JAEA Robotics' Emergency Response to FUKUSHIMA-DAIICHI Accident - Summary and Lessons Learned -

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Abstract: Japan Atomic Energy Agency developed Nuclear Disaster Response Robotics in 2001 after JCO criticality accidents occurred. It is very sorry that Nuclear Disaster Response Robotics could not work when the FUKUSHIMA-DAIICHI accident occurred by a big earthquake and a huge Tsunami on March 11th 2011. According to the situation and condition of the FUKU SHIMA-DAIICHI accident, JAEA has modified above mentioned Nuclear Disaster Response Robotics and prepared suppo rting equipments like as Robotics Control vehicles. JAEA has provided Robotics and Robotics Control vehicle to TEPCO and is continuously supporting TEPCO for plant restoration. This paper summarize JAEA ROBOTICS' Emergency Respo nse to FUKUSHIMA-DAIICHI Accident and describe lessons learned.

Keywords: FUKUSHIMA-DAIICHI, Emergency Response, Nuclear disaster Robotics, Robotics control vehicle.

1 INTRODUCTION

Japan Atomic Energy Agency (JAEA), former Japan Atomic energy Research Institute (JAERI) and Japan Nuclear Cycle development institute (JNC), had experienced on development for reactor vessel remote dismantling machine and bilateral servo-manipulator which has been used for maintenance task under extremely high radiation dose level. Nuclear Disaster Robotics, two RESQ-A, RESQ-B, RESQ-C and RaBOT had been developed after JCO criticality accident occurred on September 30th 1999. It is very sorry that those Nuclear Disaster Robotics could not work when the FUKUSHIMA-DAIICHI accident occurred by a big earthquake and a huge Tsunami on March 11th 2011.

JAEA modified existed Remote Operated Vehicle (ROV) which had been used cold test for Glove Box dismantling and two RESQ-A and prepared Robotics Control Vehicles and provides them to TEPCO for supporting FUKUSHIMA-DAIICHI restoration based on experiences obtained during above mentioned development.

2 Back Ground

2.1 reactor vessel remote dismantling system

JAERI developed reactor vessel remote dismantling machine based on single arm power manipulator 1981 to 1990, and deployed the system during decommissioning of The Japan Power Demonstration Reactor. See **Fig. 1**

2.2 Bilateral Servo-Manipulator System

JNC developed Bilateral Servo-Manipulator System 1982 to 1999 in order to deploy the system for maintenance in Tokai Vitrification Facility which has extremely high dose area. See **Fig. 2**.

Fig. 1

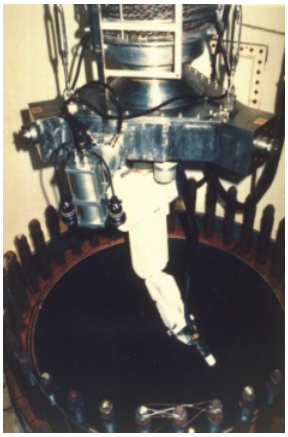

Fig. 2

2.3 Nuclear Disaster Robotics

JAERI developed nuclear Disaster Robotics, two RESQ-A, RESQ-B, RESQ-C and RaBOT in 2000 to 2001 with cooperation of some company, based on the lesson learned that operator could not access easily for repressing criticality during JCO criticality accident which was occurred on the September 30th. See **Fig. 3**.

2.4 Remote Operated Vehicle for decommissioning

JAEA deploy Remote Operated Vehicle in cold test for dismantling Glove BOX which was use for Mixed Oxide

Fuel for Fast Breeder Reactors and an Advanced Thermal reactor. See **Fig. 4**.

Fig. 3

Fig. 4

3 Emergency response to FUKUSHIMA-DAIICHI accident

3.1 Outline

At the 2:46PM on March 11th 2011, the earthquake of the East Japan Pacific Ocean was occurred and following huge Tsunami attacked FUKUSHIMA-DAIICHI Nuclear Power Station, therefore Station black out occurred reactor coolant could not be maintained. As a result, hydrogen explosion was occurred. See **Fig. 5**.

At that time, RaBOT was already discarded, and RESQ-A, RESQ-B and RESQ-C were not able to work with some failure. It was requested to repair to the company which cooperated when developed, however the request was rejected by the company with reason why engaged engineer were had dissipated and the technology was not handed down.

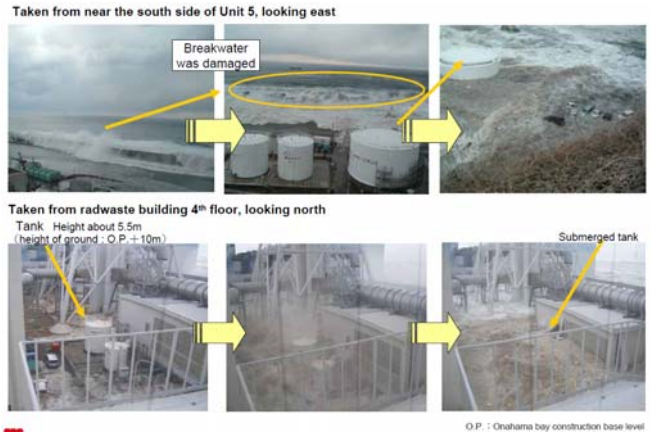

Fig. 5

3.2 Robotics Control Vehicle 1 (RC-1)

It is known that Robotics can't be used successfully without various supporting equipment. JAEA prepared Robotics Control Vehicle – 1 (RC-1) which is for JAEA-1 and JAEA-2 operation and is equipped with Steel shielded operation BOX, a gamma-camera, a teletecter, a viewing camera, a generator.

Based on request from Tokyo Electric Company (TEPCO), JAEA was provide the RC-1 to TEPCO for TALON operation which a robot has radiation mapping system and is provided by Idaho National Laboratory, DOE. Also, a thermo camera and a 3-D laser camera were equipped which were developed and provided by Tadokoro Laboratory of Tohoku University. See **Fig. 6**.

Fig. 6

RC-1 was supplied to FUKUSHIMA-DAIICHI on May 1st and have been used for radiation measurement. The picture taken by gamma camera was shown in **Fig.7**, and the hot point was indicated clearly.

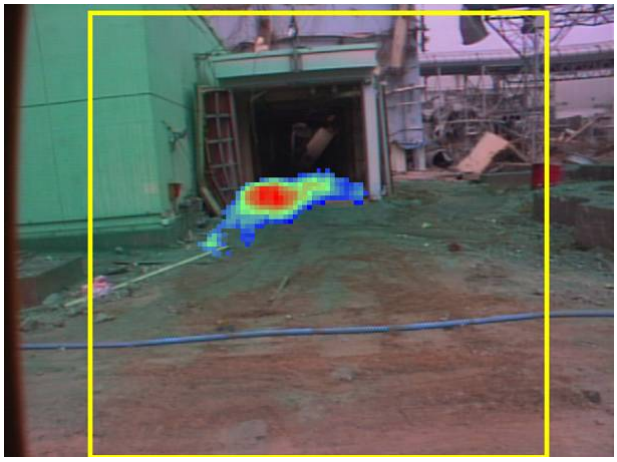

Fig. 7

3.3 JAEA-1

JAEA-1 was modified based on Remote Operated Vehicle used for cold test for Globe BOX dismantling, and is for cleanup of rubbles Rubble scattered by the explosions. See **Fig. 8**.

Fig. 8

3.4 JAEA-2

JAEA-2 was modified based on RESQ-A and equipped with 6 MPa high pressure water spray for decontamination. See **Fig. 9**.

3.5 JAEA-3

JAEA-3 was modified based on RESQ-A and equipped with a prototype of gamma camera which was made based on the experiences on the gamma camera which was equipped on RC-1. See **Fig. 10**.

3.6 Robotics Control Vehicle 2 (RC-2)

As a result of RC-1 preparation, TEPCO requested a new Robotic Control Vehicle. **Fig 11** shows the steel shielded BOX which was not fitting yet.

Fig. 9

Fig. 10

Fig. 11

4 Consideration

4.1 Organization and Scheme for operation and maintenance

It is most important lesson learned that an organization and scheme for operation and maintenance of Emergency response Robotics and accessories like as Robotics control vehicle.

This issue had been pointed out and discussed when Nuclear Disaster Robotics were developed after JCO criticality accident, however conclusion had not been reached.

If such organization and scheme had been established other lessons learned mentioned below could have been pointed out and solved.

4.2. Systematization

As mentioned above, it was known that a Robotics itself can't be used successfully without accessories. Accessories like as Robotic Control Vehicles, gamma cameras, teletecters lights, cooler/heater, generators and others should be prepared in advance and should be systematization. Especially, generators were difficult to obtain after the earthquake and Tsunami attacked.

4.3. Optimization under emergency

As experienced, maker cannot be always depended, under the emergency situation. Minimum tasks like as to optimize Robotic systems in accordance to the situation of the accidents should be performed by operators of the organization.

Therefore, Platform and tool systems should be recommended. Platform is mobile mechanism and should be prepared two or three type according to size and weight of tools. Tools should be prepared or modified based on conventional equipment on the shelf.

4.4 Mobility

Even if an organization established, it is very difficult to prepare logistics in the damaged area just after earthquakes and Tsunamis attacked, so the organization should cooperated with the Defense Forces of Japan. Also Robotics Control Vehicles should be designed and prepared in accordance with transport plane and helicopter of Defense Force of Japan.

5 CONCLUSION

We are TEAM NIPPON.

We shall overcome!

Fig. 12

REFERENCES

[1] Ohno (2011), Robotic Control Vehicle for measuring Radiation in Fukushima Daiichi Nuclear Power plant, SSRR 2011