Chernobyl Summary

WHAT HAPPENED

The accident occurred during low power testing when the reactor power surged from 200 megawatts to about 1600 megawatts (At full power the reactor produces 3200 megawatts.) We believe that either faulty control rod manipulation or loss of cooling water initiated the accident.

-- Within seconds the fuel overheated and chemical reactions began producing hydrogen.

-- A hydrogen explosion occurred -- apparently within minutes -- damaging the reactor and starting fires in the reactor building.

-- Damage to the reactor was so severe that it was impossible to remove heat and the 1700 tons of graphite in the reactor core were heated to the ignition point.

-- The explosion blew radioactive debris into the environment. The fire continued to expel radioactive materials from the core.

Reactor Status

The damaged reactor continued to burn for about 2 weeks.

-- The high temperatures -- thousands of degrees -- threatened to destroy critical safety systems in the adjacent reactor. Heroic efforts were required to save this reactor from destruction.

-- A combination of improvisation -- using helicopters to drop thousands of tons of materials into the burning reactor -- and heroism by technicians who were able to enter the building while the reactor blazed, finally stabalized the situation.

RECOVERY OPERATIONS

High radiation levels at the site have made recovery operations difficult.

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-- In areas near the reactor the levels are so high that only remotely operated equipment could be used. A shielded above ground concrete tunnel is now being constructed to allow people access around the reactor building.

-- At greater distances access is possible, but workers are receiving the maximum allowable dose of 25 rem in 15 to 20 working hours. (Under similar circumstances the US would allow only 3 rem.)

-- Operations are greatly hindered by blowing radioactive dust. Materials are being sprayed from helicopters to cover the ground and immobilize airborne contaminants.

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-- A tunnel has been dug under unit 4 and preparations are underway to construct a concrete structure under the building.

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RADIOLOGICAL EFFECTS

Acute Radiation Sickness

--About 299 people have been hospitalized for acute radiation sickness of the first to fourth degree, 18 of these victims were described as being of the fourth degree. This indicates that at least 18 persons received highly lethal radiation doses.

--[redacted] some persons had received more than 800-900 rads. (About 450 rads will be lethal to 50 percent of those exposed, assuming no medical intervention. One rad is equivalent to the radiation dose of 50 chest X-rays.) 25X1

--[redacted] about 85 of the victims are in serious condition, overall. 25X1

--Thus far, 23 of the radiation victims have died; 12 of these had received bone marrow transplants. Two persons died in the initial fire/explosions.

--Most exposure victims are now passing the critical period. The principal risk for all radiation sickness victims is due to infection because the bone marrow is suppressed and does not make white blood cells. (There is also the problem of bleeding due to the loss of platlets to clot the blood.)

Nature of Radiation Injuries

--The distribution of radiation injuries is to guards, firemen, physicians, and reactor physicists. The physicians may have been heavily exposed when they treated highly contaminated victims.

--The Soviets may still be able to ascertain exposures to workers and the general population even for those who did not manifest symptoms. The have been collecting blood cells for examination from certain persons. These will be examined for abnormalities in the chromosomes; human exposures down to 15 rads can be detected by this method. (The Soviets have already contacted us for assistance on this technique.) Thus, the Soviets could eventually assess their population dose.

Long-Term Consequences

--Research on atomic bomb survivors and other exposed population groups has shown that radiation induces cancers. Models which predict cancer potential show that the probability increases as a function of the amount of radiation and total number of persons exposed.

--If we use the Soviet figure for the population at risk, then about 300 excess cancers can be expected...depending on the total dose to them.

--We are currently conducting computer modelling to refine these estimates. Potential thyroid cancers will be much higher due to the larger quantities of radioactive iodine released, which concentrates in the thyroid gland.

USSR: Economic Impact of the Chernobyl' Accident

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Preliminary analysis of the Chernobyl' nuclear accident indicates that direct damage to the Soviet economy will be relatively minor. Although the cost of the evacuation, decontamination, cleanup, imports of technical equipment and medical supplies, and some permanent resettlement will be large—perhaps as much as 25 billion rubles

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direct damage to agriculture, industrial facilities, and the environment will be limited to a fairly small area. Nonetheless, the potential loss of electric power this year could put a crimp in General Secretary Gorbachev's hopes to get the new five-year plan off to a fast start in 1986.

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The Human Costs

Preliminary calculations suggest workers and firemen at the reactor site and local residents who were drawn to the area by the fire—perhaps as many as 200 to 300 persons—received potentially lethal doses of radiation. As of 21 May, the death toll was 15—13 from radiation and two from the explosion. Additional deaths among the heavily irradiated victims are expected in the next several weeks. Onlookers near the site would have inhaled considerable airborne radioactivity and may be among the hospitalized victims, who, according to Gorbachev, numbered 299 on 14 May. People within 5 kilometers (km) of the site who were exposed to the initial radioactive plume could have received substantial doses of radiation. An additional 25,000 to 30,000 persons who were exposed may have received enough radiation to show mild symptoms such as nausea, and these people will be at risk for future cancers.

The accident also forced a large-scale relocation of many in the area. As of 13 May, Moscow acknowledged that 92,000 persons had been evacuated from a 30-km zone around the plant. We estimate the population of this area to be 150,000 to 180,000, including the two towns of Pripyat' and Chernobyl' and the surrounding rural population. It is likely that many fled on foot—some with their livestock—before vehicles arrived. In addition to the official evacuees, thousands of persons, mostly women and children, have left Kiev and other cities outside the 30-km area.

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It is difficult to estimate the cost of the evacuation, but assuming military units were involved, little incremental cost would accrue to the Soviets. Volunteers are housing many of the evacuees; and, if existing housing is properly decontaminated, residents could begin returning within months. The Soviets reportedly are applying a polymer to the immediate area that can later be removed, taking contamination with it. The roofs of buildings are also being coated to prevent rain from washing radioactive debris into drainage systems. It is likely that permanent relocation will be required for some of the population. Indeed, in some areas, the evacuees are already being put to work.

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Impact on Agriculture

The initial plume of radioactivity appears to have passed over an area covered largely by forests and swamps. Not more than 15 to 25 percent of the crop and pasture land in the Chernobyl' region would have been seriously affected. Soviet data show that the region accounts for a minuscule share of total Ukrainian farm output. Damage to farming regions beyond the immediate area of the accident is likely to be minimal. Because harmful levels of contamination are localized, we do not anticipate substantial, long-term effects on international commodity supplies or trade.

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What Happened in Chernobyl?

Our best estimate of the cause of the accident is that the reactor power suddenly surged, producing superheated steam. A reaction between superheated steam and zirconium-alloy fuel cladding produced hydrogen gas. The gas built up until it exploded, damaging the reactor and leading to fuel melting and a fire in the graphite. The destruction of the reactor hall allowed large quantities of radioactivity to escape. The explosion reportedly knocked out the radiation alarm system, and officials at the site did not learn of the high levels of radioactivity until hours later. Two and possibly three persons were killed by the explosion, and at least 35 people at the site, including some of the firemen who responded, were exposed to lethal doses of radiation. Helicopters were used to drop sand, lead beads, clay, dolomite, and boron into the burning reactor. The fire was finally extinguished on 11-12 May.

The livestock sector may be more seriously disrupted in the area. Indeed, we have already seen reports of livestock being slaughtered because of high radiation levels. Soviet press reports however, indicate many livestock were evacuated along with the population. Livestock that ingested contaminated feed before being evacuated should survive if quickly switched to clean feed. Except for milking cows, radioactive isotopes not excreted by these animals would be localized in organs generally not consumed by humans, such as the thyroid, and in bones. Some pastureland beyond the evacuated area may have to be taken out of use until radiation drops to acceptable levels, putting pressure on local supplies of stored feed.

The local dairy industry will be most seriously affected because cows consuming radioactive feed concentrate radioiodine—the main contaminant—in their milk. Cows fed contaminated feed will produce hazardous milk for several weeks after switching to clean feed. Soviet dairy authorities will have to not only monitor the milk but also assure that condemned milk does not reach black-market channels.

Local Effects of Radiation on Agriculture

The effects on farming activities near the site are likely to be varied. Although the affected area contains very small quantities of grain and sugarbeets, winter grains planted last fall and sugarbeets that are just emerging have been exposed to radioactive particles settling on leaves. Some of this radiation will be incorporated into the plants. Lightly contaminated grain may be mixed with clean grain during milling to dilute any harmful effects, but any heavily contaminated grain will have to be collected and disposed of. Sugarbeets exposed to radiation would tend to concentrate radioactivity in their roots and will likely have to be destroyed.

According to US experts, spring grains and vegetables can be planted in areas of light contamination because most of these crops—with the exception of sunflowers—do not absorb radiation through their roots. Danger to humans, however, could result from contaminated dust raised by machinery in fields during planting, subsequent field operations, and harvesting. Thorough monitoring and decontamination of workers, equipment, and crops in the areas adjacent to the evacuated zone will be necessary, slowing field work. Even in those areas where contamination is light, crops could suffer some losses if normal spring field operations are delayed. Workers may be kept from the fields as a safety precaution or diverted to cleanup operations. Growing seasons in the USSR are short, and harvests are frequently disrupted by the early onset of winter.

The Chernobyl' power plant is located just north of the Kiev Reservoir, which supplies the bulk of the drinking water for the Ukraine's capital. Some radiation was undoubtedly carried to the reservoir

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by winds and by the two major rivers feeding it—the Pripyat' and the Dnepr. Fish, particularly freshwater shellfish, taken from these waters will also require monitoring for some time.

Soviet environmental authorities, however, maintain that regular water samples are being taken from the Kiev Reservoir and that they show levels of radioactivity below established norms.

Local Industry

An inventory of industrial facilities within the 30-km zone around the reactor reveals only a small number of civilian plants, including two concrete products plants, a machine-tool plant, perhaps 10 food-processing sites, three textile mills, and a railroad repair yard. several of these facilities have been shut down—probably as a result of the evacuation order. How long they will be affected remains an open question, depending on the degree of contamination and how quickly the Soviets want to resume their operation. Moscow has already discussed bringing reactor units 1 and 2 at Chernobyl' back on line as quickly as possible, but local industry may not have such a high priority.

In all likelihood, the accident disrupted—at least temporarily—electricity supplies beyond the 30-km area. All industries suffer problems in the event of brownouts or blackouts, but the largest users of energy—metals processing, cement, food processing, and chemicals—would be hardest hit from resulting damage to machinery and products in process. We have no information to date regarding specific disruptions in electric power supplies to local industry. In addition to electricity, industrial facilities depend on water for cooling and processing. If irradiated water is used in processing, some end products could be affected, particularly in the chemical and food sectors.

Electricity Supplies

The shutdown of the four 1,000-megawatt (MW) reactors at Chernobyl' will probably have a wide range of effects. During the summer lull in electricity demand, the Soviets will be able to compensate for most of the power losses associated with Chernobyl' by using other generating capacity more intensively. Beginning in September, however, the upsurge in demand for electricity probably will eliminate most of the painless adjustment mechanisms. Moreover, two reactors at Kursk identical to the damaged one at Chernobyl' may not now be operational. We cannot be certain whether these other reactors are completely shut down or are operating at reduced power levels for safety reasons. Moreover, if they are in fact shut down, it is unclear that the Chernobyl' accident was the reason. Moscow, however, probably would not disrupt the economy further by shutting down the remaining nine graphite-moderated, boiling-water reactors (RBMK) similar to those at Chernobyl' unless the cause of accident is judged to have stemmed from basic design faults.

The confirmed shutdowns at Chernobyl' and the likely shutdowns at Kursk—assuming the latter reactors remain out of service for the remainder of the year and the power is not made up from other plants—would reduce Soviet electricity output in 1986 by about 25 billion kilowatt-hours (kWh), roughly 1.5 percent of the annual total. The impact, however, is concentrated on two power grids that would experience losses of about 10 percent. Power cuts of this magnitude, although unlikely, could seriously affect key economic activity in the Ukraine and Moscow regions. We believe the Soviets will attempt to ease the impact by drawing electricity from adjoining grids, and possibly from more distant grids in the Urals and Kazakhstan. Moscow may also request that Czechoslovakia, Bulgaria, Romania, and Poland reduce imports of electricity from the Ukraine—roughly 20 billion

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kWh was sent to these countries in 1985. Cutting exports to Eastern Europe, however, may not be a politically attractive way to ease the crunch.

The Soviets could compensate for the loss of electricity over the next several months if they forgo maintenance—normally scheduled for the summer—at power plants using fossil fuels and operate them at full winter capacities. Moscow has already reported that one generating unit at a thermal power plant in Kiev, normally held in reserve at this time of the year, is now operating at full capacity to partially compensate for the loss of Chernobyl'. Seven other power plants in the Ukraine—four hydroelectric and three thermal—are also reported to be working at full capacity.

Increasing output at conventional plants, however, is only a stopgap measure. Maintenance must still be performed, and if it is not finished by winter the Soviets will be hard pressed to meet the surge in electricity demand that will take place then. In any event, domestic supplies of fossil fuels will have to be supplemented with increases in domestic fuel production and possibly with imports, such as additional coal from Poland. The additional fuel required to offset the loss of the Chernobyl' reactors would amount to perhaps 150,000 barrels per day oil equivalent and half again as much if the other two reactors remain shut down. If domestic fuel oil supplies are used to generate replacement electricity for these six reactors, at the expense of exports of oil to the West, hard currency losses would amount to $100 million per month at current prices.

The Chernobyl' disaster is likely to result in some setback to the USSR's nuclear power program. The Soviets currently have 28,300 MW of nuclear generating capacity, supplying some 11 percent of their electricity. Moscow's plans call for expansion of nuclear capacity to 70,000 MW by 1990, boosting the nuclear share of total electricity output to more than 20 percent. The accident may prompt the Soviets to at least put construction of new RBMK reactors on hold temporarily. The Soviet decision to allow placement of nuclear plants closer to populated areas to supply centralized district heating systems—including one in Kiev—could be reexamined.

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