Bundesamt für Strahlenschutz

| Verantwortung für Mensch und Umwelt |

BfS-Workshop on Chernobyl Health Consequences, 9-10 Nov 2006

MINUTES

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prepared by

Bernd Grosche

Background

During the weeks before the 20th Anniversary of the Chernobyl Accident a number of reports and papers were published with different numbers of anticipated additional cancer deaths and cancer cases related to the radioactive releases caused by the accident. The table shown below was used as a stimulus and summarises some of the assessments made by participating parties.

Table 1: Some of the published numbers of anticipated additional cancer cases and deaths[1]

	IARC	Chernobyl Forum	TORCH	Greenpeace
Population	Europe	Highly contaminated	World	All affected countries
Cancer deaths	25,000	4,000	30-60,000	93,000
Thyroid cancer cases	16,000		18-66,000	137,000

These differences not only resulted in highly controversial debates within the scientific community but also in the public and the media. The result was a loss of trust in science in the population, because the large differences were interpreted as a major lack of scientific consensus on the order of magnitude of the effects.

It was the aim of the BfS Workshop to discuss the scientific basis of the different assessments together with the authors of these reports. In addition, scientists from the three most affected republics were invited to provide new results on health effects in their countries. It was not the aim of the BfS Workshop to achieve consensus under any circumstances, but to provide a platform for an open dialogue between the different parties. Only such an open discussion can help to regain scientific credibility in public opinion.

Agenda

The agenda and the list of participants are given in the Appendix.

The workshop agenda covered three topics:

1) Limits and applicability of collective dose and LNT

   All studies mentioned in Table 1, used both the linear no-threshold assumption (LNT) and the collective dose are prerequisites to make the step from exposure or dose estimates to an assessment of additional cancer deaths. The aim was to gather possibly different points of view about the limits and applicability of these principles.

[1] The Chernobyl Forum Report gave also numbers larger than 4,000, but this number was the most cited one and was circulated by a press release. It is evident, that Table 1 was not aimed to give a complete overview on the different risk projections, but on those numbers used in the public debates.

2) Estimated cancer risks
   The rationale for the different risk assessments studies and the resulting differences in the calculated numbers of additional cancer deaths were presented.
3) Results from the three affected republics – cancer and non-cancer effects
   More detailed insight into the health effects observed in the three most affected republics, i.e. Ukraine, Belarus and the Russian Federation was given.

For every topic, four presentations were given with sufficient time available for extensive discussion. The three sessions were followed by a general discussion, were the workshop's results were put into context and recommendations were developed. The major conclusions are summarised in the following sections.

Session 1: Limits and applicability of collective dose and LNT

Presentations

On behalf of ICRP, Mr. Dietze pointed out that radiation protection practice is strongly based on LNT. Among other advantages, the LNT allows exposures from different time periods to be added. It has to be kept in mind that LNT is applicable for doses below 500 mSv and for stochastic effects. And it has to be recognised that the dose-effect relationship below 50 mSv is not well known. Some results from biological experiments indicate that some effects do not follow a linear dose-response relationship (e.g. adaptive response, radiation hypersensitivity, bystander effect). However these effects appear relevant and can only be studied at the cellular level. Major uncertainties still remain in risk estimates for doses lower than a few mSv. From epidemiological data as well as from experimental studies a threshold at very-low doses cannot be excluded, although radiobiological studies generally support LNT. On balance, with much information supporting LNT and with LNT remaining the most prudent risk model, it can be reasonably concluded that LNT is an acceptable approximation in the range of low doses and dose rates.
For collective dose, Mr. Dietze cited ICRP 77: "The unlimited aggregation of collective dose over time and space into a single value is unhelpful because it deprives the decision makers of much necessary information. The levels of individual dose and the time distribution of collective dose may be significant factors in making decisions." Based on that, ICRP in Publication 101 (2006) discusses a matrix for working with collective dose, because risks from ionising radiation exposure depend on many individual factors and when using collective dose this should not be ignored. It might, therefore, be appropriate to show, in addition to collective dose, the distribution of doses with respect to the range of individual doses, the age and gender of exposed individuals, the dose distribution in time, and the geographical distribution of the exposed individuals.

For UNSCEAR, Mr. Crick explained, that the concept of collective dose was first used in the context of nuclear weapons testing fallout and that it is now used for radiation protection purposes, but not for risk assessment. UNSCEAR has expressed great concern on that subject, namely for risk assessment in a far distant future and at very low doses.
With respect to LNT, Mr. Crick pointed out that a threshold would implicate 100% repair below a certain dose. Non-targeted effects and delayed effects complicate the understanding of radiation effects at low doses. It has to be borne in mind that the absence of an observable risk does not mean that there is no risk, and that linearity of an effect is not always to be expected. Mr. Crick concluded that from UNSCEAR's point of view collective dose is useful for comparison of sources, trends, and options, but not for projections. LNT is useful for radiation protection, whereas the truth is probably not that simple. Thus, UNSCEAR does not make projections of deaths. Major uncertainties mean wide ranges of projections.
UNSCEAR's report on Chernobyl is to be published in 2007, and it will be pointed out in this report that confusion on the number of projected cancer deaths can undermine not only the results of the Chernobyl Forum, but also those of all parties involved.

The Chairman of the German Commission on Radiological Protection (Strahlenschutzkommission, SSK), Mr. Müller, pointed out, that there are many different biological mechanisms to be considered in the low dose range. Conclusions can only be drawn on individual mechanisms but not on all combined. Many of the known biological mechanisms are affecting the response of organisms in the low dose range. Most, if not all, of these show a non-linear dose response. In addition, individual differences are to be expected. Thus, an exactly linear, non-threshold response is highly unlikely. Despite this, for practical reasons, the convention to use the LNT in radiation protection is justified.
The applicability of collective dose depends on the fact that LNT is “right”. When using collective dose, the following factors have to be taken into account: age, life expectancy, gender proportion, health status (particularly important in medical radiation exposure), and ethnicity. Collective dose is only applicable when the risk coefficient for the population under study is well known. Finally, Mr. Müller cited ICRP: "Specifically, the computation of cancer deaths based on collective doses involving trivial exposures to large populations is not reasonable and should be avoided. Such computations based on collective dose were never intended and are an incorrect use of this radiological protection quantity."

As co-author of "The Other Report on CHernobyl – TORCH", Mr. Fairlie stated that the use of collective dose depends on the LNT being a reliable means of extrapolating risks from high doses to low doses and low dose rates. Such a scrutiny could raise four questions regarding LNT: 1. What are the lowest doses for which good epidemiological evidence exists for increased cancer risk?; 2. What is the most appropriate way to extrapolate these risks to even lower doses?; 3. What does radiobiology tell us?; 4. What about non-targeted effects?.

He concluded that epidemiological studies provide evidence of effects down to about 6 to 10 mGy and that there was good evidence of linearity (at least). Below 6 mGy, it was necessary to rely on radiobiological insights. These indicated that a linear non-threshold relationship is likely at doses lower than 10 mGy. At the very lowest doses, non-targeted effects were complex, diffuse, and largely not dependent on dose. They did, however, not alter the validity of using the LNT for radiation protection purposes.

Discussion

During the discussion, Mr. Ivanov from the Medical Radiological Research Center in Obninsk gave a short additional report on "Optimization of the system for radiation protection in nuclear industry: Individual cancer risks management (Mayak plant personnel)". He stated that the Medical Radiological Research Center has worked with collective dose in Russia in the past, but good results were not obtained.

As a comment to Mr. Dietze's presentation, Mr. Malko pointed out that some epidemiological data show an increase in risk per unit dose with decreasing dose. These data require careful investigations into radiation effects in the range of doses less than 50 mSv. It seems however that acceptance of the LNT does not overestimate radiation effects at low doses. Nevertheless, he agreed that at present LNT is an acceptable approximation in the range of low doses and dose rates.

An opposite point of view to Mr. Crick's presentation was expressed by Mr. Malko. According to him the concept of collective dose is a useful tool in case of populations irradiated as a result of an accident. He showed his assessment of additional stomach cancers in Belarus attributable to the Chernobyl NPP accident. His data show a strong linearity between additional stomach cancers and collective dose for different regions of Belarus. He stated that the same relationship between numbers of additional malignant neoplasms and collective doses was established for the atomic bomb survivors.

Further discussion led to the agreement that LNT can be used as a model in radioprotection. LNT has the great advantage that doses from different time periods and different sources can be added. Further, it was agreed that collective dose could serve as a model for risk estimation, but that ranges should be given rather than single numbers to reflect the uncertainties involved in risk projections. The time periods over which calculations were projected should also be stated.

<u>Session2</u>: Estimated cancer risks

At the beginning of Session 2 its Chairman Mr. Weiss reminded the participants that he had asked the speakers to answer the following questions regarding the basis for risk projection:
1) What are the characteristics of the populations under consideration (area, size, age structure)?
2) Which time period is considered?
3) What dose estimates are used?
4) Which risk coefficient is applied?
5) What are the risk assumptions at low doses and low dose rates (DDREF, linear, curvature)?

Presentations

On behalf of the IARC Working Group on Chernobyl a presentation was given by Ms. Darby. She showed that since 1997 there is a decline in thyroid cancer incidence among those who were children at the time of diagnosis, but still increasing rates among adolescents and young adults. For leukaemia, studies gave inconsistent results, but the final version of the largest study on childhood leukaemia, IARC's ECLIS study, is still not published. While there is evidence of a two-fold increased risk among the highly exposed liquidators, increases reported for the general population are not related to contamination levels. Here, it is difficult to draw any conclusions. While there is no scientifically demonstrated effect of Chernobyl radiation exposure amongst the general population on leukaemia and solid cancers other than thyroid cancer, there is the suggestion of a possible increase in breast cancer in young women in the most contaminated districts. But, the absence of a clearly demonstrated increased cancer risk does not imply that an increase in risk has not occurred. It is expected that the low to moderate doses received will cause a small increase in the relative risk of cancer, and a small increase in the relative risk could mean many cancer cases, given the large number of individuals exposed. The prediction of the cancer burden from Chernobyl is based on data on population distribution, life table, cancer incidence and mortality, average dose for each of the 40 countries in Europe. Predicted numbers of cancer cases and of cancer deaths up to 2005 and 2065 were given for all types of cancers excluding leukaemia, leukaemia excluding chronic lymphatic leukaemia, thyroid cancer and breast cancer. US NAS BEIR VII risk estimation models were used with a DDREF of 1.5 (except for leukaemia, where estimates were based on a linear quadratic model and a DDREF of 1). Up to 2065, 15,700 additional thyroid cancers are predicted with a 95% confidence interval of 3,400 –

72,000. This has to be compared to an estimated number of 1,886,000 thyroid cancers due to other causes. For cancers other than thyroid and non-melanoma skin cancer up to 2065 the predicted numbers for incidence in Europe are 22,800 (10,220-51,100) for non-leukaemia and 2,400 (700-7,700) for leukaemia. These numbers have to be compared to 194,000,000 and 5,475,000 spontaneous cases, respectively.

Mr. Bennett presented the Chernobyl Forum's predictions. They are based on IAEA Publication 1001: Cardis et al., One Decade after Chernobyl, 1996. A number of 4000 deaths was projected for a population of 600,000 more highly exposed workers, evacuees, and residents; an additional 5000 deaths in 6,000,000 residents of less contaminated regions was also projected, summing up to an overall 9,000 expected cancer deaths. It became clear, that this population is not identical with the one Ms. Darby presented the prediction for, and that Mr. Bennett's presentation was based on mortality rather than on incidence. Furthermore, Mr. Bennett pointed out, that several other contributors to ill health have to be considered as well: smoking, excessive alcohol consumption, poor diet, and inadequate health care or advice. There are still challenges ahead: the radioactive contamination will only slowly decline, stress and worry will only slowly dissipate, and the economy in the affected region will only slowly improve.

Mr. Fairlie presented the risk projection used in the TORCH report. The considered population is given in the following table:

Population	Number of population	Average dose (mSv)
Liquidators*	240,000	100
Living in high contaminated areas*	270,000	50
Evacuees in 1986*	116,000	33
Living in low contaminated areas*	5 mill.	10
Rest of Europe	600 mill.	~0.4
Rest of World	4,000 mill.	~2.5 x 10-2

According to Mr. Fairlie, the best global estimate for collective dose is the 1988 UNSCEAR figure of 600,000 person-sieverts. Using risk factors of 5% and 10% per sievert (the current ICRP risk factor with and without a DDREF of 2) results in 30,000 – 60,000 predicted excess cancer deaths. About 1/3 if this number is expected in Belarus, Ukraine and Russia, the rest in the northern hemisphere, mostly in West Europe. It is clear that this calculation depends on the validity of LNT.

As main author of the Greenpeace report, Mr. Yablokov reported on difficulties with dose and risk estimates. He criticised the radiation risk factors used by IAEA, WHO and UNSCEAR. He considered them ungrounded, because they are based on incomplete and biased Hiroshima and Nagasaki data (e.g. selection of most healthy people as reference group, difficulties with health statistics). Furthermore, he stated that it is impossible to calculate the level of irradiation (including the collective dose) based on average background radiation level and average food/water intake. There is lack of data regarding the different distribution patterns for Sr, Cs, Pu, etc., the territorial spotting of the fallout, and the temporal variation of dose rate. Furthermore, there is a lack of scientific knowledge on radionuclide behaviour in the ecosystems and on the specific health effect of each radionuclide and of "hot" particles. A theoretical possibility to overcome these problems and to calculate the true consequences of the accident: information is needed on the ecosystem behaviour of radionuclides, on nuclide-specific pollution patterns, on dose rates during the first days after the accident, on specific effects of each radionuclide, on the range of these effects, and on the variability of radio-sensitivity among individuals and groups. But practically, there is only the scientifically based approach to calculate the true public health consequences: to compare the health situation in territories with similar socio-economical, demographic and geographic characteristics, but with distinct differences in the levels of ionising radiation. Further, Mr. Yablokov presented results of such comparisons.

Discussion

During the discussion, there was consensus that IARC should be encouraged to finalise and publish the ECLIS study[1]. Mr. Yablokov and the other participants from the three affected republics (Mr. Ivanov, Mr. Malko, and Mrs. Nyagu) invited the participants from the other countries to initiate and continue co-operation in analysing the existing data. Mr. Kelly said that, in principle, such collaborative studies could be eligible for support from the Commission's research programme but, in practice, much would depend on the quality of any proposal – in this context it would be important for previous research (on which future research would rely) to be published. Mr. Baverstock supported this idea by saying that the claims made by Mr. Yablokov should further be examined. In this, the cultural gap in doing science has to be considered. Mr. Smital added, that probably all reported effects are due to Chernobyl, but not all are due to radiation (e.g. psycho-social effects due to the evacuation of

[1]) The following information was send from Elisabeth Cardis, IARC, to Bernd Grosche on 15 February 2007: "The reason why analyses of infant leukaemia in ECLIS could not be completed are related to data quality and availability. The major limiting factor is the lack of dates of birth for many leukemia cases which prevent the evaluation of risk in specific windows of time after birth. The problem is not mainly in Belarus but in a number of other Eastern European countries (including Poland, Czech Republic) where the cancer registries only have permission to include year – but not exact date - of birth. To obtain exact dates of births in these countries would require setting up a collaboration with appropriate bodies in these countries, and, first and foremost the approval from local and national ethics review boards for these data to be obtained for the purpose of this project and sent to IARC for analysis within the study. I think this is probably possible, but it will require time to make the proposals, seek ethics approvals and, assuming these approvals are obtained, time for the collection of the additional data and their analysis. This cannot be done without funding for staff time, meetings and travel."

Pripyat). Ms. Darby made it clear that health effects reported from the Chernobyl area can only be properly evaluated when the apparent overall changes in the health situation since 1986 are considered. As an example she showed the increase in mortality for males but not for females since the accident in all three republics.

Session 3: Results from the three affected republics – cancer and non-cancer effects

Presentations

Mr. Malko reported on observed health effects in Belarus. He gave a description of the exposures in different zones on Belarus (see Table below).

Description of zones	Annual equivalent dose resulted from the accident	Contamination levels of Chernobyl radionuclides		
		^{137}Cs	^{90}Sr	^{238}Pu, ^{239}Pu, ^{240}Pu
	mSv/year	kBq/m^2 (*Ci/km^2*)	kBq/m^2 (*Ci/km^2*)	kBq/m^2 (*Ci/km^2*)
Residence zone with periodic radiation control	<1	37 – 185 (*1 – 5*)	5.55 –18.5	0,37 – 0.74
Zone with the right to resettle	>1, but <5	185 – 555 (5 – 15)	18.5 - 74	0.74 – 1.85
Zone of subsequent resettling	>5	555 – 1480 (*15 – 40*)	74 - 111	1.85 – 3.7
Zone of priority resettling	>5	>1,480 (>40)	>111	>3.7
Evacuation (exclusion) zone	Territory in 30-km zone around the Chernobyl NPP, from which the population was evacuated in May – September 1986			

His report was based on data from the Belarusian Hematological Republican Registry, the Belarusian National Genetic Monitoring System Registry as well as from the Belarusian Cancer Registry. Analyses were made using an ecological approach. His analyses showed an increase in the frequency of congenital malformations, mainly among those who had been exposed *in utero* within the first 28 days of pregnancy, in leukaemias among children and adults as well as in solid cancers. The risk estimates based on his analyses are one order of magnitude higher than those reported for the atomic bomb survivors. He assessed the overall health effect of the accident as approximately 84 additional congenital malformations, about 83 additional leukaemias in children and approximately 2,218 leukaemias in adults. The total number of additional solid cancers including thyroid and non-melanoma skin cancers is estimated to be approximately 28,500 cases (95%CI from 23,000 to 34,000 cases). Mr. Malko pointed out that incidence data are by far a better basis for risk analysis than mortality data, because there has been major progress in therapy, namely for thyroid cancer and childhood leukaemia in his country.

Mr. Ivanov reported on health effects in the Russian Federation. His report was based on data from the National Radiation and Epidemiological Registry, which collects data from 20 regional centres all over Russia. The registry includes information from 4,000 hospitals and clinics, covering 638,000 registered persons (clean-up workers and general population) with up to now 12,000,000 diagnoses. For the clean-up workers he reported a 2-fold increase in leukaemia risk for those with exposures between 150-300 mSv as compared to those with lower exposures. This increase was observed for the time period 1986-1996, but not for later years (1997-2003). Further, an increased risk for cerebrovascular diseases was reported for those who received more than 150 mSv within less than six months. For the general population in Bryansk oblast, the fraction of Chernobyl related radiation induced cancer diseases is estimated to be 0.5%. For this oblast, it is predicted that the number of radiation induced thyroid cancers will stay above that of spontaneous cancers for those having been exposed as children.

Ms. Nyagu presented results based on data from the Ukrainian Ministry of Health, namely the Ukrainian State Chernobyl Registry, which includes 2,252,130 individuals (liquidators, evacuees, highly exposed and less exposed individuals). She stated that for the general population there is not only evidence for an increased risk for thyroid cancer, but also for leukaemia. During a conference in May/June 2006 in Kiev the following resolution was developed: "Considering that leukemia incidence rate is the principal indicator of possible radiation effects, it is critically important to continue wide scale epidemiological studies on the issue taking into account the factors of uncertainty in medical and dosimetry information. Special attention should be drawn to groups which were in early age at the moment of Chernobyl accident (exposed *in utero*, 0-9, 10-19 years old)". In the most heavily exposed areas of Ukraine, a statistically significant increase in cancer incidence is observed between 1991 and 1999 as compared to 1980-1990 for the following sites: all solid cancers, female breast cancer, prostate cancer, thyroid cancer, and lymphomas. Next to that, Ms. Nyagu reported on an overall poor general development of children in the highly exposed areas compared to those from the less exposed areas. There are also results showing a lower intelligence among the highly exposed children as compared to the others. There is a close correlation between the dynamics of collective dose and overall mortality in Ukraine. It is observed that the appearance of radiation-induced cataracts among all groups of survivors, and especially the liquidators, is increasing. A much lower threshold of irradiation doses is observed for cataract development compared to earlier assessments. It has been found that radiation cataract can appear not only due to high doses, but also to doses well below 1 Gy. Cataract should be considered as a stochastic effect without a threshold.

Mr. Jacob presented results obtained from a number of studies on thyroid cancer after the Chernobyl accident. He showed that the excess absolute risk is 50% higher among females compared to males, and that it strongly depends on age at exposure. Based on his analyses, he estimated the excess thyroid cancer cases in Belarus and Ukraine among those having been 0-18 years of age at the time of the accident. The respective numbers are 1,139 for Belarus and 643 for Ukraine. The number of baseline cases was estimated as 777 and 2,031, respectively. From 1986-2002 about 5,000 thyroid cancer cases occurred in Belarus, Ukraine und in the contaminated areas of Russia, of which about 2,000 are attributed to radiation (age at exposure 0-18). The increase of thyroid cancer incidence in highly contaminated regions is correlated to the radiation exposure during childhood. The annual number of excess cases increased continuously in the period 1990 to 2001. A thyroid dose of 0.2 Gy during childhood increases the cancer risk at 15 years after exposure by about a factor of 3. The risk estimates from Chernobyl studies are consistent with risk estimates after external exposures.

Conclusions

The participants agreed on the following points.

a) General Conclusions

- The LNT while still a model is a justified tool for definition of quantities used in radiation protection and for practical radiation protection decisions. But for risk assessment, its use must be appropriately qualified depending on the levels of dose and dose rate. In reality, the shape of the dose-response relationship at low doses may not be linear and the risk may be smaller or larger than implied by the LNT.
- The concept of collective dose was developed for radiation protection purposes. It is a crude indicator of detriment and, as such, is a useful tool for risk assessment, but due to the large uncertainties derived point estimates are insufficient. Levels of uncertainty should always be estimated and ranges of estimated risks should be reported. The outcome/s should be carefully qualified in particular where the collective dose arises largely from low levels of individual dose far from exposure levels where direct epidemiological evidence is available or for exposures distributed over very long time periods. Comparisons with collective doses from other sources may also provide useful perspective.

- There is a need for improvement in specifying doses and dose assessment.
- Whenever possible, epidemiological studies should focus on incidence of diseases rather than on mortality data.

b) Conclusions from the reports

- The number of thyroid cancers is still rising, mostly among those who were children at the time of the accident.
- There is emerging evidence of increases in leukaemia and solid cancers, mental disorders and cataracts, which should be confirmed through further research. Rigorous epidemiological studies should be initiated among the general population. Priority should be given to those having been children at the time of the accident and among the clean-up workers.
- With respect to non-cancer diseases, namely cardio-vascular diseases, the cohort studies among the clean-up workers should be continued; it is important to consider dose rate in addition to dose in these studies.
- Research into congenital malformations should be based on existing data of good quality. Adequate control data on rates in uncontaminated regions must be carefully considered.
- Epidemiological studies on cataracts should be continued.

Recommendations of the participants

1. Where collective dose is used as an indicator of detriment, the potential of the dose matrix as proposed by ICRP should be explored further, in particular to better inform those who use such estimates in a policy setting.
2. The participants strongly encourage IARC to finalise and publish the European Childhood Leukaemia and Lymphoma Incidence Study (ECLIS).
3. Participants from the three most affected countries claim that the health impact of the accident has been much larger and more diverse than is broadly accepted by the international scientific community. Mechanisms need to be found to enable these claims, which are made largely in non-peer reviewed literature (or non-English language literature), to be subject to careful and informed review.
4. Pooled epidemiological studies between the three countries should be encouraged as this would improve their statistical power and would be more compelling if the effects were shown to be common to all three countries.
5. Decisions on future epidemiological studies should be based on demonstrations of sufficient statistical power and of the control of relevant confounders. In future the focus should be on cohort and case-control studies given the methodological weaknesses and biases of ecological studies.

Appendix

Programme and List of Participants

Bundesamt für Strahlenschutz
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BfS-Workshop on Chernobyl Health Consequences, 9-10 Nov 2006
Programme

Thursday, 09 Nov. 2006

W. Weiss	Welcome and Introduction	09.00
B. Grosche	Technical information	09.20

Session 1: Limits and applicability of collective dose and LNT[1]
Chair: G. Kirchner

G. Dietze	Limits and applicability of collective dose and LNT – ICRP's view	09.30
M. Crick	Limits and applicability of collective dose and LNT – UNSCEAR's view	10.00
	Coffee	10.30
W.U. Müller	Limits and applicability of collective dose and LNT – SSK's view	10.50
I. Fairlie	Implications of LNT and collective dose	11.20
General discussion		11.50
Lunch		12.30

Session 2: Estimated cancer risks*
Chair: W. Weiss

S. Darby	IARC's risk projection	13.30
B. Bennett	Chernobyl Forum's estimates	14.00
I. Fairlie	Results from TORCH	14.30
	Coffee	15.00
A. Yablokov	Basis of the Greenpeace report: The consequences of the Chernobyl Catastrophe - Meta-Analysis	15.20
General discussion		15.50
End of first day		17.00
Dinner		19.30

[1] the time schedule includes 5 minutes of discussion after each presentation

Friday, 10 Nov. 2006

Session 3: Results from the three affected Republics – cancer and non-cancer effects[1]
Chair: Th. Jung

M. Malko	Health effects in the Republic of Belarus	09.00
V. Ivanov	Health effects in the Russian Federation	09.30
A. Nyagu	Health effects in Ukraine	10.00
	Coffee	10.30
P. Jacob	Thyroid cancer after the Chernobyl accident	10.50
General discussion		11.20
Lunch		12.15
Final discussion on the results of the workshop Chair: W. Weiss		13.00
End of the Workshop		14.00

[1] the time schedule includes 5 minutes of discussion after each presentation

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BfS-Workshop on Chernobyl Health Consequences, 9-10 Nov 2006

List of Participants

Amannsberger, Karl	Federal Office for Radiation Protection (BfS)	GERMANY
Baverstock, Keith	Department of Environmental Sciences, Kuopio University	FINLAND
Bennett, Burton	Chernobyl Forum	USA
Crick, Malcolm	UNSCEAR	AUSTRIA
Darby, Sarah	Oxford University	UNITED KINGDOM
Dietze, Günther	ICRP	GERMANY
Fairlie, Ian	Consultant on Radiation in the Environment	UNITED KINGDOM
Grosche, Bernd	Federal Office for Radiation Protection (BfS)	GERMANY
Helming, Manfred	Federal Ministry for the Environment (BMU)	GERMANY
Ivanov, Viktor K.	Russian Academy of Medical Sciences Medical Radiological Research Centre	RUSSIAN FEDERATION
Jacob, Peter	gsf Research Center for Environment and Health	GERMANY
Jung, Thomas	Federal Office for Radiation Protection (BfS)	GERMANY
Kelly, George Neale	European Commission	BELGIUM
Kirchner, Gerald	Federal Office for Radiation Protection (BfS)	GERMANY
Kuhlen, Johannes	Federal Ministry for the Environment (BMU)	GERMANY
Land, Charles	NCI	USA
Malko, Mikhail	National Academy of Sciences	BELARUS
Martignoni, Klaus	Federal Office for Radiation Protection (BfS)	GERMANY
Michel, Rolf	German Radiation Protection Commission (SSK)	GERMANY
Minkov, Vladimir	Federal Office for Radiation Protection (BfS)	GERMANY
Müller, Wolfgang- Ulrich	German Radiation Protection Commission (SSK)	GERMANY
Nyagu, Angelina	Physicians of Chernobyl	UKRAINE
Rühm, Werner	German Radiation Protection Commission (SSK)	GERMANY
Smital, Heinz	Greenpeace Deutschland	GERMANY
Wakeford, Richard	University of Manchester; Editor Journal of Radiological Protection	UNITED KINGDOM
Weiss, Wolfgang	Federal Office for Radiation Protection (BfS)	GERMANY
Yablokov, Aleksei	ecopolicy; Russian Academy of Sciences	RUSSIAN FEDERATION