Accuracy Evaluation of Reactor Records based on Solution Analyses Data of Spent Fuels at JNC Tokai Reprocessing Plant

Ishi Mitsuhashi(1),
Mitsuro Matsumoto(2) and Masanori Ebihara(3)

(1)Core & Fuel Cycle Analysis Technology Group
Nuclear System Analysis Technology R&D Department
Power & Industrial System Research & Development Center
Toshiba Corporation Power System & Services Company
4-1, Ukishima-cho, Kawasaki-ku, Kawasaki, 210-0862 Japan
(2)Engineering Department
Nuclear Fuel Transport Co., Ltd.
1-1-3, Shiba Daimon, Minato-ku, Tokyo, 105-0012 Japan
(3)Transport Engineering Group
Nuclear Fuel Cycle Engineering Center
Nuclear Power Engineering Department
Tokyo Electric Power Company
1-1-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo, 100-0011 Japan

ABSTRACT

A series of ^{235}U residual enrichment of reactor records, which affects reactivity of individual fuel assembly directly, were compared with solution analyses data as an example of reactor records validation. The validation was based on solution analyses data of spent fuels at JNC(Japan Nuclear Fuel Cycle Development Institute) Tokai reprocessing plant. A large majority of the difference data between reactor records and solution analyses data about ^{235}U residual enrichment were within ±0.1wt%, it could be concluded that the error of ^{235}U residual enrichment of reactor records were within ±0.1wt%. The initial enrichment tolerance of a fuel is within ±0.1wt% also. It was concluded that the accuracy of ^{235}U residual enrichment of reactor records may be same as the initial enrichment tolerance from the study based on solution analyses data at the Tokai reprocessing plant.

INTRODUCTION

Burnup credit implementation requires a verification of the burnup level of each individual fuel assembly by a measurement, after irradiation but prior to shipment, to make sure that it satisfies the burnup acceptance criteria. A verification of the burnup level of each individual fuel assembly by a reactor record may be substituted for this pre-shipment confirmation performed by the measurement.

A reactor management system is composed of monitoring data and regulated core design codes[1]. A burnup value and an isotopic composition of an individual fuel assembly are involved in a reactor record, which are evaluated with the reactor core management system based on reactor thermal power with heat balance measurement, neutron flux with in-core neutron monitors and initial uranium weight of the assembly[2].

The isotopic composition of reactor records can be validated through a comparison with solution analyses data of a spent fuel at a reprocessing plant. The uranium and plutonium isotopic compositions of the solution analyses data at reprocessing plants are available to validate reactor records. Another minor-actinides isotopic data can be obtained with post-irradiated destructive assays for a spent fuel assembly.

SOLUTION ANALYSES DATA

A series of ^{235}U residual enrichment of reactor records were compared with solution analyses data as an example of reactor records validation, which affects reactivity of individual fuel assembly directly. The validation was based on solution analyses data of spent fuels at JNC(Japan Nuclear Fuel Cycle Development Institute) Tokai reprocessing plant.

One bundle is dissolved for PWR spent fuels, two bundles are dissolved in the case of BWR spent fuels from the dissolver volume at the Tokai reprocessing plant. The validation were performed based on the data whose residual enrichment deference from the previous one are within $\pm$0.5wt%, because a remained tail of the previous solution in the dissolver affects analysis data of residual enrichment measurement. Total numbers of the data points which satisfy the enrichment difference criteria were 595 for the PWR, 1173 for the BWR respectively.

VALIDATION RESULTS

The difference of ^{235}U residual enrichment between reactor records and the solution analyses data (Reactor Recode Error) were classified according to a initial enrichment of each fuel assembly. Figure 1 shows the average and the standard deviation(1ó) of Reactor Recode Errors as a function of the initial enrichment for PWR fuels. Figure 2 correlates the Reactor Recodes Errors to the bundle averaged burnup for PWR fuels. The average and the standard deviation(1ó) of Reactor Recode Errors as a function of initial enrichment for BWR fuels is shown in figure 3, and the correlation of the Reactor Recodes Errors to the bundle averaged burnup for BWR fuels is shown in figure 4. The initial enrichment and the burnup dependencies were not observed on Reactor Recode Errors from these figures.

Figure 5 and Figure 6 depict Reactor Recodes Errors as frequency histograms for the PWR fuels and BWR fuels. The average and the standard deviation(1ó) are –0.036, 0.044 for PWR, 0.004,0.035 for BWR respectively. A large majority of the data were within $\pm$0.1wt%, it can be concluded that the error of ^{235}U residual enrichment of reactor records were within $\pm$0.1wt%. The initial enrichment tolerance of a fuel is within $\pm$0.1wt% also. It was concluded that the accuracy of ^{235}U residual enrichment of reactor records may be same as the initial enrichment tolerance from the above study based on solution analyses data at the Tokai reprocessing plant.

CONCLUSION

A series of ^{235}U residual enrichment of reactor records were compared with solution analyses data as an example of reactor records validation. The validation was based on solution analyses data of spent fuels at JNC(Japan Nuclear Fuel Cycle Development Institute) Tokai reprocessing plant. It was concluded that the accuracy of ^{235}U residual enrichment of reactor records may be same as the initial enrichment tolerance from the study.

To substitute a verification of the burnup level of each individual fuel assembly by a reactor record for a pre-shipment measurement, the accuracy of isotopic composition except ^{235}U, which also affects the reactivity, should be studied.

A scheme that provide assurance against a misloading of unexpected fuel assembly should be well planed, if it is intended that a confirmation of reactor records may be substituted for a measurement. Consignors should be expected that they establish a rational and reliable control procedure against a misloading of unexpected fuel assembly, which may be originated from confirmation of fuel ID number, Cherencov ray measurement and so on.

REFERENCES

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[2]TSUIKI, et al., 'TARMS An On - Line Boiling Water Reactor Management System Based on Core Physics Simulator,' Proceeding of a Topical Meeting, ANS, vol.1.1 70-86 (1998)

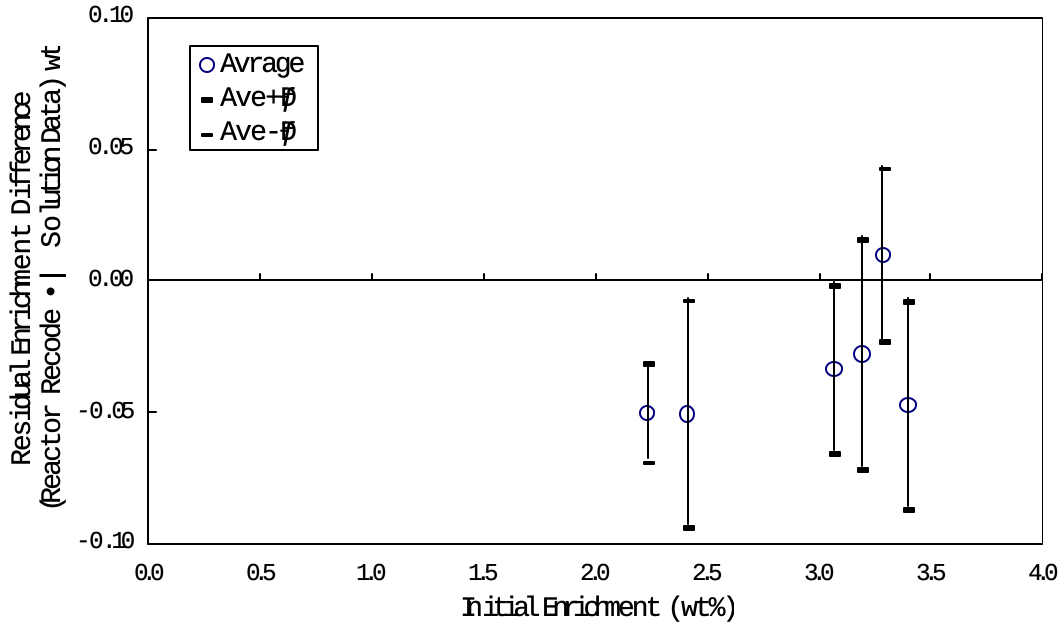

Fig.1 Average and the standard deviation(1ó) of Reactor Recode Errors vs. Initial enrichment (PWR fuels)

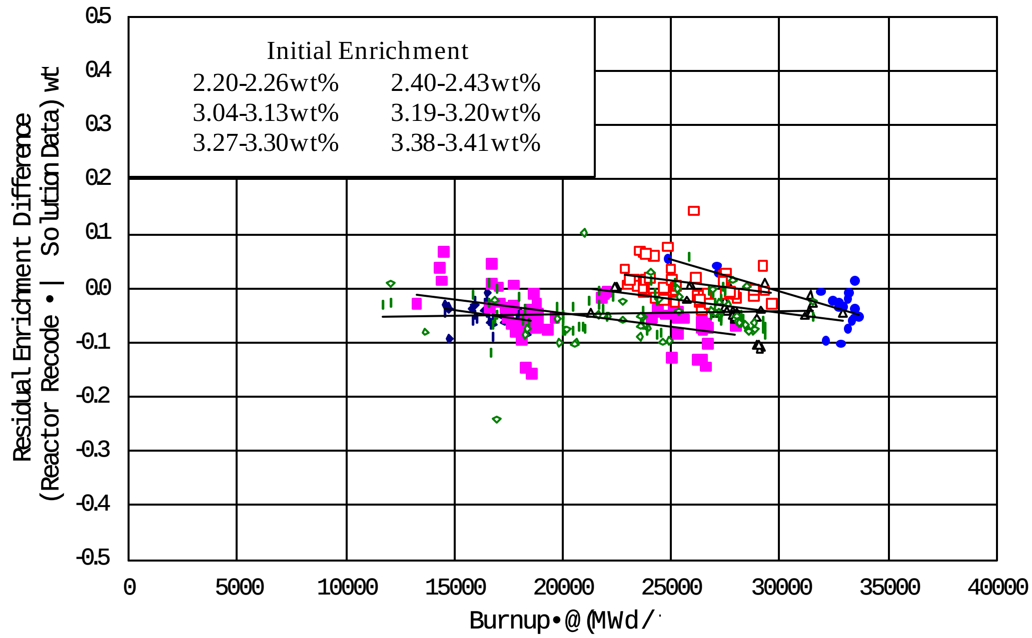

Fig.2 Reactor Recodes Errors vs. Bundle averaged burnup (PWR fuels)

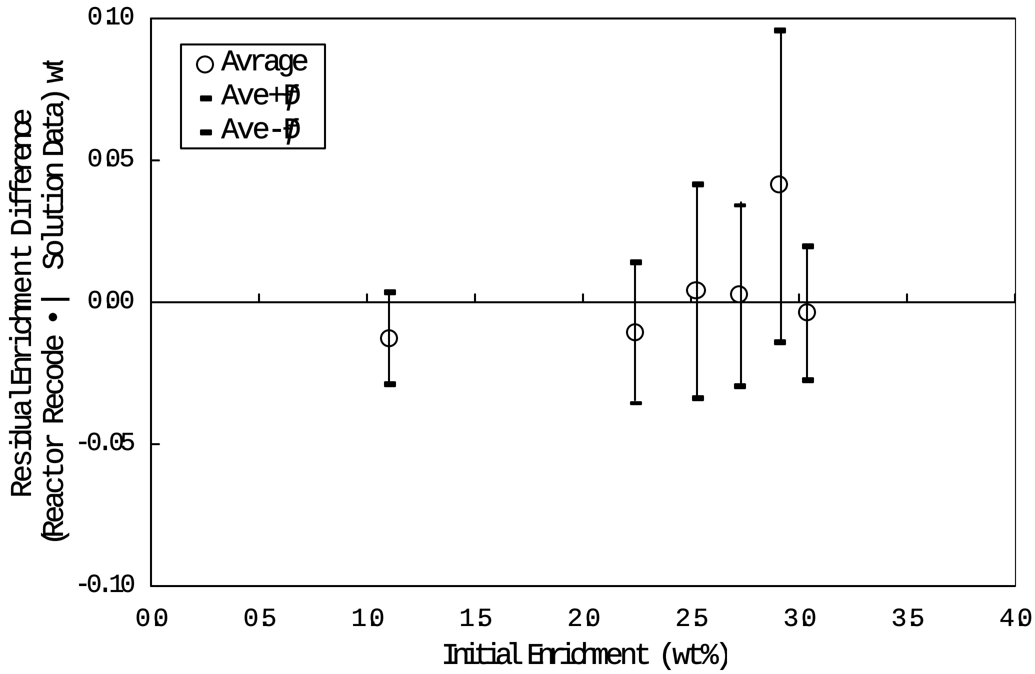

Fig.3 Average and the standard deviation(1σ) of Reactor Recode Errors vs. Initial enrichment (BWR fuels)

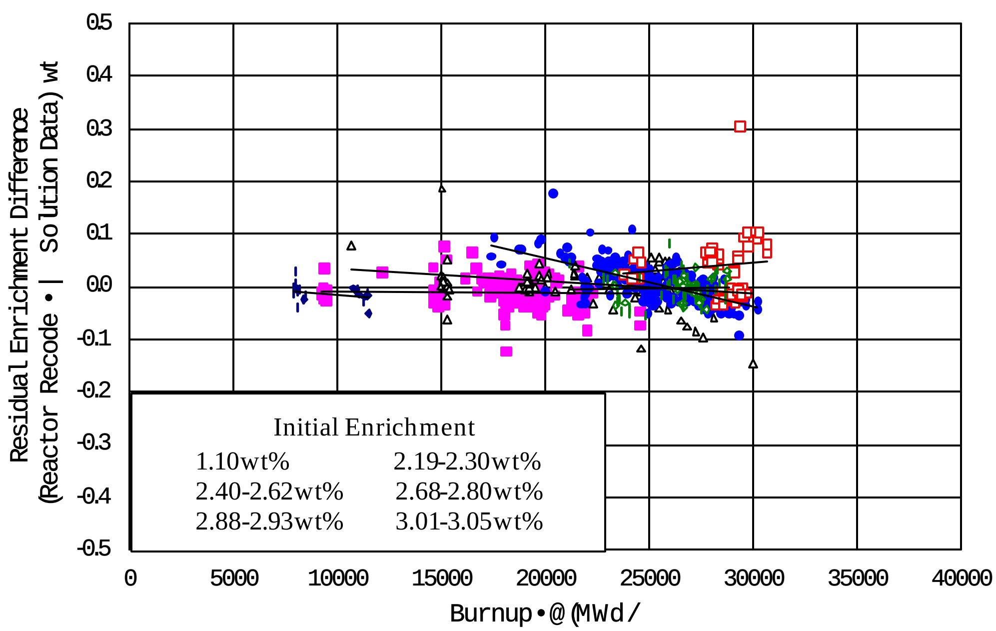

Fig.4 Reactor Recodes Errors vs. Bundle averaged burnup (BWR fuels)

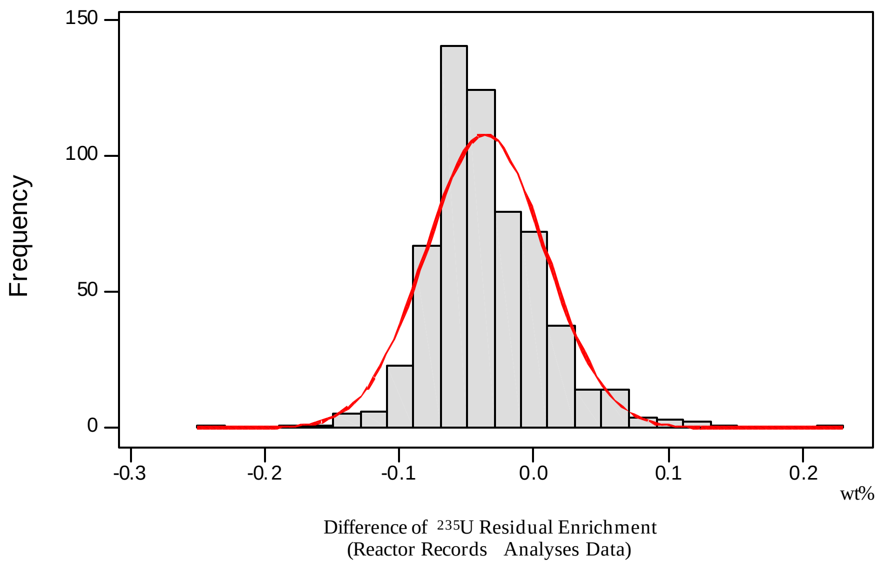

Fig.5 Frequency Histogram of ^{235}U Residual Enrichment Error of Reactor Records (PWR)

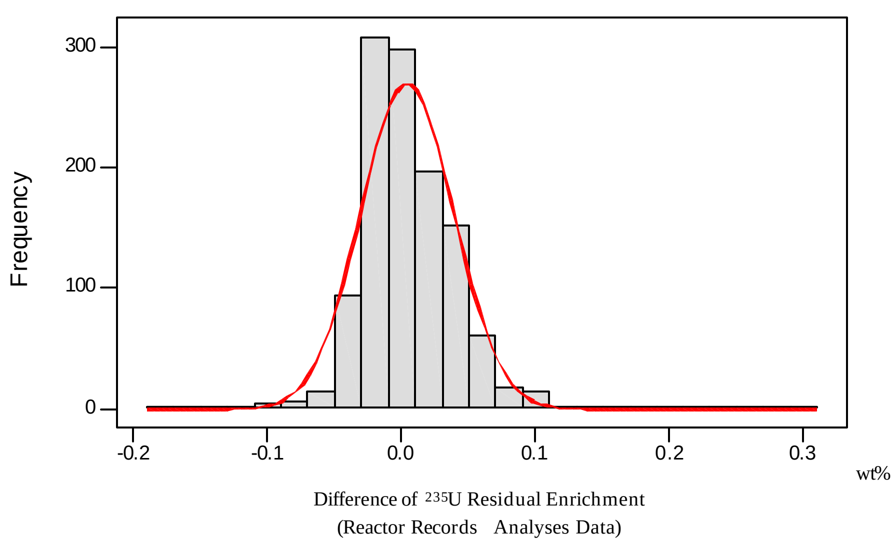

Fig.6 Frequency Histogram of ^{235}U Residual Enrichment Error of Reactor Records (BWR)