Trial Calculation of Actual Integrated Exposure Dose of Students, under assumption of a Living Patterns of Students of Schools, etc. with 3.8μSv/hr Air Dose Rates in Schoolyard, etc.

1. Outline

In the "Interim Policy in Deciding on Use of School Buildings and Schoolyards, etc. at Schools, etc. in Fukushima Prefecture," (outdoors 3.8μSv/hr × 8hrs + indoors 1.52μSv/hr × 16hrs) × 365 days results in 20mSv. Therefore, a schoolyard air dose rate of 3.8μSv/hr was set as the limit value for school use. However, this means that if a student, etc. is in the schoolyard or playground (hereinafter, reffered to as "schoolyard") for eight hours every day, and stays 16 hours in a wood building for one year, then it reaches 20mSv. One does not imagine that students, etc. actually have this kind of living pattern.

That is, actually,

● Compared to schoolyards, air dose rates in the surroundings are lower
● Conduct patterns of child students, etc. on school days differ from 8 hours outdoors, 16 hours indoors
● Schools have concrete construction, which has a strong shielding effect

Therefore, values which take into account these points are <u>integral doses which students actually receive as estimated from living patterns of students, etc.</u> We estimated the integral dose by also taking these points into account.

2. Assumptions

Air Dose Rates of Schoolyards and Surroundings

First, at 13 schools which exceeded 3.8μSv/hr in the MEXT's survey (April 14), air dose rates of the surroundings were 39% below the level in schoolyards on average. Therefore, this value is used.

Conduct Patterns of Students, etc.

<u>(1) 34 Days from the Accident Date until Schools Opened (April 14)</u>

For places where the air dose rate is 3.8μSv/hr, according to the estimation methods when creating the integral dose estimate map (8 hours outdoors, 16 hours indoors, etc.), this is estimated as 2.56 mSv. During this period, schools were closed, so this part corresponds to the non-school related portion.

<u>(2) School Weekdays: 200 days</u>

Assume for the school related portion: one hour going to and from school, two hours outdoors in schoolyard, etc., five hours in concrete construction school buildings. For the non-school related portion: three hours outdoors, 13 hours indoors.

(3.8 × 0.61 × <u>1 hour</u>): Going to and from school   School portion
(3.8 × <u>2 hours</u>): Schoolyard, etc.

    (3.8 × 0.1 × <u>5 hours</u>): In school buildings (concrete building)
    (3.8 × 0.61 × <u>3 hours</u>): Outdoors   Non-school portion
    (3.8 × 0.61 × 0.4 × <u>13 hours</u>): Indoors (wooden building)

<u>(3) School Holidays: 131 days (165 - 34 days)</u>
    As the non-school related portion, assume 8 hours outdoors, 16 hours indoors.
    (3.8 × 0.61 × <u>8 hours</u>): Outdoors   Non-school portion
    (3.8 × 0.61 × 0.4 × 16 hours): Indoors (wood building)

    Here, regarding the portion since April 15, the average decay rate shall be considered 0.705, based on soil analysis results of 13 schools which exceeded 3.8μSv/hr in the MEXT's survey (April 14).

3. Results, etc.
    Based on the above assumptions, <u>the integral dose in the one year period after the accident occurred, received by students, etc. at schools with a schoolyard air dose rate of 3.8μSv/hr</u> is

9.99 mSv   [of this, school related portion 1.67 mSv (approximately 17% of total)]

    That is, <u>even at schools with 3.8μSv/hr</u> which is the limit value for placing restrictions on schoolyard use by the "Interim Policy" <u>the integral dose which students, etc. actually receive is 10 mSv (approximately half of 20 mSv)</u>.

    Also, approximately 17% of the integral dose is contributed by the school related portion. To reduce the total exposure of students, etc., efforts to reduce exposure in school lives are also important, but this alone has limits. Efforts to reduce exposure outside the school life portion are very important.

Schools with a 3.8μSv/hr Schoolyard

μSv/h								μSv/h
0.38	In school buildings	5	0.38	Outdoors	8	2.43		2.32
3.80	Schoolyard, etc.	2	1.52					
2.32	Going to and from school	1	0.46					
	Outdoors	3	1.39	Indoors	16	1.94		0.93
0.93	Indoors	13	2.41					

	Hour	mSv			Hour	mSv	
School Weekdays	200	days		School Holidays	131	days	

Decay rate
0.705

34 Days from the Accident
2.56

Total **9.99**		mSv
School portion **1.67**	Non-school portion **8.32**	mSv
16.7 %	83.3 %	

Estimates of Integrated Dose at Each Continuous Monitoring Location based on Measured Values (1/2)

Location Number	Location (Motiroring Area)	From Fukushima Dai-ichi NPP		Starting Date of Monitoring Air Dose Rate	Estimates of Integrated Dose 1		Latest Readings (mSv/h)	Estimates of Integrated Dose as of March 11, 2012 Sv
		Direction	Distance		Sv	Note		
(1) Planned evacuation zones								
83	Akogi Kunugidaira, Namie Town, Futaba County	Northwest	24km	2011/3/24	44.5	2	0.0408	235.4
81	Akogi Ishikoya, Namie Town, Futaba County	Northwest	31km	2011/3/24	25.3	2	0.0349	188.6
32	Akogi Teshichiro, Namie Town, Futaba County	Northwest	31km	2011/3/16	23.8	5	0.0185	110.2
79	Shimotsushima Kayabuka, Namie Town, Futaba County	West-northwest	29km	2011/3/16	10.6	5	0.0097	56.2
31	Tsushima Nakaoki, Namie Town, Futaba County	West-northwest	30km	2011/3/17	9.9	5	0.0082	48.2
34	Tsushima Taikogi, Namie Town, Futaba County	West-northwest	30km	2011/3/19	4.6	2 5	0.0042	24.2
21	Kaminogawa, Katsurao Village, Futaba County	West-northwest	32km	2011/3/17	2.5	5	0.0033	18.0
104	Aza Ochiai, Oaza Ochiai, Katsurao Village, Futaba County	Northwest	25km	2011/4/7	2.6	2	0.0018	11.0
33	Nagadoro, Iitate Village, Soma County	Northwest	33km	2011/3/16	13.7	5	0.0102	61.7
62	Kusano Taishido, Iitate Village, Soma County	Northwest	39km	2011/3/17	5.3		0.0063	34.8
61	Yagisawa, Iitate Village, Soma County	Northwest	36km	2011/3/17	4.3		0.0047	26.3
63	Nimaibashi, Iitate Village, Soma County	Northwest	44km	2011/3/17	2.0		0.0017	10.0
46	Yamakiya Mukaideyama, Kawamata Town, Date County	West-northwest	34km	2011/3/17	5.5		0.0040	24.2
36	Yamakiya Onukari, Kawamata Town, Date County	West-northwest	40km	2011/3/20	3.7	2	0.0034	19.6
(2) Other zones								
108	Ohara Daihata, Haramachi Ward, Minami Soma City	North-northwest	30km	2011/4/7	3.4	2	0.0026	15.6
107	Baba Shimonakanouchi, Haramachi Ward, Minami Soma City	North-northwest	25km	2011/4/7	3.0	2	0.0019	11.9
6	Nishimachi, Kashima Ward, Minami Soma City	North	32km	2011/3/17	0.9		0.0010	5.5
103	Taka Mamegarauchi, Haramachi Ward, Minami Soma City	North	20km	2011/4/7	0.7	2	0.0006	3.5
7	Terauchi Motoyashiki, Kashima Ward, Minami Soma City	North-northwest	32km	2011/3/17	0.6	5	0.0006	3.3
80	Takamicho, Haramachi Ward, Minami Soma City	North	24km	2011/3/20	0.8	2 5	0.0004	2.8
4	Kawabata, Oaza Tsuruzawa, Kawamata Town, Date County	Northwest	47km	2011/3/17	1.0		0.0015	8.1
78	Tsuruzawa, Kawamata Town, Date County	Northwest	48km	2011/3/20	1.2	2	0.0010	5.7
37	Ishida Hojizawa, Ryozen Town, Date City	Northwest	48km	2011/3/31	3.4	2	0.0038	21.2
3	Ishida Hikohei, Ryozen Town, Date City	Northwest	46km	2011/3/17	2.4		0.0029	16.0
102	Tsukidate Town, Date City	Northwest	50km	2011/4/7	1.5	2	0.0007	4.8
101	Aza Minowa, Oishi, Ryozen Town, Date City	Northwest	55km	2011/4/7	1.3	2	0.0006	4.1
2	Onami Takinoiri, Fukushima City	Northwest	56km	2011/3/17	2.7		0.0017	10.6
88	Hikarigaoka, Fukushima City	West-northwest	55km	2011/4/3	2.1	2	0.0014	8.7
1	Sugitsumacho, Fukushima City	Northwest	62km	2011/3/16	1.4	5	0.0007	4.6
85	Arai Harajuku, Fukushima City	West-northwest	66km	2011/3/27	0.5	2	0.0004	2.4
77	Kamiogawa, Ogawa Town, Iwaki City	Southwest	26km	2011/3/20	1.4	2	0.0011	6.6
72	Aza Kitaaramaki, Hisanohama, Hisanohama Town, Iwaki City	South	31km	2011/3/20	0.7	2	0.0009	5.0
44	Aza Yanomezawa, Ohisa, Ohisa Town, Iwaki City	South-southwest	28km	2011/3/17	1.0		0.0005	3.4
73	Yotsukura Town, Iwaki City	South	35km	2011/3/20	0.6	2	0.0005	3.0
74	Takahagi, Ogawa Town, Iwaki City	South-southwest	36km	2011/3/20	0.5	2	0.0005	2.8
38	Hokita, Shiraiwa, Yotsukura Town, Iwaki City	South-southwest	34km	2011/3/31	0.7	2 5	0.0003	2.0
75	Uchigomimaya Town, Iwaki City	South-southwest	43km	2011/3/20	0.3	2	0.0003	1.7
106	Aza Shokangoya, Ojiroi, Kawamae Town, Iwaki City	Southwest	30km	2011/4/7	0.2	2	0.0003	1.6
84	Saiso, Miwa Town, Iwaki City	Southwest	39km	2011/3/26	0.3	2 5	0.0002	1.0
45	Utsukushimori, Yamadaoka, Naraha Town, Futaba County	South	20km	2011/3/17	1.2		0.0008	4.7
71	Nawashirogae, Shimokitaba, Hirono Town, Futaba County	South	23km	2011/3/20	1.0	2 5	0.0005	3.3
11	Aza Shimoda, Ota, Nihonmatsu City	West-northwest	43km	2011/3/17	1.2		0.0009	5.4
10	Aza Nakajima, Harimichi, Nihonmatsu City	West-northwest	44km	2011/3/17	0.9		0.0008	4.7
35	Aza Hagidaira, Tazawa, Nihonmatsu City	West-northwest	37km	2011/3/19	0.8	2	0.0008	4.5

Estimates of Integrated Dose at Each Continuous Monitoring Location based on Measured Values (2/2)

Location Number	Location (Motiroring Area)	From Fukushima Dai-ichi NPP		Starting Date of Monitoring Air Dose Rate	Estimates of Integrated Dose 1		Latest Readings (mSv/h)	Estimates of Integrated Dose as of March 11, 2012 Sv
		Direction	Distance		Sv	Note		
89	Toyota Town, Koriyama City	West	60km	2011/4/3	2.1	2	0.0017	10.1
86	Aza Choemonbayashi, Otsuki Town, Koriyama City	West	63km	2011/3/27	1.2	2	0.0012	6.8
87	Hananouchi, Kamikawauchi, Kawauchi Village, Futaba County	West-southwest	29km	2011/3/27	0.9	2	0.0009	5.1
76	Aza Hayawata, Kamikawauchi, Kawauchi Village, Futaba County	West-southwest	22km	2011/3/20	0.6	2 5	0.0004	2.5
43	Aza Miyawata, Shimokawauchi, Kawauchi Village, Futaba County	West-southwest	22km	2011/3/16	0.5		0.0004	2.3
20	Aza Shimo, Niitate, Funahiki Town, Tamura City	West	41km	2011/3/17	0.5		0.0012	6.2
42	Aza Tomioka, Yamane, Tokiwa Town, Tamura City	West	33km	2011/3/17	0.8		0.0008	4.3
15	Aza Kashima, Yamane, Tokiwa Town, Tamura City	West	32km	2011/3/17	0.9	5	0.0006	3.6
41	Furumichi, Miyakoji Town, Tamura City	West	21km	2011/3/17	0.7		0.0006	3.5
14	Aza Uchimachi, Tokiwa, Tokiwa Town, Tamura City	West	34km	2011/3/17	0.3		0.0006	3.1
23	Aza Suityuuchi, Minamiutsushi, Funehiki Town, Tamura City	West-northwest	39km	2011/3/17	0.6		0.0005	3.0
52	Aza Babakawara, Funehiki, Funehiki Town, Tamura City	West	41km	2011/3/17	0.2		0.0003	1.7
22	Aza Ushirota, Kamiutushi, Funehiki Town, Tamura City	West-northwest	35km	2011/3/17	0.5		0.0002	1.4
105	Furumichi, Miyakoji Town, Tamura City	West	25km	2011/4/7	0.3	2	0.0002	1.3
13	Aza Yakata, Tokiwa Town Nishimuki	West	37km	2011/3/17	0.4		0.0001	0.9
12	Aza Ozawakawashiro, Funehikimachi, Tamura City	West	39km	2011/3/17	0.3		0.0001	0.8
39	Yamakami-kaminamiki, Souma City	North-northwest	41km	2011/4/1	0.9	2 5	0.0006	3.7
5	Nakano-teramae, Souma City	North-northwest	42km	2011/3/17	0.6		0.0004	2.5
51	Ononiimachi-tatemawari, Ono Town, Tamura County	West-southwest	39km	2011/3/17	0.3		0.0002	1.2

This table was jointly compiled by the Nuclear Safety Commission, MEXT, and the Nuclear and Industrial Safety Agency.

*1 Shown values are integrated values monitored from 6:00, March 12 through 24:00, April 21. The same estimation method as that used by the Nuclear Safety Commission on March 28, 2011 is used, whereby the values are estimated by multiplying the monitored values by 0.6 in consideration of the reduction effect of wooden buildings (0.4) when staying outdoors for eight hours and indoors for 16 hours.

*2 For locations where the monitoring was started on or after March 19, the dose data for the period from March 16 to the day before the start of monitoring has been derived by assuming that the dose has changed in proportion to changes at Location No. 32, where the steepest dose change has been observed.

*3 Shown values are the latest air dose rates monitored by the time of the press release at 10:00, April 22. As for locations [*5] where actual values have been obtained by a simple integrating dosimeter, the values are the integrated values monitored since the time of the previous data sampling divided by the time lapsed.

*4 Shown values have been obtained by the same method as that mentioned in *1, while supposing that the latest monitored values [*3] will stay unchanged on and after April 22.

*5 For the period where actual values monitored by a simple integrating dosimeter are available, such values are indicated.

To prepare the isogram map of estimated integrated doses, the values for a total of 2,138 locations were used (the 63 locations mentioned above plus the air dose monitoring locations mentioned below [2,075 locations]).
(1) Air dose rates observed in the emergency environmental monitoring conducted by Fukushima Prefecture from March 20 to April 21: 91 locations
(2) Air dose rates observed in monitoring conducted by MEXT on April 9 in Katsurao Village and Namie Town: 16 locations
(3) Air dose rates observed within the area covered by the isogram map in the grid survey conducted by Fukushima Prefecture from April 12 to April 16: 1,790 locations
(4) Air dose rates observed inside the 20 km zone in monitoring conducted by MEXT and TEPCO on March 30 and 31, and April 2, 18 and 19: 178 locations

The Annual Integrated Dose Rate of Schools with an Air Dose Rate of 3.8μ Sv/h in the School Field on April 14 (Image)

Dose amount the children will receive

(μ Sv/h)

Up to 4/14   when school was closed

Outside building: 8hrs
Inside building: 16hrs

After 4/14   when school opened
* School day(200 days)
  Commuting to school: 1hr,
  School field: 2 hrs
  Inside school building: 5hrs
  Outside building: 3hrs,
  Inside building: 13hrs
* Holiday(131 days)
  Outside building: 8hrs,
  Inside building: 16hrs

Logic behind 3.8μ Sv/h

$3.8μ_{Sv/h}*(8hrs+16hrs*0.4)*365_{days}=20_{mSv/year}$

8 hrs in school field

16 hrs inside building (wooden)

1 year

Dotted line indicates estimates for when school is open, and not when school is closed

2.56mSv

$2.56 + 7.43 = 9.99mSv$

Ⓐ   Ⓑ   (Shaded section)

Air Dose Rate 3.8μ Sv/h
  School field 8hrs
  Inside building
  (wooden) : 16 hrs

When spending 1 year in the above condition

Rectangle 20mSv

Compared to the period during which the school was closed, the amount of dose received by children since the school opened is 58% lower.

Ⓐ

Decay evaluated by nuclide analysis (Decay rate: around 0.7)

7.43mSv   Ⓑ

3/11   4/14

Next year 3/11

34 days
School closed

331 days
School open