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Article

Protection of French workers operating in Japan, AREVA's experience

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ABSTRACT **In the framework of assistance for Japan, the ACTIFLORAD project for liquid waste decontamination mobilized over 200 AREVA collaborators and 47 people who led their mission in the damaged site. Led between May 18th and July 6th, 2011, the French mission aimed at supervising the ACTIFLORAD process building and assisting Japanese teams in performing it. The post-accidental situation and emergency led to setting up a radiation protection organization in agreement with French regulation as well as integrated into the Japanese organization. This text establishes a testimony of the everyday life of the mission and its preliminary preparation.**

Keywords: Fukushima / AREVA / ACTIFLORAD / workers / Japan

1. Introduction

1.1. Context

Consequently to the March 11th 2011 earthquake and to the tidal wave, or tsunami, which followed, the impact on the nuclear power plant Fukushima N° I (FNPP I), and the following events involved the nuclear community in an international co-operation as exceptional as the events which struck Japan. Logistics, material means, assessments, simulations, calculations, coordination: a continuous mobilization of all the nuclear industry actors supported the emergency plans and the assistance for the victims sent on the spot.

In order to cool the four reactors which lost their heat sink, the decision was taken to inject sea water into the core, to which is added boric acid, a well-known neutron poison.

However, the issue of the reactor containment flooding rather quickly appeared. It is well known that the reactors experienced containment failure, as the ambient dose rate and contamination show, which led to population evacuation. Moreover, July is known in this region as the beginning of the rain and typhoon season. To avoid a massive overtopping of contaminated water towards the ocean, close to the reactors, finding a solution was vital.

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In this context the AREVA – VEOLIA – ATOX – TEPCO collaboration and ACTIFLORAD project were born (Pagis, 2012). This project consists of nuclearizing a co-precipitation process of water treatment, in order to decontaminate the sea water present in containments and to send it back towards the reactors, creating a recycling loop allowing stopping the makeup of sea water and limiting the effluent production.

ACTIFLORAD is one element among the processes put in place for the effluent decontamination. These also include oil removal, filtration on cartridges, reverse osmosis treatment and evaporation processing.

1.2. Mission contents

Efficiently managed in collaboration among the various entities (engineering, project ownership, commissioning, instrumentation), this on-site mission took place from May 18th until July 6th, 2011, and brought 47 French volunteers to work on the site. Besides, this mission involved about 220 persons in France, in Germany, in the United States and, naturally, in Japan. The goal of the mission is to supervise directly the assembly, the maintenance tests and the mud processing tests, to assist, when needed, with the ACTIFLORAD system commissioning tests performed by the ATOX company's teams with the VEOLIA specialists' support, and to supervise directly the completion of performance tests of all the functions (draining / rinsing, etc.).

2. Start of the mission

2.1. Preparation of a first-of-a-kind mission

The first logistical challenge met was to determine in a reliable way the radiological status of the site and the region in terms of contamination. One of the tasks is to define the location for the living base in a zone relatively close to the site but clear of contamination and external exposure. This was complicated by the devastation caused by the earthquake and the tsunami in Sendaï region and surroundings. It is also necessary to define the means of monitoring and protection adapted to the nature of the activities which will be performed by the French participants, and the prerequisites before departure to Japan.

Based on the dose rate mapping of the site published by TEPCO, and the mapping performed in the population protection zone published by the NISA (Japanese safety authority) and the MEXT (Japanese Ministry of Health), the logistics work performed by teams in Tokyo allowed identifying and settling the French living base in a hotel in the municipality of Onahama, 50 kilometers from

the power plant FNPP I, in the prefecture of Iwaki. The Japanese living base, J-village, a national sports complex, is located exactly 30 kilometers south of the site. It was reorganized as an entrance airlock to the population protection zone and constitutes the real nerve center of the Japanese organization for the on-site operations. It includes the medical staff and all the equipment for operation, it allows controlling entrances and exits, and accommodates the space dedicated to the press. The transportation between the French living base (in Onahama) and Japanese living base (J-village) was organized by an agreement with a local taxi company.

The AREVA logistics in Japan is managed from the office in Tokyo. Teams in Japan were reinforced accordingly, in particular with interpreters.

Based on the available radiological and site data and in close relationship with the French work regulation[1], the AREVA health organizations[2], the Group's corporate support departments (legal, safety, HSE, human resources), the exact perimeter of the operations, and the conditions for transportation, hygiene, safety, radiation protection and medical follow-up associated were defined. All these data were formalized in procedures. The assessment[3] of the mission and the data sheet of exposure[4] were drafted, as well as the measures of coverage on the way back to France. The actual working conditions are the following:

- presence of a radiation protection physicist and of a "*Personne Compétente en Radioprotection*" ("PCR" according to the French regulation definition) for all the teams;
- the PCR is in charge, in support of the other radiation protection physicists within the various teams, of collecting the operational dosimetry data and transmitting them to the Company Medicine Doctor (MD in the following) and to the PCR of every employee;
- within every team of operation, a radiation protection physicist leads the control and monitoring activities as regards safety and radiation protection. He benefits from all the equipment necessary for his missions;
- the team in Japan manages the supply and the logistics necessary for the mission;
- every team is provided with a mobile phone allowing contact for emergency means and with the specialists of the Group project;
- except for exceptional events, this organization allows a minimum 11 hours daily rest;

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1 *Inspection du travail*, French authority related to the Labor Ministry.
2 *Comité hygiène sécurité et conditions de travail, Comité d'établissement*, which are part of French labor organization.
3 *Document unique*, according to French labor regulation.
4 *Fiche d'exposition*, according to French labor regulation.

- English is the working language with the Japanese teams. At least one person in each team speaks English;
- concerning radiation protection, except for exceptional events, the daily maximum duration of mask-wearing is set at 4 hours a day with a maximum 2 hours of continuous wearing. This duration will be adapted according to environmental conditions (temperature) in agreement with the accompanying company MD;
- dose constraints are described in paragraph 2.4.

These conditions, defined prior to the arrival of the first participants, have as an objective to insure protection from the risks inherent in the operations identified within the framework of this assistance, *id est*:

- external exposure,
- potential internal and external contamination,
- high temperatures possible during summer,
- significant co-activity on-site.

2.2. Prerequisites for departure and conditions of return to France

In order to take part in the mission, the following prerequisite conditions were imposed on the participants:

- to volunteer,
- to belong to category A[5],
- possess medical ability without limitation to the data sheet of exposure and specific substation established for this mission, delivered by the company MD before departure,
- to have had whole-body spectrometry before departure, the results of which were given to the interested party by the company MD,
- to have a dosimetry over the last 12 months inferior to 5 mSv (0.5 rem), information verified by the company MD.

The measures set for return are:

- an end-of-mission medical examination by the company MD as well as whole-body gamma spectrometry,
- an evaluation of the passive dosimetry which is transmitted to the company MD,
- the update of the data sheet of exposure of every employee.

[5] According to French regulation, annual maximum exposure (total effective dose equivalent, TEDE) for a category A worker is 20 mSv (2 rem). Maximum TEDE is 6mSv (0.6 rem) for category B.

2.3. Project organization

Necessarily, the project organization involved AREVA up to the highest management, and beyond the French borders. The decision-making structure, based in Paris, was supported by the Tokyo staff as regards the logistics, the material aspects as well as the relations with TEPCO and the Japanese authorities. The local action was led by the teams of operation on-site, based in Onahama. Support and expertise units were based in Tokyo, in France, in Germany, and in the United States.

Each team of operation on-site was to comply with the following organization.

The mission of test supervision was realized 24 hours a day and 7 days a week. To do so, the French participants on the site were organized into 4 teams of 4 agents:

- a test engineer in charge of the preparation of the tests, their follow-up, and of analyzing them, announces to the experts in the back base his observations and insures the coordination with the ATOX test teams,
- a test operator who assists the test engineer and realizes the handling in the control room,
- a radiation protection physicist (including a PCR who also works in one of the teams) assesses the provisional dosimetry, determines intervention areas and bounds them, determines protective measures adapted in the zones concerned, makes a statement of the operational dosimetry every return of daywork, transmits daily all the data to the accompanying company MD, assists the employees in their operations, insures the setting up of the operational dosimeters, assesses and sets up the dose follow-up extremities (wrists and pegs) and guarantees, with the MD, the ALARA approach in the operations,
- an interpreter, a key element of the team on the site.

In support of these teams, occurring punctually on the site but being essentially posted at the living base (hotel):

- a company MD insuring support for the duration of the mission. He participates in the risk assessment, advises the operation manager on all the health / hygiene aspects, insures the "closest" follow-up of employees, lists and assesses the local sanitary structures and intervenes in case of medical events.
- team managers, experts in support for the commissioning insure the coordination, the holding of the schedule constraints, and the connection among the teams in Tokyo, teams in France, contacts with TEPCO, and teams going on the site,
- a logistician makes sure of the organization of transport between Onahama and J-village, but also of transport inside the site. He also manages the supplies of

equipment on the living base, and employees' very numerous departures at the end of mission and arrivals of newcomers.

Finally, 47 AREVA agents entered the FNPP Daï Ichi site between May 18th and July 6th, 2011. These volunteers came from all the sites to share their know-how and their experience. The diversity of the paths and previous history of the participants, linked by their skills and their motivation to bring their know-how to help Japan, contributed in a major way to the success of the project.

2.4. Organization of radiation protection, safety and medical follow-up

Japanese and foreign participants had to coordinate their action and their safety policy concerning safety and radiation protection. The Japanese organization is spread according to three levels of operation:

- on-site:
  - in Fukushima Daï NI (FNPP II): a medical team with a general practitioner and a company MD and first-aid workers,
  - in Fukushima Daï Ichi (FNPP I): a medical team with an emergency physician and first-aid workers,
  - the medical permanence is continuously insured, 24 hours a day,
  - two provided with medical care ambulances are kept on-site,
  - the medical team in charge of monitoring the zone of the ACTIFLORAD project is in the control room of the safety building (*cf.* paragraph 3.6);
- at J-village: a medical team is available 24 hours a day including two MDs and two nurses;
- off-site: according to the pathology and the degree of emergency, two points of hospitalization are defined:
  - a general hospital of medicine – surgery, one hour from J-village by road,
  - a university hospital specialized in the treatment of radio-contaminated injured persons, with the possibility of helicoptered evacuation.

For the French teams, the training in safety-security is integrated, including by sharing between volunteers, from the arrival into Onahama. On the site, the radiation protection physicist is also in charge of the good application of these instructions by the French teams.

From the point of view of radiation protection, considering the statutory context, the rules in Japan and considering a post-accidental situation, the usual recommendations of radiation protection must be adapted and lay on the following

principles:

1. respect for fundamentals: control, monitoring, protection, zoning, ALARA, etc.
2. respect for the instructions and the procedures organized on the site,
3. implementation of additional means for monitoring and control to get closer to French practices.

The particularly close collaboration among the PCR, all the radiation protection physicists of the teams and the company MD, with many meetings a day and transmission of fast and clear information in particular by the implementation of a radiation protection shift log insures the coordination of actions dealing with radiation protection and safety-security.

Good practices shared among volunteers are really the keystone of the plan.

The health physics equipment available is the following:

- for collective radiation protection:
  - digital counter MIP 10 and SB probes,
  - Icam (Air monitoring provided with alarm);
- hand equipment:
  - Radiagem with SB 20 probes, SABG probes and connecter,
  - contamination meter (PCM 5 with DP6 probe),
  - portable spectrometry;
- concerning individual dosimetry:
  - French passive dosimeters: breast, wrists and pegs,
  - French operational dosimeter: breast (and peg the first time to establish a breast / pegs ratio),
  - reference dosimeters at the living base,
  - TEPCO operational dosimeters.

The target of the daily dose constraint is fixed at 0.2 mSv (20 mrem) and must remain strictly lower than 0.5 mSv (50 mrem).

The exposure limit for the mission per employee is fixed at 6 mSv (0.6 rem), with a maximum of 10 mSv (1 rem) after agreement of the company MD.

3. In situ

3.1. Arrival in Japan

Essentially, the whole reference base established prior to the mission must be spread in Japan. Tokyo French teams, specially reinforced, were in charge of organizing the reception of the participants intended to go on-site. This reception consists of

Figure 1 – ***Dress-up procedure for outside interventions.***

Japanese regulatory and administrative aspects, *id est* the medical examinations by the Japanese medical staff, the registration as a worker of the nuclear industry in Japan including the establishment of the equivalent of the "*Carnet d'accès*" (Access book) of the GIIN[6], the registration as an authorized person to enter the site, but also the organization of the training in safety-security and radiation protection imposed by TEPCO, the AREVA internal training courses concerning processes, and the logistics of the transport between Tokyo and Onahama.

Figure 2 – ***Picture taken in Tokyo in June 2011: life goes on.***

[6] French NGO of nuclear industrials.

3.2. The main role of the first team

The members of the first team sent, holding the pioneers' role, had a complex mission and in multiple aspects. Indeed, this team was responsible for consolidating the reference base, for bringing it the necessary modifications and for reporting it by drafting new versions of the instructions and procedures, to deploy the plan to Onahama and on-site, and to establish the missing parts of the reference base safety and radiation protection.

This first team, the first French group to enter the site, had to finalize the procedures of attribution and follow-up of the passive and operational dosimetry, the procedures of access to J-village, then from J-village to the site, and identify the Japanese correspondents. They had to determine the procedures of packaging according to site areas and activities, choose the protection equipment from among those given by the Japanese, prepare the training support for the following teams, determine traffic lanes within the site, set up pre-job and post-job briefing, define the list of the material needs transmitted to Tokyo and relieved in France, establish the mapping and the radiological markings, and, naturally, define a place for the French teams among the Japanese participants, including and especially when configurations held by the French differed from those established by the Japanese (it is, for example, the case of the dose constraint fixed at 6 mSv (0.6 rem) for the whole mission for the AREVA staff when the Japanese authorities had fixed their regulatory limit at 200 mSv (20 rem)).

It is the essential work realized by this first team which conditioned the success of the project. It is necessary to add an element which turned out to be determining: the organization of the living base, in Onahama.

3.3. Continuous evolution

About 1500 persons enter the site every day to perform operations, with activity 24 hours a day, multiple interfaces among the Japanese authorities, TEPCO, ATOX, AREVA, VEOLIA, KURION, TOSHIBA, JNFL, JGC and several other companies; the Japanese instructions and the configurations on-site could change in the course of the day. That is why, in answer to these changes in the situation, the reference base of the participants, the procedures and the instructions also evolved, and until the last day of the demobilization, at the end of the mission.

Among the most considerable changes, to which it was necessary to adapt the operation of the mission, was the imposition of the Japanese training in safety and radiation protection before entry on-site (this training was fairly equivalent to the "PR 1" training of the CEFRI[7] reference base). We shall also note the release to

[7] French association for worker training and company certification.

the AREVA teams of vehicles with a driver to insure the movements within the site and between the site and J-village, exempting the French participants from traveling by bus at fixed hours. The path of access between J-village and the control room of the process, preceded at the beginning of the mission by a path in the safety building, was directly from J-village to the control room from the middle of June.

3.4. The living base

Installed in a part of the first floor of a hotel in Onahama, with continuous activity and requests at every hour, the living base, besides the place of meals and rest, is above all a big working and meeting room, quickly provided with computing equipment, but also with means of maintenance, calibration and storage of equipment, and a place for reception of the newcomers.

Activities are realized there, carried out by the radiation protection physicists:

- daily recording of the participants,
- daily statement of the operational dosimetry (hourly statement or per operation at the beginning of the mission, according to the possibilities),
- counting of the realized surface and atmospheric samplings,
- updating of the radiation protection shift log,
- update of the instructions and the procedures,
- calibration and maintenance of masks and equipment,
- reception and training of the newcomers.

A specific clothing management is also instituted:

- the departure for J-village is made in overalls,
- no civil garment will be taken to or left on the site,
- the additional controls allow a standard management of working clothes (return to the hotel, cleaning).

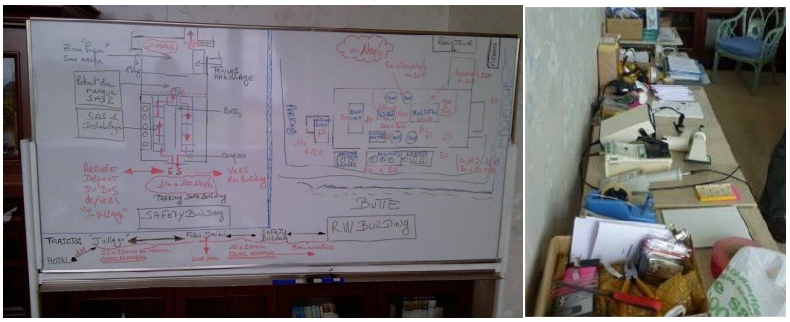

Figure 3 – ***June 2011, organization of the living base: a hotel becomes a work place.***

3.5. J-village

A modern ensemble of infrastructures intended to receive the public, located on the verge of the exclusion area, J-village is not a work area, but a zone of transit (with the exception of the medical teams) which corresponds to a universal changing room and to the entrance / exit of the zone. The J-village zone is considered as equivalent to a conventional zone.

Arriving, to go on-site, it is there that the Japanese operational dosimeter is necessarily taken and returned. The traceability is insured by identification with a bar code on the access badge delivered to the participants and on the dosimeters.

Self-service stands of food and drinks are installed and procured every day. It is also in this place that the undergarments and over-garments, gloves and over-gloves, protective headgears and anoraks are supplied, and it is where Japanese masks for respiratory protection are handed out. At the time of leaving, it is also in this zone that outlet of zone controls for contamination, the final undressing and the preparation for returning to the hotel are performed. The observed radiological conditions are:

- ambient dose rate around 0.5 to 1 µSv/h (50 µrem to 100 µrem),
- atmospheric contamination below the detection threshold,
- no specific protection disposition according to Japanese recommendations.

However, it is located on the border of an exclusion area of a nuclear accident. To avoid any ambiguity concerning the risks for the French staff brought to work on the spot, the following conditions of access are organized:

- at least belong to category B[8] (category A to go beyond J-village),
- French passive dosimeter,
- French operational dosimeter extra to the one provided by the Japanese,
- no respiratory protection as no air contamination is detected.

To complete the means available at J-village, a vehicle of the “mobile-home” kind is installed by and for the benefit of French workers on the outer area. It is provided with small counting equipment, replacement equipment, complementary control equipment for finer measurements, changes and small drainage equipment (wipes, towels). It also serves as storage for the equipment and for diverse clothing: shoes, masks, gloves.

3.6. The safety building

An essential location, this zone of the ALARA refuge, the medical head office and crisis cell, and a zone of rest and food supply, is one of the rare refuges of the site.

[8] In accordance with French regulation: annual exposure limit is 6 mSv (0.6 rem) for category B, 20 mSv (2 rem) for category A.

Figure 4 – ***Main entrance of J-village in June 2011.***

Figure 5 – ***Dressing up for car travel to the damaged site.***

We access it by an airlock, which did not stop evolving and even moving between May and July.

This building contains two levels. The first floor is the access airlock and the equipment zone. The second floor is the decision room and the "company offices".

The building is ventilated and provided with very high-efficiency filters and iodine filters. Mask-wearing is not recommended by the Japanese inside the building except in the entrance/exit airlock. The safety building is considered as a green controlled area[9].

From the Japanese point of view, the conditions of access to the safety building are different as we come from J-village or from work on the site (removal or not of the Tyvek suit (Paper suit) in the airlock, control or not of the contamination).

[9] According to French regulation, in a green controlled area, the ambient dose rate is between 7.5 µSv/h (0.75 mrem/h) and 25 µSv/h (2.5 mrem/h).

For the French staff, the removal of the Tyvek suit and the control of contamination are compulsory whatever the origin. Because of the particular situation on the site and for sanitary reasons, two waivers are made with regard to the usual practices:

- authorization of food and drink in the building, because it is about the only "living" zone on the site,
- absence of mask-wearing after the airlock, while the conditions do not exclude potential exposure in the residual low level of air contamination in the outlet of the airlock.

Figure 6 – ***June 2011: exit airlock of the safety building and medical emergency equipment.***

3.7. The central control room

Made of connected fitted out ISO 20-ft containers, fully plasticized, the control room is equipped so as to be used as a non-contaminated work area: with overpressure ventilation and filtered (dust and iodine) and an access airlock with control of contamination. Its zoning corresponds to a yellow[10] controlled area.

It shelters the headquarters and remote control of all the processes of decontamination of effluents. It also shelters a meeting room where twice a day the progress meetings of the assembly and commissioning are held.

We do not wear masks and we can drink inside. The participants remain in "undergarments" (standard suit). However, because of the still intense seismic activity, the present teams in June set up an instruction to gather masks ready to be worn and to put on one paper suit rolled around the waist in case of order of

[10] According to French regulation, in a yellow controlled area, the ambient dose rate is between 25 µSv/h (2.5 mrem/h) and 2 mSv/h (200 mrem/h).

evacuation. These measures are completed by the presence of iodine tablets available, to be used on order of the contactable French company MD by cell phone from the control room.

A zone dosimeter provided with an alarm and monitoring of air contamination with an alarm (ICAM) was organized. Daily statements were also made by the Japanese teams on key sampling started up every night.

The measurements of surface contamination and the ambient dose rate are realized in every team rotation (thus three times a day) by the radiation protection physicists of teams.

The ambient dose rates in the control room vary from 20 µSv/h (2 mrem/h) to 30 µSv/h (3 mrem/h) according to zones. On the other hand, the closer the measurements were made towards the roof the more the dose rate increased, achieving 45 µSv/h (4.5 mrem/h) in contact with the roof. The most plausible explanation for this is a combination of the irradiation due to the deposits in the foliage of the surrounding trees and the effect of sky reflection.

The surface controls all showed results lower than 0.4 Bq/cm^2.

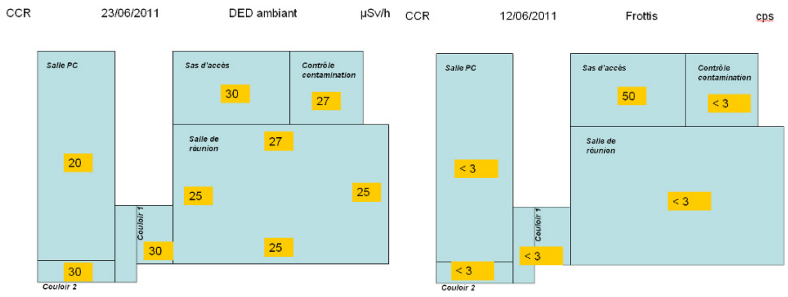

Figure 7 – ***Dose rate and labile contamination cartography of the central control room, in June 2011.***

3.8. The local control room

Adjacent to the rad waste building (described in the next paragraph), this ISO 20-ft fitted out container contains electrical cabinets and panels of the local command of the ACTIFLORAD process.

This zone, unprotected and not followed by the Japanese radiation protection teams, is considered as an outer area and a regulated stay yellow area with risk of contamination. The same rules of radiation protection as for the RW building and

Figure 8 – ***French volunteers dressing up for an exit from the central control room to the rad waste building, June 2011.***

the fieldwork are applied to it: mask, Tyvek suit, a pair of cotton gloves, two pairs of vinyl gloves, two pairs of socks, safety footwear and helmet-wearing. Protective shoe covers were not worn except on routes by car between the site and J-village because they induce a risk of skidding, especially on rainy days.

3.9. The rad waste building

People's safety in the RW building, which contains all the processes, is insured by ambient dose rate mapping of the area, which is frequently realized and updated.

According to the zones of the building, the ambient dose rates during the assembly (before the commissioning) vary from 4 µSv/h (400 µrem/h) to 20 mSv/h (2 rem/h) at certain hot spots marked out accordingly. However, the main concern, because of the co-activity and the erection operations including cutout, weld and power supplies, with erection of scaffolds, the whole in a cramped and badly-lit building, is definitely conventional safety. Although the operations defined for the French participants are limited to visual inspections, these were nevertheless realized in a difficult context, requiring watchfulness at every moment.

Especially, in terms of radiological zoning, the RW building, like the “local control room” and the outer areas, is considered as a regulated stay yellow area (with the exception of the hot spots identified and marked out in orange[11] when necessary) with risk of contamination.

[11] According to French regulation, in an orange controlled area, the ambient dose rate is between 2 mSv/h (0.2 rem/h) and 100 mSv/h (10 rem/h)

We work here wearing the individual mask, Tyvek-type suit (an anorak in rainy weather), cotton gloves, two pairs of vinyl gloves, two pairs of working socks, safety footwear, a helmet (and naturally the Japanese operational dosimeter, the French breast operational dosimeter, the French breast passive dosimeter and the French passive dosimeter wrist and peg).

Figure 9 – ***June 2011, pictures of the rad waste building during construction of the process: security is the main issue.***

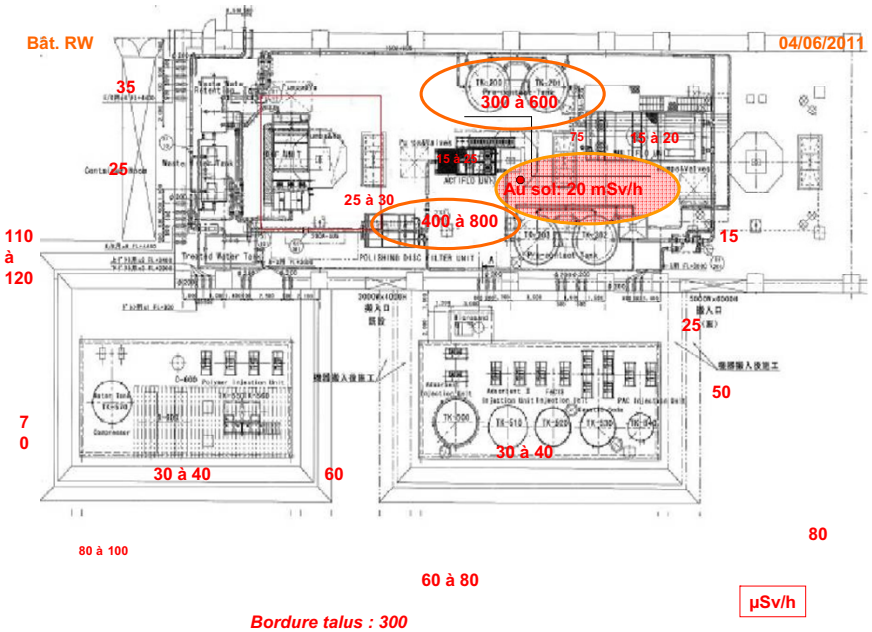

Figure 10 – ***June 2011: dose rate cartography of the RW building and outsides.***

3.10. Routes and movements

Throughout the site, any movement on foot between two work areas is strictly and formally forbidden within the French teams, both for the reasons of radiation protection and safety.

Three work areas are identified: the zone of the "safety building", the zone of the "RW building" (and of the neighboring "local control room") and the "central control room". Three paths of access, defined on the basis of the dose rate mapping (which can reach 400 µSv / hour (4 mrem/h) on these paths, in direct sight of the reactors), were defined for the drivers, which allowed the French teams to move around.

This vehicle system allowed the French teams to free themselves from the hourly constraint inherent in the common shuttles organized by TEPCO.

These vehicles were the object of periodic radiological inspections by the French radiation protection physicists. Except for a slight contamination of the carpets and the shell, no significant contamination was detected. The wheels were not subject to control, because it seemed obvious that they would be marked.

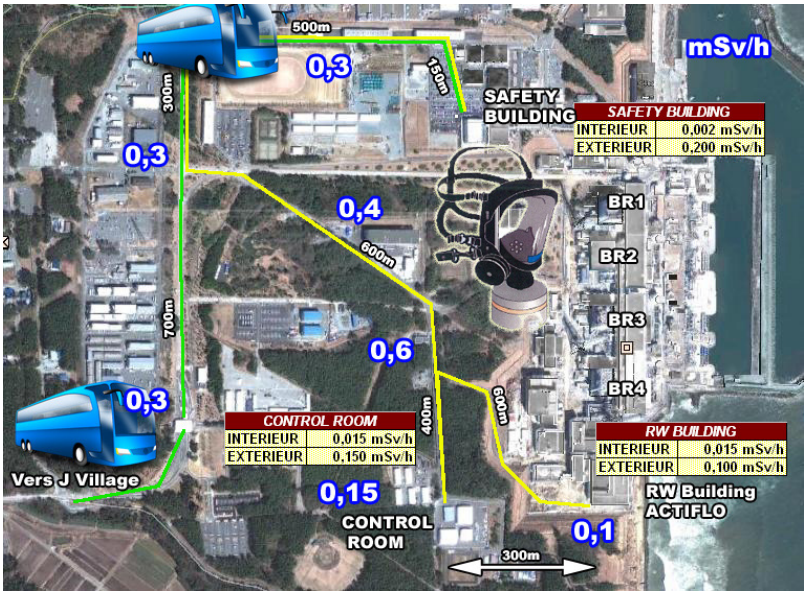

Figure 11 – ***Routes defined in May 2011 for movements by car on the site between three work areas, and calculated provisional exposure.***

4. Dosimetry report

In spite of the situation of a major nuclear accident, the dose results of the French teams are relatively low, and in any case lower than what we would have expected. No engaged dose was recorded after the return of the whole-body anthroporadiometry (whole-body counting).

TABLE I
AREVA employees operational dosimetry results. Total number of persons: 47.

Cumulated operational dosimetry stats			Extremities estimations: coef 1,3	
Max dose	1,724 mSv	Whole body	2,241 mSv	pegs
Average dose	0,711 mSv	Whole body	0,925 mSv	pegs
Collective dose	33,425 Man.mSv			
Daily operational dosimetry stats			**Extremities estimation: coef 1,3**	
Max dose	0,27 mSv/d	Whole body	0,351 mSv/d	pegs
Average dose	0,091 mSv/d	Whole body	0,119 mSv/d	pegs

Because of the dose rate on three defined routes of circulation, every movement by car led to the integration of 10 μSv (1 mrem). The optimization of movements is thus an important element for the provisional dose, taken into account during balance assessments and preparation of operations organized from the living base.

Looking at the statements of the operational dosimetry and their analysis, it emerges that the dose was fairly distributed among the members of teams.

The watchfulness and anticipation erased the influence of the commissioning on the average daily dose. However, any activity on the site induces a not insignificant dose, including the simple fact of moving.

5. A human experience

5.1. Daily life

The day-to-day organization, for all the teams, is set out in the following way:

- before departure: preparation of the equipment and pre-job briefing,
- route,
- sharing data with the previous team,
- work,
- transmission to the next team,
- return: daily cumulated dose report, preparation for the next day, updating of the process and radiation protection log data sheet.

To these tasks add the reception and the training of the newcomers, the documentary updates and the maintenance of equipment.

Team rotations were:

- morning team: 5 am – 6 pm and 8 am – 4 pm on-site,
- afternoon team: 10 am – 11 pm and 1 pm – 9 pm on-site,
- night team: 3 pm – 4 am and 6 pm – 2 am on-site,
- rotation every 2 days.

5.2. Integration, working with the Japanese

The organization described was with the objective of becoming integrated into the instructions and Japanese reference bases while staying close to the procedure of the AREVA Group and in respect of the French regulation.

The keystone of this integration was the presence of the interpreters. The instructions written in Japanese and oral exchanges would not have been possible without them. However, in spite of the language barrier, which, anyway, became negligible during an operation in masks in a noisy building because of all of the work which takes place there, the working relations between Japanese and French teams, in particular between Japanese and French radiation protection physicists, were particularly enriching and fruitful. In the non-contaminated zones, where the mask was removed, the vital presence of the interpreters allowed prolonging this collaboration.

The technical exchanges, on all subjects, were mutually profitable.

5.3. Commissioning

The first introduction of liquid waste, an exceptional event, occurred on June 17th, 2011 (some days ahead of the schedule), and was a day of great concentration and an almost tangible tension. This moment arrived after two months of continuous work and tests.

From the point of view of the radiation protection physicists, all their attention went to the preparations in the RW building and in particular to its evacuation within the time limit. Several patrol inspections were realized during the day. The French teams refrained, from then on, from accessing the building. This measure widely contributed to the fact that the beginning of the liquid waste treatment is invisible from the point of view of the daily dosimetry.

During the first entry of effluents to the installation, followed from the central control room, attention settled on the dose rate probes settled in the RW building and on the various sensors allowing detection of a possible leak.

The radiological dose rate during the operation increased from some µSv/h (several 100 µrem/h) to a few mSv/h (a few 100 mrem/h), then decreased again in the shutdown of the process.

As often occurs during a commissioning, the installation was shut down after a short operation to verify the first results obtained and adjust settings.

Some dysfunctions detected in certain parts of the process, upstream of ACTIFLORAD, were adjusted by the Japanese teams.

After several short starts, on June 21st the installation was in operation for the duration of 20 continuous hours. A measurement of the dose rate in the entry of the RW building proceeding to the shutdown shows a slight increase (60 µSv/h (6 mrem/h) instead of 15 before the commissioning), likely due to the generation of mud from treatment of effluents.

From June 25th, the installation operated continuously.

5.4. Surprises, and unexpected events

Unforeseen encounters were, of course, as unique as the situation was unique.

From forgetting a Radiagem in the hotel (more than one hour by road) to the performance of a tracking to find the access airlock to the safety building, moved a day before to another side of the building (with an announcement displayed in Japanese at J-village), by way of the member of the team who, in a moment of forgetfulness due to the summer heat while the team wore three or even four layers of vinyl, opened the window of the vehicle to be less hot, or another one who followed a group of Japanese in error thinking they were his team (all the suits are identical and through the mask it is not easy to recognize faces). The situations from the funniest to the most delicate occurred, even in the French living base (we can now say that performing a mask test in the main entrance of a hotel in front of people arriving for holidays and who cannot speak French is a bad idea…).

6. Conclusion

Although this paper focuses on the work of the AREVA participants, one must not forget the admirable work realized by the Japanese teams which, in two months, made *ex nihilo* an operational highly active installation of decontamination of effluents, in conditions without standards.

Figure 12 – ***Picture taken by French team in June 2011, on the way back from J-village to the living base, on the coast.***

The management of the radiation protection, in a situation where the most harmless gestures must be made in a hostile environment, is particularly complex and requires cold blood, reactivity, anticipation and motivation. On this last point, the daily presence of 1500 volunteers on the site shows the solidarity and the implication of a whole country, already suffering from more than 20 000 deaths due to the earthquake and to the tsunami, thousands of injured persons and uncountable people who lost all their possessions.

As experienced as it is possible to be, nobody could have been prepared for such a situation.

Technical skill was only the passport allowing people to take part in an exceptional human experience. If proof were needed, each of the 47 participants who entered the site declared themselves ready to start again as and whenever necessary.

REFERENCES

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