# Crud Cleaning for Reloaded PLUS7 Nuclear Fuels

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## 1. Introduction

Crud which is made in reactor system as a corrosion product stains high burnup nuclear fuel cladding while flowing with a fluid in nuclear system. AOA(Axial Offset Anomaly) which is define as a significant negative axial offset deviation from the predicted nuclear design value was resulted from deposition of Crud. For solving AOA, there are several methods to solve it like improving nuclear fuel design, reactor-operating and water hydrochemistry.

However, the most effective method is cleaning Crud directly on nuclear fuel cladding by ultrasonic waves which are effective and safety means. Hereupon, KNF developed Crud cleaning technique some years ago, and apply it in domestic reloaded nuclear fuel[1]. For this time, Crud cleaning was performed about PLUS7 fuel designed in-country. This paper introduces about efficiency of Crud cleaning and mass of collected Crud, what if Crud is cleaned directly by applying this technique in PLUS7 fuel.

## 2. Performance and Result

### *2.1 Performance*

KNF performed Crud cleaning in spent fuel pool. KNF installed cleaning chamber, included diverter valve and supportable tools in order to handle stream flow, and filtration skid for cleaning and gathering in Cask Loading. In addition, control panels were installed on floor for operating equipment.

KNF completed Crud cleaning on 108 assemblies which included 68 first burned fuels and 40 second burned fuels preferred to predict high cumulated Crud without defective symptom for five days.

Crud cleaning took 6 minutes per assembly. Before and after cleaning, visual test was performed about fuel closely incase defects or other unusual case. Moreover, measuring radiation variation continuously in filtration skid made it possible to be able to examine process of cleaning. Analyzing radiation variation, most Crud was cleaned in 2 minutes (Refer Fig 2).

In addition, KNF calibrated pressure differential and radiation dose rate in filter for deciding replacement. Unlike other form of filtration skid type which contains 8 filters and 2 pumps, KNF operated compact type which consists of 2 filters and 1 pump. While cleaning 108 assemblies, KNF replace 2 filters as flow exceed the standard. Before and after using, all filters are measured weight accurately for evaluate Crud weight.

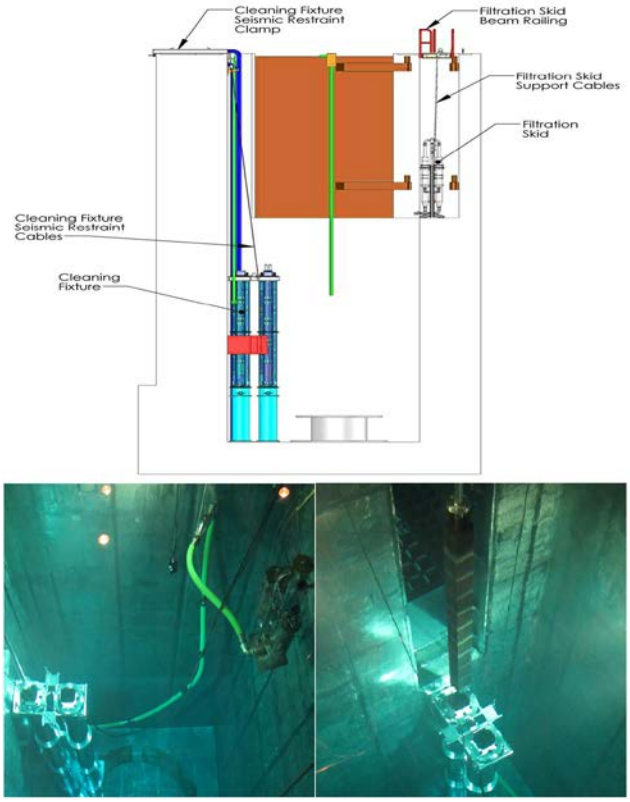


Fig 1. Outline of Crud cleaning equipment(up) and installed Crud cleaning equipment in water(down).

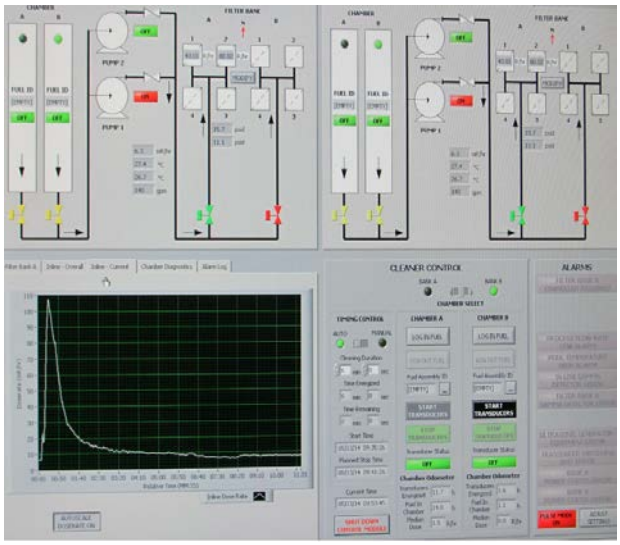

Fig 2. Changing radiation dose during Crud cleaning. Most Crud was cleaned in 2 minutes.

*2.2 Result*

The effect of Crud cleaning can be seen in the upper of assembly because most of Crud is stuck on there. The efficiency of cleaning is quite different between first burned fuel and second burned fuel. The result of visual inspection showed first burned fuel was 20% cleaned a Crud, and second burned fuel was 80%(Refer Fig 3). The total radiation dose rate in filter was 192R/hr which means 1.8R/hr per each assembly[2].

Mass of Crud was analyzed in water level 4ft and 37ft for reflecting buoyancy. Every filter was weighed because of analyzing. The entire mass was 269g (2.5g per assembly) concerned buoyancy. This result which belongs to world average cleaning range (100g~1000g).

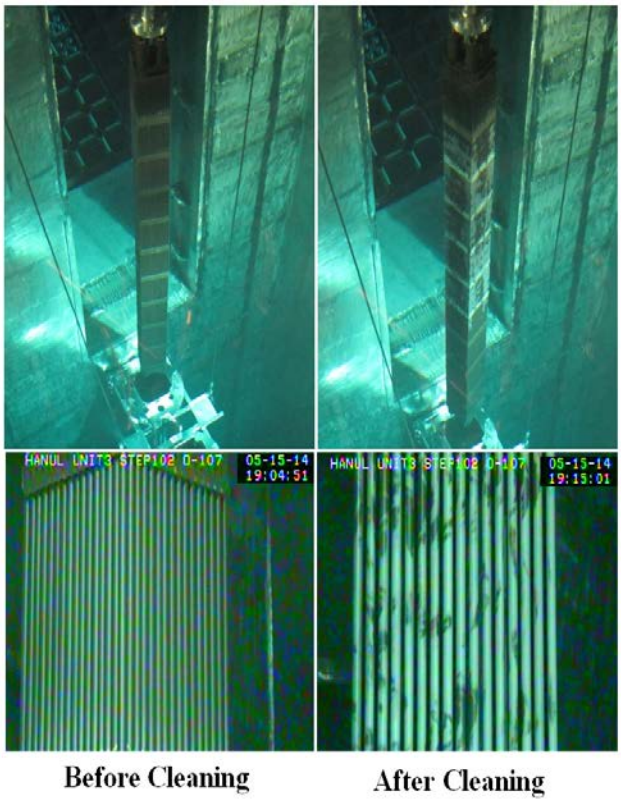


Fig 3. Before and after of Crud cleaning for second burned fuel.

## 3. Conclusion

Reloaded 108 PLUS7 fuels were cleaned and the result of visual inspection showed first burned fuel was 20% cleaned a Crud, and second burned fuel was 80%. The outcome was as same as other plants in abroad since the quantity of collecting Crud was 269g. By accomplishing the project, KNF was able to gather data about different type of fuel and nuclear plant can produce electricity stably. Crud cleaning in all domestic nuclear plants makes it possible to reduce AOA, corrosion rate about components in NSSS(Nuclear Steam Supply System), exposing rate for person and etc. After Crud cleaning, ultrasonic waves were taken to clean high dose radiated parts as well because some

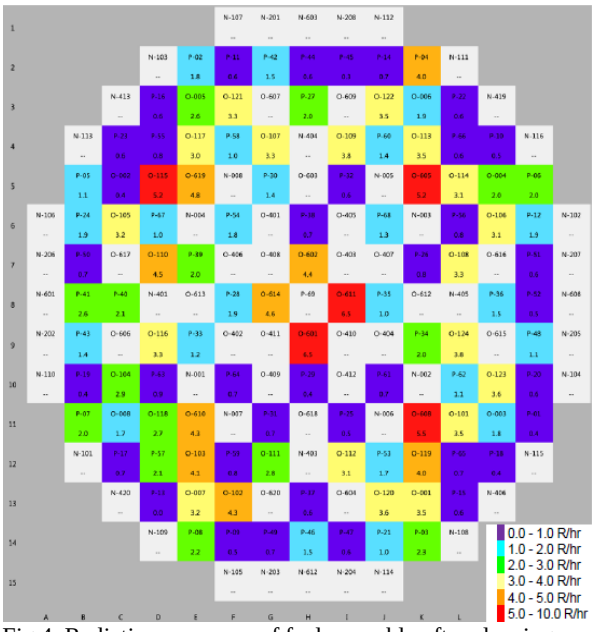


Fig 4. Radiation core map of fuel assembly after cleaning.

equipment were contaminated. If improved this technique, cleaning by ultrasonic waves could apply in diverse such as, eliminating Crud, washing equipment, and deactivating nuclear plants in advance.

## REFERENCES

[1] Park JY, Kwon YB, Shin JC, Choi JS, Kim YK, Choi KS, Choi IK, KNFC Crud Sampling and Fuel Cleaning Technology Development, Australian Nuclear Association, 2006.
[2] J Block, P Frattini, T Moser, Advances in ultrasonic fuel cleaning, IAEA, 2002.