Good practices to illustrate the collaboration between a certified health physics expert and an occupational physician

CONTROLE PHYSIQUE
DES RADIATIONS
UNIVERSITÉ DE LIÈGE

Dr Véra Pirlet

23th October 2020

Collaboration in routine

- Visits of working place in departments using ionising radiations
  - Programme received few weeks before;
  - Participation of the HP regarding the radiation protection aspects
  - Dosimetry checking
- Dosimetry
  - Results of the dosimetry transfered every 3 month
  - When dose > 1 mSv/month : Report to the worker and copy to OP
- Information of the workers by the HP
- Copy of the reports of the HP
- Exchange of mails with some specific demands from OM (advices, not known situation…)
- Protection of the maternity: Evaluation of the working place to guarantee protection of the foetus

6 december 2018: Royal Decree modifying the Royal Decree of 20th july 2001 (general regulations on the protection of the population, workers and environment against the danger of ionising radiations regarding specifically health physics

Modification of the tasks of the Health Physics

CONTROLE PHYSIQUE
DES RADIATIONS
UNIVERSITÉ DE LIÈGE

Tasks of the health physics expert (art 23.1.5.b) linked to occupational medicine

- ……
- the determination, in consultation with the occupational physician in charge of the medical survey of the workers, including external workers and emergency responders :
  - Of the individual doses resulting from internal exposure, the ones due to accidental expositions, concerted accidental expositions and emergency expositions;
  - Of the radioactive contaminations of the workers having led to decontamination measures with medical response.
- Supervision of the implementation of the health surveillance program relating to radiation protection aspects;
- Verification of the suitability of the work place of the pregnant workers, in consultation with the occupational physician

CONTROLE PHYSIQUE DES RADIATIONS
UNIVERSITÉ DE LIÈGE

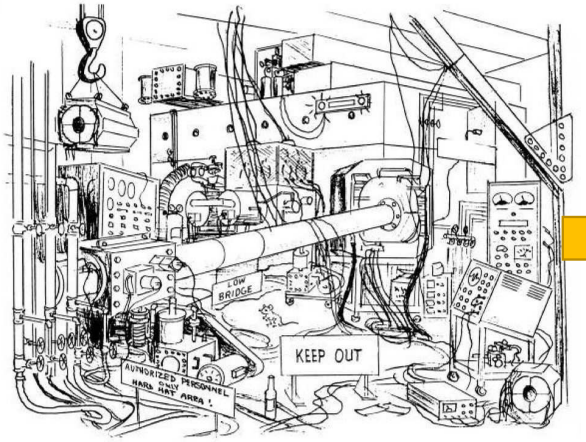
Good collaboration between HP and OM in case of incidents?

Contamination of a worker with Zn-65 at a cyclotron facility

Writing of a common procedure of decontamination between HP and OM

Contamination of a worker with F-18

Un cyclotron du point de vue du visiteur

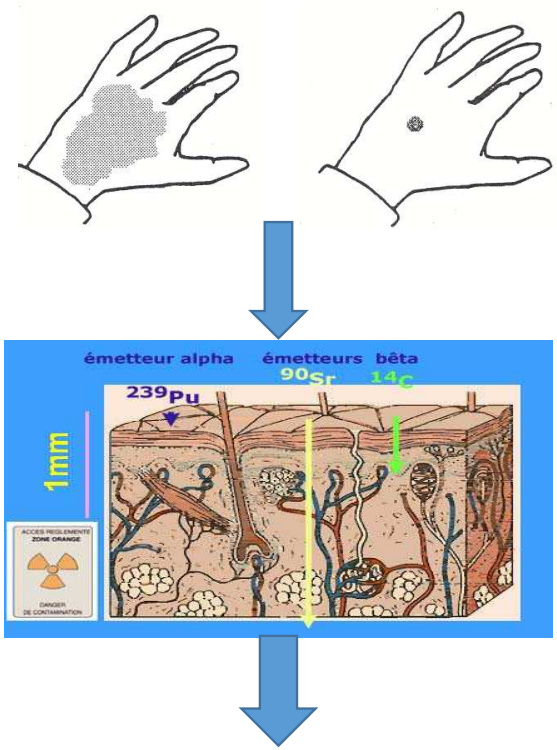


Contamination ? A predictable incident….

- **When?** Every time when radioactive substances are present on a surface (skin) or a medium.

- **Risk?** Superficial irradiation of the skin by the particles or the radiations ⇨ equivalent dose to the skin

- **Who?** The occupational physician responsible for the decontamination of the workers ⇨ delegation to trained workers (art 68) on the field



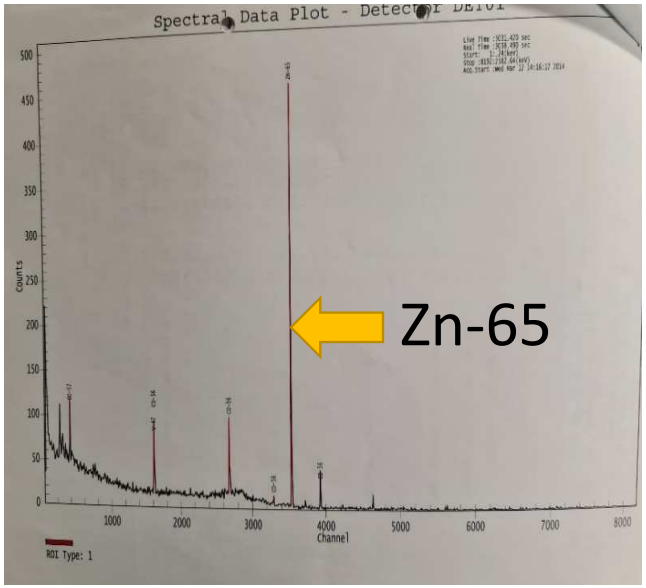
^{99m}Tc	9,1 mSv/h
^{18}F	72 mSv/h

(37.000 Bq (1 µCi)/cm^2)

Contamination of 2 workers of the Nuclear Physics Institute

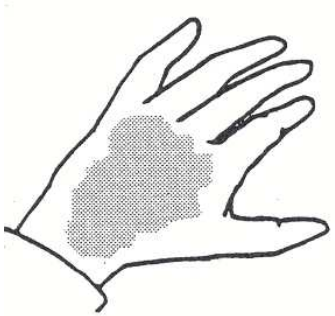
- The facts….
  - 2 workers using sandpaper to make the Cyclotron deflector maintenance
  - Nitrile gloves used by the workers and changed regularly
  - After the maintenance, check the absence of contamination
    - Worker 1: Contamination of the clothes ⇨ remove his pull-over
    - Worker 2: Contamination of the fingers ⇨ washing his hands a few times ⇨ contamination still there !

- Intervention of the HPE
  - Worker 1: Contamination measured on the clothes
    - Sweater sleeve: 1000 cps – pants pocket: 100 cps – belt: 100 cps
    - All the contaminated clothes considered as radioactive waste….WHY?
    - Identification of the isotope: Zn-65 (half-life of 244 days) by spectrometry
  - Worker 2: Contamination on two fingers of 100 cps
    - fingers with CRACKS…..
    - Contamination was already fixed (no decrease by washing the fingers)
    - Activity quantified by spectrometry (Ge): 7150 Bq on the fingers



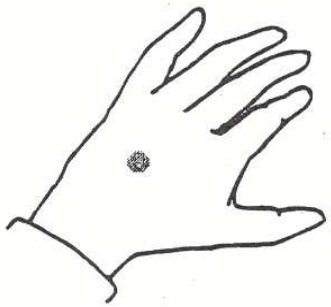
Dose rate with an external contamination of Zn-65

37.000 Bq (1 µCi)/cm^2



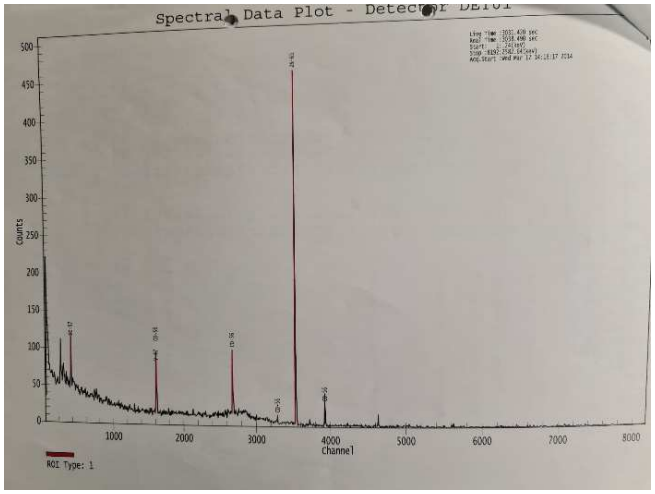
2,8 mSv/h

Drop of 37.000 Bq (1 µCi)



0,56 mSv/h

(For 7000 Bq: 105 µSv/h)



<u>Physical characteristics:</u>

E (Gamma) : 511 keV (3%) and 1116 keV (51%)

E (beta): 330 keV (2%)

Call to the occupational physician !

- Advice of the doctor: use a chelator (no doctor available physically)
  - We looked for DTPA and tried on the skin….No decrease of the contamination !
- But we were lucky that day! One occupational physician for the agreement had to come in my department to make her training on health physics !
  - Use of EDTA: No good results
  - Use of $KMNO_4$ with a soft sponge followed by solution of hydroxylamine (to remove permanganate..)
    - It worked ! After 3 washing…. 25 cps for one finger and 15 cps for the other one (about 2100 Bq left)
    - Time spend: 2 hours
- The day after
  - still….10 cps (900 Bq)
  - Visit to the occupational physician of the University

Feedback…….

- Nuclear Physics institute…
  - Write an appropriate working procedure to make the deflector maintenance
  - Adapted Protection clothes : more solid gloves and disposable overalls
- Occupational physician
  - Decontamination is a medical act ⇨ delegation to some others
  - Ask for a clear procedure of decontamination
    - Necessity to define the limits of what we can do or not in the frame of emergency.
  - We need to have occupational physicians available in case of emergency !

« Common procedure of radiation protection: decontamination of the workers »

If a contamination is detected, we have to reduce its extension and intensity as fast as possible.

The efficiency of a decontamination depends on : its speed and the way the treatment care is done.

Good practices !

« To avoid a dose rate on the skin »

Every user should know : what to do and not to do at a first step!!!!

3 levels of intervention

- Level 1: the users
- Level 2: the health Physics
- Level 3: the occupational physician

Decontamination Level 1: the workers…

<u>Decontamination Kit present in the user departments</u>

Disposable gloves

Vinyl canvas of 1 to 2 m^2.

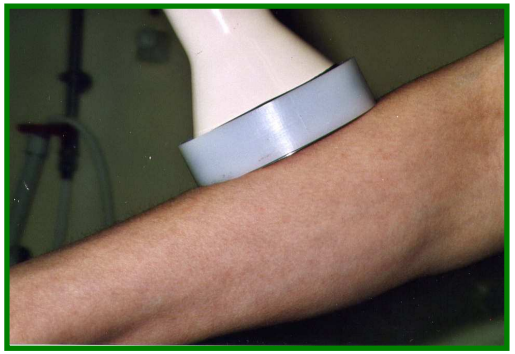
Paper tissues.

Plastic bags for waste generated

Tape.

Soap

Overshoes



<u>Precautions to be taken:</u>

<u>1. For the person who helps to decontaminate (always better to be helped)</u>

Gloves (it is a minimum), labcoat, overshoes and a dosimeter (if required)

<u>2. For the person who is contaminated</u>

Avoid to touch anything (objects, surfaces, other parts of the body)…Just avoid to disperse contamination!!

A shower ? No way….!

3. If necessary remove the clothes which are contaminated with precaution to avoid extending the contamination to other parts of the body.

4. A shower? To be avoided if contamination is localised !

5. Be careful to the skin conditions

Damaged skin = complex decontamination, even impossible

Decontamination Level 1: the workers…

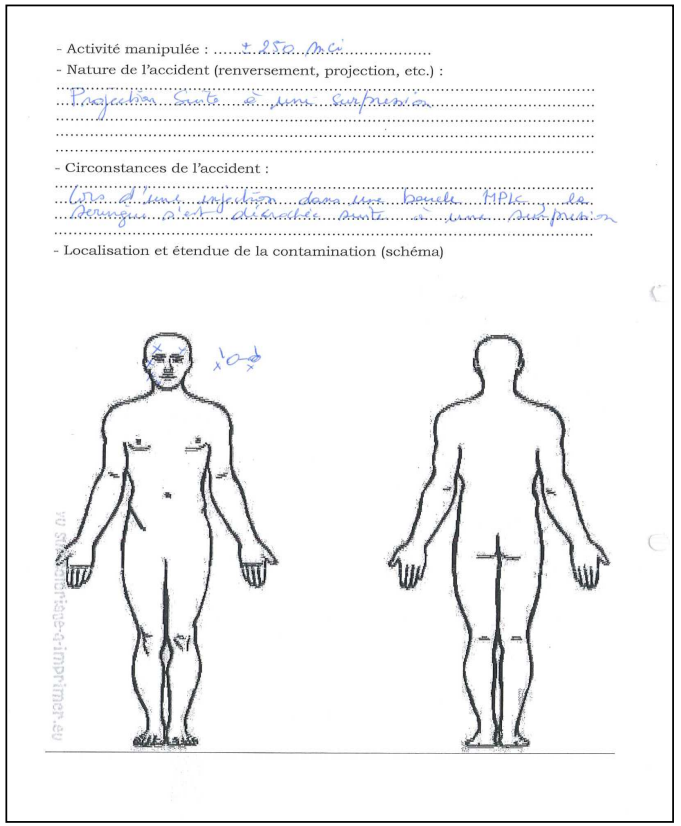
- **The worker should not leave and panic**!!! But think first and act properly !!! ⇨ call the RPO
- Reassure the person
- Mark out the incident area and secure the situation
- Evaluate the gravity by asking to the person (Isotope, activity manipulated, nature and circumstances of the incident).
- Go to a place where there is a sink to make decontamination, in quiet place.
- Vinyl canvas fixed on the floor to put all the material necessary for decontamination
- Use the appropriate probe !
- Start to measure the face and the hair
- Check the lab coat, clothes and gloves.
- Check the hands and personal clothes.
- All the clothes contaminated are placed in a bag
- Remove the dosimeter just in case and measure the dose.

The spots of contamination can be reported on a schema, to facilite the decontamination.

Decontamination:

Wash with warm water and soap
2 times
Dry carefully and use new materials for drying after each decontamination step to avoid again transfer of contamination which was previously removed
For the hands: insist on the folds and nails, if necessary cut the nails but avoid any trauma

Contamination still there ? → call the HP


- Activité manipulée : ± 250 mCi
- Nature de l'accident (renversement, projection, etc.) :
Projection suite à une surpression
- Circonstances de l'accident :
Lors d'une injection dans une boucle HPLC, la seringue s'est déconnectée suite à une surpression
- Localisation et étendue de la contamination (schéma)

Decontamination Level 2: Health physics

- New evaluation of the situation
- Third washing with water and soap, then measure
- Use of citric acid 3 % or EDTA solution (swab, brush smoothly, rinse with warm water, dry (2x)): to be used on sensitive area
- Callused area: krestopol, smooth friction, rinse (2 x)

Material	Decontamination products
Soft brush	Slightly abrasive paste (Krestopol)
Q-tip	Physiological serum and dropper bottle + Spray Citric Acid 3 %
Cotton wool	EDTA Solution Alcohol vinegar (P-32)
Washcloth	Osmogel
Toothbrush	Face peeling cream Bleach (2,6 % active chlorine) to dilute to 1 % Bulbs of Ca-DTPA Toothpaste Shampoo

Decontamination Level 3: Call the Occupational physician

- Failure of the previous actions
- Decision to stop decontamination and to apply the principe of sweating or application of osmogel ***or***
- Use of bleach water or DTPA
- Presence of damaged skin or wounds
- Contamination of the face

- In case of failure of the other and simple methods of decontamination, or in case of damaged skin, use the technique of sweating.
- Use two pairs of gloves to lock up the hands in a closed environment (potentially use of osmogel) to eliminate by perspiration the contamination present in the skin pores and around the hair follicles.
- Check after 2 hours

When internal contamination is suspected?

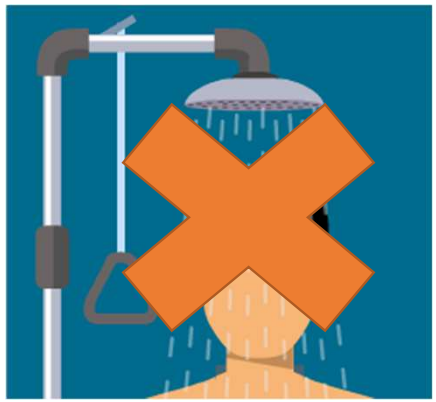
- Contamination of the working surfaces
- External contamination of the skin mostly at the face level or close to the face.
- Presence of wounds, cracks on the skin.
- Use of volatile products: iodine
- Easy passing of some isotopes through the skin (H-3, P-32, F-18).
- Ingestion, injection (very uncommon for workers)

Occupational physician will have to manage decontamination

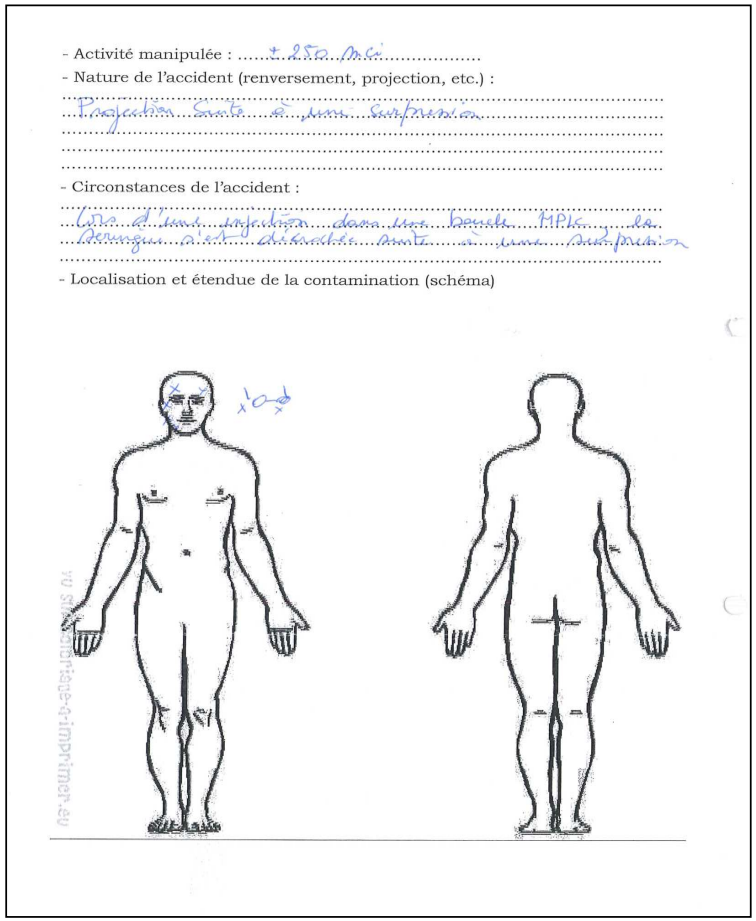
Contamination of a PhD student with F-18

- <u>The facts:</u>

- Injection of an aqueous solution containing a radiotracor of F-18 on a purification system (HPLC) ➔ Overpressure.
- Projection of the solution of F-18 on the face, hair, hands and glasses of the student.
- Estimated activity : 1 mCi (37 MBq).
- A technician gives her the advice to take a shower ! (no respect of the procedure of decontamination !)
- The radiation protection officer was called and made the first measurements.
- Second shower using an abrasive cream on the face and soap…
- Then, call to the radiation protection Expert and filled the « intervention » card.



Intervention card filled by the radiation protection officer



- Activité manipulée : ..... ± 25 mCi .....
- Nature de l'accident (renversement, projection, etc.) :

Projection suite à une surpression

- Circonstances de l'accident :

Lors d'une injection dans une boucle HPLC, le flacon s'est désolidarisé suite à une surpression

- Localisation et étendue de la contamination (schéma)

Positive aspects !!!

- Call from the RPO to the health physics
- Filling of the card (procedure OK).

Negative aspects

- Should call the Health physics before the shower
- No shower in the procedure !

⇨ result :

- contamination extended
- Internal in the mouth

Call the occupational physician who cames directly to the lab

- Help for decontamination and especially in the mouth
- Evaluation of the skin dose based on the activity we had

Localisation	11h15	12h45	14h	14h45
Visage	20000 Bq/cm² ***Valeur initiale estimée*** suivant période du F-18	10000 Bq/cm² (mesure SUCPR)	4500 Bq/cm² (mesure SUCPR)	3500 Bq/cm² (mesure SUCPR)

Data: Uniform deposit of 1 MBq/cm² during 5 min gives a skin dose of 116 mSv

Evaluation of the equivalent dose to the skin

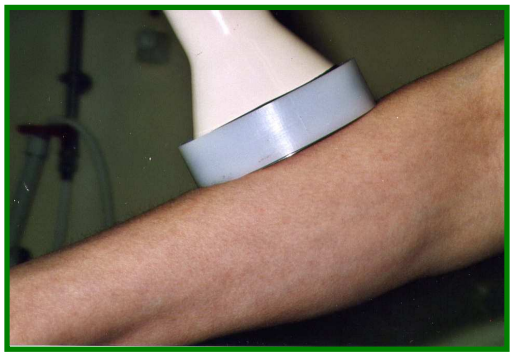
- For the skin, the exposition cannot be over 500 mSv during 12 consecutive months. This limit applies for the mean dose on every surface of 1 cm^2, whatever is the exposed surface.
- Could evaluate the equivalent dose to the skin
  - In case of cutanueous contamination before decontamination
  - In case of measured residual contamination
- According to publications 26 and 60 of ICRP, it is recommended to evaluate the [H^{Peau}] only when this equivalent dose is susceptible to reach or to exceed 50 mSv to the basal layer of the skin for the cm^2 the most contaminated.

What are the essential data we need?

- For equal activity, the isotopes in case of contamination, will induce different and variable equivalent dose rates.
- Data needed:
  - activity measured per cm² on skin
  - Identification of the radionuclides
  - Time of exposition (speaking to the worker to get the origin of the contamination)

Isotope	**DR on skin (mSv/h)** (1cm2)
F-18	72
Ga-68	67

Measure the number of cps for the most contaminated 1cm² (Emissions ß + γ) ??



Probe provided with a cover

(aluminium of 5 mm thickness with a hole

With in the middle a surface of 1 cm²)

Calculation of the skin dose

To evaluate the dose, the occupational physician decided to:

- just to take into account the decay of F-18 (pessimist scenario)
- To make the calculation over 7 half-lifes from an activity of 20000 Bq/cm^2

Total activity $= \int_0^{7t_{1/2}} A_0 e^{-\lambda t}\, dt = 188\,947\,966\ Bq.s$
$= 188{,}948\ MBq.s$

Skin dose = 188,948 x 116/300 = **73,06 mSv**

The skin dose, taking into account only the radioactive decay, smaller than the annual limit dose fixed to 500 mSv.

Conclusion

- Decontamination level 1
  - Internal procedure for decontamination was not followed properly by the first users
  - Internal procedure for decontamination was followed by the RPO (phone call to HP at time)
    - Use of the intervention card
- Decontamination level 2
  - HP came on site and re-evaluate the situation
  - Because contamination of the face supposed internal contamination ⇨ called the occupational physician
- Decontamination level 3
  - The OP came directly and helps to decontaminate the worker
  - Calculation of the skin dose was done

Improvement needed :
all the workers should know
the procedure to avoid mistakes !!

Procedure was correctly followed by the HP and the OP