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An Analysis of System Performance and
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EXECUTIVE SUMMARY
SOVIET DECISIONMAKING FOR CHERNOBYL: AN ANALYSIS OF SYSTEM PERFORMANCE AND POLICY CHANGE

by

William C. Potter

This report analyzes the systemic (as opposed to technical) factors which contributed to the April 26, 1986 Chernobyl nuclear accident, assesses the performance of the major organizational actors at Chernobyl, analyzes the impact of the accident on policy change with respect to nuclear safety, and discerns lessons from the performance of Soviet organizations at Chernobyl that may be applicable to other crisis situations. Its major conclusions may be summarized as follows:

* Chernobyl was only the latest and most catastrophic in a long series of sometimes fatal accidents at Soviet nuclear power facilities;
* The Chernobyl accident should not have been totally unanticipated, especially when viewed against the prior record of accidents at Soviet nuclear facilities;
* Gorbachev may have been the patron of one of the few pre-Chernobyl nuclear safety critics during his tenure as Central Committee Secretary in charge of agriculture;
* The immediate response to the nuclear accident by local authorities was of an ad hoc nature and did not reflect preconceived emergency procedures;
* Although professionals trained in emergency procedures, such as firefighters and medics, responded well to the crisis situation, the overall emergency response was impeded by the lack of necessary equipment, medication and trained personnel;
* Effective response was also impeded by the tendency of civilian and military officials to channel information (and responsibility for action) up the organizational chain of command rather than acting directly on information as it became available;
* A preoccupation with avoiding panic delayed the dissemination of news about the radiation danger and postponed unnecessarily the

evacuation of Prypiat, a town near the nuclear power site;

* The Chemical Troops and Soviet Air Force personnel generally displayed great courage and resourcefulness in fulfilling their missions at Chernobyl. Especially noteworthy was their ingenuity in improvising means to overcome old and/or ineffectual equipment;

* Performance of Civil Defense units was unsatisfactory and was hindered by poor training, understaffing, ineffectual equipment, and a convoluted command structure that was unresponsive to rapidly changing crisis developments;

* Soviet military commentators note the poor performance of Civil Defense and are especially critical of the lack of personal initiative displayed by officers who feared responsibility;

* A combination of systemic defects and procedural problems encountered at Chernobyl (including difficulties with production and delivery of supplies, lack of personal intitiative, and lax observance of rules and regulations) are likely to impair Soviet military performance in future crises;

* Little improvement was noted in the performance of Soviet Civil Defense units after Chernobyl at the 1988 Armenian earthquake, leading to a campaign in the military journal Voennye znaniia to revamp the structure of Civil Defense and to separate it from the Armed Forces;

* The Chernobyl accident has led to a major reappraisal of nuclear safety in the Soviet nuclear power program and the proposal of new measures of both a technical and organizational nature;

* There has been considerable slippage between the new safety measures proposed and those actually implemented, the more specific and technical the proposed policy change, the more likely its implementation;

* The most contentious technical issue is the future of the RBMK reactor, whose demise is repeatedly announced but never occurs;

* Resource constraints and conflicting policy objectives serve to impede the implementation of new nuclear safety regulations;

* The Soviet Union is anxious to enter into international cooperation agreements for nuclear safety, but has encountered difficulties in acquiring foreign equipment for training purposes for financial and technology transfer reasons;
* The 1987 trial of former employees of the Chernobyl nuclear power station and the August 1986 Soviet report to the International Atomic Energy Agency served the purpose of safeguarding the future of nuclear power development by isolating the causes of the accident ("human error") and exonerating the system.

One may discern a number of lessons that have been learned by Soviet leaders, nuclear specialists, and the public as a consequence of Chernobyl. They are of both a tactical/instrumental and strategic/philosophical variety. Illustrative of the former is Gorbachev's recognition that he erred in not taking an early public stance after Chernobyl and is reflected in his subsequent behavior after the 1988 Armenian earthquake and the 1989 gas pipeline explosion.

More difficult to categorize are the lessons learned with respect to glasnost and the need for perestroika in the nuclear industry. On the one hand, Gorbachev clearly capitalized on the Chernobyl crisis to gain support for his policies of glasnost and perestroika. A number of organizational changes in the nuclear field, for example, enabled Gorbachev to sweep aside much of the old guard in the nuclear power industry. Whether intentionally or, more likely, inadvertently, Chernobyl also led to the unprecendented release of data on a Soviet disaster and helped to nurture a more fact conscious, socially responsible, and aggressive media. What seems to have occurred in the realm of glasnost is the evolution of an information policy conceived in the wake of Chernobyl to make people think they were receiving the truth (as the government sought to prevent panic) into a broad-guaged, escalating critique of the nuclear power industry, nuclear safety procedures, and the government's commitment to the further development of nuclear energy.

Chernobyl also appears to have had a catalytic effect on Soviet thinking at the popular, expert, and leadership levels on the need to take more concerted action to protect the environment. Although this lesson of Chernobyl is most manifest in the rise of popular opposition to the siting of new nuclear plants and the completion of previously initiated projects, it is also reflected in the proliferation of new ecology movements throughout the country with very broad environmental (and often nationalist) agendas. Critiques of nuclear power and the government's environmental policy may represent a surrogate for more broad-based criticism of the society, especially by the populace of regions affected by Chernobyl who now believe they were misled and betrayed by a government that promised to protect and care for them.

The Soviet Union under the leadership of Mikhail Gorbachev has demonstrated, especially in the foreign policy arena, that it can reconsider basic goals and values when they have led to repeated failures. One might have expected after Chernobyl that a similar learning process would have taken place in the sphere of nuclear safety policy.

Although some attributes of a new philosophy of nuclear safety can be discerned among the Soviet scientific community, and may also account in part for increased anti-nuclear popular sentiment, the Soviet leadership to date has not yet decided to sacrifice the goal of rapid nuclear development for the sake of nuclear safety. It has instead sought to define the two objectives as compatible, as well they may be in theory. In practice, however, severe economic constraints, an irrational pricing and incentive system, and a bewildering organizational structure combine to dilute the safety effort in the Soviet Union.

SOVIET DECISION-MAKING FOR CHERNOBYL: An Analysis of System Performance and Policy Change

by
William Potter*

At 1:23 AM on Saturday, April 26, 1986 an accident occurred at the Chernobyl nuclear power station, approximately sixty miles north of Kiev. During a poorly planned safety test of a turbine generator in the fourth unit of the nuclear power station two explosions took place resulting in the release into the atmosphere of intensely radioactive fission products.[1] According to the report of the governmental commission that inquired into the causes of the disaster, "irresponsibility, negligence, and indiscipline" led not only to the loss of life, but caused "radioactive contamination of about 1000 square kilometers, direct economic losses of approximately two billion rubles, and difficulties with power supply to the national economy."[2] The failure of the Soviet Union to notify the world community promptly of the accident also produced substantial political fallout damaging to Soviet interests abroad, especially in Europe.

The magnitude of the nuclear accident--the most severe one to date internationally--and its direct impact on the nuclear power industry in the Soviet Union and abroad are sufficient reasons to study the Chernobyl disaster. A number of other circumstances, however, combine to make the accident an excellent focal point and

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vehicle for examining a series of broader questions pertaining to Soviet decisionmaking, policy change, and the responsiveness of the political system to a crisis. Among these intriguing circumstances are the lengthy delay in initial Soviet commentary on the accident; the even longer silence on the subject by General Secretary Gorbachev; the 36 hour delay in evacuating people near the accident; the formation of a new national ministry in response to the crisis; a reappraisal of various aspects of the civilian nuclear power program; the unusual candor and thoroughness with which the Soviet Union discussed the accident before an international body (the International Atomic Energy Agency); and the very different fashion in which several Warsaw Pact states responded to the accident. The extraordinary amount of Soviet media coverage of the disaster at the local and regional levels also increases data availability for the study and provides an unusual opportunity to compare local, regional, and national perspectives on government and party performance.

A book length manuscript which more fully analyzes the performance of the major institutional actors involved in the formulation and implementation of Soviet policy in response to the Chernobyl accident will be available within six months. This report presents the major findings from the larger study. More specifically, it: (1) provides an overview of the systemic and structural (as opposed to technical) factors which contributed to the Chernobyl accident; (2) identifies the major organizational (and when relevant, individual) actors at Chernobyl; (3) compares their actual crisis performance with the behavior they were supposed to exhibit; (4) analyzes the impact of the Chernobyl accident on policy change with respect to nuclear safety; and (5) discerns lessons from the performance of Soviet organizations at Chernobyl that may be applicable more broadly.

I. THE SOVIET NUCLEAR LEGACY: AN ACCIDENT WAITING TO HAPPEN

At the time of the Chernobyl accident the Soviet Union was the third largest nuclear power producer in the world, with approximately 28,000 MW_e (megawatts of electricity) of capacity at 41 reactor units.[3] Since Chernobyl and despite the shutdown of additional nuclear reactors, Soviet nuclear power capacity has risen to over 33,000 MW_e.[4] The present size of the Soviet nuclear power program, however, does not adequately convey the significance of nuclear power for the Soviet energy future or the commitment to nuclear power by the Soviet political leadership. This is a commitment that has been a long time forming and has demographic, geopolitical, economic, organizational, and psychological underpinnings.[5] It is worth noting in this context a poem written in 1954 to commemorate the start-up of the first Soviet demonstration power reactor:

Atoms for Peace[6]

Read,
    Drink with your eyes the lines:
The inevitable came true, the newest of
    the miracles of the earth--
The uranium forces
    by electric current
Over Soviet wires started to run!
And somewhere,
    echoing to hearts inspired
In this festive--humdrum hour,
In honor of peace
    new motors began to drone,
And flashed up
    the lamps of Il'ich.
The river of Time
    will carry away into silence
The cannibal's pyre
    on the island Eniwetok,
But our Atom of Peace--
    child of Five-Year Plans,
For people
    will shine for ages,
What was a dream, a fledgling yesterday,
Today is trying out
    its powerful wings.
Glory be to those masters,
Who, out of the fairy tales
    of the days by gone,
Created this reality.

Even in the aftermath of Chernobyl, official Soviet energy forecasts and pronouncements continued to display unbridled enthusiasm for and faith in nuclear power. Valery Legasov, the late deputy director of the I. V. Kurchatov Institute of Atomic Energy, maintained in 1987 that the Soviet energy program goal of raising the capacity of nuclear power stations by 400 to 600 percent by the end of this century would not be revised in light of Chernobyl, although the need to enhance the safety of nuclear plants made it less likely that the higher target would be realized.[7] As late as mid-1989 senior Soviet energy officials held to their optimistic forecasts that Soviet nuclear capacity would surpass 100,000 MW_e by the year 2000.[8] Although the government did finally scale back the current five year plan (1986-1990) to a total of 36,000 MW_e instead of the goal of 44,000 megawatts foreseen when the plan was adopted, it reportedly is aiming for a 30,000 megawatt increase of new nuclear generating capacity in the five year plan for 1991-95.[9] The factors dictating development of the nuclear power industry, Soviet officials argue, have not changed. Most importantly, "they are linked with the geographical distribution of organic fuel sources in the east, while industry is mainly in the west."[10]

Because of its location, the Ukraine has become the major center for expansion of the Soviet nuclear power program in the 1970s and 1980s. Not only is it part of the Soviet industrial heartland, but its western location makes it the logical region from which to link a number of East European states to the Soviet nuclear power grid, thereby reducing East Europe's demands on Soviet oil.[11]

Since the first Ukrainian nuclear power unit began operation in 1977, fourteen additional reactors have come on-line in the Ukraine at the Chernobyl, Khmelnytsky, Rovno, South Ukraine and Zaporizhia stations.[12] At least five more are under construction.[13] At the beginning of 1986 prior to Chernobyl, the total capacity of Ukrainian nuclear plants was 8,880 MW_e, or

approximately 32 percent of the total nuclear capacity in the Soviet Union.

Although this output represents a significant accomplishment, it was still well below government projections, total nuclear power capacity in the Ukraine in 1985 falling ten percent short of the Eleventh Five Year Plan target (1981-1985).[14] The failure to meet the previous five year plan, however, does not appear to have led to a scaling down of plans for the 1986-1990 period. According to the target figures of the Twelfth Five Year Plan, prepared prior to Chernobyl, the Ukraine was to complete construction of nuclear power plants at four sites (Chernobyl, Odessa, Zaporizhzhia, and the Crimea) and to bring on-line new units at Khmelnytsky, Rovno, and South Ukraine.[15] In 1986, alone, Ukrainian nuclear power capacity was to have risen 150 percent.[16]

Not surprisingly, the central position of the Ukraine in the Soviet nuclear power expansion program also meant great pressure on those actors charged with meeting the plan's target. This, in turn, encouraged the resort to high-speed and often shoddy construction practices at nuclear power plant sites and reliance on a workforce whose training was at best suspect.[17] Although these construction practices were not peculiar to the Ukrainian nuclear power program -- and indeed are endemic to the Soviet nuclear power industry -- they were accentuated by the existing skilled labor shortage in the region and by the unreasonable deadlines for plant completion.

The accident at Chernobyl has focused attention on construction problems in the Soviet nuclear industry and their safety implications. It would be a mistake, however, to assume that Soviet officials were unaware of or unconcerned about nuclear safety problems prior to Chernobyl.[18] Indeed, one can find numerous articles in the Soviet press since the 1970s which are scathing in their criticism of the nuclear power industry. Usually the articles bemoan low worker morale, improper training, erratic delivery of building material and equipment, shortages of spare

parts, defective material, and the lack of quality control throughout the manufacturing process. Occasionally one also finds reference to the potential negative impact of the expansion of nuclear power on the environment.[19] What is generally missing in Soviet commentary is explicit discussion of how management and construction problems in the nuclear industry relate to nuclear safety and the general population's welfare. This is especially the case in articles with a domestic as opposed to an international audience. Also rarely discussed prior to Chernobyl is the issue of the safety risks of siting nuclear power plants near large population centers.[20] Although the Soviets were forced to confront this issue after the 1979 nuclear accident at Three Mile Island, their reaction generally was to attribute the problem to the nature of the American economic system (i.e., an emphasis on profits over safety) and to dismiss the possibility of a similar accident in the Soviet Union.[21] As Vladimir Asmolov, chief of the Safety Department at the Kurchatov Institute of Atomic Energy acknowledges, the question of nuclear safety in the Soviet Union was resolved essentially by the logic "the Soviet nuclear industry is safe for the sole reason that... it is safe." Therefore, there was no need to increase investments for nuclear safety.[22]

Asmolov attributes this complacent attitude to the period of "stagnation" in the Soviet Union and "the production relations it engendered," a period in which one could commission a nuclear power station with flaws. These flaws in the nuclear power industry, he emphasizes, are not limited to the "poor quality of equipment and of installation and construction work." They include:

> the failure to carry out timely scientific research to ensure safety, the poor quality of our engineers' training, and penny pinching when it comes to international cooperation.... And finally, it is also the declining quality of these stations as AES's [atomic power stations] became commonplace. In conditions where the economic mechanism only stimulates gross output indicators, "secondary" consideratins may be sacrificed for the sake of improving these

> "important" indicators. And the safety of the operation of these power stations was, alas, regarded as a "secondary" indicator.[23]

To be sure, this public cavalier attitude toward nuclear safety noted by Asmolov and manifest in the Soviet response to Three Mile Island, was dictated in part by domestic and international political concerns. Given their commitment to domestic nuclear power development, Soviet energy planners sought to minimize the impact of Three Mile Island on the Soviet program. The accident also afforded Moscow an opportunity to escalate its campaign for a comprehensive nuclear test ban. Prior to Three Mile Island, however, this public stance was reinforced by the prevailing view in the Soviet nuclear scientific community that the possibility of a severe loss of coolant accident at a Soviet nuclear power plant was not credible.[24] This perspective was well expressed by the Chairman of the State Committee on the Utilization of Atomic Energy, A. M. Petrosyants: "We will build power reactors with secondary containment shells for those customers who want them, but we do not consider them necessary."[25]

Experts remain divided today over the question of whether or not a Western style containment shell would have reduced radiation damage at Chernobyl.[26] There is also disagreement over the extent to which the accident was the result of management and operator errors, reactor design flaws, and the more general Soviet approach to nuclear safety. What is clear is that the Chernobyl nuclear power station was plagued from the outset by construction problems.[27] David Marples' careful survey of the Ukrainian press during the 1970s elicits a number of complaints about the shortage of skilled labor, labor discipline, and the quality of construction at the Chernobyl plant.[28] V.T. Kizima, the plant building department head, acknowledged these problems and described Chernobyl as "the first university of atomic construction at which [the workers] themselves had to discover the solutions to problems."[29] Evidently they did not discover all of them as the

Ukrainian press continued to report on labor and supply problems at Chernobyl. Especially damning and prophetic was an expose in the March 1986 periodical Literaturna Ukraina.[30] The author of the article, Lyubov Kovalevska, a journalist with the small Prypiat paper Tribuna energetika, provided detailed descriptions of equipment and material shortages, low labor morale, equipment defects, unrealistic building deadlines, and a slackening of construction standards. Worse yet, Kovalevska complained, no learning was taking place. "The problems of the first energy block were passed on to the second, from the second to the third, and so on." The failure, she noted, would be repaid, "repaid over decades to come."[31]

Approximately one week before the Chernobyl accident there was one additional prescient report pertaining to nuclear safety conditions in the Ukraine. The author was Boris Paton, the President of the Ukrainian Academy of Sciences. At a general assembly meeting of the Academy, held on April 18, Paton decried the Academy's input into environmental protection in the Ukraine and proposed that "a thorough study of the entire complex of ecological-economic questions" be undertaken, "using the Chernobyl nuclear power plant as an example."[32]

Notwithstanding the prophetic, cautionary notes sounded by Paton, Kovaleska, and Kizima, the nuclear tragedy that unfolded at the Chernobyl nuclear power station on April 26, 1986 has been treated by most Western and Soviet analysts as an isolated and totally unanticipated occurrence.[33] Even those most inclined to blame the accident on structural defects in the economic and political system and to discount the official Soviet explanation of "operator error," generally accept the premise that Chernobyl was the first significant accident at a Soviet nuclear power facility. To the extent that they acknowledge other relevant Soviet nuclear accidents, they usually only cite the 1957 explosion of radioactive waste at a nuclear materials production complex at Kyshtym in the southern Urals.[34] Even as well-informed an analyst

on the Soviet nuclear program as Zhores Medvedev, for example, in his analysis of the road to Chernobyl, confines his discussion of prior Soviet accidents to this 1957 occurrence, although he alludes to "several previous accidents" and recognizes the role their coverup played in the unfolding of the Chernobyl tragedy.[35]

Although still very much shrouded in secrecy, evidence is increasing that Chernobyl was only the latest and most catastrophic in a long series of sometimes fatal accidents at Soviet nuclear power facilities. This nuclear history, unreported in any systematic fashion in the public record and difficult to corroborate, is beginning to appear in bits and pieces in the Soviet press and in private discussions among U.S. and Soviet nuclear scientists. The most significant events are noted in chronological order in Table One, along with relevant sources.

TABLE ONE

A CHRONOLOGY OF REPORTED ACCIDENTS AT SOVIET NUCLEAR REACTORS PRIOR TO 1986

May 7, 1966	"Uncontrolled prompt-neutron reaction at the nuclear power plant with boiling-water reactor in the city of Melekess. Dosimeter operator and shift chief of the nuclear plant irradiated." (Grigorii Medvedev, "Chernobylskaia Tetrad'," Novyi mir (June 1989), p. 10.) Medvedev probably refers to the 50 MW boiling reactor completed in 1965 at the Atomic Reactor Scientific Research Institute in Dmitrovgrad, Ul'yanovsk Oblast. This was not a commercial nuclear power plant, but a pilot facility.
1971-76	Explosion and/or fire variously reported to have occurred at the Shevchenko nuclear power plant on the coast of the Caspian Sea. The plant consists of a RBN-350 fast-neutron (breeder) reactor that became operational in 1973. See "Soviet Breeder Reactor Accident," Nature (March 8, 1974), p. 95; Oberg, p. 239; Ze'ev Wolfson (Boris Komarov), "Some

Environmental and Social Aspects of Nuclear Power Development in the USSR," Research Paper No. 63, The Marjorie Mayrock Center for Soviet and East European Research, Hebrew University (March 1987), p. 23; David Satter, "Moscow Admits Nuclear Accidents," Financial Times (April 24, 1979), p. 2; and Marshall Goldman, "Nuclear Tragedy, Historical Secrecy," The Boston Globe (May 4, 1986), pp. A-17 and A-20. David Katsman reports that the Shevchenko reactor experienced at least two emergency situations, one in 1974-75 due to leaking in natural circulation pipes and one in 1976 due to ruptures in the fuel assembly seals. See Katsman, Soviet Nuclear Power Plants (Falls Church, VA: Delphic Associates, 1986), p. 44.

1964-1979 — Repeated ruptures (burning) of fuel assemblies of the core of Unit 1 at the Beloyarsk AES. Medvedev ("Chernobylskaia Tetrad'," p. 10) reports that operating personnel were overirradiated in repairing the core of the 108 MW light water graphite-moderated reactor, which has since been shut down.

January 7, 1974 — "Explosion of the reinforced-concrete gasholder which served as a holding tank for radioactive gases in Unit 1 at the Leningrad AES." (Medvedev, "Chernobylskaia Tetrad'," p. 10)

February 6, 1974 — Rupture of the intermediate loop of the 1000 MW RBMK reactor at Unit 1 of the Lenigrad AES. Medvedev ("Chernobylskaia Tetrad'," p. 10) reports that three persons were killed and that highly radioactive water was dumped into the environment.

October 1975 — "Partial breakdown of the core ('local flaw in the metal') at Unit 1 of the Leningrad AES." Medvedev ("Chernobylskaia Tetrad'," p. 10) reports that 1.5 million curies of highly radioactive radionuclides were released into the environment.

March 1976 — Accident of unspecified nature, "corrected without any lethal consequences" at the Leningrad AES. (Yuri Shcherbak in roundtable discussion reported in "The Big Lie," Moscow News, No. 42 (1989), p. 8. See also Medvedev, "Chernobylskaia Tetrad'," p. 10.

1977	Meltdown of half of the fuel assemblies of the core of Unit 2 of the 194 MW light water graphite moderated Beloyarsk AES. Medvedev ("Chernobylskaia Tetrad'," p. 10) reports that during repairs, which took about a year, plant personnel were overirradiated.
Dec. 31, 1978	Major fire at Unit 2 of the Beloyarsk AES due to a short circuit in a power cable. According to the first Soviet public report in Sotsialisticheskaya industriya (October 21, 1988), the fire spread to the reactor room and caused the roof to cave in. More than 1200 firemen fought the fire. Oberg (p. 240) reports that several firemen were killed before the fire was brought under control. See also Medvedev, "Chernobylskaia Tetrad'," pp. 10-11 and "1978 Beloyarskii-2 Fire Reported for First Time," Nuclear News (January 1989) and Sagers, p. 341; and Vera Rich, "Fire Threatened Fast Reactor Cooling System Says Unofficial Report," Nature (January 31, 1980), p. 420.
January 1980	Complete loss of electrical power at the Kursk RBMK nuclear power plant. Flow of cooling water dropped to about twenty percent of normal, but little damage reported. See Hamman and Parrot, pp. 102-105, who cite the USSR State Committee on the Utilization of Atomic Energy, The Accident at the Chernobyl Nuclear Power Plant and Its Consequences (Annex 2 (August 1986), pp. 180-181. Hamman and Parrot suggest that the Kursk RBMK accident may have prompted the ill-fated experiment that triggered the Chernobyl accident.
1981	Unspecified accident at the Rovno AES (Wolfson/Komarov, p. 23 and Goldman, p. A-20).
September 1982	"Rupture of the central fuel assembly of Unit 1 of the Chernobyl AES because of operator errors. Emission of radioactivity into the industrial zone and city of Prypiat...." (Medvedev, "Chernobylskaia Tetrad'," p. 11).
October 1982	Generator explosion and turbine room fire at Unit 1 of the Armenian AES. Medvedev ("Chernobylskaia Tetrad'," p. 11) reports that most of the operating personnel fled, leaving the reactor without adequate supervision.

June 27, 1985 — Accident at Unit 1 (1000 MW pressurized water reactor) of the Balakova AES involving the blow up of a safety valve during startup and adjustment operations. Medvedev ("Chernobylskaia Tetrad'," p. 11) reports that fourteen people were killed and attributes the accident to "unusual haste and nervousness following mistakes by inexperienced operating personnel."

Although former Soviet minister of Power and Electrification, P. S. Neporozhny, admitted to a group of visiting U.S. congressmen in 1979 that the Soviet Union had experienced two accidents, as well as a series of fires at undisclosed nuclear stations, prior to the 1986 Chernobyl accident, the Soviet Union did not officially acknowledge the occurrence of any nuclear power-related accidents.[36] In the words of Androvnik Petrosyants, Chairman of the USSR State Committee for the Utilization of Atomic Energy at the time of the Chernobyl disaster, "We have no accidents which would give rise to anxiety among people and set them against the development of nuclear power engineering."[37]

Recent testimony from past and present Soviet nuclear engineers suggests that not only were accidents at nuclear power plants not reported to the Soviet people, they were concealed from personnel at the country's nuclear power plants. Yuri Shcherbak, for example, cites a document written by A. Yadrikhinskii, an engineer responsible for industrial safety at the Kursk Nuclear Power Station, which suggests that information about the 1976 accident at the RBMK reactor in Leningrad was classified because the reactor belonged to the Ministry of Medium Machine Building and was not conveyed to anyone servicing similar reactors at the Chernobyl Nuclear Power Station.[38] Grigorii Medvedev, who worked for many years in the nuclear power industry, believes this attitude toward secrecy was the norm rather than the exception and set the stage for the Chernobyl tragedy.[39] Indeed, one might point to secrecy and the Soviet nuclear power program's aversion to unpleasant news as a major contributory factor in the Chernobyl

accident. As Zhores Medvedev caustically observes,

> Small mishaps were concealed from their superiors by operators and local engineers and often not even recorded in the operational logs. More serious accidents and shutdowns were covered up by the nuclear plant administrators because all their bonuses and rewards depended upon good records. Construction and design faults were covered up by the ministerial and atomic energy bureaucracies, which had vested interests in the good image of the nuclear industry. Really major accidents, like the Kyshtym nuclear disaster in the Urals... were covered up by the government.[40]

When viewed against the backdrop of secrecy and denial that "protected" the Soviet nuclear power program since its inception, the 1986 accident at Chernobyl appears less surprising and even more tragic. Chernobyl was unprecedented in its severity. It was not, however, an isolated event, nor should it have been totally unanticipated.

PART II. ASSESSING SYSTEM PERFORMANCE

It has been reported that as many as half a million people from all over the Soviet Union were mobilized to deal with the consequences of the accident at Chernobyl.[41] This figure includes representatives from such diverse professions as coal mining, fire fighting, dosimetry, hydrometeorology, statistics, engineering, transportation, communications, veterinary medicine, tunnel construction, aviation, economics, computer science, and the military. Indeed, simply to list all of the professions and their corresponding institutional ties -- at the national, Ukrainian republic, and local levels -- not to mention a description of their performance -- would yield a report of unwieldy size.[42] The focus in this section of the report, consequently, is limited to a number of the more important institutional actors at different levels who had to cope with the disaster shortly after its onset.

UKRAINIAN LEADERSHIP PERFORMANCE

Table Two presents a list of some of the significant organizational actors in the Ukraine at the republican level and below who were involved in the aftermath of the Chernobyl accident.

TABLE TWO
UKRAINIAN ORGANIZATIONS INVOLVED IN
AFTERMATH OF THE CHERNOBYL ACCIDENT

1. The Ministry for Internal Affairs (MIA) and its
   (a) Main Directorate for Firefighting and corresponding oblast, city, and raion firefighting brigades;
   (b) State Auto Inspection (SAI) Department and its corresponding lower-level divisions;
   (c) Militia and corresponding oblast, city and raion divisions;
2. Ministry of Health and the corresponding obl-, gor-, and rai-zdravotdely. The latter include medical-sanitary departments, hospitals, and emergency services;
3. Ministry for Power and Electrification and the subordinate organization, -- the Chernobyl Nuclear Power Station (ChNPS);
4. Organizations of the Ukrainian Communist Party at the levels of:
   (a) Kiev oblast committee (obkom);
   (b) Kiev city committee (gorkom);
   (c) Prypiat gorkom;
   (d) Chernobyl raion committee (raikom);
   (e) Borodiansky raikom;
   (f) Polisky raikom;
   (g) Ivankivsky raikom;
   (h) Makarivsky raikom;
   (i) ChNPS party organization;
5. Komsomol organizations:
   (a) Prypiat gorispolkom;

(b) Chernobyl raion executive committee (raiispolkom);
(c) Borodiansky raiispolkom;
(d) Ivankivsky raiispolkom;
(e) Makarivsky raiispolkom;
(f) Polisky raiispolkom;

7. Prypiat civil defense organization.
8. ChNPS Authorities
   (a) Machine shop
   (b) Reactor shop
   (c) Reactor control center
   (d) Central monitoring unit (SKALA)
   (e) Electric shop
   (f) Coolant shop
   (g) Turbogenerator shop

In order to assess the performance of those Ukrainian institutional actors, it is necessary to compare their actual performance with the behavior they were supposed to exhibit. An effort is made to do this with respect to four issues: reporting the accident, fire fighting, provision of medical aid, and evacuation of the local population.

Kto-komu or Who Told Whom

Each Soviet nuclear power station is a complex organization that consists of one or more power units with their own workshops and support services. In April 1986, the Chernobyl Nuclear Power Station had four reactors and, correspondingly, four power units, with two other units under construction. Each of these units, in turn, appears to have been supported by a machine shop, reactor shop, reactor control center, electric shop, coolant shop, turbogenerator shop, and a central computer-based monitoring service. Typically, these shops had different heads for each shift. Each power unit also had its own chief engineer, subordinate to the chief engineer of the power station and the station director.

At the time of the accident, the Chernobyl Nuclear Power Station (ChNPS), like all Soviet nuclear power stations, reported to and was supervised by the all-Union Ministry of Power and Electrification. Additional all-Union bodies with formal supervisory functions concerning plant safety at Chernobyl were the State Committee for the Supervision of the Safe Conduct of Work in the Nuclear Power Industry (under the supervision of the Council of Ministers), the State Nuclear Safety Inspection, and the State Sanitary Inspection (under the supervision of the Minstry of Public Health.[43]

The first to learn that something was wrong with the fourth reactor at the ChNPS were those directly involved in the experiment. The Soviet report to the IAEA reveals that at 1:23 AM the shift manager of the plant gave the command to press the scram button for the emergency release of the control rods into the reactor core. After a few seconds a number of shocks were felt in the control room, and the operator noticed that the control rods had stopped before reaching the bottom ends. He therefore deactivated the rods to let them fall by their own weight. At about 1:24 AM, witnesses who were outside of the fourth unit reported hearing two explosions, one after another; hot fragments and sparks flew up above the unit and started a fire on the roof of the turbogenerator room.[44]

According to the general rules for emergencies, those responsible at any given moment for work and for the safety of the people and property at an administrative, industrial or economic unit should first undertake steps to protect the people and property and second should report immediately to the next higher level of adminstration, which, in turn, should follow the same procedure. Thus, following the explosions, the shift manager should have informed plant personnel on the state of alert. However, he neglected his direct responsibilities and for that was accused during the trial.[45] As a result of this breach of rules, at least 400 people who were present at the ChNPS did not receive

timely warning of the nature of the accident.[46]

Even the operators of the centralized monitoring system ("SKALA") at the 4th reactor which was located at the same building, though on a different floor, only knew that manipulations unforeseen by the experiment had taken place. Then a general blackout followed, and the operators sought to save their own computer system. They had no time to explore the reasons for the blackout and were not informed officially of the accident, which was not clearly revealed to them by their computer monitor nor was directly apparent to them due to the controlled, "greenhouse-like" conditions of the room in which they worked.[47]

Confounding the situation at Unit 4 and leading to unnecessary loss of life was the unwillingness of deputy chief engineer for operations (A. Dyatlov), who was in the control room of Unit 4 at the time of the accident, to believe that the reactor had actually been destroyed.[48] Dyatlov consequently marshalled efforts to save the reactor and propagated the false information to his supervisors, unit engineer N. Fomin and plant director V. Brukhanov, who were only too willing to embrace the mistaken news. The myth of the intact reactor, in turn, was conveyed to Moscow when Brukhanov called Vladimir Maryin, CPSU Central Committee deputy secretary for the nuclear power industry at his home at 3 AM on the 26th.[49]

Dosimetrists at the plant also became aware of the accident at an early stage because their radiation monitoring equipment went berserk (zashkalilo - literally, off-scale). When they sought to notify the plant administration of the accident (it is not clear from various accounts whether the chief engineer or the safety engineer was contacted), the news allegedly was not acted upon immediately because proper reporting procedures specified that a shift manager (not a dosimetrist) was supposed to make accident reports.[50] Dosimetrists also were hampered in their efforts to report on the radiation situation by the unavailability of appropriate radiometers. Those that might have been of use were

locked up in an inaccessible region of the plant, and those at hand either had too limited a range or malfunctioned.[51] As was the case with respect to the destruction of the reactor, Brukhanov also refused to believe the unsettling news about radiation reported to him by the plant's civil defense chief - the one person at the reactor site who had a radiometer with a fairly high scale. According to the testimony of a duty officer from the dosimetry department, Brukhanov's response to the civil defense chief's news that he was getting readings above 250 roentgens at various places in the unit was, "Your instrument is broken.... You figure out your instrument or throw it on the dust heap."[52] Brukhanov thus reported to Moscow that not only was the reactor in Unit 4 intact, but that "the radiation situation [was] within normal limits."[53]

Although it is not clear who first informed the director of the ChNPS, Victor Brukhanov, -- definitely not the shift manager who was supposed to do so -- he soon learned of the accident and was on the scene within about an hour.[54] According to extant procedures for accidents, Brukhanov, or somebody acting on his behalf, was supposed to notify all nuclear power station personnel and order them to report to work immediately. One can infer from numerous Soviet press accounts that the heads of all the departments, shifts, machine shops, electric shops, construction sites, and other plant services were contacted and instructed to inform their subordinates and to report to work immediately.[55] They began to arrive by 4:30-5 AM.[56]

Standard emergency procedures also called for the head of the power station to communicate directly with his ministerial supervisor at the Ministry of Power and Electrification in Moscow[57] and with party officials (the first secretary of the Prypiat gorkom and, most likely, given the importance of the Chernobyl plant for the republic's economy, the first secretaries of the Kiev gorkom and obkom). There is considerable evidence that these procedures of emergency communication were followed. It is apparent from press reports, for example, that most of the relevant party

officials in Prypiat and Kiev were informed soon after the accident.[58] The first secretary of the Prypiat gorkom, A. S. Gamanyuk, arrived at the plant in a couple of hours, even though he had been in the hospital.[59] The Prypiat chairman of the gorispolkom, Voloshko, also was quickly informed and was at the station around 2:30 AM.[60] Even the second secretary of the Kiev obkom of the Ukrainian Communist Party was in Prypiat before 10 AM to hold a meeting with local authorities.[61] We also know that Brukhanov called Maryin in Moscow at 3 AM and that the USSR Deputy Minister for Power and Electrification, Shasharin, was also notified about the same time.[62] The fact that Brukhanov was not charged during his trial for failure to follow standard reporting procedures also suggests that he notified the proper parties.

The firefighting service also was informed almost immediately after the accident. Various sources report the alert signal was received by Firefighting Brigade 2 -- a special unit servicing the ChNPS -- at either 1:27 or 1:28.[63] Because the signal came from the nuclear power station, it had to be treated as the highest degree of alarm and compelled them immediately to alert the firefighting brigades at Prypiat (Brigade 6) and headquarters in Kiev. Brigade 2 arrived at the plant at 1:30 AM, and the Pripyat firefighters arrived five minutes later.[64] At 1:40 AM the Chief of Directorate for Internal Affairs (DIA), V. M. Korniichuk, arrived at DIA headquarters and ordered the implementation of the plan for the highest degree of fire alert.[65] This entailed sending fire engines from the Chernobylsky, Ivankivsky, and Polisky regions to the NPS.

Another body that was notified right after the accident was the Prypiat medical service. The city ambulance of the Pripyat medical-sanitary department (MSD) 126 was at the accident site at 1:30 AM, but only with a doctor's assistant. The assistant requested a doctor's presence at 1:40 AM, and a Dr. Valentin Belokon arrived at the station at 1:50 AM. By 2:30 AM the deputy chief of the MSD 126, Pecherytsa had arrived at the department's

headquarters and transmitted information to the department chief, V. A. Leonenko.[66] The Medical Department of the Ministry of Health also was informed of the accident within the space of several hours although the precise time is uncertain. In any case, by 4:30-5 AM ambulances from the closest raions (Chernobylsky, Polisky, and Ivankivsky) had rushed to the accident scene.[67]

It should be noted that other important organizations which should have been among the first informed were not officially notified before Saturday afternoon. They include the Prypiat civil defense headquarters and the Prypiat gorkom of the Komsomol organizations.[68] Another prominent Prypiat figure, the deputy chairman of the gorispolkom, Yesaulov, who was responsible for transport, means of communication, roads, and medicine also was not informed through official channels although he learned of the accident quite early by chance and decided to inform the chief of the Prypiat civil defense.[69]

The Immediate Response

According to the major all-Union and republic level newspapers, the firefighters who first received the alarm understood the nature of the situation from the outset and acted accordingly. In fact, however, the firefighters do not appear to have known about the radiation danger they would encounter or how to deal with it. This is indicated by their lack of protective clothing and handling equipment, their careless handling of radioactive material as they bravely fought the fire, and the testimony of participant-observers at the scene of the fire.[70] Nevertheless, they managed first to contain the spread of the fire and then to put it out by 5:00 AM[71]

The ChNPS medical service unit that was first engaged in providing assistance to the victims at Chernobyl also did not receive prompt information on the nature of the accident. When it arrived on the scene, therefore, it did not have appropriate medicine or protective clothing. The doctor's assistant who first

arrived at the site, for example, saw an operator who suffered from steam burns and called headquarters asking for a doctor's help and narcotics appropriate for steam burns.[72] It was only after Dr. Belokon saw the accident victims himself (around 2:40 AM) that he concluded that they suffered from radiation sickness. Although he communicated this information to his superior, it was not until 3:30-4 AM when the victims started to arrive at the medical headquarters that the department chief and deputy chief believed his diagnosis.[73] Unfortunately, even then, they could not meet Belokon's request for iodide tablets and respirators because the former were available in only a very limited quantity, and the latter were not there at all.[74]

Despite the initial delay in correctly assessing the situation, the medical services in Prypiat (and later in Kiev and in the Kiev oblast) made the necessary preparations to treat the victims of acute radiation and to examine those in less severe conditions. The doctors organized dosimetric monitoring of people, cattle, food, and drinking water in the region and also disseminated information on nuclear hygiene. In order to fulfill these enormous tasks, 1300 doctors, nurses, doctors' assistants, and last-year medical students were mobilized into 240 emergency brigades.[75]

Shortly after the firefighters and medical personnel at Prypiat realized the radiation danger and transmitted information about it to their superiors, another institution independently learned of the radiation at the ChNPS. While taking measurements, the chief of the Chernobyl meteorological station, Z. J. Kordyk, noted extremely high radiation levels. Although unaware of the accident at that time, in accordance with standard procedures she sent the information immediately to the republic Gidrometsentr.[76] Therefore, by 6-7 AM Kiev city, oblast, and republican leaders had multiple and independent sources of data on radiation levels around the nuclear plant.

In a paper presented at an IAEA workshop in 1980, a Soviet official described the organization for accident management at nuclear power stations.[77] "At the top of the management organization is a 'coordination center' involving both government authorities and plant personnel" and divided into five sections corresponding to the following problem areas:

- constant surveillance of the operating conditions of the power plant
- radiation control
- dosimetric inspection of the territory around the plant and the environmental protection zone
- protection of the population and provisional evacuation, if necessary
- medical aid for the population and plant personnel, including iodine prophylaxis.[78]

Presumably a similar plan was in effect at the ChNPS because during the trial the former director of the plant was charged with not implementing it.[79]

Although the plant director may have had overall responsibility for seeing that the accident management plan was operational, the planning itself should have been closely coordinated with the civil defense system.[80] It is therefore surprising that the person directly resonsible for the evacuation plan, the chief of the Prypiat civil defense department, only learned of the accident by chance. Also odd was his behavior after he learned of the accident. Instead of going directly to the site to assess the situation personally and to see that appropriate measures were taken, he rushed to the gorispolkom to see its deputy chief, Yesaulov, who at that moment did not have any precise information on the accident. Only after the arrival of the chairman of the gorispolkom, Voloshko, who had been at the accident site, did the chief of civil defense learn of the radiation hazard. Moreover, according to Shcherbak's account, he was then uncertain what to do.[81] The decision to start washing the streets, it seems,

was a sensible one but not based on the implementation of any specific contingency plan. It was also impeded by the lack of adequate equipment. The city of 50,000 inhabitants had only four sprinkler trucks.[82]

In the absence of more corroborating information one must be cautious not to overinterpret the evidence. The picture that emerges from the available data, however, suggests that Prypiat simply did not have the necessary equipment, medication, or trained personnel to implement the designated accident management plan. Effective implementation also was impeded by the tendency of Ukrainian authorities to channel information (and responsibility for action) up the organizational chain of command rather than acting directly on information as it became available.[83]

To be sure, those professionals trained in emergency procedures, such as firefighters and medics, responded well, for the most part, to the post accident situation. Indeed, the first parties to respond did so heroically and often intelligently. The response, however, generally appears to have been ad hoc, rather than according to preconceived emergency procedures.

The Evacuation

Another major task which involved most of the institutional actors under examination in this study was the protection and evacuation of people from Prypiat. Soviet sources identify the following measures to be taken after nuclear accidents of the most severe kind:

- limit stay in the open air
- limit consumption of contaminated food
- use iodine as prophylaxis
- provide temporary shelter
- decontaminate skin and clothing.[84]

In the case of Prypiat, a city of 50,000, additional evacuation tasks included prevention of traffic tie-ups, sealing off the area from tourists and curiosity-seekers, provison of means

of transport for the evacuation, clean-up of the contaminated area, and prevention of panic among the populace. Local party, soviet, civil defense, and Komsomol organizations and different divisions of the MIA were supposed to fulfill these tasks.

The first task noted above -- limiting exposure in the open air -- required informing the residents of Prypiat of the accident and the dangers of spending time outdoors. The Kiev party obkom, however, chose not to inform the population of Prypiat on April 26th.[85] At the meeting of Prypiat party and Komsomol leaders and city aktiv, held at 10 AM on the 26th, before the arrival of any Moscow officials, V. G. Malomuzh -- the second secretary of the Kiev obkom and a member of the Central Committee of the Ukrainian Communist Party -- gave orders that everything should be done to ensure the normal life of Prypiat citizens.[86] As a consequence, that Saturday, children went to school and had their regular activities, including outdoor Pioneer meetings and physical training; soccer games were held (one only several blocks from the Chernobyl power station); shops were open and filled with people; and weddings were celebrated.[87] The party/city aktiv, for the most part, it should be pointed out, also were unaware of the level of radiation on Saturday and, while assisting in measures to cope with the accident, spent time outdoors and were exposed unnecessarily to radiation.[88] Neither the chief of the Prypiat medical-sanitary department who knew of the radiation danger, nor the chief of civil defense, who probably did not know, raised the issue of adhering strictly to the five standard safety guidelines previously noted.[89]

It is difficult because of conflicting reports to determine who was most responsible for the decision to delay the evacuation. Yuri Shcherbak clearly places the blame on the Ukrainian leadership.[90] There is some recent testimony, however, that suggests that officials monitoring the accident in Moscow, rather than (or in addition to) local authorities, initially opposed requests for evacuation. Such a request by Brukhanov on the morning of April 26 reportedly was refused with the explanation

that nothing along those lines should be done until Shcherbina arrived, and that panic should be avoided.[91] According to Grigorii Medvedev, one participant in a meeting of the Prypiat CPSU gorkom on the evening of the 26th testifies that MVD Major General Bedrov, who had spent the early morning hours at the nuclear plant, recommended evacuation. He reportedly was admonished by the Minister of Power and Electrification (A. Mayorets) who exclaimed, "Why are you telling me all this about evacuation.... The reactor has to be shut down and everything stopped. The radiation will return to normal."[92] Mayorets is reported to have reiterated his opposition to the evacuation at the same meeting when it was advocated by a representative of the USSR Ministry of Health.[93] Medvedev also cites the testimony of former USSR deputy minister for power and electrification, Gennadyi Shasharin, to the effect that Shcherbina also opposed early evacuation. Shasharin, who was one of the first officials from Moscow to see for himself that the reactor had been destroyed, allegedly approached Shcherbina before an evening meeting on the 26th and urged immediate evacuation, only to receive a rebuff.[94] Nevertheless, sometime around 10 or 11 PM on the night of the 26th, Shcherbina agreed that evacuation was necessary and should be begun on the 27th.[95]

At 12 noon on April 27 evacuation information was first broadcast on the local radio -- two hours before the start of the evacuation.[96] At that time many citizens were outdoors enjoying the good weather or working at their garden plots. During the actual evacuation the militia, who assisted the gorkoms of the party and Komsomol, instructed the evacuees to leave their apartments while the people responsible for the evacuation collected information on their names, age, and other personal data.[97] As a rule, this procedure took about sixty to ninety minutes, during which time many of the evacuees, especially children, wandered outdoors where they received additional exposure to radiation.[98]

The tasks of preventing panic and assuring the free flow of traffic to and from Prypiat fell to several divisions of the Ministry of Internal Affairs. The first task was executed by units of the militia (with the assistance of local party and Komsomol workers), while the second was performed by the State Auto Inspection division. During the night and early morning of April 26-27 local militiamen, by order of the deputy chief of the Ukrainian MIA, Berdov, determined the number of apartment buildings, private houses, and doorways in each building, in order to know how many buses were needed for evacuation. On April 27, 1,100 buses from Kiev moved to Prypiat, and at 2 PM each of them drove up to an assigned building.[99] According to Soviet witnesses, the evacuation was well organized and was accomplished in two to three hours. For the most part there was no panic, probably because people did not know the extent of the danger. There are some reported instances of panic, however, when people tried to leave the city on their own, sometimes going in the direction of the highest levels of radiation.[100] In order to prevent panic the Kiev obkom representative in Prypiat only gave two hours warning of the evacuation and propagated the lie that the evacuees would only be gone for a short period of time and need not take provisions of food or clothes for more than three days.[101]

State Auto Inspection units also organized the smooth flow of traffic to and from Prypiat very professionally. Virtually from the onset of the accident the roads leading to the city were closed to all private vehicles. This was necessary because the area is famous for its recreation places and attracts hundreds of vacationers during the spring and summer months. As was proudly reported later in the Soviet press, there was not a single traffic jam before and during the evacuation thanks to the efforts of the SAI.[102]

The evacuation also required that the evacuees receive temporary shelter. The solution to this problem was provided by the party and local soviet organizations of Polisky, Makarivsky,

Borodiansky, and Ivankivsky raions. When they were informed that it was decided by Kiev oblast authorities to move evacuees to their raions, the local leaders made a radio appeal to their listeners to accommodate the people from Prypiat. In addition, to assure that virtually each house would accommodate some of the evacuees, the party, raion, Komsomol, and village activists organized door to door visits, persuading the owners to accept as many people from Prypiat as possible.[103] Unfortunately, the speed that was achieved in resettling the evacuees was not matched by safety. Since the people from Prypiat were moved to villages and raion centers near Prypiat, they too turned out to be contaminated, and in a couple of days the evacuees had to be resettled in more distant areas.[104]

Decontamination of skin, clothes, cars, tools, and different equipment was organized at an early stage, initially by the medical services which were the first to understand that they were dealing with radiation, then by SAI units on the roads to and from Prypiat. They organized mobile showers and stations to clean people and objects from the contaminated areas. Although generally these efforts appear to have been well handled, there are some reports of insufficient numbers of showers and cleaning stations.[105]

There are contradictory reports with respect to iodide prophylaxis. Soviet delegates at an IAEA meeting have indicated that virtually all peasants in the area enthusiastically took potassium iodide tablets.[106] This would imply that the Soviets had in place a plan for the distribution of adequate quantities of the tablets.[107] Other Soviet sources, however, indicate that there were insufficient quantities of iodide tablets available immediately after the accident.[108]

POLITICAL REPERCUSSIONS

What is perhaps most striking given the magnitude of the Chernobyl disaster and its political fallout abroad, is the relatively minor direct political impact it had domestically. This impact can be seen primarily in the creation of several new

administrative organs in the nuclear energy sector, the removal and/or reprimanding of a number of senior government officials with responsibilities in the energy-nuclear safety sector,[109] the purge of a relatively few low level party members,[110] and the trial and conviction of five former members of the Chernobyl nuclear power station (including its former director) and a former state inspector from the USSR State Committee for Safety in the Atomic Power Industry.[111] The position of the Ukrainian First Party Secretary, Volodymyr Shcherbitsky, however, did not appear to have been substantially affected by the nuclear accident, despite many predictions by Soviet-watchers in the West that he would be made a scapegoat for Chernobyl and notwithstanding the fact that he was criticized sharply for other shortcomings before his removal in September 1989.[112]

To be sure, the final chapter on the political repercussions of Chernobyl may not have been written.[113] The ecology-minded Congress of Peoples' Deputies and the newly constituted Supreme Soviet seem intent upon reappraising the Soviet nuclear energy program and insisting upon greater safety measures.[114] It is nevertheless appropriate to ask why the direct political repercussions to date have been so limited.

It is possible to develop an argument that the senior Ukrainian political leadership should have been held responsible for at least some of the difficulties relating to the post-accident evacuation, medical service, and clean-up. Although the evidence is not clear cut, and counter arguments consistent with other bits of information can be made, Shcherbitsky was vulnerable to the charges of detachment during the crisis, failure to see that the population received timely information about radioactivity in the region, and of negligence in not ordering a more immediate evacuation. These charges, in fact, were leveled against some of Shcherbitsky's subordinates, including the first secretary of the Kiev oblast committee, Hryhorii Revenko and the second secretary of the Kiev obkom, V. H. Malomuzh.[115] What may have afforded

Shcherbitsky some protection was his tolerance of criticism of the construction of nuclear power plants in the Ukraine and his prior record of support for more attention to environmental protection. According to one account that cannot be confirmed but has a number of adherents among Soviet specialists in the U.S. government, Shcherbitsky also may have gained some leverage by independently notifying Moscow as soon as he learned of the accident, only to be told that he should do nothing and that Moscow would take care of things. Regardless of the accuracy of the aforementioned account, several other factors help to explain his continuation in office for over three years after Chernobyl and the reluctance of the Kremlin to search very actively -- especially in high places -- for culprits. They pertain to Shcherbitsky's skills in managing ethnic issues in the Ukraine, his role as an active promoter of nuclear power develoment in the republic, and the more general problem of reassuring the public that nuclear power is safe and that Chernobyl was an isolated occurrence resulting primarily from operator errors.

David Marples probably overstates the case and exaggerates Shcherbitsky's signficance as a symbol by arguing that "Had Shcherbitksy fallen casualty to Chernobyl, not only would the program for nuclear power development have been imperiled, but the public may have perceived his removal as precisely an attack on current energy policy.[116] He is correct, however, in highlighting the importance the Soviet leadership attaches to nuclear power and its concern in the aftermath of Chernobyl that the accident not serve as the catalyst for anti-nuclear sentiment as did the Three Mile Island nuclear accident in the United States. In this respect, both the trial and the Soviet report to the International Atomic Energy Agency served the same purpose of safeguarding the future of nuclear power development by isolating the causes of the accident ("human error") and exonerating the system -- and all of the government and party organizations and individuals -- which made the accident possible, if not likely, to occur.[117]

NATIONAL LEADERSHIP PERFORMANCE

Reference already has been made in the preceding section to certain individual and organizational actors at the national level who were active in the aftermath of Chernobyl. A list of the more significant national institutions that played a part in the Chernobyl crisis is provided in Table Three. The remainder of this section focuses on two of these actors: the CPSU Politburo and the government commission it set up to deal with the Chernobyl accident.[118] An effort also is made to address the individual role played by Mikhail Gorbachev in the crisis and the manner in which the Soviet media was mobilized.

TABLE THREE
NATIONAL ORGANIZATIONS INVOLVED IN THE
AFTERMATH OF THE CHERNOBYL ACCIDENT

1. Politburo
2. Party Control Committee of the Central Committee of CPSU
3. Council of Ministers of the USSR
    (a.) Government Commission
4. Ministry of Defense
    (a.) The General Staff
5. Academy of Sciences
    (a.) Kurchatov Institute of Atomic Energy
6. Ministry of Internal Affairs of the USSR
7. Ministry of Foreign Affairs of the USSR
8. Ministry of Power and Electrification
    (a.) Atomic Power Stations (Glavatomenergo)
    (b.) Construction of Atomic Power Stations (Glavatomenergostroi)
    (c.) Iuzhatomenergostroi
    (d.) Iuzhatomenergotrans
    (e.) Scientific Research Institute "Gidroproekt"

(f.) Iuzhteploenergomontazh

(g.) Slavutichatomenergostroi

9. State Committee for Utilization of Atomic Energy
10. The State Committee for Safety in the Atomic Power Industry (Gosatomenergonadzor)
11. Ministry of Medium Machine Building
12. State Committee for Hydrometeorology and Environmental Control
13. State Planning Committee (Gosplan)
14. All-Union Central Council of Trade Unions (VTsSPS)
15. Academy of Medical Sciences
    (a.) All-Union Scientific Research Institute of Biophysics
16. Ministry of Health
    (a.) Sanitary Epidemiological Main Administration
    (b.) Institute of Radiological Medicine
17. Gossnab
18. Ministry of the Coal Industry
19. USSR Supreme Court
    (a.) Criminal Cases Collegium
20. USSR Procuracy
21. State Committee for Labor and Social Problems
22. State Committee for Cinematography
23. Ministry of the Fish Industry
24. Ministry of Civil Aviation
25. State Agroindustrial Committee
    (a.) Livestock Production and Processing Department
    (b.) Agrochemical service
26. Ministry of Higher and Secondary Specialized Education
27. Industrial Association "Kombinat"

The Politburo

The information first released by Soviet government spokesmen sought to portray the Politburo as the victim of tardy and misleading information from local authorities. Valentin Falin, director of the Novosti News Agency, for example, told the West

German magazine Der Spiegel that Gorbachev did not receive a detailed account of the accident until the government commission headed by Shcherbina made a report on April 28th and that the initial news the Politburo received was incomplete and inaccurate.[119]

The recent account of the accident sequence and the government's response by Grigorii Medvedev lends credence to the interpretation that officials in Moscow -- at least until the evening of the 26th -- may have been operating under the false impression that the accident at Chernobyl did not involve actual destruction of the reactor at Unit 4. During the afternoon and evening of the 26th, however, different teams from Moscow began to arrive in Prypiat and presumably coveyed their own first-hand impressions of the disaster to their respective agencies. These teams included not only civilian specialists representing Soyuzatomenergo, the Kurchatov Institute, Gidroproyekt, NIKIET (the chief designer of the RBMK reactor), the Ministry of Health, the Ministry of Medium Machine Building, Soyuzenergomontazh, CPSU Central Committee sector for nuclear power, and the Ministry of Power and Electrification, but also senior representatives of the Soviet Defense Council, the Ministry of Internal Affairs, and the armed forces.[120] There is no reason to assume that any of these institutions (and certainly not all of them) neglected to channel the information they received from their representatives in the field to the General Secretary.

The receipt of accurate information, while a necessary condition for rational decisionmaking does not assure an appropriate response. In the case of Politburo decisionmaking during the Chernobyl crisis, lack of accurate information from the field was probably of less consequence than the absence of well defined standard operating procedures for coping with a major nuclear accident. By excluding the possibility of an accident of the magnitude and type of Chernobyl, Soviet nuclear power and safety specialists following the "caution to the wind" nuclear

philosophy of the political leadership, effectively deprived the Politburo of any preconceived plan for managing the Chernobyl accident.[121] The absence of plans for a Chernobyl-like disaster also must have increased the psychological shock of the event for members of the Politburo.[122]

Determination of the tasks performed by the Politburo as a body with respect to Chernobyl is complicated by the different hats worn by many of its members. It is difficult to discern, for example, in what capacity Ryzhkov visited the site of the accident -- as representative of a Politburo working group or as Chairman of the Council of Ministers.

As best we can discern, the initial Politburo response to news of the accident at Chernobyl was to form both a government commission to investigate the situation and to create a Chernobyl working group of the Politburo under the direction of Nikolai Ryzhkov.[123] The Politburo at this time also may have instructed other organizations and ministries to set up operational groups to implement the Government Commission's decisions.

Another early issue considered by the Politburo must have concerned how to deal with media coverage of the accident. If indeed Politburo members initially thought the accident did not involve destruction of the reactor and extraordinary radiation conditions, they may have believed that it was possible to contain news of the event as had been done with prior nuclear accidents. This interpretation, if it is correct, may account in part for the delay in Soviet public commentary on the accident. Quite possibly this initial prediction was reinforced by the desire not to contribute to panic conditions among the public -- a situation that may well have been anticipated once the Politburo began to receive reports from Shcherbina and other ministry and military officials in the field on the true magnitude of the disaster. This fear, wishful thinking, and the resort to old ways of doing things, rather than a lack of information, may explain the Soviet news blackout on Chernobyl that extended until 8 PM on April 28th.[124]

It does not, however, account for the much longer public silence on the subject by Mikhail Gorbachev.

According to Roy Medvedev, dissident historian and brother of Zhores, at the Monday, April 28 Politburo meeting which received the Government Commission report, "Gorbachev tried to assert a policy of lucidity and correct information" about Chernobyl. He was backed, Medvedev maintains, only by Vorotnikov and KGB head Chebrikov, the rest of the Politburo pressing for containment of information. "Only when the scale of the disaster and of the West's protest became apparent did Gorbachev succeed in imposing his line and holding the famous press conference [on May 14] at which the Soviet people and the entire world were informed of all the facts available at the time."[125]

Medvedev's account of the Politburo meeting on the 28th cannot, at this time, be independently corroborated. Although there is considerable evidence of high level debate about the scope and pace of the glasnost campaign at the time of Chernobyl, it is unlikely that Gorbachev ever envisaged an event like Chernobyl when he launched the campaign in Spring 1985 or conceived of glasnost as a useful vehicle for disseminating candid informatin about such an occurrence.[126] Gorbachev's first public commentary on the disaster, subsequent Soviet media coverage of the accident, and even the widely praised Soviet report to the International Atomic Energy Agency in August 1986, for example, do not reveal the commitment to a policy of candor alleged by Medvedev. This is apparent from the two occasions in his May 14th speech when Gorbachev characterized the Chernobyl accident as "the first time we have encountered in reality such a sinister force of nuclear energy that has escaped control."[127] As Erik Hoffmann has noted in his analysis of that speech, "survivors of the 1957 Urals disaster and informed Soviet citizens and foreigners knew otherwise."[128] As misleading was Gorbachev's statement in the same speech that "as soon as we received reliable initial information it was made available to the Soviet people and sent through

diplomatic channels to the governments of foreign countries."[129] In fact, there was no government announcement about the accident until a four sentence TASS statement was reported on the evening news at 9 PM on the 28th.[130] The first story to appear in the national press was the same TASS release in the April 29 afternoon edition of Izvestiia. Neither Pravda nor Krasnaia Zvezda made reference to the accident until April 30th, and the first still photo of the accident was not shown until May 1.[131] Although the scope and volume of Soviet media coverage increased substantially after May 4 (when the first film footage of the nuclear plant was shown on the television program Vremia), Gorbachev's involvement in the post-accident response was conspicuously absent in media reports.

Some analysts have sought to explain the low profile in terms of the precedence Gorbachev may have given to managing the results of the accident over explaining it to the public.[132] According to their interpretation, "the rules of glasnost' still had not been systematized" and "at a time of tragedy and confusion, no one had the leisure to referee the competition between the (new) impulse to inform... and the (old) tendency to reassure."[133] There is little evidence, however, that Gorbachev was intimately involved in the management of the crisis.

More persuasive is the argument that Gorbachev waited so long because he wanted to be sure that the situation at Chernobyl would not further deteriorate and that he could report that the accident was under control.[134] This explanation is fairly consistent with the dates Gorbachev's scientific advisors assigned to the most dangerous phase of the accident, although it does not account for the precise timing of Gorbachev's speech.[135]

Regardless of the reasons that motivated Gorbachev to divorce himself from the accident, both he and the Politburo ultimately had to acknowledge the seriousness of the event. Meeting in special session on July 19, 1986 the Politburo discussed the report of the Governmental Commission on the causes of the

accident and on the measures to eliminate its consequences. In an unusual public statement reprinted in Pravda on July 20, 1986, the Politburo announced its findings:

> The accident had been caused by a series of gross breaches of the reactor operations regulations.
>
> Irresponsibility, negligence and indiscipline led to grave consequences. Altogether 28 people died as a result of the accident and the health of many others was impaired.
>
> The dire losses caused by the accident amount to about two billion rubles. There are difficulties with power supply to the national economy.
>
> The chairman of the State Atomic Energy Inspection System, two deputy ministers, and a deputy director of a research and design institute have been dismissed from their posts.
>
> An all-Union Ministry of Atomic Power Engineering has been set up.
>
> Additional measures will be mapped out and implemented to assure safe operation of existing nuclear power plants, to strengthen operational discipline at every level, and to demand more rigorous observance of regulations regarding the operation of reactors and other equipment.[136]

The Politburo and the General Secretary, however, soon learned it was much easier to declare new policy than to implement it, even when the old policy was clearly flawed and extremely dangerous. The disjuncture between policy initiation and implementation in the field of nuclear safety is the subject of a later section of this report.

The Government Commission

Few members of the Government Commission appointed on April 26, 1986 to investigate the Chernobyl accident and to deal with its consequences could have foreseen that it would still be active at the end of 1989.[137] During its first three years of existence the composition of the body and its chairman changed frequently. The

major tasks undertaken by the Commission and its general approach to coping with the consequences of the accident, however, have remained basically those established by the first group of Commission members and its chairman, Boris Yevdokemovich Shcherbina.

The process by which the Government Commission functioned has been described as follows:

> A scientist or a specialist gives some recommendations.... A minister or his deputy, who is a member of the Government Commission, gives orders to the representative of Gossnab [Government Supply Commission]. The latter immediately gives orders to an enterprise where necessary materials or equipment could be produced and in several hours the order is realized.[138]

The Government Commission, in short, set various tasks, defined the means to fulfill them, and then ensured that they were realized within specified deadlines.

On the flight to Prypiat on the 26th, USSR Minister for Power and Electrification, A. Mayorets, defined the main task of the commission as the restoration of the damaged reactor unit as quickly as possible and its reconnection to the country's power system.[139] Mayoret's deputy, G. A. Shasharin, however, proposed a much more specific plan of action for the Commission involving the creation of five working groups to: (1) study the causes of the accident and the present safety of the power station; (2) study the radiation situation around the plant, (3) repair the damage and restore operations, (4) evaluate the need to evacuate the population of Prypiat and nearby farms and villages, and (5) to provide instruments, equipment, and supplies.[140]

The tasks initially proposed by Shasharin were revised once the Commission members arrived at Prypiat and confronted the confusion at the accident site. Priority efforts were directed at obtaining accurate information on the condition of the reactor and on radiation levels in its vicinity. Subsequent tasks set by the

Commission over the course of the first few days for the territory of the plant included sealing the destroyed reactor unit, preservation of Unit 3, clean-up of the power plant, and prevention of contaminated water at the plant from reaching the Prypiat River. The Commission had to see that necessary people, machinery, and materials were provided so that the tasks could be expeditiously fulfilled.[141]

The tasks assigned and coordinated by the Commission dealing with the territory outside of the nuclear station were even more numerous and complex. In addition to the initial task of determining radiation levels in Prypiat and the health risks in Prypiat and surrounding regions, the Commission had to initiate the evacuation of the population without generating panic, to see that medical care was extended to those in need, to provide evacuees with housing, financial and material assistance, to isolate and decontaminate the affected area, and to initiate long-term research on the biological and medical consequences of the accident within the 30 kilometer special zone.[142] Outside the 30 kilometer zone, additional tasks were set for so-called "zones of strict control" and areas less directly affected by radioactive pollution. They involved a range of radiation monitoring, decontamination, medical treatment, and recovery services.[143] In order to oversee the implementation of these diverse tasks, the Commission set up headquarters or special operational groups in each affected city and region.[144]

The scope and complexity of the Government Commission's responsibilities, its changing constitution over time, and the markedly different problems it has faced between the acute crisis days of late April and early May 1986 and the subsequent three years, make it difficult to render a simple judgment about its performance. On the one hand, the Commission was successful in quickly making sense out of a very confused and dangerous situation. Although a number of individual decisions, especially the delay in ordering evacuation of Prypiat may be severely

faulted, the Commission's organizational efforts, especially during the first two weeks of the post-accident period, were impressive. An enormous quantity of people, scientific expertise, machines, and material were marshalled at short notice, and a great deal of work was accomplished in a short period of time. The overall success of the Commission in directing efforts to seal the reactor, clear the site of radioactive debris, and protect the water supply of the region is especially notable given the equipment and material constraints under which the accident response team had to perform.[145] The Commission also displayed a commendable ability to improvise on the spot and was not reluctant to recommend largely untried scientific approaches.[146]

The Commission's performance is seen in a less favorable light the further removed in time it became from the crisis phase of the accident response. Obsessive secrecy, coverups, arbitrary and ill-informed behavior, failure to halt counterproductive techniques, and disregard for the longer term consequences of the actions it undertook (or failed to undertake) are among the charges directed with increasing frequency and bitterness at the Government Commission.[147]

The Commission, for example, has been criticized for unnecessarily exposing workers to high levels of radiation in its haste to fulfill certain tasks.[148] It has also been accused of concealing data on health and social conditions in affected areas, on pursuing poorly defined policies to attain elusive goals, and of making recommendations with an eye to preserving the institutional reputations of involved parties.[149] Particularly critical charges have been raised during the past year about postponement of the resettling of 100,000 Belorussians. The situation in some regions of Belorussia and the Ukraine has become so explosive that republican and national leaders reportedly are afraid to appear there and the prospect has even been raised of "Karabakh in Narodichy."[150]

Members of the Government Commission may argue that it is unfair for them to be held responsible for every shortcoming of the enormous set of efforts to liquidate the consequences of the Chernobyl accident. The Commission, however, was granted extraordinary responsibilities and powers and now must bear the brunt of the blame.

SOVIET MILITARY PERFORMANCE[151]

Troops of the Soviet armed forces traditionally have performed internal missions in peacetime ranging from erecting apartment buildings to fighting fires and providing emergency rescue relief.[152] The mobilization of thousands of active duty troops and reservists following the accident at Chernobyl, however, was an unusual occurrence in terms of the number of different military units involved and the scope and duration of their intervention.

It is still impossible to identify with precision the number of Soviet military forces engaged in the Chernobyl cleanup.[153] That number, moreover, continues to grow as new troops are rotated into the ongoing cleanup operation. What is apparent is that the post-accident military effort has involved at least three services of the armed forces--Ground, Air, and Navy--as well as Engineer, Chemical, Road Construction, Automotive, and Railroad and Communications "special troops," support troops from the Rear Services (the Tyl), Civil Defense, and Construction and Billeting, and internal troops of the Ministry of Interior (See Table Four).

TABLE FOUR

A PARTIAL LIST OF MILITARY ORGANIZATIONS

INVOLVED IN POST-CHERNOBYL OPERATIONS

I. Ministry of Defense of the USSR and its General Staff

A. Air Forces
   1. Air Forces of Red Banner Kiev Military District (KVO)
      a. Headquarters of the air forces of the KVO
      b. Guards regiment of Serebriakov
   2. Composite air battalion
   3. Air engineering services
   4. Training platoon of aviation subunit of air mechanics

B. Ground Forces
   1. Ground forces of Moscow Military District
   2. Ground forces of KVO
      a. Military Council of the KVO
      b. Political Directorate of the KVO
      c. Tank repairing plant of the KVO
      d. Ground forces of other military districts

C. Special Troops
   1. Chemical Troops of the USSR
      a. Chemical Troops of the KVO
      b. Chemical Troops of other military districts
      c. Operational group of Chemical Troops (formed by Pikalov on April 26)
      d. Mobile unit of Chemical Troops
      e. Military Academy for Chemical Protection named after Marshall S. K. Timoshenko
      f. Graduates of Saratov High Military College for Chemical Protection
      g. Tombov High Military Commanders' College for Chemical Protection
   2. Engineering Troops of the USSR
      a. Sappers
      b. Construction Units
      c. Engineering Troops of the KVO
   3. Civil Defense of the USSR
      a. Headquarters of the Civil Defense (GO) of the USSR

b. Headquarters of the GO of the Ukrainian SSR
c. Headquarters of the GO of the KVO
d. Headquarters of the GO of the Chernobyl NPS
e. Operational Group of the GO of the Ukrainian SSR
f. Political department of Operational Group of GO of the Ukrainian SSR
g. Mobile Unit of GO of the Ukrainian SSR
h. Military Units of the Civil Defense of the Ukrainian SSR
i. Military units of the Civil Defense of the Ukrainian SSR
j. GO chemical units
k. GO dosimetric units
l. GO firefighting units
m. Civilian units of the Civil Defense of the Ukrainian SSR

4. Troops of Communication
   a. Troops of Communication of the KVO
5. Rear Services (Tyl) of the USSR
   a. Rear Services of the KVO
   b. Clothes services
   c. Vol'sk High Military College for Rear Services
   d. Bath and Laundry Services
6. Automobile Services
7. Military Auto-Inspection
8. Railroad Services
9. Pipeline services
10. Military Medical Services
    a. Kiev District Military Hospital
    b. Medical-sanitary battalions
11. Construction and Billeting Services

II. Military Organs Established Specifically to Cope with the Accident

A. Central headquarters for liquidation of the Chernobyl accident's consequences (in Chernobyl)
   1. Operational group of the special zone
   2. Headquarters to coordinate all activities at the NPS and to provide constant information to the government of the USSR and to the headquarters in Chernobyl (in the administrative building of the NPS)

An analysis of the activities of each of these parties is provided in our larger study. The focus in this report is limited to the performance of four major military actors: the Chemical Troops, the Air Force, the Engineer Troops, and the Civil Defense Units. A comparison is also made of the crisis performance of the Soviet military at Chernobyl and during the subsequent Armenian earthquake.

The Command Structure at Chernobyl

The nature of most Soviet commentary on military activity at Chernobyl makes it easier to discern the kind of work that was done (e.g., decontamination, tunnelling, dam construction) than the precise military units involved. The fact that large units of Soviet military personnel, including engineering, chemical, and construction troops, are not assigned to any single service compounds this identification task as does the close interaction that occurred at Chernobyl among different military units and civilian workers in the performance of numerous cleanup tasks.

The high level, civilian Government Commission initially headed by Boris Shcherbina, Deputy Chairman of the USSR Council of Ministers, had primary responsibility for organizing the post-accident government response. Commission members began to arrive in Chernobyl around 4 PM on April 26 approximately three hours after the arrival of the first team of nuclear specialists from Moscow.[154] Because no clear plan was in effect prior to the Commission's arrival, it had to devise a course of action on the

spot.[155] This involved, among other things, Shcherbina's immediately calling in helicopter units to complement the Chemical Troops that had already been summoned by Chief of the General Staff, Sergei Akhromeyev.[156]

It appears that operational groups for Chernobyl were set up in Moscow within the Politburo, the General Staff, and the Chemical Troops.[157] It is also clear from the memoirs of Academician Valeri Legasov and the comments of Deputy Chief of the Chemical Troops, Lieutenant-General A. Kuntsevich that the Government Commission on the scene was in constant consultation with Moscow, including specialists at the Kurchatov Atomic Energy Institute and the Ministry of Power and Electrification.[158] The commanders of the military units at Chernobyl also communicated with Chief of the General Staff Akhromeyev, at times even on relatively minor issues.[159] A central command post for coordinating the activities of personnel from the various ministries and military services, however, does not appear to have gone into operation until May 7. It reportedly was organized by Ivan Silaev, Deputy Chairman of the USSR Council of Ministers (who replaced Boris Shcherbina as head of the Government Commission on May 3) and was under the charge of Colonel V. Dolgopolov, Deputy Chief of Administration of the USSR Civil Defense.[160] Sometime in May, General Valentin Varennikov, a member of the General Staff and the Chief of the Ministry of Defense Operational Group in Afghanistan, was sent to Chernobyl to coordinate military operations there.[161]

The Chemical Troops

Chemical Troops belong to the category of "special troops" and are directly subordinate to the minister of defense. They are assigned throughout the five services of the Soviet Armed Forces and are charged with providing defense against chemical, nuclear, and bacteriological weapons.[162] Their specific tasks include radiation and chemical reconnaissance, dosimetric control,

degasification and disinfection of areas exposed to chemical, nuclear, or bacteriological contamination.[163]

Units of Soviet Chemical Troops arrived at the site of the Chernobyl NPS on the day of the accident. Although discrepancies in Soviet accounts make it difficult to reconstruct the precise sequence of events, it appears that units of the Chemical Troops, as well as other military units of the Kiev Military District received an alert as early as 3:12 AM on April 26.[164] At that time, however, Colonel General V. K. Pikalov, Chief of the Chemical Troops, was in the Carpathian Military District where he had been observing military exercises. On the morning of the 26th he received a telephone call from Chief of the General Staff, Marshall S. Akhromeev, who ordered him to proceed immediately to Chernobyl. By the time he arrived at Prypiat at 2PM, several units of the Chemical Troops had already been there for a few hours and had begun their operations.[165]

The tasks performed by the Chemical Troops at Chernobyl may be divided into two general categories: reconnaissance and cleanup. The reconnaissance mission included determination of the precise location of the explosion, identification of radioactivity levels at the NPS, and detection of the safest routes to the 4th unit of the power station. Subsequently, the reconnaissance mission evolved into the constant monitoring of radiation levels in a 30 kilometer zone around the NPS and in the towns and villages affected by the radioactive plume. Specific tasks involved the collection of samples of water, soil, grass, leaves, and diverse plants for analysis; drafting of maps indicating levels of radioactivity within and outside the 30 kilometer danger zone; charting of "safe routes" for troops, scientists, and other personnel in the region; and preparation of schedules showing the amount of time one could work safely in different locales.[166]

The Chemical Troops also performed a variety of tasks associated with the massive clean-up operation. Their specific duties included decontamination of the nuclear power station and

surrounding roads and buildings, clearing of topsoil (up to 10 centimeters); disinfecting combat equipment, uniforms and vehicles; protection of food and water supplies; and prevention of the spread of contaminated material. The latter task was performed at "special treatment stations" (punkty spetsialnoi obrabotki) where all people leaving the zone were checked and if necessary decontaminated along with their possessions.

The volume of work undertaken by the Chemical Troops was staggering.[167] The conditions under which they worked also were extremely hazardous. Especially challenging was the task of cleaning the roof of the 3rd Unit of the Chernobyl NPS, which had been contaminated by highly radioactive graphite and other material and equipment from the explosions in the adjacent 4th Unit. Because of the great dangers posed in this operation, only volunteers were used. Soldiers were allowed to work on some portions of the roof for no more than 30-40 seconds and were required to wear protective suits of lead weighing over 45 pounds.[168]

The Chemical Troops who participated in this operation, as well as those involved in more routine but also dangerous cleanup and monitoring tasks, generally displayed great courage and resourcefulness in fulfilling their missions. Indeed their innovations, including a method for rapid radioactive analysis, were highly praised by the Government Commission, although not at the outset.[169] In recognition of their exemplary execution of assignments, the Chemical Troops were awarded the Pennant of the USSR Ministry of Defense. Their commander, Colonel General Pikalov also was praised for his exploits and was awarded the Order of Lenin with the Gold Star of the Hero of the Soviet Union.[170]

An assessment of the performance of the Chemical Troops at Chernobyl however, must also include a number of less praiseworthy elements. They pertain to faulty equipment, inadequate training, and questionable policy decisions on the part of General Pikalov.

The bulk of Soviet press accounts suggest that the Chemical Units of Chernobyl possessed state-of-the art equipment for operating in a radioactive zone. Much of the credit for the advanced state of the Chemical Troops was given to Colonel-General Pikalov who, at the time of the accident, had been in charge of the chemical forces for sixteen years.[171]

This positive portrayal, however, is at odds with a number of accounts by eyewitnesses, television and film documentaries, some newspaper photographs, and a few newspaper articles.[172] What emerges from these reports is a picture of often ill-prepared troops operating with old and ineffectual equipment. Perhaps most telling in this respect is Colonel General Pikalov's own initial reconnaissance sortie on the night of April 27 conducted in an ordinary passenger car equipped with a dosimeter.[173] Similarly, the units of the Kiev Military District that arrived on the scene in the early morning of April 26 were initially without armored carriers and lacked protective clothes.[174] As a consequence they were exposed unnecessarily to high doses of radiation.

The prescribed means of decontamination also proved to be ineffective in many instances. The standard decontamination compound, SF-2, for example, did not work well and a new method of decontamination using a polymer spray had to be utilized. The film produced by this spray, however, quickly clogged the lines of the "special machines" for the new type of decontaminant and much of the work had to be done manually.[175]

The Chemical Troops also encountered difficulties with their robotic machinery. On the one hand, high levels of radiation rendered the robotic equipment inoperable. Robot bulldozers, for example, often stood idle and servicemen were compelled to perform their tasks. Human activity also was dictated, however, by the primitive state of the robots that were available and their slowness. A simple task that took one and a half minutes of human work required nearly an hour for a robot to complete.[176]

Dosimetric equipment available to the Chemical Troops also was mostly old and primitive. It was produced in the 1960s and did not have the capability to detect powerful doses of gamma emission or beta rays.[177]

Soviet equipment shortages were not limited to high technology and extended to the most simple means of conveyance, including even wheelbarrows.[178] Chemical Troops responsible for washing buildings and other structures in the contaminated zone, for example, sometimes had to use horses attached to "auto pouring stations" (ARS)--machines for dispensing water and other chemical cleaning agents.[179]

A number of the problems encountered by the Chemical Troops at Chernobyl cannot be attributed primarily to poor equipment. The first units to arrive in Prypiat, for example, did not begin to conduct radioactive reconnaissance until after they were already exposed to high radiation doses.[180]

In order to determine the level of radiation on the ground, reconnaissance units of the Chemical Troops used armored personnel carriers (BTRs) and armored reconnaissance and patrol vehicles (BRDMs) equipped with special instruments to survey the radiation situation and to collect air and soil samples. Often, however, the measurements were taken with portable hand-held radiometers, with the operators leaving the armored vehicles. As one Soviet commentator notes, little attention was paid to the risks to the personnel or to the contamination of the instruments themselves.[181] Moreover, although the exterior of the armored vehicles were cleaned when they returned from the patrol, nothing was done to decontaminate the interior of the vehicle.[182]

The need for conducting radiation monitoring on a massive scale also exposed the lack of sufficient numbers of trained personnel. This shortcoming was reflected in the efforts to train and retrain many of the servicemen and also in the number of errors that were made in the preparation of maps of the contaminated zone.[183]

A sense of false security and the failure to observe safety rules is another problem that confronted soldiers of the Chemical Troops. According to one account that cites the experience of troops at Chernobyl as an important case study of troop performance in a nuclear war environment, "the reaction of soldiers to real radioactive contamination is reflected in a certain psychological excitement." The invisible danger, it is noted initially produces "tension and alarm," but over time the soldiers become accustomed "to the ever-present danger" and may fail to observe safety precautions.[184]

Lax safety precautions, faulty radiation measurements, and/or poor judgment on the part of the leadership of the Chemical Troops also is reflected in the selection of the initial locale for the evacuees of Prypiat. Only two days after the evacuees arrived in their new domiciles they and their hosts had to be reevacuated because of the determination of dangerously high radiation levels.[185] A much more tardy and hazardous reconsideration involved the decision in 1987 to level the railroad station at Janov, a site 1.5 kilometers from the NPS. That decision was made because of the determination of dangerously high radiation levels. Janov, however, had long served as the principal point of delivery for supplies to the danger zone and had been populated by soldiers working round the clock.[186]

Some of the training-related problems among the Chemical Troops can be attributed to the number of reservists (referred to as partizany by the draftees) who were mobilized after Chernobyl. Many of them had not been retrained in decontamination techniques for years and not surprisingly, were ill-prepared for the tasks they had to face at Chernobyl.

The relatively low standing of the Chemical Troops in the status hierarchy of the Soviet Armed Forces also may have impaired their general preparedness. According to one critical account by a former soldier of the Chemical Troops, they were at the "backyard" (na zadvorkakh) of the Soviet Armed Forces and were

denied adequate training and equipment.[187] These deficiencies were reflected in the lack of rudimentary knowledge of radiological hygiene on the part of many soldiers in the Chemical Troops. The soldiers who worked at the "special treatment stations," for example, reportedly ate and drank at the same spot where they chemically treated contaminated vehicles.[188]

A number of decisions made by Colonel General Pikalov also raise questions as to his appreciation of the dangers posed by radiation. Although one may perhaps attribute his initial reconnaissance sortie without protective gear to selfless if rash behavior, it is more difficult to excuse his opposition to early evacuation of the residents of Prypiat. This stance, which was at odds with that of a number of other key policymakers, was taken despite his apparent awareness of rising radiation levels in the city.[189]

The Air Force

The decision to deploy the Air Force appears to have been made on the afternoon of April 26 by the special Government Commission.[190] This body regarded the use of helicopters as the only means to approach and seal the still burning 4th Unit of the Chernobyl NPS.

Although the precise channels by which the order from the Commission's chairman, Shcherbina, reached the Kiev Military District remain unclear, it is known that Lieutenant General N. P. Kryukov and Major General N. T. Antoshkin -- the district's Air Force Commander and Chief of Air Staff, respectively -- were told to report to Military District Headquarters on the evening of the 26th. Antoshkin received orders to proceed to Prypiat and to organize the efforts of the helicopter and supporting units.[191]

General Antoshkin left for Prypiat by car on the night of the 26th, along with Lieutenant Colonel Anotolii Kushnin, the chief of the district's Chemical Troops.[192] Upon their arrival in Prypiat in the early morning of the 27th, Antoshkin reported to

Shcherbina who told him that "All hopes are riding on you, on your helicopters. [The destroyed reactor] has to be completely sealed with sand."[193]

Despite Shcherbina's strong desire to start the helicopter sand drop immediately, the first "bombing" mission did not begin until the late afternoon of the 27th -- about forty hours after the accident.[194] This significant time lag -- all the more notable because several helicopter units were stationed nearby in Kiev--was the result of a combination of factors including the delay in obtaining reliable information on the conditions at the NPS, the lack of helicopters with adequate lighting equipment, and the absence of contingency plans for the kind of air operations demanded of General Antoshkin's forces.[195]

The most urgent task General Antoshkin was ordered to perform was to seal the crippled reactor with sand.[196] Before the operation could begin, however, it was necessary to find an appropriate basing position for the helicopters, to organize the supply of sand bags, to determine the routes for the helicopters to the 4th Unit, and to calculate the optimal speed and height for the sand drop so as to minimize the exposure to radiation. It took the first helicopter crews and General Antoshkin all morning to find answers to these questions of logistics.

When, in the late afternoon of the 27th, the sand drop operation began, the helicopter crews concentrated on target acquisition. Lacking prior training for this specific mission, they initially flew cautiously and had to revise continuously the air speed and altitude for the air drop.[197] As a consequence, relatively few sorties (93) were flown and a small payload of sand (60 tons) was delivered on the first day.[198]

The Air Force troops, however, displayed great ingenuity in improvising means to increase their production. Instead of manually pushing one 100 kilogram sandbag out of the helicopter door--the typical payload per sortie of the first day--the airmen found they could double the payload by placing sandbags in crates

and suspending a number of bags tied together on a rope attached beneath the helicopters.[199] This quantity, however, was still not sufficient so a new plan was devised that employed drag parachutes to carry the loads slung under the helicopters. A special device for attaching the parachutes was quickly manufactured and by April 29th the payload delivered had increased four-fold.[200] Experience gained from The Great Patriotic War (World War II) was also put to use with the implementation of the so-called "Polbin's Carousel," in which helicopters closely followed one another over the reactor.[201] Significantly, these innovations did not come from scientists, but from General Antoshkin and the pilots themselves. They enabled the airmen to increase the tonnage dropped from 60 tons on April 27 to 900 tons on May 1. By May 8, 5000 tons of sand, lead, boron, and dolomite had been deposited. The daily airdrop was subsequently reduced, although the mission continued until mid-May.[202]

Major General Antoshkin was awarded the Hero of the Soviet Union with the Gold Star for his innovative efforts. The pilots under his command, many of whom had gained combat experience in Afghanistan,[203] also displayed unusual improvisational skills as well as great courage. Because of the power lines, poles, and other tall obstructions around the reactor, considerable skill was needed simply to reach the target. The "air slalom" course was also complicated by the extremely high temperatures at the 200 meter altitude above the reactor from which sandbags were released. This extreme heat created conditions affecting the aerodynamic properties of the helicopters and made it difficult for pilots to control the machines.[204] The pilots also faced the invisible danger of exposure to high doses of radiation, a hazard that led to Antoshkin's hospitalization on May 2.[205] These demanding tasks were often performed by men who had little time to sleep and who labored from dawn until late at night.[206]

One of the most impressive accomplishments of the Air Force was its ability to integrate rapidly and efficiently subunits as

they arrived from different locations. By incorporating troops that had served together in Afghanistan, the Air Force leadership was able to facilitate coordination between the subunits. The veterans of the Afghan conflict also proved to be especially adept at flying under difficult conditions.

The Chernobyl experience revealed many positive features of the Soviet Air Force. A number of deficiencies, however, also were exposed. Reference already has been made to the delay in getting suitable helicopters to Prypiat. Not only were the first helicopters on the scene deficient in powerful spotlights, but they were too big and clumsy to work within the confines of the power plant.[207]

The Air Force contingent at Chernobyl also appeared to lack radio-controlled aircraft equipped with radiation-measuring instruments.[208] As a consequence, a considerable number of pilots and airmen had to devote time to reconnaissance and the collection of measurements. Helicopter crews also had to divert their energies initially from bombing the reactor to loading the aircraft. This was the result of problems associated with the "tail" of the sandbag operation, involving Air Force coordination with local authorities. According to Legasov's account:

> They [the airmen] had a particularly hard time during the first few days. The order was issued to fill sandbags. For some reason the local authorities were unable to organize immediately a sufficient number of people to prepare the bags and to prepare the sand.[209]

The conduct of the Air Force sandbag operation, while a success in smothering the reactor, was achieved at high costs in terms of exposing airmen to radiation. Neither the helicopters nor their crews, for example, initially had any shielding from radiation.[210] One may also argue that the initial helicopter landing pad, while convenient from the standpoint of quick helicopter "turn-around time," was too close to the reactor in terms of irradiation.

The superior flying skills of pilots with military experience in Afghanistan has already been noted. These same veterans, however, at times suffered from a lack of discipline. This problem was manifest in their failure to monitor closely and to report their accumlation of radiation dosages. Some of the most talented pilots, therefore, received higher than permissible radiation exposure and were permanently removed from the flight operation.[211] A disregard for safety procedures also may have led to several accidents involving the likely loss of life.[212]

The Engineer Troops

Engineer Troops, like Chemical Troops, belong to the category of "special troops" and are directly subordinate to the minister of defense.[213] They provide engineering support "for combat operations of all the services and service branches."[214] Their tasks in combat include pontoon and bridge construction, clearing of obstacles, camouflage, assault crossing, and preparing defenses against nuclear attack.[215]

Published Soviet reports do not reveal how and when Marshal S. Aganov, Chief of the Engineer Troops, learned of the accident or when the Engineers arrived on the scene. The most detailed Western account suggests that they did not arrive until three or four days after the explosion, although units from the Kiev Military District may have been brought in earlier.[216] In any case, their first major task was to clear a corridor through the radioactive debris to Reactor Number 4. This work was necessary in order for bulldozers to get close enough to the reactor to assist the entombing process. The Engineers accomplished this path-clearing task by means of controlled explosions and the use of the Engineer Obstacle-Clearing Vehicle (IMR).[217]

Operation of the IMR revealed some of the typical problems encountered by the Engineer Troops (and other military units) at Chernobyl, as well as their ability to respond creatively to unforeseen difficulties. One early problem was the inability of

the four-fingered mechanical "hand" of the IMR to pick up smaller pieces of debris. The ad hoc but effective solution that was devised involved weaving a metal web around the vehicle's hand.[218]

Once they succeeded in opening a path to the reactor, the Engineer Troops, in collaboration with civilian workers, sought to clear the area beside the reactor of radioactive rubble. This work reportedly took three weeks and entailed the use of remote-controlled bulldozers. The first of these, weighing 19 tons, was flown in from a tractor plant some 3,000 kilometers away in an IL-76.[219] According to several Soviet reports, the high levels of radiation in the vicinity of the reactor, however, incapacitated some of the robot equipment. The result was that despite the radiation risks, servicemen had to "take over when the machines failed."[220]

By May 2 sappers from the Engineer Troops and their civilian counterparts had received instructions from the Government Commission to construct a series of levees along the Prypiat River and the small streams and canals running into it in order to prevent rainwater runoff from the contaminated area from reaching the river.[221] This was a critical task since the Prypiat River flows into the Kiev Reservoir and could contaminate the water supply of the Ukrainian capital. It was also perceived to be an urgent one because of forecasts that there would be heavy rain during the first week of May. The forecasts turned out to be wrong, but an imposing number of levees and embankments were completed in a ten-day period instead of the month or more usually required for such work.[222] By the time the rains actually came in May, 7.5 kilometers of earth dams and mud ramparts wrapped in polythene sheeting had been built along the Prypiat River.[223] When the water protection work was finally completed in the fall of 1986, 140 dikes totaling more than 40 kilometers in length had been constructed, including one unique two kilometer long dike built at a depth of 32 meters.[224] In addition, more than 400,000 cubic meters of earth and sand were dredged from the riverbed and nearly

250,000 cubic meters of gravel were laid underwater to create traps and filtering dams.[225]

A third major set of tasks performed by the Engineer Troops, working closely with power station and construction workers and miners, was the blasting of holes for the purpose of emplacing pipes to drain water from beneath the damaged reactor and to pump liquid concrete to reinforce its foundation. These measures were necessary to prevent the reactor and volatile core--now weighted down by over 5,000 tons of sand, marble chippings, dolomite, lead, and boron--from sinking through its disintegrating concrete base and making contact with water from the damaged cooling systems.[226]

According to Colonel General Ivanov, Deputy Chief of USSR Civil Defense, work on pumping out the water from beneath the reactor was basically completed on May 8. The Engineer Troops then began to bore under the reactor.[227] This entailed the use of directional explosives to penetrate three walls of ventilation shafts for the purpose of laying pipe through which liquid concrete could be pumped. The complex and delicate nature of the task and the channels of command and control in the cleanup operation are indicated by the disagreement that arose between Marshal Aganov, the Chief of the Engineer Troops, and Colonel Dolgapolov at the Forward Command Post over the use of explosives.

The explosions were to take place at 2 PM on May 9. In preparation for the mission, sappers under the command of Lieutenant Colonel Galyas practiced blowing holes in concrete walls identical to those under the reactor.[228] The Command Post, however, had not been informed of the planned explosions, and when Dolgapolov learned of the plan he requested a delay in order to implement safety measures. Marshal Aganov, however, rejected this request, and it required the intervention of the Government Commission to delay the detonation.[229] The explosions were finally undertaken after personnel and equipment in the area of the reactor were moved to a safe location. Miners and pipelayers were then able to complete the tunnel and by the end of June the reactor

foundation had been reinforced.[230]

The Engineer Troops, for the most part, performed their tasks at Chernobyl admirably and exhibited impressive traits of courage and ingenuity. They appear to have been in an adequate state of operational preparedness in terms of physical deployment capabilities and appropriate operational procedures, although they, like other military participants in the cleanup, suffered from the absence of contingency plans for a nuclear power accident of the magnitude of Chernobyl.[231] The major supply problem for the engineering and construction units concerned delays in the production and delivery of concrete for the entombment process.[232] These difficulties, however, may be attributed more to endemic shortcomings of the system as a whole than to the readiness of the Engineer Troops, a distinction that is apparent in Soviet press criticism.

Particular note should be made of the ability of sapper units to carry out their assigned missions in timely fashion and to adopt ad hoc measures to cope with novel situations. This tactical flexibility was tested frequently and was the product of both creative leadership in the field and defective equipment and plans. Perhaps most impressive given the crisis conditions under which they had to operate was the generally smooth cooperation and coordination that prevailed among the different military and civilian workers engaged in engineering-related tasks.

Civil Defense Units

Responsibility for civil defense activities in the Soviet Union rests with the Chief of Civil Defense, who is also a Deputy Minister of Defense.[233] At the time of the Chernobyl accident General A.T. Altunin had held this position for fourteen years.

Civil Defense units, according to Soviet organization charts, are stationed in the 16 military districts of the Soviet Union, each district having a deputy commander for civil defense.[234] Their primary tasks entail Rescue and Urgent Disaster

and Restoration Work (SNAUR), including "locating and marking areas of contamination, localizing and extinguishing fires, giving first aid to and evacuating the injured, removing people from disaster areas, disinfecting people and decontaminating clothing, transport, equipment..."[235]

Soviet authorities called on the units of Civil Defense to perform all of these tasks (often in conjunciton with other military units and civilian workers) following the Chernobyl accident. More specifically, Civil Defense units had major responsibility for evacuating local inhabitants and livestock and were active in efforts to pump out water from underneath the damaged reactor, to prevent water contamination, to conduct radiation reconnaissance, and to decontaminate equipment and clothing. They also participated in a variety of agitation and propaganda work designed to improve safety consciousness and to bolster morale.[236]

The most revealing and damning accounts of the performance of Civil Defense is provided in an extraordinary series of articles in Voennye znaniia by Colonel General B. Ivanov, Deputy Chief of USSR Civil Defense.[237] According to Ivanov, the staff of the USSR Civil Defense in Moscow learned of the accident approximately two hours after the explosion.[238] Action was then taken, with the authorization of General Altunin to place appropriate Civil Defense staffs in the Ukraine and Kiev Oblast and forces in the Kiev Military District in a state of readiness and to send units to Prypiat "to participate in the liquidation of the consequences of the accident and fire."[239] These orders, Ivanov reports, corresponded to the basic plan for the protection of nuclear power station personnel that were drawn up several years before the accident. It was based on exercises previously conducted by Civil Defense units at different nuclear power stations, as well as on experience gained in organizing protective measures at chemically dangerous sites.[240]

Implementation of the basic plan, however, left much to be desired. Radiation reconnaissance by the units of Civil Defense, for example, was not carried out in an effective manner. As a consequence, General Ivanov reports, people, especially firemen, were unnecessarily exposed to radiation dangers.[241]

Implementation of the plan also suffered from the failure of any Civil Defense contingency operations to anticipate an accident of the magnitude at Chernobyl. As a result, Civil Defense units encountered severe manpower shortages.[242]

Civil Defense units also appear not to have known how to operate properly certain dosimetric instruments.[243] The dosimetry equipment, for its part, also did not always perform adequately and suffered from poor design. One device (the DP-5), for example, was reported to have tiny and inconvenient dials which made night time use especially difficult.[244]

Civil Defense units were also criticized by the Soviet press for their organization of civil defense propaganda--both prior to and after the nuclear accident. Major propaganda shortcomings before the accident involved the neglect of "safety precautions that must be observed in the vicinities of nuclear power plants and other facilities where accidents may occur."[245] Post-accident deficiencies concerned media procedures for disseminating information. As a consequence of improper media coverage,

> people did not have a lucid impression of what had happened on the first days of the accident. This prompted circulation of fictitious accounts about the state of affairs in the plant's vicinity, and it created a nervous atmosphere in the work of individuals and often entire collectives.[246]

More to the point, the residents of Prypiat were not informed in a timely fashion of the radiation dangers caused by the accident, nor were they advised to take protective measures.[247]

The picture that emerges from Soviet accounts of the performance of Civil Defense at Chernobyl is not uniformly negative. There are reports of responsive, courageous and skillful

behavior by select Civil Defense units.[248] In balance, however, the typical, pre-Chernobyl, Western image of a massive, well-equipped, finely-tuned, and vigilant Soviet civil defense apparatus corresponds poorly to the actual conduct of Civil Defense forces prior to and in the immediate aftermath of the Chernobyl accident. Instead, one finds a poorly trained, ill-equipped, and at least with respect to the accident at hand, understaffed body of Civil Defense units. These shortcomings -- most evident in Colonel General Ivanov's critiques -- were compounded by convoluted organizational procedures and a Civil Defense command structure that was unresponsive to rapidly changing crisis developments.[249] As a consequence of these deficiencies, the units of Civil Defense were unable to perform adequately their designated mission. No representatives of Civil Defense received decorations for exceptional performance at the January 1987 award ceremony and General Altunin, the Chief of Civil Defense, was replaced shortly after the accident.[250]

An Overall Assessment and General Lessons[251]

As part of the application of perestroika to the Soviet military, the argument has been made that resource restraints require the Soviet Armed Forces to improve performance primarily by the more intensive (and efficient) use of resources rather than from the allocation of more funds. It is in this context of restructuring the armed forces that the Soviet military has pursued a policy of samokritika with respect to its performance at Chernobyl. Major themes in this discussion include the need for greater personal responsibility and initiative of officers, improved managerial efficiency, leadership by positive initiative, the need for disciplined observance of military regulations and greater concern by officers for the well-being of enlisted men.[252]

While officers in the Chemical Troops and the Air Force at Chernobyl are often cited as positive role models regarding these themes, the forces of Civil Defense are singled out for their

organizational and operational flaws. Delays in notification, overexposure to radiation, and improper radiation reconnaissance are depicted as the product of command failure, poor discipline, and personnel unpreparedness. Ivanov, for example, is critical of the lack of personal initiative exhibited by officers who feared responsibility. In addition, he blames an excessively bureaucratic command structure for the confused nature of the cleanup and the evacuation process.[253]

Other critics emphasize the need to intensify classroom and situational training of troops for assigned missions. The absence of such training, they suggest, contributed to negligence and an underestimation of the gravity of the situation, as well as to problems of discipline.[254]

What more general lessons about the readiness and capabilities of the Soviet Armed Forces can be derived from the mixed record of Soviet military performance at Chernobyl? On the one hand, the ability of the Air Force and Chemical Troops in particular to overcome flawed plans and equipment demonstrates considerable tactical flexibility on the part of Soviet military units. One must also be impressed with the generally effective cooperation that was achieved among the different military and civilian actors engaged in the massive cleanup task. The bravery and endurance of Soviet Troops facing the invisible enemy at Chernobyl also is noteworthy and underscores the significance of the human factor in combat situations.[255] There is also little doubt that the Soviet military gained valuable experience that should enable it to improve its performance for rendering disaster relief in the future, whether the disaster is an accident or military action.[256]

On the other hand, a combination of systemic defects and procedural problems encountered at Chernobyl are likely to impair Soviet military performance in other crises in the foreseeable future. They include endemic shortcomings of the system with respect to production and delivery of materials, lack of personal

initiative and responsibility, and lax observance of rules and regulations.

MILITARY PERFORMANCE AFTER THE ARMENIAN EARTHQUAKE: A BASIS FOR COMPARISON[257]

Less than three years after the Chernobyl nuclear accident, the Soviet armed forces were again called upon to respond to a non-military crisis -- the December 7, 1988 earthquake in Armenia. Many branches of the armed forces, including Civil Defense, Engineering Troops, the Air Force, the Military Medical Services, and internal troops of the Ministry of the Interior participated in what the Soviets refer to as "liquidating the consequences" [likvidatsiia posledstvye] of the Armenian disaster. Discussion here is limited to the units of Civil Defense.

Civil Defense forces played the largest role in the aftermath of the earthquake, both in terms of the scope of work and the number of troops engaged. Approximately 23,000 Civil Defense military personnel were involved, and 18,000 nonparamilitary civil defense workers also participated in disaster relief work.[258]

Civil Defense units, under the supervision of General Gorovov, worked side by side with other military units and civilians to rescue people from the rubble, to clear roads, and to remove debris. According to one eyewitness account, helicopters arrived at the northern part of the disaster area only an hour after the earthquake struck at 11:41 AM, and by 6 PM civil defense personnel were actively engaged in relief work.[259]

Civil defense rescue and relief efforts, however, were hindered by a number of material and organizational factors. As was the case in Chernobyl, Civil Defense units -- and those of other branches -- suffered from the absence of adequate technical equipment, especially powerful lifting machines and lighting sources. As a consequence, rescuers were often forced to clear rubble by hand with light generated by bonfires and car headlights.[260] Much of the heavy equipment that was available was unsuitable for removing rubble from people. According to one Civil

Defense official, the lack of suitable equipment accounted for half of the deaths.[261]

Specialists able to operate machinery that was available were also in short supply. These shortcomings were highlighted by the superior equipment and performance of the foreign rescue teams in Armenia. An article in Pravda, for example, praises the performance of the British and French rescue teams, but is less complimentary of Soviet rescue efforts:

> Specialists, equipment, trained dogs -- we too have all this. But instead of acting like a clenched fist we sometimes wave an open palm. Dogs are under one department, electronic devices under another, and experts under yet another. How are they to be united into a single whole? We need a group which will react quickly and immediately to such disasters.[262]

Minister of Defense Yazov was also critical of the performance of Soviet Civil Defense, noting in an interview that:

> Civil defense subunits were not fully prepared to tackle their tasks, even though they are in fact intended for action in an emergency situation. Their inadequate level of technical equipment and the inability of a number of specialists to make effective use of modern mechanisms were brought to light.[263]

Yazov also noted problems of discipline with some of the servicemen, especially reservists, who sought to evade assignments in dangerous areas.

Organizational deficiencies within the Civil Defense force also were acknowledged by General Govorov, who was critical of his unit's failure to provide quick relief to a number of the smaller villages damaged by the earthquake. Some of the delays can be attributed to "bottlenecks" and the fact that staff reductions made it impossible to deploy units swiftly.[264] The organizational problem, he argues, is compounded by the structure of civil defense:

> At the top of the pyramid is the chairman of the Armenian SSR Council of Ministers, below him is the republic civil defense headquarters, followed by the individual services headed by ministers. On the next rung are plants, kolkhozes, and sovkhozes headed by directors or chairmen who have chiefs of staff released for this purpose.[265]

Govorov goes on to emphasize that workers at each of these levels are responsible for Soviet civil defense, and that if we are going to speak about shortcomings in the performance of civil defense, we must say that the reason lies in poor leaders who are not even aware that they are leaders.[266]

Govorov may, in part, have been responding to criticism of the civil defense effort made ten days earlier by USSR Council of Ministers chairman, Nikolai Ryzhkov, who had visited Armenia as head of the Politburo commission dealing with the effects of the earthquake. In a press conference in Yerevan Ryzhkov complained that not all leaders had met the challenges posed by the earthquake, and that some leaders showed irresponsibility and incompetence in the face of disaster.[267]

Few direct comparisons in the Soviet press were discerned regarding the military's performance at the Chernobyl and Armenian disasters although one can find occasional reference to how individual performances were improved by "cutting swords" at Chernobyl.[268] Military medical units, in particular, appear to have profited from the Chernobyl experience despite the differences in the medical emergencies that were confronted.[269] The most direct negative comparison is reserved for Civil Defense units. A correspondent for Voennye znaniia actually observes that "the accidents in Chernobyl and Sverdlovsk and the earthquake in Armenia have shattered the myth of Civil Defense's strength and omnipotence."[270]

Perhaps the most striking feature of Soviet military commentary after the Armenian disaster is an awareness on the part of some analysts that there was little or no improvement in the

military's crisis preparedness after Chernobyl. One of the problems that is noted is the orientation of civil defense efforts toward wartime emergencies rather than to natural disasters. Because of the changes in world politics, one commentator points out, there is a need to redefine society's security and to develop a new attitude toward civil defense. This new attitude should apply, it is argued, to the development of different equipment and the training of its operators.[271]

Another analyst argues that the structure of nonparamilitary civil defense also needs to be substantially modified. "The first priority is to clearly delineate the functional obligations of officials, determine the role of civil defense in the new conditions of activity of the economy, specify the principles of defending people and establishments from natural disasters, industrial accidents and catastrophes, and more closely tie the procedures of civil defense to the regulations of industrial work."[272]

In yet another article in Voennye znaniia, which appears to have initiated a campaign to revamp the structure of Civil Defense, the point is made that it is now time to generalize the work experience gained under crisis conditions.

> It has been three years since the accident at Chernobyl. Since then there have been many other disasters.... What are we waiting for?[273]

One of the weakest aspects of civil defense activities, the author notes -- a catastrophe -- is the failure to analyze experience gained during a specific disaster, to apply it to other situations, and to develop reference materials.

One way to facilitate this comparison and synthesis, several contributors to Voennye znaniia suggest, is to reorganize the civil defense command structure, to separate it from the Armed Forces, and to have it permanently headed by a high level government minister, along the lines of the special commissions created after the Chernobyl and Armenian disasters.[274]

It remains to be seen whether or not the calls to apply perestroika to the military in general, and to civil defense organs in particular, will be heeded. Similar, if less specific and concerted, calls for reform were also heard after Chernobyl with little discernible effect. Deficiencies in military performance were, for the most part "corrected" by removing individuals rather than instituting changes in disaster preparedness training methods or revamping standard operating procedures for decisionmaking. These recommended changes, at least, were not apparent in the military's response to the Armenian earthquake.

PART III. CHERNOBYL AND POLICY INNOVATION IN NUCLEAR SAFETY[275]

One useful method of conceptualizing Soviet decisionmaking is to view it as a sequential process involving five analytically distinct phases: initiation, controversy, the formal decision, implementation, and termination.[276] This method of viewing Soviet policymaking has the advantage of highlighting three stages of the decisionmaking process that are often ignored or underanalyzed (i.e., the stages of initiation, implementation, and termination) and of calling attention to the dynamic nature of the policy process and the possibility of policy change. An effort is made in this section of the report to analyze Soviet nuclear safety policy at the policy initiation and implementation phases.[277] Particular attention is given to the impact of the Chernobyl accident on policy change.

POLICY INITIATION

The policy initiation phase of the decisionmaking process is the period during which a potential problem (or opportunity) is first recognized.[278] It is at this stage when "problems come to be defined as political issues and make their way onto the political agenda."[279] It also represents the phase during which "the other face of power" is exercised, that is, the power to determine which issues will be considered and which alternatives

will be accepted as legitimate policy options.[280]

The View from the Top[281]

Research in the field of public policy indicates that how an issue is defined plays a major role in policy choice and affects the propensity for policy continuity or change.[282] Prior to the 1986 Chernobyl accident the Soviet political leadership and its spokesmen sought to define nuclear safety policy very narrowly and therby to restrict policy change.[283] More specifically, nuclear safety was defined in a comparative context with thermal energy. As long as nuclear power was considered to be safer than thermal energy, it was judged unquestionably safe. According to Andronik Petrosyants, chairman of the State Committee for the Utilization of Atomic Energy between 1982 and 1988, nuclear power was ten times less harmful to the environment than the burning of coal.[284] Moreover, Petrosyants argued, the radiation emitted by nuclear power plants did not appreciably raise the level of exposure to the public compared to the daily background radiation they normally received.[285] Nuclear power, Petrosyants and other government spokesmen maintained, was reliable, and Soviet equipment in the nuclear power sector was "state-of-the-art." Although Petrosyants acknowledged that no serious scientist could altogether "rule out the probability of the improbable," the danger of a major accident, he believed, was not a realistic probability. "One might as well scare the public with the danger of the Empire State Building collapsing."[286] Accordingly, plans to begin siting atomic heating stations near population centers were announced in the late 1970s.

One might have expected the 1979 nuclear accident at Three Mile Island to prompt a change in Soviet leadership attitudes toward nuclear safety, especially in light of the series of unpublicized accidents at their own nuclear plants (See Table One). The policy sciences literature, however, suggests that just because an unanticipated event -- even a crisis -- occurs, does not lead automatically to a change in the policy agenda. As Elder and Cobb

point out, "whether or not a particular situation bespeaks an urgent need for action... is always a matter of interpretation."[287] It also depends upon the perceived availability of a viable option.[288] Given the high priority the Soviet leadership attached to the expansion of nuclear power, the lack of a perceived viable alternative to nuclear energy, and a readiness to attribute the severe American accident to the nature of the U.S. economic system, Soviet policymakers chose to interpret Three Mile Island in a way that did not fundamentally alter their policy toward nuclear power or nuclear safety. The American nuclear accident, however, did raise the salience of the nuclear safety issue for Soviet policymakers and prompted the adoption of more stringent rules for the design and employment of nuclear power reactors.[289] The leadership also established a new institute, the All-Union Scientific Institute for the Operation of Atomic Electric Stations charged with "elaborating and introducing measures to raise the standard of safety, reliability and economic viability of nuclear power stations"[290] and created the USSR State Committee for the Supervision of Safe Working Practices in the Atomic Power Industry.[291]

The Role of Experts

Because of their special knowledge, experts may also partake in agenda-setting by helping to define issues and standards of evidence. Prior to the Chernobyl nuclear accident, the Soviet scientific community was a major ally of the political leadership in promoting the potential and minimizing the risks of nuclear power.

At a technical level, the Soviet concept of nuclear safety has been driven by what is referred to as the "maximum design accident (MDA)" -- the most extreme, credible breakdown a reactor is likely to experience. Although the perceived MDA varied according to the reactor type, a rupture of a main coolant tube generally was regarded as the worst case scenario.[292]

The rationale for adoption of the MDA standard was the absence of data on the probability of system failure. As a U.S. scientific delegation to the Soviet Union noted in 1970, the Soviet safety philosophy was to concentrate on design and operation and not to consider hypothetical possibilities. This approach was adopted because the addition of many back-up systems whose need and reliability were not demonstrable were perceived by Soviet scientists as only complicating the operation of the reactors, therby reducing overall safety.[293] The approach also appeared to provide economic savings and was compatible with and probably sensitive to the nuclear expansion prejudices of the political leadership. Soviet reluctance to adopt Western style containment structures, for example, were explained in terms of both the additional capital outlays that would be required and the questionable safety advantages that would accrue.[294] Development of the RBMK reactor was also justified in terms of economic savings and safety features, ironic as this may appear in light of Chernobyl.[295]

There is no evidence that the accident at Three Mile Island caused Soviet nuclear scientists to alter their attitude toward nuclear power. What one can discern in Soviet technical journals after 1979, is more attention to the issue of nuclear safety and technical measures to reduce the likelihood of the occurrence of reactor accidents.[296]

Despite the preponderance of Soviet scientific support for the leadership's approach to nuclear safety, one can discern scattered instances prior to Chernobyl when a few specialists sought publicly to broaden the prevailing definition of nuclear safety. One of the earliest known attempts was by Petr Kapitsa in his Fall 1975 address commemorating the 250th anniversary of the Soviet Academy of Sciences. An advocate of nuclear power development, Kapitsa nevertheless had reservations about provisions in the 10th Five Year Plan which called for construction of more and larger nuclear plants in the densely populated European region

of the country. Kapitsa voiced concerns about the dangers of radiation release due to accidents or sabotage, raised doubts about the problem of waste disposal and the proliferation risks associated with fission reactors, and proposed that until these problems were resolved (preferably by the introduction of fusion reactors), nuclear power plants should be built in very remote areas.[297]

The issue of the siting of nuclear plants was also raised by N. Dollezhal and Iu. Koryakin in articles in Pravda (1976) and Kommunist (1979).[298] The thrust of both articles was that if nuclear power plants continued to be built primarily in the European part of the Soviet Union, the "ecological capacity" of the zone -- in terms of adequate water supply and land for cooling ponds -- would soon be exhausted. The alternative recommended by the authors was to create large atomic energy complexes in regions of low population density.

Not surprisingly, the 1975 proposals by Kapitsa and the 1979 suggestion by Dollezhal and Koryakin were attacked by the president of the Soviet Academy of Sciences.[299] What is more intriguing is that the Dollezhal and Koryakin article in Kommunist was published at all. The fact that it appeared in the major theoretical journal of the CPSU suggests that the reservations expressed by the scientists were shared by at least some senior political officials. One may even have been Mikhail Gorbachev who, at the time, held the Central Committee portfolio for agriculture and was known to be concerned about water conservation issues.[300] If this were the case, it may help to explain the readiness of the Soviet government after Chernobyl to reverse a long-standing policy and actually cancel a number of nuclear power plants that were under construction.[301]

The Impact of Chernobyl on the Nuclear Safety Agenda

Incidents like the accidents at Three Mile Island and Chernobyl may be thought of as "focusing events."[302] These are

events that compel policymakers to direct their attention to a problem or set of problems at a time when they otherwise might not have. Chernobyl may also be thought of as a textbook crisis situation involving the elements of high threat, surprise, and short decisionmaking time for response.

For the most part, research on crises has focused on the pathological consequences of crises for organizaiton decisionmaking. These effects, which characterized aspects of the Soviet response to Chernobyl, include narrowing of the cognitive processes, information distortion, and rigidities in choice selection. Research in social psychology and the policy sciences, however, indicate that under certain circumstances crisis-induced threat may promote more rational decisionmaking and facilitate policy innovation.[303] Precisely because crises generally involve sharp discontinuities, they may highlight the need for realignments of organizational issues, roles, and functions and may foster innovation, especially if some "issue entrepreneurs" anticipated the need for change.

One positive consequence of the Chernobyl accident has been a significant reappraisal of nuclear safety in the Soviet nuclear power program and the decision to consider a number of new measures of both a technical and organizational nature to prevent the recurrence of a Chernobyl-like accident.

Technical Measures: The Soviet Union in its report to the IAEA in August 1986 proposed a set of "Initial Measures to Increase Nuclear Power Plant Safety with RBMK Reactors." These technical measures designed to decrease the reactors' positive void coefficient and improve its emergency protection system involved the use of more absorber rods constantly in the core, higher fuel enrichment (to limit rapid power increases), and the adjustment of control rods to prevent overwithdrawal.[304] Additional safety measures proposed for the RBMK include development of a rapid accident protection system featuring fast scram rods to decrease insertion time[305] and

temporary shut-down and in-depth safety checks of all RBMK reactors before they resume operation.[306] A proposal was also approved to cancel construction of four planned RBMK units and not to build any more RBMK-type reactors.[307]

A number of new safety measures were also proposed which were not specific to the RBMK. They called for, among other things, creation of new operator training centers equipped with facilities to simulate all possible accident situations,[308] relicensing of all USSR nuclear plant operators,[309] investment of $3-5 million in additional safety equipment for every existing nuclear plant,[310] provision of containment protection for all future nuclear plants,[311] development of on-line, post-accident decisionmaking systems,[312] strengthening of computer support for nuclear power stations,[313] development of regional response centers to expedite the delivery of experts to a reactor site in the event of an accident,[314] undertaking research to develop new safety control concepts (e.g., new diagnostic and automated systems),[315] application of probabilistic risk assessment to analyze VVER reactors,[316] adoption of new guidelines regarding the siting of nuclear power (and district heating) plants,[317] and development of a new system of inherently safe reactors.[318] Many of these initiatives envisage close cooperation with nuclear power and safety specialists from the United States and other countries.[319]

Organizational Change: One of the first actions of the Politburo after it reviewed the government commission report on the causes of the Chernobyl accident was to create a new all-Union Ministry of Atomic Energy with the intent of raising "the level of management and responsibility for nuclear power engineering."[320] This move appeared to strip the Ministry of Power and Electrification -- which was admonished for its role in the Chernobyl accident -- of responsibility for civilian nuclear power. At the same time, the Politburo announced the creation of the post of CPSU Central Committee Party Organizer for Atomic Power

Stations' Party Organizations for the purpose of strengthening discipline and enhancing the Party's influence at atomic power stations.[321] Subsequently, a host of new regulations were issued, and new organizations, agencies, and institutes were established -- at least on paper -- at the local, regional, republic, national, and international level to promote nuclear safety and the accident-free operation of nuclear power plants. Indeed the volume of the organizational actors, the interlocking (if not overlapping) nature of their directorships, and the rapidity with which the organizations come and go make the task of charting organizational change nearly impossible.[322] Indicative of the proliferation of new Soviet actors in the nuclear sector and the lack of coordination and clear division of responsibilities among them -- relevant to the topic of policy implementation -- is the observation of a U.S. Department of State representative who recently participated in a joint US-Soviet meeting in Moscow on the consequences of Chernobyl. The official reports the thanks expressed to the Americans by many of the Soviets for bringing together the Soviet participants, many of whom had not met previously and were unaware of their colleague's activities.[323]

Prior to Chernobyl, one of the agencies with primary responsibility for nuclear safety was Gosatomenergonadzor (variously translated in English as the State Committee for the Supervision of Safe Working Practices in the Atomic Power Industry or the State Committee on Supervision of Nuclear Power Safety) or GAEN for short.[324] In February 1987, the statute of GAEN was amended to give the agency a greater formal role in approving safety norms and in supervising compliance with rules and standards concerned with nuclear safety in the design, construction, and operation of nuclear facilities.[325] These statutory changes followed the firing of GAEN's founding chairman, E. V. Kulov, for major errors associated with Chernobyl.[326] Sometime in mid-1989, GAEN appears to have been merged with another non-nuclear supervisory body (Gosgortekhnadzor) to create the Union-Republic

Gospromatomnadzor (State Committee for the Supervision of Work Safety in Industry and Nuclear Power Engineering).[327] The former chief of GAEN, Vadim Malyshev, now heads Gospromatomnadzor. According to the report of his deputy to the IAEA General Conference in September 1989, the role of the new agency is being changed from supervision to licensing, and the U.S. Nuclear Regulatory Commission is seen as a relevant model.[328]

Another body that is usually reported to have been created after the Chernobyl accident is the All-Union Scientific-Technical Institute of Nuclear Power Plant Operations.[329] Set up within the new Ministry of Atomic Energy, the Institute is often described as akin to the Institute of Nuclear Power Operations (INPO) formed in the United States after the Three Mile Island accident.[330] Its responsibilities include conducting R & D on the operating experience of existing plants, carrying out diagnostic tests, investigating future plant designs (with the Kurchatov Institute), developing systems (including simulators) for operator training, and exploring new maintenance philosophies.[331] The Institute, presently headed by Armen Abagyan, is reported to have set up a computerized center in Moscow for daily collection and analysis of reports from all operating nuclear plants in the Soviet Union.[332]

Having created a number of new agencies in the nuclear sector following Chernobyl, the Soviet leadership began to reconsider the new configuration in the spring of 1989. Among the proposed reorganization plans was the dissolution of the fledgling Ministry of Atomic Energy (Minatomenergo), headed by Nikolai Lukunin, and/or its absorption into or amalgamation with the Ministry of Medium Machine Building (Minsredmash), headed by Lev Riabev. Even the venerable State Committee for the Utilization of Atomic Energy (GKAE) was mentioned as a possible casualty of the reorganization scheme, in part, because it was unclear whether GKAE, Minatomenergo, or some other body was in charge of the nuclear power program.

Although the picture is still not perfectly clear, it now appears that the Ministry of Medium Machine Building and the Ministry of Atomic Energy have indeed been replaced by a new Ministry of the Nuclear Power Industry.[333] The new ministry is headed by Vitaly Konavalov and is under the supervision of the Council of Ministers' Bureau of the Fuel and Energy Complex (formerly headed by Boris Shcherbina and since the end of 1989 by Lev Ryabev). Aleksandr Protsenko, the former head of the State Committee for the Utilization of Atomic Energy, now appears to be Konovalov's first deputy. The fate of the State Committee for the Utilization of Atomic Energy is not clear although there are reports that it continues to function informally with Protsenko as its head.[334] Konovalov's super ministry, one of 25 all-union ministries in the Soviet government, reportedly will have responsibility for defense as well as civilian activities.[335] In discussing what at the time was only a proposal under consideration, Chairman of the Council of Ministers Ryzhkov cited the need to develop a more comprehensive approach to the "problems of atomic power engineering, and especially safety." In his view, "the proposed amalgamation of the two ministries [would]... help the all-around progress of the nuclear power industry, and, most important, guarantee its safety.[336]

Three other new safety-related organizations merit attention. They are the international counterpart of the Scientific-Technical Institute of Nuclear Power Plant Operations and INPO -- the World Association of Nuclear Operators -- formed in Moscow in May 1989 and committed to maximize the safety and reliability of the operations of nuclear power stations by exchanging information and encouraging comparison, communication, and emulation;[337] the Institute of Nuclear Safety, set up within the past year by the USSR Academy of Sciences as a center of technical expertise independent of the traditional nuclear engineering and R & D institutes such as Kurchatov;[338] and the State Commission for Extraordinary Events, responsible to the USSR

Council of Ministers, and intended to coordinate response to major accidents such as Chernobyl and the Armenian earthquake.[339]

POLICY IMPLEMENTATION

The fourth stage of the policymaking process, implementation, is the time when those charged with the responsibility for executing policy may either further or frustrate the objectives of those who make the formal decision. As such, policy implementation frequently may represent the continuation of policy controversy by other, less visible, means. Those who execute policy, moreover, may become in a very real sense policymakers.

The public policy literature points to a number of factors that influence the ability and inclination of policy executors to interpret selectively the formal decision. These factors, many of which are relevant to the issue of nuclear safety policy after Chernobyl, include the source of the policy; constraints of time; the division of responsibilities among actors charged with formal decisional and implementation tasks; the workload, resources, and efficiency of the organization; the clarity and specificity of the formal decision and the rules for its implementation; the complexity of the administration (especially the number of institutional entities involved); the types of control available to the various agencies in the implementation process; the degree of conflict among the objectives embodied in the policy at the formal decision stage; the extent to which the policy represents a modification of existing policy; the linkage of the policy realms (that is, does it straddle issue areas?); the legitimacy of the body making the formal decision; the incentives for the administrative agency built into the policy; and the development of conditions unauthorized or unintended by the original policy architects.[340] Especially relevant to the issue of policy change is the finding that "people who carry out policy are most likely to make policy when they are engaged in implementing policy shifts

in ongoing practices."[341]

Examination of the implementation of the many safety-related measures proffered and formally adopted after Chernobyl points to the relationship between the clarity of the formal decision, the specificity of the rules for its implementation, and the likelihood that the policy change has been faithfully implemented. In other words, the more specific and technical the proposed policy change, the greater the resemblance between policy proposal and policy product. A number of the technical improvements for the operation of RBMK reactors which the Soviet Union promised the IAEA it would undertake, for example, appear to have been made or are in the process of being implemented. A delegation of American Nuclear Society members who toured a number of Soviet nuclear facilities in July 1989 reports that "modifications to the control system at Chernobyl and the other RBMK plants have reduced the scram time from 24 seconds to 12 seconds."[342] Chairman Lando Zech of the U.S. Nuclear Regulatory Commission, reporting on a two-week visit to the Soviet Union in the summer of 1988, also indicated that he understood that post-accident modifications had been made to the three undamaged units at Chernobyl "including modifications to improve the void coefficient problem, to speed up control rod insertion, and to provide more absorption rods, among others," and that the "same modifications are being made at other operating reactors of the same type (RBMK) as well as those that are under construction but nearly completed...."[343] The main difficulty in carrying out these changes, which the Soviets acknowledge, is the slower than anticipated pace of implementation.[344]

The Soviet Union appears to have partially implemented plans for improving operator quality, including the creation of two new simulation centers.[345] Although the Soviets have sought to upgrade further their simulation capabilities, they have encountered difficulties in acquiring foreign equipment for financial and technology transfer reasons.[346] They have been quite successful, however, in implementing a series of international cooperation

accords which should assist their efforts to improve operator training. These international safety agreements with the United States and other western countries have had the additional public relations attraction for Soviet officials who see cooperation with the West as a means to reassure a public that is increasingly anxious about nuclear power.

The one technical issue that is probably most contentious and refuses to go away despite what would appear to be formal government pronouncements, is the future of the RBMK reactor.[347] As previously noted, the USSR Council of Minsters decided formally on April 20, 1989 to cancel construction of four planned RBMK 1000 units and not to build any more RBMK reactors.[348] This was only the latest, if highest level, announcement that the RBMK program would be scrapped.[349] It is unclear whether or not research on an enhanced RBMK reactor with "inherent safety features" has actually stopped at the Kurchatov Atomic Energy Institute or at the reactor design institute in Leningrad. Advocates of the RBMK concept, in any case, continue to argue publicly for retention of the reactor type.[350] The growing popular sentiment against nuclear power in the Soviet Union and the difficulty in commissioning even new VVER reactors, however, ultimately is likely to assist in the implementation of the formal ban on future RBMKs.

If the Soviet leadership has been relatively successful in obtaining implementation of safety decisions of a technical nature, it has experienced more difficulty with administrative and organizational changes. The latter have strained the workload and resources of different agencies charged with administration and have also encountered bureaucratic resistance and worker indifference.

One U.S. government official, in contemplating the impact of Chernobyl on Soviet standard operating procedures, observed that it forced the Soviets to learn that putting regulations in a book or posting them does not work.[351] Outside of the scientific community, which does appear to have revised its assessment of the

risks of nuclear accidents and to have become a more forceful advocate of corrective action,[352] Chernobyl does not appear to have fundamentally altered the production, construction and management practices in the nuclear power industry or the safety philosophy of plant workers. One can still find in the Soviet press the same kind of charges about shoddy workmanship, unrealistic building deadlines, and low labor morale that were evident in the pre-Chernobyl era. The Kiev party obkom bureau in 1988, for example, sharply criticized the leadership of the "Kombinat" -- the organization formed in October 1986 to handle all aspects of life and work in the 30 kilometer exclusion zone around the Chernobyl plant. It accused the Kombinat's leadership of failing to learn the lessons from past events and noted that inspections had revealed problems of nepotism and moral decay among certain leadership cadres and no decline in breaches of labor discipline and drunkenness at the power station.[353] Similar accusations at a more general level were made by peoples' deputy Shcherbak during questioning of Vadim Malyshev at the July 14, 1989 USSR Supreme Soviet joint session. According to Shcherbak, "even now safety regulations with regard to the location, planning, construction, and operation of nuclear power stations are often ignored."[354]

Western visitors to Soviet nuclear plants in the post-Chernobyl era have also expressed surprise at the apparent laxness of their hosts to (or low regard for) the dangers of radiation. Many report that they were not required to carry dosimeters during their plant tours and were not checked for radiation exposure upon their completion.[355]

One may also question the extent to which certain administrative changes, in the absence of more fundamental systemic changes, can actually have an impact. One obvious problem that remains is the incentive structure at Soviet nuclear plants. As the chairman of the USSR State Committee for the Utilization of Atomic Energy lamented only a year ago, nuclear "specialists are paid less than a massive number of less qualified working people.

An operator in charge of a reactor like the one at the Chernobyl AES receives less than a city bus driver."[356] A close reading of the new safety regulations adopted in February 1988 for GAEN are also instructive in this regard. The statute states that the Gosatomenergonadzor worker is obliged, among other things, "to possess high professional training.... know and unswervingly observe the appropriate rules, norms, and instructions for the safe conduct of operations,... to discover the reasons and conditions that facilitate the appearance of emergencies,... to further the incorporation of the latest achievements of science and technology,... and to observe the rules of socialist communal living and the norms of communist morality...."[357] In return workers to whom the statute extends are given the following incentives "for the model fulfillment of labor duties, the improvement of work quality, innovation in labor, the display of initiative, selflessness and resourcefulness in work and continued and irreproachable work in the organs of USSR Gosatomenergonadzor" -- "a) expression of gratitude; b) payment of bonuses; c) awarding of a valuable gift; d) awarding of a testimonial; e) entry into the Roll of Honor or onto the Board of Honor; f) granting of the title of best worker in the given profession...."[358] Even at a bus driver's wages, assuming that GAEN employees have a higher salary than nuclear power plant operators, one must question the impact of the new statute's incentive structure on improved performance by GAEN's nuclear safety employees.

A Soviet psychologist who also has studied the experience of the Chernobyl accident points out another obstacle in "the long hard path... from the adoption of a decision to the eventual completion of work..." The chief obstacle, she believes, is "the fact that very many people involved in nuclear power safety have not developed a sense of responsibility for what happened." "The cup of responsibility for the Chernobyl events," she suggests, "has been drained by those who are no longer among the living."[359] As a consequence, she argues, necessary changes in training

specialists for the nuclear power industry are not being made quickly enough. Moreover, "nuclear power station worker status is declining," which "will increase the exodus of skilled cadres and, consequently, lower the overall standard of professionalism, expertise, and reliability of work."[360]

Resource constraints and conflicting policy objectives, it was hypothesized, may impede policy implementation. This appears to be borne out with respect to new nuclear safety provisions. Although safety considerations, for example, may well have risen in the hierarchy of factors influencing Soviet policy making with respect to nuclear power, there is no indication that economic calculations have lost their priority position. This situation reportedly has led the chairman of GAEN to complain that he is frustrated by the body of the Council of Ministers in carrying out his tasks.[361] Before GAEN could implement its own recommendations for shutting down a reactor, for example, it appears that Malyshev first had to obtain support from the full Council of Ministers and was routinely outvoted. This outcome is consistent with information provided by a senior Soviet econometrician who was involved in a post-Chernobyl study to see whether or not increased expenditures for nuclear safety could substantially reduce the risks of another major nuclear accident. The study's conclusion was positive, but its findings were not well received because they indicated that the necessary investment in safety would cause the cost of nuclear power to exceed that of coal or oil.[362]

Part IV. LESSONS LEARNED.

An effort was made in the preceding sections to assess the performance of a number of Soviet institutional actors in response to the Chernobyl crisis and to analyze the impact of the 1986 accident on policy change in the field of nuclear safety. More general lessons were also derived about the crisis readiness and capabilities of the Soviet Armed Forces based upon their performance at Chernobyl and after the 1988 earthquake in Armenia.

Rather than reiterate those points, the concluding section of this report addresses the question of the lessons the Soviets themselves learned from the Chernobyl experience.

One may discern a number of lessons that appear to have been learned by Soviet leaders, experts, and the public of both a tactical/instrumental and strategic/philosophical variety. The former refers to "simple learning" in which one can observe a change of behavior in the face of failure, without a fundamental altering of values having taken place.[363] Illustrative of this kind of learning is Gorbachev's behavior on the occasion of more recent national crises. Gorbachev appears to have learned that his prolonged silence after the Chernobyl accident was inappropriate and counterproductive and has made a point after subsequent disasters (such as the 1988 Armenian earthquake and the 1989 gas pipe line explosion near Arzamazas) of promptly addressing the nation to demonstrate that he was in charge.

Many of the organizational and administrative changes regarding nuclear safety that were discussed in the preceding section also are indicative of simple learning. Their failure, to date, to result in noticeable changes in leadership priorities concerning the conflict between energy economics and nuclear safety prevent them from being classified as strategic or philosophical.

More difficult to categorize are the lessons learned with respect to glasnost and the need for perestroika in the nuclear industry. On the one hand, Gorbachev clearly capitalized on the Chernobyl crisis to gain support for his policies of glasnost and perstroika. A number of organizational changes in the nuclear industry, for example, enabled Gorbachev to sweep aside much of the old guard which had dominated Soviet nuclear energy policy for decades. Whether intentionally or, more likely, inadvertently, Chernobyl also led to the unprecedented outpouring of details on a Soviet disaster and helped to nurture a more fact conscious, socially responsible, and aggressive media. Today, many of the most probing and critically-minded journalists are those who

figuratively cut their teeth on Chernobyl. The international dividends of the relative candor displayed at the International Atomic Energy Agency, also has encouraged a policy of more open discussion of other nuclear-related issues.[364] What one may be witnessing in the realm of glasnost, in effect, is the evolution of an information policy conceived in the wake of Chernobyl to make people think they were receiving the truth (as the government sought to prevent panic) into a broad-gauged, escalating critique of the nuclear power industry, nuclear safety procedures, and the government's commitment to the further development of nuclear energy.[365]

One difficult to document, but arguably most significant lesson that Gorbachev learned from Chernobyl was of a philosophical nature and pertains to a reassessment of the dangers of nuclear conflict and the urgency of nuclear arms limitations. Although much of what Gorbachev said publicly about the linkage between nuclear safety and nuclear war in the immediate aftermath of Chernobyl may be interpreted as propaganda,[366] there is a close correspondence in time between the Chernobyl accident, the articulation of Gorbachev's new political thinking on security, and the advancement of new Soviet proposals that have made possible significant progress on the arms control front.[367] Interviews with senior Polish and Hungarian Communist Party officials who had contact with the Soviet political leadership in the months following Chernobyl also point to the profound impact of the accident on Gorbachev's thinking about the consequences of nuclear war.[368]

Chernobyl also appears to have had a catalytic effect on Soviet thinking at the popular, expert, and leadership levels on the need to take more concerted action to protect the environment. Although this lesson of Chernobyl is most manifest in the rise of popular opposition to the siting of new nuclear plants and the completion of previously initiated projects,[369] it is also reflected in the proliferation of new ecology movements throughout

the country with very broad environmental (and often nationalist) agendas.[370] This surge of environmental consciousness and activism probably reflects the learning of both tactical lessons (e.g., a surprising degree of criticism is tolerated on environmental issues and can be used to promote regional interests vis a vis the center) and more fundamental attitudinal change. Critiques of nuclear power and the government's environmental policy, for example, may represent a surrogate for more broad based criticism of the society, especially by the populace of regions affected by Chernobyl who now believe they were misled and betrayed by a government that had promised to protect and care for them.[371]

The Soviet Union under the leadership of Mikhail Gorbachev has demonstrated, especially in the domain of foreign policy, that it can engage in "complex learning."[372] Conflicting norms and goals appear to have been replaced with more compatible aims and values. One might have expected after Chernobyl, that a similar learning process would have taken place in the sphere of nuclear safety policy, and that the tactical approach of tinkering with the system would give way to a new, internalized philosophy of nuclear safety.

Although some attributes of a new philosophy can be discerned among the Soviet scientific community, and may also account in part for increased anti-nuclear popular sentiment, the Soviet leadership to date has not decided to sacrifice the goal of rapid nuclear energy development for the sake of nuclear safety. It has instead sought to define the two objectives as compatible, as well they may be in theory. Severe economic constraints, an irrational pricing and incentive system, and a bewildering organizational structure, however, combine to dilute the safety effort. The fundamental dilemmas of how to implement safety improvements even if a change in leadership values occurs is apparent in the testimony of the former director of the Chernobyl nuclear power station, provided in a prison interview this past year.

According to V. Brukhanov, reactor design improvements alone will not prevent future Chernobyls as long as Soviet economic conditions strain the resources of nuclear plant managers.[373] The Soviet nuclear power plant manager, Brukhanov explains, by virtue of his position, has to do a number of things that are detrimental to the safety of his plant. These include supply of scarce consumer goods (e.g., food products, door locks, etc.) and maintenance of the infrastructure (e.g., roads and sewage systems) of the locality where the plant is situated. These non-nuclear activities take up much of the manager's time as well as material and labor resources that were allocated for plant operation and maintenance. Nevertheless, it must be done at the order of local party officials.[374]

In addition, Brukhanov observes, the plant manager is obliged frequently to substitute the materials and components specified in the design for safety reasons by "what-you-can-get" materials and components.[375] The philosophy, in short, is "Do whatever is necessary to provide a given very high level of electricity production; everything else, including safety considerations, is secondary."[376]

Although safety considerations have probably risen in the hierarchy of factors influencing Soviet policymaking with respect to nuclear power since Brukhanov was a plant manager, most signs indicate that the basic economic considerations which compromised nuclear safety before Chernobyl have not been replaced. In this limited economic sense, at least, Chernobyl does not yet appear to have fundamentally altered Soviet thinking.

After Three Mile Island, the Soviets chided the Americans for putting profits before safety. It remains to be seen how many rubles will be invested in nuclear safety after Chernobyl. What is certain, to paraphrase Khrushchev, is that the Soviet leadership now knows that nuclear energy -- be it for war or peace -- does not obey the class principle.

NOTES

1. For a detailed description of the accident see The Accident at the Chernobyl AES and Its Consequences, Report of the State Committee for the Utilization of Atomic Energy to International Atomic Energy Agency Expert Conference (August 1, 1986); E. O. Adams et al., "Analysis of the First Phase of the Development of the Accident in the Fourth Block of the Chernoby Atomic Power Station," Atomnaya energiya (January 1988), pp. 24-28; Victor G. Snell, "The Cause of the Chernobyl Accident," in David R. Marples, The Social Impact of the Chernobyl Disaster (New York: St. Martins Press, 1988), pp. 1-24; U.S. Nuclear Regulatory Commission Report on the Accident at the Chernobyl Nuclear Power Station (Washington, D.C.: U.S. Government Printing Office, December 1987), pp. 3-1 to 5-10; J. H. Gittus et al., The Chernobyl Accident and Its Consequences (London: U.K. Atomic Energy Authority, March 1987), pp. 5.1-5-4.5; T. S. Kress et al., "The Chernobyl Accident Sequence," Nuclear Safety (January-March 1987), pp. 1-9. For a reinterpretation of the accident based on new information see Ann MacLachlan and Ray Silver, "West and East Debate Chernobyl Sequence at Sochi Meeting," Nucleonics Week (December 7, 1989), pp. 1, 11-12.

2. TASS, July 19, 1986. Subsequent Soviet estimates place the direct Chernobyl recovery effort -- what the Soviets refer to as "the liquidation of the consequences of the accident" at approximately 4.4 billion rubles. This is the figure reported in a February 13, 1989 communique from the Politburo to the Central Committee of the CPSU. See Ann MacLachlan, "Chernobyl Aftermath: Trees Recovering but Fallout of Faith Remains," Nucleonics Week (March 23, 1989), p. 8. See also "V Politburo TSK KPSS," Pravda (January 15, 1988).

3. Judith Thornton, "Chernobyl' and Nuclear Energy," Problems of Communism (November-December 1986), pp. 11-12.

4. Different sources place the present total capacity in 1989 at between 33,000 and 35,400 MW_e. See Oleg Shumyatski, "The Soviet Nuclear Power Industry," Nuclear News (September 1989), p. 64; Mathew J. Sagers, "News Notes," Soviet Geography (april 1989), p. 339; and "Lapsin on Chernobyl 'Routine,' AES Progress," TASS (January 22, 1989) reported in FBIS (Soviet Union, National Affairs, February 2, 1989), p. 78.

5. For a discussion of the motivations underlying the Soviet nuclear program see Gloria Duffy, Soviet Nuclear Energy: Domestic and International Politics, Rand Report R-2362-DOE (December 1979).

6. Igor Volski, Trud (July 4, 1954), p. 2 and cited by Arnold Kramish, Atomic Energy in the Soviet Union (Stanford: Stanford University Press, 1959), pp. 142-143.

7. Valery Legasov, "A Soviet Expert Discusses Chernobyl," Bulletin of the Atomic Scientists (July-August 1987), p. 32. See also N.F. Lukonin, "Iadernaya energetika posle Chernobylia: tekushchie problemy i perspektivy pokazatelei AES," Paper presented at the International Conference on Nuclear Power Performance and Safety, Vienna (September 28-October 2, 1987), p. 2.

8. See, for example, "Lapshin on Chernobyl 'Routine,' AES Progress; "Capacity of Nuclear Power Station to Triple," JPRS (Soviet Union, January 13, 1989), p. 21; and "USSR: Supreme Soviet Approves Nuclear Program, Nucleonics Week (August 10, 1989), p. 14.

9. "USSR: Supreme Soviet Approves Nuclear Program," p. 14.

10. Legasov. A decline in the rate of growth of the domestic oil industry and a desire on the part of the Soviet leadership to preserve oil reserves as a source of hard currency also contributes to the emphasis given to nuclear power development. See Marples, Chernobyl and Nuclear Power in the USSR, p. 46.

11. See Marples, pp. 50-52 and 117. He reports that Ukrainian nuclear plants exported electricity to Romania, Bulgaria, Poland, and Hungary.

12. World Nuclear Industry Handbook, 1989 (Supplement to Nuclear Engineering International), pp. 36-37.

13. Ibid. This figure excludes Chernobyl units 5 and 6 and the Odessa electricity and heat production nuclear plant which reportedly is being reconstructed into a gas-fired thermal plant. See Sagers, p. 342.

14. Marples, p. 75.

15. Pid praporom leninizmu, No. 2 (January 1986) cited by Marples, p. 77.

16. Marples, p. 77.

17. For documentation see Marples, pp. 75-92; Marples, "Chernobyl' and Ukraine," Problems of Communism (November-December 1986), pp. 26-27 and Allen Kroncher, "Soviet Nuclear Power Construction Poses Constant Hazards," Radio Liberty Research, RL 194/86 (May 15, 1986)

18. For excellent Western reviews of Soviet treatment of nuclear safety see Philip R. Pryde and Lucy T. Pryde, "Soviet Nuclear Power," Environment (April 1974), pp. 26-34; Joseph Lewin, "The Russian Approach to Nuclear Reactor Safety," Nuclear Safety (July/August 1977), pp. 438-450; and Marples, Chernobyl and Nuclear Power in the USSR, pp. 95-114. Relevant Soviet commentary includes E.P. Ananyev and G.N. Krushilin, "Radioactive Safety Barriers in Nuclear Power Stations, Atomnaia energiia (July 1974), pp. 22-27;

A.I. Burnazyan, "Radiation Safety in the Operation of Nuclear Power Station," Atomnaia energiia (September 1975), pp. 167-172; N. Dollezhal and Yu. Koryakin, "Nuclear Power Engineering: Achievements and Problems," Kommunist (September 1979), pp. 19-28; B.A. Semenov, "Nuclear Power in the Soviet Union," IAEA Bulletin, Vol. 25, No. 2 (1983), pp. 47-59; and The Accident at the Chernobyl AES and Its Consequences; V. G. Asmolov, "The USSR Approach to Safety Studies," Paper presented at the First Meeting of the Working Groups of the US/USSR Joint Coordinating Committee for Civilian Nuclear Reactor Safety (MOscow, December 5-9,1988); V. G. Asmolov et al., "Development of Nuclear Power Plant Safety Research in the USSR," Paper presented at the First Meeting of the Working Groups of the US/USSR Joint Coordinating Committee for Civilian Nuclear Reactor Safety (Moscow, December 5-9, 1988); and P. P. Aleksashin et al., "Razvitie trebovaniia po bezopasnosti i sistemy gosudarstvennogo nadzora kak osnovy bezopasnogo razvitiia iadernoi energetiki," Unpublished paper (1987). The stories of Gregorii Medvedev are also very revealing. See, for example, his three short stories in Neva, No. 11 (1986), pp. 19-41 and his lengthy work "Chernobylskaia Tetrad'," Novyi Mir (June 1989), pp. 3-108. A condensed version of the latter work appears in Kommunist (March 1989), pp. 93-105.

19. The most significant article was by Academician N. Dollezhal and Doctor of Economics Yu. Koryakin, "Iadernaia elektroenergetika: dostizheniia i problemy," Kommunist (September 1979), pp. 19-28. It provoked a major counter attack led by President of the Academy of Sciences, Anatoly Aleksandrov. Ironically, Vladimir Gubarev, the science editor for Pravda and author of the nuclear safety conscious play Sarcophagus, was part of the campaign that sought to dissipate the fears raised by Dollezhal and Koryakin. See his article "Atomnaia energetika: ryvok v budushchee," Pravda (January 15, 1980).

20. The Dollezhal and Koryakin article is again a notable exception. See also Burnazyan, p. 778.

21. See, for example, "U.S. Companies Don't Provide Safeguards at Nuclear Plants," Foreign Broadcast Information Service (FBIS), USSR (April 4, 1979), p. A-3; "Deputy Power Minister Comments on Harrisburg Accident," FBIS, USSR (April 19, 1979), p.A-8; "Firms Give Priority to Profits," FBIS, USSR (April 5, 1979), p. A-4. The argument was also made that Soviet control room operators were engineers unlike their American counterparts who were high school graduates without technical education. See O. P. Kazachkovskii, "Some General Principles for Improving Nuclear Safety," Atomnaia energiia (April 1988), p. 245.

22. Andrei Illesh, "AES: A Look into the Future," Izvestiya (January 15, 1989), p. 2.

23. Ibid.

24. See Lewin and Semenov.

25. June 1976 at a meeting with U.S. officials from the Energy Research and Development Administration cited by Lewin, p. 442.

26. Cf., M. Donahue, R. Gardner, and G. Levine, "Assessment of the Chernobyl-4 Accident Localization System" Nuclear Safety (July-September 1987), pp. 297-311; Stuart Diamond, "Western Experts Say Soviet Has Worst Nuclear Safety," New York Times (May 1, 1987), p. A-12; Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident, Safety Series No. 75-INSAG-1 (Vienna: IAEA, 1986), p. 70.

27. Marples, Chernobyl and Nuclear Power in the USSR (p. 116) notes that the ceremony for the laying of the foundation stone for the plant took place in March 1970, but that the second stone was not in place until about eighteen months later. The four units came on line in 1977, 1978, 1981, and 1983, respectively. See also Bohdan Nahaylo, "Unsatisfactory Conditions at Chernobyl' Nuclear Power Station Previously Admitted in Soviet Press," Radio Liberty Research, RL-176/86 (April 30, 1986).

28. Marples, Chernobyl and Nuclear Power in the USSR, pp. 118-124. The problems were especially acute during construction of the first power block where, according to the chief construction engineer, work "was conducted blindly" because of the absence of engineering and technical personnel at the construction site with experience in nuclear power station construction. See "Interview with Vladimir Timofeyevich Gora," Energeticheskoe stroitel'stvo (February 1984), pp. 2-4.

29. Radianska Ukraina (December 29, 1985) cited by Marples, Chernobyl and Nuclear Power, p. 120.

30. Lyubov Kovalevska, "Ne pryvatna sprava," Literaturna Ukraina (March 27, 1986), p. 1.

31. Yuri Shcherbak, in the first part of his two part article on Chernobyl, provides an interview with Kovalevska in which she recounts the abuse she suffered as a result of the expose. See Shcherbak, "Chernobyl," Yunost, No. 6 (1987), p. 50.
31.22

32. Boris Paton, Visnyk Akademii nauk Ukrainskoi RSR, No. 8 (1986) cited by Roman Solchanyk, "Pre-Chernobyl' Premonitions at the Ukrainian Academy of Sciences," Radio Liberty Research, RL-343/86 (September 10, 1986), p. 1.

33. The most noteworthy exceptions are Medvedev, "Chernobylskaia Tetrad'," Henry Hamman and Stuart Parrot, Mayday at Chernobyl: One Year On, the Facts Revealed (London: New English Library, 1987); and James E. Oberg, Uncovering Soviet Disasters (New York:

Random House, 1988); and David Kaplan, "Was Chernobyl an Isolated Incident?" San Francisco Chronicle (November 12, 1986), pp. A1, 7.

34. The 1957 accident was first officially acknowledged by the Soviet government in mid-1989. On June 20, 1989 TASS reported that data on the accident had been declassified and in July 1989 the Soviet Union submitted a short report on the accident to the IAEA. See B. V. Nikipelov et al., "Accident in the Southern Urals on 29 September 1957," IAEA Information Circular 368 (July 28, 1989). Zhores Medvedev first sparked international interest in the accident with his article, "Two Decades of Dissidence," New Scientist, Vol. 72, No. 1025 (1976), pp. 264-267. See also his "Facts behind the Soviet Nuclear Disaster," New Scientist, Vol. 74, No. 1058 (1977), pp. 761-764, and Nuclear Disaster in the Urals (New York: Random House, 1979). For discussion of the debate generated by Medvedev's revelations as well as earlier mention of a Urals accident see Oberg, Uncovering Soviet Disasters, pp. 211-228. Oberg (p. 294) notes the curious fact that neither Nikita Khrushchev nor Oleg Penkovskii mention the Urals accident or any other related nuclear incidents in their celebrated memoirs covering the period of the 1950s and early 1960s.

35. Zhores Medvedev, "The Soviet Nuclear Energy Programme: The Road to Chernobyl," in Louis MacKay and Mark Thompson, eds., Something in the Wind: Politics after Chernobyl (London: Pluto Press, 1988), pp. 13-45.

36. See David Satter, "Moscow Admits Nuclear Accidents," The Financial Times (April 24, 1979), p. 2.

37. Petrosyants (2979) cited in Oberg, p. 238.

38. Shcherbak in "The Big Lie," Moscow News, No. 42 (1989), p. 8.

39. See his "Chernobylskaia Tetrad'." Medvedev's chronicle of the Chernobyl disaster is very detailed and includes what is reported as verbatim testimony by many first-hand participants in the crisis. There are some strange omissions in his account, however, and some observers have challenged the accuracy of portions of the text. See, for example, E. Kolesnikova, "Versia Brukhanova," Sotsialisticheskaia industriia (September 17, 1989), p. 3.

40. Medvedev, "The Soviet Nuclear Energy Programme," p. 43.

41. Interview with Vladimir Gubarev, September 15, 1987, Los Angeles.

42. Over one hundred diverse organizations took part in the construction of the new town of Slavutych. See Yu. Safonov, "Komu sporudzhuvaty Slavutych," Robitnycha gazeta (July 25, 1987).

43. See B. A. Semenov, "Nuclear Power in the Soviet Union," IAEA Bulletin 25/2 (June 1983), pp. 47-59. See also Marples, Chernobyl and Nuclear Power in the USSR, p. 104 and USSR Energy Atlas (Central Intelligence Agency, January 1985), p. 5.

44. The Accident at the Chernobyl AES, p. 24. For a more detailed reconstruction of the accident sequence see Victor Snell in Marples, pp. 1-24 and Girgorii Medvedev, "Chernobylskaya Tetrad'," pp. 29-46. Medvedev (p. 37) maintains that there were at least three explosions.

45. See "Surovye uroki Chernobylya," Pravda (August 1, 1987). See also Andrei Pralnikov, "Verdict Reached," Moscow News, No. 32, 1987, p. 12. The shift supervisor was identified as Rogozhkin at the trial. According to Medvedev's account, however, he did not figure prominently in the accident's development. This is one of the curious discrepancies in Medvedev's account.

46. The Soviet report to the IAEA mentions "176 duty operating personnel and, also, other workers of various shops and repair services at the site of the first and second phases of the Chernobyl AES on the night of April 25 and 26, 1986. In addition, 268 construction workers and assemblers were working on the night shift at the site of the third phase of the AES." (p. 17). It is not clear from the Soviet report how many people were at the fourth reactor unit. A number of armed guards at the AES also were reported to have received considerable doses of radiation. See Pralnikov.

47. See Yuri Shcherbak, "Chernobyl," Yunost', No. 6 (1987), p. 51.

48. See Medvedev, "Chernobylskaia Tetrad'," p. 48. In Dyatlov's view, the emergency safety control tank in the central hall had exploded, carrying away the roof.

49. Ibid., p. 53.

50. See Shcherbak, p. 56 and N. Dolgopolov and P. Polozhevets, "Tam u chetvertogo bloka," Komsomolskaia Pravda (May 15, 1988).

51. See testimony of N. Gorbachenko, duty officer of the dosimetry department in Medvedev, "Chernobylskaia Tetrad'," p. 46.

52. Ibid., p. 53. Medvedev (p. 74) reports that the plant's civil defense chief, to his credit, nevertheless sent a separate distress signal to the republic's civil defense office in which he reported the same high radiation readings. It is not clear who received the message or the response to it.

53. Testimony of A. Martynova, wife of V. Maryin, head of the nuclear power industry sector of the CPSU Central Committee in Medvedev, "Chernobylskaia Tetrad'," p. 57.

54. A. Levin, "K sudu v Chernobyle," Boradcast Russian Service, New Feature, RFE/RL (July 8-9, 1987) says that Brukhanov was on the scene within half an hour. Medvedev (p. 53) places his arrival in the Unit 4 control room at 2:30 AM.

55. See, for example, "Chasy muzhestva," Pravda (May 21, 1987).

56. E. Pershin, "Pershymy stupyly u vogon," Literaturna Ukraina (May 22, 1986) notes that plant personnel began to arrive at the scene when the fire was almost put out, or approximately 4:30-5 AM.

57. See Yemelyanov's explanation of the procedure in "Nuclear Planner Interviewed," FBIS, USSR (June 5, 1986), p. R-3.

58. See Pravda Ukrainy for May-June 1986.

59. V. Gubarev and M. Odinets, "Raikom rabotaet krugle sutki," Pravda (May 12, 1986) and A. Sokol, "Ispolnenie dolga," Pravda Ukrainy (May 11, 1986).

60. Shcherbak, p. 57.

61. Preduprezhdenie (1986 documentary film) and Shcherbak, pp. 57 and 59. See also A. Sokol, "Ubezhdat lichnym primerom," Pravda Ukrainy (May 11, 1986).

62. Martynova in Medvedev (p. 56) reports that upon receiving Brukhanov's call, her husband passed the information on to Frolyshev (deputy chief of the Machine Building Department of the CPSU Central Committee), who called candidate member of the CPSU, Dolgikh, who in turn contacted Gorbachev and other members of the Politburo. Shasharin in Medvedev (p. 61) indicates that he was in Yalta in a sanatorium on the morning of the 26th when at 3 AM he received a call about the accident from the Yalta department of the Ministry for Power and Electrificaiton.

63. E. Pershin. See also Andrei Illesh, "Sherenga nomer odin," Izvestiia (May 19, 1986).

64. Pershin.

65. Ibid.

66. Shcherbak, pp. 55-57; V. Korsunska, "Povynen -- znachyt mozhesh," Robitnycha gazeta (February 1, 1987).

67. Shcherbak, pp. 53-54; Andrei Illesh and Victor Loshak, "S samykh pervykh minut," Nedelia, No. 29, 1986, p. 11.

68. The Komsomol secretary of the Prypiat Gorkom, Perkovska, did not learn of the accident until 10 AM during the meeting of the

city aktiv. See Shcherbak, pp. 58-59 and Gagik Karapetian, "Reportazh iz Chernobylia," Zhurnalist, No. 11, 1987, p. 56.

69. In an interview with Shcherbak (p. 57), Yesaulov says that the gorispolkom's technical secretary was awakened by her neighbor who worked at the ChNPS. The secretary then woke up Yesaulov around 3:30 AM. However, it was neither the plant employee or secretary's responsibility to transmit such information.

70. Soviet officials have acknowledged that personnel dealing with the accident did not have all of the necessary equipment. A specific example cited at the IAEA was the absence of hydraulic lifts to place firefighters on the burning roofs of the plant. See U.S. Nuclear Regulatory Commission, Report on the Accident at the Chernobyl Nuclear Power Station (Washington, D.C.: January 1987), p. 7-6. See Shcherbak, p. 54 for eyewitness accounts, Shcherbak (p. 56) reports that a dosimeter able to accurately record levels at the plant did not arrive until shortly after 5 AM.

71. V. Zhukovsky, V. Itkin, and L. Chernenko, "Bytva bez linii fronty," Molod Ukrainy (May 8, 1986).

72. See Shcherbak, pp. 55-56 and Korsunska.

73. Shcherbak, p. 56.

74. Shcherbak, pp. 56 and 59.

75. See "Kak v boevoi obstanovke," Pravda (May 9, 1986); "Suvora perevirka," Literaturna Ukraina (May 22, 1986); and "Kak lechili geroev Chernobylya," Pravda Ukrainy (August 8, 1986).

76. V. Gubarev and M. Odinets, "Stantsia i vokrug nee," Pravda (May 6, 1986).

77. Published as N. V. Bekrestnov and V. Ph. Kozlov, "Aspects of Accident Management at Nuclear Power Plants in the USSR," in J. W. Lathrop, ed., Planning for Rare Events: Nuclear Accident Preparedness and Management (New York: Pergamon Press, 1981), pp. 147-151. The presentation is cited by the U.S. Nuclear Regulatory Commission, p. 7-2.

78. U.S. Nuclear Regulatory Commission, p. 7-2.

79. "Surove uroki Chernobylia."

80. See U.S. Nuclear Regulatory Commission, p. 7-5.

81. See Shcherbak, p. 57. Gagik Karapetian, in his review of Pralnikov and Illesh's book, Reportazh iz Chernobylia, summarizes the authors' report to the effect that "The alert signal did not

come to the civil defense headquarters and no measures were undertaken there."

82. Ibid.

83. The failure of civil defense organs to function properly was repeated in the aftermath of the Armenian earthquake and is discussed below in the section on "Soviet Military Performance." One plausible partial explanation for the poor performance of civil defense in Prypiat is that it was not taken seriously by much of the population, including some of the individuals who were supposed to administer it. The attitude may be that there is always someone else who will know what to do in a crisis and the belief/hope that they will not be directly involved. In the Soviet documentary film Preduprezhdenie, one nurse states that there were teams trained by Prypiat civil defense organs for nuclear emergencies. She claims, however, that her offer to help contact other team members to start their prescribed work was rejected as unnecessary by the Prypiat chief of civil defense.

84. See Bekrestnov, pp. 148-149 and U.S. Nuclear Regulatory Commission, p. 7-2.

85. There are several contending views regarding the issue of who actually decided to withhold information from the public. One view is that the decision was made by the Ukrainian leader Shcherbitsky. Another points the finger at Moscow and in particular the head of the government commission, Boris Shcherbina. Other variants of these views are: (1) Kiev obkom leaders (Revenko and Malomuzh) knew the real situation in Prypiat but concealed it from Shcherbitsky; (2) Shcherbitsky knew what happened but chose to minimize the accident and gave orders to downplay the significance and danger of the event; (3) Shcherbitsky knew what happened, told Malomuzh to take necessary measures to cope with the situation and essentially delegated authority and responsibility for dealing with the accident to Malomuzh and perhaps Revenko; (4) Moscow did not appreciate the scope of the accident until their own representatives reached the scene; (5) Moscow had a good grasp of the magnitude of the accident, but gave the Ukrainian leadership discretionary power to act as it saw fit; and (6) Moscow sought to conceal the real state of affairs from the world and pretended that there was no threat to the population in and around Prypiat.

86. Shcherbak, p. 59.

87. See K. Lubarsky, "Chernobylskaya tragediya," Strana i mir, No. 5 (1986) and No. 10 (1986); Shcherbak, pp. 58, 59, and 63.

88. A. Pralnikov, "Verdict Reached;" Preduprezhdenie; Shcherbak, p. 61.

89. Those outside of the power station who knew of the high level of radiation by Saturday morning were Malomuzh, Leonenko (the chief of Medical-Sanitary Unit #26), Leonenko's deputy (Pecheritsa), and probably Gamanyuk (first secretary of the Prypiat gorkom). It is possible that Voloshko (the chairman of the gorispolkom) also knew. The question of responsibility for failure to follow the safety procedures is raised in the documentary Preduprezhdenie, and also by Shcherbak, p. 63.

90. This is also the view of Professor Bohdan Kravchenko, Director of the Ukrainian Center at Edmonton University, who held numerous discussions with members of the Ukrainian Academy of Sciences (based on personal communication, Edmonton, August 1987).

91. Testimony of Vladimir Shishkin, deputy chief of Soyuzelektromontazh of USSR Minergo reported in Medvedev, p. 74.

92. Ibid., p. 73.

93. Ibid., p. 71.

94. Ibid., p. 75. One may infer from Medvedev's account that there were two different meetings on the evening of the 26th, an earlier one chaired by Mayorets before Shcherbina's arrival and a later one chaired by Shcherbina.

95. V. Legasov, "Moi dolg rasskazat vam....," Pravda (May 20, 1988), p. 3. It is unclear from published reports whether or not Shcherbina made the decision to evacuate before he actually viewed the reactor himself, which he did from a helicopter in "the radioactive nighttime sky." See Medvedev, p. 79.

96. For the text of the radio announcement see Shcherbak, p. 60. See also Lyubov Kovalevska, "Vy geroi, druzi moi," Literaturna Ukraina (April 23, 1987). Legasov, ("Moi dolg rasskazat vam....") says the evacuation was officially announced at 11 AM. Medvedev (p. 79) says that Shcherbina called for the evacuation to begin on the morning of the 27th. The reason for the delay is not known, although it may have been due to problems in securing sufficient buses.

97. "Po veleniu dolga," Sotsialisticheskaa industriia (May 16, 1986).

98. Ibid. See also "Byl i nebyl Chernobylia," Trud (May 8, 1986); Shcherbak, pp. 60-61; and V. Yavorivsky, "Maria s polynyi v kontse stoletiia," Druzhba narodov, No. 9, 1987, pp. 121-122.

99. Zhukovsky et al.

100. Shcherbak, pp. 56 and 63. See also Gubarev, "Sarcophagus," Znamia, No. 9 (1986), p. 105.

101. Shcherbak, p. 59; Yavorinsky; Kovalevska, "Vy geroi, druzi moi."

102. "Po veleniyu dolga" and Zhukovsky et al.

103. "Chas Vymoglyvykh otsinok," Radianska Ukraina (June 14, 1986) and "Raikom v eti dni," Pravda Ukrainy (May 13, 1986); O. Vinkurov, "Na vulytsi druzhby," Molod Ukrainy (May 14, 1986); A. Savytska, "Teplo dushi," Molod Ukrainy (May 14, 1986); and M. Starozhytska and Yu. Gavinsky, "Dii Nadii," Molod Ukrainy (May 17, 1986).

104. Shcherbak, p. 61.

105. See, for example, V. Vernodubenko, "Trassy vedut k Chernobyliu," Pravda Ukrainy (May 18, 1986) and K. Lavrova, "Dusha zhivaia," Komsomolskaia pravda (December 30, 1987).

106. Edward A. Warman, Notes of private discussions with Soviet delegates at Vienna meetings (September 5, 1986), p. 6, cited by Nuclear Regulatory Commission, p. 7-4. But see Shcherbak, pp. 56 and 59 and Yavorinsky, pp. 100, 102, 110.

107. This is the inference drawn in the Nuclear Regulatory Commission study, p. 7-4.

108. See Shcherbak, pp. 56 and 59 and Yavorivsky, pp. 100, 102 and 110.

109. As Marples notes, "the government rather than the party bore the brunt of the blame for accident." See "The Political and Economic Consequences of the Chernobyl Disaster on the USSR," paper prepared for the 1987 Annual Meeting of the American Political Science Association (September 1987), p. 11. Among government officials who lost their post were First Deputy Minister of Power and Electrification, G. Shasharin; Deptuy Director of the Institute for Energy Equipment Studies, Ivan Yemelyanov; and Chairman of the State Committee for Supervision of Safe Working Practices in the Atomic Energy Industry, Evgeny Kulov. Receiving severe reprimands were Minister of Power and Electrification, A. I. Mayorets; First Deputy Minister of Power and Electrification, Aleksei Makukhin; Deputy Chairman of the State Committee for the Supervision of Safe Working Practices in the Atomic Industry (SCSSWP), Viktor Sydorenko; and Deputy Chairman of the SCSSWP, M P. Alekseev. For a discussion of complaints that people who were fired or demoted were being forgiven see Marples, The Social Impact of the Chernobyl Disaster, p. 117.

110. Pravda (September 2, 1986) reported that 27 party members from the Kiev oblast were expelled for "cowardice and alarmism." Sixty-seven others received reprimands on their party cards. See Pravda Ukrainy (August 7, 1987). See also Roman Solchanyk, "Chernobyl:

Dismissals and Reprimands in the Ukraine," Radio Liberty Research, RL 309/86 (August 1986), pp. 20-34.

111. For accounts of the trial see Moscow News, No. 29 and 32 (1987) and Henry Hamman, "An Analysis of the Chernobyl Trial," Radio Liberty Research, RL 309/87 (July 29, 1987). See also the chapter on the trial in the revised edition of Andrei Illesh and Andrei Pralnikov, Reportazh iz Chernobylia (Moscow: Mysl, 1987).

112. On February 16, 1988 Gorbachev even presented Shcherbitsky with the Order of Lenin in recognition of his extensive services to the party and state.

113. Contrary to early indications, however, there no longer appears to be much prospect that the July 1987 trial will be expanded to include judicial hearings on other aspects of the Chernobyl disaster such as construction of the nuclear plant, the timing and organization of the evacuation, and the inadequacy of medical treatment for the evacuees. Alexander Kovalenko, information director at the Chernobyl plant suggested after the trial that there would be additional hearings. See Hamman, "Chernobyl Officials Get 10 Years," Financial Times European Energy Report, No. 245 (August 7, 1987), p. 2; and "Surove uroki Chernobylia."

114. See, for example, D. J. Peterson, "Supreme Soviet Passes Environmental Resolution," Radio Liberty Report on the USSR (December 8, 1989), pp. 7-8.

115. See Shcherbak, No. 6, pp. 62-63. Shcherbitksy did not visit the scene of the accident until May 2nd and made infrequent public comments about Chernobyl. By contrast, his Belorussian counterpart, N. N. Slyunkov, is reported to have flown to the contaminated zone in the southern part of Gomel oblast several times a week. See Marples, Chernobyl and Nuclear Power in the USSR, pp. 155-156.

116. Marples, "The Political and Economic Repercussions of the Chernobyl Disaster in the USSR," p. 7.

117. This report does not dwell on the failure of the Soviet government's strategy to retard the rising popular opposition to nuclear power in the Soviet Union. For an analysis of the post-Chernobyl debate over nuclear power see William Potter, "The Debate over Nuclear Power in the Soviet Union after Chernobyl," paper to be presented at the World Congress for Soviet and East European Studies, Harrogate, United Kingdom (July 21-26 1990).

118. The role of the armed forces is analyzed in a separate section.

119. Falin cited in Marples, Chernobyl and Nuclear Power in the USSR, p. 167.

120. The composition of the first teams from Moscow is provided in Grigorii Medvedev, pp. 66 and 70.

121. Despite recent claims that Soviet experience with the 1957 Urals accident helped the government cope with certain recovery efforts, there is no available evidence that the immediate Soviet response to Chernobyl was influenced by prior nuclear accidents. See Ann MacLachlan, "USSR Says Urals Accident Held Valuable Lessons for Chernobyl," Nucleonics Week (August 17, 1989), pp. 12-13.

122. For a discussion of the psychological unpreparedness of Soviet authorities for the Chernobyl accident see Marples, Chernobyl and Nuclear Power in the USSR, pp. 126-127. Grigorii Medvedev (pp. 22-23) also discusses the psychological issue from the vantage point of the nuclear operators. See also V. Gubarev, "K AES -- bez illyuzii i strakhov," Agitator (October 19, 1989), p. 29.

123. See Gorbachev's May 14 television address reported in Pravda (May 15, 1986). An earlier report in Pravda indicates that the Government Commission was set up under the auspices of the Council of Ministers. See "Sobitiam na Chernobylskoi AES," Pravda (May 6, 1986).

124. For a discussion of Soviet media policy regarding Chernobyl see Erik P. Hoffmann, "Nuclear Deception in Soviet Information Policy;" Marilyn J. Young and Michael K. Launer, "Signposts of Change and Chernobyl as a Media Event in the Soviet Union," paper presented to the Annual Meeting of the American Association for the Advancement of Slavic Studies, Honolulu (November 18-21, 1988), and Ellen Jones and Benjamin L. Woodbury, "Chernobyl' and Glasnost'," Problems of Communism (November-December 1986), pp. 28-39. Young and Launer (p. 3) report a statement by Vladimir Asmolov, who headed the design team for the Chernobyl entombment, that a radio announcement on the accident was first broadcast locally at mid-afternoon on the 26th. We are not aware of other such reports. A much more detailed analysis of the Soviet media's treatment of Chernobyl is provided in our book length study.

125. See Kevin Devlin, "Gorbachev in Minority at Politburo Meeting on Chernobyl, Medvedev Says," RAD Background Report 78, RFE/RL (June 5, 1986).

126. See Natalie Gross, "Glasnost': Roots and Practice," Problems of Communism (November-December, 1987), pp. 69-80.

127. Pravda, May 15, 1986, also cited by Hoffmann, p. 34.

128. Hoffmann, p. 34.

129. Ibid.

130. The text of the TASS announcement was: "An accident has occurred at the Chernobyl nuclear power plant as one of the reactors was damaged. Measures are being taken to eliminate the consequences of the accident. Aid is being given to those affected. A government commission has been set up.

131. See Young and Launer, p. 3.

132. See Jonathan Sanders, "Comrade X Was Wrong: Chernobyl's Fallout on the Blue Screen," paper presented at the 1987 meeting of the American Political Science Association, p. 38.

133. Ibid.

134. Ibid., pp. 37-38.

135. See E. Velikov cited in V. Gubarev and M. Odinets, "Bitva prodolzhaetsya," Pravda (May 13, 1986) and V. Legasov cited in A. Illyesh, "Neskol'ko interviu po odnomu voprosu," Izvestiia (May 13, 1986). Both Velikov and Legasov state that the accident was localized and the situation stabilized by May 11, 1986.

136. See Pravda, July 20, 1989 and also "The Lessons of Chernobyl," Moscow News, No. 30 (1986).

137. David Marples is incorrect when he implies that it only remained in operation until November 1986. See Marples, The Social Impact of the Chernobyl Disaster, p. 113. For a recent report on the ongoing activities of the Commission see "Chernobyl Commission Holds Session," "Vremia" newscast (September 16, 1989) in FBIS (September 18, 1989), p. 68.

138. M. Retnev, "Terminogo dlia Chernobylia," Robitnycha gazeta (May 29, 1986).

139. Grigorii Medvedev, "Chernobylskaia tetrad'," p. 70. Note that Mayorets at the time still believed that the reactor had not been fully destroyed.

140. Shasharin quoted in G. Medvedev, pp. 70-71.

141. See "V press tsentre MID SSSR," Pravda (May 6, 1986); "V press tsentre MID SSSR," Pravda (May 11, 1986); and N. Baklanov, "Stantsiya vozrozhdaetsya," Izvestiia (December 16, 1986).

142. For a discussion of the measures undertaken at the instigation of the Commission to reduce the consequences of the accident see the Soviet report to the IAEA, The Accident at the Chernobyl AES and Its Consequences, pp. 40-63. See also David Marples, The

Social Impact of the Chernobyl Disaster, pp. 161-193 for a description of work in the special zone.

143. See The Accident at the Chernobyl AES. A detailed account of the tasks implemented under the Government Commission's direction during the past three years in the Gomel oblast is provided in A. Gotovchits, "Uberechsia ot bedy," Sovetskaia Belorussiia (September 29, 1989).

144. See O. Ignatyev and M. Odinets, "Suvenir izpod reaktora," Pravda (June 27, 1986) and N. Lukovskii, M. Odinets, and O Gusev, "Vremia ispytanii," Pravda (May 16, 1986).

145. For a discussion by one Commission member of some of the equipment problems see V. Legasov, "Moi dolg rasskazat vam...."

146. O. Tertichnii, "Yak vylikivaty zemliu," Robitnicha gazeta (March 17, 1987).

147. See, for example, Yurii Smirnov, "Chernobyl' vyzyvaet na sviaz," Znamia iunosti (August 8, 1989); S. Prokopchuk, "Sela 'Zhestkogo rezhima,'" Trud (August 2, 1989); Vasily Yakovenko, "Bomba dlia Potomkov," Sovetskaia kultura (September 30, 1989); V. S. Lutsenko, "Atomnaia energetika - nadezhdy vedomstv: trevogi obshestva," Novyi mir (April 1989), p. 192; and T. Nemeshaeva, "Miliony - v pesok," Bryanskii rabochii (August 23, 1989).

148. See Smirnov. A Professor Lepin is quoted by Smirnov as recalling an incident in which the chief engineer of the "Kombinat" claimed that he would send a thousand men to be burned by radiation if needed to get work done on time.

149. See, for example, "V pravitel'stvennoi komissii po likvydatsii posledstvii avarii na Chernobylskoi AES," Pravda (September 29,1 989) and V. Gubarev, "Bez illyuzii i strakhov," Agitator (October 1989).

150. See Ibid.

151. Adam Stulberg and Betsy Perabo provided valuable research assistance for this section. We also profited from access to Leon Goure's The Chernobyl Accident Data Base: The Role of the Military (SAIC, August, 1988).

152. See Harriet Fast Scott and William F. Scott, The Soviet Control Structure: Capabilities for Wartime Survival (New York: Crane Russak, 1983), pp. 63 and 94; and N. Vybodovsky, "Nekotorye uroki Chernobylia," Voennyi Vestnik, No. 9, 1987.

153. A counselor at the French Embassy in Moscow visited Chernobyl near the end of May 1986 and estimated that approximately 10,000 military personnel were then present. Personal communication.

154. See testimony of Vladimir Pavlovich Voloshko, Chairman of the Prypiat Gorispolkom in Grigorii Medvedev, "Chernobylskaia Tetrad'," p. 66.

155. See V. Legasov, "Moi dolg rasskazat vam....," Pravda (May 20, 1988), pp. 3 and 8. For an analysis of the local response see William Potter and Lucy Kerner, "Soviet Decisionmaking for Chernobyl: An Assessment of Ukrainian Leadership Performance," Studies in Comparative Communism (Summer 1988), pp. 203-220.

156. See A. Gorokhov, "Zona otvetstvennosti," Pravda (December 25, 1986). Legasov mistakenly attributes the summoning of the Chemical Troops to Shcherbina.

157. See Lieutenant-General A. Kuntsevich on the Soviet television program "Sluzhu Sovetskomu Soiuzu" (April 25, 1988).

158. See the Ministry of Defense documentary, "Raion deistvia -- Chernobyl," shown on Soviet television in April 1988.

159. See Colonel General B. Ivanov, "Chernobyl: Liquidation of the Consequences," Voennye Znaniia, No. 4 (April 1988), p. 26 and the documentary, "Raion deistvia -- Chernobyl." According to one recent account, Chernobyl initially consumed much of Akhromeyev's time. See "Afghanistan: Podvodia itogi," Ogonek, No. 12 (1989), pp. 6-8, 30-31.

160. See Ivanov, p. 26. According to one source, Dolgopolov was replaced by Yu. Keleberda on May 9. See Gorokhov, "Voevaia rabota," Pravda (May 20, 1986).

161. "Afghanistan: Podvodia itogi."

162. See Scott and Scott, The Soviet Control Structure, pp. 65-67.

163. A. Gorokhov, "Zona otvetstvennosti," Pravda (December 25, 1986). See also Scott and Scott, The Armed Forces of the USSR, Second edition (Boulder: Westview Press, 1981), p. 246.

164. Ibid.

165. Ibid. Lieutenant Colonel A. Kushnin, Chief of the Chemical Troops of the Kiev Military District, did not arrive in Prypiat until the early morning of April 27.

166. For a description of these different tasks see A. Polyakov, "Posty u trassy," Krasnaia zvezda (May 18, 1986); Yu. Shcherbak, "Suvora perevirka," Literaturna Ukraina (May 22, 1986); A. Moroz, "Zona osobykh otnoshenii," Krasnaia zvezda (July 3, 1986); A. Polyakov, "Oni byli pervymi," Krasnaia zvezda (October 24, 1986); V. Itkin and O. Moskovskii, "V osoboi zone," Krasnaia zvezda (June 6, 1986); K. Zheleznov, "Oni byli pervymi," Voennyi vestnik, No.

9, 1986; V. Perov, "Chernobyl: One Year Later," Soviet Military Review (May 1987); Major General Timerkhanov, "V zone opasnosti," Voennye znaniia (January 1987); Colonel N. Vybodovskii, "Nekotorye uroki Chernobylya," Voennyi vestnik, No. 9, 1987; and Colonel General V. Pikalov, "Sovershenstvovat' zashchitu voisk," Voennyi vestnik (July 1987), pp. 18-21.

167. For an account of one unit's tasks see V. Zhitarenko, "Chernobyl: Vesna 1988 Goda," Krasnaia zvezda (April 23, 1988).

168. Major General N. Tarakanov, "Sekundy podviga," Krasnaia zvezda (December 9, 1986); Major General D. Timerkhanov, "U samogo reaktora," Voennye znaniia, No. 3, 1987; Yuri Zylyuk, "Polyn prozreniia," Komsomolets Kirgizii (August 19, 26; September 2, 16, 23, 30; October 7, 1987).

169. N. Vybodovskii, "Nekotorye uroki Chernobylya," Voennyi vestnik, No. 9, 1987; S. Lavrentia, "Energiia muzhestva," Kommunist Vooruzhennykh Sil, No. 13, 1987; A. Maroz; A. Kuntsevich, "Vozvrashchaias' k tem dniam," Krasnaia zvezda (April 24, 1989).

170. See Krasnaia zvezda (January 15, 1987), p. 1.

171. Colonel V. Moroz, "Zona otvetstvennosti," Krasnaia zvezda (December 25, 1987) and Gorokhov.

172. Especially explicit in this sense are the documentaries "Preduprezhdenie," "Kolokol Chernobylia," "Chernobyl: Khronika trudnykh nedel'," "Chernobyl: Dva tsveta vremeni," and "V nebe Chernobylia." See also the articles by Zylyuk, Timerkhanov, and Tarakanov.

173. See, for example, V. Moroz.

174. Ivanov.

175. Vybodovskii, p. 75.

176. Tarakanov and Zylyuk.

177. This information was corroborated in interviews with Soviet journalists in Moscow in 1988. See also Medvedev, "Chernobylskaia Tetrad'" and "The Chernobyl Accident from the Viewpoint of a Soviet Army Radiologist," Environmental Policy Review (January 1989), pp. 1-6.

178. V. Zhitarenko, "Chernobyl: Vesna 1988," Krasnaia zvezda (April 23, 1988).

179. Based on interviews with Soviet journalists, Moscow (October 1988). Many of the soldiers who used those machines during the

first month of the cleanup did not have adequate protective covering and received high dosages of radiation.

180. Ivanov, No. 2.

181. V. Kovalev, "Radiatsionnoi razvedkoi ustanovleno," Sovetskaia Belorussiia (August 3, 1986). See also Tarakanov.

182. Based on interviews with two participants in the post-Chernobyl, Alexander Chaikovskii and Eduard Armirov.

183. See Yu. Zylyuk, "Polyn prozreniya," "Kogda rabota po dushe," Voennye znaniia, No. 11, 1986, and interviews with Chaikovskii, Sineluikov, and Illesh.

184. Major E. Litvinenko, "Opasnost' byla realnoi," Voennyi vestnik (June 1987).

185. Shcherbak, Part 1, pp. 61-62.

186. Documentary "Chernobyl: Dva tsveta vremeni," Part 3.

187. Zylyuk.

188. See Nikolai Goshchinskii, "Upala zvezda polyn," Ogonek, No. 38, 1987, p. 27.

189. See Ivanov, Part 3. Shcherbina decided to initiate the evacuation in the afternoon of the 27th, despite Pikalov's opposition and his own reluctance to do so on the preceding day.

190. V. Legasov.

191. Colonel V. Filatov, "V chas ispytaniia," Krasnaia zvezda (June 7, 1986). See also Lt. Colonel V. Larin, "Liudi neobychnogo podviga," Aviatsiia i kosmonavtika (May 1987), pp. 28-31. Before leaving for Prypiat, Antoshkin realized that the helicopters would have to be relocated closer to the NPS and alerted their crews to be ready to move.

192. Oddly, Kushmin appears to have learned of the accident from Antoshkin. See Filatov.

193. Filatov.

194. A. Popov, "Komandirskaia zrelost'," Aviatsiia i kosmonavtika (September 9, 1987). See also Shcherbak, "Chernobyl," Yunost', No. 7, 1987, pp. 37-39.

195. According to Larin (p. 28), Antoshkin informed Shcherbina that aviation work could not be done at night. Several sources, however, suggest that some form of night operations, most likely

reconnaissance, were conducted after the helicopters were outfitted with proper lighting equipment. See A. Zhilin, "Chuzhoi bedy," Aviatsiia i kosmonavtika (August 1986), p. 10; Krasnaia zvezda (August 1986); and Krasnaia zvezda (December 6, 1986).

196. Other tasks assigned to the Air Force included aerial photography and radiation measurements, cargo and personnel transport, monitoring road traffic and dust suppression. For accounts of these activities see "Vertolety nad reaktorom," Aviatsiia i kosmonavtika, No. 7 (1986), pp. 14-15; A. Polyakov, "Sovetskii kharakter," Krasnaia zvezda (May 9, 1986); V. Zhukovskii, V. Itkin, and L. Chernenko, "Geroiskie parni Chernobylia," Sovetskaia Belorussiia (May 16, 1986); V. Itkin and L. Chernenko, "Chernobyl: budni podviga," Ekonomicheskaia gazeta, No. 23 (June 1986); V. Nikipelov, "Pod nami reaktor," Pravda Ukrainy (July 10, 1986); N. Baklanov, "Nad reaktorom -- vozdushnaia razvedka," Izvestiia (July 9, 1986); and A. Zhilin. See also David Marples, Chernobyl & Nuclear Power in the USSR, p. 160.

197. "Vertolety nad reaktorom."

198. Marples, p. 157. Shcherbina reportedly characterized the amount of sand dropped during the first day as insignificant. See Larin.

199. Larin.

200. Ibid.

201. Ibid.

202. These calculations are derived from figures provided in Filatov and Larin. See also SPC Dalziel, "Helicopters over Chernobyl," Soviet Studies Research Centre, Sandhurst (October 1986).

203. See, for example, Zhilin; V. Filatov and V. Ankov, "Pod nami reaktor," Krasnaia zvezda (May 16, 1986), p. 4; V. Shcherban, "Zvezda generala Antoshkina," Izvestiia (December 31, 1986); Major General V. Pavlov, "Gotovit k podvigu," Krasnaia zvezda (October 5, 1986); and V. Chernikov, "Nad povre zhdennym reaktorom," Znamenosets, No. 6, 1986.

204. Zhilin, p. 11 and Shcherbak, Yunost', No. 7 (1987), p. 38.

205. In the Soviet documentary, Preduprezhdenie, Legasov states that a person could receive 3-5 roentgens in a single flight over the reactor, even though this was not during the first few days after the accident. A. Krutov, a Soviet television commentator, describes the helicopter operations at Chernobyl as follows: "They [the helicopters] flew into the radioactive plume of gases over it and dropped bags of protective materials.... You can imagine the

dosages of radiation they received while flying over the damaged reactor during all the daylight hours." "Disturbing May at Chernobyl," "Vremia" news program, Moscow Television (June 13, 1986).

206. After the first four days the norm was to fly 20-22 missions a day, some crews occasionally performing 30 flights in a 24 hour period. See Preduprezhdenie; Filatov; and Shcherban.

207. Zhilin.

208. V. Legasov.

209. Ibid.

210. See Medvedev, "Chernobylskaia Tetrad'," p. 83. Although some Soviet sources indicate that lead shields were used on helicopters, it is not clear when such protective devices were introduced.

211. Preduprezhdenie.

212. V. Sinelnikov, the producer of the documentary Kolokol Chernobylia, revealed that he was aware of at least six helicopter accidents. Personal interview conducted in October 1988.

213. This is unlike "support" troops such as Construction and Billeting, the Rear Services, and Civil Defense which are subordinate to a deputy minister of defense.

214. V. K. Kharchenko, "Inzhenernye Voiska," Sovetskaia voennaia entsiklopediia (Moscow: Voenizdat, 1976-1980), Vol. 3, p. 344, cited in Harriet Fast Scott and William F. Scott, The Armed Forces of the USSR, p. 265.

215. Ibid. and V. Ya. Plyaskin, ed., Inzhenernoe obespechenie obshchevoiskovogo boia (Moscow: Voyenizdat, 1972), pp. 336-339.

216. SPC Dalziel, "The Role of Engineer Troops of the Soviet Army in the Chernobyl Clean-up Operation," Soviet Research Centre, Sandhurst (March 1987), p. 2.

217. Ibid. See also Vladislav Vinogradov, "Vozvrashchenie," Avrora, No. 3, 1987, p. 12.

218. Major V. Rodin, "At the Point of the Attack," Znamenosets, No. 7 (1986), p. 17 as cited in Dalziel, pp. 2-3.

219. See O. Gusev, "Chernobyl AES, Diary of Events: Robot Sent to Reactor," Pravda (May 19, 1986), p. 3. See also Dalziel, p. 4 and A. Illesh and A. Pralinkov, "V dvukh shagakh reaktorov," Izvestiia (May 21, 1986).

220. N. Vybodovskii, "Nekotorye uroki Chernobylya," Voennyi vestnik, No. 9 (1987), p. 75. See also Krasnaia zvezda (December 9, 1986), p. 2. A more positive assessment is provided by Gusev.

221. Ivanov, p. 27.

222. See Lieutenant Colonel A. Polyakov, "The Battalion Was Assigned a Mission," Krasnaia zvezda (May 14, 1986) and Polyakov, "A Guard on the Bridges and Dams," Krasnaia zvezda (March 18, 1987).

223. "Ramparts Keep Water Uncontaminated," Moscow Domestic Service in Russian, 1500 GMT, May 22, 1986 in Foreign Broadcast Information Service (FBIS), USSR National Affairs (May 23, 1986), p. R-8.

224. Lieutenant Colonel V. Baberdin, "Vigil at Chernobyl, Krasnaia zvezda (June 13, 1987), p. 3. See also "Interview with Colonel General A. I. Bezotosov, USSR Civil Defense Chief of Staff," Literaturnaia gazeta (April 15, 1987), p. 13 and A. Sokol, "Chistaya voda," Pravda Ukrainy (April 13, 1987).

225. M. Odinets, "Chernobylskaia AES: Khronika sobytii," Pravda (October 31, 1986), p. 6. See also Ye. Shimanko, "Moskvichi v Chernobyle," Moskovskaia pravda (November 5, 1986), p. 2.

226. The fears were twofold:(1) that contact would produce a tremendous explosion and (2) that the core would continue to burn through the earth, polluting the water table. See Dalziel, "The Role of Engineer Troops," p. 6.

227. Ivanov, "Chernobyl; 4: Liquidation of the Consequences," p. 27. Dalziel (p. 7), citing other Soviet sources, dates the completion of the drainage work as several days later. See also V. Nechiporenko, "Vagon dushi," Molod Ukrainy (September 3, 1986); Eduard Pershin, "Pershymy stupyly u vagon," Literaturna Ukraina (May 22, 1986); and A. Polyakov, "Ispytaniya," Krasnaia zvezda (June 21, 1987).

228. Colonel B. Lyapkalo, "Missiia sapyorov," Krasnaia zvezda (June 1, 1986).

229. Ivanov, "Chernobyl; 4: Liquidation of the Consequences, p. 27.

230. "Suvenir iz pod reaktora," Pravda (June 27, 1986). See also Dalziel, p. 8.

231. See Ivanov, Part 4, pp. 26-27.

232. See, for example, M. Odinets, "Stena iz betona," Pravda (August 6, 1986).

233. Prior to 1960 the Ministry of Internal Affairs was in charge of civil defense.

234. Although both Soviet and Western writings often refer to Troops of Civil Defense, it is unclear whether the forces exist as standing units or simply as a command structure which draws upon troops from other military branches. Organizationally, troops assigned to military districts of Civil Defense are distinguished from civil defense personnel reporting to chiefs of staff in the union republics, autonomous republics, autonomous oblasts, national okrugs, krais, oblasts, cities, and raions -- positions usually associated with the "civilian side of civil defense." For discussion of these distinctions see Scotts, The Soviet Control Structure, pp. 103-109.

235. Scotts, The Armed Forces of the USSR, p. 264.

236. Descriptions of these activities are provided in G. Bagdasarov, "Some of the Exploits," Voyennye znaniia (August 1986), pp. 10-11; B. Rudenko, "Contamination of the Exploit," Pozharnoe delo (July 1986), pp. 4-8; N. Baklanov, "Fighters and Commanders," Izvestiia (May 22, 1986); V. Korobkov, "Premiu na schyot No. 904," Pravda Ukrainy (December 17, 1986), p. 2; A. Kochevga, "When Work Is Close to One's Heart," Voyennye znaniia (November 1986), pp. 12-13. See also Bernd Knabe, Der Reaktorunfall im Kernkraftwerk Tschernobyl (Koln: Bundes-institut fur Ostwissenchaftliche und Inernationale Studes, 1986).

237. See Colonel General B. Ivanov, "Chernobyl," Voyennye znaniia (January 1988), pp. 32-33; Ivanov, "Chernobyl; 2: 'Better the Bitter Truth,'" Voyennye znaniia (February 1988), pp. 22-23; Ivanov, "Chernobyl; 3: Education," Voyennye znaniia (March 1988), pp. 38-39; Ivanov, "Chernobyl; 4: Liquidation of the Consequences," Voyennye znaniia (April 1988), pp. 26-27.

238. See Ivanov, "Chernobyl," pp. 32-33 for a discussion of the channels of communication between the Chief of Civil Defense at the Chernobyl nuclear power station, the Kiev Oblast Civil Defense staff, and the Ukrainian Civil Defense staff.

239. Ibid.

240. Ibid.

241. Ivanov, Part 4, p. 33.

242. Ibid.

243. See A. Zaitsev, "Problemy zhdut resheniia," Voyennye znaniia (May 1987), pp. 20-21 and N. Belan "Vzone osobogo vnimaniia," Kommunist vooruzhennykh sil, No. 2 (1987), p. 65.

244. O. Korolev, "Derzhat ekzamen vazvedchiki," Voennye znaniia, No. 12 (1988), p. 10.

245. E. Prokhorov, "Do soznaniia kazhdogo," Voyennye znaniia (April 1987), p. 27.

246. Ibid. Civil defense films were also the subject of criticism because of their weak content and antiquated cinematographic form.

247. For details of this negligence see Potter and Kerner, "Soviet Decisionmaking for Chernobyl: An Assessment of Ukrainian Performance," pp. 215-217. See also Ivanov, "Chernobyl," pp. 32-33 and Yuri Shcherbak, "Chernobyl," Yunost', No. 6 (1987).

248. See, for example, V. Korobkov.

249. See Ivanov.

250. Krasnaia zvezda (September 24, 1986).

251. Adam Stulberg's research was particularly useful in preparing this section.

252. See, for example, Krasnaia zvezda (July 19, 1987), p. 3; D. Yazor, "Perestroika v rabote voennyk Kadrov," Voenno storicheskii zhurnal, No. 7 (1987).

253. Ivanov, Part 3, p. 39. See also A. Bezotosov, "Sovetskaia voennaia doktrina i aktual'nye problemy grazhdanskoi oborony," Voennye znaniia, No. 11 (1987), pp. 18-19.

254. See Bezotosov, p. 19; Prokhorov, p. 10; and V. Borlsovskii, "Glavnoe praktika," Voennye znaniia, No. 3 (1987), p. 29. Disciplinary problems were reportedly especially widespread among Estonian military reservists conscripted for decontamination work. According to articles published in the Estonian language Communist Youth paper, Noorte Haal, there were "work stoppages" and "uprisings" instigated by Estonian conscripts disgruntled by the unexpected extension of their service from two to four months.

255. As one Soviet airman put it, "people have turned out to be stronger than metal...." See JPRS - UPS - 86 - 038, p. 152.

256. The impact of the Chernobyl experience on Soviet military performance in the aftermath of the 1988 Armenian earthquake is discussed below.

257. Betsy Perabo provided valuable research assistance on this topic.

258. "Civil Defense Work in Armenia Described," Interview with Army General V. S. Govorov, USSR Deputy Defense Minister and Civil Defense Chief, Yerevan Kommunist (December 31, 1988), p. 3 in FBIS (January 12, 1989). General Lieutenant A. Kopochkin reports the much higher figure of 85,000 nonparamilitary Civil Defense workers, although this number is not corroborated elsewhere. See "Armiia otkliknulas' nemedleno," Krasnaia zvezda (December 10, 1989), p. 1.

259. "Gory v Shramak," Voennye znaniia (April 1989), pp. 22-23.

260. See S. Bablumyan et al., "Place of Service -- Spitak," Izvestiia (December 17, 1988), pp. 1, 6. See also "Civil Defense Importance Cited," Komsomolskaia Pravda (December 12, 1989), p. 4.

261. "Days of Grief, Days of Help: In the Epicenter of Disaster," Nedelia (December 12-18, 1988), p. 3.

262. N. Krivomazov et al., "Linked by Pain," Pravda (December 12, 1988).

263. "Yazov Remarks on Army Role," TASS International Service in Russian 1215 GMT, December 30, 1988 cited in FBIS (January 3, 1989). Interestingly, the English language summary by TASS an hour later was less specific and less harsh in its criticism of the Civil Defense units and their leadership.

264. See "Civil Defense Work in Armenia Described," p. 3.

265. Ibid.

266. Ibid.

267. "Vtoroi etap -- vostanovlenie," Pravda (December 21, 1988), p. 2.

268. "Bol' v kazhdom serdtse," Krasnaia zvezda (December 11, 1988), p. 4.

269. See, for example, "Armenia: Novaia situatsiia dlia meditsiny," Krasnaia zvezda (December 28, 1989), p. 4.

270. V. Sinutin, "Bespravnost'," Voennye znaniia (May 1989), p. 32.

271. V. Boichukom in interview with A. Zaitsev, "Uchityvat' prognoziruemye situatsii," Voennye znaniia (May 1989), p. 32.

272. A. Voronko, "Ne ukhodit ot otvetstvennosti," Voennye znaniia (March 1989), p. 28.

273. R. Matolich, "A naverkhu -- stil'," Voennye znaniia (April 1989), p. 19.

274. See A. Zaitsev, "Ne boizat'sia oshibok," Voennye znaniia (April 1989), pp. 18-19.

275. This section of the report is part my larger study on U.S. and Soviet policy innovation in nuclear safety. Donna Gold provided valuable research assistance for this section.

276. For prior efforts to conceptualize Soviet decisionmaking as a sequential process see William C. Potter, "The Study of Soviet Decisionmaking for National Security: What Is to Be Done?" in Jiri Valenta and William Potter, eds., Soviet Decisionmaking for National Security (Boston: Allen & Unwin, 1984), pp. 298-307 and Potter, "Sources of Policy Change: Insights from the Policy Sciences," paper prepared for the Conference on the Domestic Sources of Soviet Foreign Policy," UCLA, Los Angeles (October 10-11, 1985). See also the related frameworks of analysis suggested by Zbigniew Brzezinski and Samuel Huntington, Political Power: USA/USSR (New York: Vintage Press, 1963), pp. 202-223 and Gail Lapidus, "The Study of Contemporary Soviet Policy-making: A Review and Research Agenda," paper prepared for the Workshop on Contemporary Soviet Policy-making, Berkeley (August 1980).

277. The other phases are discussed in our forthcoming book.

278. Brzezinski and Huntington, p. 18.

279. Lapidus, p. 21.

280. See Peter Bachrach and Morton Baratz, "Two Faces of Power," American Political Science Review (December 1962), pp. 947-952.

281. This section draws upon Donna Gold's "Agenda-Setting in Soviet Domestic Politics: The Case of Nuclear Safety Policy," paper presented ot the annual conference of the American Association for the Advancement of Slavic Studies, Honolulu (November 18-21, 1988).

282. See Charles D. Elder and Rober Cobb, "Agenda-Building and the Politics of Aging," Policy Studies Journal (September 1984), p. 115.

283. Principal spokesmen on the issue included Andranik Petrosyants, chairman of the USSR State Committee for the Utilization of Atomic Energy; V. S. Yemelyanov, deputy chairman of the State Committee for Atomic Energy; Aleksandr Aleksandrov, president of the USSR Academy of Sciences; and P. S. Neporozhny, minister of Power and Electrification.

284. TASS Report, April 25, 1987 in FBIS (April 28, 1987), p. R1.

285. Elena Knorre, "The Atom of Progress," New Times, No. 13 (1976), p. 19.

286. Ibid.

287. Elder and Cobb, p. 127.

288. Elder and Cobb (p. 123) suggest that "Although we normally tend to think of solutions as being generated by problems, in a very real sense it is the availability of 'solutions' that make problems possible."

289. See interview with Valery Legasov and Leonid Ilin in TASS Report (May 14, 1982) in FBIS (May 14, 1982), p. U1.

290. Sotsialisticheskaia industriia (January 30, 1981), p. 2. in FBIS (February 5, 1981), p. 53.

291. See Izvestiia (August 20, 1983).

292. See Gold, p. 32.

293. See "The USSR Nuclear Power Program: Report of the USSR Reactor Delegation," Nuclear News (October 1970), pp. 20-24. See also Gold, pp. 32-33 and Joseph Lewin, "The Russian Approach to Nuclear Reactor Safety," Nuclear Safety (July/August 1977), pp. 438-450.

294. See, for example, E. P. Anan'ev and G. N. Kruzhilin, "Radioactive Safety Barriers in Nuclear Power Stations," Soviet Atomic Energy (July 1974), pp. 701-703 and V. A. Sidovenko, "Present-day Problems of Safe Operation of Nuclear Power Stations," Thermal Engineering, Vol. 23, No. 2, 1976, p. 9. Anan'ev and Kruzhilin (p. 701) even quote an executive of Westinghouse who in 1955 is alleged to have admitted that containment vessels were expensive and would be phased out in time in the United States.

295. Zhores Medvedev, "The Soviet Nuclear Energy Programme: The Road to Chernobyl," p. 16 argues that in fact "It was not so much considerations of economic efficiency, safety or institutional support which... gave priority to the RBMK system in the late 1950s and 1960s, it was simply easier for the Soviet industry to manage the less sophisticated design." For positive assessments of the RBMK, including its safety features, see B. A. Semenov, "Nuclear Power in the Soviet Union," IAEA Bulletin (June 1983), p. 51 and N. A. Dollezhal and I. Ya. Yemelyanov, "Experience in the Construction of Large Power Reactors in the USSR," Soviet Atomic Energy (February 1976), p. 138.

296. For a review of the relevant Soviet literature see Sergei Voronitsyn, "Further Debate on Safety of Nuclear Power Stations in the USSR," Radio Free Europe/Radio Liberty No. 350 (September 7, 1981). One of the most thoughtful and sophisticated Soviet analyses of the potential safety problem is provided by M. Kh. Ibragimov, "Technical Aspects of Nuclear Power Plant Reliability

and Safety," in John W. Lathup, ed., Planning for Rare Events: Nuclear Accident Preparedness and Management (New York: Pergamon, 1981), pp. 209-217.

297. See Petr L. Kapitsa, "Energiia i fizika," Vestnik akademiia nauk, Vol. 1, 1976, pp. 34-43.

298. N. Dollezhal and Iu. Koryakin, Pravda (July 14, 1976), p. 3 and Kommunist (September 1979), pp. 19-28.

299. See Izvestiia (April 11, 1976 and May 3, 1976), Robert C. Toth, "Russ Try to Ease Doubts on A-Power," Los Angeles Times (May 30, 1976) and Nucleonics Week (December 20, 1979), p. 6. I have not been able to identify any public attack on the 1976 Dollezhal-Koryakin article.

300. Zhores Medvedev hints at this connection in "Innovation and Conservatism in the New Soviet Leaderhip," New Left Review (May-June 1986), p. 12. This linkage was also noted by David A. Hillinck, Chernobyl and Soviet Politics, unpublished masters' thesis, London School of Economics (September 15, 1987), p. 50 and Gold, p. 44.

301. The first announced cancellation involved a nuclear power plant near Krasnodar. See K. Aksenov, "Tishina nad Perepravnoi," Pravda (January 21, 1988).

302. See John Kingdom, Agendas, Alternatives and Public Policies (Boston: Little, Brown, and Co., 1984), pp. 99-105. I am thankful to Donna Gold for bringing this concept to my attention.

303. See, for example, Gary D. Brewer, "On the Theory and Practice of Innovation," Technology in Science, Vol. 2 (1980), pp. 337-363; George W. Downs, Jr. and Lawrence D. Mohr, "Toward a Theory of Innovation," Administration and Society (February 1979), pp. 379-408; and Stephen L. Elkin, "Toward a Contextual Theory of Innovation," Policy Sciences (August 1983), pp. 367-387.

304. See Soviet Report to the IAEA, Section 5.

305. For a technical discussion of specific characteristics envisaged see V. G. Asmolov et al., "The Chernobyl Accident: One Yera Later," Soviet Atomic Energy, Vol. 64, No. 1 (1988), pp. 20-22. See also Ann MacLachlan, "Chernobyl Aftermath," Nucleonics Week, p. 8.

306. "Chernobyl Today," IAEA News Features (1988), p. 3. See also V. Asmolov et al., "Increasing the Safety of Atomic Power Stations with RBMK Reactors," Atomnaia energiia (April 1987), pp. 219-226.

307. Brian Jordan, "Top USSR Decision-Makers Veto More RBMKs, Order Safety Backfits," Nucleonics Week (May 4, 1989), pp. 1 and 10-11.

308. See, for example, L. Kanaykina, "For Operator Training," Pravda Ukrainy (July 15, 1987), p. 2 in JPRS, Soviet Union, Economic Affairs (November 5, 1987); Ann MacLachlan, "Soviets Upgrading Operator Training to Prevent Chernobyl Repeat," Nucleonics Week (October 22, 1987), pp. 11-12; and O. D. Kazachkouskii, "Some General Principles for Improving Nuclear Safety," Atomnaia energiia (April 1988), pp. 243-248.

309. "USSR: Chernobyl Integrated into Operator Training," Nucleonics Week (September 21, 1989), p. 14.

310. Legasov cited in "Official on Nuclear Plant Safety Measures," FBIS (November 23,1 987), p. 64.

311. Ibid.

312. See T. M. Kott, "Expert Systems for Analyzing Emergencies at AES Power Units," Energetika i elektrofikatsiia (October-December 1987), pp. 8-11 in JPRS, Soviet Union, Economic Affairs (May 5, 1988), pp. 38-41.

313. See Z. Shupayeva, "Safety Above All -- Reporting from the Ignalinskaia AES," Sovetskaia Litva (November 1987), p. 3 in JPRS, Soviet Union, Economic Affairs (February 12, 1988), pp. 39-41.

314. See the March 16, 1988, memorandum by Steve Blush on January 1988 discussions held between the Soviet Union and the National Academy of Science Panel on Cooperation with the USSR on Reactor Safety. Blush's trip report provides an excellent survey of the new safety-related research activities triggered by the Chernobyl accident.

315. Ibid., p. 2.

316. Ibid., pp. 4-5. See also V. G. Asmolov et al., "Development of Nuclear Power Plant Safety Research in the USSR," in Steve Salomn, "Report on the First Meeting of the Working Groups of the U.S.-USSR Joint Coordinating Committee for Civilian Nuclear Reactor Safety," U.S. Nuclear Regulatory Commission (May 1989), Appendix G, pp. 7-8.

317. Ibid., p. 11. See also Mark Hibbs, "Soviet Experts Set Major Accident Risk Maximum at One in 10 Million," Nucleonics Week (September 21, 1989), pp. 7-8; "Security Measures Improving at Nuclear Power Plants," Moscow News, Documents Supplement (February 14-21, 1988), p. 8; and "Putting Passive Safety into Practice at the Gorky/Voronezh AST-500 Plants," Nuclear Engineering International (July 1989), pp. 18-22.

318. Blush, p. 8. See also Nikolai Ponomarev-Stepnoi, "Measures Taken to Improve the Safety of Nuclear Power Plants in the USSR after the Chernobyl Accident," Report to the 15th Water Reactor

Safety Information Meeting, Gathersburg, Maryland (October 26-27, 1987).

319. The number of proposed international nuclear safety cooperation ventures of both a private sector and governmental nature are voluminous and are reported reguarly in such nuclear trade journals as Nucleonics Week, Nuclear News, and Nuclear Engineering International. A computer-based listing of all nuclear safety-oriented international accords is maintained by the MIIS/CISA Project on the Emergin Nuclear Suppliers and Nonproliferation and is available from the author. For illustrative nuclear cooperation activities with the United States see Salomon and Michael B. Congdon, "Effects of Chernobyl on Opening the Soviet Union to International Cooperation in Nuclear Safety," paper presented to the annual meeting of the American Association for the Advancement of Slavic Studies, Honolulu (November 1988).

320. See Pravda (July 20, 1986), pp. 1 and 3.

321. Ibid.

322. This difficulty was repeatedly expressed to the author by U.S. government officials engaged in nuclear cooperation activities with the Soviet Union. It is compounded by the similarity of some of the agency names and a lack of consistency in translating them into English.

323. Personal communication, October 1989.

324. The full Russian name is Gosudarstvennyi komitet SSSR po Narodu za bezopasnym vedeniem rabot v atomnoi energetike. For a description of GAEN's origins and responsibilities see "Improving Safety Practices in the Soviet Union," Nuclear Engineering International (March 1989), pp. 13-16. See also "Stronger Supervision after Chernobyl," Nuclear News (January 1987), p. 63, U.S. Nuclear Regulatory Commission, Report of the Visit of a U.S. Nuclear Safety Delegation to the Soviet Union, August 19-31, 1988 (Washington, D.C., USNRC, March 1989), pp. 17-19. For useful information on Soviet organization for nuclear safety prior to Chernobyl see Lewin, 445; B. A. Semenov, "Nuclear Power in the Soviet Union," IAEA Bulletin, Vol. 25, No. 2 (1983), pp. 53-54. See also C. Osakwe, "Nuclear Energy," in F. J. M. Feldbrugge et al., eds., Encyclopedia of Soviet Law, Second Revised Edition (Boston: Martin Nijhoff, 1985), pp. 542-546.

325. See Donald Barry, "A Law on Atomic Energy, Preliminary Observations," preliminary comments on a paper to be presented at the University of Bridgeport Symposium on Soviet Legislation, 1986-1990 (September 1987) and "List of Soviet Nuclear Safety Organizations Represented at Seventh Joint Committee Meeting," April 18, 1988.

326. See Izvestiia (July 21, 1986), p. 1.

327. See "Malyshev to Head Nuclear Safety Body," JPRS (July 28, 1989), pp. 27-28 and "An New Ministry Has Been Formed in the USSR," Nuclear News (August 1989), p. 19.

328. "Nuclear Plant Licensing Process Being Developed," Nuclear News (November 1989), pp. 72-73.

329. See, for example, Ann MacLachlan, "Soviet Equivalent of INPO Pushes to Reduce Scrams in New Units," Nucleonics Week (May 19, 1988), pp. 2-3; and Simon Ripon, "Chernobyl Two Years Later," Nuclear News (May 1988), pp. 79-80. A. March 2-13 , 1987 "Report of a Trip to the USSR by an NRC-DOE Nuclear Safety Team," however, identifies the Institute as being created at the end of 1979 (p. 10). If so, it would have to have been affiliated with another ministry prior to 1986.

330. See, for example, Rippon, p. 80 and "Stronger Supervision after Chernobyl," Nuclear News (January 1987), p. 64.

331. See "Report of a Trip to the USSR by an NRC-DOE Nuclear Safety Team," pp. 10-11.

332. Rippon, p. 80.

333. Unfortunately, I have yet to see reference to the new body in the Soviet press. Western publications refer to the new agency variously as the Ministry for Nuclear Power Engineering and the Nuclear Power Industry; the Ministry for Nuclear Power, Engineering, and Industry; and the Ministry of Nuclear Power Engineering and Industry. See "Soviet Ministries Restructured," Nuclear Engineering International (September 1989), p. 11; "Late News in Brief," Nuclear News (August 1989), p. 19; and Ann MacLachlan, "Soviet Nuclear Reorganization to Be Finalized by November 1," Nucleonics Week (October 5, 1989), p. 2. I have used the designation as it was reported by Soviet nuclear officials to the U.S. Department of State.

334. Personal communication with U.S. government official (December 1989).

335. See "Late News in Brief," Nuclear News (August 1989), p. 19.

336. Ryzhkov cited in "Soviets Ponder Reorganization," Nuclear Engineering International (August 1989), p. 10.

337. See "WANO is born," Nuclear Engineering International (July 1989).

338. See "USSR Academy of Sciences to Create Institute of Nuclear Safety," Nucleonics Week (February 16, 1989), p. 3; and Ann MacLachlan and Ray Silver, "West and East Debate Chernobyl Sequence at Sochi Meeting," Nucleonics Week (December 7, 1989), pp. 1, 11-12.

339. See "Soviet Streamlining Will Revamp Nuclear Agencies," Nuclear News (July 1989), p. 109; and "Echo of Chernobyl," TASS Report (September 15, 1989) in FBIS (September 20, 1989), p. 68.

340. Many of these factors are discussed in Gary Brewer and Peter deLeon, The Foundations of Policy Analysis (Homewood: Dorsey Press, 1983), pp. 265-274; and Martin Rein and Francine Rabinowitz, "Implementation: A Theoretical Perspective," in Walter Dean Burnham and Martha Wagner Weinberg, eds., American Politics and Public Policy (Cambridge, MA: MIT Press, 1978), pp. 325-330.

341. Michael Lipsky, "Standing the Study of Public Policy Implementation on Its Head," in Burnham and Weinberg, p. 400.

342. Edward A. Warman, "New Observations of Soviet Nuclear Power," Nuclear News (November 1989), p. 68. The Soviets plan to further reduce the scram time to 2 seconds over the course of the next two years.

343. "Moscow Meeting Produces Optimism," News Review Comment (September 1988), p. 4. See also U.S. Nuclear Regulatory Commission, Report on the Visit of a U.S. Nuclear Safety Delegation to the Soviet Union, August 19-31, 1988 (Washington, D.C., USNRC, March 1989),. p. H-1.

344. See GKAE Chairman Protsenko quoted in Ann MacLachlan, "USSR Seeks Public Acceptance of Improved Reactor Designs," Nucleonics Week (September 29, 1988), p. 2. Some members of U.S. nuclear delegations to the Soviet Union also have been critical of the pace at which promised technical changes have been made although they are reluctant to state these publicly.

345. See "New Soviet Simulation Centre," Nuclear Engineering International (April 1988), p. 7 and N. Baklanov and A. Illesh, "Chernobyl: Third Difficult April," Izvestiia (April 25, 1988), p. 4 in FBIS (April 26, 1988), p. 57. For a description of a Soviet nuclear accident simulation see Yu. Barov, "The Alarm Has Sounded: Results of Training at the Baklovo Nuclear Power Station," Sovetskaia Rossiia (June 17, 1987), p. 6 in JPRS (November 5, 1987), pp. 62-65.

346. See Armen Abagyan quoted in "USSR Seeking Thomson-CSF Help in Simulators," Nucleonics Week (October 15, 1987), p. 1 and Clyde Farnsworth, "U.S. Said to Weigh New Export Rules for Eastern Bloc," New York Times (December 17, 1989), pp. 1 and 15.

347. This issue is discussed more fully under the section on "Policy Termination" in our longer study.

348. See Ann MacLachlan and Danielle Weaver, "Top USSR Decision-Makers Veto More RBMKs, Order Safety Backfits," Nucleonics Week (May 4, 1989), pp. 1, 10-11.

349. See "Ann MacLachlan, 'Soviets Report Development of Enhanced," Safer RBMK-1500," Nucleonics Week (March 24, 1988), pp. 1 and 10.

350. See "UK to Assess RBMK," Nuclear Engineering International (August 1989), p. 10. The director of the Leningrad RBMK plant is quoted in the article to have recently said "We want to prove that this [RBMK] type of reactor is certainly no worse and possibly better than a VVER."

351. Interview with U.S. government official (October 15, 1987). Another U.S. official, however, has observed that it is precisely the absence of written procedures for operations in the nuclear plant control room that pose a problem. Personal communication (October 1989).

352. The extent to which the scientific community and especially its leadership has actually internalized new norms as opposed to adjusting behavior in the face of failure is difficult to assess. One of the more positive statements suggesting a change in outlook is provided in Asmolov, "The USSR Approach to Safety Studies." The memoir of Valery Legasov, published after his suicide in 1988, convey a less flattering picture of the Soviet scientific establishment and its receptivity to change.

353. V. Gubarev and M. Odinets, "Chernobyl: Two Years On. The 'Zone's' Echo," Pravda (April 24, 1988), p. 3 in FBIS (April 26, 1988), pp. 61-62.

354. "Remarks by Deputy Shcherbak," Moscow Television (July 14, 1989) in JPRS (July 28, 1989), p. 27.

355. See, for example, "Impressions of the Chernobyl Plant," Nuclear News (July 1989), p. 61 and Mark Hibbs, "Atop the Graphite Pile Cap at Leningrad 1," Nucleonics Week (May 25, 1989), p. 8.

356. A. Protsenko, "Nuclear Power after Chernobyl," Pravda (September 6, 1988), p. 3 in FBIS (September 13, 1988), p. 57.

357. "Text of Disciplinary Statute for Workers in the USSR Gosatomenergonadzor System," Sobranie postanovlenyi pravitel'stva Soyuza Sovetskikh Sotsialisticheskikh Respublik, No. 2, 1988, pp. 19-29 in JPRS (April 29, 1988), pp. 65-66.

358. Ibid., pp. 66-67.

359. V. Abramova quoted by N. Baklanov and I. Illesh, "Chernobyl: Third Difficult April," Izvestiia (April 25, 1988), p. 4 in FBIS (April 26, 1988), p. 58.

360. Ibid.

361. This account was provided to me by a U.S. government official who had recently discussed GAEN's operation with the agency's representatives in Moscow.

362. Interview with a senior Soviet econometrician (March 24, 1987).

363. See Jack Snyder, "Science and Sovietology: Bridging the Methods Gap in Soviet Foreign Policy Studies," World Politics (January 1988), pp. and Robert Legvold, "War Weapons and Soviet Foreign Policy," in Seweryn Bialer and Michael Mandelbaum, eds., Gorbachev's Russian and American Foreign Policy (Boulder: Westview Press, 1988), p. 120.

364. One recent example is the report to the IAEA on the 1957 Urals accident. A much longer nine volume study of the accident reportedly will soon be issued.

365. For charges that the government has not yet abandoned its effort to curb glasnost in the area of nuclear power see N. Baklanov and A. Illesh, "At the Station, in the Zone, and Nearby...," Izvestiia (April 26, 1989), p. 6 and A. Illesh, "Nuclear Electric Power Stations without Secrets," Izvestiia (May 6, 1989), p. 2. See also "New Soviet Curbs on Press," Los Angeles Times (April 27, 1989) and David Marples, "Third Anniversary of Chernobyl Disaster," Radio Liberty (May 19, 1989), p. 25.

366. See, for example, his May 14th address.

367. See Stephen M. Meyer, "The Sources and Prospects of Gorbachev's New Political Thinking on Security," International Security (Fall 1988), pp. 124-165.

368. Personal interview conducted in Warsaw (December 1987) and Budapest (December 1988).

369. For a discussion of these issues see William Potter, "The Debate over Nuclear Power in the Soviet Union after Chernobyl," and David Marples, The Social Impact of the Chernobyl Disaster, pp. 239-278.

370. See "Russia's Greens: The Poisoned Giant Wakes Up," The Economist (November 4, 1989, pp. 23-26 and Jonathan Peterson, "A Green Baltic - the Growth of Green Movements in Estonia, Latvia, and Lithuania," Unpublished paper, Monterey, CA (December 19, 1989). The Center for Russian and Soviet Studies at the Monterey

Institute of International Studies maintains an extensive television broadcast archive and print database on "The Politics of the Environment in the Soviet Union."

371. For a relevant empirical study of the hypothesis that increased concern with the risks of new technologies by certain groups is partly a surrogate for underlying ideological criticism of U. S. society see Stanley Rothman and S. Robert Lichter, "Elite Ideology and Risk Perception in Nuclear Energy Policy," American Political Science Review (June 1987), pp. 383-395.

372. Until recently the Soviet Union has been wary of environmental cooperation at the international level. For a review of its approach to environmental issues and some indicators of change in Soviet thinking see Philip R. Pryde, "The Future Environmental Agenda of the USSR," Soviet Geography (June 1988), pp. 555-567 and Charles Ziegler, Environmental Policy in the USSR (Amherst: University of Massachusetts Press, 1987), pp. 134-153.

373. See E. Kolesnikova, "Versia Brukhanova," Sotsialisticheskaia industriia (September 17, 1989), p. 3.

374. Brukhanov's account, I have been told, is consistent with the observations of the U.S. nuclear specialist who resided at a Soviet nuclear power plant as part of the April 1988 U.S.-Soviet Memorandum of Cooperation in the Field of Civilian Nuclear Reactor Safety. Personal communication, October 1989.

375. Kolesnikova, p. 3.

376. Ibid.