Reviewing the flood risk at the NPP Paks site

Dec 2024, Oda Becker

Heavy rainfall brought by storm “Boris” has left devastating marks on central Europe in September 2024. The storm caused extreme flooding, and the region around the Paks nuclear power plant in central Hungary was also affected by high water levels. At the Paks site, the Danube River reached its highest level on the 22 September 2024 with 806 cm.

According to a media report, measures to protect the Paks NPP from high water levels have been implemented.[1] For example, the embankment was constantly monitored by the plant's own fire brigade and water management specialists. Among other things, the grid of the canal leading to the NPP had to be cleaned more frequently because the volume of sediment increases during floods. According to a speaker of the NPP, the dam itself is so well built that it stands three meters above the highest water level ever recorded, so no special measures were needed.[2] The government has published several pictures showing how close the water came to the nuclear power plant.[3]

Figure 1: Flooding around the Paks NPP in September 2024[4]

However, the media only raised the question whether the floods caused by heavy rainfall in Central Europe posed a threat to the energy production of the Paks nuclear power plant. The media then concluded that the floods had no impact on the energy production of the Paks nuclear power plant which had continued operating without interruptions.[5]

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[1] https://www.euronews.com/2024/09/24/flooding-did-not-pose-threat-to-hungarys-only-nuclear-power-plant

[2] https://de.euronews.com/2024/09/24/hochwasser-in-ungarn-konnte-die-energieerzeugung-im-kernkraftwerk-paks-zum-erliegen-kommen

[3] https://www.szeretlekmagyarorszag.hu/hirek/fotok-ennyire-megkozelitette-a-paksi-atomeromuvet-az-arado-duna/

[4] https://www.szeretlekmagyarorszag.hu/hirek/fotok-ennyire-megkozelitette-a-paksi-atomeromuvet-az-arado-duna/

[5] https://de.euronews.com/2024/09/24/hochwasser-in-ungarn-konnte-die-energieerzeugung-im-kernkraftwerk-paks-zum-erliegen-kommen

Hungary is currently preparing another life-time extension for the four existing VVER-440 units at Paks I. Together with the two new blocks that are to be completed in the meantime, it is expected that the six blocks could produce electricity in parallel at the site for about 20 years.[6]

However, the question whether the flooding posed an accident risk to the Paks NPP was not raised. The following paragraphs will show that this needs to be followed up by the competent authority, the Nuclear Regulator HAEA.

Results of the European Stress Tests

After the severe accident at the Fukushima nuclear power plant in March 2011, the European Union carried out a targeted safety review, the so-called stress test, to determine the extent to which nuclear power plants in Europe can withstand extreme external hazards.

According to the Hungarian Stress Test Report, the site of the Paks nuclear power plant is not prone to flooding, as the level of the embankment both on the opposite side of the Danube River and upstream on the right bank lies below the Paks site's level. Consequently, in the event of an extremely high water level, the opposite bank and areas far from the power plant site will be flooded.[7] Figure 2 with the marked altitudes shows that no risk of flooding exist, if the analyzes are correct.

No.	Name	Level (Bf m)
11	Filled up level of Paks NPP site	97.15
10	Formation level of embankment on right bank	96.30
9	Icy flooding in design basis	96.07
8	Formation level of embankment on left bank	95.80
7	Peak water level at the back of ice pack	95.90
6	Open river flooding in design basis	95.51
5	Typical spring water level	91.00
4	Typical autumn water level	87.00
3	Calculated level in cold water canal during design basis low water flow	84.04
2	Minimum level required for operation of condenser pumps	83.60
1	Minimum level required for operation of essential service water pumps	83.50

(Bf m) – water height above Baltic se level

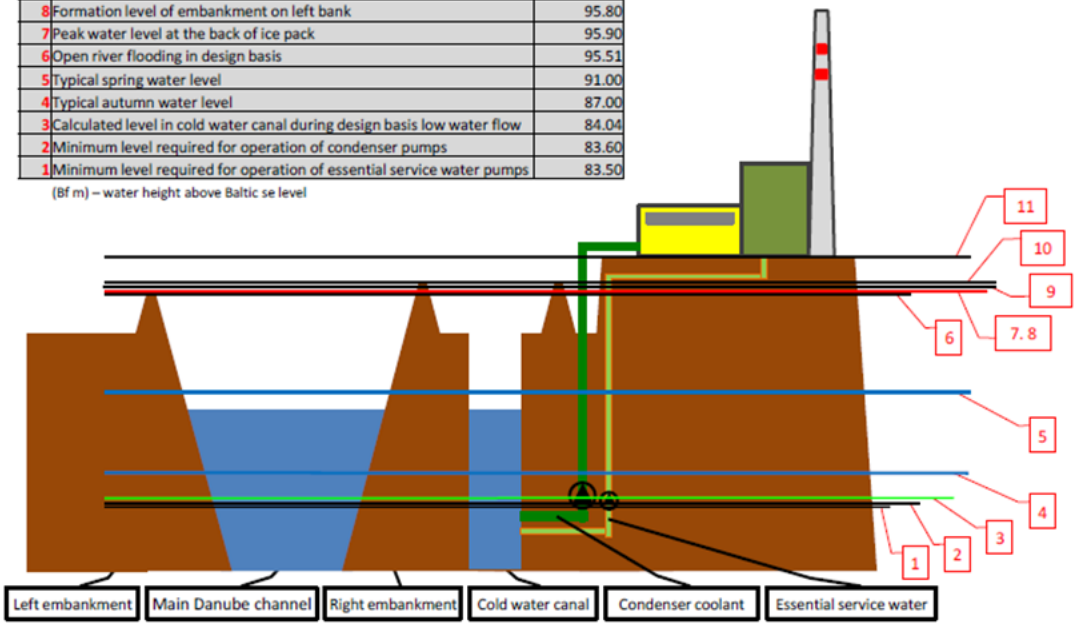

Figure 2: Levels at the site of the Paks NPP[8]

In the safety reviews and back-fitting of nuclear power plants a return frequency of 10^{-4} per year with respect to external hazards should be considered. The corresponding analyses for the Paks NPP in 2011 showed that this requirement for flooding of the Danube River is met.

[6] https://www.world-nuclear-news.org/articles/hungary-aims-to-extend-life-of-paks-nuclear-plant
[7] National Report of Hungary on the Targeted Safety Re-assessment of Paks Nuclear Power Plant, Compiled for the European Commission by the Hungarian Atomic Energy Authority, Hungarian Atomic Energy Authority, Budapest, December 29, 2011
[8] National Report of Hungary on the Targeted Safety Re-assessment of Paks Nuclear Power Plant, Compiled for the European Commission by the Hungarian Atomic Energy Authority, Hungarian Atomic Energy Authority, Budapest, December 29, 2011

The Stress Tests Report claimed that the risk of flooding does not need to be taken into account because the level of the design basis flood is 1 m below the site elevation.

Regarding the Design Basis Flood (DBF), ENSREG confirmed that the approach used for the assessment appears to be appropriate and in line with international standards. For the flood exceeding the Design Basis, some model calculations were carried out with conservative assumptions to derive safety margins. It was concluded that a flood cannot lead to the loss of fundamental safety functions of the plant because there is a sufficient safety margin.[9]

However, some wall penetrations in the machine room of the essential service water pumps lie below the DBF. These penetrations are not equipped with water sealing, so flooding of the machine room may occur if a flood exceeding this level takes place.

According to the Final National Action Plan, in 2014 six wall penetrations located in the machine hall of Essential Service Water System (ESWS) were equipped with additional water isolation in order to prevent machine hall flooding in case of water level higher than this.[10] The pumps of the ESWS are located there.

Conclusions

Analyses in Hungary and confirmations from international experts showed that the Paks nuclear power plant was sufficiently protected against extreme flooding in 2011. It can be assumed that this fact still applies today.

Nevertheless, the analyses should be repeated at regular intervals, especially since the site is now expected to be used for nuclear power operation for almost another century and due to climate change more extreme weather scenarios with higher water levels are very likely.

Another risk can result from additional extreme precipitation events in case of high water levels. These can result in the embarkment becoming soaked and thus failing.

Furthermore, it must be ensured that the floodplains and altitudes of the surrounding areas in 2011 will remain stable in the long-term.

Questions

- What was the frequency of the highest water level during the flood in September 2024? Was this water level higher than the calculated hundred-year flood in 2011?
- How is the stability of the embankments ensured? How often is maintenance work carried out on the embankments?
- How is the Paks NPP management ensuring that the floodplains and the elevation of the surrounding areas, as they were in 2011, will be stable in the long term, i. e. for the next about 80 years?
- Have the possible impacts of additional extreme precipitation events on the nuclear power plant site and the embankments been evaluated? Those extreme events will become more frequent and intense as a result of climate change?

[9] Peer review country report Hungary; Stress tests performed on European nuclear power plants; European Nuclear Safety Regulators Group; 2012

[10] National Action Plan of Hungary on the implementation actions decided upon the lessons learned from the Fukushima Daiichi accident, Hungarian Atomic Energy Authority, Budapest, December 2021

- Have the analyses of extreme water levels corresponding to the 10,000-year flood since 2011 been re-evaluated? Have the results changed and, if so, how?
- Since the Paks nuclear power plants are expected to remain in operation at the site for almost another century and more extreme weather scenarios with higher water levels might occur due to climate change, will the flood analyses be re-evaluated regularly?