The increasing mass of the mother nuclide shifts the mass of the lighter fission product (Why?)

Increasing mass of the mother nuclide shifts the mass of the lighter fission product due to the presence of the "doubly magic" nucleus with a proton number of 50 and a neutron number of 82, which results in anomalous stability of fission products with a mass number 132. This is explained on page 2 of the document.

Axial expansion of pellets leads to an increase in core active height (By how much?)

Axial expansion of pellets leads to an increase in core active height, which could increase neutron leakage from the core towards the radial direction. The axial expansion effect is negligible in large cores but comparable to other reactivity feedbacks in small cores, especially with a height-to-diameter ratio of H/D > 0.5. This information can be found on pages 28-29 of J. Wallenius & S. Bortot's Fast Neutron Generation IV reactors article.

Radial expansion of pellets does not lead to an expansion in core radius (Why?)

Radial expansion of pellets does not lead to an expansion in core radius because the diameter of the active zone remains unchanged. Therefore, the reduction of reactivity associated with the reduced density of the fuel is entirely due to the axial expansion. This phenomenon is negligible in commercial thermal spectrum reactors, as discussed on page 28 of the document.

The axial expansion will increase the radial leakage of neutrons (Why?)

Axial expansion in a liquid metal-cooled fast reactor will increase the radial leakage of neutrons because as the coolant in the diagrid expands in the radial direction due to heating, the gap between the fuel assemblies increases, leading to an increase in axial neutron leakage from the core. This is explained on page 29 of the document "Fast Neutron Generation IV Reactors" by J. Wallenius & S. Bortot.

Axial expansion feedback is more important for cores with large H/D ratios (Why?)

Axial expansion feedback is more significant for cores with large H/D ratios because the fuel temperature increase leads to a greater axial expansion of the fuel rods, decreasing the coolant-to-fuel ratio and increasing neutron leakage. This effect is more pronounced in reactors with longer fuel rods with a larger H/D ratio. This is discussed in section 2.3.1 of the document "Fast neutron Generation IV reactors" by J. Wallenius & S. Bortot.

Feedback is delivered with the speed of sound (How fast is that?)

The sound velocity in a solid, which determines the response time of reactivity feedback, is around 5000 m/s. In fast reactor kinetics, the time constant for fuel axial expansion is approximately 0.1 milliseconds, which is considerably faster than any other reactivity feedback except for the Doppler effect. This information can be found on page 23 of the document.

By how much does the core radius increase?

The document needs to provide a specific answer to this question. It discusses the effects of diagrid radial expansion on reactivity and core performance but does not quantify the increase in core radius resulting from this phenomenon.

The radial expansion will increase the axial leakage of neutrons (Why ?)

Radial expansion in a liquid metal-cooled fast reactor will increase the size of the gap between fuel assemblies in the diagrid, leading to an increase in axial neutron leakage from the core. This is because the fuel assemblies are fixed in the diagrid, and the increase in coolant temperature causes the diagrid to expand radially, causing the distance between fuel assemblies. This is discussed on pages 28-29 of the document.

Radial expansion feedback is more important for cores with a low H/D ratio (Why?)

Radial expansion feedback is more important for cores with low H/D ratio because the increase in coolant temperature in the diagrid is directly transplanted to the inlet region of the core, and reducing the H/D ratio may lead to an increasing size of the gap between fuel assemblies, causing axial neutron leakage from the core to increase. This is discussed on pages 31-32 of the document.

Feedback is delivered once the hot coolant temperature has been translated to the inlet of the core (How fast is that?)

The delivery of feedback through diagrid radial expansion occurs after the increase in active zone coolant temperature is transplanted to the inlet region of the core, which may take several hundred seconds depending on the coolant inventory. This is mentioned in page 28 of the document "Fast neutron Generation IV reactors" by J. Wallenius & S. Bortot.

Safety parameters depend on core dimensions! why in terms of "ELFR: 600 MWe" vs "SLFR:100 MWe"

The safety parameters of a reactor depend on its core dimensions as it affects the magnitude and behavior of reactivity feedback. For example, the coolant temperature coefficient may be positive or negative depending on the core’s conversion ratio and H/D ratio. The document does not mention ELFR or SLFR specifically. Still, it provides information on the effect of core dimensions on safety parameters throughout the section on fast neutron Generation IV reactors (pages 29-33).

Explain why the delayed neutron fraction is small for plutonium-bearing fuels

The delayed neutron fraction is small for plutonium-bearing fuels because plutonium isotopes have a shorter half-life than uranium isotopes, releasing fewer delayed neutrons. Additionally, plutonium isotopes have a lower probability of fissioning from thermal neutrons, reducing the delayed neutron fraction. This information is discussed on pages 15-16 of the document.

Why is the Doppler feedback smaller in a fast reactor than in a thermal spectrum reactor?

The Doppler feedback is smaller in a fast reactor than in a thermal spectrum reactor because the effective neutron generation time is much shorter in a fast reactor, meaning there is less time for the thermal oscillations of the atoms in the lattice to affect the resonance cross-sections. This is explained on page 4 of the document.

Explain why a fast reactor's coolant temperature coefficient can be either positive or negative.

The coolant temperature coefficient in a fast reactor can be either positive or negative depending on the core size and conversion ratio. A larger core with a conversion ratio above unity tends to have a positive coefficient, while a smaller core may have a negative coefficient. This is due to the effect of neutron leakage, which is inversely proportional to the radius of the core. (Pages 27-28)

Why does the radial expansion of the fuel not affect reactivity?

The radial expansion of the fuel does not affect reactivity because the diameter of the active zone remains unchanged. The reduction of reactivity associated with reduced fuel density is entirely due to axial expansion. This effect is negligible in commercial thermal spectrum reactors but can be significant in small, fast reactors. This information can be found on pages 28-29 of the document. (49 words)

How can one design a fast neutron core to optimize feedback from fuel axial expansion and diagrid radial expansion?

The magnitude of feedback from fuel axial expansion and diagrid radial expansion can be optimized by designing the fast neutron core with a higher height-to-diameter ratio, which reduces the contribution of leakage to the coolant temperature coefficient. Additionally, increasing the height of the active core reduces the magnitude of the diagrid radial expansion coefficient. This information can be found on page 27 of the document.

From the safety perspective, what are the pros and cons of designing a fast reactor core with a high or low conversion ratio?

From a safety perspective, a fast reactor with a higher conversion ratio can produce more fissile material, which increases the risk of proliferation. On the other hand, a lower conversion ratio can lead to higher breeding of plutonium, which also poses a proliferation risk. A lower conversion ratio can also result in a more negative coolant temperature coefficient, which improves safety during transients. These factors are discussed in pages 31-32 of the document.