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Nuclear Power in Switzerland (CH)

A Brief Chronology

1955:	UNO Conference in Geneva „Atoms for Peace“
1955:	US Swimming Pool Reactor „SAPHIR“ purchased by CH
1957:	SAPHIR begins operation
1961:	First Criticality of the DIORIT Heavy Water Reactor in CH
1968:	First Criticality of the Lucens Underground Reactor
1969:	First Criticality of the Beznau 1 Reactor
1989:	Cancelling of the Kaiseraugst NPP
2000:	Commissioning of the ZWILAG Interim Storage Facility
2008:	Commisioning of the ZWIBEZ Interim Storage Facility
2011:	Fukishima followed by Government phase out decision

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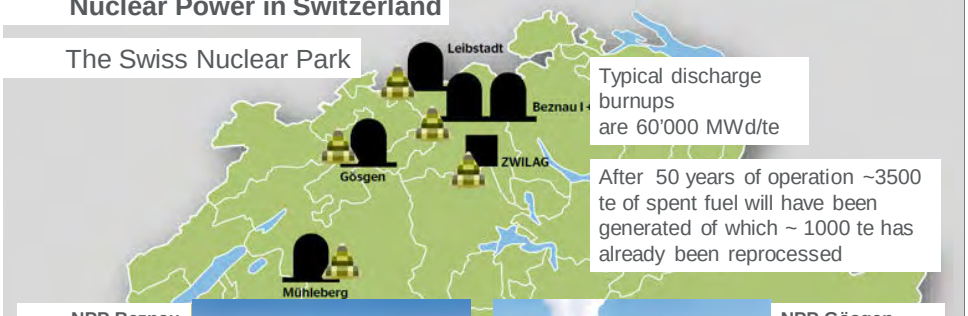
Nuclear Power in Switzerland

The Swiss Nuclear Park



Typical discharge burnups are 60’000 MWd/te

After 50 years of operation ~3500 te of spent fuel will have been generated of which ~ 1000 te has already been reprocessed

NPP Beznau
2 x 365 MWe
1969 & 1971

PWR
Westinghouse
„2-loop“

NPP Gösgen
1060 MWe
1979

NPP
KWU „Vor-Konvoi“

NPP Leibstadt
1200 MWe
1984

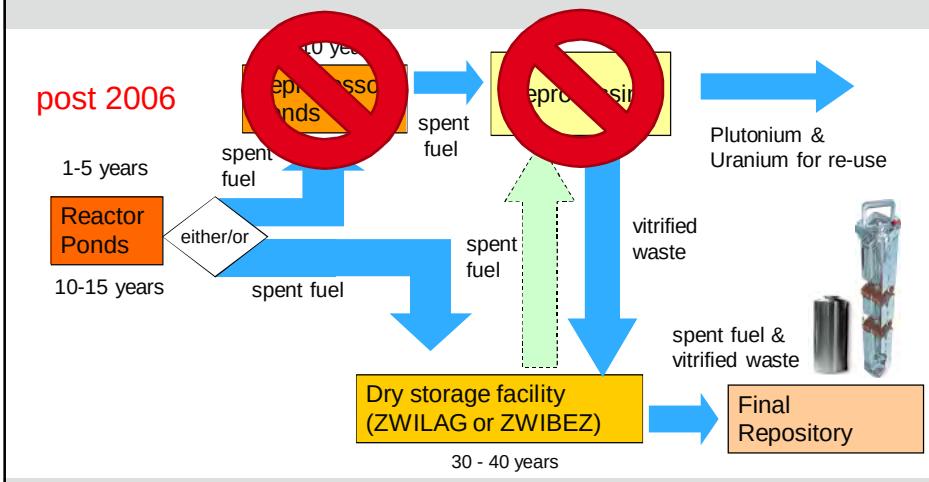
BWR
GE BWR 6

NPP Mühleberg
373 MWe
1972

BWR
GE BWR 4

The Management of Spent Fuel

The Swiss Storage & Disposal Route



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The Management of Spent Fuel

Interim Storage (dry)

Zwilag: Operational since 2001
Inventory 38/200 Casks

Zwibez: Commissioned 2008
Inventory 5/48 Casks

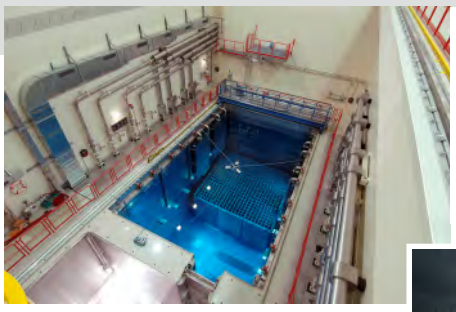
The Management of Spent Fuel

Interim Storage (dry)

Inside Hall H : ZWILAG

The Management of Spent Fuel

Interim Storage (wet)



- As a means of optimising their spent fuel disposal route, NPP Gösgen decided in 2002 to build an external cooling pond ca. 100m from the plant
- Max. Capacity 1000 FA / 1MW
- Transfers from the plant are made dry with TN12/2 casks (4x12 FA per year)

NPP Gösgen

Commissioning in 2008

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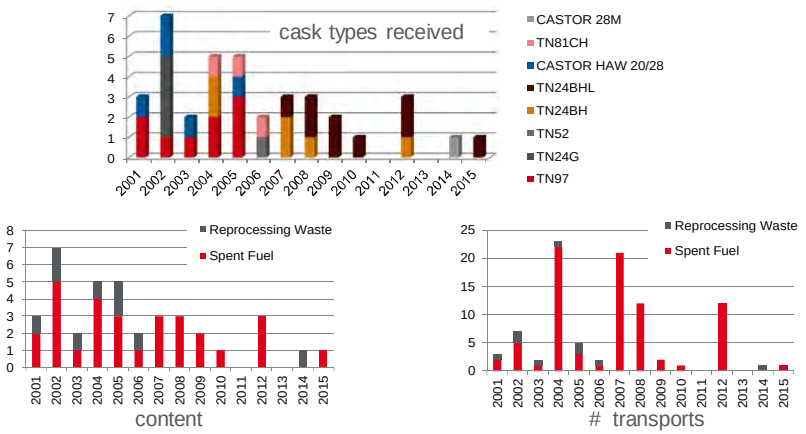
Transports of Spent Fuel & Waste

To ZWILAG : According to Cask Type, Content & Number



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Transports of Spent Fuel & Waste

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Transports of Spent Fuel & Waste

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Transports of Spent Fuel & Waste

A convoy of 3 Vitrified Waste Casks arriving at Zwilag

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Transports of Spent Fuel & Waste

A Vitrified Waste Cask being transferred onto a low loader at Zwilag

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Transport and Storage Casks

Developments over the past 15 Years of interim storage in CH

- Generally, dual purpose casks are used for interim storage at ZWILAG & ZWIBEZ
- First of all «old & cold» fuel was used and loaded into high capacity casks
- As hotter fuel needed to be stored, more sophisticated casks were needed
- Modern, high burnup fuels are beginning to push the limits of current casks
- Originally, only one spent fuel cask supplier was used / available
- With the introduction of more sophisticated designs, new suppliers have emerged
- Experience has taught us that diversity of supply is imperative

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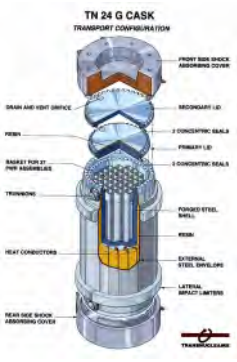
Transport and Storage Casks

Casks in Use / in Licensing Process

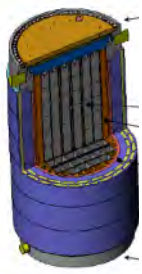
Cask Type	Type	Capacity	Status
TN97L	BWR	97	licensed, stored but no longer in active use
TN52L	BWR	52	licensed, stored but no longer in active use
TN24BHL / BH	BWR	69	licensed, currently in use
TN NOVA	BWR	69	in licensing process
HISTAR 180L	BWR	69	potential candidate
CASTOR V/52	BWR	52	potential candidate
TN24G	PWR	37	licensed, stored but no longer in active use
TN24GB	PWR	37	licensed, currently in use
HISTAR 180	PWR	37	in licensing process
CASTOR V/19	PWR	19	in licensing process
CASTOR HAW 20/28	HAW	28/20	licensed, stored but no longer in active use
CASTOR 28M	HAW	28/20	licensed, currently in use
TN81	HAW	28/20	licensed, currently in use

Transport and Storage Casks

Various cask designs



TN24 Series



HISTAR 180

CASTOR V/19

TNNOVA

Regulatory Requirements and Issues

Transport approval

- Transport of Nuclear Material governed by IAEA Safety Standards
- These Standards are updated every 5-7 years (currently SSR-6 (2012))
- A package approval is granted by assessing the SAR for the package against these Standards
- The approval for a package Type is generally provided by the country of origin, and is normally valid for 5 years
- Package cannot be grandfathered over several revisions of the Standards
- In addition, national & international transport regulations apply for the transport itself (ARD, RID)
- The Package types B(U*nilateral*)F and B(M*ultilateral*)F are of relevance
- Standards require a demonstration of the ability to withstand a series of accident conditions during transport (Drop Test / Thermal Test / Immersion Test

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Regulatory Requirements and Issues

Storage approval

- Storage Approval is provided by the country in which the Package will be stored on the basis of the T(opical) SAR
- In Switzerland, this is governed by guidelines (G05, G04), which impose their own criteria on the package
  - Resistance to static and dynamic loads *: including aircraft impact*
  - Requirements for the lid system : *double lid*
  - Requirements for the leaktightness : *continual surveillance*
  - Criticality requirements : *by flooding*
  - Material ageing : *over the asumed storage period*
  - Requirements on pressure barriers : *all welds can be tested*
  - Resistance to Aircraft impact : *scale test or transfer of similar test results*
  - Resistance to effects of earthquake : *casks should not topple*
  - Dose rates : surface < 0.5mSv/h average
  - Temperature of the contents : *temperature limits to preclude degradation*
  - Temperature of the cask surface . *120°C*
  - Removability of fuel .*during the storage period*

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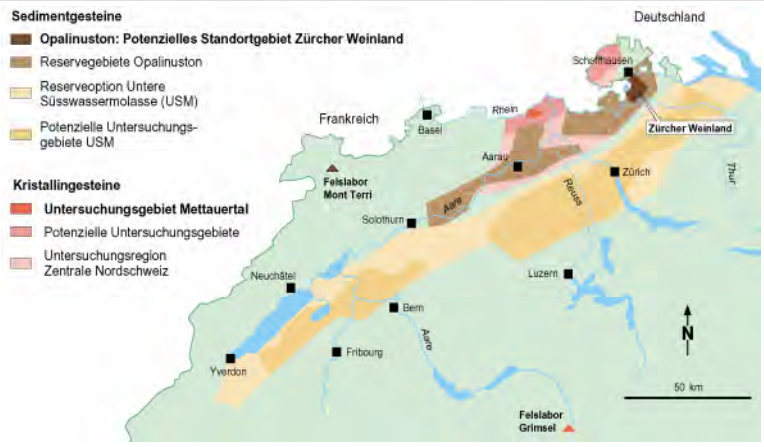
Regulatory Requirements and Issues

Current Issues

- Transportability of casks after extended storage (formal, technical)
  - IAEA issue http:// www-pub.iaea.org/iaeameetings/46528/International-Conference-on-Management-of-Spent-Fuel-from-Nuclear-Power-Reactors-An-Integrated-Approach-to-the-Back-End-of-the-Fuel-Cycle
  - Advances in materials & cask designs
- Behaviour of contents during storage
  - Large body of knowledge https://euronuclear.org/events/topfuel/topfuel2015/index.htm
- Optimisation of Post Operation Phase
  - Just economics
- High Burn Up and MOX Fuel
  - Advances in cask designs
  - Trend to reduced loadings

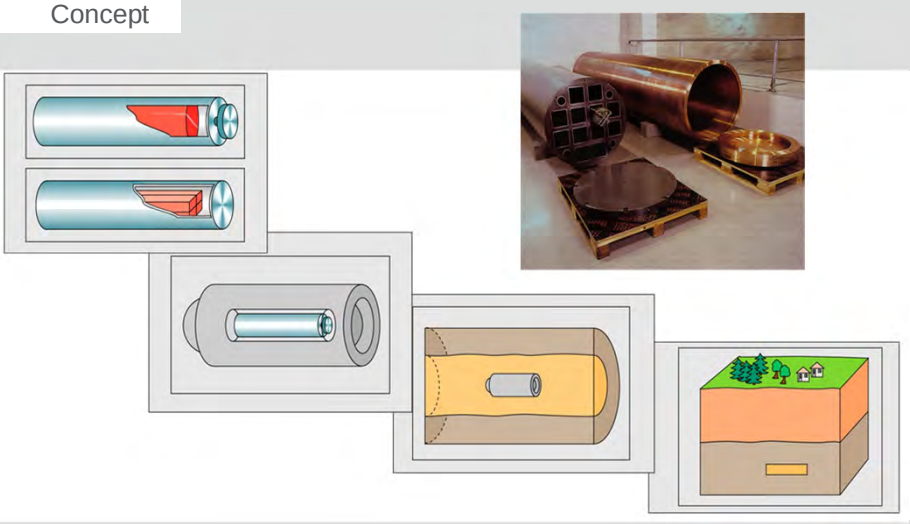
The Quest for a Waste Repository in Switzerland

Siting



The Quest for a Waste Repository in Switzerland

Concept



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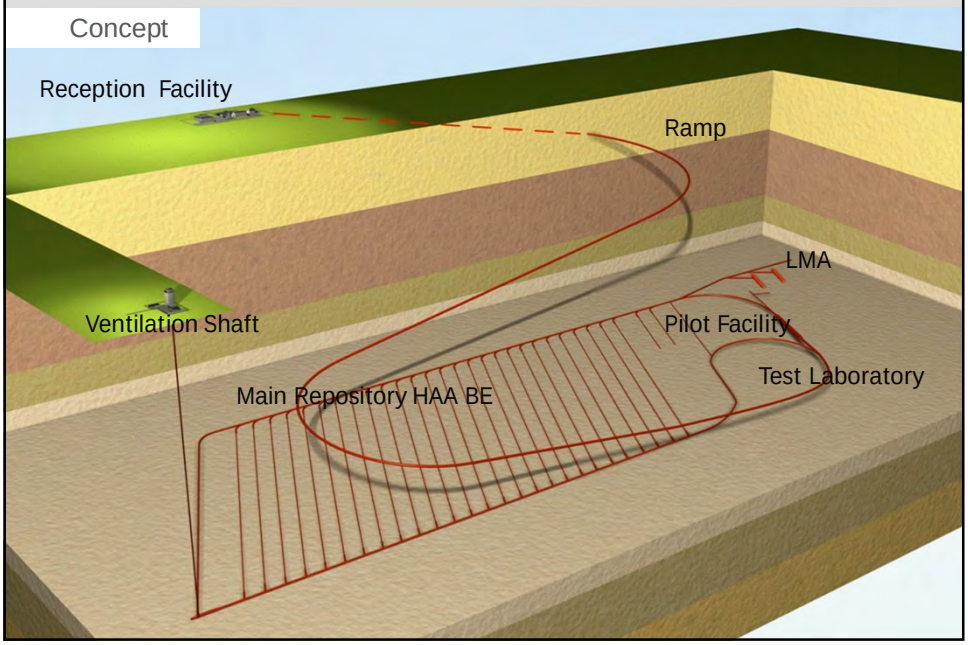
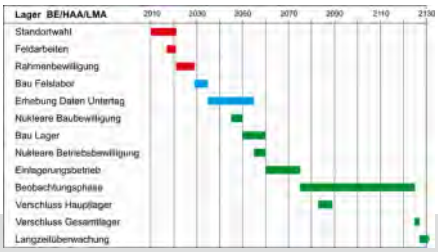
The Quest for a Waste Repository in Switzerland

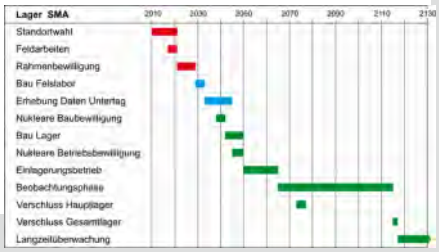
Concept



The Quest for a Waste Repository in Switzerland

Timescales





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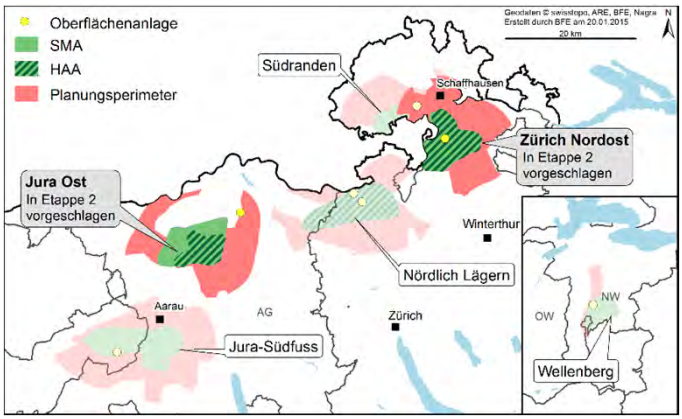
The Quest for a Waste Repository in Switzerland

Siting



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Summary

- The storage route for spent fuel and reprocessing waste in CH is well established
- National and International road and rail transports take place regularly without public/media attention
- The importance of a stable and reliable long term storage is being emphasised by current events (Premature plant shut downs and repository siting)
- There are some technical issues associated with long term storage of spent fuel but these are not insurmountable
- The transportabilty of casks after storage is an issue but is being adressed at a high level
- «Conflicting» requirements for storage & transport potentially leading to overregulation

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Thanks for your attention !!!

… some final impressions