ISOE EG-SAM Interim Report

Chapter 7. Key Lessons Learned form Past Accidents

Report on behalf of the Sub Expert Group

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Chapter Content

- **Key lessons learned from:**
  - **TMI-2 accident (1979)**
    - Contribution from R. Doty
  - **Chernobyl accident (1986)**
    - Contribution from C. Schieber
  - **Fukushima accident (2011)**
    - Contribution from Y. Hayashida
- **Focus on occupational RP issues during emergency and recovery phases**

TMI-2 Accident (28 March 1979) (1)

- **Accident consequences**
  - 45% of core melt, remaining in the reactor pressure vessel, which remained intact

- **Occupational tasks to be performed**
  - Starting just after the accident = "recovery phase"
  - **Objectives to decontaminate and defuel:**
    - Maintaining the reactor in a safe state
    - Decontaminate the plant
    - Process and immobilize fission products
    - Remove and dispose reactor core

TMI-2 Accident (28 March 1979) (2)

28 March 1979
- Accident

23 July 1980
- 1st reactor building entry

July 1984
- Reactor vessel head removed

October 1985
- Defueling began

January 1990
- Defueling completed

28 December 1993
- Post Defueling Monitored Storage

Major Activities from 1986 to 1989	Dose (person.Sv)
Defueling operations – reactor vessel	6.98
Defueling support (tools, repairs, water clean-up)	10.58
Reactor Building miscellaneous (robotics, crane operations, radioactive waste, etc.)	7.65
Decontamination outside the Reactor Building	4.24
Routine operations (ops, chemistry, RP) outside the Reactor Building	2.77
Ex-vessel defueling (pressurizer, etc.)	2.16
TOTAL	**34.38** **(≈ 8 person.Sv/year)**

Total collective dose from March 1979 to December 1993 : About 66 person.Sv

TMI-2 Accident (28 March 1979) (3)

- **Some key lessons learned from ORP point of view**
  - **Design changes/improvements:**
    - Remote monitoring of area radiation levels
    - Collect and analyse of reactor coolant samples and other potentially highly radioactive samples without incurring unnecessary dose
    - Airborne effluent monitoring systems to address the need for monitoring of higher concentrations of radioactive materials
  - **Training improvements:**
    - Emergency plan response training
    - Conduct of drills and exercises
  - **Development of ‘unmanned robots’**
    - Characterization of source terms and/or clean-up of areas (highly contaminated/high radiation fields areas)

Chernobyl Accident (26 April 1986) (1)

- **Accident consequences**
  - Explosion ruptured the reactor vessel – 10 days of fire
  - High release of nuclear fuel (9% on NPP site; 44% on 80 km zone, 44% rest of USSR; 3% outside USSR)
- **Workers involved**
  - Urgent response team : 27th April 1986 – 20th May 1986
    - **35,000 persons** (13,000 military - 22,000 civil)
  - Recovery operation workers: 21st May 1986 – 30th November 1986
    - **89,000 persons** (49,000 military – 40,000 civil)
  - Total number of workers involved until 1990
    - **≈ 600,000 persons** (240,000 military servicemen)
- **Collective dose 1986 – 1990 :**
  - **≈ 60,000 person.Sv**
    - 73% in 1986, 22% in 1987

Chernobyl Accident (26 April 1986) (2)

FIRST ACTIONS

- Fire control, Saving life, Cut-off ventilation / electricity, switching of cooling system, Examination of equipment, Radiation survey, and Water supply

RECOVERY OPERATIONS

1986

- Construction of Sarcophagus
- Construction of settlement for reactor personnel

1987

- Construction of water filtration system

1986 - 1988

- Construction of Slavutich town
- Construction of waste repositories

1986 - 1990

- Decontamination of reactor block, reactor site and roads
- Radiation monitoring and security operations

Chernobyl Accident (26 April 1986) (3)

Some key lessons learned from ORP point of view:

- **Monitoring /Dosimetry**
  - Need for adequate dose and dose rate measurement devices, able to cope with very high dose rates,
  - Need for instrumental dosimetry of beta exposure,
  - Necessity to create a centralised dose recording system,
- **Tools**
  - Develop robotics supporting high dose rates
  - Develop suitable and adequate personal protective equipment
- **Training**
  - Not all emergency workers may be trained on RP (firemen, militaries, etc.)
- **Work management issue**
  - A very large number of recovery workers might be necessary

Fukushima Accident (11 March 2011) (1)

- **Accident consequences**
  - Total loss of power supply
  - Destruction of building, equipment installations, and other machineries
  - Explosion and partial meltdown at plant facilities
  - Large amount of radioactive release

- **Workers involved** (on site)
  - Immediately after tsunami: 400 workers (130 operators, 270 maintenance personnel)
  - Emergency services: Fire-fighters, Police, Self-Defense Force
  - Recovery workers: from March 2011 to March 2014: ≈ 33,000 workers (87% of contractors)

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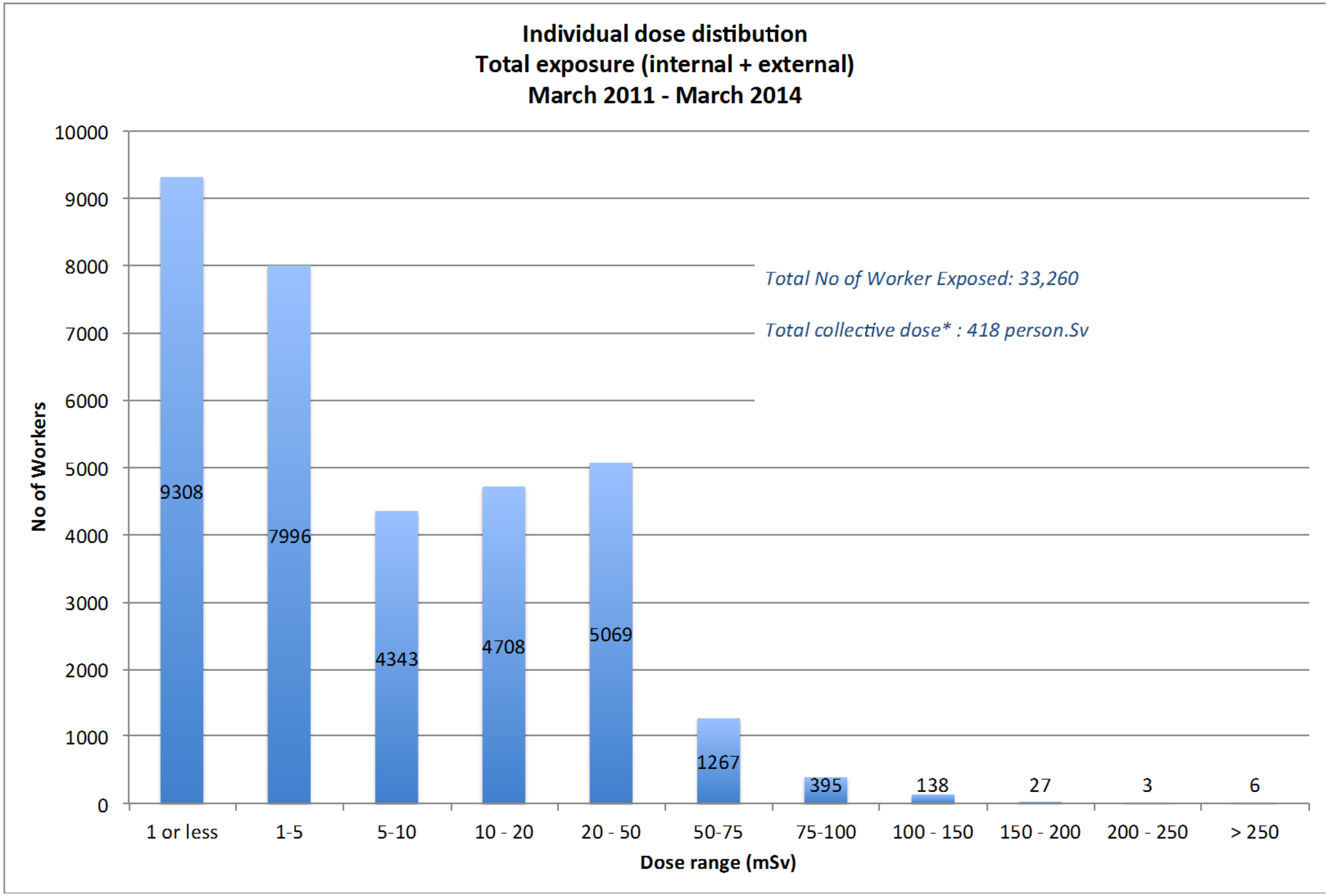
Fukushima Accident (11 March 2011) (1)



*Source : TEPCO Monthly publication – *Collective dose is estimated by multiplying the No of workers reported to be exposed by the average individual dose*

Fukushima Accident (11 March 2011) (3)

Some ORP issues (for emergency phase)

- **Monitoring / Dosimetry**
  - Unusable APD's and dose reading devices
  - Worker Dose Registration had to be performed manually
  - Unusable WBC (shielding geometry and increase of background level)
  - High number of persons to be controlled
- **Training**
  - Lack of training for workers involved in the emergency operations
- **Working conditions**
  - Major hazards: radiation, heat, stress, machine operation and manual handling
  - Highly contaminated site by deposition of uncontrolled radioactive releases
  - Increase of radiation levels on the entire site
  - Very high number of workers needed

Key topics & Discussion points

- Major differences between the three accidents, however, from the point of view of ORP, some similarities in the issues, eg:
  - Monitoring and recording of doses
  - Tools/robotics adapted to high level of radiation conditions
  - Adapted protective equipment (radiation, contamination, heat,..)
  - Management of high number of workers
  - Training (emergency workers, new workers employed for remediation, …)

- Collection and analysis of feed back experience is essential to improve the preparedness of accident management:
  - Need to understand much better how and when workers are exposed, as well as actions implemented to manage their protection