# Fuel integrity assessment for Bushehr NPP, Unit 1, Fuel Cycle 4

Operation parameters of Unit 1 and coolant activity during fuel campaign No.4 (for time interval from April 1 through September 21, 2017) are shown in figures 1-8.



Reactor thermal power [MW] and flow rate to ion-exchange filters (Q\*100) [t/h]

Iodine activity [Ci/kg]

Ratio of normalized release rates for 131I and 134I

Figure 1 – Data for the 4th fuel cycle, Unit 1: reactor operation parameters and iodine activity (Ci/kg) in primary coolant during cycle 4, Bushehr-1



Figure 2 – MTU(131I)/MTU(134I) ratio[[1]](#footnote-1) for cycle 4, Bushehr-1

Relations between iodine normalized release rates

![](data:None;base64...)

Figure 3 – Ratio of normalized release rates of iodine radionuclides during cycle 4, BNPP-1 (the left vertical axis);

the right vertical axis is for reactor thermal power (MW)



Cesium activity [Ci/kg]

Noble gas activity [Ci/kg]

Activated coolant and corrosion products activity [Ci/kg]

Figure 4 – Activity (Ci/kg) of cesium radionuclides in primary coolant,

Unit 1, cycle No.4



Figure 5 – Activity (Ci/kg) of noble gases in primary coolant,

Unit 1, cycle No.4



Figure 6 – Activity (Ci/kg) of activated coolant and corrosion products in primary coolant, Unit 1, cycle No.4



Ratio of activities Kr/Xe

Figure 7 – Ratio of activities in pairs 85mKr/135Xe and 88Kr/135Xe, Unit 1, cycle No.4

Ratio of activities Xe/I

![](data:None;base64...)

Figure 8 – Ratio of activities in pairs 133Xe/133I and 135Xe/135I, BNPP-1, cycle 4 (the left vertical axis); the right vertical axis is for reactor thermal power (MW)

## Previous results of activity analysis

For time interval from April 1 to July 31, 2017, data on fuel cycle No.4 at BNPP-1 was analyzed recently. It was concluded that (as of July 31, 2017) there was at least[[2]](#footnote-2) one leaking fuel rod in the core. No indications of fuel washout into coolant were detected. For estimation of fuel burnup it was recommended to make more frequent (1 time per 2-3 hours) measurements of activity of long-lived 134Cs and 137Cs in case of reactor power transients.

## Current situation

From July 31 until September 18, 2017, Unit 1 at BNPP operated under nominal conditions. On September 18 reactor power was dropped down by 20%. After that reactor returned to the nominal power level with was maintained until September 21.

During the steady state operation activity of all the reference radionuclides were approximately the same as at the end of the time interval analyzed previously (July 31, 2017). Minor changes took place also for relations between activities of different radionuclides (see figures 7,8).

On September 18, spiking in activity of radioactive noble gases (RNB) 133Xe, 135Xe, 85mKr was detected during decrease of reactor power. The magnitude of these spikes was not large in comparison with the preceding levels of RNB activities. No spiking was observed for iodine radionuclides.

Unfortunately, the received data file does not contain activities of 134Cs and 137Cs starting from September 18. This fact does not provide an opportunity to use 134Cs and 137Cs for estimation of fuel burnup in the leaking fuel rod (rods).

Conclusions

As of June 28, 2017, there is at least one leaking fuel rod in the core. The upper estimate for the number of leaking fuel rods in the core is 2. There were no new fuel failures in August and September, 2017. As well, fuel washout does not take place.

No indication of degradation of leaking fuel was detected after the reactor power drop down on the time interval from 18 to 21 September.

During power transients, if they will take place, it is important to monitor activity of all the reference radionuclides including 134Cs and 137Cs (sampling frequency 1 time per 2-3 hours).

1. MTU is the mass of tramp uranium (fuel contamination in the core) calculated by activity of one of the radionuclides: either 131I or 134I. MTU(131I)/MTU(134I) is equivalent to the ratio of normalized release rates for 131I and 134I. [↑](#footnote-ref-1)
2. The upper estimate for the number of leaking fuel rods in the core was 2. [↑](#footnote-ref-2)