INTERNATIONAL NUCLEAR SAFETY: THE CASE OF THE CHERNOBYL NUCLEAR POWER STATION

David R. Marples* **and Tatyana E. Cerullo****

INTRODUCTION

The Chernobyl nuclear disaster took place more than thirteen years ago. As an accident its known direct casualties were not high, and as an event in the media it has long ceased to capture popular attention in the West. But in the areas affected, Chernobyl continues to raise questions and pose problems for the local population. These questions include: what has happened to the nuclear power station itself; does it still pose dangers; and how has the international community responded to this question and cooperated with the new authority, the government of independent Ukraine? This paper examines the fate of the power station since the Chernobyl accident as an issue in international environmental security. In addition, it looks generally at the question of the development of nuclear power in Ukraine in order to answer the question: what lessons have been learned over the past thirteen years? The last section analyzes the Nuclear Safety Convention of 1994 and discusses its effectiveness as the only international nuclear safety regime aimed at minimizing the risk of another Chernobyl-type disaster.

I. CASUALTIES

According to Ukrainian and Belarusian authorities, approximately 5.4 million citizens living in those countries should be classified as victims of Chernobyl.[1] They include liquidators (the term given to clean-up crews), evacuees, and those obliged or choosing to live in zones in which the ground remains contaminated with radioactive cesium, strontium, plutonium and other elements. The most discernible health consequence to date has been a dramatic increase in incidences of thyroid gland cancer, especially among children aged five and under at the time of the accident.[2] This disease was

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* David R. Marples is Professor of History at the University of Alberta, Canada and Acting Director of the Canadian Institute of Ukrainian Studies. Professor Marples participated in the Vermont Law Review 1999 Symposium, International Environmental Law: A Global View of the New Millennium, in South Royalton, Vermont. He has written extensively on the subject of Chernobyl.

** Tatyana Cerullo is a graduate of Vermont Law School, 2000, and is a federal clerk for the Honorable Francis Yamashita of the Ninth Circuit District Court in Honolulu, Hawaii.

1. *See* Olena Horodetska, *Chernobyl Kills and Cripples 14 Years After Blast*, REUTERS, Apr. 21, 2000. On Belarus, *see generally* DAVID R. MARPLES, BELARUS: FROM SOVIET RULE TO NUCLEAR CATASTROPHE, Chs. 4 and 5 (1996).

2. *See, e.g.*, Dr. Peter Wraight, *Chapter V of the report by the Nuclear Energy Agency*, <http://www.nea.fr/html/rp/chernobyl/c05.html>; *Chernobyl Radiation Linked to Thyroid Disease*, REUTERS, Sept. 3, 1998.

negligible among children prior to 1986. Yet in October 1998, the Ukrainian newspaper *Den'* reported that over 1,000 people were suffering from the disease.[3] By April 1999, Ukrainian deputy health minister Ol'ha Bobyleva was reporting that the number was 1,200 and that four children had died of thyroid cancer.[4] According to the deputy director of the Institute of Endocrinology in Kyiv, Volodymyr Tereshchenko, the peak of the disease will likely be reached in the years 2001-2005.[5]

Direct casualties of Chernobyl are extremely difficult to assess, not least because of the wildly fluctuating figures that have been provided by various sources. Clearly the major problems are found among the liquidators, approximately 350,000 of which came from Ukraine. Of these, 12,519 have since died, and 4,300 have passed away from causes related to the accident.[6] People's Deputy Volodymyr Yatsenko has declared that over the period of 1993-1998, 5 million residents of Ukraine died prematurely; while a report from Interfax news agency suggests that the number of direct deaths from Chernobyl in Ukraine is 4,229, of whom 2,929 were clean-up workers.[7] There is no question that medical problems have increased markedly since 1986. Since then, according to Bobyleva, of the 3.2 million designated victims of Chernobyl, only 10 % can be considered healthy today, and there has been a general rise in incidences of diseases of the blood, the nervous system, and respiratory organs.[8] The Chernobyl Union, the organization formed by the liquidators themselves, keeps its own statistics. It raises the number of victims to 3.7 million, noting that among them the level of oncological diseases has risen by a factor of twelve; psychic-nervous ailments by seven times; and heart diseases by five times. In the post-Chernobyl period, it is claimed, approximately 350,000 Ukrainians have died as a result of the disaster, while 70,000 have been rendered permanent invalids.[9] Once a liquidator becomes an invalid, his future life-span averages 4.5 years, and mortality among those

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3. *See* Inna Zolotukhina, *Memorial Candles of Chornobyl*, THE DAY DIGEST, Apr. 27, 1999.

4. *See Chornobyl's Lethal Legacy Hits New Generations*, REUTERS, Apr. 21, 1999.

5. *See* Svyatoslav Rechnyskyi, *Chornobyl'-98: Spokutuvannya Chuzhykh Hrikiv*, DEN', Apr. 25, 1998.

6. *See* Horodetska, *supra* note 1. By spring of 2000, the figure was around 15,000; *Over 15,000 Involved in Clearing Up Chernobyl Have Died*, INTERFAX (Moscow), Apr. 21, 2000.

7. *See Chornobyl Veterans Brought Their Own Bells to Protect Their Privileges*, THE DAY DIGEST, June 23, 1998; *see also* Marko Levytsky, *Ukraine Mourns Chornobyl*, KYIV POST, Apr. 29, 1999.

8. *See* Horodetska, *supra* note 1.

9. *See* Inna Kolesnykova, *Stan zdorov'ya 'Chornobyl'tsiv pohirshyvsya u 8 raziv stverdzhuyut' u Ukrains'komu Minzdorov'i*, TSENTR ZHURNALISTS'KYKH DOSLIDZHEN', No. 5, Apr. 21, 1999. It should be noted that the figure of 350,000 is exactly 100 times more than the figure provided by the government. *See id.*

who are today aged between thirty and fifty-five has risen more than twelve times since the time of the accident.[10]

However one regards these official and unofficial figures from Ukraine—and there are clearly differences between them and those from international sources, such as the International Atomic Energy Agency—one should not underestimate the scale of the disaster for an economy in a newly developing nation. The approximate toll of the accident on the economy has been $11 billion and continues to occupy a significant part of the annual budget (between 5 % and 7 %).[11] Some 1.6 million residents of Ukraine are entitled today to free rest and recuperation at sanatoria and other centers.[12] Such a bill is a significant burden for an economy that has been struggling with debt since independence. In a sense, adverse publicity about the disaster may attract international aid for victims of Chernobyl, but it also adds to the toll on the government, which must find funds to cover the assistance its own sources declare necessary. The thirteen years since the accident have seen little alleviation of the Chernobyl predicament as far as casualties and victims are concerned. But what is the fate of the station itself?

II. CHERNOBYL: THE QUESTION OF CLOSURE

In 1995, at a meeting of the G-7 countries and Russia in Ottawa, Canada, an agreement was signed with Ukraine concerning the proposed closure of the Chernobyl nuclear plant by the year 2000.[13] A reported $3.2 billion in aid was promised to Ukraine in return for shutting down the station.[14] Part of this sum was assigned for decommissioning costs, and part to cover the costs of completing construction of two new reactors that would compensate for the loss of energy capacity at the Rivne and Khmelnytsky nuclear power stations in western Ukraine. Funds were also required for urgent work on the cover of the destroyed fourth reactor unit, known as the Shelter. Since that meeting, relations on this issue between Ukraine and the G-7 countries have been strained. The G-7 countries continue to demand changes to Ukraine's national energy sector and what they perceive as wasteful practices in the use of

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10. *See* Mykola Lavrynenko & Eduard Kats, *Likvidator, Yak Yaderne Palyvo: Vykorystaly I Khoronyat'*, HOLOS UKRAINY, June 15, 1999, at 6.

11. *See Ukraine Says Chernobyl Blast Cost $11 Bln So Far*, REUTERS, Apr. 13, 1999.

12. *See* Oleksandr Fandeev, *Pravo na bezkoshtovne ozdorovlennya mayut' 1600 tysyach postrazhdalykh vid avarii na ChAES*, DEN', Aug. 12, 1999, at 2.

13. *See Ukraine—G-7 Memorandum of Understanding On the Closure of Chernobyl Nuclear PowerStation, Completion of Khmelnitsky 2 and Rovne 4 Nuclear Units, Terms of Reference for Economic Due Diligence ByAn International Panel of Experts* <http://www.ebrd.com/opera/k2r4/kr9.htm>.

14. *See, e.g., Chernobyl's grim legacy*, BBC NEWS, (Apr. 27, 2000) <http://www.news.bbc.co.uk/hi/english/world/europe/newsid_727000/727426.str>.

electricity. Ukraine maintains that while the G-7 countries continue to insist that the Chernobyl plant be shut down permanently, only a fraction of the promised funds to conduct this process have been forthcoming.[15] Of the $900 million estimated to be necessary for the closure of the nuclear plant, Ukraine maintains that only about $190 million has arrived from the G-7 countries and from the European Bank for Reconstruction and Development (EBRD), which has the task of supervising matters at the site.[16] Ukrainian president Leonid Kuchma, facing a reelection campaign in late October 1999, made much political capital over the protracted impasse.[17] In the spring of that year he announced that the Chernobyl plant would continue to operate until the G-7 group fulfilled its financial obligations.[18] He noted further that the Western countries had agreed to finance the completion of two new reactors in western Ukraine, to deal with the social problems of Chernobyl workers, and to build storage facilities for nuclear waste.[19]

Of the G-7 countries, Germany has in the past been most committed to aid for Ukraine. However, the new SPD (Socialist Party of Germany) government, obliged to form an alliance with the Greens to possess a working majority, has complicated matters for the Kyiv government. In July 1999, German Chancellor Gerhard Schroeder visited Kyiv and met with President Kuchma. There he recommended that Ukraine scrap the proposed new reactors and use non-nuclear sources to replace the Chernobyl plant. The recommendation infuriated the Ukrainian side, who regarded it as changing an agreement in midstream. Kuchma retorted that the West should come up with $1 billion for the completion of work on the new reactors.[20] Nuclear power, he noted, was the least expensive of all the possible options for Ukraine and the new reactors had been 80 % complete even at the time of the collapse of the Soviet Union in December 1991.[21]

Ukraine has also stressed that it is fulfilling its side of the bargain, in contrast to the G-7 countries. Of the three operating Chernobyl reactors after 1986, the second unit was shut down in 1991 following a fire and has been placed in a "holding regime," (i.e., it could be returned to service if the situation warranted it). Such a process–which arouses horror among some

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15. *See, e.g.*, Yana Stadil'na, *Holos E, Ta Nema Vidholosu*, HOLOS UKRAINY, May 19, 1998, at 1, 10; *Western Complacency on Chornobyl May Force Ukraine to Look East For Assistance*, MONITOR DAILY REPORT, May 21, 1998. *See generally Ukraine Holds Out Cap for Funds to Close Chernobyl*, REUTERS, July 14, 1998 (explaining that additional funds are necessary to complete two new reactors, permitting Chernobyl to be shut down).

16. *See Hard-Up Ukraine to Launch Two Nuclear Reactors Alone*, REUTERS, Apr. 20, 1999.

17. *See id.*

18. *See id.*

19. *See Chornobyl's Lethal Legacy Hits New Generations*, *supra* note 4.

20. *See Kanstler FRN—u Kyevi*, HOLOS UKRAINY, July 9, 1999, at 1.

21. *See id.*

international experts–would take about a year and cost 110 million *hryvnya* ($20.22 million).[22] Unit one was shut down on schedule in 1997, and is being decommissioned. The third unit, which shares a building with the buried fourth reactor, has suffered from constant problems that the Ukrainian authorities have frequently described as regular maintenance. In June 1997, for example, it was shut down for capital repair work for 70 days. But at the time of an inspection, a large number of tiny cracks were found in the weld of the tubing in the reactor core.[23] Altogether there were reportedly 338 such defects, which took seven months to eradicate, ostensibly because radiation levels were so high that the work had to be conducted in shift form.[24] Further repairs were carried out early in 1999 and were to be completed by February 15, but were extended once again when more defects were discovered in the pipelines.[25] When the European Union (EU) urged Ukraine not to restart the reactor in March, Deputy Energy Minister Hennadiy Yaroslavtsev criticized the request and claimed that it was a further attempt to exert political pressure on Ukraine.[26] After a further period of maintenance commencing on July 1, the reactor was returned to the grid on November 28, once again in the face of strong criticism from the international community.[27]

Of the various parties involved in the complex question of the closure of the Chernobyl plant, perhaps the EBRD has played the most critical role. One of its harshest critics has been the former director of the Chernobyl plant, subsequently the First Deputy Minister of Energy, Mikhail Umanets. The latter noted in late 1998 that the two sides had been trying for over two years to reach an agreement on credits for the completion of the fourth unit at Rivne station and the second unit at the Khmelnytsky station (referred to frequently as the K2/R4 project).[28] Umanets complained that the EBRD had demanded that Ukraine must fulfill 74 conditions to obtain these credits, and yet the country had no alternative sources to provide funds needed for a new cover for the fourth unit complex and for the stabilization of the Shelter.[29] For its part, the EBRD has faced severe protests from anti-nuclear elements in Western Europe and in May 1998, it balked at providing funds for the K2/R4 project. Ukraine must first privatize energy distribution firms, seek alternative sources

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22. *See* Serhiy Parashyn, *Cherez Rik—ChAES Mozhe Zupynytsysya Po Sebi*, HOLOS UKRAINY, Apr. 25, 1998, at 8 [hereinafter *Cherez Rik*].
23. *See id.*
24. *See id.*
25. *See Chernobyl Repairs Continue to March 6*, REUTERS, Mar. 3, 1999.
26. *See Ukraine Dismisses EU Demand to Close Chornobyl*, RFE/RL NEWSLINE, Mar. 10, 1999.
27. *See Ukraine Restarts Chornobyl*, RFE/RL NEWSLINE, Nov. 29, 1999.
28. *See Ukraine Raps West Over Delay in Chernobyl Funds*, REUTERS, Nov. 3, 1998.
29. *See id.*

of financing, meet the needs of international nuclear safety, and reduce barter payments for electricity.[30]

In the face of what it sees as increasing Western intransigence on financing its urgent nuclear projects, Ukraine has either turned to Russia for aid, or else stated its intention to complete the projects itself. Russia promised to supply about $180 million worth of nuclear equipment, and agreed to be compensated at some point in the future.[31] Mykola Dudchenko, the president of Ukraine's nuclear power agency, Enerhoatom, notes that the two new reactors can be brought into service by 2002, but that the process could be reduced by a year's time with external assistance.[32] In his view the EBRD was imposing serious conditions on Ukraine that the state could not possibly meet in full.[33] The current rift raises the question of the safety of Chernobyl and of the Shelter over the destroyed fourth reactor in particular.

III. THE SHELTER PROGRAM AND SAFETY IN THE CHERNOBYL ZONE

The Shelter Implementation Program (SIP) is a plan to construct a new cover over the fourth Chernobyl unit. Recall that the existing cover was built rapidly and under very difficult conditions after the April 1986 accident. At the time the Soviet authorities appeared to believe that the cover—they used the term "sarcophagus"—would last for a lifetime. However, the Shelter, which was built with ventilation shafts to prevent a rise of heat, soon developed problems. There was no consensus on the amount of radioactive fuel left in the reactor core, and there were fears both within and outside Ukraine that another accident might take place. The Shelter Implementation Plan is anticipated to take 9 years to complete (1997-2006) at a cost of $750 million.[34] The G-7 countries, meeting in Denver in 1997, promised to provide $300 million (including $100 million from the EU), while the EBRD signed an agreement with Enerhoatom in May 1998 by which it agreed to allocate grants totaling $130 million for the repair of the sarcophagus.[35] The EBRD also administers the SIP project though it does not finance it directly. The two grants of May 1998 were intended to stabilize the structure, particularly to

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30. *See EBRD Defends Ukraine Nuclear Power Project*, REUTERS, Apr. 19, 1999.

31. *See Ukraine Sees No Russia Aid For Nuclear Reactors*, REUTERS, Feb. 10, 1999.

32. *See Repairs of Nuclear Power Units to be Put Off*, THE DAY DIGEST, Aug. 31, 1999. <http://www.day.kiev.ua/DIGEST/1998/25/daybyday/day-4.htm>.

33. *See id.*

34. *See* David R. Marples, *Nuclear Power in Ukraine in the Late 1990s*, Post-Soviet Geography and Economics, Vol. XXXIX, No. 6 (June, 1998), at 363.

35. *See EBRD Meeting in Kyiv Produces Stopga Measures For Chornobyl*, MONITOR DAILY REPORT, May 13, 1998; *see also* NUCLEAR ENGINEERING INTERNATIONAL, Oct. 2, 1997, at 2.

treat the dust and water that have penetrated inside.[36] The task of reinforcing the Shelter has been given to an international consortium led by the French firm, Technique Atom and including firms from the United Kingdom, Germany, and the United States.[37]

In the summer of 1998, U.S. Vice-President Al Gore visited Chernobyl, during which time the U.S. commitment to the Shelter and safety at the Chernobyl site were emphasized. Of the $390 million donated at that time to the project by 26 countries, it was noted, that the U.S. had provided $78 million.[38] In particular, the U.S. Department of Energy had contributed $1 million for the repair of ventilation pipes and $1.8 million worth of dosimetric equipment for the Shelter.[39] The department had contributed almost $20 million altogether for projects related to Chernobyl since 1986.[40] The Shelter is calculated to last a maximum of fifteen more years without any work to construct a new cover and to eliminate existing problems.[41] A detailed account of the problems in this unique 20th-century structure, considered a nuclear "tomb" by the deserted city of Pripyat, two miles to the north, was provided last year by the then director of the Chernobyl station, Serhiy Parashyn.

Parashyn noted that the construction as a whole was dangerous.[42] In one area there is a deviation of the wall and unreliable support may cause the collapse of the roof.[43] There was, in his view, a catastrophic lack of information about the internal state of the tomb.[44] As noted earlier, scientists know "practically nothing" about the state or amount of the nuclear fuel therein.[45] There is also nuclear fuel under the central room of the fourth unit and experts have not dismissed the possibility of a chain reaction in these remains.[46] The high temperatures at the Shelter are a result of 2,000-3,000 tons of material still burning inside the object.[47] In 1992, a fire there continued for three days.[48] Twenty-nine unsafe zones had been exposed

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36. *See id.*
37. *See International Consortium to Reinforce Chornobyl Sarcophagus*, RFE/RL NEWSLINE, Aug. 5, 1998.
38. *See id.*
39. *See* Vitaly Kuska, *Albert Gore Visits Chornobyl*, THE DAY DIGEST, July 21, 1998.
40. *See id.*
41. *See Cherez Rik*, *supra* note 22.
42. *See id.*
43. *See id.*
44. *See id.*
45. *See id.*
46. *See id.*
47. *See id.*
48. *See id.*

within the Shelter, five of which required immediate attention.[49] In the western part of the structure there were "significant defects" in the elements and joints of the framework, which had an anticipated life-span of only five years.[50] The southern protective shield in one locality was crumbling and could not withstand the force of a tornado.[51] Worst of all, was the ventilation of the V block tower (it has since been repaired).[52]

Was another disaster possible? Parashyn believed that this could occur if the building construction within the Shelter crumbled. Some 34 tons of radioactive dust would then be released, which would under normal circumstances (absent high winds) fall within the confines of the 30-kilometer exclusion zone around the reactor.[53] An earthquake of 3-4 points on the old Soviet 10-point scale could result in the collapse of parts of the Shelter, including the walls between the operating third unit and the buried unit four. Fires could spread radiation. In 1993, a fire in the Shelter resulted in a ten-fold increase in the number of alpha particles.[54] Parashyn also feared that radioactive deposits might seep into the ground water of the Pripyat River, which flows into the massive Kyiv Reservoir, the main water supply for Ukraine's capital city.[55]

This dramatic account might have been geared to persuading international experts that without immediate attention, another tragedy could soon occur at Chernobyl. However, statements from international nuclear safety experts in the spring of 1999 supported Parashyn's report.[56] Lars Larsson, nuclear safety director for the EBRD, estimated that there might be twenty to thirty tons of radioactive dust within the Shelter, as compared to a surmised single ton in 1997.[57] At the base of the sarcophagus are thousands of meters of radioactive water that pose a threat to the ground water supply. Though work is well under way on the Shelter Implementation Project, concerns remain about working conditions and the amount of radiation to which workers on the site will be subjected.[58] On July 20, Mykola Dudchenko of Enerhoatom signed an agreement with Novak Vins of the EBRD concerning the consignment of funds, for the first stage of the SIP, 111.6

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49. *See id.*

50. *See id.*

51. *See* Pavlo Beba, *Chornobyl: hirkyi spomyn i vichnyi bil'*, URYADOVYI KUR'YER, Apr. 25, 1998, at 4-5.

52. *See Cherez Rik*, *supra* note 22.

53. *See id.*

54. *See id.*

55. *See id.*

56. *See* Ron Synovitz, *Ukraine: Experts Concerned About Radioactive Dust at Chornobyl*, RFE/RL NEWSLINE, Apr. 28, 1999.

57. *See id.*

58. *See id.*

million Euros.[59] This stage is to continue until July 1, 2005.[60] Thus, work on the most urgent problem—that of the crumbling shelter—has continued without significant problems between Ukraine and the grant donors from the West. Nonetheless, it is still not clear whether the entire project will be funded in full.

The final question in the Chernobyl zone concerns the town of Slavutych, a city that was built in the aftermath of the 1986 disaster to house employees at the station and their families. It was intended as a replacement for Pripyat. Today, about 26,000 people live in Slavutych and one of the key questions has been: what will happen to them when the nuclear power station is closed down? About 12,000 residents are employees of the nuclear power plant, and about 7,000 are children. Already the unemployment rate in the town, which was constructed as a "21st century city" by workers from many of the former Soviet republics, has reached 6 %, and its mayor anticipated that the figure would soon rise to 16 % as the nuclear power station began to lay off its employees.[61] The Ukrainian Energy Ministry has held talks with the Russian Gazprom firm regarding the construction of a gas-powered electrical plant on the foundations of the Chernobyl station.[62] There has also been discussion of other futures for Slavutych, such as the manufacture of protective clothing. It is evident that the Ukrainian authorities are preoccupied with the possibility of economic alternatives. In late June 1999, a new law on the creation of a special economic zone based on the town of Slavutych was published in the press, a status that is to last until the year 2020 in the hopes of attracting outside investment.[63]

With Slavutych, as with the question of the closure of Chernobyl, the Ukrainian authorities have given priority to practical matters: providing electricity for the stumbling economy and maintaining a low level of unemployment. Such priorities are understandable, but the question is whether in adopting such policies, safety is being compromised. Paradoxically, the safety question had long concerned Ukrainian environmental activists in the period from 1986 to 1991, when control over nuclear power stations was out of Ukrainian hands. Since independence, the safety issue has been one that has concerned international nuclear experts rather than republican authorities. This has been the case since the

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59. *See Grant na obsluhovuvannya ob'ekta 'Ukryttya,'* URYADOVYI KUR'YER, July 22, 1999, at 3.

60. *See id.*

61. *See* Lily Hyde, *Ukraine: A New Town Depends on Chernobyl's Fate*, RFE/RL NEWSLINE, Oct. 19, 1998.

62. *See GazProm Aims to Build Energy Station in Chernobyl*, REUTERS, Nov. 3, 1998.

63. *See* HOLOS UKRAINY, June 30, 1999, at 5. *See also* Oleksandr Fandeev, *Chy Ochikue Slavutych Dyversyfikatsiya?* DEN', May 21, 1999, at 7.

International Atomic Energy Agency (IAEA) declared the Chernobyl plant to be unsafe in 1994, eight years after the disaster. How dangerous are Ukrainian nuclear power stations today?

IV. THE UKRAINIAN NUCLEAR POWER INDUSTRY

Ukraine currently has five nuclear power stations: Chernobyl, Rivne, Khmelnytsky, Zaporizhzhya, and South Ukraine, with 14 nuclear reactors. The industry has been in operation for 22 years and despite Chernobyl and its ramifications, its share of electricity production in the Ukrainian overall total has been expanding.[64] At the same time, the output of electricity at nuclear power stations has declined in recent years; though this decline has been in line with government plans. In 1996, it stood at 79.6 billion kilowatt/hours; in 1998, the total fell to 75.2 billion, but the annual plan was over fulfilled.[65] All the current stations were in existence in 1986, and no new stations have been commissioned since the Chernobyl accident. What Ukraine wishes to do, however, is to complete this particular stage of the old Soviet program, despite almost overwhelming problems with the acquisition of fuel, regular payments of wages, and chronic mismanagement of the energy sector in general.

There is no shortage of pro-nuclear propaganda. Serhiy Parashyn maintains that nuclear energy has been the single stable working branch in the industry during eight years of crisis.[66] In 1998, he notes, 43 % of the total output of electricity was obtained at nuclear plants.[67] In this regard nuclear power is close to overtaking thermal power stations that, at one time, held a virtual monopoly over electricity production in Ukraine. Parashyn notes that although Ukraine is obliged to import nuclear fuel from Russia, its cost remains low.[68] Thus, whereas the state will pay about $300 million for imports of fuel for the nuclear industry in 1999, the cost of importing oil, gas, and coal for the thermal power stations will amount to $1.6 billion.[69] The cost of producing a kilowatt/hour of electricity at a nuclear plant is 2.5 times less than that at thermal power stations, and the life-span of Ukrainian nuclear

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64. *See* Oleksii Kostusev, *Dev'yat paradoksiv energetiki krainy*, HOLOS UKRAINY, July 27, 1999, at 6,7.

65. *See* URANIUM INSTITUTE NEWS BRIEFING, 97.39-8, Sept. 24-30, 1997; *see also Enerhoatom (Department of Communications with the Public), Atomni stantsii zustrichaly novyi rik u hrudni, perevykonavshy plan vyrobnytstva elektroenerhii*, HOLOS UKRAINY, Jan. 30, 1999, at 3.

66. *See* Serhiy Parashyn, *Atomna Enerhetika: Natsional'ne Nadbannya Chy Zahroza?* DEN', Apr. 27, 1999, at 6 [hereinafter *Atomna Enerhetika*].

67. *See id.*

68. *See id.*

69. *See* Anatoliy Osadchiy, "Enerhoatom" vycherpav zapasy yadernoho [Do rechi], DEN', July 16, 1999, at 6.

power stations has barely reached the halfway mark, in Parashyn's opinion.[70] Thermal power stations have, by contrast, almost reached the end of their designated span.[71] In the independence period, the loss of Chernobyl-1 from the power grid has been compensated by the arrival of Zaporizhzhya's sixth unit—the Zaporizhzhya station on Ukraine's Dnipro River is on paper the largest nuclear plant in the world.[72] According to Parashyn, the country needs now only the willpower to complete the reactors at Khmelnytsky and Rivne in order to maintain current performance.[73]

Providing fuel for nuclear reactors has been a major difficulty. Dudchenko, the President of Enerhoatom, maintains that the lapse in fuel purchases from Russia last year was a result of the financial collapse of Russia and the lack of a stable exchange rate for the ruble.[74] Why does Ukraine insist on Russian fuel? Ukrainian reactors, he asserts, were designed to use Russian fuel and Russia also processes Ukraine's nuclear waste.[75] Moreover, the fuel problems at thermal power stations has become equally critical. Whereas last summer only 7 out of Ukraine's 14 reactors were operating, the figure at thermal power stations was 42 out of 102.[76] Dudchenko's remarks, however, are misleading since cash shortages have proven an acute problem for Ukraine. The best that can be said for the performance in the nuclear energy sector is that it has been slightly better than that of the outdated thermal power stations, which suffer from low supplies of coal at the sites themselves and in state reserves.

V. THE SAFETY QUESTION

The late 1990s have seen a long chronology of mishaps, incidents, and potentially dangerous accidents at Ukraine's nuclear power stations. A similar log can be compiled of lax attention to safety procedures. Thus in July 1998, the Minister of the Power Industry, Oleksiy Sheberstov, demanded that the first unit of the South Ukrainian station be restarted even though new safety measures being undertaken there had not been completed.[77] At the end of this year, South Ukraine's second unit was shut down automatically after a

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70. *See Atomna Enerhetika*, *supra* note 66.

71. *See id.*

72. *See id.*

73. *See id.*

74. *See* Vitaly Kniazhansky, *Repairs of Nuclear Power Units to be Put Off*, THE DAY DIGEST, Aug. 31, 1999.

75. *See id.*

76. *See* Vzymku elektroenerhiya nam ne svityt', DEN', July 27, 1999, at 1.

77. *See* Vitaly Kuska, *Nuclear Safety in Ukraine: Are Ukraine's Nuclear Plants Being Pushed Toward Another Chornobyl?*, THE DAY DIGEST, July 21, 1998.

malfunction of safety equipment. This incident occurred after five months of repairs and only two days after the plant had been returned to normal operations.[78] Oleksander Smyshliayev, who heads the nuclear regulatory agency with Ukraine's Environmental Ministry, noted in the fall of 1998 that malfunctions at Ukrainian reactors had increased by 50 % over the same period in 1997.[79] President Kuchma turned angrily on the Energy Ministry following the South Ukraine-2 incident, blaming the ministry for the continuing problems in the energy sector, but notably ignoring the safety factor.

On July 9th, an accident occurred at the Chernobyl-3 unit that was officially ranked at level one on the seven-rank international scale for nuclear emergencies. According to the official account, the accident was a result of human error during the period when the reactor unit had been shut down for regular maintenance work. The operator "set the equipment in motion without making sure that the operation to disengage equipment from the elements of the reactor had been completed."[80] As a result, two workers at the unit received over four times the amount of radiation permitted annually for nuclear plant operatives, though there was no off-site release of radiation.[81] The president of Enerhoatom, Mykola Dudchenko, tried to reassure the public that no shortcuts had been taken as far as safety measures were concerned. His comments, however, were quite revealing as to the lamentable state of the industry. Equipment is aging since the newest atomic plant in Ukraine is now ten years old. A fundamental improvement of safety, he noted, required an investment of a substantial sum, but the Ukrainian nuclear industry only had enough money to maintain the current levels.[82] In terms of safety of nuclear reactors on a world scale, Ukraine is "somewhere in the middle."[83] The pattern is a familiar one; the industry is in a very similar state to that of 1986, when emphasis was placed on bringing reactors into service to keep up with demands of five-year plans. The difference today is that investment is lower, safety is neglected, and funds cannot be readily moved from one energy sector to another as was the case in the Soviet period.

An issue related to both nuclear safety and environmental security is that of nuclear waste. As Ukraine's plants grow older, the question is becoming

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78. *See Safety System Shuts Down a Ukraine Nuclear Reactor*, REUTERS, Dec. 7, 1998.

79. *See Ukraine Improves Nuclear Safety Record*, RFE/RL NEWSLINE, Oct. 23, 1998.

80. *Minor Accident Occurs at Chernobyl Nuclear Station*, ITAR-TASS, July 16, 1999; *see also Ol'ha Krasovs'ka, "Avtorstvo" pmylky na ChEAS vysnachyt' komisiya*, HOLOS UKRAINY, July 23, 1999, at 6.

81. *See* URANIUM INSTITUTE NEWS BRIEFING, 99.29-11, July 14-20, 1999 (*citing NucNet News*, 302/99, July 19, 1999); *See* DEN', July 10, 1999, at 1.

82. *See id.*

83. *See id.*

paramount. Earlier this year, Ukraine completed three months of negotiations with the Russian Ministry of Nuclear Energy and the Russian chemical plant at Krasnoyarsk that has been processing Ukrainian nuclear waste. Although Ukraine has been sending ever larger numbers of spent fuel rods to the Krasnoyarsk plant for reprocessing (510 in 1997; 560 in 1998), Russia had proposed to double the costs. A compromise was reached in mid-February whereby the price was to rise from $285 to $330 per kilogram. The link with Russia dates from the Soviet period when the entire industry was centralized. It is likely to present further problems in the future, as Russia's own aging nuclear power stations are decommissioned. Plants such as Kursk, for example, were built around the same time as Chernobyl, the oldest nuclear plant in Ukraine.

VI. THE NUCLEAR SAFETY CONVENTION OF 1994

When the Iron Curtain fell in the former Soviet bloc, several alarming safety risks arising from failing, antiquated nuclear reactors were exposed.[84] Because of these newly exposed risks, the IAEA's General Conference of 1991 expressed support for a nuclear safety convention.[85] As a result of the Conference, a group of legal and technical experts from more than fifty countries developed a draft of the Nuclear Safety Convention.[86] Although this Convention is lacking in many respects, it represents a bold attempt on the part of the IAEA to internationalize nuclear safety, traditionally viewed as a domestic responsibility and economic hindrance.[87] More specifically, the Convention was meant to persuade countries like Ukraine to bind themselves to important safety rules and accept the obligation of reporting and participating in periodic peer review meetings to verify the implementation of the treaty obligations.[88] As of March 2000, sixty-five countries had signed on, but only thirty-seven had ratified the Convention.[89] Ukraine signed on September 20, 1994, and proceeded to ratify on April 8, 1998.[90] The Convention tries to appeal to countries by not forcing them to replace their whole system with a modern high-tech Western model. Instead, the Convention reaffirms that the responsibility for nuclear safety rests with the

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84. *See* Robert W. Schaaf, *New Convention on Nuclear Safety*, 22 INT'L J OF LEGAL INFO. 277 (1994).

85. *See id.*

86. *See id.*

87. *See id.* at 278.

88. *See id.* at 277.

89. *See Convention on Nuclear Safety, Signatories and Parties* (visited Mar. 30, 2000) <http://www.iaea.org/worldatom/glanic/legal/nukesafety.html>.

90. *See id.*

state having jurisdiction over a nuclear installation.[91] In recognizing this concept, the Convention requires "a commitment to the application of fundamental safety principles for nuclear installations rather than of detailed safety standards."[92] By not requiring adherence to the highest safety standards, but just offering them as examples, the Convention provides a middle ground between no international law for nuclear safety and a badly needed, but unrealistic, high-standard treaty.

A. The Legislation and Regulation Requirement

The Convention requires countries to establish and maintain a "legislative and regulatory framework to govern the safety of nuclear installations."[93] This framework must then establish national safety requirements and regulations and develop a system of licensing, inspection, assessment, and enforcement.[94] In addition to establishing a legislative and regulatory framework, a contracting party, a state that has ratified the Convention, must designate a regulatory body with adequate authority, competence, and the financial and human resources to implement the nuclear safety regime.[95] The Convention then stipulates that the contracting party must take appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body concerned with the promotion or utilization of nuclear energy.[96] In short, leaving it to the state to establish national safety requirements and a legislative, regulatory, and administrative framework probably will not lower the risk of another disaster. Countries interested in promoting nuclear power, such as Ukraine, will not want to subject themselves to strict standards that might curb nuclear power generating capacity. Therefore, the Convention should require countries to meet certain internationally uniform base standards that will lower the risk of disaster.

B. Financial Resources and "Safety"

Even if the state regulatory body establishes certain policies that put nuclear safety first, what it considers "safe" may not be safe according to the

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91. *See* Convention on Nuclear Safety, June 17, 1994, IAEA Doc.Infcirc/449/Annex, 33 I.L.M. 1518, at Preamble iii, *available in* 1994 WL 1026185.

92. *Id.* at Preamble vii. This states that the Convention is "desiring to promote an effective nuclear safety culture." *Id.* at Preamble iv.

93. *See id.* at art. 7, sec. 1.

94. *See id.* at art. 7, sec. 2.

95. *See id.* at art. 8, sec. 1.

96. *See id.* at art. 8, sec. 2.

rest of the international community. Furthermore, in cases such as Ukraine where many countries—including the United States and international entities such as the EBRD–are engaged in activities directly related to nuclear installations, it is unclear what policy, if any, exists for them under the Convention.[97] Unfortunately, international cooperation for resolving nuclear crises, or lack thereof, is driven by politics and money, not by a commitment to nuclear safety. The international community must create a structured way to deal with the dangerous situations that are prevalent in Ukraine and other former Soviet bloc countries. This Convention in no way provides a solution or even addresses the reality of the situation in the countries for which adherence to international nuclear safety standards is most desirable. The Convention must add a section on handling emergency situations and create a structured, methodical approach to financial aid and technical assistance. Without some functioning mechanism through this Convention or otherwise, nuclear safety will continue to play a secondary role to politics. One way the Convention could make nuclear safety play a primary role would be to clarify and codify the multilateral financial mechanisms already in existence such as the Nuclear Safety Account (NSA).[98]

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97. The United States recognized Ukraine's determination to get technical and financial assistance for the completion of K2R4 and decided to use it as leveraging power for its own agenda. The United States wants to help secure Ukraine as a non-nuclear weapon state and to emphasize U.S. opinion on nuclear export policies and physical protection of nuclear material. *See* H.R. Doc. No. 105-248, at 56 (1998). At a meeting in March 1998 between U.S. Secretary of State Madeleine Albright, President Kuchma, and Foreign Minister Hennadiy Udovenko, Ukraine signed a thirty-year agreement on nuclear cooperation with the United States called the Agreement for Cooperation Between The United States and Ukraine Concerning Peaceful Uses of Nuclear Energy. *See id.* This Agreement opens up "the possibility of expanding civil nuclear cooperation between our two countries and thereby demonstrates the benefits that can accrue to countries that make strong commitments to nuclear nonproliferation." *Id.* Under the Agreement, U.S. companies will assist the completion of the K2/R4 reactors. *See* David R. Marples, *Ukraine: 12 years later*, 54 BULL. OF THE ATOMIC SCIENTISTS (1998), *available in* 1998 WL 15209386.

98. The Nuclear Safety Account (NSA) was formed at a G-7 Summit meeting in Munich in July 1992. At the meeting, the G-7, which consists of the United States, Japan, Germany, France, United Kingdom, Italy, and Canada, decided that they must help improve safety at nuclear power plants in Eastern Europe and Russia. *See* Nuclear Safety (visited July 15, 1998) <http://www.ebrd.org/opera/nucsafe/nucsaf.htm>. The EBRD is the administrator of the NSA and its job has been to receive contributions, prepare safety projects, and submit them for approval to the Assembly of Contributors. *See id.* While other funding institutions such as the World Bank have purposely steered clear of nuclear projects, the EBRD was founded in the early 1990s at least partly on the principle that it could improve the nuclear safety heritage of the former Soviet Union. *See* Ann MacLachlan, *Tomlinson Exit Seen as Risk for EBRD's K2/R4 Funding*, NUCLEONICS WK., Aug. 28, 1997, *available in* 1997 WL 8871034.

C. Assessment and Verification of Safety

Article 14 of the Convention states that contracting parties must take appropriate steps to ensure that comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life.[99] Additionally, such assessments must be well-documented and updated, in light of operating experience and significant new safety information, and be subject to review by the regulatory body.[100] It is well documented that Chernobyl-type RBMK (Russian for "reactor, big power, channel-type) reactors and VVER reactors like the ones built at Khmelnytsky and Rivne have design defects and are generally outdated.[101] If Ukraine ratified the Convention, the Ukrainian regulatory body would probably deem the reactors safe according to their own standards because the government wants the reactors built. It is unreasonable to think that Ukraine could commit to the requirement to separate the regulatory body from any other nuclear-industry promoting body such as the Ukrainian government because the nuclear power industry has been an appendage of the government since its creation.[102] Therefore, even if Ukraine ratified the Convention, nothing would change regarding the construction of K2/R4.

With regard to existing nuclear installations, contracting parties must make all "reasonably practicable" improvements to upgrade their safety as a matter of urgency.[103] If such upgrading cannot be achieved, the Convention requires plans to be implemented to shut down the nuclear installation "as soon as practically possible."[104] These provisions seem tough at first inspection, but there could be several interpretations of "reasonably practicable" and "practically possible." Moreover, these provisions are modified by the last sentence in Article 6: "The timing of the shutdown may take into account the whole energy context and possible alternatives as well

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99. *See* New Convention on Nuclear Safety, *supra* note 84, at art. 14, sec. 1.

100. *See id.*

101. The RBMK-type reactors are considered by experts to be the least safe nuclear reactors because they are built without a containment shield. *See* ROBERT E. EBEL, THE CENTER FOR STRATEGIC & INTERNATIONL STUDIES (CSIS) ENERGY AND NATIONAL SECURITY PROGRAM, CHERNOBYL AND ITS AFTERMATH: A CHRONOLOGY OF EVENTS (1994). Had Chernobyl been built with a containment shield, such a tremendous disaster could have been avoided. *See id.* A further problem with the RBMK design is that the containment shield cannot be added on after the whole reactor is built. *See id.* According to the IAEA, safety risks of VVER reactors have to do with design flaws, which are responsible for increased risk of fire due to improper cable layout, faulty steam generators, containment vessels susceptible to rupture, faulty control rods, and poor or obsolete instrumentation and control. *See The Most Compelling Arguments Against Completion of Two Nuclear Reactors at Rivne and Khmelnitsky* (updated Aug. 9, 1998) <http://ecnl.ecn.cz/k2r4/argument.stm>

102. *See* New Convention on Nuclear Safety, *supra* note 84, at art. 8, sec. 2.

103. *Id.* at art. 6.

104. *Id.*

as the social, environmental and economic impact."[105] If Ukraine were to abide by Article 6 of the Convention, it would not feel compelled to shut down Chernobyl. Ukraine would argue, as has already been demonstrated, that it cannot close Chernobyl until new reactors are operating due to significant social and economic ramifications.[106] Thus, the Convention would be highly ineffective in resolving Ukraine's nuclear impasse.

D. Design and Construction

The provisions for design and construction all hinge upon a contracting party's definition of "safe." Article 18 requires contracting parties to take appropriate steps to ensure that the design and construction of nuclear installations provide for several reliable levels and methods of protection against the release of radioactive materials.[107] Furthermore, technologies incorporated in the design and construction of a nuclear installation must be proven safe by experience or qualified by testing and analysis.[108] Although experience and testing have shown that RBMK and VVER reactors are not safe, Ukraine would be able to circumvent Article 18 and continue operating Chernobyl and building K2/R4 because of its definition of "safe."

E. Review Meetings

The heart of the Convention is the requirement for peer review meetings in Article 20.[109] The contracting parties must hold these meetings at least every three years for the purpose of reviewing the reports submitted pursuant to Article 5.[110] Specifics of the review process, such as the form and content of national reports, the structure and procedures of review meetings, and the nature of any recommendations for improvements, were left out of Articles 5 and 20.[111] The Convention drafters probably felt that they had to keep the process flexible to account for vast differences in nuclear activities from country to country. The idea of Article 20 is that peer pressure will cause countries to decide for themselves to adhere to safety standards rather than enforcement measures compelling them to do so. In addition to peer pressure, the Convention requires contracting parties to subject themselves to public

105. *Id.*
106. *See supra* Part II.
107. *See id.* at art. 18, sec. i.
108. *See id.* at art. 18, sec. ii.
109. *See id.* at art. 20.
110. *See id.* at art. 21, sec. 3.
111. *See id.* at arts. 5, 20.

influence.[112] Article 25 requires contracting parties to make available to the public documents addressing issues discussed and conclusions reached during review meetings.[113]

The main shortfall of the Convention is that it is not as forceful and rigid as would be appropriate for such worldwide concerns as nuclear safety and prevention of another Chernobyl-type accident. One suggestion to remedy this shortfall might be to build a consensus on certain implemented safety measures at review meetings and then codify them. Another way might be to establish a base standard, voted on by contracting parties, and then the parties could improve upon this standard at review meetings. This way, contracting parties would still honor countries' sovereignty over their nuclear safety regimes, but they would compromise slightly in order to meet important threshold international norms. As a result, contracting parties that are more advanced in terms of nuclear safety would pressure other parties lagging behind and help them reach the consensus level.

Although the Convention could be criticized for being too vague and not strict enough, it is a good step toward compromising between international nuclear safety norms and traditional state practices in Ukraine and elsewhere to win over as many signatories as possible. Further, although the obligations of the Convention itself would not go far enough to resolve Ukraine's nuclear crisis, it does at least engage contracting parties in discussion and review of safety measures. It also introduces two persuading factors: peer review and public influence. Thus, the Convention creates a forum for assistance and amicable pressure rather than for intimidation and contentiousness. In the future, however, the Convention could be expanded to include more details as consensus is reached in review meetings, and the Convention could give more guidance for an internationally consolidated approach to resolving nuclear crises in countries with struggling economies.

CONCLUSIONS

Eight general conclusions can be drawn from this study.

1) The question of the future of the Chernobyl nuclear power station remains on the table. The plant cannot be shut down in the year 2000 as scheduled. It is possible that reactors 2 and 3 could continue to operate for another decade, should the Ukrainian government deem this to be necessary.

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112. *See id.* at art. 25.
113. *See id.*

2) Chernobyl, the biggest industrial disaster in history, continues to take its toll in Ukraine and Belarus, but neither republic is in a position to devote sufficient funds to deal with its after-effects today.

3) The "Shelter" is a vital concern because the structure is collapsing and no one really knows how serious the consequence of such a collapse could be.

4) The energy question has become vital. Nuclear power accounted for about 13 % of electricity production in Ukraine in 1986; today the figure is 45 %. Also, in Belarus there are plans to build a nuclear power plant, despite the fact that 20 % of the republic remains contaminated as a result of the Chernobyl accident.

5) The governments in the former Soviet republics, especially Ukraine, Russia, and Armenia, are concerned more with output than with safety. This is evident in President Kuchma's constant tirades against it and the replacement of energy leaders in the republic. Electricity is also a monopoly industry—vested interests are involved. The interests of the workers, on the other hand, are neglected, and frequent strikes of employees seek to receive wages that have been unpaid for four to six months.

6) There are suspicions in the West that Ukraine in particular has not modernized its nuclear industry or increased its safety and efficiency since Chernobyl. This situation had led to delays in dispatching promised funds from the West for Chernobyl problems, which, paradoxically, has led Ukraine to rely on the Chernobyl station and nuclear power even more than in the past.

7) From the perspective of environmental security, there is every reason for countries of Europe, especially, to be very concerned about nuclear power plants in Ukraine and Russia, and the dangers that new accidents pose to the entire region. RBMKs still operate not only at Chernobyl, but also at Ignalina in Lithuania, and Sosnovyi Bor, Smolensk, and Kursk in Russia. In the latter three cases, the modifications to a reactor that has been declared inherently unsafe have been even less than at Chernobyl itself.

8) There is, however, some hope that Ukraine can be persuaded to adhere to certain minimum requirements as far as international nuclear safety requirements are concerned. Whatever its failings, the

> Nuclear Safety Convention of 1994 at least got Ukraine to the "drawing board" and may have established the foundation for future discourse, no matter how deep the rift between Ukraine and the West concerning the closure of Chernobyl and the alleged reneging on promised funds from the G-7 countries.

Under these circumstances it is worthwhile to give renewed attention to a solution advanced by a US nuclear specialist five years ago, namely to provide payment for local or international safety inspectors while making good on proposed payments and credits to Ukraine. Ultimately, whether Ukraine replaces the Chernobyl reactors with alternative nuclear ones (K2/R4) or selects a non-nuclear alternative is a secondary matter when compared to the way the industry and the Chernobyl nuclear plant have performed over the thirteen years since that tragic catastrophe in April 1986.