International Workshop on Application of Advanced Plant Information Systems for Nuclear Decommissioning and Life-cycle Management

### **Evaluation of VR software as a Knowledge Management for the Decommissioning of Nuclear Facilities**

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15min+5min



# **TODAY's Outline**

- Decommissioning is a long term project. This project occur a succession to experience, knowledge, technics and skills between to experts and next generation of NPP staff.
- To solve these issues, we focuses on a computer technology and knowledge management. Decommissioning KM is one of method as a solution of succession.
  - Todays main topics is VR and MR.
- It is facing that necessity to keep a real memories for the next generation on a safety work. VR and MR can be across virtual and real world. But, our all experience and knowledge would not install on virtual cloud. Then, we need to select an important things and should leave information. At this case, the project request a guide line. This is a knowledge management.
- I'll show you a VR trial of actual decommissioning site of Fugen.



# Contents

- 1. Basic information of Fugen decommissioning
- 2. VRdose experience at Fugen
- 3. MR developing at the Smart decommissioning center



# **Schematic Diagram of ATR FUGEN**



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(\*1) Reorganization: Fugen N.P.S.  $\rightarrow$  FUGEN Decommissioning Engineering Center

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### **Status of Dismantling Work**





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### **Basic Concept of dismantlement of reactor core**







### **Distribution of Waste in Fugen**



# **2.VR**



- VRdose is a 3D simulation software that simulate radiation dose risk on real time.
- VR technology is useful for safety decommissioning works.
- Fugen has a cooperation with IFE to update VRdose, for example we added some functions there are annotation tags for using KM and 3D touch operational function to discuss of simulation.



#### **Other outcomes of VRdose development**















arget Cutting pip	Number
Binch	6
linch	13
Removed Material	Number
Air Valve	1
Pipe	9
lbow	4
ee	2

-



#### VRdose demonstration Decommissioning for CUW heat exchanger

Deconstruction of "Regenerative Heat Exchanger"



# **Results of VR and interpretation**

#### **Target of Decommissioning works**

Pre-studyOPlanning, ARALADismantlementNoneWork managementSettle sortOAfter discussion and L&L

 $\bigcirc$ Very well  $\bigcirc$ Well  $\triangle$ Slightly well

- Real world V.S. Virtual world
  - Animation of VRdose simulation feel cool. Is this easy to make this one?
  - Who make it? How to make a real cutting on a VRdose? For example, we need to cut pipes or devices each 10 cm.

High

Low

None

- At the real situation of dismantlement work, we need to confirm a work space, temporary place, location and system isolation and cutting or transportation method...
- We thought, the result of simulation and the demand of worker have a different purpose. There are "to understand without going to the decommissioning site" and "to focus on a real site". VRdose simulation focuses on a dose rate and offer a discussion point of deconstruction. But, worker tends to request a real result of simulation. How to connect both aim?



Area a radiation dose rate

 $\triangle$  Good workability

simple deconstruction

 $\triangle$  Remote

Middle O Useful for VR

Δ



### **Impressions and discussion**

- Procedure of VRdose scenario making
  - 1. To prepare a 3D-CAD data. \*making a original 3D-CAD data is higher cost and using a data need a professional staff.
    - More over, using a CAD data, remove a interference/ obstructer ceiling, wall, pipes and devices when making a 3D VR animation
  - 2. To transport a CAD data into a VRdose
    - VRML (filename extension), Need to fix a geographical data (XYZ) and adjust other some factors.
  - 3. A operability of scenario creation is somewhat old procedure and a bit hard to make one.
- NPP's facility also changing and updating, but to fix a CAD data is not easy tasks.
  - Worker tend to want to know a real site state when use VR. At this case, we need to update a CAD data. However, VRdose aim is not alternation of real world. We need to connect a both wishes. This issue is KM problem too.
- One of answer is Mixed Reality. MR is more interactive VR technology.

# **3.MR**

## FUKUI Smart Decommissioning Center (2018~)

- Promotion of decommissioning, Support for decommissioning business of local company and economy
- Fukui prefecture has a lot of NPPs that is almost a 25% in Japan.

#### **Collaboration partners**

Fukui Prefecture, University of Fukui, Wakasawan energy research center

#### **Cooperating companies**

RIKEN, Fukui Chamber of Commerce and Industry, Fukui Institute of Technology, Nuclear power backend promotion center, Electric companies (Kansai, JAPC), other 6 companies

#### Decommissioning Dismantling Technology Verification Field



Mixed reality system development

#### Laser processing advanced field



Laser fusion adaptive control system development







2018,6,16 Opening Ceremony



Decommissioning measures mockup test field

Demonstration test of decommissioning technology

#### **Mixed Reality System overview**



- MR system using a VR goggle that is "head mount display (HMD)".
- User watch a virtual facilities though the HMD. The screen follows the direction user saw by a 6 optical cameras.
- Our MR system is using 3D-CAD data and a point cloud data. Point cloud data collect a 3D scanning device.
- 3D scanner could be correct a real data
- To get a correct 3D data can access a target to stride a interpreter goods.

MR Feature and overview

- Close to the real site of NPP
- Confirm a workability (Tool interference, working posture etc.)
- Examine a exposure dose of workers
- Examine a optimum work procedure





### Conclusions



- Since the decommissioning work going to have more difficulty task in terms of complicated structure at high radiation area, a good simulation system will be needed for the dismantling. VRdose and MR enable workers to practice the dismantling procedures and estimate radiation exposure in advance.
  - However, making a VR animation and using CAD software is not easy for worker. This task need a corroboration with IT processioning staff.
- VR and MR don't request a accurately reproduce everything. However, decommissioning activity can keep a more visual information and that is good for understand to newcomers by using there. This one relating a succession.
- During dismantlement work will be advanced from a low level radioactive facilities to high level one, we can accumulate our experience, technology and knowledge of dismantlement by VR and MR. There are also important to share the important points of work and notes and to utilize it.
- In the future, using a VR and MR technology, we will try to open the substance of decommissioning on the real situation of NPP that "lessons and learned" is useful to other case of decommissioning.

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## Thank you for your attention

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# Appendixes

# Sight of FUGEN decommissioning engineering center



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#### Decommissioning of NPPs in Japan (as of Sep. 2018) • Operational



#### **Current Status of Dismantling Work**



#### **Ref; Main technologies for Decommissioning of Fugen**





# Feature of MR System MR devices





#### Feature of Mixed Reality System Dismantling Technology Demonstration Field

- MR experiencing person to see the correct 3D display image with actual size.
- The motion space is possible to experience the site while moving through this space.
- This MR system is supposed to be utilized for the purpose of developing human resources and improving technical skills in order to support companies in Fukui prefecture that wish to enter the decommissioning work. In addition, it is expected to be used for practical lessons for university students etc.
- MR good for the decommissioning work safely and rationally, sufficient examination of work procedures in advance is necessary.
- MR enables visualization of the dose equivalent rate at the site, examination of the dismantling procedure of the facility, examination of the installation place and size of the temporary equipment (scaffold, curing material, shielding) and confirmation of carryin route and interference of the equipment necessary for dismantling work.



The MR motion space



#### **VRdose Worldwide application**

VRdose and extended products were provided and tested in worldwide.



IFE historic fuel site, Norway



Cooperation Research of TEPSYS for TEPCO, Japan



Ringhals NPP (Vattenfall), Sweden

