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The Forbach Accident - what is the situation now : Do we really use feedback experience?

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Abstract

In August 1991, three persons were seriously injured by radiation from an industrial accelerator. This accident cannot merely be considered as an exceptional and isolated occurrence as 4 months later, the same type of accident occurred in Maryland. Records show that during the 1978 to 1992 period there were 34 serious accelerator accidents. The utilisation of Forbach type accelerators is very widespread; in France more than 20 such accelerators are used for industrial applications and 192 for medical purposes. Accidents of this type result from a combination of several factors : non respect of regulations in force, total lack of awareness of associated risks, absence of non accessibility barriers....

The different actors in the nuclear industry (Bureau National d' Equipement Nucléaire) reacted to this accident by developing and introducing a new standard for industrial accelerators. A very positive approach was adopted associating both users and constructors of machines of this type in drafting the standard.

Will this standard prevent accidents of this type? Is it necessary to render the application of this standard obligatory with a regulatory text? Is it necessary for specialised inspectors to ensure that the regulation is respected? It is questions of this type that have been raised by the Forbach accident...

The irradiator used at Forbach was a 2.5 MV, 35 ampere Van de Graaff type electrostatic electron accelerator. It was used by a small company to irradiate polytetrafluorethylene (Teflon) in order to fabricate microionized Teflon powder [1]. The maximum dose rate in the irradiation beam is estimated to be 80000 $Gy.s^{-1}$.

In August 1991, three temporary workers entered the irradiation area believing the irradiator to be in a safe state. In fact, although the electron source current had been shut down, the h-t voltage had not been cut off. Residual radiation generated under these conditions is said to be due to «the dark current». Under these conditions, the beam dose rate is evaluated to be about 0.1 $Gy.s^{-1}$. The three persons involved were severely irradiated. One of the victims was exposed to a skin dose of 40 Sv. The other two persons were exposed to 9 and 5 Sv respectively. The maximum whole-body dose was estimated to be 1 Sv [1].

This accident cannot merely be considered as an exceptional and isolated occurrence as 4 months later, the same type of accident occurred in Maryland in the USA. The committed dose to the victim's finger was 55 Gy [2]. Records show that during the 1978 to 1992 period there were 34 serious accelerator accidents, 15 of which were fatal [4]. The utilisation of Forbach type accelerators is very widespread; in France more than 20 such accelerators are used for industrial applications [4] and 235 for medical purposes [5]. The medical use of accelerators in France is well documented as the corresponding medical acts are reimbursed by the services of the French Social Security. It is much more difficult to obtain comprehensive information about industrial accelerators.

Accidents involving machines of this type are often of similar origins. Attention is drawn, for example, to the following failings at Forbach [1]:

- materials, design and work organisation had not been defined to reduce both individual and collective doses to the minimum values below regulatory limits in accordance with the ALARA (**A**s **L**ow as **R**easonably **A**chievable) principle
- absence of physical non accessibility barriers preventing access to the beam during irradiation
- absence of any declaration to the factory inspector about the existence of this electrical generator of ionising radiation
- absence of a designated radiation protection specialist who would have periodically analysed the different exposed working posts, ensured that radiation protection measures were being respected and made an inventory of working situations likely to lead to exceptional radiation exposure or accident conditions; it

would also have been the radiation protection specialist's responsibility to provide basic radiation protection safety training to the persons implicated in the use of the irradiator

- the absence of any French translation of the danger warning signs observed when the irradiator was operating
- the absence of any training of the workers involved as to the potential dangers of the machine
- the absence of radiation protection controls prior to putting the machine into service

This results of this blatant non respect of elementary radiation protection practice for such a potentially dangerous piece equipment led the actors concerned to react through the Bureau National d'Équipment Nucléaire by defining a standard to regulate the design of industrial particle-accelerator-type irradiation installations. Both users and manufacturers of accelerator equipment expressed their determination for standardisation in spite of the general prevailing point of view up to then that accelerators were less dangerous than radioactive sources: because when no longer required accelerators can be simply «switched-off ». It was however difficult to draft the standard because of differences in user and equipment supplier perceptions of risk. It took all of seven years after the Forbach accident for agreement to be reached on a preliminary standard project to be submitted to the authorities for approval [6]. Attention is drawn to the fact that this standard, drafted by experts, deals with all the safety aspects related to particle accelerators, treating the problems encountered with greater acuity than a government law.

One can however question the fact of whether maximum benefit has been drawn from the conclusions on the causes of this accident. In 1991, pertinent radiation protection regulations to prevent this type of accident from occurring were already in existence: for example: decree 86-1103 on the radiation protection of workers outside nuclear installations [7]. The corresponding texts, perfectly familiar to nuclear industry workers, were completely ignored at Forbach. Forbach could not be considered either as INB (***I**nstallation **N**ucléaire de **B**ase*) or as an ICPE (**I**nstallation **C**lassée pour L'**E**nvironment). INB's and ICPE's are legally defined categories for nuclear installations in France (e.g. for an electron accelerator is INB if E>50 MeV and P>1kW). Qualified Nuclear inspectors have the authority to prevent equipment, which does not respect the safety and security regulations in force from operating. However Forbach was unknown to the authorities, being neither an INB nor an ICPE. Had qualified inspectors been assigned to Forbach type installations, permission to operate the accelerator equipment would have been conditioned by compliance with the 86-1103 decree and the 62-105 standard (assuming that it existed at that time). The Forbach accident would not then have been able to occur.

[1] J.C. ZERBIB. Forbach, une certaine logique industrielle ? SÉCURITÉ Revue de préventique n° 6 August - September 1993.

[2] D.A. Schauer et al. A radiation accident at an industrial accelerator facility. Health Phys. 65(2) 131-140 1993.

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[4] H.VIDAL. Les rayonnements ionisants applications médicales et industrielles. Radioprotection Vol. 29 n° 2 213-229. 1994.

[5] A. LAUGER, L.H.T. TRUONG. Annuaire de la cancérologie / radiothérapie et des images médicales en France. Parc des équipements dits lourds soumis à la procédure de la carte sanitaire et liste des spécialistes les faisant fonctionner. 16ème édition ISSN 1242.3327 ACRIM 1996.

[6] Projet de norme Accélerateurs industriels : installations NF M 62-105, 1998.

[7] Decree 86-1103.