Radiation Safety around High Energy Particle Accelerators
(As Seen with the Benefit of Hindsight)
G. William Morgan Lecture

Health Physics Society Meeting
Portland, Oregon

Anthony H. Sullivan
CERN
(Retired)

July 11, 2007

“Too Soon Old ------Too Late Smart!”

(Gordon Livingston, M.D.)

Anthony H. Sullivan
July 2007 #2

Outline

- Abstract
- Foreword
- Introduction
- Radiation Accidents
- Safety Interlocks
- Computers

Outline (Continued)

- Beam- and Target-Area Safety
- Radiation Measurements
- The “Real Problems”
- Conclusions
- Acknowledgements
- References

Foreword

- **Not a summary of the history of accelerator radiation safety**
- **Draws on personal experiences in Europe and the USA**
- **Comments on some aspects that could be improved**
- **Contact: <anthony.sullivan@onetel.net>**
- **I wish you all a pleasant conference there in Portland**

Radiation Accidents

- **Experience suggests that radiation injury (or worse) is most likely to result from human errors**
- **Many apocryphal tales to support this contention**
- **One such actual incident at an unidentified laboratory will be related**
- **Contributing factors:**
  - **Absence of professional advice**
  - **Incorrect “amateur” judgements as to severity**
  - **The “Prima Donna” complex**
  - **Mistaken corrective action**
  - **Complicated chain of events leading to injury**

Safety Interlocks

- **Serious accidents are likely due to interlock system failure**
- **Instruments for measuring pulsed radiation outside accelerator need improvement**
- **International standardisation & uniformity required for:**
  - **Interlock logic**
  - **Search and clearance procedures of occupied areas**
  - **Lighting for beam & interlock status**
  - **Safety signs and area designations (dose rates)**
- **Written protocols agreed to by all stakeholders essential**

Computers

- Computer calculations should not be used to “blind with science”
- Important to know and explain limitations
- Computer software must be impeccable
- Authors of calculations must identified by name rather than by the computer code
- With these constraints - very helpful

Beam- and Target-Area Safety

- **Back-up measures in addition to beam turn-off**
- **Beam-stopper to range out primary particles (N.B. - shielding)**
- **Collimators in beam channels**
- **“Beam fuse”**
- **Primary beam “downwards” where possible**
- **Radiation monitors not sufficiently reliable**

Radiation Measurements

- **Well reviewed**
- **General agreement**
- **Based on radiation energy spectrum**
- **High-energy components often determined by activation analysis; *ergo,* a need for consensus on cross section and threshold data**
- **“Whatever happened to the much-vaunted bismuth fission chamber?”**

The “Real Problems”

- **Despite the best of intentions experience suggests that the “real problems” are caused by aberrant human behaviour**

- **Examples will be described, involving improper modifications to shielding**

Moral

The cost of an accelerator health physicist’s peace of mind is eternal vigilance.

Conclusions

- **In general – radiation safety gets a good grade**
- **Beware of the unexpected**
- **Education of <u>all</u> personnel, to the highest levels vital**
- **Consider "nesting" an accelerator physicist (engineer) in the protection team – could be "part of the solution - not part of the problem"**
- **Work towards universal protection systems**
- **Universal radiation protection manual needed for entire accelerator work force**

Acknowledgements

I would like to thank the Awards Committee of the Accelerator Section of the Health Physics Society for the honor of the award to present this paper and their helpfulness with the preparation. The honor of this award I feel in many ways reflects on my professional and technical colleagues, in particular those with whom I worked in the early pioneering days: Drs. Johan Baarli, Klaus Goebel and an old friend Sandro Rindi.

References

To avoid complicating the presentation individual references are not made. All terms and quantities are comprehensively found in the following two books:

Sullivan, A. H. *Guide to Radiation and Radioactivity Levels near High Energy Particle Accelerators*. Nuclear Technology Publishing, Ashford, Kent (1992).

Patterson, H. Wade and R.H. Thomas. *Accelerator Health Physics*. Academic Press, New York (1973*).*