SCALE6.2 ORIGEN library produced from JENDL/AD-2017

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A SCALE6.2 ORIGEN library was produced from JENDL Activation Cross Section File for Nuclear Decommissioning 2017 (JENDL/AD-2017) with the AMPX-6 code in order to popularize JENDL/AD-2017 widely. The produced ORIGEN library of JENDL/AD-2017 was tested with the JPDR decommissioning data, which demonstrated that the library had no problems.

1. Introduction

The SCALE code system is a modeling and simulation tool complex for nuclear safety analyses and designs. The SCALE6.2 code system [1] was released in 2016 (the latest version is SCALE6.2.4). The ORIGEN code [1] in SCALE6.2 used for activation calculations in decommissioning is completely different from the previous ORIGEN-S code [2] until SCALE6.0 [2] and has the following features.

1) The input format of ORIGEN is easy to use and understand.
2) It is expected that the calculation accuracy improves because ORIGEN uses one group cross section data generated from multigroup neutron spectra in all calculation points with the COUPLE code [1] in SCALE6.2, while the ORIGEN-S code uses three group cross section data generated with a multigroup neutron spectrum in a typical pressurized-water reactor.
3) The calculation time of ORIGEN including COUPLE is at most about twice of that of ORIGEN-S even for 200 groups.

We expect that ORIGEN in SCALE6.2 will be mainly used for activation calculations in nuclear facility decommissioning. JAEA released JENDL Activation Cross Section File for Nuclear Decommissioning 2017 (JENDL/AD-2017) [3] in 2018. Thus we have produced a SCALE6.2 ORIGEN library from JENDL/AD-2017 in order to popularize JENDL/AD-2017 widely.

2. Method

The nuclear data processing code AMPX-6 [4] in SCALE6.2.4 was used to produce the SCALE6.2 ORIGEN library of JENDL/AD-2017 because the format of SCALE6.2 ORIGEN library was not open. The processing conditions are as follows.

- Group structure : 200 groups (the same as one of the ORIGEN libraries attached in SCALE6.2)

- ✓ We assume transport calculations with the multigroup library MATXSLIB-J40 (neutron : 199 groups) [5].
- ✓ The 200 group structure is the same as the 199 group structure except for its first group.

- Temperature : 300 K
  - ✓ We assume activation calculations for bio-shield concrete.
- Weight function : Maxwell+1/*E*+Fission spectrum + 1/*E* (above 10 MeV)
- Infinite dilution cross sections

Input data of AMPX-6 are very complicated. We used the ExSite code [4] in SCALE6.2.4 in order to generate a typical template input file for AMPX-6. We produced an ORIGEN library from each file of JENDL/AD-2017 with AMPX-6 and the template input and combined all the ORIGEN libraries to one ORIGEN library with AMPX-6.

We encountered several problems during the processing of JENDL/AD-2017 with AMPX-6. Thus we adopted the following coping strategies.

- We used the 0K MF10 version of JENDL/AD-2017 because AMPX-6 could not process the 0K MF9 version.
- We modified a metastable state level based on the decay data of SCALE6.2 (ex. ^{134m}Cs level : 3 in JENDL/AD-2017, 1 in decay data of SCALE6.2).
- JENDL/AD-2017 includes resonance data which should not be used to re-construct cross section data. However AMPX-6 re-constructs and adds cross section data with the resonance data in JENDL/AD-2017 as shown in Fig. 1. Thus we removed the resonance data in JENDL/AD-2017.

3. Comparison with Continuous Energy Cross Section

Two hundred group cross sections of typical nuclei and reactions in the produced ORIGEN library of JENDL/AD-2017 were extracted with the graphical user interface code Fulcrum [1] for visualizing SCALE libraries in SCALE6.2.4 because the format of the ORIGEN libraries is not open. Figures 1 to 4 plot them with continuous energy ones produced with the nuclear data processing code NJOY [6]. The figures show that the processing of the modified JENDL/AD-2017 with AMPX-6 is adequate.

4. Test with JPDR Activation Calculation

We calculated radioactive inventories in bio-shield concrete of JAEA JPDR (Japan Power Demonstration Reactor) [7], whose decommissioning completed in 1996, for validating the produced ORIGEN library of JENDL/AD-2017. Neutron spectra inside the concrete are calculated with the Sn DORT code [8], a 199 group library including up-scattering data from MATXSLIB-J40 and a partial JPDR model shown in Fig. 5. Radioactive inventories were calculated in the concrete with COUPLE and ORIGEN in SCALE6.2.4 and the calculated neutron spectra, where two activation libraries were used; the 200 group library produced from JENDL/AD-2017 and the 200 group library [1] attached in SCALE6.2 (produced from JEFF-3.1/A [9]). “0.0” was added before 199 group neutron spectra because the first group value of the 200 group structure was lack in the 199 group structure and negligibly small. The elapsed time for 161 ORIGEN and COUPLE calculations was 4 minutes, which is not so long compared with 2.5 minutes of 161 ORIGEN-S calculations. Figure 6 shows the calculated radioactivity distribution at Z=340 cm (cooling time : 15 years). The calculation results with two libraries are almost the same, which suggests that the ORIGEN library from JENDL/AD-2017 has no problems. The

calculated results are different from the measured ones. This is considered to be due to reinforced steel in the bio-shield concrete, which was not included in the calculations.

5. Summary

A 200 group SCALE6.2 ORIGEN library from JENDL/AD-2017 was produced with AMPX-6. Radioactive inventories in bio-shield concrete of JAEA JPDR were calculated with ORIGEN in SCALE6.2.4 for testing the library. As a result, it was demonstrated that the produced library had no problems. The produced library will be released from JAEA.

References

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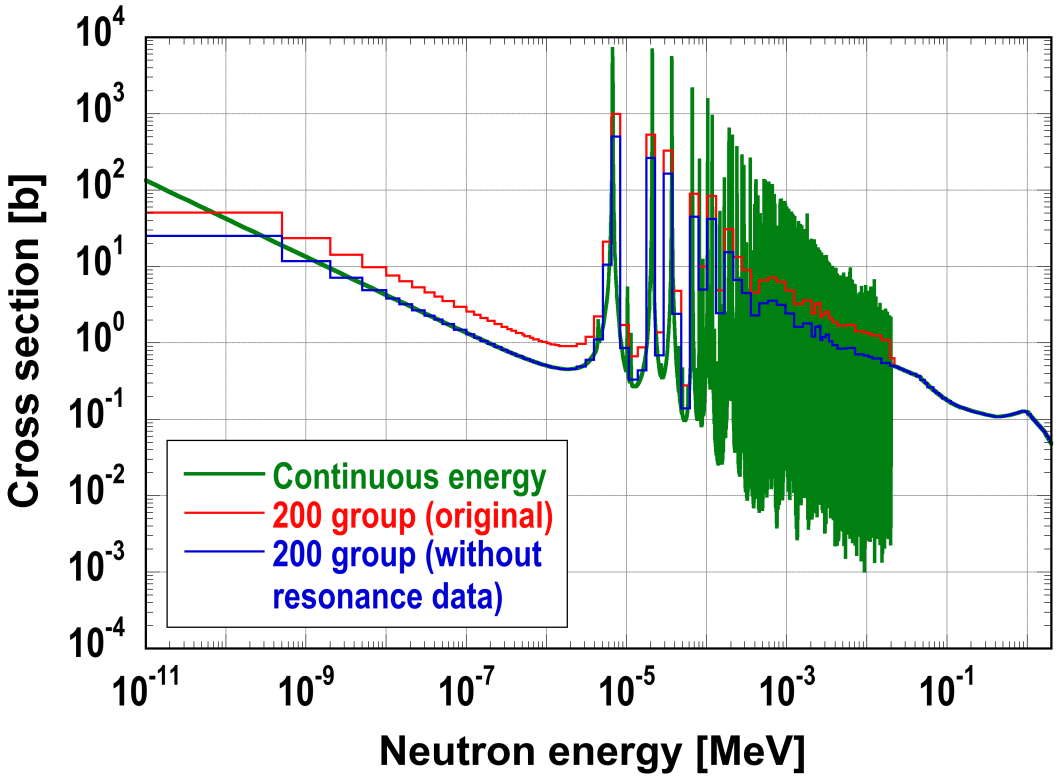

Fig. 1 Capture cross section of ^{238}U in JENDL/AD-2017.

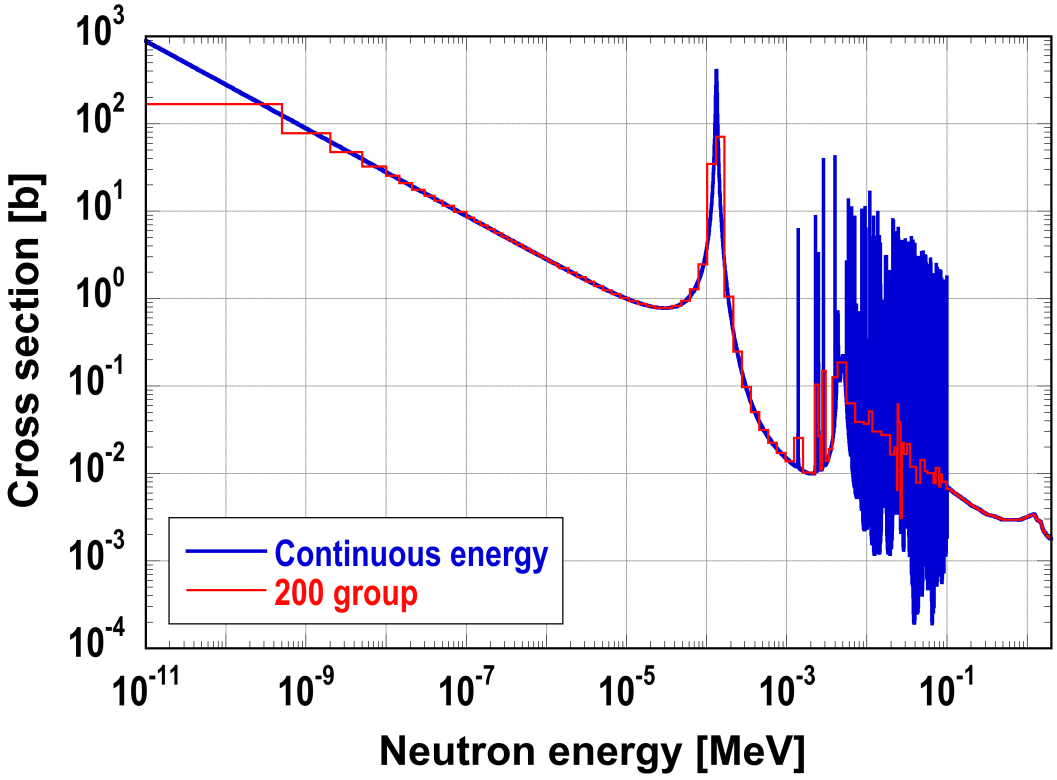

Fig. 2 Cross section of ^{59}Co(n,γ)^{60g}Co in JENDL/AD-2017.

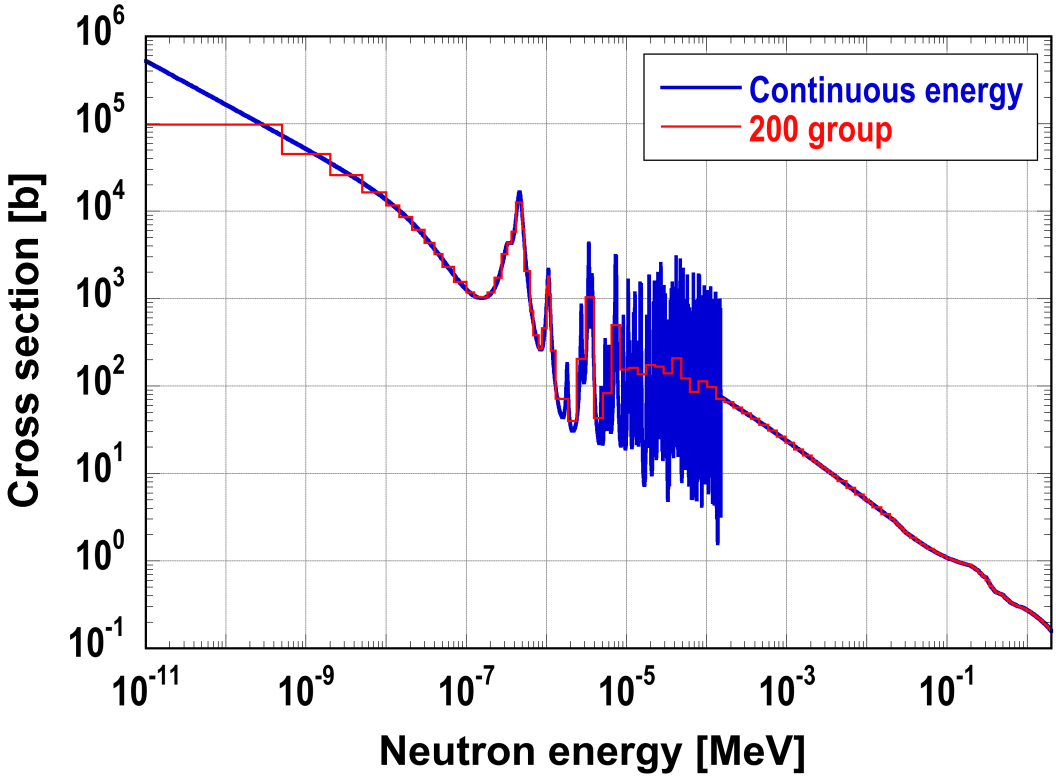

Fig. 3 Cross section of ^{151}Eu(n,γ)^{152g}Eu in JENDL/AD-2017.

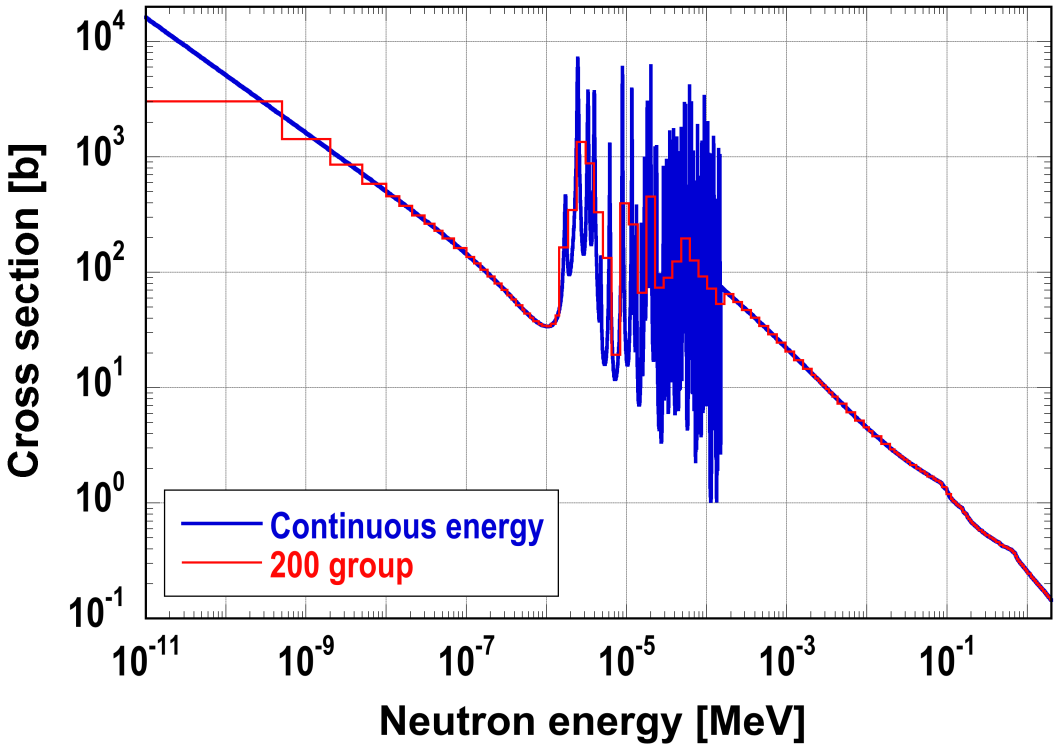

Fig. 4 Cross section of ^{153}Eu(n,γ)^{154g}Eu in JENDL/AD-2017.

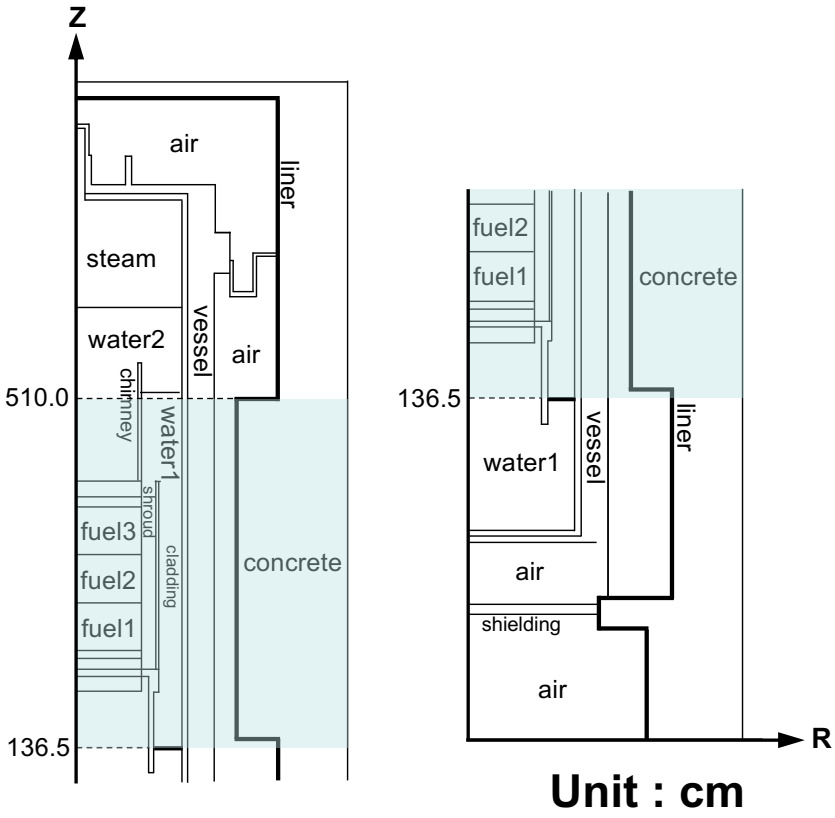

Fig. 5 Two-dimensional JPDR calculation model. Only the colored region was used in DORT calculation.

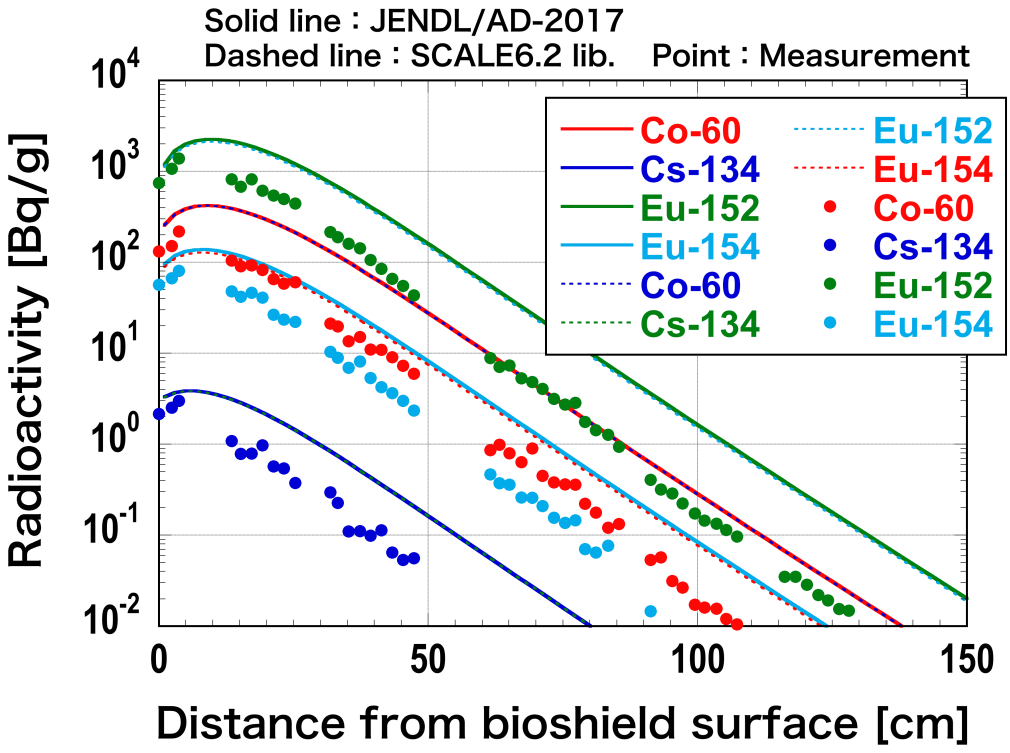

Fig. 6 Radioactivity distribution at Z=340 cm (cooling : 15 years).

日本語タイトル：JENDL/AD-2017 から作成した SCALE6.2 の ORIGEN ライブラリ

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