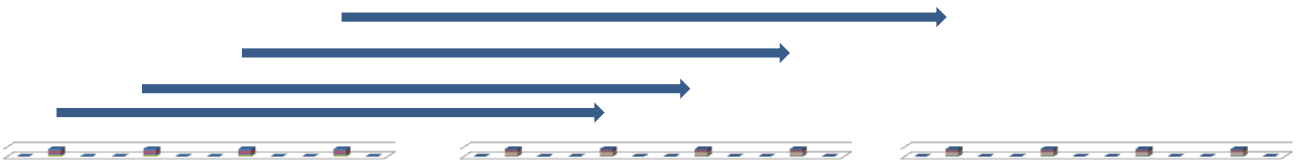
- Enrichment close to 5%
- Shroudless geometry
- Longer (18m) fuel cycles

Results :

- Not really proper way of 18m cycles
- 15m cycles are clearly manageble

Also end of 2010 : idea how to operate Paks with 15 cycle

Outages :
february, may, august, november



0.	1.	2.	3.	4.	5.
1,4,2,3	-,1,**4**,2	3,-,**1**,4	**2**,3,-,1	4,2,**3**,-	1,4,2,3

1st half of 2011

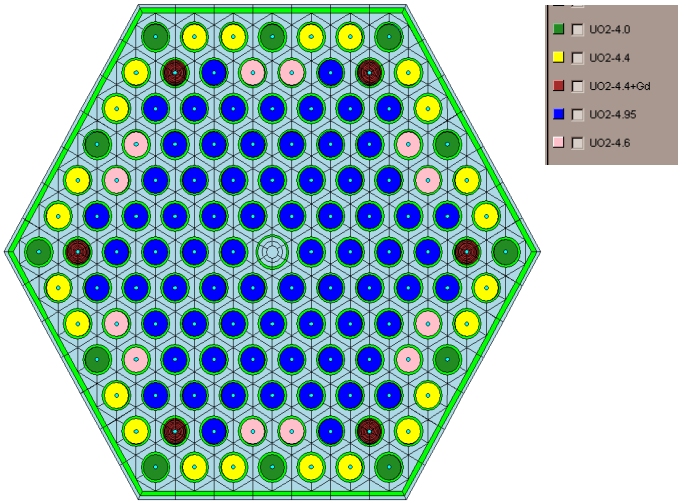
- 1st proposal for fuel specification : U and Gd enrichment pattern
- Equilibrium cycle calculations

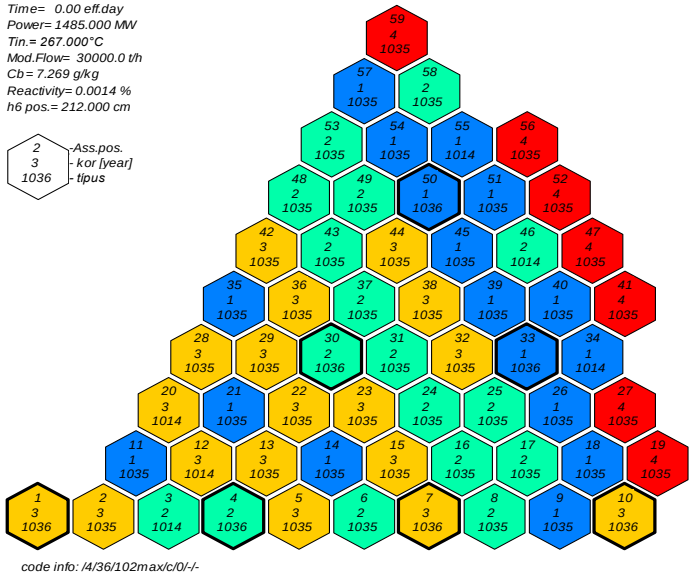
Then :

- Meeting and consultations with MTA EK
- Meeting and consultation with TVEL and usual subcontractors (MSZ, Kurchatov Inst. Etc) :
  new standpoints : applicable enrichments are defined

2nd half of 2011

- Fuel specification (U and Gd enrichment pattern) is modified
- Equilibrium and transient cycles are planned
- Fuel specification (U and Gd enrichment pattern) is accepted by Russian supplier





2012-13

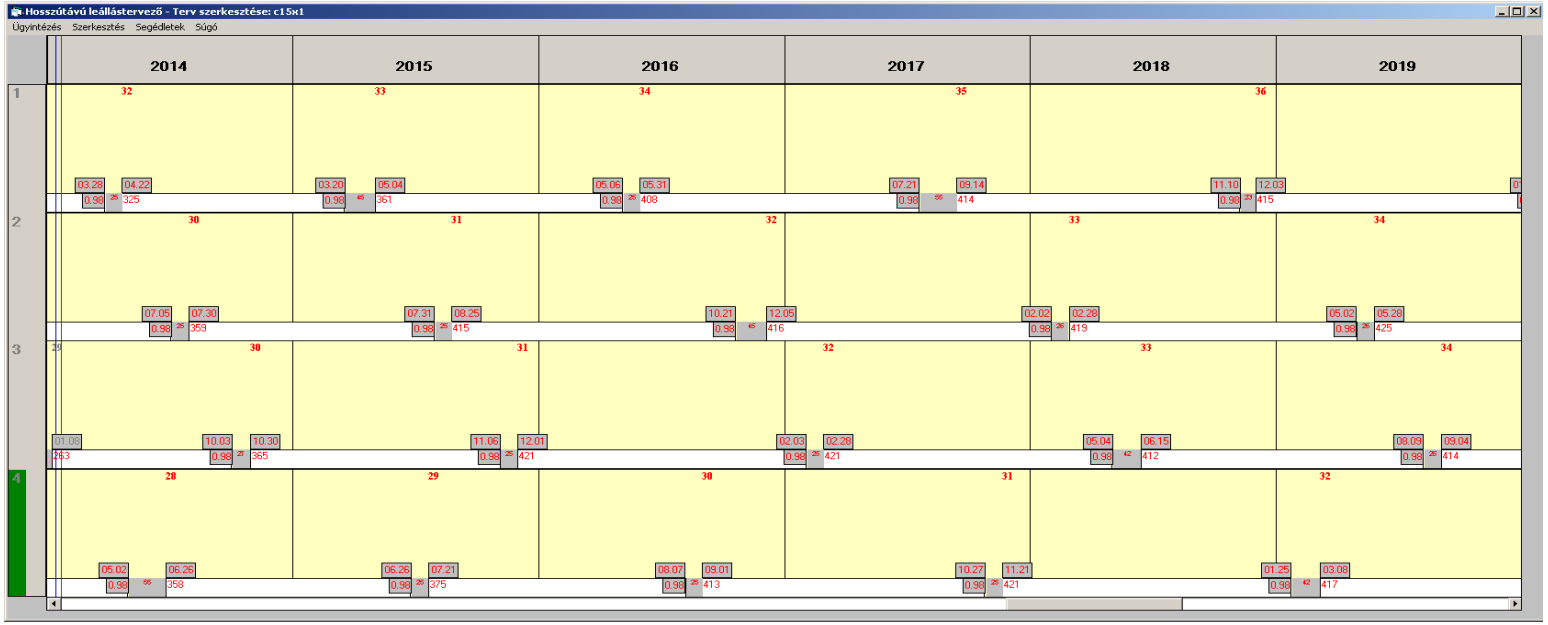
- Contracts with MTA EK and TVEL + some others) (1st half of 2012)
- Safety analysis calculations :
  - Transport and storage
  - Normal operation , AOO and PA cases (Fuel relevants, selected)
  - Fuel behaviour analysis
  - Possible enviromental effects

2014

- Consequences from SA are collected
- (Fuel) licencing material is prepared (fuel part of licensing) with proposals to changes in technical specification
  - Pin power and burnup limits
  - Boron efficiency
  - Burnup credit in spent fuel pond
- (Fuel) licensing started, test program on Unit 3 with 12 pcs. of 4.7% enriched assemblies

In the meantime…

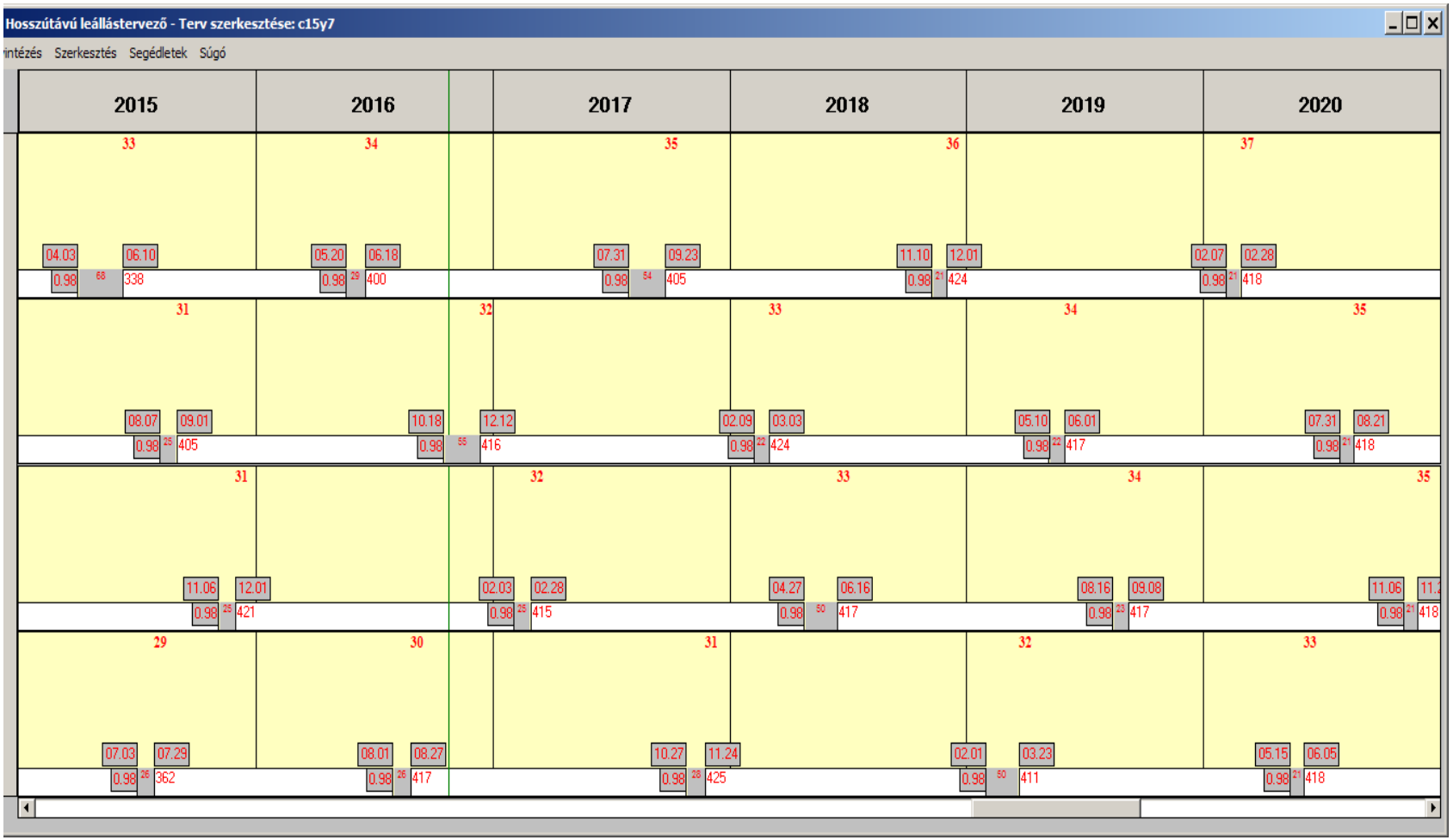
- C15 project established in June 2013 for the coordination of transient and non-fuel related licensing
- Non-fuel related
  - Longer operation period of equipments
  - Maintenance and supervision cycle of equipments
  - Fuel and non-fuel related tasks are harmonised, transient plan is prepared



2015

- New fuel test program is evaluated
- (Fuel related) final licence is received
- Unit 2 is loaded with reload quantity of new fuel
- Unit 2 Cycle 31 is started and operated sucessfully, P=100%, Teff > 400 fpd
- Unit 3 Cycle 31 is started and operated sucessfully, P=100%, Teff > 420 fpd

End of 2016



- All units operates in long cycle
- Transition was completely sucessfull

Benefits

- ❑ +2 % more power generation
- ❑ Decreased maintenance cost
- Reduced number of spent fuel
- Significantly reduced amount of radwaste
- Much lower collective dose rate
- Reduced number of transients on main equipments – longer lifetime

Plans to improve fuel and fuel strategy

Today : 102 fresh fuel / cycle

	1st cycle (14m)	2nd cycle (28m)	3rd cycle (42m)	4th cycle (56m)
4.7 W	90	90	90	42
4.7 F	12	13	12	
4.2 W	12	12	12	

What we are thinking about (SLIM fuel) :

2nd generation fuel with slim pins and solid pellet

pellet outer diam., mm	hole in pellet , mm	pin outer diam., mm	clad thickness , mm	assembly shroud thicness, mm	pin pitch, mm	Assembly U-weight (kg)
7.6	0	8.9	0.575	1.5	1.23	129.5

15m cycles with SLIM fuel

90 fresh asemblies / cycle

	1st cycle (14m)	2nd cycle (28m)	3rd cycle (42m)	4th cycle (56m)
Highly enriched W	78	78	78	78
Highly enriched F	12	13	12	

96 fresh asemblies / cycle

	1st cycle (14m)	2nd cycle (28m)	3rd cycle (42m)	4th cycle (56m)
Higher enriched W	60	60	60	60
Follower	12	13	12	
Lower enriched W	24	24	24	

Thank You for
invitation
and
attention !