Education and Training of Workers for Development of a Safety Culture in a Radioactive Facility

Zayda Amador Balbona, Miguel A. Soria Guevara,
Centre of Isotopes, Cuba

zabalbona@centis.edu.cu

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Introduction

- ✓ **Over the last twenty years the Centre of Isotopes (CENTIS) of the Republic of Cuba has been manufactured of a wide range of radioactive products for healthcare, life science research and industrial applications and there has been realized biodistribution and pharmacokinetic studies. Besides, this center has been the main consignor and carrier of radioactive material in our country.**

- ✓ **The analysis of radiological occurrence in CENTIS shows that a 54 % of registered events happen due to human fails in the period 1997-2015.**

- ✓ **During those years the education and training system has been focused in promotion of safety culture and the systematic labour of education of staff with responsibilities for protection and safety.**

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Safety Culture

- ✓ **This is the assembly of characteristics and attitudes in the organizations, its managers and workers which assures that, as an overriding priority, safety issues receive the attention warranted by their significance". Safety is understood "as the protection of people and environment against the associated risks of ionizing radiation and also the radiological safety and the security of radiation sources", assuming that they are inextricably linked.**

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Table 1. Courses on Radiation Safety in CENTIS

Number	Year	Course	Time (hours)	Participants
1	1998	Elements of radiation protection	40	21
2		Basic course of radiation protection for workers	60	31
3		Radiation safety for the transport of radioactive material	5	20
4	1999	Radiation safety for staff with safety and protection responsibilities	60	11
5	2002	Updated radiation safety aspects for workers and staff with safety and protection responsibilities	60	52
6	2005	Updated radiation safety aspects for workers and staff with Safety and Protection Responsibilities	96	60
7		Updated in radiation safety aspects for the staff related with the transport of radioactive material	60	11
8	2007	Updated in radiation safety aspects for workers and staff with safety and protection responsibilities	96	53
9		Updated radiation safety aspects for the staff related with the transport of radioactive material	40	9
10	2008	Updated radiation safety aspects for the staff related with the transport of radioactive material	40	9
11	2009	Updated in radiation safety aspects for the staff related with the transport of radioactive material	40	16
12		Updated radiation safety aspects for workers and staff with safety and protection responsibilities	96	9
13	2011	Updated radiation safety aspects for workers (including them related with the transport of radioactive material)	20	57
14	2012	Updated radiation safety aspects for workers related with the process of production	20	30
15	2013	Workshop on Safety Culture and Good Manufactured Practices	32	30
16	2014	Workshop on waste water management in the radiopharmaceuticals production	20	30
17	2015	Updated radiation safety aspects for workers (including them related with the transport of radioactive material)	60	30
18		Workshops for BowTie methodology applying to risk analysis for radiopharmaceuticals production	20	20
19	2016	Current in radiation safety aspects for workers (including them related with the transport of radioactive material and importing and exporting operations)	60	40

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Cuban Nuclear Safety Centre "Expectative of Regulatory Body on Safety Culture in the Organizations with Activities with Radiation Ionizing Sources", 2015

Basic elements on safety culture and highlighted those improved with these capacitation activities in CENTIS

1. Priority of safety.
2. Visible leadership and compromise with safety.
3. Identification and opportune solution of safety problem.
4. Permanent focus in the safety.
5. Responsibility, involvement and individual behaviour respect to safety.
6. Culture on communication on safety.
7. Culture of report.
8. Fair culture on individual behaviors.
9. Culture of continuous learning.
10. Collective behaviour respect to safety

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Program of courses for updating in radiation safety

- State of the art of the epidemiologic study on biologic effect of ionizing radiations.
- New Cuban regulations on radiation safety.
- Analysis of occupational exposure behaviour during the correspondent period of time.
- Experiences from the occurrence of radiological events.
- Analysis of results from radiological surveillance by workplace.
- Analysis of detected violations of radiation protection procedures.
- Acquired experience from packaging and transport operations of radioactive materials.
- Management of radioactive wastes.
- Modifications to Manual of Safety and Plan for Radiological Emergency.
- Analysis of behaviour of relevant systems for safety.
- Optimization of radiation safety.
- Safety culture on our organization, how to promotion it?
- Risk analysis by BowTie methodology.

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Indicators of human behaviour

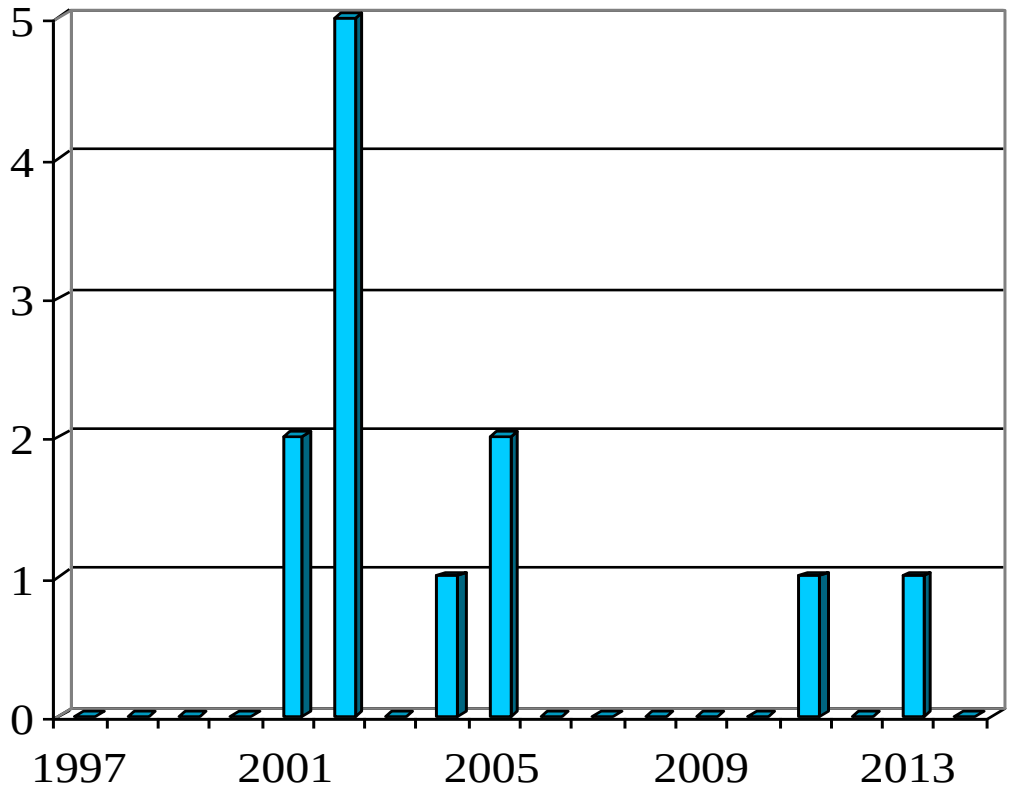

Figure 1. Incidents by year in CENTIS due to human factor

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Table 1. Annual activities of the main radionuclides and collective doses (S)

Year	Activity ^{131}I (Bq y^{-1})	Activity ^{99}Mo (Bq y^{-1})	Activity ^{32}P (Bq y^{-1})	S (Man Sv y^{-1})
1996	Not handled	3.20E+11	Not handled	0.025
1997	7.33E+11	5.92E+11		0.016
1998	4.90E+12	5.39E+11		0.039
1999	4.87E+12	6.60E+11	1.19E+10	0.030
2000	4.84E+12	5.35E+11	3.64E+11	0.054
2001	4.88E+12	1.38E+12	3.43E+11	0.036
2002	4.60E+12	1.59E+12	2.35E+11	0.063
2003	3.94E+12	1.49E+13	2.35E+11	0.075
2004	4.71E+12	2.73E+13	1.93E+11	0.026
2005	4.08E+12	2.77E+13	9.75E+10	0.035
2006	3.28E+12	2.29E+13	5.45E+10	0.022
2007	4.91E+12	2.52E+13	8.27E+10	0.017
2008	4.33E+12	2.32E+13	2.03E+11	0.018
2009	5.76E+12	4.01E+13	2.24E+11	0.042
2010	7.09E+12	3.19E+13	3.17E+11	0.055
2011	1.05E+13	3.19E+13	3.12E+11	0.098
2012	1.54E+13	4.42E+14	1.68E+11	0.095
2013	1.86E+13	6.79E+13	2.65E+11	0.077
2014	2.13E+13	6.77E+13	1.16E+11	0.047
2015	2.02E+13	1.19E+14	1.58E+11	0.057

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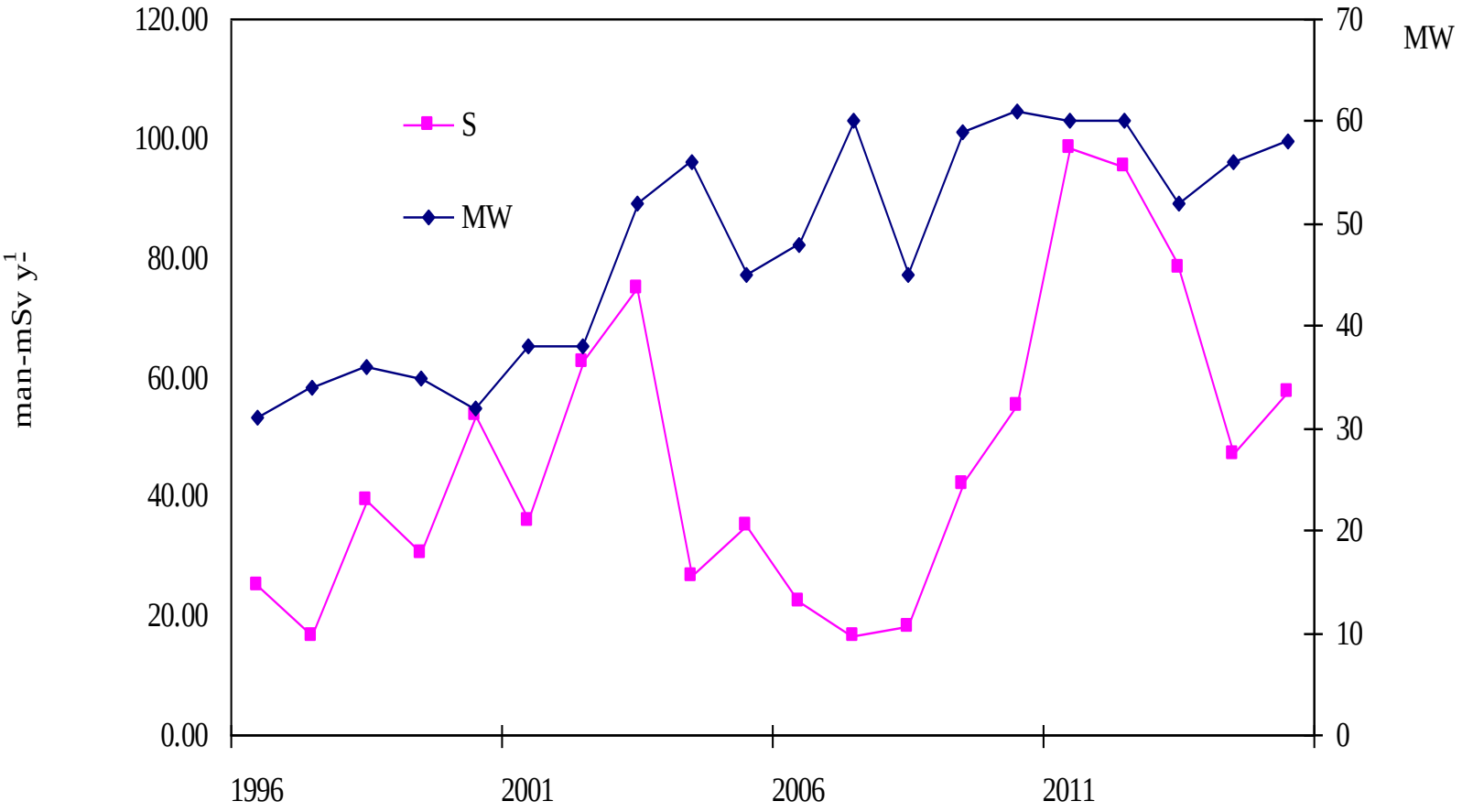

Figure 2. Collective doses and annual controlled workers

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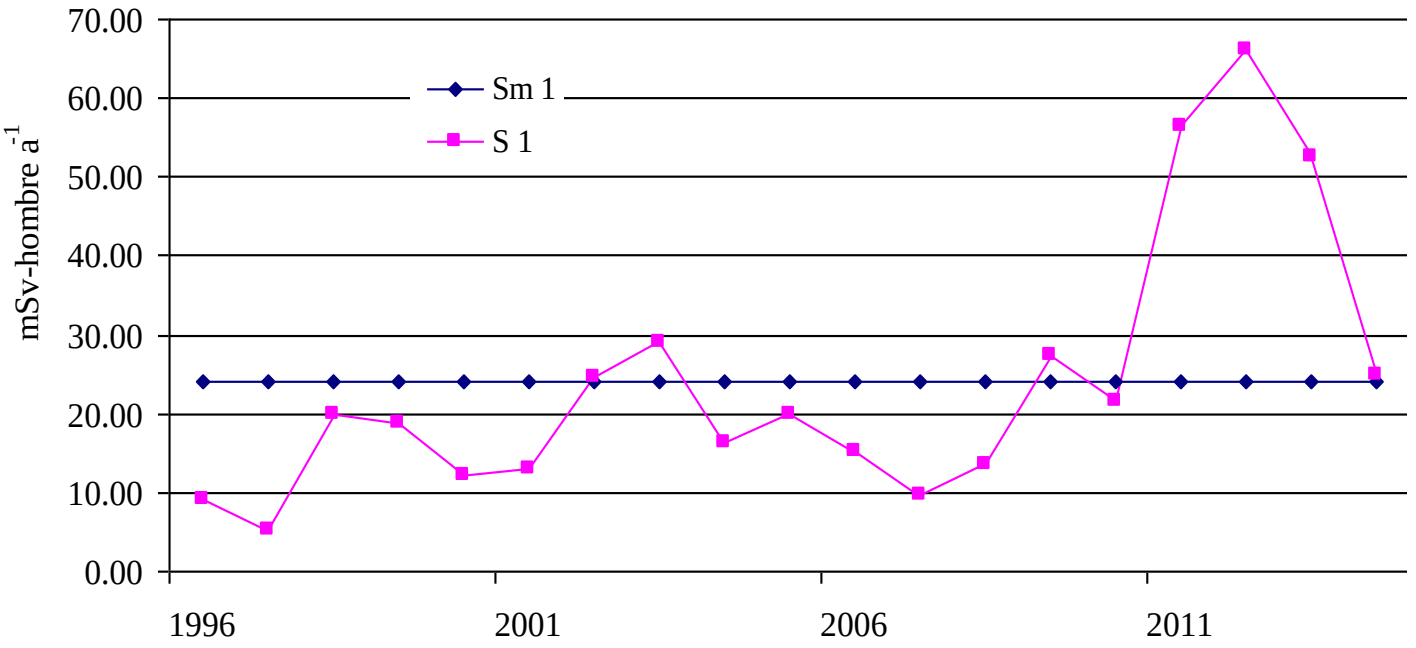

Figure 3. Collective Dose of the highest exposure group with respect to medium S media of this for the studied period

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Table 3. Maximum values of dosimetric magnitudes and relationship with the dose constrain

	E (mSv)	Hp(0.07) (mSv)	Hp(3) (mSv)
Dose constrains	**12**	**200**	**15**
1996	4.73	8.15	NC
1997	4.02	8.56	NC
1998	10.27	17.85	2.60
1999	4.85	49.38	4.38
2000	**25.77**	65.43	1.27
2001	3.22	117.97	1.90
2002	7.06	97.94	8.47
2003	5.89	91.47	**12.09**
2004	4.17	73.41	5.14
2005	6.52	145.17	5.89
2006	6.09	**232.71**	3.49
2007	2.96	117.70	3.86
2008	4.28	168.38	2.18
2009	5.32	172.49	4.85
2010	5.14	60.68	3.85
2011	9.13	194.60	12.05
2012	12.56	116.59	9.95
2013	13.23	159.23	7.49
2014	5.46	97.00	6.95
2015	6.68	125.14	8.75

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Conclusions

- **The Eduta system described in this paper allows maintaining the staff preparation in radiation safety accordance with its safety function and the Regulatory Body in Cuba.**
- **The approach focusing in a safety culture is permanent in our organization since this is a lingering process.**
- **The safety performance indicators analysis behaviour in the training of the staff is a good experience since this allows improvement the feedback process and promotion the improvement of safety culture.**

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Many thanks for your attention!

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