

THE NORTH RHINE - WESTPHALIAN FACTORY INSPECTORATE'S INCORPORATION MONITORING MEASURES FOR THE ROUTINE CONTROL OF POTENTIALLY ENDANGERED RADIATION WORKERS AND THE RESULTS OF THIS CONTROL COMPILED OVER THE PERIOD 1964-1976

H.R. Erlenbach

Central Office for Safety Engineering, Radiological Protection and Nuclear Engineering, Factory Inspectorate of the State of North Rhine - Westphalia, Duesseldorf, Federal Republic of Germany

1. INTRODUCTION

As a result of the provision made by the Supreme Factory Inspection Authority of North Rhine - Westphalia (NW) for the precautionary regular incorporation monitoring of radiation workers who are considered to be potentially endangered because of their handling unsealed radioactive substances beyond specified radioactivity limits, three Incorporation Monitoring Centres (IMCs) for the obligatory incorporation surveillance of the radiation workers concerned are so far available in NW. These three laboratories are:

The Duesseldorf IMC, which was established by the Factory Inspectorate of NW in late 1963 in order to provide the public with an official IMC,

The Juelich IMC, which is the authorized incorporation control laboratory for the Juelich Nuclear Research Establishment, but also free to monitor radiation workers from elsewhere,

The Cologne IMC, which is officially authorized as well, but basically confines itself to monitoring persons affiliated to the Cologne university and refrains from excretion radioassay.

The extent of the obligatory incorporation surveillance for radiation workers is detailed in the ministerial order of July 24, 1968, promulgated in the Ministerial Gazette of the State of NW (1). At the present time, these guidelines are being discussed and revised in a committee at Federal level.

2. THE DUESSELDORF INCORPORATION MONITORING CENTRE AND ITS FINDINGS

The single-detector chair technique of Human Whole-Body Counting (HBC) employed at the Duesseldorf IMC and its performance is described elsewhere (2). The Liquid Scintillation Counting (LSC) of urine samples and the Fluorometric Urine Analysis for Uranium (FUU) are both standard methods. They need no further comment but the statement of the respective detection limits, which amount to less than 4 nCi/l for tritium and carbon-14 and 0.3 µg/l for uranium.

The Duesseldorf IMC's findings compiled over the period 1964-1976 are presented in the following tables 1-4, which are self-explanatory.

3. CONCLUSIONS DRAWN FROM THE FINDINGS

- 3.1 In spite of the usually small activities involved, a general release from incorporation control obligations for radiation workers in nuclear diagnostics is not justified considering their contribution to incorporation statistics.
- 3.2 It is not the lowest detectable radiotoxicity range that shows the highest frequency of incorporations, which is indicative of a "non-linear" intake if working conditions admit of any uptakes of radioactive material at all.
- 3.3 The distribution of the recorded incorporation cases over the 34 detected radionuclides and the preset radiotoxicity ranges, which has been obtained from the surveillance of all the significant applications of unsealed radioactive material in all walks of modern life apart from nuclear technological research and nuclear industry and which covers the majority of radiation workers in the 17 million population of NW and a time span of more than a decade, shows that there are only a few radionuclides constituting an appreciable incorporation hazard under normal conditions.

REFERENCES

- (1) "MINISTERIALBLATT FÜR DAS LAND NORDRHEIN-WESTFALEN - Ausgabe A -", 21. Jg. Nr. 107 (ausgegeben zu Düsseldorf am 16.8.1968) 1398
- (2) "DIRECTORY OF WHOLE-BODY RADIOACTIVITY MONITORS", GY 10.1, International Atomic Energy Agency, Vienna (1970)

PERIOD	0.1 - 1 (%MPBB) _?		1 - 10 (%MPBB) _?		10 - 100 (%MPBB) _?		100 - ... (%MPBB) _?	
	I ¹³¹	I ¹²⁵	I ¹³¹	I ¹²⁵	I ¹³¹	I ¹²⁵	I ¹³¹	I ¹²⁵
1974	35D+2oDT	1D	34D+19DT	3D	7D+ 7DT	o	1DT	o
1975	58D+18DT	4D+1DT	37D+14DT	5D+1DT	6D+ 3DT	o	o	o
1976	82D+12DT	7D	5oD+1oDT	1D	6D+ 1DT	o	2D	o
74-76	175D+5oDT	12D+1DT	121D+43DT	9D+1DT	19D+11DT	o	2D + 1DT	o

LEGEND (%MPBB)_? : Percentage of the Maximum Permissible Body Burden calculated according to the ICRP Recommendations on the disputable assumption (emphasized by the subscript ?) that the determined incorporation value represents an Annual Incorporation Average for the monitored person and the detected radionuclide

D or DT : Incorporations due to the handling of IODINE-131 and IODINE-125 for sole DIAGNOSTIC or for DIAGNOSTIC and THERAPEUTIC purposes

TABLE 1 Preponderance of Iodine Incorporations due to Nuclear Diagnostics Over Those due to Nuclear Therapeutics in Monitored Medical Personnel

PERIOD	MEASUREMENTS			RADIATION WORKERS			LEGEND
	HBC	LSC	FUU	HBC	LSC	FUU	
1964	783	o	o	248	o	o	HBC: Human Whole-Body Counting
1965	685	48	o	154	25	o	
1966	453	197	16	2o5	5o	-	
1967	5o7	351	36	28o	18o	-	
1968	45o	396	2o	287	18o	-	LSC: Liquid Scintillation Counting
1969	414	527	5o	295	35o	-	
197o	519	7o6	49	4o3	322	26	FUU: Fluorometric Urinalysis for Uranium
1971	3o8	623	46	27o	321	-	
1972	553	573	434	417	258	8o	
1973	5o8	7o7	238	423	328	78	
1974	6o6	697	291	57o	456	89	
1975	932	614	319	889	376	81	
1976	1155	1158	256	1112	498	82	
1964-76	7873	6597	1755				

TABLE 2 Incorporation Control Measurements and Monitored Radiation Workers

PERIOD	0.001-0.01 (%MPBB)?		0.01 - 0.1 (%MPBB)?		0.1 - 1 (%MPBB)?		1 - 10 (%MPBB)?		10-100 (%MPBB)?		100 - ... (%MPBB)?		1 - 10 ($\mu\text{g}/\text{l}$) FUU	10 - ... ($\mu\text{g}/\text{l}$) FUU
	HBC	LSC	HBC	LSC	HBC	LSC	HBC	LSC	HBC	LSC	HBC	LSC		
1964	0	1	0	0	3	0	9	0	3	0	2	0	0	0
1965	0	0	0	36T	3	36T	5	12T	2	0	0	0	0	0
1966	1	2	0	53T	6	53T	10	36T	5	7T	0	1T	0	0
1967	1	5	0	24T	13	24T	17	25T	13	1T	3	0	0	0
1968	0	3	0	42T	9	42T	15+1M	12T	5+3M	2T	2M	0	0	0
1969	1	9	49T	36T	25	36T	24	16T	10	2T	2	0	1	0
1970	2	12	47T	83T	47	83T	29+2M	30T	7+2M	0	1+ 2M	0	12	1
1971	0	11	30T	89T	49	89T	27	33T	6	1T	1M	0	41	5
1972	9	47	23T	105T	63+1M	105T	46+5M	36T	9	7T	3	0	13	7
1973	6	21	38T	104T	67	104T	49+1M	46T	8	3T	2M	0	6	0
1974	23	57	72T	90T	84+1M	90T	66+1M	55T+ 7C	17+2M	4T	1+ 1M	0	4	0
1975	38	55	66T	92T	107+1M	92T	67+1M	38T+ 7C	12	4T	1+ 5M	0	9	0
1976	88	123	79T	111T	153	111T	76	73T+ 7C	8	3T	2+ 7M	0	5	0
1964-76	169	346	404T	865T	629+3M	865T	440+11M	412T+21C	105+7M	34T	15+20M	1T	91	13

LEGEND (%MPBB)_? , HBC , LSC , FUU : cf. TABLE 1 ; T : Tritium incorporation(s); C : Carbon-14 incorp.(s)

M : Incorporations attributable to Medical Treatment of radiation workers and being remarkable for their possibly misleading or masking potentials

TABLE 3 Frequency and Significance of Detected Incorporations by the HBC, LSC and FUU Methods

(%MPBB) ? :	0.001-0.01	0.01-0.1	0.1-1	1-10	10-100	100 - ...
RADIONUCLIDE						
1) SODIUM-22		1				
2) SCANDIUM-46			1			
3) CHROMIUM-51		1	1			
4) MANGANESE-54		16	14	1		
5) IRON-59	1	1	3	1		
6) COBALT-57		1				
7) COBALT-58	1	20	13	3		
8) COBALT-60	1	8	19	2		
9) ZINC-65	2	20	6			
10) ARSENIC-74			1			
11) SELENIUM-75	40	25		1		
12) RUBIDIUM-86			1	1		
13) STRONTIUM-85	5	5				
14) NIOBIUM-95			1	1		
15) TECHNETIUM-99m	117	169	72	24	3	1
16) ANTIMONY-124		1				
17) IODINE-125	3	31	21	21		
18) IODINE-131		18	414	399	91	10
19) CESIUM-137		2	1		2	
20) BARIUM-133		1				
21) TERBIUM-160			1			
22) YTTERBIUM-169			1			
23) HAFNIUM-175			1			
24) HAFNIUM-181		2	5			
25) TANTALUM-182			1			
26) OSMIUM-191			1	1		
27) GOLD-198	1	7	3			
28) MERCURY-197			2	1	1	
29) MERCURY-203		14	50	1	1	
30) LEAD-212 (THORIUM B)				1	3	5
31) RADIUM-226				1	2	1
SUM TOTAL	171	343	633	459	103	17

TABLE 4 Synoptic Presentation as to Radionuclide and Significance of all the Incorporations Recorded During the 1964-76 Period Exclusive of Tritium, Carbon-14, and Uranium Incorporations, Which are Already Presented in TABLE 3