

Appendices
to the
**Report on the Questionnaires on
Occupational Exposure in
Industrial Radiography**

Working Group on Industrial Radiography (WGIR)

*Information System on Occupational Exposure in Medicine,
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Working material

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APPENDIX I. DETAILED RESULTS OF THE QUESTIONNAIRE ON OCCUPATIONAL RADIATION PROTECTION IN INDUSTRIAL RADIOGRAPHY ADDRESSED TO OPERATORS

The principal findings from the Operator's questionnaire are given in the Results section of the main text. Appendix I gives additional data in the form of tables and figures. Note, not all questions were answered by all responders. The abbreviation RP is often used for "radiation protection".

Table I.0. Details of responses to the Operator questionnaire.

	Number of operators	Number of NDT companies	Number of countries
Africa	17	7	3
Asia-Pacific	49	36	7
Europe	166	60	16
Latin America	72	17	3
North America	128	33	2
Global	432	153	31

Table I.0a. Estimated number of responses to the Operator questionnaire per NDT Company.

Number of operators responding per NDT company	Number of NDT companies
1	101
2 - 5	29
6 - 10	17
10 - 20	4
> 20	2

I.1. QUESTIONNAIRE RESPONSES

Table I.1. Responses to Question 1 – Was radiation protection training included in your NDT-training on Radiographic Testing? *Please answer for all levels that are applicable to you.*

a. Level 1:

	Yes	No	Don't know	No reply	Total
Africa	11	2	0	4	17
Asia-Pacific	37	0	0	12	49
Europe	85	19	6	56	166
Latin America	61	3	2	6	72
North America	92	0	3	33	128
Global	286	24	11	111	432

b. Level 2:

	Yes	No	Don't know	No reply	Total
Africa	8	0	1	8	17
Asia-Pacific	33	0	2	14	49
Europe	109	23	5	29	166
Latin America	18	4	1	49	72
North America	81	1	3	43	128
Global	249	28	12	143	432

c. Level 3:

	Yes	No	Don't know	No reply	Total
Africa	5	0	1	11	17
Asia-Pacific	12	2	6	29	49
Europe	20	12	9	125	166
Latin America	4	2	1	65	72
North America	6	3	4	114	128
Global	47	19	21	344	432

Table I.1d. Highest level of NDT training of responding operators, derived from their responses to Question 1.

	Highest NDT level attained – number and percentage* of operators			Sub-total of responses indicating an NDT level	No reply	Total
	Level 1	Level 2	Level 3			
Africa	6 (35)*	6 (35)	5 (30)	17	0	17
Asia-Pacific	14 (29)	21 (43)	14 (29)	49	0	49
Europe	18 (12)	105 (68)	32 (21)	155	11	166
Latin America	47 (68)	16 (23)	6 (9)	69	3	72
North America	36 (31)	73 (62)	9 (8)	118	10	128
Global	121 (30)	221 (54)	66 (16)	408	24	432

* Percentage of those responses that indicated an NDT level of training.

Table I.2. Responses to Question 2 – Did you receive separate training on radiation protection, either in addition to or instead of any radiation protection training in your NDT-training?

	Yes	No	Dont know	No reply	Total
Africa	13	4	0	0	17
Asia-Pacific	41	8	0	0	49
Europe	137	28	1	0	166
Latin America	66	6	0	0	72
North America	107	15	1	5	128
Global	364	61	2	5	432

Table I.2a. Responses to Question 2a – If yes to question 2, do you have a formal radiation protection qualification or certification?

	Yes	No	Dont know	No reply	Total
Africa	8	5	0	0	13
Asia-Pacific	38	2	0	1	41
Europe	121	10	3	3	137
Latin America	62	3	0	1	66
North America	83	18	5	1	107
Global	312	38	8	6	364

Correlating the responses to Questions 1 and 2, it appears that 8 responding operators had not had radiation protection training, either as part of NDT training or as separate training.

Table I.3. Responses to Question 3 – If you have had radiation protection training, were procedures for emergencies included in the training?

	Yes	No	Dont know	No reply	Total
Africa	14	3	0	0	17
Asia-Pacific	46	3	0	0	49
Europe	126	27	7	6	166
Latin America	72	0	0	0	72
North America	117	5	2	4	128
Global	375	38	9	10	432

Note: Of the 38 “no” responses, 5 were operators who used X-Ray sources only, and 10 were operators who did not specify what sources they worked with. However, 27 operators who stated that they worked with X-rays sources only also reported that they had been trained in emergency procedures.

Table I.3a. Responses to Question 3a – If yes to question 3, did the training include practical exercises for creating a safe situation until the source is able to be recovered?

	Yes	No	Dont know	No reply	Total
Africa	12	1	0	1	14
Asia-Pacific	39	6	0	1	46
Europe	67	57	2	0	126
Latin America	56	12	0	4	72
North America	73	42	2	0	117
Global	247	118	4	6	375

Note: Of the 118 “no” responses, 8 operators were operators who used X-Ray sources only, and 12 were operators who did not specify what sources they worked with. However, 16 operators who stated that they worked with X-rays sources only reported that they had had practical exercises for creating a safe situation.

Table I.3b. Responses to Question 3b – If yes to question 3, did the training include practical exercises for source recovery?

	Yes	No	Dont know	No reply	Total
Africa	11	1	0	2	14
Asia-Pacific	29	12	3	2	46
Europe	49	62	0	15	126
Latin America	57	9	2	4	72
North America	49	56	2	10	117
Global	195	140	7	33	375

Note: Of the 140 “no” responses, 11 were operators who used X-Ray sources only, and 18 were operators who did not specify what sources they worked with. However, 11 operators who stated that they worked with X-rays sources only also reported that they had had practical exercises for creating a safe situation.

Table I.3c. Responses to Question 3c – Are you allowed to perform a source recovery on your own without first contacting a specialized source recovery person?

	Yes	No	Dont know	No reply	Total
Africa	1	14	0	2	17
Asia-Pacific	12	23	1	13	49
Europe	20	124	15	7	166
Latin America	38	27	4	3	72
North America	8	114	1	5	128
Global	79	302	21	30	432

Note:

- 1: Many countries do not allow operators to perform recoveries, with this operation being restricted to specialist persons.
2. Of the 79 operators that were allowed to perform source recovery, 71 had had separate RP training and 62 had had practical training on source recovery.
3. 14 (of the 79) operators had level 3 RT training, 33 level 2, 29 had level 1, and 3 had not specified their RT training. These proportions are similar to the overall proportions of responding operators in each level of NDT training, suggesting that the level of RT training in itself has little correlation with being allowed to perform source recovery.

In all the above tables on emergency training, approximately 90% of the “yes” responders had indicated that they had had separate RP training. There is always the possibility that specific emergency training, for example for creating a safe situation, may be given through licensee procedures rather than formal RP training.

Table I.3d. Further analysis of responses to Questions 3a and 3b – details on emergency training.

	Number of operators with emergency training that included:				Number of operators that had had emergency training
	Practicals for creating a safe situation, but not source recovery	Practicals for source recovery, but not creating a safe situation	Practicals for <u>both</u> creating safe situations & source recovery	Details not specified	
Africa	1	0	11	2	14
Asia-Pacific	10	0	29	7	46
Europe	20	2	47	57	126
Latin America	4	5	52	11	72
North America	25	1	48	43	117
Global	60	8	187	120	375

Table I.4. Responses to Question 4 – Do you feel sufficiently well qualified and trained to be able to work safely and reliably?

	Yes	No	Dont know	No reply	Total
Africa	16	1	0	0	17
Asia-Pacific	46	2	0	1	49
Europe	153	6	5	2	166
Latin America	71	1	0	0	72
North America	124	0	0	4	128
Global	410	10	5	7	432

Table I.4a. Responses to Question 4a – Do you feel you are well prepared for an emergency situation?

	Yes	No	Dont know	No reply	Total
Africa	15	1	1	0	17
Asia-Pacific	43	4	0	2	49
Europe	124	28	9	5	166
Latin America	60	5	6	1	72
North America	113	2	6	7	128
Global	355	40	22	15	432

Table I.4a(i). Further analysis of the “No” responses to Question 4a – Do you feel you are well prepared for an emergency situation?

	“No” response	Responded “No” and:				
		Had no training in creating a safe situation	Had no source recovery training	Had no training in creating a safe situation or in source recovery	Were not allowed to perform source recovery	Had no training in creating a safe situation or in source recovery or were not allowed to perform source recovery
Africa	1	0	0	0	0	0
Asia-Pacific	4	0	2	2	2	4
Europe	28	13	13	14	23	25
Latin America	5	5	2	5	4	5
North America	2	0	0	0	2	2
Global	40	18	17	21	31	36

Note: There was no correlation between level of NDT training and feeling “Not well prepared”.

Table I.5a. Responses to Question 5a – When on-site radiography is being performed, is there a qualified radiation safety expert, e.g. one of the radiographers or a RPO, who is on the work site and supervises the jobs?

	Always	Sometimes	Never	Dont know	No reply	Total
Africa	12	4	1	0	0	17
Asia-Pacific	33	11	1	0	4	49
Europe	61	75	16	9	5	166
Latin America	53	14	0	1	4	72
North America	73	37	8	6	4	128
Global	232	141	26	16	17	432

Note: For the 26 “never” responses, most of the operators (88%) had either Level 2 or 3 NDT training.

Table I.5b. Responses to Question 5b – When on-site radiography is being performed, is there a qualified radiation safety expert, e.g. a RPO, who monitors or audits the safe operation of the jobs on a regular basis?

	Always	Sometimes	Never	Dont know	No reply	Total
Africa	9	7	1	0	0	17
Asia-Pacific	21	14	1	0	13	49
Europe	72	80	5	4	5	166
Latin America	38	26	3	1	4	72
North America	35	77	6	6	4	128
Global	175	204	16	11	26	432

Table I.6. Responses to Question 6 – Do you check for the presence of the source in the exposure device before taking the device from the store?

	Always	Sometimes	Never	Dont know	No reply	Total
Africa	15	2	0	0	0	17
Asia-Pacific	47	1	0	0	1	49
Europe	130	16	14	0	6	166
Latin America	64	5	0	0	3	72
North America	117	5	2	0	4	128
Global	373	29	16	0	14	432

Note: There was no obvious pattern to the 16 “never” responses, with operators either using X-rays only or working with non-specified sources accounting for only 1 and 2 of the “never” responses, respectively.

Table I.7. Responses to Question 7 – Do you check for the presence of the source in the exposure device after the NDT test?

	Always	Sometimes	Never	Dont know	No reply	Total
Africa	17	0	0	0	0	17
Asia-Pacific	47	2	0	0	0	49
Europe	147	9	5	0	5	166
Latin America	66	2	0	0	4	72
North America	119	4	0	0	5	128
Global	396	17	5	0	14	432

Note: Of the 5 “never” responses, none was an operator using X-rays only and only 1 was an operator using non-specified sources.

Table I.8. Responses to Question 8 – Have you had any incidents (i.e. deviations from normal, near misses or accidents) (with respect to radiation and hence occupational exposure) during the last 5 years?

	Yes	No	Dont know	No reply	Total
Africa	3	13	0	1	17
Asia-Pacific	8	38	1	2	49
Europe	33	128	4	1	166
Latin America	13	56	0	3	72
North America	26	99	0	3	128
Global	83	334	5	10	432

Table I.8a(i). Responses to Question 8a(i) – How many deviations from normal were there in the last 5 years?

	Replies	No value given	Number of deviations from normal						
			Total	Mean	Min	Q1	Median	Q3	Max
Africa	15	2	0	0	0	0	0	0	0
Asia-Pacific	44	5	18	0.4	0	0	0	0	6
Europe	161	5	153	1.0	0	0	0	0	100
Latin America	69	3	11	0.2	0	0	0	0	3
North America	120	8	47	0.4	0	0	0	0	12
Global	409	23	229	0.6	0	0	0	0	100

Note 1: One operator reported 100 deviations. This is included in the analysis in the Table, but it is noted that the next highest value was only 12. Excluding this datum gives a global total of 129 deviations and a mean of 0.3.

Note 2 for Tables I.8a(i) to (iii):

- If the response to Question 8 was “yes”, but values were given for only some of the number of deviations, near misses and accidents for the last 5 years, then a value of 0 was assigned for the missing data. If however the response to Question 8 was “yes” but no values were given, then no values were assigned.
- If the response to Question 8 was “no”, then a value of 0 was assigned for each of the number of deviations, near misses and accidents for the last 5 years.
- If the response to Question 8 was either “do not know” or “blank”, then no values were assigned for each of the number of deviations, near misses and accidents for the last 5 years.

Table I.8a(ii). Responses to Question 8a(ii) – How many near misses were there in the last 5 years?

	Replies*	No value given	Number of near misses						
			Total	Mean	Min	Q1	Median	Q3	Max
Africa	15	2	2	0	0	0	0	0	1
Asia-Pacific	44	5	2	0.0	0	0	0	0	2
Europe	161	5	18	0.1	0	0	0	0	2
Latin America	69	3	9	0.1	0	0	0	0	3
North America	120	8	10	0.1	0	0	0	0	5
Global	409	23	41	0.1	0	0	0	0	5

* See Note 2 to Table I.8a(i).

Table I.8a(iii). Responses to Question 8a(iii) – How many accidents were there in the last 5 years?

	Replies*	No value given	Number of accidents						
			Total	Mean	Min	Q1	Median	Q3	Max
Africa	15	2	0	0.000	0	0	0	0	0
Asia-Pacific	44	5	6	0.136	0	0	0	0	4
Europe	161	5	5	0.031	0	0	0	0	2
Latin America	69	3	3	0.043	0	0	0	0	1
North America	120	8	2	0.017	0	0	0	0	1
Global	409	23	16	0.039	0	0	0	0	4

* See Note 2 to Table I.8a(i).

Table I.9. Responses to Question 9 – If you had deviations, near misses, or accidents in the last 5 years, did you report these to your company?

	Always	Sometimes	Never	Dont know	No reply	Total
Africa	1	1	1	0	0	3
Asia-Pacific	8	0	0	0	0	8
Europe	28	2	2	0	1	33
Latin America	11	2	0	0	0	13
North America	23	0	3	0	0	26
Global	71	5	6	0	1	83

Table I.9a. Responses to Question 9a – If yes to question 9 (i.e. “always” or “sometimes”), did your NDT company report any of these to the (radiation protection) regulatory body?

	Yes	No	Dont know	No reply	Total
Africa	0	1	0	1	2
Asia-Pacific	7	0	1	0	8
Europe	11	5	14	0	30
Latin America	5	3	5	0	13
North America	10	6	6	1	23
Global	33	15	26	2	76

Note: This table reports what each operator believed occurred in the company they work for. Of the 76 individual operators that responded “always” or “sometimes” to Question 9, 21 were the sole responders for their company. The other 55 operators came from 25 different companies, making a total of 46 NDT companies reflected in this table. For most NDT companies with multiple operators, the majority did not provide responses to these questions. However, for 3 NDT companies there were 4 instances of contradictory responses – i.e. one or more operators said that the events were reported to the RB and one or more said they were not.

Table I.9b. Responses to Question 9b – If yes to question 9a, which type were reported: All cases ; near misses & accidents; accidents only?

	Total number responding “yes” to reporting to the RB	No of operators who stated that their NDT company reported to the RB the following events:		
		All cases	Near misses & accidents	Accidents only
Africa	0	0	0	0
Asia-Pacific	7	5	3	2
Europe	11	10	2	2
Latin America	5	1	2	0
North America	10	7	0	1
Global	33	23	7	5

Table I.10. Responses to Question 10 – Does the NDT company you work for have an emergency plan for site radiography?

	Yes	No	Dont know	No reply	Total
Africa	15	1	1	0	17
Asia-Pacific	45	1	2	1	49
Europe	138	2	16	10	166
Latin America	65	0	2	5	72
North America	122	1	1	4	128
Global	385	5	22	20	432

Note: This table reports what each operator believed with respect to the company they worked for. Of the 5 individual operators that responded “no”, 2 were the sole responders for their company, but 3 were contradictory to the responses of other operators from the same NDT company. Only 2 NDT companies had operators giving consistent responses that there was no emergency plan for site radiography (1 of which the operator used only X-Rays), 5 NDT companies had operators giving consistent responses that they did not know if there was an emergency plan, and for 4 NDT companies the operators did not answer the question.

Table I.10a. Responses to Question 10a – 1 If yes to question 10, have you received training for the roles and responsibilities of radiographers in that emergency plan?

	Yes	No	Dont know	No reply	Total
Africa	13	2	0	0	15
Asia-Pacific	39	5	1	0	45
Europe	116	17	3	2	138
Latin America	63	1	1	0	65
North America	107	10	1	4	122
Global	338	35	6	6	385

Table I.11. Responses to Question 11 – Do you use collimators when you perform gamma radiography?

	Always	Sometimes	Never	Dont know	No reply	Total
Africa	8	7	1	0	1	17
Asia-Pacific	36	11	1	0	1	49
Europe	141	20	1	0	4	166
Latin America	46	22	0	0	4	72
North America	107	17	0	0	4	128
Global	338	77	3	0	14	432

Note: 1 of the 3 “never” responses was for an operator who used Ir, Se and X-Ray sources in 2009, while the other 2 did not specify the sources used in 2009. Of the 14 “no replies”, 6 were from operators that had replied that they used X-Ray sources only in 2009.

Table I.12. Responses to Question 12 – Do you use diaphragms/collimators when you perform X-ray radiography?

	Always	Sometimes	Never	Dont know	No reply	Total
Africa	3	4	5	0	5	17
Asia-Pacific	21	15	9	0	4	49
Europe	81	62	14	0	9	166
Latin America	25	27	9	0	11	72
North America	51	25	26	0	26	128
Global	181	133	63	0	55	432

Note: 27 of the 63 “never” responses were for operators who had stated that they used in 2009 gamma sources only. Of the 55 “no replies”, 34 were from operators that had stated that they used in 2009 gamma sources only.

Table I.13. Responses to Question 13 – Do you know what occupational radiation doses you receive?

	Yes	No	Dont know	No reply	Total
Africa	13	2	1	1	17
Asia-Pacific	40	8	1	0	49
Europe	146	14	5	1	166
Latin America	70	0	0	2	72
North America	118	3	2	5	128
Global	387	27	9	9	432

Table I.13a. Responses to Question 13a – If yes, how many times per year are you informed about your occupational radiation dose?

	Replies	No value given	Number of times per year the operator was informed about their occupational dose					
			mean	min	Q1	median	Q3	max
Africa	13	4	9.3	1	4	12	12	12
Asia-Pacific	34	15	7.6	1	4	5	12	12
Europe	129	37	8.8	0	4	12	12	20
Latin America	49	23	11.4	4	12	12	12	12
North America	93	35	14.4	0	4	12	26	26
Global	318	114	10.7	0	4	12	12	26

Table I.13a(i). Responses to part of Question 13b(ii) – What is the duration of your monitoring period?

	Replies	No value given	Monitoring period for occupational dose		
			2weeks	1 month	3 months
Africa	12	5	0	12	0
Asia-Pacific	27	22	0	12	15
Europe	99	67	3	87	9
Latin America	50	22	0	48	2
North America	75	53	42	33	0
Global	263	169	45	192	26

Table I.13b(i). Responses to Question 13b(i) – If yes to Question 13, what was your total occupational dose in 2009?

	Replies	No value given	Annual occupational effective dose 2009 (mSv)					
			mean	min	Q1	median	Q3	max
Africa	9	8	1.9	0.0	0.0	0.6	2.4	8.5
Asia-Pacific	24	25	4.5	0.0	0.1	1.4	5.3	30.0
Europe	92	74	2.4	0.0	0.1	1.4	4.1	8.9
Latin America	41	31	3.0	0.0	0.3	1.6	2.9	20.0
North America	68	60	5.0	0.0	0.7	3.1	8.0	30.0
Global	234	198	3.4	0.0	0.3	1.8	4.7	30.0

Table I.13b(ii). Responses to Question 13b(ii) – If yes to Question 13, what was the highest dose you received in a given monitoring period in 2009?

	Replies	No value given	Highest occupational dose received in a monitoring period in 2009, normalized to a 1 month period					
			mean	min	Q1	median	Q3	max
Africa	12	5	2.07	0.00	0.23	0.33	2.17	8.79
Asia-Pacific	17	32	0.42	0.00	0.01	0.08	0.26	4.49
Europe	73	93	1.45	0.00	0.11	0.40	1.00	32.00
Latin America	32	40	1.61	0.00	0.22	0.80	1.03	12.30
North America	47	81	1.40	0.00	0.28	1.00	1.90	9.00
Global	181	251	1.36	0.00	0.13	0.49	1.40	32.00

Table I.13b(iii). Responses to Question 13b(iii) – If yes to Question 13, what was your radiographic workload in 2009?

	Replies	No value given	Radiographic workload in 2009 – number of films					
			mean	min	Q1	median	Q3	max
Africa	10	7	2395	30	180	1250	3781	10000
Asia-Pacific	19	30	3165	0	135	400	2000	17000
Europe	112	54	2605	0	200	1000	4000	16000
Latin America	6	66	1130	18	351	675	1713	3111
North America	49	79	2900	0	200	2000	4500	20000
Global	196	236	2677	0	200	1000	4000	20000

Table I.13b(iv). Responses to Question 13b(iv) – What type and strength of sources did you use in 2009?

a. Ir-192 sources used in 2009: Activity (Ci)

	Number of operators:		Ir-192 source activity (Ci)						
	Used Ir-192	No reply	Replies with activity	mean	min	Q1	median	Q3	max
Africa	7	10	7	52	10	20	45	75	120
Asia-Pacific	32	17	28	44	5	20	30	63	108
Europe	118	48	105	32	4	20	25	40	113
Latin America	56	16	45	35	2	17	30	50	100
North America	109	19	99	61	20	50	60	72	140
Global	322	110	284	44	2	25	40	60	140

b. Ir-192 sources used in 2009: Exposure time (secs)

	Number of operators:		Ir-192 exposure time (secs)						
	Used Ir-192	No reply	Replies with time	mean	min	Q1	median	Q3	max
Africa	7	10	5	119	30	95	120	150	200
Asia-Pacific	32	17	19	548	25	52	150	270	4000
Europe	118	48	84	159	10	60	95	180	1200
Latin America	56	16	32	291	10	50	120	300	3600
North America	109	19	78	171	7	30	60	120	3600
Global	322	110	218	216	7	45	80	180	4000

c. Se-75 sources used in 2009: Activity (Ci)

	Number of operators:		Se-75 source activity (Ci)						
	Used Se-75	No reply	Replies with activity	mean	min	Q1	median	Q3	max
Africa	1	16	1	20			20		
Asia-Pacific	8	41	7	56	28	35	55	70	98
Europe	97	69	86	42	10	25	40	50	120
Latin America	26	46	16	22	5	20	20	23	50
North America	16	112	14	47	20	40	46	54	80
Global	148	284	124	41	5	25	40	50	120

d. Se-75 sources used in 2009: Exposure time (secs)

	Number of operators:		Se-75 exposure time (secs)						
	Used Se-75	No reply	Replies with time	mean	min	Q1	median	Q3	max
Africa	1	16	1	40			40		
Asia-Pacific	8	41	5	96	45	45	50	98	240
Europe	97	69	66	125	5	60	90	164	480
Latin America	26	46	10	98	3	16	40	103	360
North America	16	112	11	133	60	60	120	143	340
Global	148	284	93	121	3	60	80	160	480

e. Co-60 sources used in 2009: Activity (Ci)

	Number of operators:		Co-60 source activity (Ci)						
	Used Co-60	No reply	Replies with activity	mean	min	Q1	median	Q3	max
Africa	4	13	3	20	14		15		30
Asia-Pacific	1	48	1	110			110		
Europe	21	145	18	32	4	19	24	36	115
Latin America	12	60	10	54	28	60	60	60	60
North America	16	112	16	44	14	29	40	53	80
Global	54	378	48	41	4	22	36	60	115

f. Co-60 sources used in 2009: Exposure time (secs)

	Number of operators:		Co-60 exposure time (secs)						
	Used Co-60	No reply	Replies with time	mean	min	Q1	median	Q3	max
Africa	4	13	4	233	30	98	150	285	600
Asia-Pacific	1	48	0						
Europe	21	145	10	1616	300	315	1200	2525	4200
Latin America	12	60	9	5653	480	6300	6300	6300	6300
North America	16	112	9	1159	120	300	350	600	7200
Global	54	378	32	2450	30	300	600	6300	7200

g. X-Ray sources used in 2009: kV

	Number of operators:		X-Ray potential (kV)						
	Used X-Rays	No reply	Replies with kV	mean	min	Q1	median	Q3	max
Africa	7	10	6	210	150	160	160	175	450
Asia-Pacific	27	22	27	239	160	180	245	295	400
Europe	106	60	96	227	120	198	223	250	450
Latin America	41	31	36	222	100	168	240	250	300
North America	30	98	28	232	110	180	250	265	420
Global	211	221	193	228	100	180	240	250	450

h. X-Ray sources used in 2009: Tube current (mA)

	Number of operators:		Tube current (mA)						
	Used X-Rays	No reply	Replies with mA	mean	min	Q1	median	Q3	max
Africa	7	10	6	5.3	3	3	4	7	10
Asia-Pacific	27	22	27	6.6	3	5	5	5	50
Europe	106	60	96	5.5	3	4	4	5	22
Latin America	41	31	34	6.5	3	5	5	5	13
North America	30	98	27	5.2	2	3	4	7	10
Global	211	221	190	5.8	2	4	5	5	50

i. X-Ray sources used in 2009: Exposure time (secs)

	Number of operators:		Exposure time (secs)						
	Used X-Rays	No reply	Replies with time	mean	min	Q1	median	Q3	max
Africa	7	10	5	102	40	45	45	180	200
Asia-Pacific	27	22	19	175	1	60	180	300	440
Europe	106	60	79	84	0.3	26	60	110	600
Latin America	41	31	27	376	0.4	40	120	180	3600
North America	30	98	28	123	20.0	60	90	149	390
Global	211	221	158	152	0.3	30	60	152	3600

Table I.14. Responses to Question 14 – Do you ever discuss your radiation protection issues and/or your occupational doses with your Radiation Protection Officer?

	Yes	No	Dont know	No reply	Total
Africa	14	1	0	2	17
Asia-Pacific	36	10	1	2	49
Europe	112	47	3	4	166
Latin America	58	11	0	3	72
North America	100	21	2	5	128
Global	320	90	6	16	432

Table I.14a. Responses to Question 14a – If yes, approximately how many times per year would this happen?

	Replies	No value given	Number of times per year that discussions took place with the RPO					
			mean	min	Q1	median	Q3	max
Africa	10	4	5.0	1	2	3	9	12
Asia-Pacific	31	5	4.6	1	2	4	5	25
Europe	98	14	5.5	1	2	3	5	75
Latin America	45	13	9.9	1	3	6	12	52
North America	80	20	5.7	1	2	3	9	52
Global	264	56	6.2	1	2	4	6	75

I.2. ADDITIONAL ANALYSIS OF QUESTIONNAIRE RESPONSES

The following tables and figures provide further details, utilizing the responses to the various questions.

I.2.1. ANNUAL OCCUPATIONAL DOSES

Table I.15a. Numbers and percentages of the industrial radiographers whose reported 2009 annual effective doses (D) were in the following dose bands – global results.

Dose band	Number of industrial radiographers	Percentage of industrial radiographers (%)
D<mdl*	35	15.0
mdl≤D<1	52	22.2
1≤D<5	90	38.5
5≤D<10	35	15.0
0≤D<15	15	6.4
15≤D<20	2	0.9
20≤D<30	3	1.3
30≤D<50	2	0.9
D≥50	0	0.0
Total	234	100.0

* mdl = minimum detection limit of the personal dosimetry system.

Table I.15b. Percentages of the industrial radiographers whose reported 2009 annual effective doses (D) were in the following dose bands – regional results.

	Annual effective dose bands (mSv)								
	D<mdl*	mdl≤D<1	1≤D<5	5≤D<10	10≤D<15	15≤D<20	20≤D<30	30≤D<50	D≥50
Africa	33.3	22.2	33.3	11.1	0.0	0.0	0.0	0.0	0.0
Asia-Pacific	20.8	25.0	25.0	8.3	12.5	4.2	0.0	4.2	0.0
Europe	18.5	20.7	42.4	18.5	0.0	0.0	0.0	0.0	0.0
Latin America	12.2	26.8	43.9	7.3	7.3	0.0	2.4	0.0	0.0
North America	7.4	20.6	35.3	17.6	13.2	1.5	2.9	1.5	0.0
Global	15.0	22.2	38.5	15.0	6.4	0.9	1.3	0.9	0.0

* mdl = minimum detection limit of the personal dosimetry system.

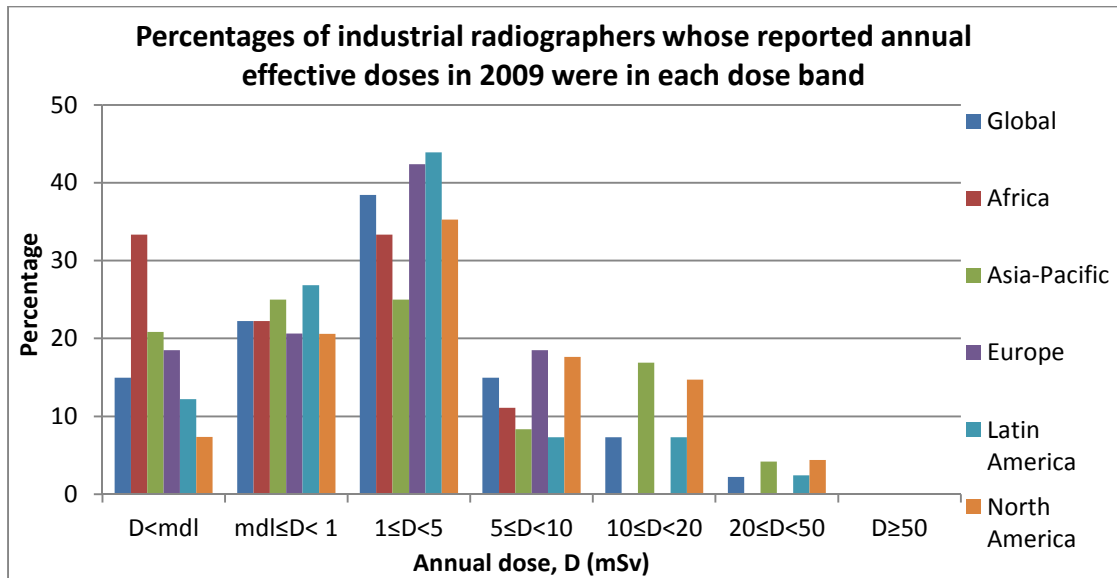


FIG. I.1. Results from Table I.15b giving percentages of industrial radiographers whose reported 2009 annual effective doses were in the given dose bands.

I.2.2. HIGHEST MONTHLY DOSES

Table I.16a. Number of operators whose (normalized) maximum monthly dose (D_m) in 2009 was in the following dose bands:

	Number of operators in the dose bands (mSv, in a month):						
	$D_m < 1$	$1 \leq D_m < 2.5$	$2.5 \leq D_m < 5$	$5 \leq D_m < 10$	$10 \leq D_m < 20$	$20 \leq D_m < 50$	$D_m \geq 50$
Global	122	34	18	3	3	1	0

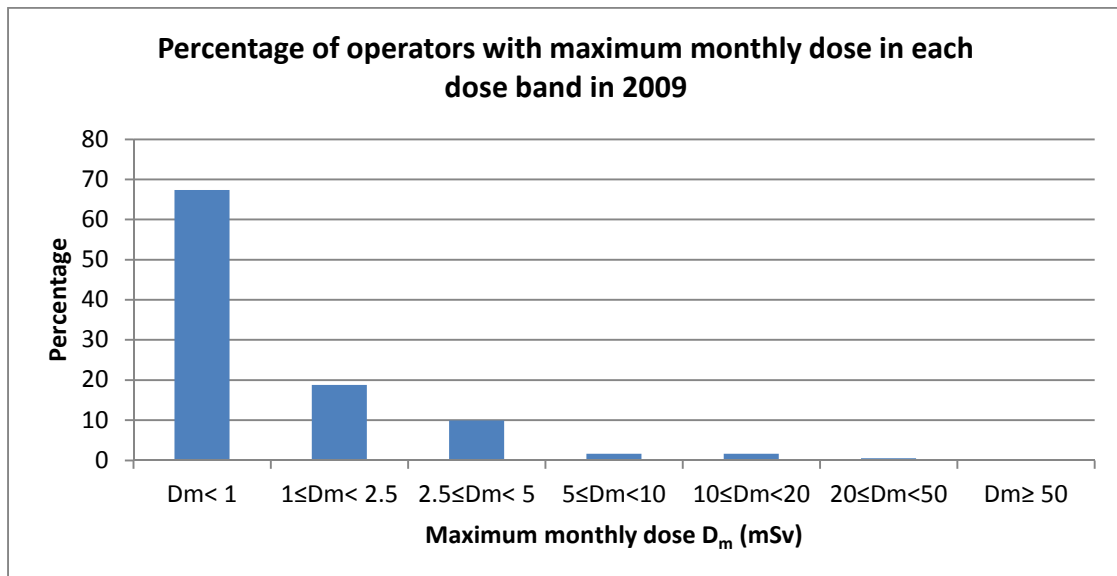


FIG. I.1a. Results from Table I.16a, giving percentages of operators whose reported maximum monthly dose in 2009 was in the given dose bands.

Table I.16b. Ratios of the highest occupational dose received in a monitoring period in 2009, normalized to a 1 month period, to the annual occupational effective dose in 2009.

	Replies	No value given	Ratio of highest occupational dose received in a monitoring period in 2009, normalized to a 1 month period, to the annual occupational effective dose in 2009					
			mean	min	Q1	median	Q3	max
Africa	6	11	0.48	0.13	0.23	0.33	0.66	1.00**
Asia-Pacific	13	36	0.19	0.05*	0.09	0.15	0.29	0.39
Europe	60	106	0.30	0.09	0.14	0.23	0.45	1.00**
Latin America	28	44	0.49	0.02*	0.27	0.40	0.75	1.00**
North America	42	86	0.42	0.04*	0.18	0.28	0.53	1.71**
Global	149	283	0.36	0.02*	0.15	0.27	0.45	1.71**

* In a very few cases the reported highest monthly dose was less than one-twelfth of the annual dose – logically not possible, but perhaps simply reflecting errors in recalling past doses.

** The normalization of two-week monitoring periods to a one month monitoring period has led to some instances where the extrapolated monthly dose equalled or exceeded the annual dose. In no case did the actual highest dose per actual monitoring period exceed the annual dose.

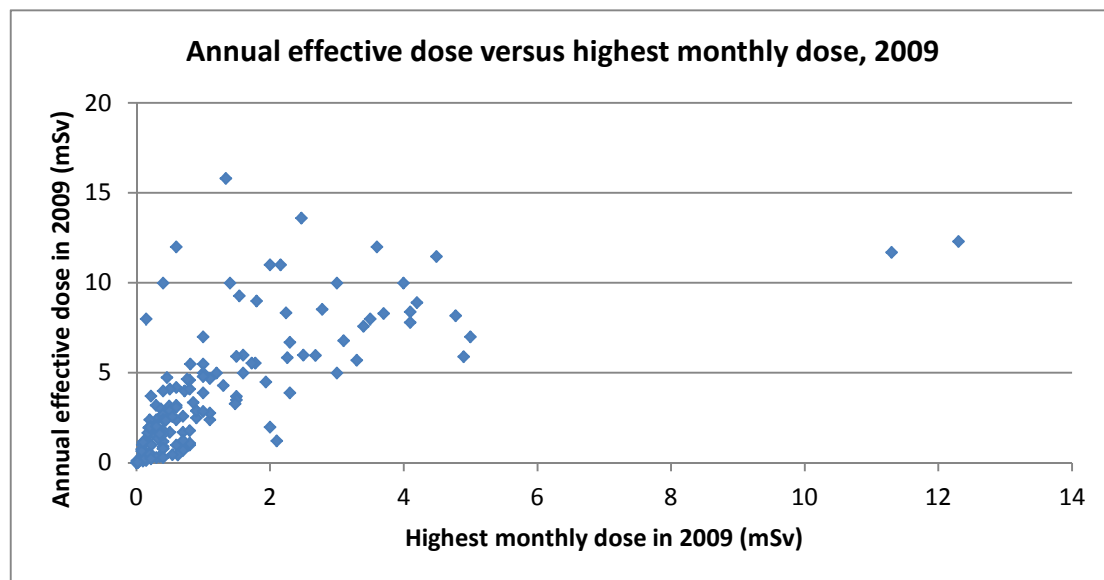


FIG. I.2. Annual effective dose versus highest monthly dose, for reported values in 2009. There were 149 data points (as in Table I.16b). The coefficient of correlation was 0.67.

I.2.3. WORKLOADS AND OCCUPATIONAL DOSE

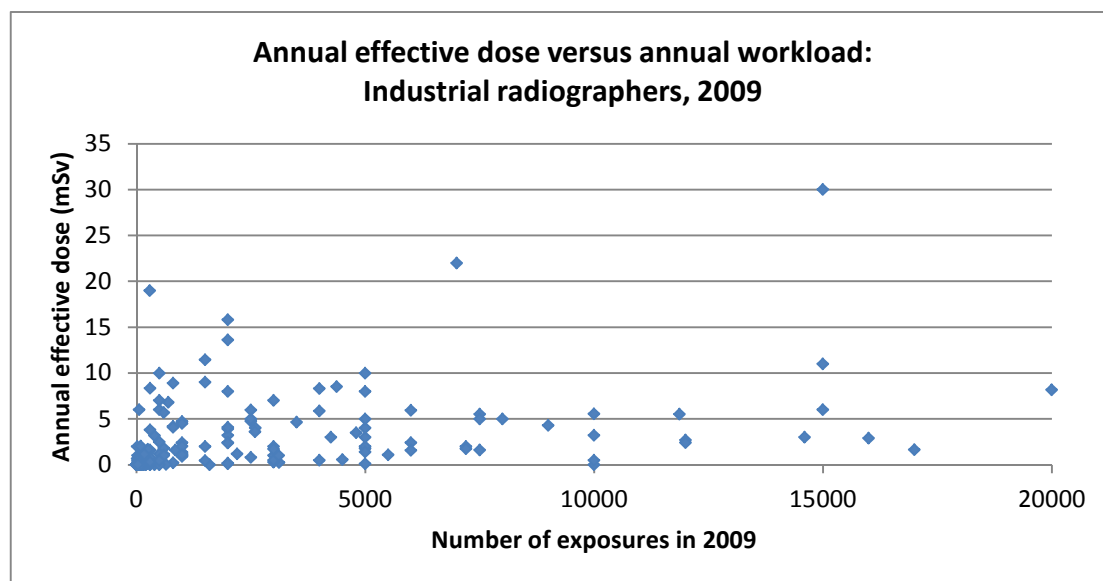


FIG. I.3. Annual effective dose versus annual workload, for reported values in 2009. There were 150 data points, and the coefficient of correlation was 0.34.

Table I.17a. Occupational dose per exposure, based on reported annual doses and annual workloads in 2009.

	Derived values	Occupational dose per exposure ($\mu\text{Sv}/\text{exposure}$)							No data given
		mean	std dev	min	Q1	median	Q3	max	
Africa	7	2.0	1.8	0.0	1.0	2.0	2.5	5.3	10
Asia-Pacific	14	6.3	17.2	0.0	0.1	1.1	1.9	65.5	35
Europe	79	3.7	12.0	0.0	0.2	0.5	2.2	100.0	87
Latin America	6	6.4	14.6	0.0	0.0	0.2	1.5	36.1	66
North America	35	7.0	17.5	0.1	0.8	1.3	5.5	100.0	93
Global	141	4.8	13.9	0.0	0.2	0.9	2.4	100.0	291

Table I.17b. Occupational dose per exposure, based on reported annual doses and annual workloads in 2009, excluding very low workloads – less than 100 exposures per year.

	Derived values	Occupational dose per exposure ($\mu\text{Sv}/\text{exposure}$)							No data given
		mean	std dev	min	Q1	median	Q3	max	
Africa	7	2.0	1.8	0.0	1.0	2.0	2.5	5.3	10
Asia-Pacific	13	6.8	17.8	0.0	0.2	1.2	2.0	65.5	36
Europe	72	2.0	3.3	0.0	0.2	0.5	2.1	14.0	94
Latin America	5	0.5	0.8	0.0	0.0	0.1	0.3	1.9	67
North America	32	4.0	6.5	0.1	0.7	1.3	3.6	27.8	96
Global	129	2.9	7.0	0.0	0.3	0.9	2.3	65.5	303

I.2.4. DOSE PER EXPOSURE AND SOURCES BEING USED

Table I.18a. Statistics for the derived occupational dose per exposure for operators who were using gamma sources only, X-Ray sources only, or both, and whose workload was 100 exposures or more per year in 2009.

	Occupational dose per exposure ($\mu\text{Sv}/\text{exp}$):		
	Gamma sources only	X-Ray sources only	Both sources
No of data	43	15	70
Mean	3.85	2.05	2.59
Standard deviation	10.09	3.56	5.04
Min	0.00	0.00	0.00
Q1	0.37	0.09	0.23
Median	1.01	0.48	0.70
Q3	3.07	1.93	2.06
Max	65.52	12.67	27.80

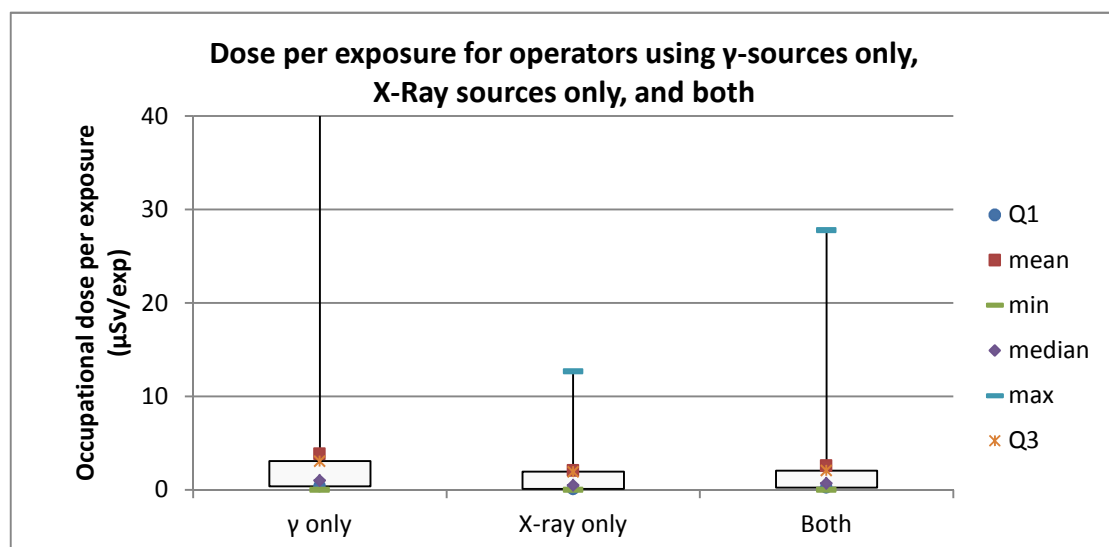


FIG. I.4. From the data in Table I.18a, distribution statistics for the derived occupational dose per exposure for operators who were using gamma sources only, X-ray sources only or both, and whose workload was 100 exposures or more per year in 2009.

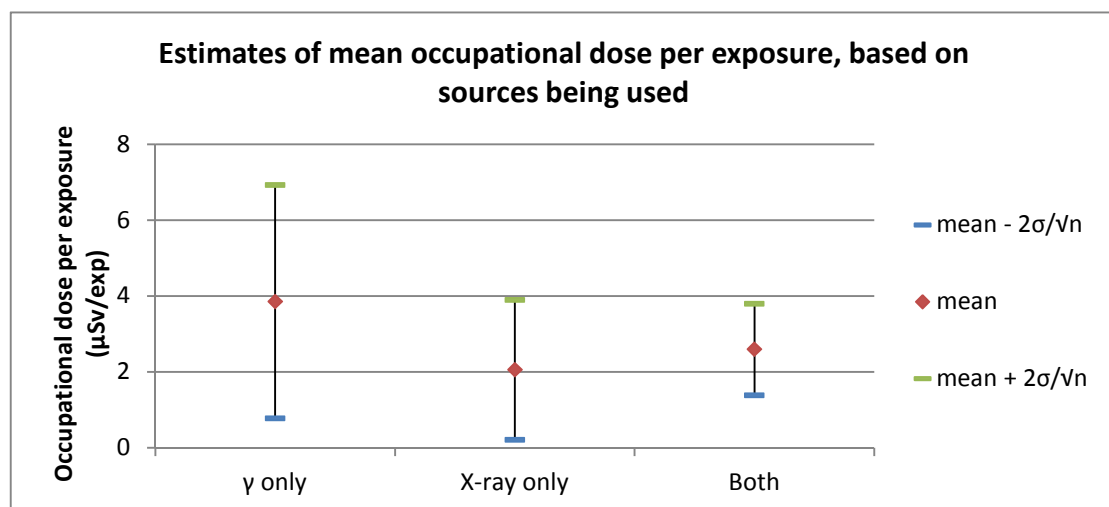


FIG. I.5. Based on the data in Table I.18.a, the estimates of mean occupational dose per exposure as a function of the sources being used. The bars are two times the standard error for the mean estimates. There was no statistically significant difference between the means of the gamma-only and X-ray only distributions.

I.2.5. OCCUPATIONAL DOSES AND IR-192 SOURCE ACTIVITY BEING USED

Iridium-192 was the most commonly used source by the responding operators.

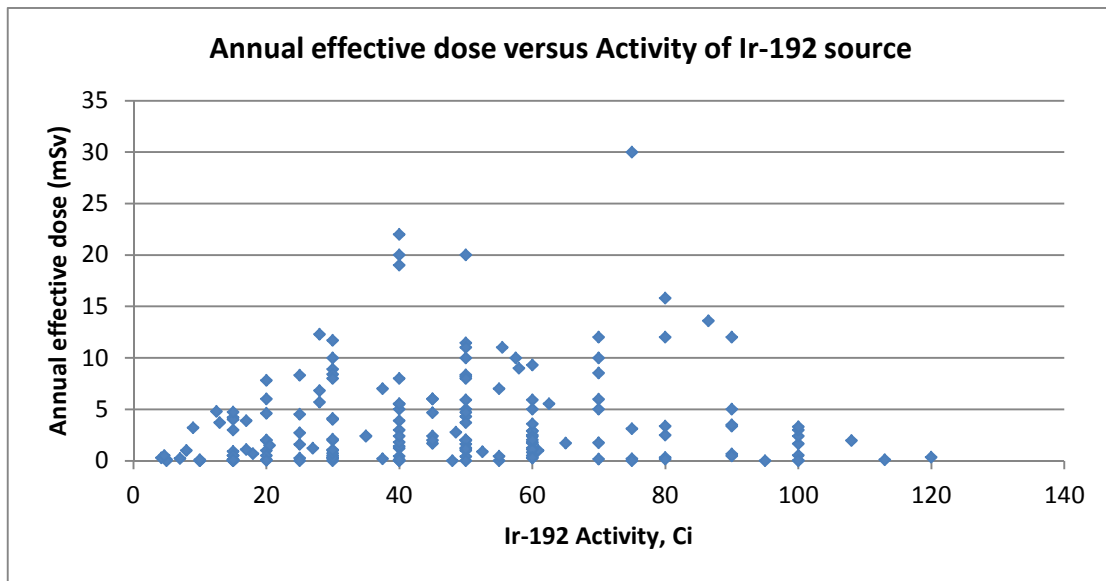


FIG. I.6. Annual effective dose versus Ir-192 source activity for operators who reported that they used Ir-192 sources and the typical activity was specified. There were 178 data points, and the coefficient of correlation was 0.12.

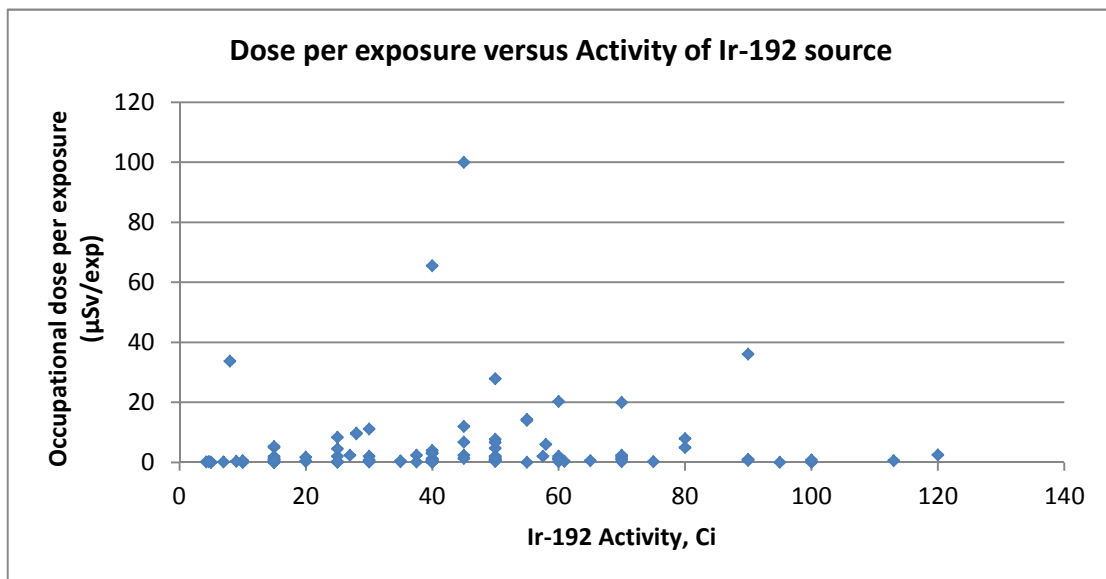


FIG. I.7. Occupational dose per exposure versus Ir-192 source activity for operators who reported that they used Ir-192 sources, the typical activity was specified, and the annual workload was given. There were 111 data points, and the coefficient of correlation was 0.05.

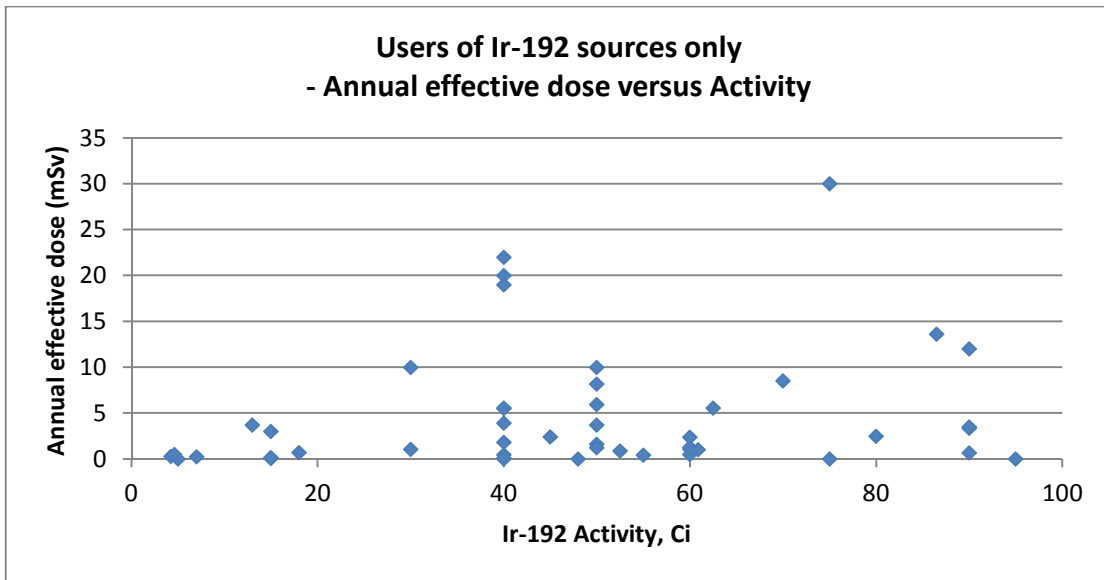


FIG. 1.8. Annual effective dose versus Ir-192 source activity for operators who reported that they used only Ir-192 sources and the typical activity was specified. There were 49 data points, and the coefficient of correlation was 0.21.

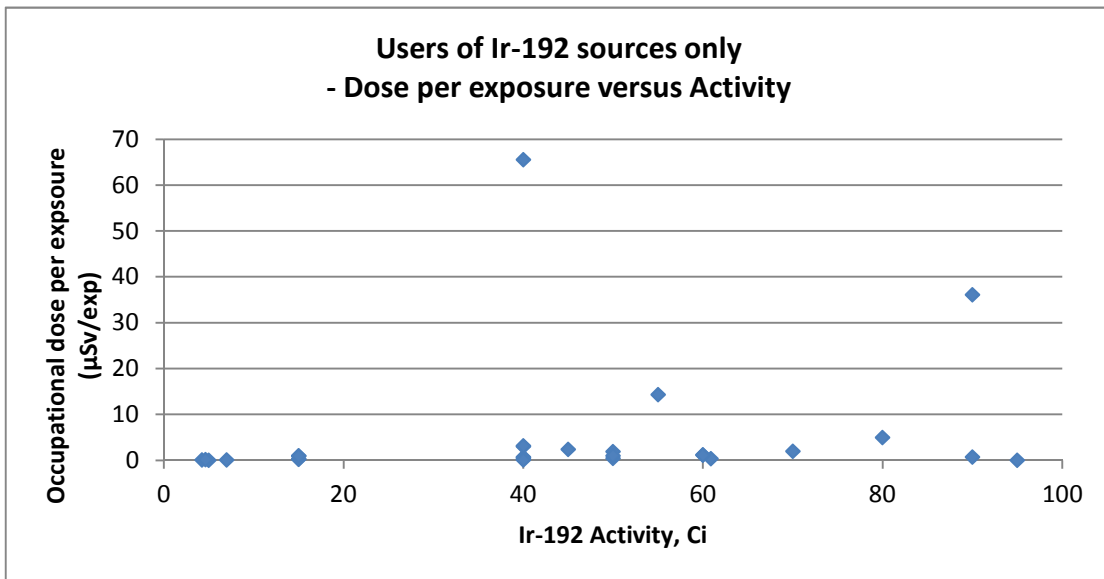


FIG. 1.9. Occupational dose per exposure versus Ir-192 source activity for operators who reported that they used only Ir-192 sources and the typical activity was specified. There were 28 data points, and the coefficient of correlation was 0.19.

I.2.6. DOSE PER EXPOSURE AND THE USE OF COLLIMATION

Table I.19a. Distribution statistics for the derived occupational dose per exposure for operators, depending on their use of collimators with gamma sources in 2009. Only 4 operators reported that they never used collimation with gamma sources. Data for operators whose workload was less than 100 exposures year in 2009 were excluded.

	Occupational dose per exposure ($\mu\text{Sv}/\text{exp}$):	
	Always used collimators	Sometimes used collimators
No of data	106	18
Mean	3.3	4.2
Standard deviation	8.3	4.4
Min	0.0	0.0
Q1	0.3	1.3
Median	0.8	2.5
Q3	2.0	5.2
Max	65.9	14.3

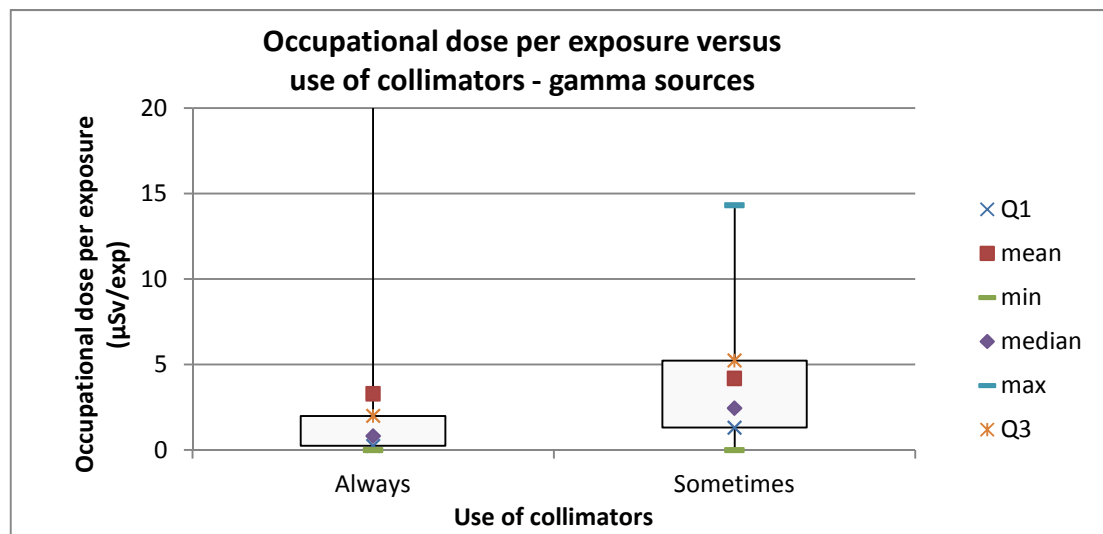


FIG. I.10. From the data in Table I.19a, graph showing the distribution statistics for the derived occupational dose per exposure for operators depending on their use of collimators with gamma sources. Only 4 operators reported that they never used collimation with gamma sources.

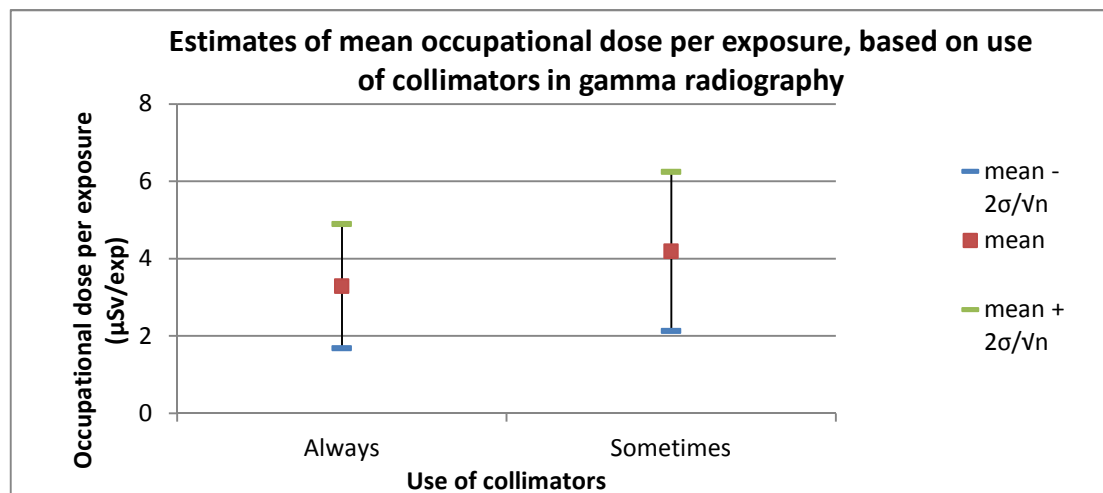


FIG. I.11. From the data in Table I.19a, graph showing estimates of mean occupational dose per exposure as a function of the use of collimation for gamma sources. The bars are two times the standard error for the mean estimates. There was no statistically significant difference between the means of the distributions for those that always used collimation versus those that only sometimes used collimation.

Table I.19b. Distribution statistics for the derived occupational dose per exposure for operators, depending on their use of collimators with X-Ray sources in 2009. Data for operators whose workload was less than 100 exposures year in 2009 were excluded.

	Occupational dose per exposure ($\mu\text{Sv}/\text{exp}$):		
	Always used collimators	Sometimes used collimators	Never used collimators
No of data	58	40	20
Mean	3.2	1.9	5.6
Standard deviation	5.1	3.2	14.8
Min	0.0	0.0	0.0
Q1	0.4	0.2	0.2
Median	1.4	0.6	0.9
Q3	2.9	1.6	2.1
Max	27.8	14.0	65.5

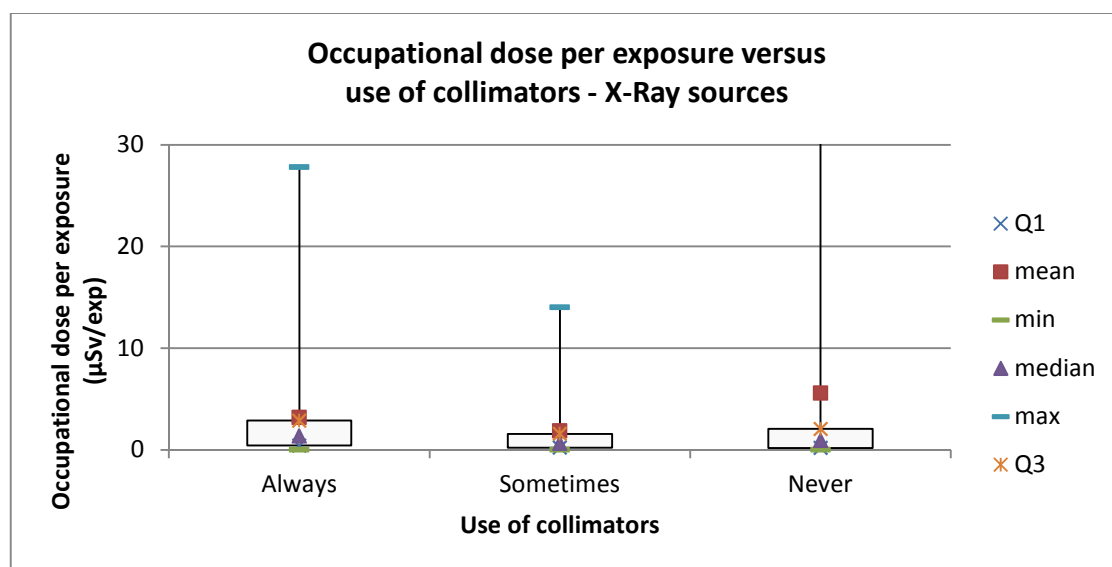


FIG. I.12. From the data in Table I.19b, graph presenting distribution statistics for the derived occupational dose per exposure for operators depending on their use of collimators with X-Ray sources.

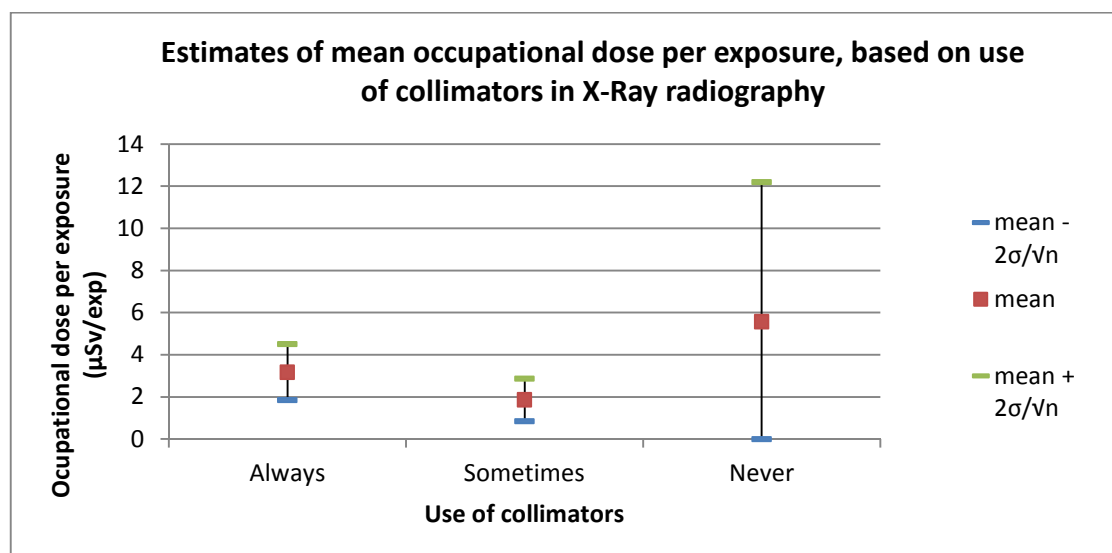


FIG. I.13. From the data in Table I.19b, graph showing the estimates of mean occupational dose per exposure as a function of the use of collimation for X-Ray sources. The bars are two times the standard error for the mean estimates. There was no statistically significant difference between the means of the distributions for those that always used collimation versus those that never used collimation.

I.2.7. OCCUPATIONAL DOSE AND THE LEVEL OF NDT TRAINING

Table I.20a. Distribution statistics for the annual occupational dose for operators as a function of their level of NDT training.

	Annual occupational effective dose (mSv):		
	NDT level 1	NDT level 2	NDT level 3
No of data	64	120	39
Mean	3.8	3.6	3.2
Standard deviation	4.9	4.7	5.0
Min	0.0	0.0	0.0
Q1	0.4	0.2	0.5
Median	2.3	2.0	1.2
Q3	5.2	5.0	2.8
Max	30.0	30.0	20.0

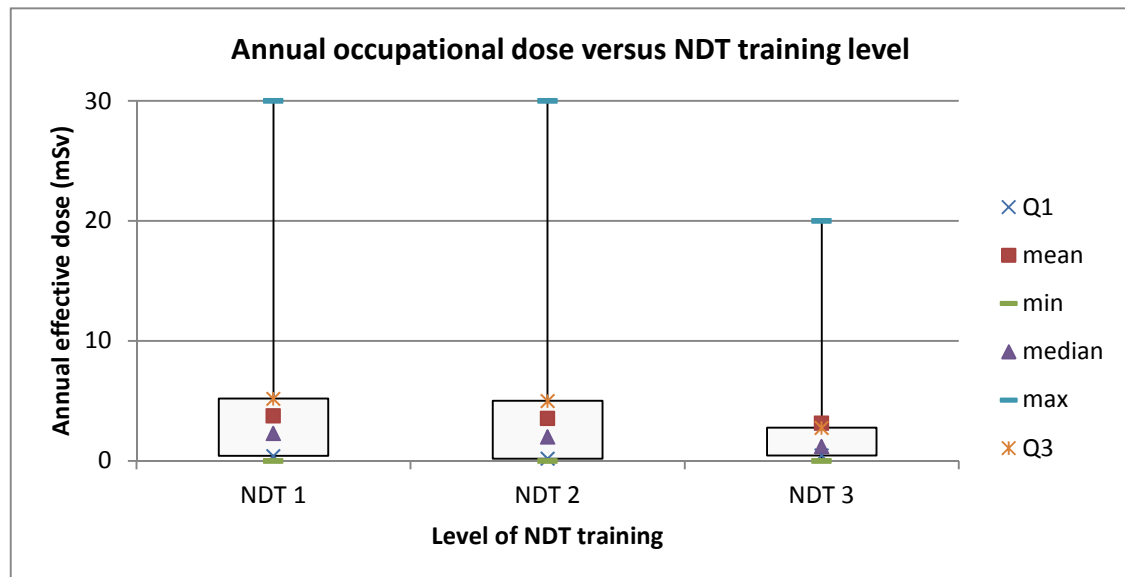


FIG. I.14. From the data in Table I.20a, graph presenting the distribution statistics for the annual effective dose of operators depending on their level of NDT training.

Table I.20b. Distribution statistics for the derived occupational dose per exposure for operators as a function of their level of NDT training. Data for operators whose workload was less than 100 exposures year in 2009 were excluded.

	Occupational dose per exposure($\mu\text{Sv}/\text{exp}$):		
	NDT level 1	NDT level 2	NDT level 3
No of data	21	76	26
Mean	3.7	2.2	4.1
Standard deviation	6.2	3.7	12.7
Min	0.0	0.0	0.0
Q1	0.5	0.3	0.2
Median	1.0	0.8	1.2
Q3	5.0	2.0	2.3
Max	27.8	20.0	65.5

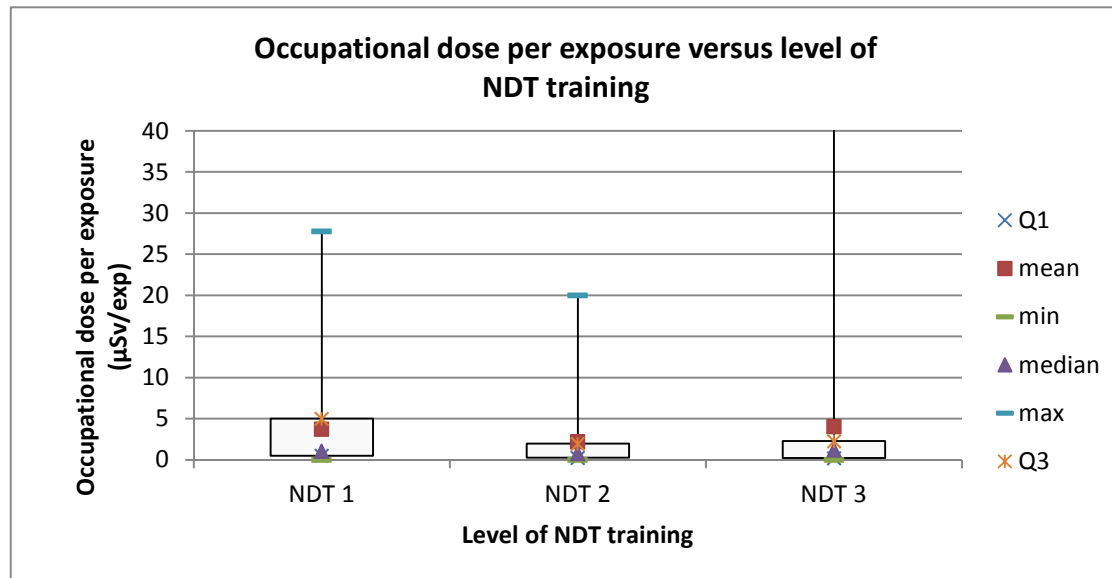


FIG. I.15. From the data of Table I.20b, graph presenting the distribution statistics for the derived occupational dose per exposure for operators depending on their level of NDT training, excluding very low workloads – fewer than 100 exposures per year.

I.2.8. OCCUPATIONAL DOSE AND THE NUMBER OF ACCIDENTS, NEAR MISSES AND DEVIATIONS

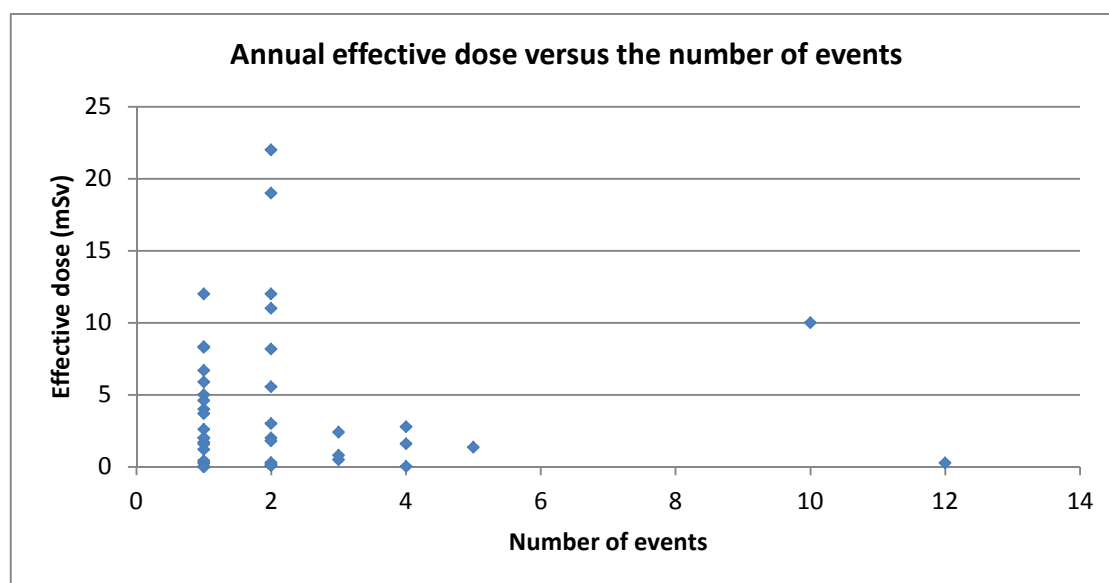


FIG. I.16. Annual occupational dose (2009) versus the total number of events (accidents, near misses and deviations) reported by the operator in the questionnaire for the last 5 years. There was no correlation. Note, the data point for one operator who reported 102 events was excluded from the graph.

Table I.21a. Annual occupational effective doses for 2009 analysed on the basis of whether operators said that they had or not had accidents, near misses or deviations in the last 5 years.

	Annual occupational effective dose, 2009 (mSv)							
	All events		Accidents only		Near misses only		Deviations only	
	None	≥ 1 event	None	≥ 1 event	None	≥ 1 event	None	≥ 1 event
No. of data	186	43	225	6	211	19	199	30
Mean	3.3	4.1	3.4	3.0	3.5	3.4	3.4	4.0
Std dev	4.7	5.1	4.8	3.0	4.7	5.1	4.7	4.9
Min	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0
Q1	0.2	0.4	0.3	0.9	0.2	0.9	0.3	0.3
Median	1.7	2.0	1.7	2.7	1.7	2.0	1.8	1.7
Q3	4.6	5.7	4.7	3.7	4.9	2.9	4.5	6.4
Max	30.0	22.0	30.0	8.3	30.0	22.0	30.0	19.0

Table I.21b. The highest monthly occupational effective dose in 2009 analysed on the basis of whether operators said that they had or not had accidents, near misses or deviations in the last 5 years.

	Highest monthly effective dose in 2009 (mSv)							
	All events		Accidents only		Near misses only		Deviations only	
	None	≥ 1 event	None	≥ 1 event	None	≥ 1 event	None	≥ 1 event
No. of data	144	33	173	5	164	14	153	24
Mean	1.4	1.2	1.3	1.0	1.4	0.9	1.4	1.1
Std dev	3.3	1.4	3.0	0.8	3.1	1.3	3.2	1.3
Min	0.0	0.0	0.0	0.01	0.0	0.01	0.0	0.0
Q1	0.1	0.2	0.1	0.7	0.1	0.2	0.1	0.3
Median	0.5	0.5	0.5	0.7	0.5	0.4	0.5	0.5
Q3	1.3	1.8	1.4	1.1	1.4	0.9	1.3	1.6
Max	32.0	4.9	32.0	2.2	32.0	4.9	32.0	4.8

Table I.21c. Occupational dose per exposure analysed on the basis of whether operators said that they had or not had accidents, near misses or deviations in the last 5 years.

	Occupational dose per exposure (µSv/exp)							
	All events		Accidents only		Near misses only		Deviations only	
	None	≥ 1 event	None	≥ 1 event	None	≥ 1 event	None	≥ 1 event
No. of data	115	23	136	3	128	11	122	16
Mean	3.8	5.6	4.0	9.9	4.3	1.6	3.9	5.9
Std dev	10.7	14.4	11.3	15.6	11.8	1.5	10.6	16.3
Min	0.0	0.05	0.0	0.2	0.0	0.2	0.0	0.05
Q1	0.2	0.3	0.3	-	0.2	0.3	0.2	0.4
Median	0.9	0.6	0.9	1.5	0.9	1.4	1.0	0.6
Q3	2.4	2.2	2.4	-	2.4	2.5	2.4	2.2
Max	100.0	65.5	100.0	27.8	100.0	4.5	100.0	65.5

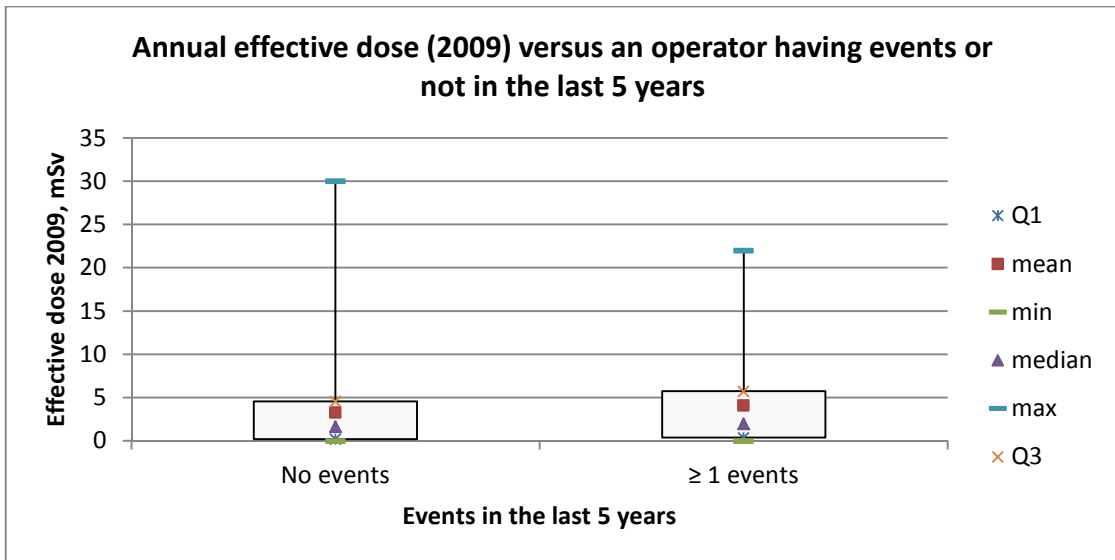


FIG. I.17. Distribution statistics for the annual occupational effective doses for 2009 analysed on the basis of whether operators said that they had or not had any events (accidents, near misses or deviations) in the last 5 years. Data are from Table I.21a.

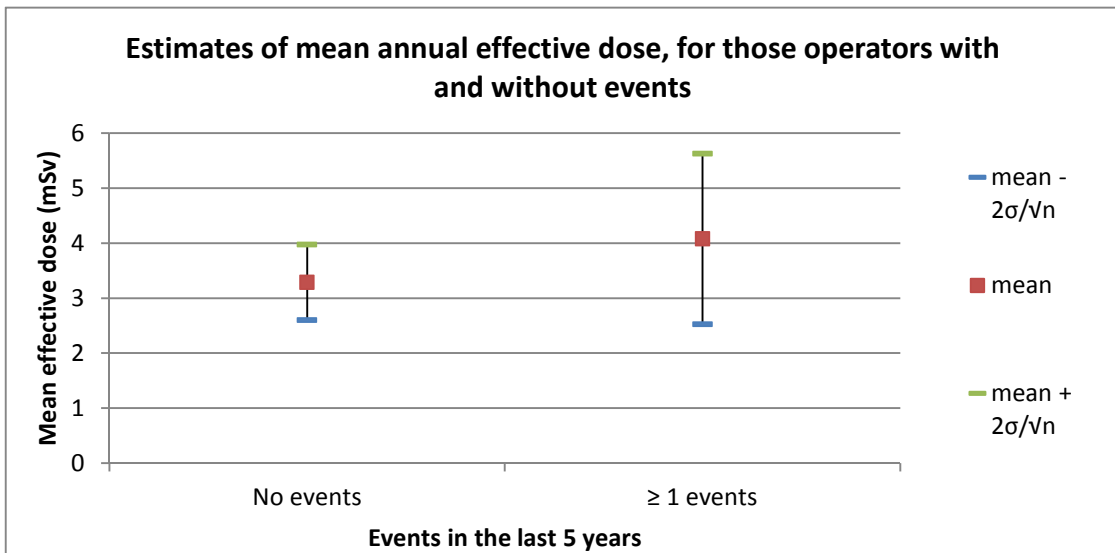


FIG. I.18. Estimates of mean annual effective dose as a function of whether operators said that they had or not had any events (accidents, near misses or deviations) in the last 5 years. The bars are two times the standard error for the mean estimates. There was no statistically significant difference between the means of the distributions for those that said they had had no events and those that said that had had some events.

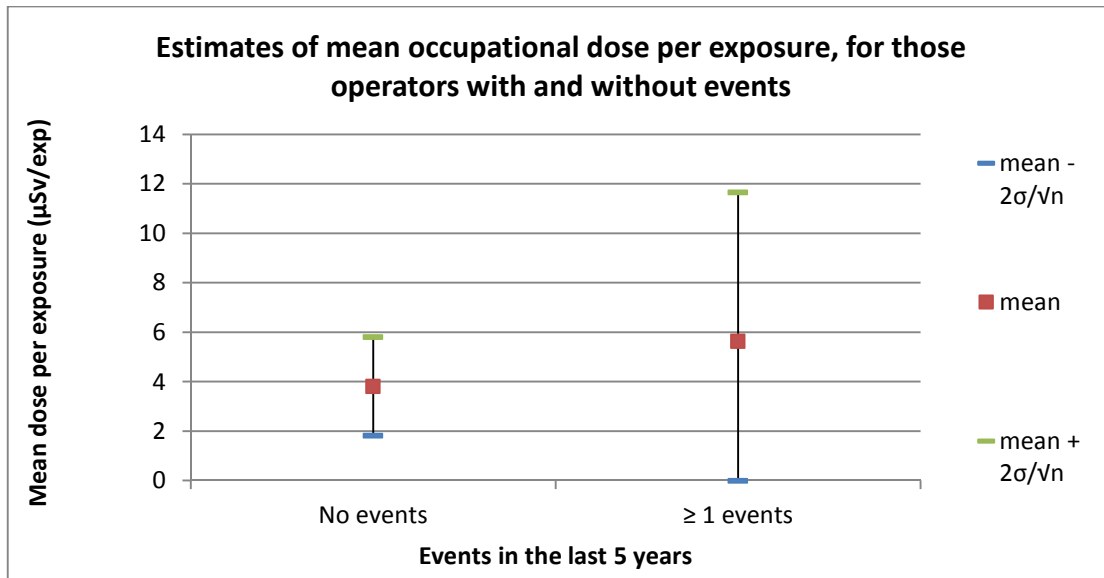


FIG. I.19. Estimates of mean occupational dose per exposure as a function of whether operators said that they had or not had any events (accidents, near misses or deviations) in the last 5 years. The bars are two times the standard error for the mean estimates. There was no statistically significant difference between the means of the distributions for those that said they had had no events and those that said that had had some events.

APPENDIX II. DETAILED RESULTS OF THE QUESTIONNAIRE ON OCCUPATIONAL EXPOSURE IN INDUSTRIAL RADIOGRAPHY ADDRESSED TO OPERATING COMPANIES

The principal findings from the NDT Company questionnaire are given in the Results section of the main text. Appendix II gives additional data in the form of tables and figures. Note, not all questions were answered by all responders. The abbreviation RP is often used for “radiation protection”.

II.1. NUMBER OF NDT COMPANY RESPONSES

Table II.0. Details of responses to the NDT Company questionnaire:

	Number of NDT Companies	Number of countries
Africa	7	4
Asia-Pacific	33	6
Europe	28	13
Latin America	19	4
North America	8	2
Global	95	29

II.2. QUALIFICATIONS & TRAINING OF INDUSTRIAL RADIOGRAPHERS IN RADIATION PROTECTION

Table II.1. Responses to Question 1 – Does your Company provide or facilitate radiation protection training for its radiographers?

	Yes	No	Don't know	No reply	Total
Africa	7	0	0	0	7
Asia-Pacific	33	0	0	0	33
Europe	26	2	0	0	28
Latin America	19	0	0	0	19
North America	8	0	0	0	8
Global	93	2	0	0	95

Table II.1a(i). Responses to Question 1a(i) – If yes to Question 1, what kind of radiation protection training do you provide to your operators – within the Company, initial training, **theory**:

	Yes	No	Duration of initial training, theory, within the NDT company (hours)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	3	4	3	14.0	8		10		24
Asia-Pacific	26	7	26	12.7	1	2	8	19	48
Europe	15	11	15	7.3	1	2	4	8	30
Latin America	16	3	15	55.3	4	26	60	80	160
North America	7	1	7	14.1	3	4	8	20	40
Global	67	26	66	21.3	1	3	8	30	160

Note: As per the questionnaire instructions, an unmarked option was interpreted as a “no” response.

Table II.1a(ii). Responses to Question 1a(ii) – If yes to Question 1, what kind of radiation protection training do you provide to your operators – within the Company, initial training, **practical**:

	Yes	No	Duration of initial training, practical, within the NDT company (hours)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	3	4	3	10.7	6		10		16
Asia-Pacific	23	10	23	13.1	1	2	8	20	48
Europe	16	10	16	17.5	2	2	6	30.5	100
Latin America	15	4	14	24.2	2	9.8	20	35.0	80
North America	7	1	7	49.0	1	6	10	10	300
Global	64	29	63	20.6	1	2.5	8	22	300

Note: As per the questionnaire instructions, an unmarked option was interpreted as a “no” response.

Table II.1a(iii). Responses to Question 1a(iii) – If yes to Question 1, what kind of radiation protection training do you provide to your operators – within the Company, refresher training, **theory**:

	Yes	No	Duration of refresher training, theory, within the NDT company (hours)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	2	5	2	10.5	5		10.5		16
Asia-Pacific	18	15	17	8.5	1	4	8	8	24
Europe	17	9	17	4.6	1	1.5	3	4	30
Latin America	18	1	17	17.2	2	4	10	20	80
North America	6	2	6	3.7	1	2.3	3.5	4	8
Global	61	32	59	9.5	1	3	4	9	80
	Yes	No	Interval between refresher training, theory, within the NDT company (months)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	2	5	2	30.0	12		30		48
Asia-Pacific	18	15	15	9.8	1	3	6	12	36
Europe	17	9	15	19.4	3	12	12	24	60
Latin America	18	1	14	8.6	6	6	6	12	12
North America	6	2	5	10.8	6	12	12	12	12
Global	61	32	51	13.2	1	6	12	12	60

Note: As per the questionnaire instructions, an unmarked option was interpreted as a “no” response.

Table II.1a(iv). Responses to Question 1a(iv) – If yes to Question 1, what kind of radiation protection training do you provide to your operators – within the Company, refresher training, **practical**:

	Yes	No	Duration of refresher training, practical, within the NDT company (hours)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	1	6	1	5.0			5		
Asia-Pacific	14	19	13	7.8	1	2	8	8	24
Europe	12	14	11	5.2	1	2	2	3.5	30
Latin America	15	4	13	14.3	2	4	6	16	80
North America	4	4	3	2.3	1		1		5
Global	46	47	41	8.7	1	2	4	8	80
	Yes	No	Interval between refresher training, practical, within the NDT company (months)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	1	6	1	12.0			12		
Asia-Pacific	14	19	11	7.5	1	3	8	12	12
Europe	12	14	10	16.5	3	12	12	12	60
Latin America	15	4	10	9.0	6	6	9	12	12
North America	4	4	4	6.0	3	3	4.5	7.5	12
Global	46	47	36	10.4	1	6	12	12	60

Note: As per the questionnaire instructions, an unmarked option was interpreted as a “no” response.

Table II.1a(v). Responses to Question 1a(v) – If yes to Question 1, what kind of radiation protection training do you provide to your operators – outside the Company, initial training, **theory**:

	Yes	No	Duration of initial training, theory, outside the NDT company (hours)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	3	4	3	35.0	20		40		45
Asia-Pacific	19	14	18	26.9	1	8	20	40	80
Europe	22	4	21	27.0	5	20	30	35	46
Latin America	10	9	10	45.0	16	21	47.5	58.8	80
North America	6	2	6	38.3	30	40	40	40	40
Global	60	33	58	31.7	1	17	30	40	80

Note: As per the questionnaire instructions, an unmarked option was interpreted as a “no” response.

Table II.1a(vi). Responses to Question 1a(vi) – If yes to Question 1, what kind of radiation protection training do you provide to your operators – outside the Company, initial training, **practical**:

	Yes	No	Duration of initial training, practical, outside the NDT company (hours)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	2	5	2	42.5	40	41.3	42.5	43.8	45
Asia-Pacific	16	17	15	26.2	1	2.5	20.0	48.0	80
Europe	17	9	16	14.1	2	7.5	8.0	16.0	40
Latin America	6	13	6	33.5	6	20.0	20.0	46.3	80
North America	3	5	3	17.3	2	6.0	10.0	25.0	40
Global	44	49	42	22.8	1	6.0	15.0	40.0	80

Note: As per the questionnaire instructions, an unmarked option was interpreted as a “no” response.

Table II.1a(vii). Responses to Question 1a(vii) – If yes to Question 1, what kind of radiation protection training do you provide to your operators – outside the Company, refresher training, **theory**:

	Yes	No	Duration of refresher training, theory, outside the NDT company (hours)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	2	5	2	32.0	24		32		40
Asia-Pacific	22	11	21	13.7	1	8	16	16	24
Europe	18	9	17	9.2	2	6	8	10	21
Latin America	6	13	6	27.8	6	17	20	23.8	80
North America	0	8	0						
Global	48	46	46	14.7	1	8	15	19	80
	Yes	No	Interval between refresher training, theory, outside the NDT company (months)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	2	5	1	60.0			60		
Asia-Pacific	22	11	17	21.0	1	12	24	24	36
Europe	17	9	13	54.2	20	60	60	60	60
Latin America	6	13	6	21.0	6	15	24	24	36
North America	0	8	0						
Global	47	46	37	33.7	1	24	24	60	60

Note: As per the questionnaire instructions, an unmarked option was interpreted as a “no” response.

Table II.1a(viii). Responses to Question 1a(viii) – If yes to Question 1, what kind of radiation protection training do you provide to your operators – outside the Company, refresher training, **practical**:

	Yes	No	Duration of refresher training, practical, outside the NDT company (hours)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	1	6	1	24.0				24	
Asia-Pacific	13	20	11	18.9	1	3	8	18	80
Europe	10	16	10	5.5	1	2	4	8	14
Latin America	5	14	5	26.4	6	6	20	20	80
North America	0	8	0						
Global	29	64	27	15.5	1	3	8	18	80
	Yes	No	Interval between refresher training, practical, outside the NDT company (months)						
			Data	Mean	min	Q1	Median	Q3	Max
Africa	1	6	1	60.0			60		
Asia-Pacific	13	20	8	15.4	1	5	9	24	48
Europe	10	16	8	55.5	24	60	60	60	60
Latin America	5	14	5	20.4	6	12	24	24	36
North America	0	8	0						
Global	29	64	22	33.1	1	12	24	60	60

Table II.1a(ix). Combining responses to Question 1a to give number of NDT companies that provide initial training, either by internal arrangements or externally or both

	Initial theory training in RP			Initial practical training in RP			Total responses
	Within OR Outside Company	Within AND Outside Company	Neither	Within OR Outside Company	Within AND Outside Company	Neither	
Africa	6	0	1	5	0	2	7
Asia-Pacific	30	15	3	27	12	6	33
Europe	26	11	0	21	12	5	26
Latin America	19	7	0	16	5	3	19
North America	8	5	0	7	3	1	8
Global	89	38	4	76	32	17	93

Table II.1a(x). Combining responses to Question 1a to give number of NDT companies that provide refresher training, either by internal arrangements or externally or both

	Refresher theory training in RP			Refresher practical training in RP			Total responses
	Within OR Outside Company	Within AND Outside Company	Neither	Within OR Outside Company	Within AND Outside Company	Neither	
Africa	4	0	3	2	0	5	7
Asia-Pacific	26	14	7	18	9	15	33
Europe	23	12	3	15	7	11	26
Latin America	18	6	1	15	5	4	19
North America	6	0	2	4	0	4	8
Global	77	32	16	54	21	39	93

Table II.1a(xi). Combining responses to Question 1a to give total hours on initial training, **theory**.

	Total duration of initial training, theory (hours)						
	Data	Mean	min	Q1	Median	Q3	Max
Africa	6	24.5	8	12.5	22.0	36.0	45
Asia-Pacific	30	27.1	1	6.5	19.5	44.0	80
Europe	25	27.1	1	18.0	29.0	36.0	46
Latin America	19	67.3	4	47.5	65.0	80.0	160
North America	8	41.1	8	40.0	43.5	45.5	60
Global	88	36.9	1	15.8	31.0	48.5	160

Table II.1a(xii). Combining responses to Question 1a to give total hours on initial training, **practical**.

	Total duration of initial training, practical (hours)						
	Data	Mean	min	Q1	Median	Q3	Max
Africa	5	23.4	6	10	16	40	45
Asia-Pacific	27	25.7	1	4	16	29.5	104
Europe	21	24.1	2	8	16	32	100
Latin America	15	36.0	2	13.5	20	40	160
North America	7	56.4	1	7	10	35	300
Global	75	30.0	1	8	16	40	300

Table II.1a(xiii). Combining responses to Question 1a to give total hours on refresher training per 5 years, **theory**.

	Total duration of refresher training per 5 years, theory (hours)						
	Data	Mean	min	Q1	Median	Q3	Max
Africa	3	23.0					
Asia-Pacific	21	126.7	10	40	40	120	900
Europe	18	22.8	5	10	16	22	85
Latin America	15	170.1	20	43	80	217	800
North America	5	22.0					
Global	62	93.5	5	18	40	80	900

Table II.1a(xiv). Combining responses to Question 1a to give total hours on refresher training per 5 years, **practical**.

	Total duration of refresher training per 5 years, practical (hours)						
	Data	Mean	min	Q1	Median	Q3	Max
Africa	2	24.5					
Asia-Pacific	12	113.3	10	35	50	123	570
Europe	12	20.0	2	9	17	21	80
Latin America	10	170.3	20	40	60	205	800
North America	3	21.7					
Global	39	87.6	2	20	30	78	800

Table II.1b. Responses to Question 1b – If yes to Question 1, do you provide different radiation protection training for gamma sources and for X-ray sources?

	Yes	No	Don't know	No reply	Total
Africa	4	3	0	0	7
Asia-Pacific	20	13	0	0	33
Europe	10	16	0	0	26
Latin America	13	6	0	0	19
North America	2	5	0	1	8
Global	49	43	0	1	93

Table II.1c(i). Responses to Question 1c(i) – If yes to Question 1, does your training include the following subjects on emergency preparedness and response – emergency procedures?

	Yes	No	Don't know	No reply	Total
Africa	6	0	0	1	7
Asia-Pacific	33	0	0	0	33
Europe	24	2	0	0	26
Latin America	19	0	0	0	19
North America	8	0	0	0	8
Global	90	2	0	1	93

Table II.1c(ii). Responses to Question 1c(ii) – If yes to Question 1, does your training include the following subjects on emergency preparedness and response – practical exercises for creating a safe situation?

	Yes	No	Don't know	No reply	Total
Africa	4	2	0	1	7
Asia-Pacific	29	4	0	0	33
Europe	18	8	0	0	26
Latin America	18	1	0	0	19
North America	8	0	0	0	8
Global	77	15	0	1	93

Table II.1c(iii). Responses to Question 1c(iii) – If yes to Question 1, does your training include the following subjects on emergency preparedness and response – practical exercises for source recovery?

	Yes	No	Don't know	No reply	Total
Africa	3	3	0	1	7
Asia-Pacific	27	5	0	1	33
Europe	12	14	0	0	26
Latin America	14	5	0	0	19
North America	4	4	0	0	8
Global	60	31	0	2	93

Table II.2(i). Responses by NDT Companies to Question 2 – Is radiation protection training included as part of NDT training in Radiographic Testing in your country?

	Yes	No	Don't know	Total
NDT Level 1				
Africa	5	0	2	7
Asia-Pacific	30	2	1	33
Europe	18	7	3	28
Latin America	15	3	1	19
North America	8	0	0	8
Global	76	12	7	95
NDT Level 2				
Africa	4	1	2	7
Asia-Pacific	23	7	3	33
Europe	19	7	2	28
Latin America	12	6	1	19
North America	7	1	0	8
Global	65	22	8	95
NDT Level 3				
Africa	2	3	2	7
Asia-Pacific	14	15	4	33
Europe	14	11	3	28
Latin America	7	9	3	19
North America	3	4	1	8
Global	40	42	13	95

Table II.2(ii). Combined responses per country to Question 2 – Is radiation protection training included as part of NDT training in Radiographic Testing in your country?

	Yes	No	Don't know	Contradictory*	Total
NDT Level 1					
Africa	3	0	1	0	4
Asia-Pacific	5	0	0	1	6
Europe	6	0	2	5	13
Latin America	3	0	0	1	4
North America	2	0	0	0	2
Global	19	0	3	7	29
NDT Level 2					
Africa	2	1	1	0	4
Asia-Pacific	4	0	0	2	6
Europe	8	0	1	4	13
Latin America	2	0	0	2	4
North America	1	0	0	1	2
Global	17	1	2	9	29
NDT Level 3					
Africa	0	2	1	1	4
Asia-Pacific	2	2	0	2	6
Europe	6	1	2	4	13
Latin America	1	1	0	2	4
North America	0	1	0	1	2
Global	9	7	3	10	29

* Note. Contradictory means that some NDT companies answered “yes”, while others from the same country said “no”.

Table II.2a. Responses to Question 2a – If yes to to any of Question 2, does your Company provide or facilitate the radiation protection training that you detailed in Questions 1a,b,c, in addition to this NDT radiation protection training?

	Yes	No	Don't know	No reply	Total
Africa	4	0	0	1	5
Asia-Pacific	30	1	0	1	32
Europe	14	3	2	1	20
Latin America	15	1	0	0	16
North America	7	1	0	0	8
Global	70	6	2	3	81

II.3. LEARNING FROM INCIDENTS (DEVIATIONS FROM NORMAL, NEAR MISSES AND ACCIDENTS)

Table II.3a. Responses to Question 3 – How many radiation incidents occurred in your Company during the last five years?

	Replies	No. with "no events"	Total no. of events	Mean	Min	Q1	Median	Q3	Max	No reply
Number of accidents with individual exposures higher than the annual limits										
Africa	5	5	0	0.00	0	0	0	0	0	2
Asia-Pacific	29	26	6	0.21	0	0	0	0	4	4
Europe	27	24	5	0.19	0	0	0	0	3	1
Latin America	17	17	0	0.00	0	0	0	0	0	2
North America	8	8	0	0.00	0	0	0	0	0	0
Global	86	80	11	0.13	0	0	0	0	4	9
Number of accidents with elevated individual exposures lower than the annual limit										
Africa	5	5	0	0.00	0	0	0	0	0	2
Asia-Pacific	29	25	13	0.45	0	0	0	0	6	4
Europe	27	22	47	1.74	0	0	0	0	35	1
Latin America	17	13	9	0.53	0	0	0	0.3	4	2
North America	8	7	13	1.63	0	0	0	0	13	0
Global	86	72	82	0.95	0	0	0	0	35	9
Number of near misses that had the potential for elevated individual exposures higher than the annual limit										
Africa	5	5	0	0.00	0	0	0	0	0	2
Asia-Pacific	27	25	3	0.11	0	0	0	0	2	6
Europe	27	23	19	0.69	0	0	0	0	10	1
Latin America	17	15	2	0.12	0	0	0	0	1	2
North America	8	6	36	4.50	0	0	0	0.5	34	0
Global	84	74	60	0.71	0	0	0	0	34	11
Number of near misses that had the potential for elevated individual exposure lower than the annual limit										
Africa	5	4	1	0.20	0	0	0	0.0	1	2
Asia-Pacific	27	25	6	0.22	0	0	0	0	4	6
Europe	27	14	36	1.31	0	0	0	1.8	15	1
Latin America	18	13	9	0.50	0	0	0	1	2	1
North America	8	4	38	4.75	0	0	1	3.3	27	0
Global	85	60	90	1.05	0	0	0	1	27	10
Number of other deviations from normal operations										
Africa	5	5	0	0.00	0	0	0.0	0.0	0	2
Asia-Pacific	26	25	36	1.38	0	0	0.0	0.0	36	7
Europe	22	17	69	3.14	0	0	0.0	0.0	52	6
Latin America	17	13	20	1.18	0	0	0.0	0.0	12	2
North America	8	4	15	1.88	0	0	0.5	1.5	10	0
Global	78	64	140	1.79	0	0	0.0	0.0	52	17

Table II.3a(i). Further analysis of combined responses to Question 3a.

	No accident, near miss or deviation	One or more events of any kind	No reply	Total
Africa	4	1	2	7
Asia-Pacific	24	5	4	33
Europe	11	16	1	28
Latin America	10	8	1	19
North America	3	5	0	8
Global	52	35	8	95

Table II.3b. Further analysis of responses to Question 3, giving data on the number of NDT companies reporting that they had had no radiation incidents in their Company during the last five years.

	Zero accidents		Zero near misses		Zero deviations	
	Number of NDT Companies	%	Number of NDT Companies	%	Number of NDT Companies	%
Africa	5	100	4	80	5	100
Asia-Pacific	25	86	24	89	25	96
Europe	22	81	14	52	17	77
Latin America	13	81	13	76	13	76
North America	7	88	4	50	4	50
Global	72	85	59	70	64	82

Table II.3c. From the responses to Question 3, the derived number of radiation incidents per industrial radiographer during the last five years?

	Average number of events per industrial radiographer per 5 years:				
	Accidents with individual exposures higher than the annual limits	Accidents with individual exposures lower than the annual limits	Near misses with the potential for elevated individual exposures higher than the annual limit	Near misses with the potential for elevated individual exposures lower than the annual limit	Other deviations from normal operations
Africa	0.000	0.000	0.000	0.029	0.000
Asia-Pacific	0.008	0.019	0.005	0.009	0.056
Europe	0.004	0.039	0.015	0.029	0.057
Latin America	0.000	0.018	0.004	0.016	0.041
North America	0.000	0.021	0.057	0.061	0.024
Global	0.003	0.027	0.020	0.030	0.047

Table II.3d. Accidents, near misses and deviation from normal per NDT Company per 5 years, based on the operator responses to Question 8 of the Operator Questionnaire, scaled by the ratio of the number of operators in the NDT Company to the number of responding operators.

	Number of NDT Companies represented	Average number of events per NDT Company per 5 years		
		Deviations from normal	Near misses	Accidents
Africa	4	0.0	2.3	0.0
Asia-Pacific	22	31.3	4.5	9.1
Europe	20	29.1	4.3	0.0
Latin America	13	6.7	6.0	1.4
North America	4	121.4	29.2	8.3
Global	63	29.3	6.2	4.0

Note: There were 63 NDT companies where data were known for: the number of industrial radiographers at the company, the company statistics on the number of events in the last 5 years, and at least one industrial radiographer from the company who had provided statistics on their number of events in the last 5 years. In most of these cases, there were zero events, but for the small number of cases where events had occurred (6 for deviations, 7 for near misses, and 4 for accidents) there was no agreement between the company statistics and the scaled operators statistics. (The operator statistics were scaled by the total number of operators in the company divided by the number of operators that provided event statistics). This is perhaps not surprising given that the scaling factor ranged from 1 to over 100, with an average of 62, coupled with the small number of events for a given operator. Further analysis is given in the next table.

Table II.3e. Comparison of estimates of accidents, near misses and deviations from normal per NDT Company per 5 years, based on: 1. All the valid NDT Company responses; 2. NDT Company responses that also gave total number of operators; 3. NDT Company responses that also gave total number of operators and had at least one operator who responded to the operator questionnaire; 4. Operator responses to Question 8 of the Operator Questionnaire, scaled by the ratio of the number of operators in the NDT Company to the number of responding operators.

	Accidents per NDT Company per 5 years							
	All NDT companies		NDT companies with operator nos		NDT companies with operator nos and operators that also responded		Scaled responses from operators at NDT companies	
	No of data	Mean	No of data	Mean	No of data	Mean	No of data	Mean
Africa	5	0.0	5	0.0	4	0.0	4	0.0
Asia-Pacific	29	0.7	22	0.8	22	0.8	22	9.1
Europe	27	1.9	27	1.9	20	2.4	20	0.0
Latin America	16	0.6	17	0.5	13	0.7	13	1.4
North America	8	1.6	8	1.6	4	3.3	4	8.3
Global	85	1.1	79	1.2	63	1.4	63	4.0
	Near misses per NDT Company per 5 years							
	All NDT companies		NDT companies with operator nos		NDT companies with operator nos and operators that also responded		Scaled responses from operators at NDT companies	
	No of data	Mean	No of data	Mean	No of data	Mean	No of data	Mean
Africa	5	0.2	5	0.2	4	0.3	4	2.3
Asia-Pacific	27	0.3	21	0.4	21	0.4	22	4.5
Europe	27	2.0	27	2.0	20	1.3	20	4.3
Latin America	17	0.7	17	0.6	13	0.6	13	6.0
North America	8	9.3	8	9.3	4	15.8	4	29.2
Global	84	1.8	78	1.9	62	1.7	63	6.2
	Deviations from normal per NDT Company per 5 years							
	All NDT companies		NDT companies with operator nos		NDT companies with operator nos and operators that also responded		Scaled responses from operators at NDT companies	
	No of data	Mean	No of data	Mean	No of data	Mean	No of data	Mean
Africa	5	0.0	5	0.0	4	0.0	4	0.0
Asia-Pacific	26	1.4	20	1.8	20	1.8	22	31.3
Europe	22	3.1	22	3.1	16	4.3	20	29.1
Latin America	17	1.2	17	1.2	13	1.5	13	6.7
North America	8	1.9	8	1.9	4	3.0	4	121.4
Global	78	1.8	72	1.9	57	2.4	63	29.3

Table II.4. Responses to Questions 4a to e – How many radiation incidents did your Company report to the regulatory body in the last five years?

	Number of reported accidents with individual exposures higher than the annual limits								No reply
	Replies	Total	Mean	Min	Q1	Median	Q3	Max	
Africa	7	0	0.00	0	0	0	0	0	0
Asia-Pacific	27	6	0.22	0	0	0	0	4	6
Europe	25	5	0.20	0	0	0	0	3	3
Latin America	16	0	0.00	0	0	0	0	0	3
North America	8	0	0.00	0	0	0	0	0	0
Global	83	11	0.13	0	0	0	0	4	12
	Number of reported accidents with elevated individual exposures lower than the annual limit								No reply
	Replies	Total	Mean	Min	Q1	Median	Q3	Max	
Africa	7	0	0.00	0	0	0	0	0	0
Asia-Pacific	27	13	0.48	0	0	0	0	6	6
Europe	25	22	0.88	0	0	0	0	15	3
Latin America	16	9	0.56	0	0	0	0.25	4	3
North America	8	13	1.63	0	0	0	0	13	0
Global	83	57	0.69	0	0	0	0	15	12
	Number of reported near misses that had the potential for elevated individual exposures higher than the annual limit								No reply
	Replies	Total	Mean	Min	Q1	Median	Q3	Max	
Africa	7	0	0.00	0	0	0	0	0	0
Asia-Pacific	25	3	0.12	0	0	0	0	2	8
Europe	25	3	0.12	0	0	0	0	2	3
Latin America	16	0	0.00	0	0	0	0	0	3
North America	8	10	1.25	0	0	0	0	10	0
Global	81	16	0.20	0	0	0	0	10	14
	Number of reported near misses that had the potential for elevated individual exposure lower than the annual limit								No reply
	Replies	Total	Mean	Min	Q1	Median	Q3	Max	
Africa	7	0	0.00	0	0	0	0	0	0
Asia-Pacific	25	2	0.08	0	0	0	0	2	8
Europe	25	9	0.36	0	0	0	0	2	3
Latin America	17	3	0.18	0	0	0	0	2	2
North America	8	6	0.75	0	0	0	0	6	0
Global	82	20	0.24	0	0	0	0	6	13
	Number of reported other deviations from normal operations								No reply
	Replies	Total	Mean	Min	Q1	Median	Q3	Max	
Africa	7	0	0.00	0	0	0	0	0	0
Asia-Pacific	24	2	0.08	0	0	0	0	2	9
Europe	23	12	0.52	0	0	0	0	10	5
Latin America	17	3	0.18	0	0	0	0	2	2
North America	8	4	0.50	0	0	0	1	2	0
Global	79	21	0.27	0	0	0	0	10	16

- Note: 1. The 11 reported accidents with individual exposures higher than the dose limits were from 6 NDT companies.
2. The 57 reported accidents with elevated individual exposures lower than the dose limits were from 13 NDT companies.
3. The 16 reported near misses that had the potential for individual exposures higher than the dose limits were from 5 NDT companies.
4. The 20 reported near misses that had the potential for individual exposures lower than the dose limits were from 10 NDT companies.
5. The 21 reported other deviations from normal were from 9 NDT companies.

Table II.5. Responses to Question 5 – Did your (radiation protection) Regulatory Body report the radiation incidents to the IAEA?

	Yes	No	Don't know	Not applicable	Total
Africa	0	0	0	7	7
Asia-Pacific	1	0	4	28	33
Europe	0	1	10	17	28
Latin America	0	0	7	12	19
North America	0	1	2	5	8
Global	1	2	23	69	95

Notes:

1. The responses to this question are dominated by “don't know” and “not applicable”. This is perhaps not surprising as the question asks about knowledge about another organization's activities and, further, most NDT companies had not reported incidents.
2. Notifications to the IAEA can be to two different parts of the Agency – those that report incidents which involved exposure which would be reported to the Incident and Emergency Centre (IEC); and those that involved loss of control of a source which would be reported to the illicit trafficking database. No independent collaboration was able to be made for individual responses.
3. The IEC had had 41 notifications of industrial radiography incidents involving exposure in the last 5 years.

Table II.6. Responses to Question 6 – How does your Company receive information about abnormal individual exposures of its radiographers?

	From the radiographers (e.g. based on the readout of their active dosimeters)?		
	Yes	No	Total
Africa	4	3	7
Asia-Pacific	15	17	32
Europe	19	8	27
Latin America	11	8	19
North America	6	2	8
Global	55	38	93
	From the NDT company's own personal dosimetry service (e.g. based on active dosimeters)?		
	Yes	No	Total
Africa	1	6	7
Asia-Pacific	11	21	32
Europe	4	23	27
Latin America	8	11	19
North America	3	5	8
Global	27	66	93
	From your third-party dosimetry service (based on readout of passive dosimeters)?		
	Yes	No	Total
Africa	5	2	7
Asia-Pacific	19	13	32
Europe	22	5	27
Latin America	15	4	19
North America	7	1	8
Global	68	25	93
	From the regulatory body (based on readout of passive dosimeters)?		
	Yes	No	Total
Africa	1	6	7
Asia-Pacific	17	15	32
Europe	16	11	27
Latin America	5	14	19
North America	1	7	8
Global	40	53	93
	From another source?		
	Yes	No	Total
Africa	0	7	7
Asia-Pacific	0	33	32
Europe	3	25	27
Latin America	2	17	19
North America	0	8	8
Global	5	88	93

Notes: 1. In line with the questionnaire instructions, an option that was not selected was interpreted as being a “no”.

Two NDT companies gave no responses.

2. The 5 responses for “Another source”, were variations on company provisional dosimetry.

3. 2 NDT companies gave no response to this question.

4. 30 companies indicated 1 method only; 34 used 2 methods; and 22 used 3 methods.

5. Not surprisingly the vast majority of approaches (85 out of 93) utilized combinations of operator and company active dosimetry and passive dosimetry from the personal dosimetry provider.

Table II.7. Responses to Question 7 – How does your Company share information about radiation incidents within your organization?

	Yes	No	Total
	Safety meetings?:		
Africa	5	0	5
Asia-Pacific	32	0	32
Europe	21	7	28
Latin America	16	2	18
North America	8	0	8
Global	82	9	91
	Notice boards?:		
Africa	2	3	5
Asia-Pacific	14	18	32
Europe	6	22	28
Latin America	3	15	18
North America	4	4	8
Global	29	62	91
	Company magazine?:		
Africa	1	4	5
Asia-Pacific	1	31	32
Europe	3	25	28
Latin America	0	18	18
North America	1	7	8
Global	6	85	91
	Company intranet?:		
Africa	1	4	5
Asia-Pacific	6	26	32
Europe	4	24	28
Latin America	4	14	18
North America	1	7	8
Global	16	75	91
	Email?:		
Africa	2	3	5
Asia-Pacific	12	20	32
Europe	13	15	28
Latin America	7	11	18
North America	4	4	8
Global	38	53	91
	Other means?:		
Africa	2	3	5
Asia-Pacific	3	29	32
Europe	6	22	28
Latin America	7	11	18
North America	2	6	8
Global	20	71	91

Notes: 1. In line with the questionnaire instructions, an option that was not selected was interpreted as being a “no”.

There were 4 NDT companies with no responses to these questions.

2. “Other means” included training, circulars and industry websites or bulletins.

3. 4 NDT companies gave no response to all options in this question, implying that they do not share information.

4. 33 companies indicated 1 method only; 33 used 2 methods; and 15 used 3 methods.

5. Almost all NDT companies used safety meetings and/or email (84 out of 91).

Table II.8. Responses to Question 8 – How does your Company share information about radiation incidents with other organizations?

	International or National Incident Database:		
	Yes	No	Total
Africa	2	5	7
Asia-Pacific	5	21	26
Europe	5	19	24
Latin America	0	16	16
North America	2	6	8
Global	14	67	81
	Industry meetings:		
	Yes	No	Total
Africa	0	7	7
Asia-Pacific	15	11	26
Europe	6	18	24
Latin America	6	10	16
North America	4	4	8
Global	31	50	81
	Email:		
	Yes	No	Total
Africa	1	6	7
Asia-Pacific	12	14	26
Europe	4	20	24
Latin America	8	8	16
North America	1	7	8
Global	26	55	81
	Other means:		
	Yes	No	Total
Africa	1	6	7
Asia-Pacific	5	21	26
Europe	4	20	24
Latin America	7	9	16
North America	1	7	8
Global	18	63	81
	The Company does not share information:		
	Yes	No	Total
Africa	4	3	7
Asia-Pacific	2	24	26
Europe	10	14	24
Latin America	3	13	16
North America	3	5	8
Global	22	59	81

Notes: 1. In line with the questionnaire instructions, an option that was not selected was interpreted as being a “no”. 14 NDT companies gave no responses to this question.

2. The 18 “other means” included through training courses, regulatory body, NDT or radiation protection societies, and accident reports.

3. 14 NDT companies gave no response to this question.

4. 35 companies indicated 1 method only; 19 used 2 methods; and 4 used 3 methods.

II.4. SYSTEMS AND PROCEDURES IN PLACE FOR SAFE OPERATION

Table II.9a. Responses to Question 9a – With regard to individual monitoring, does your Company provide its radiographers with passive individual dosimeters?

	Yes	No	Total
Africa	6	1	7
Asia-Pacific	28	5	33
Europe	25	3	28
Latin America	18	1	19
North America	7	1	8
Global	84	11	95

Table II.9b. Responses to Question 9b – With regard to individual monitoring, does your Company provide its radiographers with active individual dosimeters?

	Yes	No	Total
Africa	5	2	7
Asia-Pacific	29	4	33
Europe	25	3	28
Latin America	15	4	19
North America	8	0	8
Global	82	13	95

Note: All NDT companies stated that they supplied at least one form of dosimeter. 72 out of 95 stated that they supplied both passive and active dosimeters.

Table II.9c. Responses to Question 9c – If yes to Question 9b, are the active individual dosimeters equipped with:

	Visual alarms?				Total
	All	Some	No	No reply	
Africa	2	1	2	0	5
Asia-Pacific	18	2	9	0	29
Europe	15	6	4	0	25
Latin America	3	6	6	0	15
North America	5	1	2	0	8
Global	43	16	23	0	82
	Audible alarms?				Total
	All	Some	No	No reply	
Africa	4	0	1	0	5
Asia-Pacific	22	5	2	0	29
Europe	25	0	0	0	25
Latin America	11	3	1	0	15
North America	8	0	0	0	8
Global	70	8	4	0	82
	Vibrating alarms?				Total
	All	Some	No	No reply	
Africa	0	0	5	0	5
Asia-Pacific	1	2	26	0	29
Europe	2	5	18	0	25
Latin America	1	0	14	0	15
North America	0	1	7	0	8
Global	4	8	70	0	82

Table II.10. Responses to Question 10 – Does your Company keep records of the occupational doses received by its radiographers?

	Yes	No	Don't know	No reply	Total
Africa	7	0	0	0	7
Asia-Pacific	33	0	0	0	33
Europe	28	0	0	0	28
Latin America	19	0	0	0	19
North America	8	0	0	0	8
Global	95	0	0	0	95

Table II.10a. Responses to Question 10a – If yes to Question 10, does your Company inform its radiographers of their personal doses?

	Yes	No	Don't know	No reply	Total
Africa	5	1	1	0	7
Asia-Pacific	31	0	0	2	33
Europe	27	1	0	0	28
Latin America	19	0	0	0	19
North America	8	0	0	0	8
Global	90	2	1	2	95

Table II.10b. Responses to Question 10b – Are there investigation levels for personal doses established by:

	Your Company?				
	Yes	No	Don't know	No reply	Total
Africa	5	1	1	0	7
Asia-Pacific	21	10	1	1	33
Europe	14	13	1	0	28
Latin America	10	9	0	0	19
North America	8	0	0	0	8
Global	58	33	3	1	95
	The regulatory body?				
	Yes	No	Don't know	No reply	Total
Africa	3	1	3	0	7
Asia-Pacific	22	4	1	6	33
Europe	22	3	2	1	28
Latin America	19	0	0	0	19
North America	6	0	2	0	8
Global	72	8	8	7	95

Table II.10c. Responses to Question 10c – If yes to either part of Question 10b, how many investigations have been performed by the Company in the last 5 years as a result of the investigation level being exceeded?

	Number of investigations by NDT Companies in 5 years								Number of investigations in 5 years per operator	
	Replies	Total	Mean	Min	Q1	Median	Q3	Max	Replies	Mean
Africa	6	6	1.0	0	0	1	2	2	5	0.45
Asia-Pacific	25	82	3.3	0	0	1	4	27	18	0.04
Europe	23	320	13.9	0	0	0	10	200	22	0.18
Latin America	17	231	13.6	0	0	1	20	56	15	0.27
North America	8	114	14.3	0	0.75	2	4.25	100	8	0.24
Global	79	753	9.5	0	0	1	5	200	68	0.19

Note: 37 of the 78 replies stated that they had performed no investigations – namely, 3, 11, 13, 8 and 2 for the regions Africa, Asia-Pacific, Europe, Latin America and North America, respectively.

Table II.10d(i). Responses to Question 10d – If yes to Question 10, can you please complete the following table giving numbers of workers whose annual individual effective doses in 2009 were in the following dose ranges:

	Number of workers with annual dose in 2009, D, in the dose bands:								
	Annual effective dose bands (mSv)								
	D<mdl*	mdl≤D<1	1≤D<5	5≤D<10	10≤D<15	15≤D<20	20≤D<30	30≤D<50	D≥50
Africa	13	3	4	0	0	0	0	1	0
Asia-Pacific	236	258	274	50	15	5	2	2	1
Europe	306	431	473	116	9	1	1	0	0
Latin America	190	118	130	19	11	2	1	2	0
North America	102	301	223	57	14	4	0	0	0
Global	847	1111	1104	242	49	12	4	5	1

* mdl = minimum detection limit of the personal dosimetry system.

1. 76 NDT companies provided dose data: 2, 21, 25, 18 and 7 from Africa, Asia-Pacific, Europe, Latin America and North America, respectively. Banded dose data were given for a total of 3375 industrial radiographers.

2. 1 NDT company stated that 2 workers exceeded 50 mSv in 2009, but gave no data for the other workers in the company, and hence are not included in the table.

Table II.10d(ii). Percentages of monitored industrial radiographers whose annual doses (D) in 2009 were in the following dose bands:

	Percentage of workers with annual dose in 2009, D, in the dose bands:								
	Annual effective dose bands (mSv)								
	D<mdl*	mdl≤D<1	1≤D<5	5≤D<10	10≤D<15	15≤D<20	20≤D<30	30≤D<50	D≥50
Africa	56.5	13.0	17.4	0.0	0.0	0.0	0.0	4.3	8.7
Asia-Pacific	28.0	30.6	32.5	5.9	1.8	0.6	0.2	0.2	0.1
Europe	22.9	32.2	35.4	8.7	0.7	0.1	0.1	0.0	0.0
Latin America	40.2	24.9	27.5	4.0	2.3	0.4	0.2	0.4	0.0
North America	14.6	42.9	31.8	8.1	2.0	0.6	0.0	0.0	0.0
Global	25.1	32.9	32.7	7.2	1.5	0.4	0.1	0.1	0.1

* mdl = minimum detection limit of the personal dosimetry system.

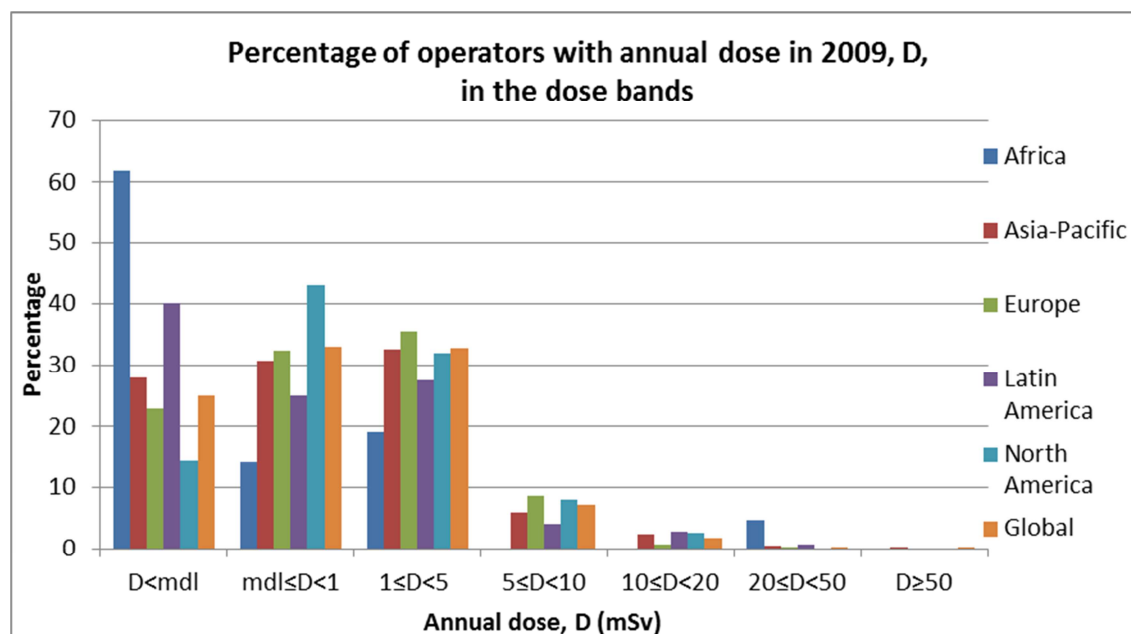


FIG. II.1. Results from Table II.10d(ii) giving percentages of industrial radiographers whose 2009 annual effective doses, D, were in the given dose bands, using the data from the NDT companies. Note, mdl = minimum detection limit of the personal dosimetry system.

Table II.11a-b. Responses to Question 11a&b – Does your Company provide any other monitoring or alarm devices?

	Survey meter?			
	Yes	No	No reply	Total
Africa	5	2	0	7
Asia-Pacific	30	2	1	33
Europe	24	4	0	28
Latin America	19	0	0	19
North America	8	0	0	8
Global	86	8	1	95
	Area monitor?			
	Yes	No	No reply	Total
Africa	4	3	0	7
Asia-Pacific	23	9	1	33
Europe	19	9	0	28
Latin America	15	4	0	19
North America	3	5	0	8
Global	64	30	1	95

Table II.11c. Responses to Question 11c – If yes to Question 11b, are the area monitors equipped with:

	Visual alarms?				
	All	Some	No	No reply	Total
Africa	2	2	0	0	4
Asia-Pacific	16	0	0	7	23
Europe	15	3	0	1	19
Latin America	10	2	2	1	15
North America	3	0	0	0	3
Global	46	7	2	9	64
	Audible alarms?				
	All	Some	No	No reply	Total
Africa	3	0	0	1	4
Asia-Pacific	16	3	1	3	23
Europe	15	3	1	0	19
Latin America	12	2	1	0	15
North America	3	0	0	0	3
Global	49	8	3	4	64

Note: In response to Question 11d, 2 NDTs responded that they supplied personal beepers.

Table II.12a. Responses to Question 12a – With regard to a warning system to prevent entry to the radiography site: At what dose rate does your Company require a warning system to be installed:

	Boundary dose rate ($\mu\text{Sv/hr}$)							No reply
	Replies	Mean	Min	Q1	Median	Q3	Max	
Africa	3	5.8	2.5	5	7.5	7.5	7.5	4
Asia-Pacific	29	5.7	0.3	2.5	2.5	7.5	25	4
Europe	20	15.1	0	0.5	4.3	25	60	8
Latin America	12	20.5	0.5	6.1	20	21.3	60	7
North America	6	32.1	2.5	20	22.5	25	100	2
Global	70	13.2	0	2.5	7.5	20	100	25

Table II.12b. Responses to Question 12b – What is used as a warning system for the work site:

	Ribbon or rope?			
	Yes	No	No reply	Total
Africa	3	3	1	7
Asia-Pacific	31	2	0	33
Europe	27	1	0	28
Latin America	15	4	0	19
North America	8	0	0	8
Global	84	10	1	95
	Passive warning signs?			
	Yes	No	No reply	Total
Africa	5	1	1	7
Asia-Pacific	24	9	0	33
Europe	22	6	0	28
Latin America	15	4	0	19
North America	5	3	0	8
Global	71	23	1	95
	Active warning signs?			
	Yes	No	No reply	Total
Africa	6	0	1	7
Asia-Pacific	26	7	0	33
Europe	17	11	0	28
Latin America	15	4	0	19
North America	3	5	0	8
Global	67	27	1	95

Note: In response to Question 12b(iv), 2 NDTs responded that they used "watchmen" as a means for preventing entry into the work site..

Table II.13. Responses to Question 13 – Has your Company determined the more common causes for unauthorized persons to trespass past the warning system?

	Yes	No	Don't know	No reply	Total
Africa	2	2	3	0	7
Asia-Pacific	18	13	1	1	33
Europe	16	7	3	2	28
Latin America	11	6	1	1	19
North America	6	1	1	0	8
Global	53	29	9	4	95

Table II.13a. Responses to Question 13a – If yes to Question 13, what are the more common causes?

	Warning system is not understood?			
	Yes	No	No reply	Total
Africa	0	2	0	2
Asia-Pacific	13	3	2	18
Europe	10	6	0	16
Latin America	4	6	1	11
North America	3	3	0	6
Global	30	20	3	53
	Wilful violation?			
	Yes	No	No reply	Total
Africa	2	0	0	2
Asia-Pacific	11	5	2	18
Europe	15	1	0	16
Latin America	8	2	1	11
North America	6	0	0	6
Global	42	8	3	53
	Warning system was not set up properly to control the area?			
	Yes	No	No reply	Total
Africa	0	2	0	2
Asia-Pacific	4	12	2	18
Europe	3	13	0	16
Latin America	1	9	1	11
North America	2	4	0	6
Global	10	40	3	53

Note: In response to Question 13a(iv) asking for other causes, 2 NDTs responded that inattention or distractions led to trespass, and 3 others stated that there was a lack of understanding about the actual dangers involved..

Table II.14. Responses to Question 14 – Does your Company require its radiographers to announce or warn whenever a radiographic exposure is made?

	Always	Sometimes	No	Don't know	No reply	Total
Africa	4	2	0	1	0	7
Asia-Pacific	31	2	0	0	0	33
Europe	15	4	8	0	1	28
Latin America	14	3	2	0	0	19
North America	3	2	2	0	1	8
Global	67	13	12	1	2	95

Table II.14a. Responses to Question 14a – If yes (every time or sometimes) to Question 14, is this with:

	An audible alarm (e.g. siren, whistle)?			
	Yes	No	No reply	Total
Africa	1	3	2	6
Asia-Pacific	17	15	1	33
Europe	7	9	3	19
Latin America	6	7	4	17
North America	0	5	0	5
Global	31	39	10	80
	A visible alarm (e.g. flashing lights)?			
	Yes	No	No reply	Total
Africa	4	0	2	6
Asia-Pacific	30	2	1	33
Europe	14	2	3	19
Latin America	11	2	4	17
North America	1	4	0	5
Global	60	10	10	80
	An announcement via a public address system?			
	Yes	No	No reply	Total
Africa	1	3	2	6
Asia-Pacific	19	13	1	33
Europe	5	11	3	19
Latin America	7	7	3	17
North America	4	1	0	5
Global	36	35	9	80

In response to Question 14a(iv) asking for other methods, 8 NDTs responded that they used some form of direct communication with client personnel, such as phone, walky-talky or talking, and of these 5 used this method only. 3 NDTs used specific warning signage in addition to other methods.

Table II.14b. Further analysis of responses to Question 14a:

	Audible alarm only	Visible alarm only	Announcement only	Other means only	Audible & visible alarms	Audible alarm & announcement	Visible alarm & announcement	Audible & visible alarms & announcement
Africa	0	3	0	0	0	0	0	1
Asia-Pacific	1	8	1	0	4	0	6	12
Europe	0	6	1	3	4	0	1	3
Latin America	0	3	3	2	4	0	2	2
North America	0	1	4	0	0	0	0	0
Global	1	21	9	5	12	0	9	18

Five NDT companies answered yes to Question 14, but did not give an information on what methods they used.

Table II.15a-d. Responses to Question 15a-d – When your Company is providing radiography services in an industrial plant, does the client:

	Provide your Company with a plan of the installation?					
	Always	Sometimes	Never	No reply	Not applicable	Total
Africa	5	1	1	0	0	7
Asia-Pacific	25	7	1	0	0	33
Europe	5	18	2	1	2	28
Latin America	2	9	3	0	5	19
North America	0	5	2	1	0	8
Global	37	40	9	2	7	95
	Inform your Company about other interfering activities on site?					
	Always	Sometimes	Never	No reply	Not applicable	Total
Africa	7	0	0	0	0	7
Asia-Pacific	27	5	1	0	0	33
Europe	11	12	2	1	2	28
Latin America	12	1	1	0	5	19
North America	3	4	0	1	0	8
Global	60	22	4	2	7	95
	Have a “permit to work” system?					
	Always	Sometimes	Never	No reply	Not applicable	Total
Africa	5	2	0	0	0	7
Asia-Pacific	26	5	1	1	0	33
Europe	5	19	1	1	2	28
Latin America	8	6	0	0	5	19
North America	1	6	0	1	0	8
Global	45	38	2	3	7	95
	Inform other workers about the radiography to be performed?					
	Always	Sometimes	Never	No reply	Not applicable	Total
Africa	6	1	0	0	0	7
Asia-Pacific	32	1	0	0	0	33
Europe	8	17	0	1	2	28
Latin America	11	3	0	0	5	19
North America	2	5	0	1	0	8
Global	59	27	0	2	7	95
	Inform other workers about the purpose and method of the warning system (beaconing)?					
	Always	Sometimes	Never	No reply	Not applicable	Total
Africa	3	3	1	0	0	7
Asia-Pacific	29	2	2	0	0	33
Europe	3	20	2	1	2	28
Latin America	8	6	0	0	5	19
North America	2	2	3	1	0	8
Global	45	33	8	2	7	95
	Inform other workers about the meaning of alarm signals?					
	Always	Sometimes	Never	No reply	Not applic	Total
Africa	2	4	1	0	0	7
Asia-Pacific	30	2	1	0	0	33
Europe	4	18	3	1	2	28
Latin America	8	6	0	0	5	19
North America	2	4	1	1	0	8
Global	46	34	6	2	7	95

Table II.15d(iv). Responses to Question 15d(iv) – When your Company is providing radiography services in an industrial plant, does the client:

	Inform other workers about the risks of ionizing radiation / sources?					Total
	Always	Sometimes	Never	No reply	Not applicable	
Africa	2	4	1	0	0	7
Asia-Pacific	31	1	1	0	0	33
Europe	3	20	2	1	2	28
Latin America	7	5	2	0	5	19
North America	2	3	2	1	0	8
Global	45	33	8	2	7	95

Table II.16. Responses to Question 16 – Does your Company require its radiographers to use:

	Collimators with Gamma radiography?					Total
	Yes	No	No reply	Not applicable		
Africa	4	2	0	1	7	
Asia-Pacific	29	3	0	1	33	
Europe	24	0	2	2	28	
Latin America	15	0	0	4	19	
North America	6	1	1	0	8	
Global	78	6	3	8	95	
	Diaphragms or collimators with X-ray radiography?					Total
	Yes	No	No reply	Not applicable		
Africa	2	3	0	2	7	
Asia-Pacific	25	5	0	3	33	
Europe	22	4	0	2	28	
Latin America	12	1	2	4	19	
North America	0	5	0	3	8	
Global	61	18	3	14	95	

Note: 1. The “not applicable” responses were for NDT companies that were X-ray radiography only, and gamma radiography only, respectively.

2. There were 70 NDT companies that answered Question 16 for gamma radiography and for which there were at least 1 individual radiographer response for the same question in the radiographer survey (question 11). For the 68 NDT companies stating that they required collimation for gamma radiography, there were no companies for which the corresponding radiography responses stated that they never used collimation. About 80% of the radiographers said they always used collimation and about 20% said they sometimes used collimation. There were 2 instances where the NDT company did not require collimation, and one radiographer also said that they did not use collimation, while another replied that collimation was sometimes used.

3. For X-ray radiography, there were 64 NDT companies that answered that part of Question 16 and for which there were at least 1 individual radiographer response for the same question in the radiographer survey (question 12). For the 45 NDT companies stating that they required collimation for X-ray radiography, there were 8 companies where at least 1 of their corresponding radiographer responses said that they never used collimation. Conversely, there were 9 companies that did not require collimation, but for 5 of them the radiographers responded that they sometimes used collimation.

Table II.17a. Responses to Question 17a – With regard to exposure devices for gamma radiography:

	What interval does your Company have between preventive maintenance - months?							Not applicable	No reply
	Data	Mean	Min	Q1	Median	Q3	Max		
Africa	3	10.0	3	7.5	12	13.5	15	1	1
Asia-Pacific	30	5.8	1	3	3	12	12	1	2
Europe	25	11.3	3	12	12	12	24	2	1
Latin America	13	6.2	3	6	6	6	12	4	2
North America	7	4.4	3	3	4	6	6	0	1
Global	78	7.7	1	3	6	12	24	8	7

Note: 1. Two NDT companies stated that preventative maintenance was not performed.

2. The “not applicable” responses were for NDT companies performing X-Ray radiography only.

Table II.17b. Responses to Question 17b – What auxiliary equipment is included in the preventive maintenance:

	Crank?				
	Yes	No	No reply	Not applicable	Total
Africa	3	0	3	1	7
Asia-Pacific	28	4	0	1	33
Europe	25	0	1	2	28
Latin America	14	0	1	4	19
North America	7	0	1	0	8
Global	77	4	6	8	95
	Control cable?				
	Yes	No	No reply	Not applicable	Total
Africa	3	0	3	1	7
Asia-Pacific	32	0	0	1	33
Europe	25	0	1	2	28
Latin America	14	0	1	4	19
North America	7	0	1	0	8
Global	81	0	6	8	95
	Guide tube?				
	Yes	No	No reply	Not applicable	Total
Africa	3	0	3	1	7
Asia-Pacific	32	0	0	1	33
Europe	25	0	1	2	28
Latin America	14	0	1	4	19
North America	7	0	1	0	8
Global	81	0	6	8	95
	Collimator?				
	Yes	No	No reply	Not applicable	Total
Africa	2	1	3	1	7
Asia-Pacific	25	7	0	1	33
Europe	19	6	1	2	28
Latin America	7	7	1	4	19
North America	3	4	1	0	8
Global	56	25	6	8	95

Note: 12 NDT companies specified other items included in their preventive maintenance, including various aspects of general equipment condition.

Table II.17c. Responses to Question 17c – Who performs the preventive maintenance:

	Your Company?				
	Yes	No	No reply	Not applicable	Total
Africa	1	3	2	1	7
Asia-Pacific	26	6	0	1	33
Europe	12	13	1	2	28
Latin America	13	1	1	4	19
North America	8	0	0	0	8
Global	60	23	4	8	95
	The device manufacturer?				
	Yes	No	No reply	Not applicable	Total
Africa	3	1	2	1	7
Asia-Pacific	14	18	0	1	33
Europe	15	10	1	2	28
Latin America	0	14	1	4	19
North America	2	6	0	0	8
Global	34	49	4	8	95
	Other service company?				
	Yes	No	No reply	Not applicable	Total
Africa	1	3	2	1	7
Asia-Pacific	17	15	0	1	33
Europe	13	12	1	2	28
Latin America	7	7	1	4	19
North America	3	5	0	0	8
Global	41	42	4	8	95

Table II.17c(i). Further analysis of responses to Question 17c – Who performs the preventive maintenance:

	NDT Company only	Manufacturer only	Service company only	NDT Company & Manufacturer	Manufacturer & Service company	NDT Company & Service Company	All 3	No one* specified
Africa	1	2	0	0	1	0	0	2
Asia-Pacific	8	0	4	7	2	6	5	0
Europe	1	7	4	4	2	5	2	1
Latin America	7	0	1	0	0	6	0	1
North America	4	0	0	1	0	2	1	0
Global	21	9	9	12	5	19	8	4

* Excluding “not applicable” responses.

There were 83 NDT companies that provided at least one “yes” response.

Table II.18a. Responses to Question 18a – With regard to X-Ray equipment:

	What interval does your Company have between preventive maintenance – months?							No reply	Not applicable
	Data	Mean	Min	Q1	Median	Q3	Max		
Africa	2	4.5	3	3.75	4.5	5.25	6	2	2
Asia-Pacific	26	6.4	1	3	5	12	12	4	3
Europe	23	10.5	1	12	12	12	12	3	2
Latin America	13	7.0	1	6	6	12	12	2	4
North America	3	6.0	0	3	6	9	12	2	3
Global	67	7.9	0	3	6	12	12	13	14

Notes: 1. One NDT company stated that preventative maintenance was not performed.

2. The “not applicable” responses were for NDT companies performing gamma radiography only.

Table II.18b. Responses to Question 18b – What items are included in the preventive maintenance:

	Yes	No	No reply	Not applicable	Total
Cables?					
Africa	2	0	3	2	7
Asia-Pacific	22	7	1	3	33
Europe	23	1	2	2	28
Latin America	15	0	0	4	19
North America	3	1	1	3	8
Global	65	9	7	14	95
Control panel?					
Africa	2	0	3	2	7
Asia-Pacific	29	0	1	3	33
Europe	24	0	2	2	28
Latin America	14	1	0	4	19
North America	3	1	1	3	8
Global	72	2	7	14	95
Diaphragm or collimator?					
Africa	2	0	3	2	7
Asia-Pacific	22	7	1	3	33
Europe	19	5	2	2	28
Latin America	10	5	0	4	19
North America	0	4	1	3	8
Global	53	21	7	14	95
Output of tube (dose rate)?					
Africa	2	0	3	2	7
Asia-Pacific	25	3	2	3	33
Europe	19	5	2	2	28
Latin America	10	5	0	4	19
North America	1	3	1	3	8
Global	57	16	8	14	95
Leakage radiation?					
Africa	2	0	3	2	7
Asia-Pacific	24	4	2	3	33
Europe	18	6	2	2	28
Latin America	11	4	0	4	19
North America	2	2	1	3	8
Global	57	16	8	14	95

Note: 6 NDT companies specified other items included in their preventive maintenance, including various aspects of general equipment condition.

Table II.18c. Responses to Question 18c – Who performs the preventive maintenance:

	Your Company?				
	Yes	No	No reply	Not applicable	Total
Africa	0	3	2	2	7
Asia-Pacific	21	8	1	3	33
Europe	15	9	2	2	28
Latin America	11	4	0	4	19
North America	3	1	1	3	8
Global	50	25	6	14	95
	The device manufacturer?				
	Yes	No	No reply	Not applicable	Total
Africa	1	2	2	2	7
Asia-Pacific	11	18	1	3	33
Europe	11	13	2	2	28
Latin America	1	14	0	4	19
North America	0	4	1	3	8
Global	24	51	6	14	95
	Other service company?				
	Yes	No	No reply	Not applicable	Total
Africa	2	1	2	2	7
Asia-Pacific	19	9	2	3	33
Europe	13	11	2	2	28
Latin America	7	8	0	4	19
North America	0	4	1	3	8
Global	41	33	7	14	95

Table II.18c(i). Further analysis of responses to Question 18c – Who performs the preventive maintenance:

	NDT Company only	Manufacturer only	Service company only	NDT Company & Manufacturer	Manufacturer & Service company	NDT Company & Service Company	All 3	No one* specified
Africa	0	1	2	0	0	0	0	2
Asia-Pacific	7	1	5	2	2	6	6	1
Europe	4	3	5	4	1	4	3	2
Latin America	7	0	4	1	0	3	0	0
North America	3	0	0	0	0	0	0	2
Global	21	5	16	7	3	13	9	7

* Excluding “not applicable” responses.

Table II.19. Responses to Question 19a – Who approved your Company's radiation protection programme?

	The Managing Director or Chief Executive Officer?			
	Yes	No	No reply	Total
Africa	6	1	0	7
Asia-Pacific	21	12	0	33
Europe	18	10	0	28
Latin America	14	5	0	19
North America	4	4	0	8
Global	63	32	0	95
	The Radiation protection Officer?			
	Yes	No	No reply	Total
Africa	3	4	0	7
Asia-Pacific	18	15	0	33
Europe	19	9	0	28
Latin America	12	7	0	19
North America	7	1	0	8
Global	59	36	0	95
	The radiation protection Regulatory Body?			
	Yes	No	No reply	Total
Africa	2	5	0	7
Asia-Pacific	16	16	1	33
Europe	17	11	0	28
Latin America	15	3	1	19
North America	7	1	0	8
Global	57	36	2	95

Table II.19a. Further analysis of responses to Question 19 – Who approved your Company's radiation protection programme?

	MD or CEO only	RPO only	RB only	MD or CEO & RPO	RPO & RB	MD or CEO & RB	All 3	No one*
Africa	2	0	1	3	0	1	0	0
Asia-Pacific	10	4	4	3	4	1	7	0
Europe	3	4	4	4	2	2	9	0
Latin America	2	2	2	0	1	3	9	0
North America	0	1	1	0	2	0	4	0
Global	17	11	12	10	9	7	29	0

Table II.20. Responses to Question 20 – Does your Company perform its own compliance inspections of its radiographers?

	Yes	No	Don't know	No reply	Total
Africa	5	1	1	0	7
Asia-Pacific	32	0	0	1	33
Europe	27	1	0	0	28
Latin America	17	1	0	1	19
North America	8	0	0	0	8
Global	89	3	1	2	95

Table II.20a. Responses to Question 20a – If yes to Question 20, are there planned compliance inspections?

	Yes	No	Don't know	No reply	Total
Africa	3	2	0	0	5
Asia-Pacific	28	2	0	2	32
Europe	10	16	1	0	27
Latin America	6	11	0	0	17
North America	6	2	0	0	8
Global	53	33	1	2	89

Table II.20b. Responses to Question 20b – If yes to Question 20, are there unplanned compliance inspections?

	Yes	No	Don't know	No reply	Total
Africa	3	2	0	0	5
Asia-Pacific	21	7	2	2	32
Europe	23	3	1	0	27
Latin America	13	4	0	0	17
North America	7	1	0	0	8
Global	67	17	3	2	89

Table II.20b(i). Further analysis of responses to Question 20a & b – Are there planned and unplanned inspections?

	Planned only	Unplanned only	Both	No inspections	Total
Africa	1	1	2	1	5
Asia-Pacific	9	2	19	0	30
Europe	2	15	8	1	26
Latin America	4	11	2	0	17
North America	1	2	5	0	8
Global	17	31	36	2	86

Table II.20c. Responses to Question 20c – If yes to Question 20, are these compliance inspections performed by:

	The Managing Director or Chief Executive Officer?			
	Yes	No	No reply	Total
Africa	0	5	0	5
Asia-Pacific	6	24	2	32
Europe	5	20	2	27
Latin America	2	15	0	17
North America	2	6	0	8
Global	15	70	4	89
	Other member of the Management Team?			
	Yes	No	No reply	Total
Africa	0	5	0	5
Asia-Pacific	15	15	2	32
Europe	9	16	2	27
Latin America	4	13	0	17
North America	2	6	0	8
Global	30	55	4	89
	The Radiation Protection Officer?			
	Yes	No	No reply	Total
Africa	4	1	0	5
Asia-Pacific	25	4	3	32
Europe	24	2	1	27
Latin America	15	2	0	17
North America	8	0	0	8
Global	76	9	4	89
	Other Radiation Protection Expert?			
	Yes	No	No reply	Total
Africa	2	3	0	5
Asia-Pacific	8	21	3	32
Europe	16	9	2	27
Latin America	7	9	1	17
North America	3	5	0	8
Global	36	47	6	89

Table II.20c(i). Further analysis of responses to Question 20c – Who performs these inspections?

	Management presence	RPO only	RPE only	Management only¹	RP experts only²
Africa	0	3	1	0	5
Asia-Pacific	17	9	1	4	13
Europe	11	6	0	1	15
Latin America	4	8	0	2	13
North America	4	2	0	0	4
Global	36	28	2	7	50

Note:

1. No RPO or RPE is present at the inspections.
2. No management team person is present at the inspections.

Table II.20d. Responses to Question 20d – If yes to Question 20, approx how many times per year would a radiographer be inspected by your Company

	Number of times per year a radiographer would be inspected by the company							No reply
	Data	Mean	Min	Q1	Median	Q3	Max	
Africa	4	2.4	1	1	1.25	2.6	6	1
Asia-Pacific	27	6.5	1	2	4	12	24	5
Europe	22	2.4	0.1	1	2	3	12	5
Latin America	17	3.1	1	2	2	3	12	0
North America	8	2.3	1	1.75	2	2.5	4	0
Global	78	4.0	0.1	1.00	2	4	24	11

Table II.20e. Responses to Question 20e – What subjects are addressed during such Company inspections?

	i. Proper wearing of passive individual dosimeters?			
	Yes	No	No reply	Total
Africa	5	0	0	5
Asia-Pacific	28	4	0	32
Europe	26	0	1	27
Latin America	17	0	0	17
North America	8	0	0	8
Global	84	4	1	89
	ii. Proper wearing and use of active individual dosimeters?			
	Yes	No	No reply	Total
Africa	5	0	0	5
Asia-Pacific	29	3	0	32
Europe	24	1	2	27
Latin America	15	2	0	17
North America	8	0	0	8
Global	81	6	2	89
	iii. Proper use of survey meters?			
	Yes	No	No reply	Total
Africa	3	2	0	5
Asia-Pacific	32	0	0	32
Europe	24	2	1	27
Latin America	17	0	0	17
North America	8	0	0	8
Global	84	4	1	89
	iv. Proper use of collimators?			
	Yes	No	No reply	Total
Africa	4	1	0	5
Asia-Pacific	29	3	0	32
Europe	23	3	1	27
Latin America	15	2	0	17
North America	8	0	0	8
Global	79	9	1	89

Table II.20e, continued. Responses to Question 20e – What subjects are addressed during such Company inspections?

	v. Proper warning system at the work site?			
	Yes	No	No reply	Total
Africa	3	2	0	5
Asia-Pacific	31	1	0	32
Europe	24	1	2	27
Latin America	15	2	0	17
North America	8	0	0	8
Global	81	6	2	89
	vi. Dose rate at the boundary of the work site within the limits set?			
	Yes	No	No reply	Total
Africa	5	0	0	5
Asia-Pacific	30	2	0	32
Europe	24	2	1	27
Latin America	16	1	0	17
North America	6	2	0	8
Global	81	7	1	89
	vii. Proper use of alarm systems (flashing lights, audible alarm, use of PA system)?			
	Yes	No	No reply	Total
Africa	5	0	0	5
Asia-Pacific	29	3	0	32
Europe	21	5	1	27
Latin America	15	2	0	17
North America	6	2	0	8
Global	76	12	1	89
	viii. Proper training and qualifications of Radiographers?			
	Yes	No	No reply	Total
Africa	4	1	0	5
Asia-Pacific	31	1	0	32
Europe	21	5	1	27
Latin America	16	1	0	17
North America	8	0	0	8
Global	80	8	1	89
	ix. Operator knowledge of procedures?			
	Yes	No	No reply	Total
Africa	5	0	0	5
Asia-Pacific	21	11	0	32
Europe	26	0	1	27
Latin America	17	0	0	17
North America	8	0	0	8
Global	77	11	1	89

Table II.20e, continued. Responses to Question 20e – What subjects are addressed during such Company inspections?

	x. Pre-operation specific equipment checks?			
	Yes	No	No reply	Total
Africa	4	1	0	5
Asia-Pacific	22	10	0	32
Europe	22	4	1	27
Latin America	16	1	0	17
North America	8	0	0	8
Global	72	16	1	89
	xi. Equipment condition?			
	Yes	No	No reply	Total
Africa	5	0	0	5
Asia-Pacific	21	11	0	32
Europe	24	2	1	27
Latin America	17	0	0	17
North America	8	0	0	8
Global	75	13	1	89
	xii. Emergency preparedness?			
	Yes	No	No reply	Total
Africa	5	0	0	5
Asia-Pacific	21	10	1	32
Europe	16	10	1	27
Latin America	15	1	1	17
North America	7	1	0	8
Global	64	22	3	89

Note: There were 15 responses that indicated that additional items were part of their inspections, including: proper documentation, storage, transport, image quality, good practice, vehicle condition, and security.

Table II.20f(i). Global (89) & Africa (5) responses to Question 20f – If yes to Question 20, please rank the common shortcomings, in order of the frequency in which they are observed in Company inspections?

	Number of times ranked as:					No. of times Not ranked	No. of times ranked 1 to 5	Overall ranking*
	1	2	3	4	5			
GLOBAL								
No proper wearing of passive individual dosimeters	6	2	5	5	3	68	21	7
No proper wearing and use of active individual dosimeters	5	2	2	7	3	70	19	9
No proper use of survey meters	8	6	6	6	7	56	33	3
No proper use of collimators	8	7	12	5	3	54	35	1
No proper warning system to prevent entry to the work site	10	0	5	5	0	69	20	6
Dose rate at the boundary of the work site not within limits set	8	12	3	4	7	55	34	2
No proper use of alarm systems	3	8	4	1	5	68	21	7
No proper training and qualifications of radiographers	1	2	0	2	2	82	7	12
Poor operator knowledge of procedures	5	7	6	2	5	64	25	5
No pre-operation specific equipment checks being performed	6	7	6	7	3	60	29	4
Poor equipment condition	5	4	2	2	3	73	16	10
Poor emergency preparedness	1	1	5	3	5	74	15	11
Other	1	1	0	0	2	85	4	13
AFRICA								
No proper wearing of passive individual dosimeters	1	0	0	0	0	4	1	5
No proper wearing and use of active individual dosimeters	0	0	0	2	0	3	2	8
No proper use of survey meters	0	0	0	0	0	5	0	10
No proper use of collimators	0	1	0	0	0	4	1	8
No proper warning system to prevent entry to the work site	2	0	0	0	0	3	2	1
Dose rate at the boundary of the work site not within limits set	1	1	0	0	0	3	2	2
No proper use of alarm systems	0	1	0	0	1	3	1	5
No proper training and qualifications of radiographers	0	0	0	0	0	5	0	10
Poor operator knowledge of procedures	0	0	1	0	2	2	3	5
No pre-operation specific equipment checks being performed	0	0	0	0	0	5	0	10
Poor equipment condition	0	1	0	1	0	3	2	4
Poor emergency preparedness	0	0	3	0	0	2	3	2
Other	0	0	0	0	0	5	0	10

* The overall ranking was determined applying weightings of 5, 4, 3, 2, 1 to the number of times a shortcoming was ranked 1st, 2nd, 3rd, 4th, and 5th, respectively. The shortcoming with the highest total was then assigned the highest overall ranking, and so on.

Table II.20f(ii). Asia-Pacific (32) & Europe (27) responses to Question 20f – If yes to Question 20, please rank the common shortcomings, in order of the frequency in which they are observed in Company inspections?

	Number of times ranked as:					No. of times Not ranked	No. of times ranked 1 to 5	Overall ranking*
	1	2	3	4	5			
ASIA-PACIFIC								
No proper wearing of passive individual dosimeters	2	1	2	0	1	26	5	8
No proper wearing and use of active individual dosimeters	5	1	1	3	1	21	11	5
No proper use of survey meters	2	3	3	3	4	17	15	4
No proper use of collimators	3	4	4	4	1	16	16	1
No proper warning system to prevent entry to the work site	2	0	4	1	0	25	7	7
Dose rate at the boundary of the work site not within limits set	5	2	2	2	3	18	14	2
No proper use of alarm systems	2	5	3	1	3	18	14	3
No proper training and qualifications of radiographers	1	1	0	0	1	29	3	11
Poor operator knowledge of procedures	1	2	0	1	1	27	5	9
No pre-operation specific equipment checks being performed	2	2	2	4	0	22	10	6
Poor equipment condition	1	1	0	1	1	28	4	10
Poor emergency preparedness	0	1	0	1	2	28	4	12
Other	0	0	0	0	1	31	1	13
EUROPE								
No proper wearing of passive individual dosimeters	2	0	2	2	1	20	7	8
No proper wearing and use of active individual dosimeters	0	1	1	1	1	23	4	10
No proper use of survey meters	3	1	2	3	1	17	10	2
No proper use of collimators	2	1	3	1	1	19	8	4
No proper warning system to prevent entry to the work site	4	0	0	1	0	22	5	6
Dose rate at the boundary of the work site not within limits set	1	7	1	0	2	16	11	1
No proper use of alarm systems	1	0	1	0	1	24	3	11
No proper training and qualifications of radiographers	0	0	0	2	1	24	3	12
Poor operator knowledge of procedures	1	2	4	0	1	19	8	4
No pre-operation specific equipment checks being performed	0	4	1	1	1	20	7	6
Poor equipment condition	4	1	1	0	0	21	6	3
Poor emergency preparedness	1	0	1	2	2	21	6	9
Other	0	0	0	0	0	27	0	13

* The overall ranking was determined applying weightings of 5, 4, 3, 2, 1 to the number of times a shortcoming was ranked 1st, 2nd, 3rd, 4th, and 5th, respectively. The shortcoming with the highest total was then assigned the highest overall ranking, and so on.

Table II.20f(iii). Latin America (17) & North America (8) responses to Question 20f – If yes to Question 20, please rank the common shortcomings, in order of the frequency in which they are observed in Company inspections?

	Number of times ranked as:					No. of times Not ranked	No. of times ranked 1 to 5	Overall ranking*
	1	2	3	4	5			
LATIN AMERICA								
No proper wearing of passive individual dosimeters	1	1	0	3	1	11	6	4
No proper wearing and use of active individual dosimeters	0	0	0	1	1	15	2	11
No proper use of survey meters	1	2	0	0	1	13	4	5
No proper use of collimators	2	1	4	0	0	10	7	2
No proper warning system to prevent entry to the work site	2	0	1	0	0	14	3	6
Dose rate at the boundary of the work site not within limits set	1	0	0	2	1	13	4	7
No proper use of alarm systems	0	2	0	0	0	15	2	8
No proper training and qualifications of radiographers	0	1	0	0	0	16	1	10
Poor operator knowledge of procedures	1	2	1	1	0	12	5	3
No pre-operation specific equipment checks being performed	3	1	2	0	2	9	8	1
Poor equipment condition	0	0	1	0	2	14	3	9
Poor emergency preparedness	0	0	0	0	1	16	1	12
Other	0	0	0	0	0	17	0	13
NORTH AMERICA								
No proper wearing of passive individual dosimeters	0	0	1	0	0	7	1	9
No proper wearing and use of active individual dosimeters	0	0	0	0	0	8	0	11
No proper use of survey meters	2	0	1	0	1	4	4	2
No proper use of collimators	1	0	1	0	1	5	3	5
No proper warning system to prevent entry to the work site	0	0	0	3	0	5	3	7
Dose rate at the boundary of the work site not within limits set	0	2	0	0	1	5	3	5
No proper use of alarm systems	0	0	0	0	0	8	0	11
No proper training and qualifications of radiographers	0	0	0	0	0	8	0	11
Poor operator knowledge of procedures	2	1	0	0	1	4	4	1
No pre-operation specific equipment checks being performed	1	0	1	2	0	4	4	3
Poor equipment condition	0	1	0	0	0	7	1	8
Poor emergency preparedness	0	0	1	0	0	7	1	9
Other	1	1	0	0	1	5	3	4

* The overall ranking was determined applying weightings of 5, 4, 3, 2, 1 to the number of times a shortcoming was ranked 1st, 2nd, 3rd, 4th, and 5th, respectively. The shortcoming with the highest total was then assigned the highest overall ranking, and so on.

Table II.20f(vii). Comparison of the regional and global five most common shortcomings, based on data in Tables 2.20f(i) to 2.20f(vi).

	Shortcoming ranking					
	Africa	Asia-Pacific	Europe	Latin America	North America	Global
No proper wearing of passive individual dosimeters	5	8	8	4	9	7
No proper wearing and use of active individual dosimeters	8	5	10	11	11	9
No proper use of survey meters	10	4	2	5	2	3
No proper use of collimators	8	1	4	2	5	1
No proper warning system to prevent entry to the work site	1	7	6	6	7	6
Dose rate at the boundary of the work site not within limits set	2	2	1	7	5	2
No proper use of alarm systems	5	3	11	8	11	7
No proper training and qualifications of radiographers	10	11	12	10	11	12
Poor operator knowledge of procedures	5	9	4	3	1	5
No pre-operation specific equipment checks being performed	10	6	6	1	3	4
Poor equipment condition	4	10	3	9	8	10
Poor emergency preparedness	2	12	9	12	9	11
Other	10	13	13	13	4	13

Table II.21. Responses to Question 21 – Does the (radiation protection) Regulatory Body perform planned inspections of your Company’s radiographers on the work site?

	Yes	No	Don’t know	No reply	Total
Africa	2	4	1	0	7
Asia-Pacific	27	5	1	0	33
Europe	17	9	2	0	28
Latin America	9	10	0	0	19
North America	5	3	0	0	8
Global	60	31	4	0	95

Table II.21a. Responses to Question 21a – If yes to Question 21, how many times (on average) would a radiographer undergo a planned inspection by the Regulatory Body?

	Approximate number times a year a radiographer undergoes a <u>planned</u> RB inspection							No reply
	Data	Mean	min	Q1	Median	Q3	Max	
Africa	1	2.0	-	-	-	-	-	1
Asia-Pacific	25	2.5	0.5	1	2	4	12	2
Europe	16	1.9	0.1	0.2	1	1	12	1
Latin America	9	1.2	0.5	1	1	1	2	0
North America	5	0.8	0.3	0.5	1	1	1	0
Global	56	2.0	0.1	1	1	2	12	4

Table II.22. Responses to Question 22 – Does the (radiation protection) Regulatory Body perform unplanned inspections on your Company’s radiographers on the work site?

	Yes	No	Don’t know	No reply	Total
Africa	2	4	1	0	7
Asia-Pacific	20	10	3	0	33
Europe	14	14	0	0	28
Latin America	15	4	0	0	19
North America	7	1	0	0	8
Global	58	33	4	0	95

Table II.22a. Responses to Question 22a – If yes to Question 22, how many times (on average) would a radiographer undergo an unplanned inspection by the Regulatory Body?

	Approximate number times a year a radiographer undergoes an <u>unplanned</u> RB inspection							No reply
	Data	Mean	min	Q1	Median	Q3	Max	
Africa	2	2.1	0.2	-	2.1	-	4	0
Asia-Pacific	17	2.7	1	1	2	2	12	3
Europe	13	1.6	0.2	0.3	1	1.5	8	1
Latin America	13	1.1	0.5	10	1	1	2	2
North America	6	0.9	0.2	1	1	1	1	1
Global	51	1.8	0.2	1	1	2	12	7

Table II.22b. Further analysis of responses to Questions 21 & 22 – Types of RB inspections?

	Planned inspections only	Unplanned inspections only	Both	Neither form of inspection
Africa	1	1	1	3
Asia-Pacific	9	2	18	3
Europe	9	6	8	5
Latin America	3	9	6	1
North America	1	3	4	0
Global	23	21	37	12

Table II.22c. Further analysis of responses to Questions 21 & 22 – Mean number of RB inspections a radiographer would undergo per year.

	RB performs <u>both</u> planned <u>and</u> unplanned inspections				RB performs <u>either</u> planned <u>or</u> unplanned <u>or</u> both inspections	
	Data	Approximate mean number times a year a radiographer undergoes:			Data	Approximate mean number times a year a radiographer undergoes any RB inspection
		A planned RB inspection	An unplanned RB inspection	Any RB inspection		
Africa	1	2.0	4.0	6.0	2	3.1
Asia-Pacific	15	3.0	2.9	6.3	27	4.0
Europe	8	1.6	1.6	3.3	21	2.4
Latin America	6	0.9	0.9	1.8	16	1.5
North America	3	0.7	0.7	1.7	8	1.1
Global	33	2.1	2.1	4.3	74	2.7

II.5. EMERGENCY PREPAREDNESS AND RESPONSE

Table II.23. Responses to Question 23 – Does your Company have an emergency plan and procedures for responding to incidents during the performance of site radiography?

	Yes	No	Don't know	No reply	Total
Africa	6	0	1	0	7
Asia-Pacific	32	1	0	0	33
Europe	27	1	0	0	28
Latin America	17	2	0	0	19
North America	8	0	0	0	8
Global	90	4	1	0	95

Note: The 4 “no” responses were X-Ray only NDT companies.

Table II.23a. Responses to Question 23a – With whom does your Company communicate and discuss the emergency plan?

	Your Company's Radiographers?				
	Yes	No	Don't know	No reply	Total
Africa	5	0	1	0	6
Asia-Pacific	31	1	0	0	32
Europe	22	4	0	1	27
Latin America	16	0	0	1	17
North America	8	0	0	0	8
Global	82	5	1	2	90
	Your Company's Clients?				
	Yes	No	Don't know	No reply	Total
Africa	1	5	0	0	6
Asia-Pacific	25	7	0	0	32
Europe	5	17	1	4	27
Latin America	8	8	0	1	17
North America	3	5	0	0	8
Global	42	42	1	5	90
	The (radiation protection) Regulatory Body?				
	Yes	No	Don't know	No reply	Total
Africa	3	2	1	0	6
Asia-Pacific	28	3	1	0	32
Europe	18	5	0	4	27
Latin America	14	2	0	1	17
North America	6	1	0	1	8
Global	69	13	2	6	90
	Other emergency response authorities?				
	Yes	No	Don't know	No reply	Total
Africa	2	4	0	0	6
Asia-Pacific	16	14	2	0	32
Europe	5	17	1	4	27
Latin America	10	4	0	3	17
North America	3	4	0	1	8
Global	36	43	3	8	90

Note: 1. 26 NDT companies said that they communicated and discussed their emergency plan with all of the above parties.

2. No NDT companies responded in the negative for all of the above parties – i.e. all 90 responding NDT companies communicated and discussed the emergency plan with at least one of the above parties.

Table II.24. Responses to Question 24 – Does your Company provide specific training to its radiographers on emergency preparedness and response?

	Yes	No	Don't know	No reply	Total
Africa	4	2	1	0	7
Asia-Pacific	33	0	0	0	33
Europe	15	13	0	0	28
Latin America	18	1	0	0	19
North America	8	0	0	0	8
Global	78	16	1	0	95

Notes:

1. The 16 “no” answers were dominated by the 13 from Europe. It is likely that these responses reflect the practice and requirements to use specialist persons in emergency roles, and hence training radiographers for this role is not considered appropriate.
2. Cross-correlating the 16 “no “ answers with Question 1c on “radiation protection training” showed that 11 had stated that they included training in emergency procedures, 6 included practical exercises for creating a safe situation, and 2 included practical exercises in source recovery.
3. See also responses for Question 24(a)(iii) in the Table II.24a, below.

Table II.24a. Responses to Question 24a – If yes to Question 24, does the training include:

	Explanation of emergency procedures?					
	Yes	No	Don't know	No reply	Total	
Africa	4	0	0	0	4	
Asia-Pacific	32	0	0	1	33	
Europe	15	0	0	0	15	
Latin America	18	0	0	0	18	
North America	8	0	0	0	8	
Global	77	0	0	1	78	
	Practical exercises on containment of the situation, i.e. keeping it safe and under control?					
	Yes	No	Don't know	No reply	Total	
Africa	3	1	0	0	4	
Asia-Pacific	31	1	0	1	33	
Europe	11	3	1	0	15	
Latin America	17	1	0	0	18	
North America	7	1	0	0	8	
Global	69	7	1	1	78	
	Practical exercises on recovery of sources?					
	Yes	No	Don't know	No reply	Not applicable	Total
Africa	2	1	1	0	0	4
Asia-Pacific	27	5	0	1	0	33
Europe	7	8	0	0	0	15
Latin America	13	1	0	0	4	18
North America	4	4	0	0	0	8
Global	53	19	1	1	4	78

Note: 1. Cross-correlating the 19 “no “ answers for practical exercises on source recovery with Question 1c(iii) on “radiation protection training” showed that 6 of the 19 had stated that they included practical exercises in source recovery in the rp training, while 12 had not. One had not responded to Question 1c(iii).

Table II.25. Responses to Question 25 – Does your company have emergency equipment for site radiography?

	Yes	No	Don't know	No reply	Not applicable	Total
Africa	6	1	0	0	0	7
Asia-Pacific	33	0	0	0	0	33
Europe	22	6	0	0	0	28
Latin America	16	1	0	0	2	19
North America	8	0	0	0	0	8
Global	85	8	0	0	2	95

Note: Of the 8 “no” responses, 3 were for X-Ray only NDT companies. The others were again reflecting the role of specialist emergency response personnel in some countries.

Table II.25a. Responses to Question 25a – If yes to Question 25, what equipment does your Company have: (*more than one answer is likely*)

	Long tongs?				
	Yes	No	Don't know	No reply	Total
Africa	5	0	1	0	6
Asia-Pacific	29	3	0	1	33
Europe	19	3	0	0	22
Latin America	14	1	0	1	16
North America	7	1	0	0	8
Global	74	8	1	2	85
	Shielding material?				
	Yes	No	Don't know	No reply	Total
Africa	5	0	0	1	6
Asia-Pacific	32	0	0	1	33
Europe	21	1	0	0	22
Latin America	15	0	0	1	16
North America	7	1	0	0	8
Global	80	2	0	3	85
	Emergency/Rescue container?				
	Yes	No	Don't know	No reply	Total
Africa	3	1	1	1	6
Asia-Pacific	29	3	0	1	33
Europe	15	6	0	1	22
Latin America	14	1	0	1	16
North America	3	5	0	0	8
Global	64	16	1	4	85

Note. There were 20 responses to other equipment, including: protective clothing (6), cutting equipment (6), additional survey meters (long) and dosimeters (4), fire extinguishers (2), first aid kit (1), and toolbox (1).

Table II.25b. Responses to Question 25b – If yes to Question 25, do your radiographers have access to the emergency equipment?

	Yes	No	Don't know	No reply	Total
Africa	5	1	0	0	6
Asia-Pacific	31	2	0	0	33
Europe	18	3	0	1	22
Latin America	16	0	0	0	16
North America	7	1	0	0	8
Global	77	7	0	1	85

Table II.26. Responses to Question 26 – In your Company's Emergency Plan, who is responsible for the following stages of an emergency: (Mark only those appropriate to your Emergency Plan)

	Radiographer	RPO or RPE	Other Qualified Expert	Authorities	Appointed institute	No. NDT Company Responses
Containment of the situation, i.e. keeping it safe and under control:						
Africa	5	3	1	0	0	6
Asia-Pacific	20	27	2	4	3	31
Europe	25	20	2	5	1	27
Latin America	11	13	6	3	0	17
North America	8	5	0	0	0	8
Global	69	68	11	12	4	89
Planning and rehearsing the recovery:						
Africa	1	6	1	0	0	6
Asia-Pacific	15	29	2	4	4	30
Europe	9	21	3	9	7	26
Latin America	8	13	5	2	0	16
North America	5	6	1	0	1	8
Global	38	75	12	15	12	86
Recovery of the situation:						
Africa	3	4	1	0	0	6
Asia-Pacific	16	28	4	5	3	30
Europe	7	16	3	10	7	26
Latin America	9	13	5	3	1	17
North America	5	6	1	1	1	8
Global	40	67	14	19	12	87
Investigation and reporting:						
Africa	1	4	1	1	0	5
Asia-Pacific	10	28	3	10	2	31
Europe	11	24	1	5	1	26
Latin America	4	15	1	1	0	17
North America	4	6	2	1	1	8
Global	30	77	8	18	4	87

Notes:

1. For Containment of the situation: 68 NDT companies stated either the radiographer or RPO or both were responsible, and not another QE, Authority or Institute. Conversely, there were no responses where the radiographer or RPO were not involved.
2. For Planning and rehearsing the recovery: 56 NDT companies stated either the radiographer or RPO or both were responsible, and not another QE, Authority or Institute. Conversely, there were 4 responses where the radiographer or RPO were not involved.
3. For Recovery of the situation: 52 NDT companies stated either the radiographer or RPO or both were responsible, and not another QE, Authority or Institute. Conversely, there were 3 responses where the radiographer or RPO were not involved.
4. For Investigation and reporting: 61 NDT companies stated either the radiographer or RPO or both were responsible, and not another QE, Authority or Institute. Conversely, there were 3 responses where the radiographer or RPO were not involved.
5. "Other qualified experts" included: recovery specialists, company inspectors, company rescue personnel, and manufacturer's specialist. "Authorities" included: the Regulatory Body, police and fire brigade. "Appointed institutes" included: Technical Service Organizations and the device manufacturer.

Table II.27. Responses to Question 27 – Does your Company hold emergency exercises to test the critical components of the Company's Emergency Plan?

	Yes	No	Don't know	No reply	Total
Africa	2	3	0	1	6
Asia-Pacific	24	4	2	2	32
Europe	10	16	1	0	27
Latin America	11	6	0	0	17
North America	2	6	0	0	8
Global	49	35	3	3	90

Table II.27a. Responses to Question 27a – If yes to Question 27, how often does your Company hold these exercises?

	Number of exercises per year							No reply
	Data	Mean	min	Q1	Median	Q3	Max	
Africa	2	2.5	1	-	2.5	-	4	0
Asia-Pacific	24	2.4	1	1	1.75	2.3	12	0
Europe	10	1.3	1	1	1.0	1.4	2	0
Latin America	11	1.6	1	1	1.0	2	3	0
North America	2	1.5	1	-	1.5	-	2	0
Global	49	2.0	1	1	1	2	12	0

Table II.28. Responses to Question 28 – Does your Company undertake a periodic formal review of its Emergency Plan?

	Yes	No	Don't know	No reply	Total
Africa	1	2	2	1	6
Asia-Pacific	24	2	3	3	32
Europe	15	10	2	0	27
Latin America	10	7	0	0	17
North America	4	4	0	0	8
Global	54	25	7	4	90

Table II.28a. Responses to Question 28a – If yes to Question 28, how often does your Company undertake a review?

	Number of reviews per year							No reply
	Data	Mean	min	Q1	Median	Q3	Max	
Africa	1	2.0	-	-	2	-	-	0
Asia-Pacific	24	1.4	1	1	1	2	3	0
Europe	14	1.0	0.2	1	1	1	2	1
Latin America	7	1.3	1	1	1	1.5	2	3
North America	4	0.7	0.3	0.5	0.75	1	1	0
Global	50	1.2	0.2	1	1	1	3	4

II.6. COMPANY PROFILES

Table II.29. Responses to Question 29. – What radiographic techniques does your Company utilize?

	Gamma ONLY	X-ray ONLY	BOTH	No reply	Total
Africa	2	1	4	0	7
Asia-Pacific	3	1	29	0	33
Europe	2	2	24	0	28
Latin America	4	4	11	0	19
North America	3	0	5	0	8
Global	14	8	73	0	95

Table II.30a(i). Responses to Question 30a, giving statistics on the number of full-time industrial radiographers employed by the responding NDT Companies.

	Replies	Number of full-time radiographers per NDT company					
		Mean	Min	Q1	Median	Q3	Max
Africa	5	7.0	1	1	5	8	20
Asia-Pacific	23	36.7	7	15	24	32.5	200
Europe	28	40.8	0	5	16.5	45	300
Latin America	18	31.4	3	7	15	41	132
North America	8	78.5	2	4	34	68	400
Global	82	39.2	0	7	17	45	400

Table II.30a(ii). Responses to Question 30a, giving the number of NDT companies whose number of full-time industrial radiographers, N, are in the following bands.

	Replies	Number of NDT companies whose number of full-time radiographers, N, is in the following bands:						
		N=0	0<N<5	5≤N<10	10≤N<20	20≤N<50	50≤N<100	N≥100
Africa	5	0	2	2	0	1	0	0
Asia-Pacific	23	0	0	3	6	9	3	2
Europe	28	1	5	6	3	7	2	4
Latin America	18	0	2	4	4	4	3	1
North America	8	0	3	1	0	0	3	1
Global	82	1	12	16	13	21	11	8

Table II.30a(iii). Responses to Question 30a, giving the number of part-time industrial radiographers employed by the responding NDT Companies.

	Replies	Number of part-time radiographers per NDT company					
		Mean	Min	Q1	Median	Q3	Max
Africa	4	0.3	0	0	0	0.3	1
Asia-Pacific	23	0.9	0	0	0	0	6
Europe	28	7.7	0	0	0	0	90
Latin America	18	0.5	0	0	0	0	5
North America	8	0.4	0	0	0	0	3
Global	81	3.1	0	0	0	0	90

Note: Most replies (67 out of 81) were that part-time radiographers were not employed in the NDT company.

Table II.30a(iv). Responses to Question 30a, giving the number of NDT companies whose number of part-time industrial radiographers, N_p , are in the following bands.

	Replies	Number of NDT companies whose number of part-time radiographers, N_p , is in the following bands:						
		$N_p=0$	$0 < N_p < 5$	$5 \leq N_p < 10$	$10 \leq N_p < 20$	$20 \leq N_p < 50$	$50 \leq N_p < 100$	$N_p \geq 100$
Africa	4	3	1	0	0	0	0	0
Asia-Pacific	23	18	2	3	0	0	0	0
Europe	28	23	0	1	1	1	2	0
Latin America	18	16	1	1	0	0	0	0
North America	8	7	1	0	0	0	0	0
Global	81	67	5	5	1	1	2	0

Note: Only 4 NDT companies replied that they employed itinerant industrial radiographers.

Table II.30b. From the responses to Question 30b, the average percentages of industrial radiographers, in a NDT company, that work at the company base, client sites, or both.

	Replies	Percentage of radiographers in a NDT company at base, client site or both:					
		Base		Client sites		Base and client sites	
		Mean	Std dev	Mean	Std dev	Mean	Std dev
Africa	5	11.7	16.2	20.0	44.7	68.3	41.0
Asia-Pacific	19	24.7	37.2	36.4	42.9	39.2	43.8
Europe	25	14.1	28.5	26.5	40.6	59.9	44.7
Latin America	17	39.9	48.4	25.7	39.7	34.4	46.2
North America	8	6.6	11.91	19.1	35.6	74.3	45.9
Global	74	21.8	35.8	27.6	40.1	50.8	45.8

Note: the percentages in this table do not necessarily correspond to the relative workloads (i.e. number of exposures) at these locations.

Table II.30c. From the responses to Question 30c, the average percentages of industrial radiographers, in a NDT company, that perform radiography with gamma sources only, X-Ray sources only, or both.

	Replies	Percentage of radiographers in a NDT company using gamma sources only, X-Ray sources only, or both:					
		Gamma only		X-Ray only		Gamma and X-Ray	
		Mean	Std dev	Mean	Std dev	Mean	Std dev
Africa	4	50.0	57.7	25.0	50.0	25.0	50.0
Asia-Pacific	23	19.8	35.6	13.4	28.1	63.8	42.2
Europe	26	16.9	34.4	9.1	27.0	71.1	41.0
Latin America	18	23.4	37.6	25.1	41.8	51.5	47.5
North America	8	55.2	47.3	2.2	4.6	42.5	47.4
Global	79	24.8	39.1	14.1	31.5	59.5	44.6

Notes:

1. There were some inconsistencies in the answers to question 30b and 30c. Some responders interpreted the options as being mutually exclusive, while others did not. Hence the values reported in Tables II.30b and c must be treated with some caution.
2. Most of the NDT companies (52 out of 60) reported that their radiographers also performed non-RT NDT methods.

Table II.31. Responses to Question 31 – Does your Company have a Radiation Protection Officer or Radiation Protection Expert included in its organization?

	Yes	No	Don't know	No reply	Total
Africa	5	1	0	1	7
Asia-Pacific	33	0	0	0	33
Europe	26	2	0	0	28
Latin America	19	0	0	0	19
North America	8	0	0	0	8
Global	91	3	0	1	95

Table II.31a. Responses to Question 31a – If yes to Question 31, does he/she report directly to the Managing Director?

	Yes	No	Don't know	No reply	Total
Africa	1	1	2	1	5
Asia-Pacific	29	2	1	1	33
Europe	22	4	0	0	26
Latin America	18	1	0	0	19
North America	8	0	0	0	8
Global	78	8	3	2	91

APPENDIX III. DETAILED RESULTS OF THE QUESTIONNAIRE ON OCCUPATIONAL RADIATION PROTECTION IN INDUSTRIAL RADIOGRAPHY ADDRESSED TO REGULATORY BODIES

The principal findings from the regulatory body (RB) questionnaire are given in the Results section of the main text. Appendix III gives additional data in the form of tables and figures. Note, not all questions were answered by all responders. The abbreviations RB and RP are used for “regulatory body” and “radiation protection”.

Table III.0. Number of regulatory bodies contacted, and numbers and percentages (in parentheses) of responses received; and the world population represented:

Region	Countries contacted	Countries responded	RBs contacted	RB responses	Total regional population, 10 ⁶	Total population of responding countries, 10 ⁶
Africa	35	8	35	8 (23)*	980	205 (21)
Asia-Pacific	27	13	35	16 (46)	3750	1660 (44)
Europe	49	27	49	27 (55)	900	255 (28)
Latin America	20	5	20	5 (25)	580	188 (32)
North America	2	2	3	3 (100)	350	350 (100)
Global	133	55	142	59	6560	2650 (40)

* Values in parentheses are percentages of the corresponding total.

III.1. TRAINING AND QUALIFICATIONS OF INDUSTRIAL RADIOGRAPHERS

Table III.1. Responses to Question 1 – Does the (radiation protection) Regulatory Body require that persons wishing to perform on-site radiography must have had radiation protection training to an acceptable level?

	Yes	No	Don't know	No reply	Total
Africa	8	0	0	0	8
Asia-Pacific	16	0	0	0	16
Europe	26	1	0	0	27
Latin America	5	0	0	0	5
North America	3	0	0	0	3
Global	58	1	0	0	59

Table III.1a. Responses to Question 1a(i) – If yes to Question 1, what radiation protection training does the Regulatory Body consider as acceptable - radiation protection training that is part of the NDT-training on Radiographic Testing?

	Yes	No	Don't know	No reply	Total
Africa	6	0	0	2	8
Asia-Pacific	10	4	0	2	16
Europe	15	7	1	3	26
Latin America	1	3	0	1	5
North America	3	0	0	0	3
Global	35	14	1	8	58

Table III.1a(ii). Responses to Question 1a(ii) – If yes to Question 1, what radiation protection training does the Regulatory Body consider as acceptable – radiation protection training that is a separate training course?

	Yes	No	Don't know	No reply	Total
Africa	4	2	0	2	8
Asia-Pacific	12	2	0	2	16
Europe	20	4	1	1	26
Latin America	5	0	0	0	5
North America	2	1	0	0	3
Global	43	9	1	5	58

Table III.1b. Responses to Question 1b. – If yes to Question 1, does the Regulatory Body have the same radiation protection training requirements for using gamma sources as for using X-ray machines?

	Yes	No	Don't know	No reply	Total
Africa	5	2	0	1	8
Asia-Pacific	14	1	1	0	16
Europe	20	4	0	2	26
Latin America	4	0	1	0	5
North America	0	0	1	2	3
Global	43	7	3	5	58

Table III.1c. Responses to Question 1c – If yes to Question 1, does the Regulatory Body require that the radiation protection training includes both theoretical and practical training?

	Yes	No	Don't know	No reply	Total
Africa	7	1	0	0	8
Asia-Pacific	13	3	0	0	16
Europe	24	2	0	0	26
Latin America	5	0	0	0	5
North America	2	1	0	0	3
Global	51	7	0	0	58

Table III.1d(i). Responses to Question 1d(i) – If yes to Question 1, does the Regulatory Body require that the radiation protection training includes practical exercises for emergencies for creating a safe situation until the source is able to be recovered?

	Yes	No	Don't know	No reply	Total
Africa	7	1	0	0	8
Asia-Pacific	12	4	0	0	16
Europe	15	8	3	0	26
Latin America	5	0	0	0	5
North America	2	0	0	1	3
Global	41	13	3	1	58

Table III.1d(ii). Responses to Question 1d(ii) – If yes to Question 1, does the Regulatory Body require that the radiation protection training includes practical exercises for emergencies for source recovery?

	Yes	No	Don't know	No reply	Total
Africa	5	2	0	1	8
Asia-Pacific	11	4	0	1	16
Europe	11	11	3	1	26
Latin America	5	0	0	0	5
North America	2	0	0	1	3
Global	34	17	3	4	58

Table III.1e. Responses to Question 1e – If yes to Question 1, does having the acceptable level of RP training (either as part of the NDT programme or as separate training) include having passed an examination at the end of the radiation protection training?

	Yes	No	Don't know	No reply	Total
Africa	6	2	0	0	8
Asia-Pacific	14	1	0	1	16
Europe	22	3	1	0	26
Latin America	5	0	0	0	5
North America	3	0	0	0	3
Global	50	6	1	1	58

Table III.1f. Responses to Question 1f – If yes to Question 1e, is the examination on radiation protection: theoretical only; practical only; or both theoretical and practical?

	Theory only	Practical only	Both theory & practical	No reply	Total
Africa	0	0	5	1	6
Asia-Pacific	8	0	6	0	14
Europe	11	0	11	0	22
Latin America	2	0	3	0	5
North America	1	0	2	0	3
Global	22	0	27	1	50

Table III.1g. Responses to Question 1g – If yes to Question 1a(ii), are the separate training courses conducted by: the RB; educational institutes; private NDT companies; private radiation protection consultants; or other?

	Number of RBs who consider separate RP training as acceptable	Acceptable as RP training providers – number of responses:			
		RB	Educational Institutes	Private NDT Companies	Private RP consultants
Africa	4	4	2	1	2
Asia-Pacific	12	6	8	8	3
Europe	20	5	10	7	11
Latin America	5	2	2	1	2
North America	2	1	2	2	2
Global	43	18	24	19	20

Several responses indicated that the “course provider” needed to be authorized or approved by the RB. A few RBs indicated that they recognized training by some other specific countries.

Table III.2. Responses to Question 2 – Does the Regulatory Body require refresher training in radiation protection for persons performing on-site radiography?

	Yes	No	Don't know	No reply	Total
Africa	6	2	0	0	8
Asia-Pacific	8	8	0	0	16
Europe	22	5	0	0	27
Latin America	3	2	0	0	5
North America	2	1	0	0	3
Global	41	18	0	0	59

Table III.2a. Responses to Question 2a – If yes to Question 2, what is the time interval between refresher courses?

	Replies	Time interval between refresher course (years)						No reply
		Mean	Min	Q1	Median	Q3	Max	
Africa	6	3.7	1	3	4	5	5	0
Asia-Pacific	8	3.0	1	1.8	2.5	5	5	0
Europe	19	4.7	1	5	5	5	10	3
Latin America	2	2.0	1	-	2	-	3	1
North America	2	3.0	3	-	3	-	3	0
Global	37	4.0	1	3	5	5	10	4

Table III.2b. Responses to Question 2b – If yes to Question 2, is there an examination as part of the refresher training?

	Yes	No	Don't know	No reply	Total
Africa	1	4	0	1	6
Asia-Pacific	2	5	0	1	8
Europe	14	6	1	1	22
Latin America	3	0	0	0	3
North America	1	0	1	0	2
Global	21	15	2	3	41

Table III.3. Responses to Question 3 – Does the Regulatory Body require that a person wishing to act as a Radiation Protection Officer (RPO) for a Company that performs on-site radiography must have had radiation protection training to an acceptable level?

	Yes	No	Don't know	No reply	Total
Africa	8	0	0	0	8
Asia-Pacific	15	1	0	0	16
Europe	26	1	0	0	27
Latin America	5	0	0	0	5
North America	3	0	0	0	3
Global	57	2	0	0	59

Table III.3a. Responses to Question 3a – If yes to Question 3, is the acceptable level higher than that for an operator (as in Question 1)?

	Yes	No	Don't know	No reply	Total
Africa	4	4	0	0	8
Asia-Pacific	11	4	0	0	15
Europe	19	6	0	1	26
Latin America	3	2	0	0	5
North America	2	1	0	0	3
Global	39	17	0	1	57

Table III.3b. Responses to Question 3b – If yes to Question 3, is there an examination as part of the training to be an RPO?

	Yes	No	Don't know	No reply	Total
Africa	5	3	0	0	8
Asia-Pacific	10	1	0	4	15
Europe	20	5	0	1	26
Latin America	4	1	0	0	5
North America	3	0	0	0	3
Global	42	10	0	5	57

III.2. INCIDENTS (DEVIATIONS, NEAR MISSES AND ACCIDENTS)

Table III.4. Responses to Question 4 – does the Regulatory Body require the authorized party (licensee) to report radiation incidents in Industrial Radiography to the Regulatory Body?

	Yes	No	Don't know	No reply	Total
Africa	7	1	0	0	8
Asia-Pacific	15	1	0	0	16
Europe	27	0	0	0	27
Latin America	3	2	0	0	5
North America	3	0	0	0	3
Global	55	4	0	0	59

Table III.4a. Responses to Question 4a – If yes to Question 4, what are the criteria for requiring a licensee to notify the Regulatory Body?

	No. of RBs stating criteria	Number of RBs stating the following criteria:			
		Lost, stolen source	Source stuck, or equipment malfunction with implications for safety	Event that caused (or could have) significant exposure (workers or public)	Specified in Regs but no details given
Africa	4	2	1	3	1
Asia-Pacific	11	2	1	5	5
Europe	23	10	5	19	4
Latin America	2	1	1	1	1
North America	3	1	2	3	0
Global	43	16	10	31	11

Table III.5a. Responses to Question 5a – How many radiation incidents in Industrial Radiography with elevated individual exposures higher than the annual limit were notified to the Regulatory Body in the last five years?

	Replies	Number of notified accidents with elevated individual exposures higher than the annual dose limits								No reply
		No. of zero notifications	Total no. of notifications	Mean	Min	Q1	Median	Q3	Max	
Africa	7	6	1	0.1	0	0	0	0	1	0
Asia-Pacific	12	3	20	1.7	0	0.8	1	1.3	9	3
Europe	25	23	3	0.1	0	0	0	0	2	2
Latin America	3	3	0	0	0	-	0	-	0	0
North America	3	1	10	3.3	0	-	1	-	9	0
Global	50	36	34	0.7	0	0	0	1	9	5

Table III.5b. Responses to Question 5b – How many radiation incidents in Industrial Radiography with elevated individual exposures lower than the annual limit were notified to the Regulatory Body in the last five years?

	Replies	Number of notified accidents with elevated individual exposures lower than the annual dose limits								No reply
		No. of zero notifications	Total no. of notifications	Mean	Min	Q1	Median	Q3	Max	
Africa	7	6	2	0.3	0	0	0	0	2	0
Asia-Pacific	11	3	126	11.5	0	0.5	1	2.5	113	4
Europe	25	16	50	2.0	0	0	0	2	11	2
Latin America	3	3	0	0	0	-	0	-	0	0
North America	2	1	3	1.5	0	-	1.5	-	3	1
Global	48	29	181	3.8	0	0	0	2	113	7

Table III.5c. Responses to Question 5c – How many near misses in Industrial Radiography, that had the potential for elevated individual exposures higher than the annual limit, were notified to the Regulatory Body in the last five years?

	Replies	Number of notified near misses with the potential for elevated individual exposures higher than the annual dose limits								No reply
		No. of zero notifications	Total no. of notifications	Mean	Min	Q1	Median	Q3	Max	
Africa	7	7	0	0	0	0	0	0	0	0
Asia-Pacific	11	8	10	0.9	0	0	0	0.5	8	4
Europe	24	19	11	0.5	0	0	0	0	4	3
Latin America	3	2	1	0.3	0	-	0	-	1	0
North America	1	1	0	0	-	-	0	0	0	2
Global	46	37	22	0.5	0	0	0	0	8	9

Table III.5d. Responses to Question 5d – How many near misses in Industrial Radiography, that had the potential for elevated individual exposures lower than the annual limit, were notified to the Regulatory Body in the last five years?

	Replies	Number of notified near misses with the potential for elevated individual exposures lower than the annual dose limits								No reply
		No. of zero notifications	Total no. of notifications	Mean	Min	Q1	Median	Q3	Max	
Africa	7	6	1	0.1	0	0	0	0	1	0
Asia-Pacific	11	9	7	0.6	0	0	0	0	4	4
Europe	24	17	34	1.4	0	0	0	1.3	12	3
Latin America	3	2	4	1.3	0	-	0	-	4	0
North America	1	1	0	0	-	-	0	-	-	2
Global	46	35	46	1.0	0	0	0	0	12	9

Table III.5e. Responses to Question 5e – How many other deviations in Industrial Radiography were notified to the Regulatory Body in the last five years?

	Replies	Number of notified other deviations								No reply
		Zero notifications	Total notifications	Mean	Min	Q1	Median	Q3	Max	
Africa	7	5	3	0.4	0	0	0	0.5	2	0
Asia-Pacific	9	7	13	1.4	0	0	0	0	11	6
Europe	24	15	50	2.1	0	0	0	3	12	3
Latin America	2	1	1	0.5	0	-	0.5	-	1	1
North America	2	0	114	57.0	4	-	57	-	110	1
Global	44	28	181	4.1	0	0	0	2	110	11

Table III.6. Responses to Question 6 – Does the Regulatory Body maintain a radiation incident database for your jurisdiction (country or state)?

	Yes	No	Don't know	No reply	Total
Africa	5	3	0	0	8
Asia-Pacific	15	1	0	0	16
Europe	16	10	0	1	27
Latin America	1	4	0	0	5
North America	3	0	0	0	3
Global	40	18	0	1	59

Table III.6a. Responses to Question 6a – If yes to Question 6, does the Regulatory Body analyse the database regularly, using established criteria, to determine if there are common factors in the incidents?

	Yes	No	Don't know	No reply	Total
Africa	2	1	0	2	5
Asia-Pacific	7	5	0	3	15
Europe	11	4	0	1	16
Latin America	1	0	0	0	1
North America	2	0	1	0	3
Global	23	10	1	6	40

Table III.6b. Responses to Question 6b – If yes to Question 6, does the Regulatory Body use the International Nuclear and Radiological Event Scale (INES) to classify the severity of the incidents?

	Yes	No	Don't know	No reply	Total
Africa	2	1	0	2	5
Asia-Pacific	8	4	3	0	15
Europe	11	3	0	2	16
Latin America	1	0	0	0	1
North America	1	1	0	1	3
Global	23	9	3	5	40

Table III.6c. Responses to Question 6c – If no to Question 6b, does the Regulatory Body use another scale to classify the severity of the incidents

	Yes	No	Don't know	No reply	Total
Africa	0	1	0	0	1
Asia-Pacific	1	3	0	0	4
Europe	0	3	0	0	3
Latin America	0	0	0	0	0
North America	1	0	0	0	1
Global	2	7	0	0	9

Note: In response to Question 6d – If yes to Question 6c, please specify, two RB replied that their regulations specified the scale for use.

Table III.7. Responses to Question 7 – Does the Regulatory Body have an established system for sharing lessons learned from reported incidents, including an analysis of the root causes and the corrective actions taken?

	Yes	No	Don't know	No reply	Total
Africa	1	5	0	2	8
Asia-Pacific	9	7	0	0	16
Europe	13	12	0	2	27
Latin America	1	4	0	0	5
North America	3	0	0	0	3
Global	27	28	0	4	59

Table III.7a(i). Responses to Question 7a(i) – If yes to Question 7, is the information disseminated to Operating NDT companies in your jurisdiction?

	Yes	No	Don't know	No reply	Total
Africa	1	0	0	0	1
Asia-Pacific	6	1	1	1	9
Europe	13	0	0	0	13
Latin America	1	0	0	0	1
North America	3	0	0	0	3
Global	24	1	1	1	27

Table III.7a(ii). Responses to Question 7a(ii) – If yes to Question 7, is the information disseminated to other regulatory bodies in other countries or states?

	Yes	No	Don't know	No reply	Total
Africa	1	0	0	0	1
Asia-Pacific	0	6	1	2	9
Europe	6	6	0	1	13
Latin America	1	0	0	0	1
North America	2	0	1	0	3
Global	10	12	2	3	27

Table III.7b(i). Responses to Question 7b(i) – If yes to Question 7, how many times in the last 5 years has information from reported incidents been disseminated to Operating NDT companies in your jurisdiction?

	Replies	Number of disseminations to NDT companies							No reply
		Total	Mean	Min	Q1	Median	Q3	Max	
Africa	1	0	0	-	-	0	-	-	0
Asia-Pacific	5	6	1.2	0	0	0	2	4	4
Europe	10	12	1.2	0	0	0.5	2	5	3
Latin America	1	0	0	-	-	0	-	-	0
North America	0	0	-	-	-	-	-	-	3
Global	17	18	1.1	0	0	0	2	5	10

Table III.7b(ii). Responses to Question 7b(ii) – If yes to Question 7, how many times in the last 5 years has information from reported incidents been disseminated to other regulatory bodies in other countries or states?

	Replies	Number of disseminations to other RBs							No reply
		Total	Mean	Min	Q1	Median	Q3	Max	
Africa	1	0	0	-	-	0	-	-	0
Asia-Pacific	3	0	0	0	-	0	-	0	6
Europe	10	5	0.5	0	0	0	0	5	3
Latin America	1	0	0	-	-	0	-	-	0
North America	1	86	86	-	-	86	-	-	2
Global	16	91	5.7	0	0	0	0	86	11

Table III.8. Responses to Question 8 – If you are the national (radiation protection) Regulatory Body, did you report the incidents to the International Atomic Energy Agency (IAEA) in the last 5 years?

	Yes	No	Don't know	No reply	Total
Africa	2	5	0	1	8
Asia-Pacific	5	7	0	4	16
Europe	5	16	2	4	27
Latin America	2	3	0	0	5
North America	2	0	1	0	3
Global	16	31	3	9	59

III.3. SYSTEMS AND PROCEDURES IN PLACE TO ENSURE PROTECTION AND SAFETY IN INDUSTRIAL RADIOGRAPHY

III.3.1. SAFETY OF THE RADIOGRAPHER

Table III.9a. Responses to Question 9a – What type of individual monitoring does the RB require the radiographer to have : passive dosimeter?

	Yes	No	Don't know	No reply	Total
Africa	6	0	0	2	8
Asia-Pacific	16	0	0	0	16
Europe	26	0	0	1	27
Latin America	5	0	0	0	5
North America	3	0	0	0	3
Global	56	0	0	3	59

Table III.9b. Responses to Question 9b – What type of individual monitoring does the RB require the radiographer to have : Active dosimeter?

	Yes	No	Don't know	No reply	Total
Africa	5	2	0	1	8
Asia-Pacific	10	5	1	0	16
Europe	24	1	0	2	27
Latin America	3	2	0	0	5
North America	3	0	0	0	3
Global	45	10	1	3	59

Table III.9c. Responses to Question 9c – If yes to 9b, is the active dosimeter required to measure integrated dose?

	Yes	No	Don't know	No reply	Total
Africa	3	2	0	0	5
Asia-Pacific	6	1	0	3	10
Europe	14	8	2	0	24
Latin America	3	0	0	0	3
North America	1	2	0	0	3
Global	27	13	2	3	45

Table III.9d(i). Responses to Question 9d(i) – If yes to 9b, is the active dosimeter required to have a visual alarm?

	Yes	No	Don't know	No reply	Total
Africa	2	1	0	2	5
Asia-Pacific	5	5	0	0	10
Europe	14	6	2	2	24
Latin America	1	1	0	1	3
North America	3	0	0	0	3
Global	25	13	2	5	45

Table III.9d(ii). Responses to Question 9d(ii) – If yes to 9b, is the active dosimeter required to have an audible alarm?

	Yes	No	Don't know	No reply	Total
Africa	4	1	0	0	5
Asia-Pacific	10	0	0	0	10
Europe	21	1	1	1	24
Latin America	3	0	0	0	3
North America	3	0	0	0	3
Global	41	2	1	1	45

Table III.9d(iii). Responses to Question 9d(iii) – If yes to 9b, is the active dosimeter required to have a vibrating alarm?

	Yes	No	Don't know	No reply	Total
Africa	0	3	0	2	5
Asia-Pacific	1	8	1	0	10
Europe	7	11	2	4	24
Latin America	0	2	0	1	3
North America	1	2	0	0	3
Global	9	26	3	7	45

Table III.10a. Responses to Question 10a – Whom does the RB require to be informed about the personal doses of the monitored radiographers – the radiographers?

	Yes	No	Don't know	No reply	Total
Africa	4	2	0	2	8
Asia-Pacific	13	2	0	1	16
Europe	20	5	1	1	27
Latin America	4	0	0	1	5
North America	3	0	0	0	3
Global	44	9	1	5	59

Table III.10a(i). Responses to Question 10a(i) – If yes, frequency per year = ?

	Replies	Number of times per year						No reply
		Mean	Min	Q1	Median	Q3	Max	
Africa	2	8.0	4	-	8	-	12	2
Asia-Pacific	9	8.7	4	4	12	12	12	4
Europe	16	9.1	1	4	12	12	12	4
Latin America	4	7.3	1	3.3	8	12	12	0
North America	3	2.0	1	-	1	-	4	0
Global	34	8.1	1	4	12	12.0	12	10

Table III.10b. Responses to Question 10b – Whom does the RB require to be informed about the personal doses of the monitored radiographers – the NDT Company or employer of the radiographer?

	Yes	No	Don't know	No reply	Total
Africa	7	0	0	1	8
Asia-Pacific	15	1	0	0	16
Europe	23	3	1	0	27
Latin America	5	0	0	0	5
North America	3	0	0	0	3
Global	53	4	1	1	59

Table III.10b(i). Responses to Question 10b(i) – If yes, frequency per year = ?

	Replies	Number of times per year						No reply
		Mean	Min	Q1	Median	Q3	Max	
Africa	6	8.3	4	4.5	9	12	12	1
Asia-Pacific	11	7.5	4	4	6	12	12	4
Europe	19	9.4	1	5	12	12	12	4
Latin America	5	8.2	1	4	12	12	12	0
North America	3	9.7	1	-	4	-	24	0
Global	44	8.6	1	4	12	12	24	9

Table III.10c. Responses to Question 10c – Whom does the RB require to be informed about the personal doses of the monitored radiographers – the (radiation protection) Regulatory Body?

	Yes	No	Don't know	No reply	Total
Africa	4	2	0	2	8
Asia-Pacific	10	4	0	2	16
Europe	18	7	1	1	27
Latin America	4	0	0	1	5
North America	2	1	0	0	3
Global	38	14	1	6	59

Table III.10c(i). Responses to Question 10c(i) – If yes, frequency per year = ?

	Replies	Number of times per year						No reply
		Mean	Min	Q1	Median	Q3	Max	
Africa	3	6.3	1	-	6	-	12	1
Asia-Pacific	7	4.1	1	1	4	5	12	3
Europe	15	6.3	1	1	6	12	12	3
Latin America	4	4.5	1	1	2.5	6	12	0
North America	1	1.0	-	-	1	-	-	1
Global	30	5.4	1	1	4	12	12	8

Table III.10d. Responses to Question 10d – Whom does the RB require to be informed about the personal doses of the monitored radiographers – the National Personal Dose Database?

	Yes	No	Don't know	No reply	Total
Africa	2	3	0	3	8
Asia-Pacific	8	4	1	3	16
Europe	21	3	0	3	27
Latin America	2	2	0	1	5
North America	3	0	0	0	3
Global	36	12	1	10	59

Table III.10d(i). Responses to Question 10d – If yes, frequency per year = ?

	Replies	Number of times per year						No reply
		Mean	Min	Q1	Median	Q3	Max	
Africa	0	-	-	-	-	-	-	2
Asia-Pacific	6	6.5	1	4	5	10.5	12	2
Europe	17	7.9	1	2	12	12	12	4
Latin America	2	8.0	4	-	8	-	12	0
North America	2	12.5	1	-	12.5	-	24	1
Global	27	8.0	1	3	12	12	24	9

Table III.11. Responses to Question 11 – Does the Regulatory Body require that the radiographer always has a functioning and calibrated survey meter with them?

	Yes	No	Don't know	No reply	Total
Africa	7	0	0	1	8
Asia-Pacific	13	0	0	3	16
Europe	24	3	0	0	27
Latin America	5	0	0	0	5
North America	3	0	0	0	3
Global	52	3	0	4	59

III.3.2. SAFETY OF THE PUBLIC

Table III.12. Responses to Question 12 – Does the Regulatory Body require that it is informed in advance about individual on-site Industrial Radiography jobs?

	Yes	No	Don't know	No reply	Total
Africa	3	4	0	1	8
Asia-Pacific	4	12	0	0	16
Europe	11	16	0	0	27
Latin America	3	1	1	0	5
North America	1	2	0	0	3
Global	22	35	1	1	59

Table III.12a. Responses to Question 12a – If yes to Question 12, how long in advance must the notification be (in hours)?

	Replies	Advance notification in hours						No reply
		Mean	Min	Q1	Median	Q3	Max	
Africa	1	24.0	-	-	24	-	-	2
Asia-Pacific	3	24.0	24	-	24	-	24	1
Europe	10	55.2	24	30	60	72	96	1
Latin America	3	56.0	24	-	24	-	120	0
North America	0	-	-	-	-	-	-	1
Global	17	48.0	24	24	24	72	120	5

Table III.13. Responses to Question 13 – Does the Regulatory Body require there to be a warning system to prevent entry to the radiography site?

	Yes	No	Don't know	No reply	Total
Africa	7	0	0	1	8
Asia-Pacific	16	0	0	0	16
Europe	26	1	0	0	27
Latin America	4	0	1	0	5
North America	3	0	0	0	3
Global	56	1	1	1	59

Table III.13a. Responses to Question 13a – If yes to Question 13, does the RB have an official standard procedure for warning systems that must be followed?

	Yes	No	Don't know	No reply	Total
Africa	5	2	0	0	7
Asia-Pacific	16	0	0	0	16
Europe	21	5	0	0	26
Latin America	3	1	0	0	4
North America	2	1	0	0	3
Global	47	9	0	0	56

Table III.13b(i). Responses to Question 13b(i) – If yes to Question 13a, does the official standard procedure for a warning system require barriers?

	Yes	No	Don't know	No reply	Total
Africa	5	0	0	0	5
Asia-Pacific	15	0	0	1	16
Europe	21	0	0	0	21
Latin America	3	0	0	0	3
North America	2	0	0	0	2
Global	46	0	0	1	47

Table III.13b(ii). Responses to Question 13b(ii) – If yes to Question 13a, does the official standard procedure for a warning system require warning signs?

	Yes	No	Don't know	No reply	Total
Africa	5	0	0	0	5
Asia-Pacific	16	0	0	0	16
Europe	21	0	0	0	21
Latin America	3	0	0	0	3
North America	2	0	0	0	2
Global	47	0	0	0	47

Table III.13b(iii). Responses to Question 13b(iii) – If yes to Question 13a, does the official standard procedure for a warning system require flashing lights?

	Yes	No	Don't know	No reply	Total
Africa	4	0	0	1	5
Asia-Pacific	10	5	0	1	16
Europe	13	6	0	2	21
Latin America	3	0	0	0	3
North America	1	1	0	0	2
Global	31	12	0	4	47

Table III.13b(iv). Responses to Question 13b(iv) – If yes to Question 13a, does the official standard procedure for a warning system require other features?

	Yes	No	Don't know	No reply	Total
Africa	0	2	0	3	5
Asia-Pacific	3	7	1	5	16
Europe	3	10	1	7	21
Latin America	2	0	0	1	3
North America	1	1	0	0	2
Global	9	20	2	16	47

Note: In response to – If yes to Question 13b(iv), please specify, eight RB replies were given: Operator vigilance/surveillance (3); an additional operator to monitor the area (2); audible alarm (2); Survey of boundary dose rate (1).

Table III.13c. Responses to Question 13c – If yes to Question 13a, what maximum dose rate does the official standard procedure specify at the barrier:

	Replies	Maximum dose rate at the barrier ($\mu\text{Sv}/\text{hour}$)						No reply
		Mean	Min	Q1	Median	Q3	Max	
Africa	3	11.0	0.5	-	7.5	-	25	2
Asia-Pacific	15	14.3	0.5	2.5	20	25	25	1
Europe	20	40.5	0.1	7.5	15	60	300	1
Latin America	3	8.2	7	-	7.5	-	10	0
North America	2	100.0	100	-	100	-	100	0
Global	43	29.8	0.1	7.5	10	25	300	4

Table III.14. Responses to Question 14 – Does the Regulatory Body require the client (who is receiving the on-site radiography services) to inform the licensee (of the Operating NDT Company) about conditions at the site that might affect the safety of other workers on site?

	Yes	No	Don't know	No reply	Total
Africa	6	1	0	1	8
Asia-Pacific	7	9	0	0	16
Europe	10	17	0	0	27
Latin America	1	4	0	0	5
North America	0	3	0	0	3
Global	24	34	0	1	59

Table III.14a(i). Responses to Question 14a(i) – If yes to Question 14, does this include the provision of site plans?

	Yes	No	Don't know	No reply	Total
Africa	4	2	0	0	6
Asia-Pacific	4	0	2	1	7
Europe	8	1	1	0	10
Latin America	1	0	0	0	1
North America	0	0	0	0	0
Global	17	3	3	1	24

Table III.14a(ii). Responses to Question 14a(ii) – If yes to Question 14, does this include information about other worker activities, occurring at the same time and in the vicinity of where the radiography will occur?

	Yes	No	Don't know	No reply	Total
Africa	5	0	0	1	6
Asia-Pacific	6	0	0	1	7
Europe	10	0	0	0	10
Latin America	1	0	0	0	1
North America	0	0	0	0	0
Global	22	0	0	2	24

Table III.15. Responses to Question 15 – Does the Regulatory Body require that there is a qualified Radiation Protection Officer (RPO) or Radiation Protection Expert (RPE) on the work site during on-site radiography?

	Yes	No	Don't know	No reply	Total
Africa	5	2	0	1	8
Asia-Pacific	9	6	0	1	16
Europe	9	18	0	0	27
Latin America	4	1	0	0	5
North America	1	2	0	0	3
Global	28	29	0	2	59

III.3.3. SAFETY OF SOURCES AND EXPOSURE DEVICES

Table III.16. Responses to Question 16 – Does the Regulatory Body require that any sealed source used for industrial radiography purposes must meet specified standards?

	Yes	No	Don't know	No reply	Total
Africa	7	0	0	1	8
Asia-Pacific	11	3	2	0	16
Europe	20	5	0	2	27
Latin America	4	1	0	0	5
North America	1	1	0	1	3
Global	43	10	2	4	59

Table III.16a. Responses to Question 16a – If yes to Question 16, please specify the standards:

	No. of RBs providing information	Standards specified							
		a	b	c	d	e	f	g	h
Africa	4	1	1	0	0	3	0	0	0
Asia-Pacific	8	4	1	3	1	0	1	0	0
Europe	15	9	1	4	0	1	3	0	0
Latin America	3	1	0	1	0	2	0	1	0
North America	1	0	0	0	0	0	0	0	1
Global	31	15	3	8	1	6	4	1	1

a = ISO2919:1999 RP - Sealed radioactive sources - general requirements

b = ISO9978:1992 RP - Sealed radioactive sources - leakage test methods

c = National regulations, standards or norms

d = ISO3999:2004 - Radiation protection - Apparatus for industrial gamma radiography - Specifications for performance, design and tests

e = Unspecified international standards - ISO, IEC, IAEA, EU

f = Current special form certificate or transport certificate

g = IAEA TS-R-1

h = ANSI N432-1980, Radiological Safety for the Design and Construction of Apparatus for Gamma Radiography

Table III.17. Responses to Question 17 – Does the Regulatory Body require that any exposure device used for industrial radiography purposes must meet specified standards:

	Yes	No	Don't know	No reply	Total
Africa	6	0	0	2	8
Asia-Pacific	11	3	2	0	16
Europe	21	3	1	2	27
Latin America	3	2	0	0	5
North America	2	1	0	0	3
Global	43	9	3	4	59

Table III.17a. Responses to Question 17a – If yes to Question 17, please specify the standards:

	No. of RBs providing information	Standards specified							
		a	b	c	d	e	f	g	h
Africa	4	1	1	0	0	3	0	0	0
Asia-Pacific	8	0	0	4	2	1	1	1	0
Europe	17	0	0	3	11	3	2	0	0
Latin America	2	0	0	1	1	0	0	0	0
North America	2	0	0	1	0	0	0	0	1
Global	33	1	1	9	14	7	3	1	1

a = ISO2919:1999 RP - Sealed radioactive sources - general requirements

b = ISO9978:1992 RP - Sealed radioactive sources - leakage test methods

c = National regulations, standards or norms

d = ISO3999:2004 - Radiation protection - Apparatus for industrial gamma radiography - Specifications for performance, design and tests

e = Unspecified international standards - ISO, IEC, IAEA, EU

f = Current special form certificate or transport certificate

g = IAEA TS-R-1

h = ANSI N432-1980, Radiological Safety for the Design and Construction of Apparatus for Gamma Radiography

Table III.18. Responses to Question 18 – Does the Regulatory Body require that the source and the exposure device are subject to rigorous periodic inspections/tests and maintenance to verify compliance with required standards?

	Yes	No	Don't know	No reply	Total
Africa	6	1	0	1	8
Asia-Pacific	11	4	0	1	16
Europe	21	4	0	2	27
Latin America	4	1	0	0	5
North America	3	0	0	0	3
Global	45	10	0	4	59

Table III.18a. Responses to Question 18a – If yes to Question 18, what is the required frequency?

	Replies	Number of months between inspections						No reply
		Mean	Min	Q1	Median	Q3	Max	
Africa	4	14.5	4	10	12	16.5	30	2
Asia-Pacific	11	10.6	3	12	12	12	12	0
Europe	15	14.7	1	12	12	12	60	6
Latin America	3	8.3	1		12		12	1
North America	2	3.0	3		3		3	1
Global	35	12.2	1	9	12	12	60	10

Note: 4 RBs stated that the frequency was variable; 2 invoked manufacturer's specifications; and 1 stated at reload.

Table III.18b. Responses to Question 18b – If yes to Question 18, are accessories included?

	Yes	No	Don't know	No reply	Total
Africa	3	0	1	2	6
Asia-Pacific	10	1	0	0	11
Europe	19	2	0	0	21
Latin America	4	0	0	0	4
North America	3	0	0	0	3
Global	39	3	1	2	45

Table III.18c(i). Responses to Question 18c(i) – If yes to Question 18, who is permitted by the Regulatory Body to perform such services – the **manufacturer or manufacturer's agent**?

	Yes	No	Don't know	No reply	Total
Africa	4	2	0	0	6
Asia-Pacific	10	0	0	1	11
Europe	16	1	0	4	21
Latin America	4	0	0	0	4
North America	3	0	0	0	3
Global	37	3	0	5	45

Table III.18c(ii). Responses to Question 18c(ii) – If yes to Question 18, who is permitted by the Regulatory Body to perform such services – the **NDT Operating Company**?

	Yes	No	Don't know	No reply	Total
Africa	2	2	0	2	6
Asia-Pacific	8	2	0	1	11
Europe	8	7	1	5	21
Latin America	3	0	0	1	4
North America	3	0	0	0	3
Global	24	11	1	9	45

Table III.18c(iii). Responses to Question 18c(iii) – If yes to Question 18, who is permitted by the Regulatory Body to perform such services – a **third party**?

	Yes	No	Don't know	No reply	Total
Africa	2	1	0	3	6
Asia-Pacific	5	3	0	3	11
Europe	15	3	0	3	21
Latin America	1	2	0	1	4
North America	2	0	0	1	3
Global	25	9	0	11	45

Note: In response to, If yes to 18c(iii), please specify: 23 out of the 25 RBs specified that such services were permitted to be performed by companies, technical service organisations, or persons who had been approved or licensed or certified by the RB or other appropriate authority. 2 RBs did not provide details.

Table III.19. Responses to Question 19 – Does the Regulatory Body require that any X-ray generator used for industrial radiography purposes must meet specified standards?

	Yes	No	Don't know	No reply	Total
Africa	6	0	1	1	8
Asia-Pacific	10	4	1	1	16
Europe	16	9	1	1	27
Latin America	2	2	1	0	5
North America	2	0	0	1	3
Global	36	15	4	4	59

Table III.19a. Responses to Question 19a – If yes to Question 19, please specify the standards:

	Replies	No reply	National Standards	International Standards
Africa	4	2	0	4
Asia-Pacific	8	2	4	4
Europe	12	4	6	8
Latin America	1	1	1	0
North America	2	0	2	0
Global	27	9	13	16

Table III.20. Responses to Question 20 – Does the Regulatory Body require that the X-ray equipment are subject to rigorous periodic inspections/tests and maintenance to verify compliance with required standards?

	Yes	No	Don't know	No reply	Total
Africa	6	1	0	1	8
Asia-Pacific	8	6	1	1	16
Europe	22	5	0	0	27
Latin America	3	1	1	0	5
North America	2	0	0	1	3
Global	41	13	2	3	59

Table III.20a. Responses to Question 20a – If yes to Question 20, what is the required frequency:

	Replies	Number of months between inspections						No reply
		Mean	Min	Q1	Median	Q3	Max	
Africa	5	18.0	6	12	12	12	48	1
Asia-Pacific	8	10.9	3	12	12	12	12	0
Europe	14	15.9	1	12	12	12	60	8
Latin America	3	8.3	1	-	12	-	12	0
North America	2	3.0	3	-	3	-	3	0
Global	32	13.5	1	12	12	12	60	9

Table III.20b. Responses to Question 20b – If yes to Question 20, are accessories included?

	Yes	No	Don't know	No reply	Total
Africa	3	1	1	1	6
Asia-Pacific	6	0	0	2	8
Europe	20	1	0	1	22
Latin America	2	0	0	1	3
North America	2	0	0	0	2
Global	33	2	1	5	41

Table III.20c(i). Responses to Question 20c(i) – If yes to Question 20, who is permitted by the Regulatory Body to perform such services – the manufacturer or manufacturer's agent?

	Yes	No	Don't know	No reply	Total
Africa	4	0	0	2	6
Asia-Pacific	7	0	0	1	8
Europe	16	3	0	3	22
Latin America	3	0	0	0	3
North America	2	0	0	0	2
Global	32	3	0	6	41

Table III.20c(ii). Responses to Question 20c(ii) – If yes to Question 20, who is permitted by the Regulatory Body to perform such services – the NDT Operating Company?

	Yes	No	Don't know	No reply	Total
Africa	2	1	0	3	6
Asia-Pacific	7	0	0	1	8
Europe	11	4	1	6	22
Latin America	1	1	0	1	3
North America	2	0	0	0	2
Global	23	6	1	11	41

Table III.20c(iii). Responses to Question 20c(iii) – If yes to Question 20, who is permitted by the Regulatory Body to perform such services – a third party?

	Yes	No	Don't know	No reply	Total
Africa	2	1	0	3	6
Asia-Pacific	4	1	0	3	8
Europe	16	4	0	2	22
Latin America	2	0	0	1	3
North America	1	0	0	1	2
Global	25	6	0	10	41

Note: In response to: If yes to 20c(iii), please specify: 22 out of the 25 RBs specified that such service were permitted to be performed by companies, technical service organisations, or persons who had been approved or licensed or certified by the RB or other appropriate authority. 3 RBs did not provide details.

Table III.21. Responses to Question 21 – Does the Regulatory Body specify requirements for on-site storage of sources?

	Yes	No	Don't know	No reply	Total
Africa	7	0	0	1	8
Asia-Pacific	15	0	0	1	16
Europe	26	1	0	0	27
Latin America	5	0	0	0	5
North America	2	0	0	1	3
Global	55	1	0	3	59

Table III.22. Responses to Question 22 – Does the Regulatory Body require the licensee to conduct periodic documented checks of sources to confirm that they are in their assigned locations and are secure?

	Yes	No	Don't know	No reply	Total
Africa	6	1	0	1	8
Asia-Pacific	15	1	0	0	16
Europe	25	2	0	0	27
Latin America	5	0	0	0	5
North America	2	0	0	1	3
Global	53	4	0	2	59

III.3.4. REGULATORY INSPECTIONS AND RADIATION PROTECTION OFFICERS

Table III.23. Responses to Question 23 – Does the Regulatory Body perform inspections of NDT Operating Companies that provide on-site radiography services?

	Yes	No	Don't know	No reply	Total
Africa	5	2	0	1	8
Asia-Pacific	16	0	0	0	16
Europe	26	1	0	0	27
Latin America	4	1	0	0	5
North America	3	0	0	0	3
Global	54	4	0	1	59

Table III.23a. Responses to Question 23a – If yes to Question 23, are these inspections to where on-site radiography is actually taking place?

	Yes	No	Don't know	No reply	Total
Africa	4	1	0	0	5
Asia-Pacific	14	2	0	0	16
Europe	21	3	2	0	26
Latin America	4	0	0	0	4
North America	3	0	0	0	3
Global	46	6	2	0	54

Table III.23b. Responses to Question 23b – If yes to Question 23, are these inspections announced, unannounced, or either?

	Announced only	Unannounced only	Either announced or unannounced	No reply	Total
Africa	1	0	4	0	5
Asia-Pacific	4	1	10	1	16
Europe	7	0	19	0	26
Latin America	1	0	3	0	4
North America	1	0	2	0	3
Global	14	1	38	1	54

Table III.23c. Responses to Question 23c – If yes to Question 23, how often is a given licensee inspected?

	Replies	Number of RB inspections to a licensee per year						No reply
		Mean	Min	Q1	Median	Q3	Max	
Africa	4	1.4	0.4	0.9	1	1.5	3	1
Asia-Pacific	14	1.1	0.2	1	1	1.2	2.5	2
Europe	21	0.8	0.1	0.5	1	1	2.5	5
Latin America	4	1.3	1	1	1	1.3	2	0
North America	3	0.8	0.3	-	1	-	1	0
Global	46	1.0	0.1	0.5	1	1	3	8

Table III.23d(i-iii). Responses to Questions 23d(i-iii) – If yes to Question 23, are the following addressed during the inspections – wearing of passive dosimeters; wearing of active dosimeters; use of survey meters?

	Wearing of passive individual dosimeters			Wearing and use of active individual dosimeters			Use of survey meters		
	Yes	No	No reply	Yes	No	No reply	Yes	No	No reply
Africa	4	1	0	4	0	1	5	0	0
Asia-Pacific	15	0	1	11	4	1	14	1	1
Europe	25	0	1	25	0	1	24	1	1
Latin America	4	0	0	3	1	0	4	0	0
North America	3	0	0	3	0	0	3	0	0
Global	51	1	2	46	5	3	50	2	2

Table III.23d(iv-vi). Responses to Questions 23d(iv-vi) – If yes to Question 23, are the following addressed during the inspections – use of collimators; use of warning systems; dose rate at the boundary of warning systems?

	Use of collimators			Use of warning systems to prevent entry at the work site			Dose rate at the boundary of warning system		
	Yes	No	No reply	Yes	No	No reply	Yes	No	No reply
Africa	3	1	1	5	0	0	5	0	0
Asia-Pacific	14	1	1	15	0	1	13	2	1
Europe	21	3	2	24	1	1	22	3	1
Latin America	4	0	0	4	0	0	4	0	0
North America	2	1	0	3	0	0	3	0	0
Global	44	6	4	51	1	2	47	5	2

Table III.23d(vii-ix). Responses to Questions 23d(vii-ix) – If yes to Question 23, are the following addressed during the inspections – use of alarm systems; training and qualifications of radiographers; operator knowledge of procedures?

	Use of alarm systems			Training and qualifications of radiographers			Operator knowledge of procedures		
	Yes	No	No reply	Yes	No	No reply	Yes	No	No reply
Africa	5	0	0	5	0	0	5	0	0
Asia-Pacific	14	0	2	15	0	1	11	1	4
Europe	23	2	1	25	0	1	24	1	1
Latin America	4	0	0	4	0	0	4	0	0
North America	3	0	0	3	0	0	3	0	0
Global	49	2	3	52	0	2	47	2	5

Table III.23d(x-xii). Responses to Questions 23d(x-xii) – If yes to Question 23, are the following addressed during the inspections – pre-operation equipment checks; equipment conditions; emergency preparedness?

	Pre-operation equipment checks			Equipment condition			Emergency preparedness		
	Yes	No	No reply	Yes	No	No reply	Yes	No	No reply
Africa	5	0	0	5	0	0	5	0	0
Asia-Pacific	11	1	4	12	1	3	11	1	4
Europe	19	6	1	25	0	1	24	1	1
Latin America	4	0	0	4	0	0	4	0	0
North America	3	0	0	3	0	0	3	0	0
Global	42	7	5	49	1	4	47	2	5

Note: In response to Question 20d(xiii) – Are other aspects addressed, please specify: 11 RBs specified additional items addressed during inspections, including: Compliance with transport regulations (4); documentation and source movement log (4); physical security arrangements (3); completeness of procedures (3); site storage (2); licensing (2); use of additional radiation protection features (1); safety management in the NDT Company (1); minimum number of operators on site (1).

Table III.23e(i). Global (54) & Africa (5) responses to Question 23e – If yes to Question 23, please rank the common shortcomings, in order of the frequency in which they are observed in CompRB inspections?

	Number of times ranked as:					No. of times Not ranked	No. of times ranked 1 to 5	Overall ranking*
	1	2	3	4	5			
GLOBAL								
No proper wearing of passive individual dosimeters	5	1	2	3	3	40	14	6
No proper wearing and use of active individual dosimeters	3	3	3	1	1	43	11	7
No proper use of survey meters	9	5	4	2	4	30	24	1
No proper use of collimators	1	2	0	3	4	44	10	12
No proper warning system to prevent entry to the work site	3	5	9	3	4	30	24	2
Dose rate at the boundary of the work site not within limits set	4	3	3	6	1	37	17	5
No proper use of alarm systems	1	9	4	2	1	37	17	4
No proper training and qualifications of radiographers	1	2	5	2	3	41	13	9
Poor operator knowledge of procedures	3	2	1	3	5	40	14	8
No pre-operation specific equipment checks being performed	1	1	4	3	5	40	14	11
Poor equipment condition	3	2	0	4	2	43	11	10
Poor emergency preparedness	5	4	3	4	4	34	20	3
Other	3	1	0	2	0	48	6	13
AFRICA								
No proper wearing of passive individual dosimeters	1	0	0	1	0	3	2	1
No proper wearing and use of active individual dosimeters	0	0	0	0	0	5	0	10
No proper use of survey meters	1	0	0	0	1	3	2	2
No proper use of collimators	0	0	0	0	0	5	0	10
No proper warning system to prevent entry to the work site	0	0	1	0	0	4	1	8
Dose rate at the boundary of the work site not within limits set	0	1	0	0	0	4	1	6
No proper use of alarm systems	0	0	0	0	0	5	0	10
No proper training and qualifications of radiographers	0	0	1	1	1	2	3	2
Poor operator knowledge of procedures	1	0	0	0	1	3	2	2
No pre-operation specific equipment checks being performed	0	0	1	0	0	4	1	8
Poor equipment condition	0	1	0	0	0	4	1	6
Poor emergency preparedness	0	1	0	1	0	3	2	2
Other	0	0	0	0	0	5	0	10

* The overall ranking was determined applying weightings of 5, 4, 3, 2, 1 to the number of times a shortcoming was ranked 1st, 2nd, 3rd, 4th, and 5th, respectively. The shortcoming with the highest total was then assigned the highest overall ranking, and so on.

Table III.23e (ii). Asia-Pacific (16)& Europe (26) responses to Question 23e – If yes to Question 23, please rank the common shortcomings, in order of the frequency in which they are observed in RB inspections?

	Number of times ranked as:					No. of times Not ranked	No. of times ranked 1 to 5	Overall ranking*
	1	2	3	4	5			
ASIA-PACIFIC								
No proper wearing of passive individual dosimeters	1	1	0	0	1	13	3	9
No proper wearing and use of active individual dosimeters	0	2	1	1	0	12	4	7
No proper use of survey meters	5	1	2	0	1	7	9	1
No proper use of collimators	0	0	0	1	3	12	4	12
No proper warning system to prevent entry to the work site	2	1	1	1	2	9	7	2
Dose rate at the boundary of the work site not within limits set	0	1	2	2	0	11	5	5
No proper use of alarm systems	0	3	3	2	0	8	8	4
No proper training and qualifications of radiographers	1	0	0	0	0	15	1	9
Poor operator knowledge of procedures	0	1	0	0	1	14	2	8
No pre-operation specific equipment checks being performed	0	0	2	1	3	10	6	11
Poor equipment condition	1	1	0	2	0	12	4	10
Poor emergency preparedness	2	1	1	1	1	10	6	3
Other	1	0	0	1	0	14	2	13
EUROPE								
No proper wearing of passive individual dosimeters	3	0	1	2	1	19	7	6
No proper wearing and use of active individual dosimeters	1	0	2	0	0	23	3	12
No proper use of survey meters	2	2	1	2	2	17	9	5
No proper use of collimators	1	1	0	2	1	21	5	9
No proper warning system to prevent entry to the work site	1	3	6	2	1	13	13	1
Dose rate at the boundary of the work site not within limits set	3	1	1	3	1	17	9	3
No proper use of alarm systems	1	5	1	0	1	18	8	3
No proper training and qualifications of radiographers	0	2	4	1	1	18	8	6
Poor operator knowledge of procedures	1	1	1	1	3	19	7	8
No pre-operation specific equipment checks being performed	1	1	0	1	1	22	4	11
Poor equipment condition	1	0	0	2	2	21	5	12
Poor emergency preparedness	3	2	1	2	3	15	11	2
Other	2	1	0	0	0	23	3	9

* The overall ranking was determined applying weightings of 5, 4, 3, 2, 1 to the number of times a shortcoming was ranked 1st, 2nd, 3rd, 4th, and 5th, respectively. The shortcoming with the highest total was then assigned the highest overall ranking, and so on.

Table III.23e(iii). Latin America (4)& North America (83) responses to Question 23e – If yes to Question 23, please rank the common shortcomings, in order of the frequency in which they are observed in RB inspections?

	Number of times ranked as:					No. of times Not ranked	No. of times ranked 1 to 5	Overall ranking*
	1	2	3	4	5			
LATIN AMERICA								
No proper wearing of passive individual dosimeters	0	0	0	0	1	3	1	10
No proper wearing and use of active individual dosimeters	1	1	0	0	0	2	2	2
No proper use of survey meters	1	1	1	0	0	1	3	1
No proper use of collimators	0	0	0	0	0	4	0	12
No proper warning system to prevent entry to the work site	0	0	1	0	1	2	2	4
Dose rate at the boundary of the work site not within limits set	0	0	0	1	0	3	1	7
No proper use of alarm systems	0	1	0	0	0	3	1	4
No proper training and qualifications of radiographers	0	0	0	0	1	3	1	10
Poor operator knowledge of procedures	1	0	0	0	0	3	1	3
No pre-operation specific equipment checks being performed	0	0	0	1	0	3	1	7
Poor equipment condition	0	0	0	0	0	4	0	12
Poor emergency preparedness	0	0	1	0	0	3	1	6
Other	0	0	0	1	0	3	1	7
NORTH AMERICA								
No proper wearing of passive individual dosimeters	0	0	1	0	0	2	1	9
No proper wearing and use of active individual dosimeters	1	0	0	0	1	1	2	1
No proper use of survey meters	0	1	0	0	0	2	1	4
No proper use of collimators	0	1	0	0	0	2	1	4
No proper warning system to prevent entry to the work site	0	1	0	0	0	2	1	4
Dose rate at the boundary of the work site not within limits set	1	0	0	0	0	2	1	2
No proper use of alarm systems	0	0	0	0	0	3	0	10
No proper training and qualifications of radiographers	0	0	0	0	0	3	0	10
Poor operator knowledge of procedures	0	0	0	2	0	1	2	4
No pre-operation specific equipment checks being performed	0	0	1	0	1	1	2	4
Poor equipment condition	1	0	0	0	0	2	1	2
Poor emergency preparedness	0	0	0	0	0	3	0	10
Other	0	0	0	0	0	3	0	10

* The overall ranking was determined applying weightings of 5, 4, 3, 2, 1 to the number of times a shortcoming was ranked 1st, 2nd, 3rd, 4th, and 5th, respectively. The shortcoming with the highest total was then assigned the highest overall ranking, and so on.

Table III.24. Responses to Question 24 – Does the Regulatory Body require that a licensee (NDT Operating Company) employs a Radiation Protection Officer (RPO) or Radiation Protection Expert (RPE)?

	Yes	No	Don't know	No reply	Total
Africa	6	0	0	2	8
Asia-Pacific	14	2	0	0	16
Europe	24	3	0	0	27
Latin America	5	0	0	0	5
North America	3	0	0	0	3
Global	52	5	0	2	59

Table III.24a. Responses to Question 24a – If yes to Question 24, does the regulatory body require that the RPO or RPE reports directly to the Managing Director of the Company?

	Yes	No	Don't know	No reply	Total
Africa	5	0	1	0	6
Asia-Pacific	12	1	0	1	14
Europe	17	6	1	0	24
Latin America	5	0	0	0	5
North America	1	2	0	0	3
Global	40	9	2	1	52

III.3.5. EMERGENCY PLAN

Table III.25. Responses to Question 25 – Does the Regulatory Body require that a licensee (NDT Operating Company) has an Emergency Plan?

	Yes	No	Don't know	No reply	Total
Africa	7	0	0	1	8
Asia-Pacific	15	1	0	0	16
Europe	27	0	0	0	27
Latin America	5	0	0	0	5
North America	3	0	0	0	3
Global	57	1	0	1	59

Table III.25a. Responses to Question 25a – If yes to Question 25, does the Regulatory Body require that the Emergency Plan specifies requirements for training and exercises?

	Yes	No	Don't know	No reply	Total
Africa	6	1	0	0	7
Asia-Pacific	13	2	0	0	15
Europe	20	7	0	0	27
Latin America	2	3	0	0	5
North America	2	1	0	0	3
Global	43	14	0	0	57

Table III.25b. Responses to Question 25b – If yes to Question 25, does the Regulatory Body approve the licensee's Emergency Plan?

	Yes	No	Don't know	No reply	Total
Africa	6	1	0	0	7
Asia-Pacific	12	3	0	0	15
Europe	19	7	0	1	27
Latin America	4	0	0	1	5
North America	2	1	0	0	3
Global	43	12	0	2	57

Table III.26. Responses to Question 26 – Does the Regulatory Body require that licensees must have emergency equipment?

	Yes	No	Don't know	No reply	Total
Africa	5	2	0	1	8
Asia-Pacific	14	2	0	0	16
Europe	18	7	1	1	27
Latin America	5	0	0	0	5
North America	1	2	0	0	3
Global	43	13	1	2	59

Table III.27. Responses to Question 27 – Does the Regulatory Body have resources to assist licensees in recovering from emergencies?

	Yes	No	Don't know	No reply	Total
Africa	1	5	1	1	8
Asia-Pacific	14	2	0	0	16
Europe	16	7	3	1	27
Latin America	3	1	1	0	5
North America	1	2	0	0	3
Global	35	17	5	2	59

Table III.28. Responses to Question 28 – Does the Regulatory Body check the Emergency Plan and the list of emergency equipment for radiographic work during the periodic inspection or at licence renewal for the NDT Operating Company?

	Yes	No	Don't know	No reply	Total
Africa	6	1	0	1	8
Asia-Pacific	14	2	0	0	16
Europe	24	2	0	1	27
Latin America	5	0	0	0	5
North America	3	0	0	0	3
Global	52	5	0	2	59

III.4. INDIVIDUAL MONITORING

Table III.29. Responses to Question 29 – Does the Regulatory Body have direct access to a national or state database of individual doses for Industrial Radiographers and other involved in NDT?

	Yes	No	Don't know	No reply	Total
Africa	2	5	0	1	8
Asia-Pacific	8	6	1	1	16
Europe	20	6	0	1	27
Latin America	2	3	0	0	5
North America	2	1	0	0	3
Global	34	21	1	3	59

Table III.29a&b(i). Reported numbers and doses of NDT workers with individual dosimetry in 2009:

	Industrial radiographers (2009)				Other NDT workers (2009)			
	No. of replies	No. monitored	Ave dose* (mSv)	Max dose** (mSv)	No. of replies	No. monitored	Ave dose* (mSv)	Max dose** (mSv)
Africa	2	193	3.0	5.2	1	47	3.4	4.5
Asia-Pacific	8	9025	2.4	98	3	3354	6.0	26.3
Europe	20	4575	1.5	158	6	1189	8.4	91
Latin America	2	728	4.9	87	0	-	-	-
North America	1	3116	5.5	44	0	-	-	-
Global	33	17637	2.9	158	10	4590	0.6	91

* Average dose is the sum of each country average dose x the number monitored in that country, divided by the total number of individuals monitored; by region and globally.

** Maximum dose is the highest individual dose reported, within that region or globally respectively.

Table III.29a&b(ii). Statistics for country averages of individual doses in 2009 – industrial radiographers:

	Replies	Country-average effective dose (mSv)						
		Mean	SD	Min	Q1	Median	Q3	Max
Africa	2	2.5	0.9	1.9	-	2.5	-	3.1
Asia-Pacific	8	2.5	2.1	0.5	1.1	2.1	3.3	6.7
Europe	20	1.8	2.5	0.0	0.3	1.3	1.9	10.0
Latin America	2	3.1	2.8	1.2	-	3.1	-	5.1
North America	1	5.5	-	-	-	5.5	-	-
Global	33	2.2	2.3	0.0	0.8	1.6	2.4	10.0

Table III.29a&b(iii). Statistics for country averages of individual doses in 2009 – other NDT workers:

	Replies	Country-average effective dose (mSv)						
		Mean	SD	Min	Q1	Median	Q3	Max
Africa	1	3.2	-	-	-	3.2	-	-
Asia-Pacific	3	2.0	1.5	0.3	-	2.3	-	3.3
Europe	6	0.5	0.5	0.0	0.1	0.3	0.9	1.0
Latin America	0	-	-	-	-	-	-	-
North America	0	-	-	-	-	-	-	-
Global	10	1.2	1.3	0.0	0.3	0.7	2.0	3.3

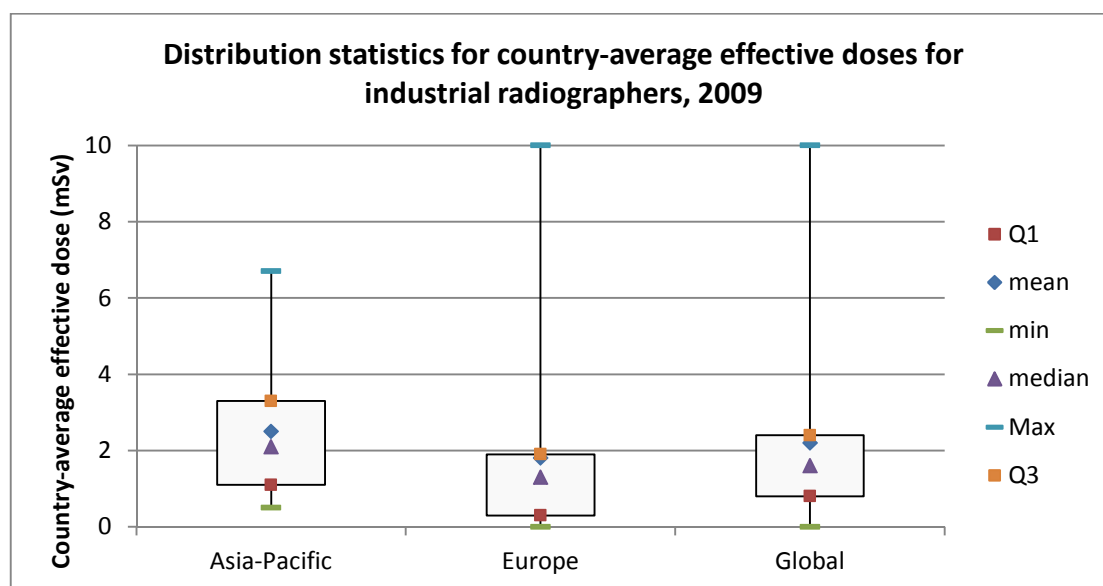


FIG. III.1. Results from Table III.29a&b(ii) giving the mean, median, minimum, maximum and first and third quartiles of the distribution of country-average annual doses for industrial radiographers in 2009.

Table III.29c(i). Numbers of monitored industrial radiographers whose annual doses (D) in 2009 were in the following dose bands:

	Number of monitored industrial radiographers whose annual dose, D, was in:								
	Annual effective dose bands (mSv)								
	D<mdl*	mdl≤D<1	1≤D<5	5≤D<10	10≤D<15	15≤D<20	20≤D<30	30≤D<50	D≥50
Africa	0	1	190	2	0	0	0	0	0
Asia-Pacific	3063	2603	1437	449	185	100	91	56	41
Europe	1811	1118	1414	91	17	6	5	4	4
Latin America	0	114	409	118	47	14	17	7	2
North America	429	768	858	549	200	197	89	26	0
Global	5303	4604	4308	1209	449	317	202	93	47

* mdl = minimum detection limit of the personal dosimetry system.

Table III.29c(ii). Percentages of monitored industrial radiographers whose annual doses (D) in 2009 were in the following dose bands:

	Percentage of monitored industrial radiographers whose annual dose, D, was in:								
	Annual effective dose bands (mSv)								
	D<mdl*	mdl≤D<1	1≤D<5	5≤D<10	10≤D<15	15≤D<20	20≤D<30	30≤D<50	D≥50
Africa	0	1	98	1	0	0	0	0	0
Asia-Pacific	38	32	18	6	2	1	1	1	1
Europe	41	25	32	2	0	0	0	0	0
Latin America	0	16	56	16	6	2	2	1	0
North America	14	25	28	18	6	6	3	1	0
Global	32	28	26	7	3	2	1	1	0

* mdl = minimum detection limit of the personal dosimetry system.

Table III.29c(iii). Numbers of monitored "other NDT workers" whose annual doses (D) in 2009 were in the following dose bands:

	Number of monitored "other NDT workers" whose annual dose, D, was in:								
	Annual effective dose bands (mSv)								
	D<mdl*	mdl≤D<1	1≤D<5	5≤D<10	10≤D<15	15≤D<20	20≤D<30	30≤D<50	D≥50
Africa	0	0	47	0	0	0	0	0	0
Asia-Pacific	1732	1163	415	36	5	1	2	0	0
Europe	315	26	646	0	1	0	0	0	1
Latin America	-	-	-	-	-	-	-	-	-
North America	-	-	-	-	-	-	-	-	-
Global	2047	1189	1108	36	6	1	2	0	1

* mdl = minimum detection limit of the personal dosimetry system.

Table III.29c(iv). Percentages of monitored "other NDT workers" whose annual doses (D) in 2009 were in the following dose bands:

	Percentage of monitored "other NDT workers" whose annual dose, D, was in:								
	Annual effective dose bands (mSv)								
	D<mdl*	mdl≤D<1	1≤D<5	5≤D<10	10≤D<15	15≤D<20	20≤D<30	30≤D<50	D≥50
Africa	0	0	100	0	0	0	0	0	0
Asia-Pacific	52	35	12	1	0	0	0	0	0
Europe	32	3	65	0	0	0	0	0	0
Latin America	-	-	-	-	-	-	-	-	-
North America	-	-	-	-	-	-	-	-	-
Global	47	27	25	1	0	0	0	0	0

* mdl = minimum detection limit of the personal dosimetry system.

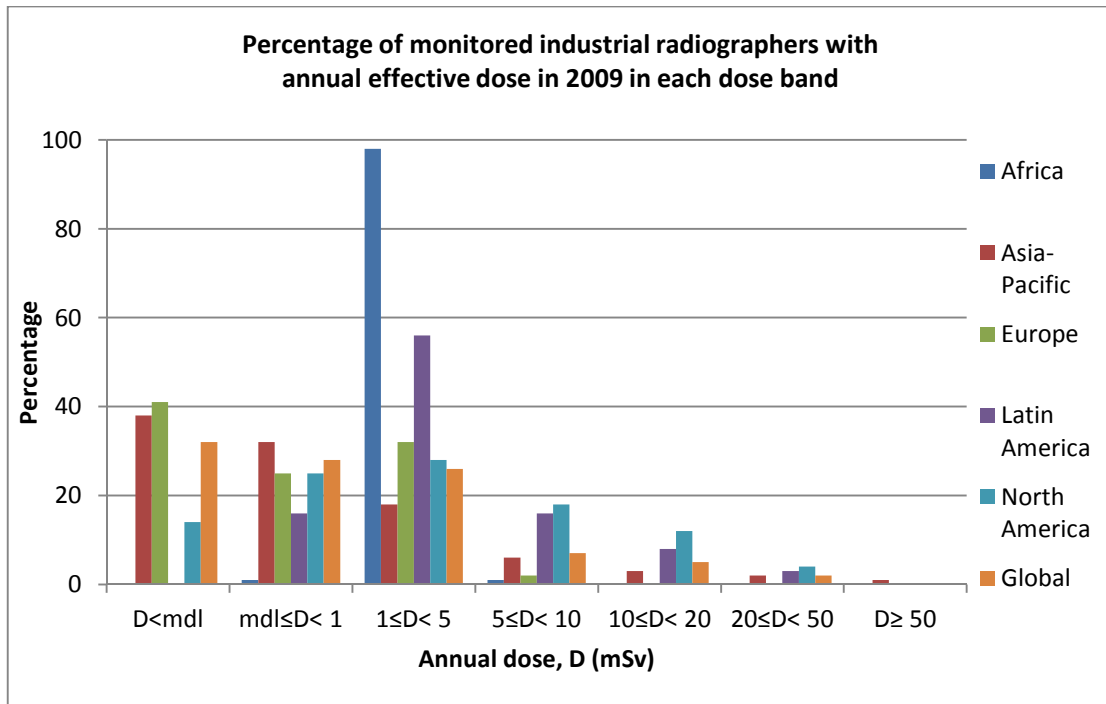


FIG. III.2. Results from Table III.29c(ii) giving percentages of monitored industrial radiographers whose annual effective doses in 2009 were in the given dose bands.

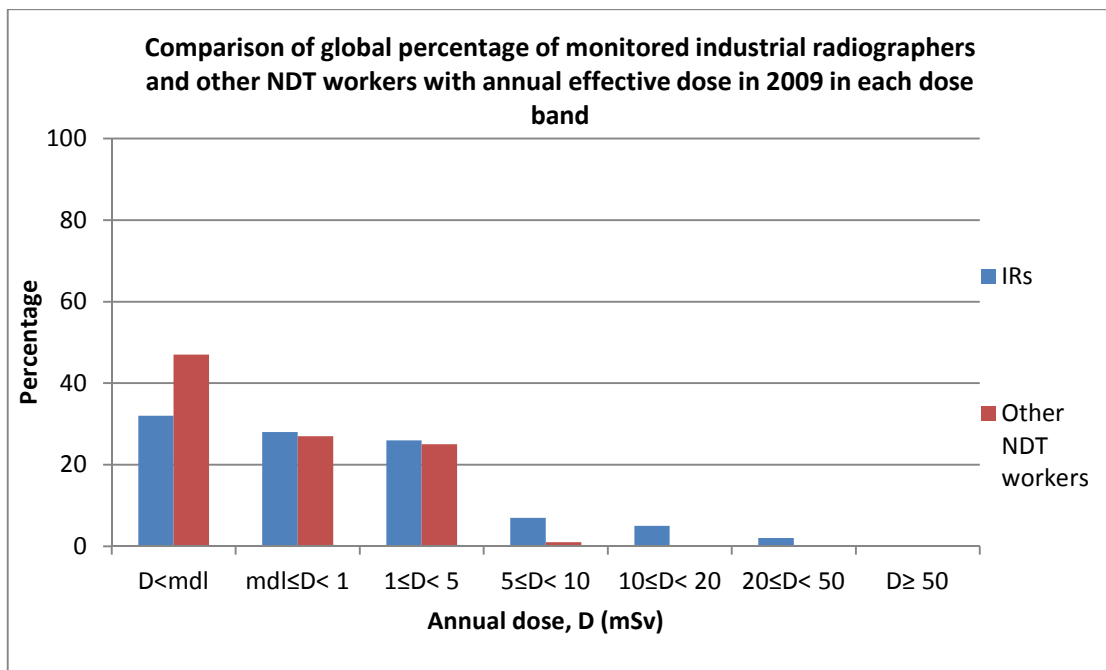


FIG. III.3. Results from Table III.29c(ii) and 29c(iv) comparing the percentages of monitored industrial radiographers and other NDT workers whose annual effective doses in 2009 were in the given dose bands.

Table III.29d(i). Number of monitored industrial radiographers whose maximum monthly dose (D_m) in 2009 was in the following dose bands:

	Number of industrial radiographers whose maximum monthly dose, D_m , was in:						
	Dose bands (mSv, in a month)						
	$D_m < 1$	$1 \leq D_m < 2.5$	$2.5 \leq D_m < 5$	$5 \leq D_m < 10$	$10 \leq D_m < 20$	$20 \leq D_m < 50$	$D_m \geq 50$
Africa	150	41	1	1	0	0	0
Asia-Pacific	6241	239	129	89	52	10	0
Europe	1391	51	15	4	0	1	1
Latin America	419	187	93	19	2	6	2
North America	-	-	-	-	-	-	-
Global	8201	518	238	113	54	17	3

Table III.29d(ii). Percentage of monitored industrial radiographers whose maximum monthly dose (D_m) in 2009 was in the following dose bands:

	Percentage of industrial radiographers whose maximum monthly dose, D_m , was in:						
	Dose bands (mSv, in a month)						
	$D_m < 1$	$1 \leq D_m < 2.5$	$2.5 \leq D_m < 5$	$5 \leq D_m < 10$	$10 \leq D_m < 20$	$20 \leq D_m < 50$	$D_m \geq 50$
Africa	78	21	1	1	0	0	0
Asia-Pacific	92	4	2	1	1	0	0
Europe	95	3	1	0	0	0	0
Latin America	58	26	13	3	0	1	0
North America	-	-	-	-	-	-	-
Global	90	6	3	1	1	0	0

Table III.29d(iii). Number of monitored "other NDT workers" whose maximum monthly dose (D_m) in 2009 was in the following dose bands:

	Number of "other NDT workers" whose maximum monthly dose, D_m , was in:						
	Dose bands (mSv, in a month)						
	$D_m < 1$	$1 \leq D_m < 2.5$	$2.5 \leq D_m < 5$	$5 \leq D_m < 10$	$10 \leq D_m < 20$	$20 \leq D_m < 50$	$D_m \geq 50$
Africa	31	16	0	0	0	0	0
Asia-Pacific	3419	34	8	5	1	0	0
Europe	122	5	0	0	1	0	0
Latin America	-	-	-	-	-	-	-
North America	-	-	-	-	-	-	-
Global	3572	55	8	5	2	0	0

Table III.29d(iv). Percentage of monitored "other NDT workers" whose maximum monthly dose (D_m) in 2009 was in the following dose bands:

	Percentage of "other NDT workers" whose maximum monthly dose, D_m , was in:						
	Dose bands (mSv, in a month)						
	$D_m < 1$	$1 \leq D_m < 2.5$	$2.5 \leq D_m < 5$	$5 \leq D_m < 10$	$10 \leq D_m < 20$	$20 \leq D_m < 50$	$D_m \geq 50$
Africa	66	34	0	0	0	0	0
Asia-Pacific	99	1	0	0	0	0	0
Europe	95	4	0	0	1	0	0
Latin America	-	-	-	-	-	-	-
North America	-	-	-	-	-	-	-
Global	98	2	0	0	0	0	0

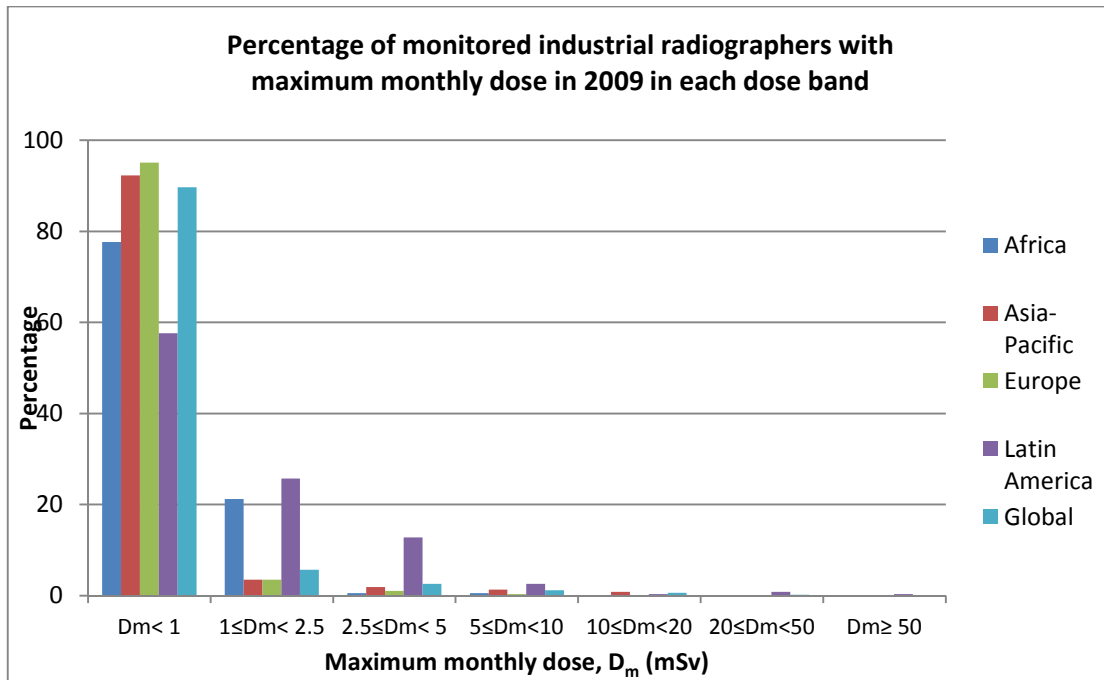


FIG. III.4. Results from Table III.29d(ii) giving percentage of monitored industrial radiographers whose maximum monthly dose was in given dose bands in 2009, by region and globally.

Table III.29e. Responses to Question 29e – If yes to Question 29, do the above given dose records include doses received from performing industrial radiography on-site at Nuclear Power Plants?

	Yes	No	Don't know	No reply	Total
Africa	0	2	0	0	2
Asia-Pacific	2	5	0	1	8
Europe	6	13	1	0	20
Latin America	1	1	0	0	2
North America	0	1	0	1	2
Global	9	22	1	2	34

Table III.29f. Responses to Question 29f – If yes to Question 29, does the Regulatory Body perform trend analyses (over, for example, 5 years or more) of occupational doses in industrial radiography, in particular for the most exposed workers, and correlate these with incidents?

	Yes	No	Don't know	No reply	Total
Africa	1	1	0	0	2
Asia-Pacific	3	1	3	1	8
Europe	11	6	1	2	20
Latin America	1	1	0	0	2
North America	1	0	0	1	2
Global	17	9	4	4	34

Table III.29g. Responses to Question 29g – If yes to Question 29f, are the results used by the Regulatory Body, in conjunction with the NDT industry, to initiate measures to reduce the likelihood of such incidents recurring?

	Yes	No	Don't know	No reply	Total
Africa	1	0	0	0	1
Asia-Pacific	3	0	0	0	3
Europe	11	0	0	0	11
Latin America	1	0	0	0	1
North America	1	0	0	0	1
Global	17	0	0	0	17

APPENDIX IV. THE QUESTIONNAIRES (ENGLISH VERSIONS) USED IN THE SURVEY

IV.1. QUESTIONNAIRE DISTRIBUTED TO INDIVIDUAL RADIOGRAPHERS

International Atomic Energy Agency

Information System on Occupational Exposure in Medicine, Industry and Research (ISEMIR)

Questionnaire on Occupational Exposure in Industrial Radiography addressed to Operators

The questionnaire should be able to be completed in less than 10 minutes. It has been developed by the Working Group on Industrial Radiography (WGIR) of ISEMIR. The purpose of this survey is to provide an overview of occupational radiation protection in this area of industry where there still is a potential for workers to be exposed to higher levels of radiation as well as the risk of accidents.

The results of the survey will be sent to all participants and made available anonymously on the Networks of Occupational Radiation Protection website at IAEA. The results of the survey will allow IAEA to address recommendations to harmonise and improve radiation protection of workers in industrial radiography.

The completed questionnaire needs to be sent to the IAEA, by email to John.Le.heron@iaea.org or by mail to John Le Heron, Radiation Safety and Monitoring Section (RSM), Division of Radiation, Transport and Waste Safety (NSRW), INTERNATIONAL ATOMIC ENERGY AGENCY, Wagramer Strasse 5, P.O.Box 100, A-1400 Vienna, Austria.

1. Was radiation protection training included in your NDT-training on Radiographic Testing?
Please answer for all levels that are applicable to you.

Level 1: Yes: No: Do not know:
Level 2: Yes: No: Do not know:
Level 3: Yes: No: Do not know:

2. Did you receive separate training on radiation protection, either in addition to or instead of any radiation protection training in your NDT-training?

Yes: No: Do not know:

2a. If yes to question 2, do you have a formal radiation protection qualification or certification?

Yes: No: Do not know:

3. If you have had radiation protection training, were procedures for emergencies included in the training?

Yes: No: Do not know:

3a. If yes to question 3, did the training include practical exercises for creating a safe situation until the source is able to be recovered?

Yes: No: Do not know:

3b. If yes to question 3, did the training include practical exercises for source recovery?

Yes: No: Do not know:

3c. Are you allowed to perform a source recovery on your own without first contacting a specialized source recovery person?

Yes: No: Do not know:

4. Do you feel sufficiently well qualified and trained to be able to work safely and reliably?

Yes: No: Do not know:

4a. Do you feel you are well prepared for an emergency situation?

Yes: No: Do not know:

5a. When on-site radiography is being performed, is there a qualified radiation safety expert, e.g. one of the radiographers or a Radiation Protection Officer, who is on the work site and supervises the jobs?

Always: Sometimes: Never: Do not know:

5b. When on-site radiography is being performed, is there a qualified radiation safety expert, e.g. a Radiation Protection Officer, who monitors or audits the safe operation of the jobs on a regular basis?

Always: Sometimes: Never: Do not know:

6. Do you check for the presence of the source in the exposure device before taking the device from the store?

Always: Sometimes: Never:

7. Do you check for the presence of the source in the exposure device after the NDT test?

Always: Sometimes: Never:

8. Have you had any incidents (i.e. deviations from normal, near misses or accidents) (with respect to radiation and hence occupational exposure) during the last 5 years?

Yes: No: Do not know:

8a. If yes, how many were there:

Deviations from normal?	Number =
Near misses?	Number =
Accidents?	Number =

9. If you had deviations, near misses, or accidents in the last 5 years, did you report these to your company?

Always: Sometimes: Never:

9a. If yes to question 9, did your NDT company report any of these to the (radiation protection) regulatory body?

Yes: No: Do not know:

9b. If yes to question 9a, which type were reported?

i. All cases:	Yes: <input type="checkbox"/>	No: <input type="checkbox"/>	Do not know: <input type="checkbox"/>
ii. Near misses & accidents:	Yes: <input type="checkbox"/>	No: <input type="checkbox"/>	Do not know: <input type="checkbox"/>
iii. Accidents only:	Yes: <input type="checkbox"/>	No: <input type="checkbox"/>	Do not know: <input type="checkbox"/>

10. Does the NDT company you work for have an emergency plan for site radiography?

Yes: No: Do not know:

10a. If yes to question 10, have you received training for the roles and responsibilities of radiographers in that emergency plan?

Yes: No: Do not know:

11. Do you use collimators when you perform gamma radiography?

Always: Sometimes: Never:

12. Do you use diaphragms/collimators when you perform X-ray radiography?

Always: Sometimes: Never:

13. Do you know what occupational radiation doses you receive?

Yes: No: Do not know:

13a. If yes, how many times per year are you informed about your occupational radiation dose? Number of times per year =

13b. If yes to Question 13:

i. What was your total occupational dose in 2009:

My dose in 2009 = *(Please specify the units used)*

ii. What was the highest dose you received in a given monitoring period in 2009:

Highest dose in a period = *(Please specify the units used)*

Duration of each monitoring period =
(Please specify whether weeks or months)

iii. What was your radiographic workload in 2009:

Number of films exposed in 2009 =

iv. What type and strength of sources did you use in 2009:

(Please tick all source types that you used in 2009, and fill in the required data per source type used)

Ir-192: Typical strength = Ci
Typical exposure time = seconds

Se-75: Typical strength = Ci
Typical exposure time = seconds

Co-60: Typical strength = Ci
Typical exposure time = seconds

X-ray: Typical voltage = kV
Typical current = mA
Typical exposure time = seconds

14. Do you ever discuss your radiation protection issues and/or your occupational doses with your Radiation Protection Officer?

Yes:

No:

Do not know:

14a. If yes, approximately how many times per year would this happen?

Number of times per year =

Requested optional information: *(Note: All information will be treated as strictly confidential by the IAEA. Only anonymised and aggregated data will be made available.)*

Name:

Institution:

Town or city:

Country:

Email:

Date:

I would like to receive the report with the results of this survey: Yes / No

International Atomic Energy Agency

Information System on Occupational Exposure in Medicine, Industry and Research (ISEMIR)

Questionnaire on Occupational Exposure in Industrial Radiography addressed to **Operating Companies**

The questionnaire should be able to be completed in approximately 20 minutes. It has been developed by the Working Group on Industrial Radiography (WGIR) of ISEMIR. The purpose of this survey is to provide an overview of occupational radiation protection in this area of industry where there still is a potential for workers to be exposed to high levels of radiation as well as the risk of accidents.

The results of the survey will be sent to all participants and made available anonymously on the Networks of Occupational Radiation Protection website at IAEA. The results of the survey will allow IAEA to address recommendations to harmonise and improve radiation protection of workers in industrial radiography.

The completed questionnaire needs to be sent to the IAEA, by email to John.Le.heron@iaea.org or by mail to John Le Heron, Radiation Safety and Monitoring Section (RSM), Division of Radiation, Transport and Waste Safety (NSRW), INTERNATIONAL ATOMIC ENERGY AGENCY, Wagramer Strasse 5, P.O.Box 100, A-1400 Vienna, Austria.

I. Qualifications & training of industrial radiographers in radiation protection

1. Does your Company provide or facilitate radiation protection training for its radiographers?
Yes: No: Do not know:

1a. If yes, what kind of radiation protection training do you provide to your operators?

(Please mark all appropriate options – more than one selection is likely. An unmarked option means it is not applicable to your Company.)

- | | | |
|---|-------------------------|--------|
| <input type="checkbox"/> : Within the Company ¹ , initial training, theory: | Duration ² : | hours |
| <input type="checkbox"/> : Within the Company, initial training, practical: | Duration: | hours |
| <input type="checkbox"/> : Within the Company, refresher training, theory: | Duration: | hours |
| | Interval ³ : | months |
| <input type="checkbox"/> : Within the Company, refresher training, practical: | Duration: | hours |
| | Interval: | months |
| <input type="checkbox"/> : Outside the Company ⁴ , initial training, theory: | Duration: | hours |
| <input type="checkbox"/> : Outside the Company, initial training, practical: | Duration: | hours |
| <input type="checkbox"/> : Outside the Company, refresher training, theory: | Duration: | hours |
| | Interval: | months |
| <input type="checkbox"/> : Outside the Company, refresher training, practical: | Duration: | hours |
| | Interval: | months |

¹ Training is provided by the Company itself, using its own resources.

² Duration of the radiation protection training in hours.

³ Interval between one training course and the next, for a given radiographer.

⁴ Training is provided by a 3rd party, but the Company requires the radiographer to attend.

1b. If yes to Question 1, do you provide different radiation protection training for gamma sources and for X-ray sources?

Yes:

No:

1c. If yes to Question 1, does your training include the following subjects on emergency preparedness and response?

i. Emergency procedures

Yes:

No:

ii. Practical exercises for creating a safe situation⁵

Yes:

No:

iii. Practical exercises for source recovery

Yes:

No:

1d. If your Company does not provide or facilitate radiation protection training, please state the reason:

Reason:

2. Is radiation protection training included as part of NDT training in Radiographic Testing in your country?

Level 1: Yes:

No:

Do not know:

Level 2: Yes:

No:

Do not know:

Level 3: Yes:

No:

Do not know:

2a. If yes to any of Question 2, does your Company provide or facilitate the radiation protection training that you detailed in Questions 1a,b,c, in addition to this NDT radiation protection training?

Yes:

No:

Do not know:

II. Learning from incidents (deviations from normal, near misses and accidents).

3. How many radiation incidents occurred in your Company during the last five years?

(Please specify or estimate the number for each of the following severity classes. If none occurred in a given category, enter "0" or nil.)

a. Accidents with elevated individual exposures higher than the annual limit:

b. Accidents with elevated individual exposures lower than the annual limit:

c. Near misses that had the potential for elevated individual exposures higher than the annual limit:

d. Near misses that had the potential for elevated individual exposure lower than the annual limit:

e. Other deviations from normal operations:

⁵ i.e. after the emergency situation occurs until the source can be recovered.

4. How many radiation incidents did your Company report to the (radiation protection) Regulatory Body during the last five years?

(Please specify or estimate the number for each of the following severity classes. If none occurred in a given category, enter "0" or nil.)

- a. Accidents with elevated individual exposures higher than the annual limit:
- b. Accidents with elevated individual exposures lower than the annual limit:
- c. Near misses that had the potential for elevated individual exposures higher than the annual limit:
- d. Near misses that had the potential for elevated individual exposure lower than the annual limit:
- e. Other deviations from normal operations:

5. Did your (radiation protection) Regulatory Body report the radiation incidents to the IAEA?

Yes:

No:

Do not know:

6. How does your Company receive information about abnormal individual exposures of its radiographers?

(Please mark all appropriate options – more than one selection is likely. An unmarked option means it is not applicable to your Company.)

- : From the radiographers (e.g. based on the readout of their active dosimeters);
- : From your Company's own personal dosimetry service (e.g. based on the collection and readout of active dosimeters);
- : From your third-party dosimetry service (based on readout of passive dosimeters);
- : From the regulatory body (based on readout of passive dosimeters);
- : Other, please specify:

7. How does your Company share information about radiation incidents within your organization?

(Please mark all appropriate options – more than one selection is likely. An unmarked option means it is not applicable to your Company.)

- : Safety meetings;
- : Notice boards;
- : Company Magazine;
- : Company Intranet;
- : E-mail notification;
- : Other, please specify:

8. How does your Company share information about your radiation incidents with other organizations?

(Please mark all appropriate options – more than one selection is likely. An unmarked option means it is not applicable to your Company.)

- : International or National Incident Database, please specify:
- : Industry meetings;
- : E-mail;
- : Other, please specify:
- : Company does NOT share incident information with other organizations.

III. Systems and procedures in place for safe operation

9. With regard to individual monitoring, does your Company provide its radiographers with:

- a. Passive individual dosimeters: Yes: No:
- b. Active individual dosimeters: Yes: No:
- c. If yes to Question 9b, are the active individual dosimeters equipped with:
 - i. Visual alarms Yes, all: Yes, some: No:
 - ii. Audible alarms Yes, all: Yes, some: No:
 - iii. Vibrating alarms Yes, all: Yes, some: No:

10. Does your Company keep records of the occupational doses received by its radiographers?

Yes: No: Do not know:

10a. If yes to Question 10, does your Company inform its radiographers of their personal doses?

Yes: No: Do not know:

10b. Are there investigation levels for personal doses established by:

i. Your Company: Yes: No: Do not know:

ii. The (radiation protection) Regulatory Body:
Yes: No: Do not know:

10c. If yes to either part of Question 10b, how many investigations have been performed by the Company in the last 5 years as a result of the investigation level being exceeded?

Number =

10d. If yes to Question 10, can you please complete the following table:

Number of workers that were in the following ranges of <u>annual</u> individual effective doses in <u>2009</u>	
<u>Range of annual effective dose, D (mSv)</u>	<u>Number of Industrial Radiographers</u>
D < MDL*	
MDL ≤ D < 1	
1 ≤ D < 5	
5 ≤ D < 10	
10 ≤ D < 15	
15 ≤ D < 20	
20 ≤ D < 30	
30 ≤ D < 50	
D ≥ 50	

* MDL = Minimum Detection Limit of the personal dosimetry system

11. Does your Company provide any other monitoring or alarm devices?

- a. Survey meter Yes: No:
- b. Area monitors: Yes: No:
- c. If yes to Question 11b, are the area monitors equipped with:
- i. Visual alarms Yes, all: Yes, some: No:
- ii. Audible alarms Yes, all: Yes, some: No:
- d. Other, please specify:

12. With regard to a warning system to prevent entry to the radiography site:

- a. At what dose rate does your Company require a warning system to be installed?
- Dose rate = _____ microSv/hour
- (Please ensure your number is in terms of microSv/hour, otherwise state your units.)*
- b. What is used as a warning system for the work site:
- i. Ribbon or rope Yes: No:
- ii. Passive warning signs Yes: No:
- iii. Active warning signals Yes: No:
- iv. Other, please specify:

13. Has your Company determined the more common causes for unauthorized persons to trespass past the warning system?

Yes: No: Do not know:

13a. If yes to Question 13, what are the more common causes?

- i. The warning system is not understood: Yes: No:
- ii. Willful violation: Yes: No:
- iii. The warning system was not set up properly to control the area:
- Yes: No:
- iv. Other, please specify:

14. Does your Company require its radiographers to announce or warn whenever a radiographic exposure is made?

Yes, every time: Sometimes: No: Do not know:

14a. If yes (every time or sometimes) to Question 14, is this with:

i. An audible alarm (e.g. a siren): Yes: No:

ii. A visible alarm (e.g. flashing lights): Yes: No:

iii. An announcement via a public address system: Yes: No:

iv. Other, please specify:

15. When your Company is providing radiography services in an industrial plant, does the client:

a. Provide your Company with a plan of the installation:

Always: Sometimes: Never:

b. Inform your Company about other interfering activities on site:

Always: Sometimes: Never:

c. Have a "permit to work" system:

Always: Sometimes: Never:

d. Inform other workers:

i. About the radiography to be performed:

Always: Sometimes: Never:

ii. The purpose and method of the warning system (beaconing):

Always: Sometimes: Never:

iii. The meaning of alarm signals:

Always: Sometimes: Never:

iv. The risks of ionizing radiation / sources:

Always: Sometimes: Never:

16. Does your Company require its radiographers to use:

a. Collimators with Gamma radiography: Yes: No:

b. Diaphragms or collimators with X-ray radiography:
Yes: No:

17. With regard to exposure devices for gamma radiography:

a. What interval does your Company have between preventive maintenance⁶?

Interval = Months

b. What auxiliary equipment is included in the preventive maintenance:

- i. Crank Yes: No:
- ii. Control cable Yes: No:
- iii. Guide tube Yes: No:
- iv. Collimator Yes: No:
- v. Other, please specify:

c. Who performs the preventive maintenance:

- i. Your Company Yes: No:
- ii. The device manufacturer Yes: No:
- iii. Other service company Yes: No:

18. With regard to X-ray equipment:

a. What interval does your Company have between preventive maintenance?

Interval = Months

b. What items / auxiliary equipment are included in the preventive maintenance:

- i. Cables Yes: No:
- ii. Control panel Yes: No:
- iii. Diaphragm or collimator Yes: No:
- iv. Output of tube (dose rate) Yes: No:
- v. Leakage radiation Yes: No:
- vi. Other, please specify:

c. Who performs the preventive maintenance:

- i. Your Company Yes: No:
- ii. The device manufacturer Yes: No:
- iii. Other service company Yes: No:

19. Who approved your Company's radiation protection programme?

- a. The Managing Director or Chief Executive Officer: Yes: No:
- b. The Radiation Protection Officer Yes: No:
- c. The (radiation protection) Regulatory Body Yes: No:
- d. Other, please specify:

⁶ Preventive maintenance is not the routine checks performed by the radiographer before commencing any radiography work, but rather are the more invasive checks and repair that occur at appropriate intervals.

20. Does your Company perform its own compliance inspections of its radiographers?

Yes: No: Do not know:

20a. If yes to Question 20, are there planned compliance inspections?

Yes: No: Do not know:

20b. If yes to Question 20, are there unplanned compliance inspections?

Yes: No: Do not know:

20c. If yes to Question 20, are these compliance inspections performed by:

- | | | |
|--|-------------------------------|------------------------------|
| i. The Managing Director of your Company | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| ii. Other member of the Management Team | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| iii. The Radiation Protection Officer | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| iv. Other radiation protection expert | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |

20d. If yes to Question 20, approximately how many times per year⁷ would a radiographer be inspected by your Company?

Number of times a radiographer is inspected per year by the Company =

20e. What subjects are addressed during such Company inspections?

- | | | |
|--|-------------------------------|------------------------------|
| i. Proper wearing of passive individual dosimeters: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| ii. Proper wearing and use of active individual dosimeters: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| iii. Proper use of survey meters: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| iv. Proper use of collimators: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| v. Proper warning system at the work site: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| vi. Dose rate at the boundary of the work site within the limits set: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| vii. Proper use of alarm systems (flashing lights, audible alarm, use of PA system): | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| viii. Proper training and qualifications of Radiographers: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| ix. Operator knowledge of procedures: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| x. Pre-operation specific equipment checks: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| xi. Equipment condition: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| xii. Emergency preparedness: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| xiii. Other, please specify: | | |

⁷ In cases where inspections are “random”, base your estimate on the expected number of inspections in a five year period divided by 5.

20f. Please rank the common shortcomings, in order of the frequency, in which they are observed in these Company inspections?

(Starting with 1 for the most frequent shortcoming, and 2 for the next most frequent, and so on, assign a number (from 1 to 5) to the five most common shortcomings from those listed below, based on your Company's experiences.)

Ranking of your five most common shortcomings:

- : No proper wearing of passive individual dosimeters;
- : No proper wear and use of active individual dosimeters;
- : No proper use of survey meters;
- : No proper use of collimators;
- : No proper warning system at the work site;
- : Dose rate at the boundary of the work site not within limits set;
- : No proper use of alarm systems (flash lights, audible alarm, use of PA system);
- : No proper training and qualifications of radiographers;
- : Poor operator knowledge of procedures;
- : No pre-operation specific equipment checks being performed;
- : Poor equipment condition;
- : Poor emergency preparedness;
- : Other (see previous question).

21. Does the (radiation protection) Regulatory Body perform planned inspections of your Company's radiographers on the work site?

Yes: No: Do not know:

21a. If yes to Question 21, how many times (on average) would a radiographer undergo a planned inspection by the Regulatory Body?

Approximate number of times =

22. Does the (radiation protection) Regulatory Body perform unplanned inspections on your Company's radiographers on the work site?

Yes: No: Do not know:

22a. If yes to Question 22, how many times (on average) would a radiographer undergo an unplanned inspection by the Regulatory Body?

Approximate number of times =

IV. Emergency Preparedness and Response

23. Does your Company have an emergency plan and procedures for responding to incidents during the performance of site radiography?

Yes: No: Do not know:

23a. With whom does your Company communicate and discuss the emergency plan?

i. Your Company's Radiographers:

Yes: No: Do not know:

ii. Your Company's Clients:

Yes: No: Do not know:

iii. The (radiation protection) Regulatory Body:

Yes: No: Do not know:

iv. Other emergency response authorities:

Yes: No: Do not know:

24. Does your Company provide specific training to its radiographers on emergency preparedness and response?

Yes: No: Do not know:

24a. If yes to Question 24, does the training include:

i. Explanation of emergency procedures:

Yes: No: Do not know:

ii. Practical exercises on containment of the situation, i.e. keeping it safe and under control:

Yes: No: Do not know:

iii. Practical exercises on recovery of sources:

Yes: No: Do not know:

25. Does your company have emergency equipment for site radiography?

Yes: No: Do not know:

25a. If yes to Question 25, what equipment does your Company have: (*more than one answer is likely*)

i. Long tongs: Yes: No: Do not know:

ii. Shielding material: Yes: No: Do not know:

iii. Emergency/Rescue container: Yes: No: Do not know:

iv. Other, please specify:

25b. If yes to Question 25, do your radiographers have access to the emergency

equipment? Yes: No: Do not know:

26. In your Company's Emergency Plan, who is responsible for the following stages of an emergency?

a. Containment of the situation, i.e. keeping it safe and under control:

(Mark only those appropriate to your Emergency Plan)

- : Radiographer
- : Radiation Protection Officer/Radiation Protection Expert
- : Other Qualified Expert: specify:
- : Authorities: specify which authority:
- : Appointed institute: specify type of institute:

b. Planning and rehearsing the Recovery *(see also following stage)*

(Mark only those appropriate to your Emergency Plan)

- : Radiographer
- : Radiation Protection Officer/Radiation Protection Expert
- : Other Qualified Expert: specify:
- : Authorities: specify which authority:
- : Appointed institute: specify type of institute:

c. Recovery of the situation:

(Mark only those appropriate to your Emergency Plan)

- : Radiographer
- : Radiation Protection Officer/Radiation Protection Expert
- : Other Qualified Expert: specify:
- : Authorities: specify which authority:
- : Appointed institute: specify type of institute:

d. Investigation and reporting:

(Mark only those appropriate to your Emergency Plan)

- : Radiographer
- : Radiation Protection Officer/Radiation Protection Expert
- : Other Qualified Expert: specify:
- : Authorities: specify which authority:
- : Appointed institute: specify type of institute:

27. Does your Company hold emergency exercises to test the critical components of the Company's Emergency Plan?

Yes: No: Do not know:

27a. If yes to Question 27, how often does your Company hold these exercises?

Number = per year

28. Does your Company undertake a periodic formal review of its Emergency Plan?

Yes: No: Do not know:

28a. If yes to Question 28, how often does your Company undertake a review?

Number = per year

V. Company “profile”

29. What radiographic techniques does your Company utilize? (*Tick only one box*)

- a. Gamma radiography only?
- b. X-ray radiography only?
- c. Both Gamma and X-ray radiography?

30. How many radiographers does your Company employ (approximately)?

a. By type of contract:

- i. Number of full-time contract radiographers =
- ii. Number of part-time contract radiographers =
- iii. Number of itinerant radiographers =

b. By work location:

- i. Number of radiographers working at base =
- ii. Number of radiographers working at client sites =
- iii. Number of radiographers working both at base and at client-sites =

c. By type of NDT radiography:

- i. Number of radiographers that only perform Gamma radiography =
- ii. Number of radiographers that only perform X-ray radiography =
- iii. Number of radiographers that perform both Gamma and X-ray radiography =
- iv. Number of radiographers that also perform other non RT NDT methods=

31. Does your Company have a Radiation Protection Officer or Radiation Protection Expert included in its organization?

Yes: No: Do not know:

31a. If yes to Question 31, does he/she report directly to the Managing Director?

Yes: No: Do not know:

Requested optional information: (*Note: All information will be treated as strictly confidential by the IAEA. Only anonymised and aggregated data will be made available.*)

Name:

Job title or position:

Institution:

Town or city:

Country:

Email:

Date

I would like to receive the report with the results of this survey: Yes / No

IV.3. QUESTIONNAIRE DISTRIBUTED TO RADIATION PROTECTION REGULATORY BODIES

International Atomic Energy Agency

Information System on Occupational Exposure in Medicine, Industry and Research (ISEMIR)

Questionnaire on Occupational Exposure in Industrial Radiography addressed to the National or State (Radiation Protection) Regulatory Body

This questionnaire has been developed by the Working Group on Industrial Radiography (WGIR) of ISEMIR. The purpose of this survey is to provide an overview of occupational radiation protection in this area of industry where there still is a potential for workers to be exposed to high levels of radiation as well as the risk of accidents.

The results of the survey will be sent to all participants and made available anonymously on the Occupational Radiation Protection Networks (ORPNET) website at IAEA. The results of the survey will allow IAEA to address recommendations to harmonize and improve radiation protection of workers in industrial radiography.

The completed questionnaire needs to be sent to the IAEA, by email to John.Le.heron@iaea.org or by mail to John Le Heron, Radiation Safety and Monitoring Section (RSM), Division of Radiation, Transport and Waste Safety (NSRW), INTERNATIONAL ATOMIC ENERGY AGENCY, Wagramer Strasse 5, P.O.Box 100, A-1400 Vienna, Austria.

I. Training and Qualifications of Industrial Radiographers

1. Does the (radiation protection) Regulatory Body require that persons wishing to perform on-site⁸ radiography must have had radiation protection training to an acceptable level?

Yes: No: Do not know:

1a. If yes to Question 1, what radiation protection training does the Regulatory Body consider as acceptable?

i. Radiation protection training that is part of the NDT-training on Radiographic Testing?

Yes: No: Do not know:

ii. Radiation protection training that is a separate training course?

Yes: No: Do not know:

1b. If yes to Question 1, does the Regulatory Body have the same radiation protection training requirements for using gamma sources as for using X-ray machines?

Yes: No: Do not know:

1c. If yes to Question 1, does the Regulatory Body require that the radiation protection training includes both theoretical and practical training?

Yes: No: Do not know:

⁸ On-site means on the site of the client and not in a fixed facility designed for radiography.

1d. If yes to Question 1, does the Regulatory Body require that the radiation protection training includes practical exercises for emergencies, namely for:

i. Creating a safe situation until the source is able to be recovered?

Yes: No: Do not know:

ii. Source recovery?

Yes: No: Do not know:

1e. If yes to Question 1, does having the acceptable level of radiation protection training (either as part of the NDT programme or as separate training) include having passed an examination at the end of the radiation protection training?

Yes: No: Do not know:

1f. If yes to Question 1e, is the examination on radiation protection:

(Please mark only one option)

- Theoretical only;
- Practical only;
- Both theoretical and practical.

1g. If yes to Question 1a(ii), are the separate training courses conducted by:

i. The (radiation protection) Regulatory Body:

Yes: No: Do not know:

ii. Educational institutes (such as Universities, Polytechnics, Trades training Schools):

Yes: No: Do not know:

iii. Private NDT companies:

Yes: No: Do not know:

iv. Private Radiation Protection consultants:

Yes: No: Do not know:

v. Other, please specify:

2. Does the (radiation protection) Regulatory Body require refresher training in radiation protection for persons performing on-site radiography?

Yes: No: Do not know:

2a. If yes to Question 2, what is the time interval between refresher courses?

A refresher course every: _____ years

2b. If yes to Question 2, is there an examination as part of the refresher training?

Yes: No: Do not know:

3. Does the (radiation protection) Regulatory Body require that a person wishing to act as a Radiation Protection Officer⁹ (RPO) for a Company that performs on-site radiography must have had radiation protection training to an acceptable level?

Yes: No: Do not know:

3a. If yes to Question 3, is the acceptable level higher than that for an operator (as in Question 1)?

Yes: No: Do not know:

3b. If yes to Question 3, is there an examination as part of the training to be an RPO?

Yes: No: Do not know:

II. Incidents (deviations, near misses and accidents).

4. Does the (radiation protection) Regulatory Body require the authorized party (licensee) to report radiation incidents in Industrial Radiography to the Regulatory Body?

Yes: No: Do not know:

4a. If yes to Question 4, what are the criteria for requiring a licensee to notify the Regulatory Body?

Please specify:

5. How many radiation incidents in Industrial Radiography were notified to the (radiation protection) Regulatory Body in the last five years?

(Please specify or estimate the number for each of the following severity classes. If none occurred in a given category, enter "0" or nil.)

- a. Accidents with elevated individual exposures higher than the annual limit:
- b. Accidents with elevated individual exposures lower than the annual limit:
- c. Near misses that had the potential for elevated individual exposures higher than the annual limit:
- d. Near misses that had the potential for elevated individual exposure lower than the annual limit:
- e. Other deviations from normal operations:

6. Does the (radiation protection) Regulatory Body maintain a radiation incident database for your jurisdiction (country or state)?

Yes: No: Do not know:

⁹ RPO means a person technically competent in radiation protection matters relevant, in this case, to industrial radiography who is designated by the licensee to oversee the application of relevant radiation protection requirements established in national regulations.

6a. If yes to Question 6, does the Regulatory Body analyse the database regularly, using established criteria, to determine if there are common factors in the incidents?

Yes: No: Do not know:

6b. If yes to Question 6, does the Regulatory Body use the International Nuclear and Radiological Event Scale (INES) to classify the severity of the incidents?

Yes: No: Do not know:

6c. If no to Question 6b, does the Regulatory Body use another scale to classify the severity of the incidents

Yes: No: Do not know:

6d. If yes to Question 6c, please specify:

7. Does the (radiation protection) Regulatory Body have an established system for sharing lessons learned from reported incidents, including an analysis of the root causes and the corrective actions taken?

Yes: No: Do not know:

7a. If yes to Question 7, to whom is the information disseminated?

i. Operating NDT companies in your jurisdiction?

Yes: No: Do not know:

ii. Other regulatory bodies in other countries or states?

Yes: No: Do not know:

7b. If yes to Question 7, how many times in the last 5 years has information from reported incidents been disseminated to:

(Enter 0, or nil if there has been no disseminations.)

i. Operating NDT companies in your jurisdiction:

ii. Other regulatory bodies in other countries or states:

8. If you are the national (radiation protection) Regulatory Body, did you report the incidents to the International Atomic Energy Agency (IAEA) in the last 5 years?

Yes: No: Do not know:

III. Systems and procedures in place to ensure protection and safety in industrial radiography

III.1 Safety of the radiographer

9. What type of individual monitoring does the (radiation protection) Regulatory Body require the radiographer to have?

a. Passive dosimeter¹⁰:

Yes: No: Do not know:

¹⁰ Such as thermoluminescence (TLD), optically stimulated luminescence (OSL), film or radiophotoluminescence (RPL) dosimeter.

b. Active dosimeter (Electronic Personal Dosimeter):

Yes: No: Do not know:

9c. If yes to part b, is the active dosimeter required to measure integrated dose:

Yes: No: Do not know:

9d. If yes to part b, is the active dosimeter required to have:

i. A visual alarm:

Yes: No: Do not know:

ii. An audible alarm:

Yes: No: Do not know:

iii. A vibrating alarm:

Yes: No: Do not know:

10. Whom does the (radiation protection) Regulatory Body require to be informed about the personal doses of the monitored radiographers?

a. The radiographer?

Yes: No: Do not know:

If yes, frequency per year =

b. The NDT Company or employer of the radiographer?

Yes: No: Do not know:

If yes, frequency per year =

c. The (radiation protection) Regulatory Body?

Yes: No: Do not know:

If yes, frequency per year =

d. The National Personal Dose Database?

Yes: No: Do not know:

If yes, frequency per year =

11. Does the (radiation protection) Regulatory Body require that the radiographer always has a functioning and calibrated survey meter with them?

Yes: No: Do not know:

III.2 Safety of the public

12. Does the (radiation protection) Regulatory Body require that it is informed in advance about individual on-site Industrial Radiography jobs?

Yes: No: Do not know:

12a. If yes to Question 12, how long in advance must the notification be?

Please specify: _____ hours

13. Does the (radiation protection) Regulatory Body require there to be a warning system to prevent entry to the radiography site?

Yes: No: Do not know:

13a. If yes to Question 13, does the Regulatory Body have an official standard procedure for warning systems that must be followed?

Yes: No: Do not know:

13b. If yes to Question 13a, does the official standard procedure for a warning system require:

i. Barriers:

Yes: No: Do not know:

ii. Warning signs:

Yes: No: Do not know:

iii. Flashing lights:

Yes: No: Do not know:

iv. Other features:

Yes: No: Do not know:

If yes, please specify:

13c. If yes to Question 13a, what maximum dose rate does the official standard procedure specify at the barrier:

Please specify: microSv/hour

(Please ensure your number is in terms of microSv/hour, otherwise state your units.)

14. Does the (radiation protection) Regulatory Body require the client (who is receiving the on-site radiography services) to inform the licensee (of the Operating NDT Company) about conditions at the site that might affect the safety of other workers on site?

Yes: No: Do not know:

14a. If yes to Question 14, does this include:

i. The provision of site plans?

Yes: No: Do not know:

ii. Information about other worker activities, occurring at the same time and in the vicinity of where the radiography will occur?

Yes: No: Do not know:

15. Does the (radiation protection) Regulatory Body require that there is a qualified Radiation Protection Officer (RPO) or Radiation Protection Expert¹¹ (RPE) on the work site during on-site radiography?

Yes: No: Do not know:

¹¹ A Radiation Protection Expert is a person having the knowledge, training and experience needed to give radiation protection advice in order to ensure effective protection of individuals, whose capacity to act is recognized by the competent authorities.

III.3 Safety of sources and exposure devices

16. Does the (radiation protection) Regulatory Body require that any sealed source used for industrial radiography purposes must meet specified standards:

Yes: No: Do not know:

16a. If yes to Question 16, please specify the standards:

17. Does the (radiation protection) Regulatory Body require that any exposure device used for industrial radiography purposes must meet specified standards:

Yes: No: Do not know:

17a. If yes to Question 17, please specify the standards:

18. Does the (radiation protection) Regulatory Body require that the source and the exposure device are subject to rigorous periodic inspections/tests and maintenance to verify compliance with required standards?

Yes: No: Do not know:

18a. If yes to Question 18, what is the required frequency:

Please specify:

18b. If yes to Question 18, are accessories included?

Yes: No: Do not know:

18c. If yes to Question 18, who is permitted by the Regulatory Body to perform such services?

i. The manufacturer or manufacturer's agent:

Yes: No: Do not know:

ii. The NDT Operating Company:

Yes: No: Do not know:

iii. Other third party:

Yes: No: Do not know:

If yes, please specify:

19. Does the (radiation protection) Regulatory Body require that any X-ray generator used for industrial radiography purposes must meet specified standards:

Yes: No: Do not know:

19a. If yes to Question 19, please specify the standards:

20. Does the (radiation protection) Regulatory Body require that the X-ray equipment are subject to rigorous periodic inspections/tests and maintenance to verify compliance with required standards?

Yes: No: Do not know:

20a. If yes to Question 20, what is the required frequency:

Please specify:

20b. If yes to Question 20, are accessories included?

Yes: No: Do not know:

20c. If yes to Question 20, who is permitted by the Regulatory Body to perform such services?

i. The manufacturer or manufacturer's agent:

Yes: No: Do not know:

ii. The NDT Operating Company:

Yes: No: Do not know:

iii. Other third party:

Yes: No: Do not know:

If yes, please specify:

21. Does the (radiation protection) Regulatory Body specify requirements for on-site storage of sources?

Yes: No: Do not know:

22. Does the (radiation protection) Regulatory Body require the licensee to conduct periodic documented checks of sources to confirm that they are in their assigned locations and are secure?

Yes: No: Do not know:

III.4 Regulatory inspections and radiation protection officers

23. Does the (radiation protection) Regulatory Body perform inspections of NDT Operating Companies that provide on-site radiography services?

Yes: No: Do not know:

23a. If yes to Question 23, are these inspections to where on-site radiography is actually taking place?

Yes: No: Do not know:

23b. If yes to Question 23, are these inspections:

(Please mark only one option)

- Announced only;
- Unannounced only;
- Either announced or unannounced;
- Do not know.

23c. If yes to Question 23, how often is a given licensee inspected?

Please specify the frequency:

23d. If yes to Question 23, are the following addressed during the inspections?

i. Proper wearing of passive individual dosimeters Yes: No:

ii. Proper wearing and use of active individual dosimeters Yes: No:

- | | | |
|--|-------------------------------|------------------------------|
| iii. Proper use of survey meters | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| iv. Proper use of collimators | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| v. Proper use of warning systems to prevent entry at the work site | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| vi. Dose rate at the boundary of the warning system to prevent entry to the work site within limits set: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| vii. Proper use of alarm systems (flashing lights, audible alarm, use of PA system): | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| viii. Proper training and qualifications of Industrial Radiographers | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| ix. Operator knowledge of procedures: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| x. Pre-operation specific equipment checks: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| xi. Equipment condition: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| xii. Emergency preparedness: | Yes: <input type="checkbox"/> | No: <input type="checkbox"/> |
| xiii. Other, please specify: | | |

23e. If yes to Question 23, please rank the common shortcomings, in order of the frequency, in which they are observed in inspections?

(Starting with 1 for the most frequent shortcoming, and 2 for the next most frequent, and so on, assign a number (from 1 to 5) to the five most common shortcomings from those listed below, based on your experiences.)

Ranking of the five most common shortcomings:

- No proper wearing of passive individual dosimeters;
- No proper wearing and use of active individual dosimeters;
- No proper use of survey meters;
- No proper use of collimators;
- No proper warning system to prevent entry to the work site;
- Dose rate at the boundary of the work site not within limits set;
- No proper use of alarm systems (flash lights, audible alarm, use of PA system);
- No proper training and qualifications of radiographers;
- Poor operator knowledge of procedures;
- No pre-operation specific equipment checks being performed;
- Poor equipment condition;
- Poor emergency preparedness;
- Other (see previous question).

24. Does the (radiation protection) Regulatory Body require that a licensee (NDT Operating Company) employs a Radiation Protection Officer (RPO) or Radiation Protection Expert (RPE)?

Yes: No: Do not know:

24a. If yes to Question 24, does the regulatory body require that the RPO or RPE reports directly to the Managing Director¹² of the Company?

Yes: No: Do not know:

III.5 Emergency plan

25. Does the (radiation protection) Regulatory Body require that a licensee (NDT Operating Company) has an Emergency Plan?

Yes: No: Do not know:

25a. If yes to Question 25, does the Regulatory Body require that the Emergency Plan specifies requirements for training and exercises?

Yes: No: Do not know:

25b. If yes to Question 25, does the Regulatory Body approve the licensee's Emergency Plan?

Yes: No: Do not know:

26. Does the (radiation protection) Regulatory Body require that licensees must have emergency equipment?

Yes: No: Do not know:

27. Does the (radiation protection) Regulatory Body have resources to assist licensees in recovering from emergencies?

Yes: No: Do not know:

28. Does the (radiation protection) Regulatory Body check the Emergency Plan and the list of emergency equipment for radiographic work during the periodic inspection or at licence renewal for the NDT Operating Company?

Yes: No: Do not know:

¹² Or other equivalent person, such as Chief Executive Officer

IV. Individual monitoring.

29. Does the (radiation protection) Regulatory Body have direct access to a national or state database of individual doses for Industrial Radiographers and other involved in NDT?

Yes: No: Do not know:

29a. If yes to Question 29, please complete the following table:

Table 1: Number of NDT workers with individual dosimetry in 2009	
<i>Category of person</i>	<i>Number monitored in 2009</i>
Industrial radiographers	
Other exposed NDT workers	
All exposed workers*	

* The sum of industrial radiographers and other exposed NDT workers

29b. If yes to Question 29, please complete the following table:

Table 2: Annual occupational <u>doses</u> for NDT workers in 2009			
<i>Category of person</i>	<u>Average</u> annual individual effective dose (mSv)	<u>Median</u> annual individual effective dose (mSv)	<u>Highest</u> annual individual effective dose (mSv)
Industrial radiographers			
Other exposed NDT workers			
All exposed workers*			

* The sum of industrial radiographers and other exposed NDT workers.

29c. If yes to Question 29, please complete the following table:

Table 3: Number of workers that were in the following ranges of <u>annual</u> individual effective doses in 2009			
<u>Ranges</u> of annual individual effective dose, D, (mSv)	Industrial Radiographers	Other exposed NDT workers	All exposed workers**
D < MDL*			
MDL ≤ D < 1			
1 ≤ D < 5			
5 ≤ D < 10			
10 ≤ D < 15			
15 ≤ D < 20			
20 ≤ D < 30			
30 ≤ D < 50			
D ≥ 50			

* MDL= Minimum Detection Limit of the personal dosimetry system.

** The sum of industrial radiographers and other exposed NDT workers.

29d. If yes to Question 29, please complete the following table:

Table 4: Number of workers whose <u>maximum</u> individual effective dose in a <u>month</u> in 2009 was in the following ranges			
<u>Ranges</u> of maximum individual effective dose in a <u>month</u> , D_m ,(mSv)	Industrial Radiographers	Other exposed NDT workers	All exposed workers*
$D_m < 1$			
$1 \leq D_m < 2.5$			
$2.5 \leq D_m < 5$			
$5 \leq D_m < 10$			
$10 \leq D_m < 20$			
$20 \leq D_m < 50$			
$D_m \geq 50$			

* The sum of industrial radiographers and other exposed NDT workers.

29e. If yes to Question 29, do the above given dose records include doses received from performing industrial radiography on-site at Nuclear Power Plants?

Yes: No: Do not know:

29f. If yes to Question 29, does the Regulatory Body perform trend analyses (over, for example, 5 years or more) of occupational doses in industrial radiography, in particular for the most exposed workers, and correlate these with incidents?

Yes: No: Do not know:

29g. If yes to Question 29f, are the results used by the Regulatory Body, in conjunction with the NDT industry, to initiate measures to reduce the likelihood of such incidents recurring?

Yes: No: Do not know:

Requested optional information: (*Note: All information will be treated as strictly confidential by the IAEA. Only anonymised and aggregated data will be made available.*)

Name:

Job title or position:

Institution:

Town or city:

Country:

Email:

Date

I would like to receive the report with the results of this survey: Yes: No:

Please send the completed questionnaire to the IAEA, by email to John.Le.heron@iaea.org