NPP CERNAVODA 2

Comments to the documents

provided for the EIA

by

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SUMMARY

The COUNCIL DIRECTIVE 97/11/EC [CD 97/11/EC] on the assessment of the effects of certain public and private projects on the environment describes the requirement of an environmental impact assessment as follows:

„This Directive shall apply to the assessment of the environmental effects of those public and private projects which are likely to have significant effects on the environment." [CD 97/11/EC] (Article 1)

„The environmental impact assessment shall identify, describe and assess in an appropriate manner, ..., the direct and indirect effects of a project on the following factors:

- human beings, fauna and flora;
- soil, water, air, climate and the landscape;
- material assets and the cultural heritage;
- the interaction between the factors mentioned ...." [CD 97/11/EC] (Article 3)
- ... „a description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects,
- the data required to identify and assess the main effects which the project is likely to have on the environment,
- an outline of the main alternatives studied by the developer and an indication of the main reasons for his choice, taking into account the environmental effects, a non-technical summary of the information ...". [CD 97/11/EC] (Article 4)

Three environmental studies for Cernavoda NPP-2

Atomic Energy of Canada Limited – Environmental Assessment Summary Cernavoda Unit 2 NPP CES-03702-ENA-001, December 2001. [AECL]

This summary is mainly a description of the general features of CANDU 6 reactor, and the various improvements which are implemented in Cernavoda 1 and will be implemented in unit 2 as well. There is only few site specific information , [AECL] contents a summary of the potential effects of plant construction and operation on the environment and a list of mitigation measures.

Task 4 Report from the Modernization Project for Cernavoda NPP-2 Environmental Impact Assessment. [PHARE]

Without doubt the PHARE study is the most comprehensive but even herein not all problems are considered, which are required to be analyzed in an EIA according to the EU COUNCIL DIRECTIVE 97/11/EC on the assessment of the effects of certain public and private projects on the environment.

Nevertheless we have found some severe failures as

- no proof of the demand of a new power station with 700 MW capacity
- no discussion of diverse options to provide 700 MW and their impact to the environment
- (only option taken into account is a coal fired plant and the CO-2 output which it would produce) – alternate options as co-generation gas turbine, use of biogas or biomass is not even thought of (the site is near an agrarian region).
- despite the appropriate description of the CANDU 6 reactor -important information is not provided: the status of the plant is not specified (40% complete ..without information whether any equipment is stored at the plant .)
- questions of the plant's safety are not sufficiently described:
- seismic qualification and fire resistance
- PSA results, severe accidents
- impact of external events which could destroy facilities used by both units

Other sources [e.g. WENRA] reccommend several improvements concerning the safety of the plant or at least the verification of the equipment's qualification:

- seismic hazard
- fire protection measures
- secondary side pipe failure
- emergency core cooling
- hydrogen explosions in the containment
- emergency center

Information on the site is incomplete, missing:

- meteorological data (frequency of stability, wind velocities, precipitation …)
- discharge rate for the DBS[1] canal (min max summer/winter ,)
- flooding (water levels during the last big floods)
- flight corridors,
- distance of gas and oil pipe line to the plant ..
- earthquake and flooding data from the last years

Impact assessment is incomplete, missing:

- temperature rise due to outlet of hot water in the Danube and in the DBS Canal and its impact
- discharge of chemicals with the CCW[2] outlet and its impact
- impact of radioactive effluent with the CCW outlet on the drinking water of villages and town (dose calculation)
- impact on the population in case of accident due to airborne radioactive release due to precipitation. Failure of serious discussion of beyond design base accidents and their impact

Cernavoda 2 NPP Environmental Impact Summary; National Institute of Research and Development for Environmental Protection – ICIM, Bucharest, July 2002 [ICIM]

This document is a translation of the summary of the impact study.

The paper is

- incomplete
- not systematic
- not understandable because there are no appropriate maps and figures
- as we have no access to the original documents we cannot find out, whether the needed data have been collected and the impact was seriously assessed by the authors.

[1] DBS: Danube Black Sea

[2] CCW: Condenser Cooling Water

CONCLUSIONS

In the last 10 years the CANDU design has not changed fundamentally. Therefore principle safety problems as

- the positive void coefficient of reactivity, [3]
- vulnerability to loss of regulation incidents [4]
- containment deficiencies[5]
- seismic hazard and fire protection

are not totally solved. Necessary improvements proposed in several mission reports, are not seriously discussed in the EIA documents.

The earthquake risk for the NPP Cernavoda is grossly underestimated. Taking into account recent earthquake risk analysis and recent data a verification of the design base of Cernavoda NPP as well as of the seismic qualification of the plant's safety system is required.

Because of missing the appropriate data it is not possible to verify the EIA's statement that there is no risk from other external events as flooding, explosions or airplane crash.

The estimation of the overall risk for accidents with large radioactive releases at lower than 10^{-7} is underestimated, hence the core melt frequency is estimated(by West-european experts to 10^{-5} and the existing PSA does not consider external events.

There is no sufficient database provided to verify the transport calculations for the impact of radioactive effluents to air and water for accident conditions.

Hence all calculations presented in the EIA are without precipitation the resulting individual dose is presumably underestimated.

Overall there are serious deficiencies and a substantial lack of recent data in the papers provided for the EIA. Therefore we recommend a fundamental improvement of the documents and a serious discussion process.

[3] physical properties which can lead to a rapid increase of power – such an increase caused the accident in Chernobyl 1986

[4] instability of heat production in the reactor due to instability of the neutron flux

[5] retention of radioactive material in the containment relies on active systems.

1. THE SITE

The exclusion zone around the NPP site is small – radius only 1 km. The distance from the NPP to the town of Cernavoda – with 23.000 inhabitants is only 2 km ! The short distance of the town to the plant is a potential risk for the population, which is multiplied because the possibilities for evacuation are limited.

„In order to improve the evacuation routes from Cernavoda, a bridge is under construction over the Danube, although work on this has stopped because of financial problems. ..[WENRA 2000]

At Temelin/CZ there are only 9500 people living inside the distance of 5 km to the plant. The nearest village is 3 km (760 residents).

The distance to the Bulgarian border is ca. 35 km. In case of an accident a serious impact on Bulgarian territory cannot be ruled out.

Seismology

„Romania is one of the most active earthquake regions in Europe outside of Italy and Turkey. On 4 March 1977 Romania suffered the strongest earthquake in centuries. This natural phenomena lasted only 60 seconds but took the lives of 1,570 people and injured another 11,000. Romania is located in an area where three faults in the earth's surface converge. At the intersection of these plates lies the so-called Vrancea zone. This strong concentration of earthquake activity in a relatively small area of approximately 100 km x 100 km is found in only one other area of the world, in the Himalayan region of Hindu Kush" [Kaufmann, 2001]. The distance from the Vrancea Zone to Bucharest as well as to Cernavoda is around 150 to 200 km.

[PHARE]Table 1.2.1. lists observed earthquakes of the region in 43.500 – 45.400 grade N and 27.500 – 29.300 grade E. The selection of this particular area is unclear as the NPP Cernavoda is not in the center of this area. If Cernavoda would be in the center of the area, the area would shift towards the South and the West. As a consequence more strong earthquakes would have been listed. In contrast to Table 1.2.1. PHARE report, [ICIM] states that the earthquake analysis is based on data from earthquakes, which occurred in a 300 km radius around the site. ICIM reports about the maximum intensity of the occurred earthquakes but no acceleration data. ICIM finally establishes that *„ the maximum observed earthquake could have an intensity of VII degrees MSK-64*[6] *and the potential maximum earthquake an intensity of VIII degrees MSK-64."*

From that ICIM draws the conclusion that *„there is a margin of 12,5% in the design data for the DBE*[7]*"*

This list of [PHARE] table 1.2.1 ends abruptly with an earthquake in October 1992. Between 1982 and 1992 57 earthquakes are listed. Alone in the last three years 1999 to 2002 10 earthquakes with a magnitude greater than 3 occurred. [8]

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[6] MSK: scale to determine the intensity of an earthquake by observation of the damage

[7] DBE: Design Base earthquake, see chapter 3

[8] [http://www-sfb461.physik.uni-karlsruhe.de/pub/B3/web.gif]

It is strange that obviously old data and literature are used and no update was done for the last ten years. It is also strange that not for all listed earthquakes magnitude and intensity data are given.

table 1: seismic hazard for Cernavoda NPP according to [PHARE].

	Acceleration	Return period	Intensity
DBE	0.15 g PGA[9]	1,000 years	
DBE	0.19 g PGA	10,000 years	
...following levels of seismic design were established			
DBE	0,2 g horizontal	1,000 years	VIII
SDE[10]	0,1 g horizontal	100 years	VII

The above mentioned correlation between intensity and acceleration is not at all conservative and in contradiction to many other standards as shown in the following table :

table 2: correlation between earthquake intensity and acceleration

Reference	I = 7	I = 8	I = 9
Murphy (1977) worldwide	0.1 g	0.18 g	0.32 g
Murphy (1977) southern Europe	0.18 g	0.31 g	0.54 g
Soviet Standard (1986), PNAE G7-002-86	0.19 g	0.38 g	0.75 g
French Standard (SCSIN)	0.25 g	0.4 g	0.6 g
German KTA-Standard	0.07-0.22	0.15-0.3	0.3-0.7
US-Standard for California, DOE/NE-0086	0.125	0.25	0.5

Source: [UBA 2000][11]

Obviously for the EIA, the correlation of Murphy (1977) for worldwide occurring earthquakes was used. But even the application of the same author for Southern Europe requires higher resistance against acceleration. The same is true if the French or the Soviet standard is applied. Therefore the ground acceleration which could occur for a given earthquake intensity is underestimated by the factor 2!

WENZEL & LUNGU (2000)12 assessed in a recent investigation the earthquake risk for Romania. Figure 7 of their publication shows that the expected level of ground shaking (PGA in g) from a Vrancea earthquake with a hundred years recurrence time for the Cernavoda area is quite higher than previously thought: It is around 0,3 g. This is three times higher than the SDE for the same recurrence time was established. It should be mentioned that this risk estimation for ground shaking is just for earthquakes

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9 PGA: Peak Ground Acceleration

10 SDE: Site Design Earthquake, see chapter 3

11 Umweltbundesamt (2000): Bericht an die Österreichische Bundesregierung zur Teil-UVE-Temelin [www.ubavie.gv.at]

12 WENZEL, F. & LUNGU, D. (2000): Earthquake Risk Assessment for Romania [www.iiasa.ac.at/Research/RMS/july2000/Papers/wenzel708.pdf]

of the Vrancea zone. Earthquake originated in the vicinity of Cernavoda pose an additional risk.

In conclusion it is obvious that the earthquake risk for the NPP Cernavoda is grossly underestimated. This is due to the fact that the EIA was done quite superficial without consideration of modern and recent publications and findings.

Meteorology

This chapter in the PHARE report refers to extreme weather situations. But there are important shortcomings in the description of the meteorological situation at the site:

- no frequency distribution of atmospheric stability categories
- no frequency distribution of wind velocity, only of wind directions
- no frequency distribution of precipitation ...

Without an appropriate database it is impossible to verify the results of the transport calculation of radionuclides released with the gaseous effluents. Especially it is impossible to assess whether the evaluation of the radiological consequences in [PHARE] chapter 6 is a worst case calculation.

The [ICIM] summary contains no meteorological data at all.

The scarcity of meteorological data makes it impossible to verify the transport calculation of airborne radionuclide emissions during normal operation as well as in case of the reference acidents.

Industrial activities and transport

Chapter 1.6. PHARE states that in the vicinity of the NPP diverse industrial and other hazardous activities are going on, but there are no details on this activities and the connected hazards. There are also mentioned pipelines for petroleum and natural gas, but without the geographical situation and distances to the plant, the potential impact of explosions cannot be evaluated. A 2 km distance for flybys with airplanes is small compared to 5 km in Czech Republic.

There is no reference to airports (international as well as local and military) and international flight corridors in the documents.

By means of the publicly provided data it is impossible to verify the situation around the site.

Hydrology

The site is located between the Danube river and the Danube-Black-Sea(DBS) Canal. The NPP gets its cooling water from the DBS Canal. „Most of the time the cooling water is returned to the Danube river, but in winter it can be released into the Canal, so that the warmed cooling water can be used to avoid freezing at the intake" !! [PHARE 1.3]. PHARE 1.3 provides basic data on discharge rates and water levels of the Danube but not of the DBS Canal.

According to [PHARE] wide fluctuations of discharge rates in the rivers and canals, natural floods or floods from breaches cannot be ruled out. The safety margin for flooding is about two meters. The data cover the years 1961-1997. In the last years big flooding events at the Danube and its tributaries occurred, therefore an update of the data in [PHARE Tab:1.3.4] is required.

Chapter III.2.1 [ICIM] summarizes water pollutant emissions and water quality protection. Several topics remain unclear:

- There is no distinct separation between potential emission sources and protection measures. It is not visible, which emissions originate from the plant, which measures are planned to reduce the environmental effects and which emissions are set free to the surrounding area. Especially as the demarcation between the plant and the surrounding area is not obvious, the listed information does not help understanding.
- The paper lists a lot of data about the current state of the Danube and DBS Canal, but there are no estimations about the changes that can occur as soon as Unit 2 starts working (for example regarding the water warming in the Danube or in the DBS Canal).
- In the chapter [ICIM] (p18, 19) diverse water sources (cooling water, boiler blowdown, effluents, neutralized waters from ionic filter regeneration, ...) are successively described, but there is no scheme which shows the arrangement. Consequently the emissions and their treatments are not comprehensive.

Chapter IV.1. [ICIM] gives background information about the characteristics of the surface waters.

Generally the site of the plant is crucial as there are several lakes, ponds and marshes nearby. Additionally the Danube water is used by villages without any pre-treatment also downstream of the plant.

In diverse passages STAS 4706-88[13] is referred to as a reference for water quality. It is undefined if this reference corresponds with any international accepted quality classification. According the Austrian water classification the values given in [ICIM] Table IV.1.2-1. correspond with the 2nd to 3rd quality class (beta mesosaprob / alphamesosaprob – critically charged). [In Austria class 2 is the minimal required quality for bathing; in general quality of water for drinking has to be better than 2].

In Table IV.1.1-2 [ICIM] physical and chemical water indicators of the Danube are shown. All the data originate from a sampling campaign in summer 2001 and show a severe temperature rise (up to 6°C) downstream the plant. As permanent monitoring is missing, the significance of the data is doubtful.

[13] Romanian State Standard .

The situation in the DBS Canal is even more unclear as the water levels of the Canal are not given. Therefore it is not assessable to what extent the discharge rate influences the water body. The data given in Tables IV.1.2 [ICIM] are hard to understand. There is no drawing that illustrates where the several measuring points are located and which factors affect changes.

In Chapter IV.2. [ICIM] data about the groundwater are summarized. It is stated that *"...there is an aquifer horizon supplied directly from rain waters, from the Danube, from the DBS Canal waters ..."* (p 85) . The groundwater is used for drinking water by many villages and towns. Therefore permanent monitoring of the water quality and special protection measures in case of contamination are essential.

In conclusion we have to state that the EIA documents contain no complete impact assessment, as they do not consider the heat impact from the waste water outlet of the NPP, and the impact of radioactive emissions to the Danube and the DBS canal. Especially it is necessary to assess the potential impact of tritium to water bodies which are used as a drinking water source for the population – an issue which was heavily discussed in Canada.

2. THE NPP

Status of construction

PHARE contains a short description of the main features of the plant and more detailed descriptions of the ventilation system, the waste water treatment and the treatment and storage of solid waste.

A serious failure of the PHARE report is the lack of discussion of the concrete status of the plant:

„...UNIT 2 (which is 40% complete)." [PHARE 1.]

„At the same time that construction was being completed on Unit 1, AAC adopted a preservation program for Units 2 through 5. The main focus was on Unit 2, as it already contained considerable equipment." [AECL 1.1] Later documents describe the status of the plant as ca. 48% complete in 1999 [ENCONET]

Hence there has been equipment stored at the plant, we miss specific information about these parts and their status after storage.

Principal safety deficiencies

CANDU plants are different from the two types of light water reactors which are widely used in Europe (pressurized and boiling water reactors). Therefore knowledge about the specific properties of this reactor is limited among the European nuclear critical institutes.

According to a study on nuclear risk made by Gruppe Ökologie Hannover the principal safety problems of CANDU plants are [Greenpeace 1993]:

- the positive void coefficient of reactivity, therefore any loss of coolant accident could lead to a power excursion. A loss of coolant accident with scram failure in a CANDU reactor can result in a rapid melting of the fuel.
- the CANDU is vulnerable to loss of regulation incidents, because of the large size of its core.
- the CANDU 6 containment relies on an active spray system for pressure suppression in combination with an active system for filtered air discharge.
- the refueling machine is a pathway for release of „hot particles", that have broken of the fuel.
- a large zirconium-steam reaction potential.

„The basic safety features of the CANDU 600 concept have not developed very much over the years. When construction of Unit 1 restarted in 1991, design improvements were introduced similar to those already implemented in the twin plants of Wolsung (South Korea), Point Lepreau and Gentilly–2 as a result of their operating experience and PSA studies. The main improvements include better separation between control and shutdown system, modification of control room design, provision for post LOCA sampling capability in the containment, etc"[WENRA 1999].

Hence the CANDU design has not changed fundamentally, the safety deficiencies are still the same as listed above. There is no entire European analysis on the differences in design and safety between CANDU and LWRs, neither from critical nor from pro-nuclear institutions. WENRA and other international organizations of experts from the nuclear community rely on the information and warranties of the vendors and the statements of the Canadian authorities. What is probably not considered in their assessment is the Canadian economic interest in the export of its nuclear plant. In former years this interest has often collided with the non proliferation treaty. [Bratt 1998]

Economic interests can also collide with investments in the plant's safety.

„The Cernavoda NPP has a Canadian designed CANDU 600 constructed and commissioned under the responsibility of a Western consortium. The safety design philosophy is similar to that of reactors in operation in Western Europe. However, the Western European regulators and their technical safety organizations have little experience of this design and no in-depth knowledge of the plant. Based on the information available, it is apparent that additional assessments are needed to confirm design safety margins against seismic events and the adequacy of fire protection. Also, a validated probabilistic safety assessment should be performed." [WENRA 1999]

Design basis and earthquake risk

Apparently the main safety concern of all examinations is the seismic resistance of the Cernavoda plant. No wonder, Romania is one of the most active earthquake regions in Europe.

„For the Cernavoda plant additional assessment *is necessary to confirm the plant design margins against seismic events and the adequacy of fire protection. „[WENRA 2000]*

- „the earthquake for which the NPP is designed so that it can still be safely shut down will be for a reoccurrence period T > 1000 years (Design Basis Earthquake [DBE])
- the earthquake for which the NPP is designed so that it can still be operated will be for a reoccurrence period T > 100 years." (Site Design Earthquake[SDE]) [AECL chapter 2.5.2]

The AECL EIA gives only the fundamental base for the earthquake design, without any actual requirements for the Cernavoda site. The concrete design requirements are determined by the ground acceleration caused by the DBE.

„For the NPP seismic assessment it was concluded that earthquakes generated from Vrancea Region could have the maximum effect on the site rated "as possible" at an intensity of VII on MSK-64 and "maximum credible" around VIII on MSK-64 scale. Independent international verification of Cernavoda NPP seismic qualification was initiated in 1996. Siemens/Iziss assessment conclusion was that the "maximum credible" earthquake acceleration at Cernavoda NPP site is 0,175g and consequently 0,0875g acceleration for site possible earthquake.

Cernavoda NPP is seismically designed to the DBE (VIII on MSK-64). For design purposes a standard accelerogramme with duration of 40 seconds and with a peak acceleration at 0,2g was considered for the Design Base Earthquake (DBE) and half of this response spectrum for the Site Design Earthquake (SDE). DBE was considered with a frequency of 1 in 1000 years and SDE with the frequency of 1 in 100 years. The seismic design should therefore be sufficient for the siting characteristics." [ENCONET Annex 6,p120]

Table 1 in chapter 2.1. presents the correlation between earthquake intensity and acceleration according to different authors: The NPP`s design base -a peak ground acceleration (PGA) of 0,2 g - is probably far too low, because an earthquake with an intensity VIII on MSK could generate a PGA of up to 0,4 g !!

Neither the seismic assessment of the plant. nor the verification by Siemens/Iziss is available for the public. Taking into account recent earthquake risk analysis and recent data a verification of the design base of Cernavoda NPP as well as of the seismic qualification of the plants safety system is required.

Improvements

Potential safety deficiencies are not seriously discussed in the EIA documents.

To improve the safety of the plant according to the diverse sources improvements are necessary concerning the following issues.

- seismic hazard
- fire protection measures

- secondary side pipe failure
- emergency core cooling
- hydrogen explosions in the containment
- emergency center
- completion of the PSA study and development of an accident management strategy

„ At present there are some issues, applicable to CANDU 6 plants like Cernavoda, that have been addressed or are under discussion in Canada. These issues include fire hazard assessment, prevention of dangerous effects of secondary side pipe failure (control room habitability), clogging of containment sump filters, core cooling in absence of forced flow, hydrogen behavior in the containment. For example, design changes for the sump filters are under evaluation at Cernavoda. However, this modification program and the possible improvement program to address the issues discussed above, may be affected by the financial situation .. "[WENRA 2000]

CANDU design has not changed fundamentally in the last years. The principal safety deficiencies are still to be considered. There is no entire European analysis on the differences in design and safety between CANDU and LWRs, neither from critical nor from pro-nuclear institutions. WENRA and other international organizations of experts from the nuclear community rely on the information and warranties of the vendors and the statements of the Canadian authorities. Special problems and deficiencies of the Cernavoda NPP, e.g. seismic hazard, are not seriously discussed and probably not sufficiently solved.

3. ACCIDENT ANALYSIS

Design base accidents

„The Cernavoda NPP, like other CANDU reactors, is designed against a set of postulated events based on the concept of single/dual failure.... [- i.e. events like large LOCA, single channel events, small LOCA, etc]. Dual failure ...is a combination of a single failure event described above and the simultaneous failure or impairment of one of the special safety systems (emergency core cooling or containment). For the single failure and the dual failure categories of events, maximum frequencies and reference dose limits for members of the public are established.

... Plant design bases include external events such as earthquake, flooding, missiles, and for the containment a reference aircraft impact." [WENRA 2000]

„Requirements have been established so that the station is designed and operated in such a way that the single failure events and the dual failure events do not exceed a frequency of one per three years and one per three thousand years, respectively. The probability for any significant release of radioactivity should be less then 10^{-7}. „[PHARE 6.]

If we assume that all given doses in the EIA papers are effective doses as in [CD 96/29 EURATOM we can compare the results of accidents analysis in [ICIM] to the Euratom dose limit of 1mSv/year.

Table 3: Doses for the evaluated single failure accidents [ICIM table VI-1]

	individual effective. dose [mSv]
maximum dose limit for failure of a single system in Romania	5
Large LOCA[14]	0,15
Small LOCA	0,16
channel blockage	0,6
end fitting failure	0,8

Table 2: shows that the EU limit for the exposure of the population is not exceeded due to a single failure reference accident, but it makes also clear that one single failure as the end fitting failure can result in a dose nearly as high as the annual limit!

However an accident which causes the maximum dose limit for a single failure would require a special authorization for operation in the following years.

„The limit for effective dose shall be 1 mSv in a year. However, in special circumstances, a higher effective dose may be authorized in a single year, provided that the average over five consecutive years does not exceed 1 mSv per year." Article 13, 2. [CD 96/29 EURATOM]

Table 4: Doses for the evaluated dual failure accidents [ICIM table VI-1]

	individual effective. dose [mSv]
maximum dose limit for failure of two systems in Romania	250
large LOCA with partial ECCS[15]	0,03
small LOCA with partial ECCS	0,07
large LOCA with partial containment	0,2
small LOCA with partial containment	0,2
channel blockage with partial containment	0,8
end fitting failure with partial containment	0,8

The maximum dose limit for failure of two systems is far beyond the EU limit for operation of a nuclear facility. The analyzed dual failure accidents do not exceed the dose limit of 1 mSv, but the documents do not explain to which extent a partial failure

[14] LOCA: Loss of Coolant Accident

[15] ECCS: Emergency Core Cooling System

of ECCS or containment is an impairment of the system. Without the missing information the presented results are no appropriate evidence for the safety of the plant.

We assume that the presented figures relate to accident sequences with a probability greater than 10^{-7} events/year as it is explained in ICIM and PHARE.

Severe accidents

„There is another category of events that needs to be assessed. These are the severe accidents that are not considered in the design because their probability is lower than 10^{-7} events/yr. In the case of some particular combination of events, accidents with consequences higher than those considered in the design can occur but with a probability lower than 10^{-7}... It may be noticed that the risks in such situations do not exceed the maximum risk allowed by the regulatory body“.[ICIM VI.2]

Following this paragraph *[ICIM VI.2]* lists six cases which were analyzed in the FSAR.[16] The sequences are described as impairment of the containment envelope and large releases in 6 and 24 hours, respectively [ICIM VI.2]. There is little further information on the accidents sequence, therefore it is impossible to follow the conclusion, that the exposure does not exceed the limit set by the regulatory body (presumable the maximum dose limit of 250 mSv)

„Beyond design basis events like Anticipated Transients Without Scram and Station Blackout are not analyzed in the CANDU safety analysis. These types of scenarios are assumed to be prevented by the existing design safety features (two independent diversified and equally capable shutdown systems and a redundant number of standby and emergencies diesel generators). Concerning severe accidents the standard CANDU safety analysis already includes scenarios with the failure of emergency core cooling in which the heat removal is provided by the moderator. For scenarios with more core degradation, the capability of the calandria to provide a spreading of the corium and sufficient heat removal area for core debris as well as the additional capability of the concrete reactor vault as ultimate heat sink are still to be analyzed and the corresponding management procedures defined.“ [WENRA 2000]

In this context it has to be mentioned, that independent diversified and redundant safety systems are required in all NPPs, but all this provisions can not rule out events (e.g. external) which can impair or even destroy more than one of these systems and which may end in a core melt accident and consequently in a severe impact on the environment and the population.

Moreover the existing safety analysis does not confirm that the probability for severe accidents is actual lower than *10^{-7}*.

[16] FSAR: Final Safety Assessment Report

"A PSA[17] level 1 was carried out for Cernavoda to verify the design. The core damage frequency is approximately 10^{-5}/ year (limited to full power operation and internal events)"[ENCONET 2001]

The probability for a big release into the requirement is not evaluated in a PSA level 1.

Information on large release probability for the CANDU-6 reactor was collected by the Institute for Risk Research:

„(NW 37/28 1996) A comparison of the Candu-6 with PWR designs, authored by Renel's manager of safety and licensing, states, "severe core damage frequency of currently operating Candus is estimated at 4 x 10^{-6} per reactor per year."

But according to Serbanescu, a Level 1 PSA for Cernavoda-1 underway since 1993 points to a higher severe accident probability, "about 10^{-5} in the best case." That conclusion, Serbanescu said, has been reviewed by safety experts at the IAEA. Using the most conservative estimates in the study, he added, the core damage frequency at Cernavoda-1 "might be, on the margin, about 10^{-4}."

(Allen 1990:205): generic CANDU 6 design CDF[18] for internal events is 4.6×10^{-6}, containment bypass is by interfacing LOCA with moderator heat sink available at 6.4×10^{-7} (Allen 1990:207)."[source UBA][19]

It is obvious that ICIM's estimation of the probability for accidents with a large release of radionuclides ($< 10^{-7}$) is too optimistic, taking into account only internal events and not the most conservative estimates for the core melt frequency. The IRR[20] estimates the probability for accidents with large radioactive releases in a CANDU reactor as 5×10^{-5}, meaning that the probability could be higher at least by one order of magnitude.

4. RADIOLOGICAL IMPACT ASSESSMENT

The radiological impact assessment has to analyze the exposure in different situations:

- the normal operation of the plant
- the reference accidents
- beyond design accidents

For every situation the relevant pathways have to be taken into account.

Normal operation

For normal operation the impact of liquid and airborne radioactive releases has to be analyzed.

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[17] PSA. Probabilistic Safety Assessment

[18] CDF: Core Damage Frequency

[19] http://www.ubavie.gv.at/umweltsituation/radio/riskmap/riskmap/english/Ebene2/Ergebnisse/LRFref2.htm

[20] IRF: Institute of Risk Research, University of Vienna, Austria

ICIM uses for this evaluation the averaged annual emissions of CANDU 6 plants and for Cernavoda-1; the data are presented in [ICIM table III.2.5-1]

We can follow most of the explanations on the pathways considered for the dose calculation given in [PHARE 4.], with one exception: why is drinking water from the Danube or the DBS Canal not considered as a pathway to the population? In [PHARE] as well as in [ICIM] it is explained that there are population groups which get their drinking water from Danube or DBS Canal (water treatment is no explanation because tritium cannot be contained in filters)

The reported exposures during normal operation of the plant are reasonable low.

Accidents

[ICIM] summarizes only the results of the dose estimation for the reference accidents without description of the model and data used for calculations . [PHARE] gives a short description of the model the pathways and the weather conditions:

The use of a Gaussian plume dispersion model is standard for this kind of evaluations. However, we cannot follow the explanation about the chosen weather situations [PHARE 6.3.] because all these situation are without precipitation.

In contrast to the authors of the PHARE report, we think that the chosen weather conditions are not a conservative approach. Only for short term exposure a weather situation without precipitation is a worst case assessment. For determination of long term exposure precipitation has to be assumed, because deposition is higher in this case and the dose for the exposed population is also higher. Because of the contamination of soil and agricultural products – the impact is more or less severe - depending on the season.

Therefore it is to assume that the inidvidual effective doses evaluated for the reference accidents presented by [ICIM] (see table 2 and 3 in chapter 4 above) could be exceeded distictly and could result in values above the EU- limit of 1 mSv/year [CD 96/29 EURATOM].

The presented dose calculations probably underestimate the impact to the population. A serious discussion is impossible because of the lack of meteorological data.

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