Chernobyl

Anxiety about reactor accident subsides

LAST week's panic in Western Europe and elsewhere about the explosion and subsequent graphite fire at the Soviet nuclear plant north of Kiev was in retreat earlier this week, as the scanty data available outside the Soviet Union were pieced together. While it is plain that the accident at Chernobyl on 26 April was the world's most serious nuclear accident so far, there is no reason to dispute the Soviet statement that only two people at the plant were killed, perhaps a consequence of the initial explosion. The longer-term consequences, including cases of radiation sickness which will become apparent in the next few weeks, and excess cancer deaths, which will be delayed by decades, cannot yet be estimated.

Part of the basis for this reassuring conclusion is the examination of members of the party of British students from Kiev and Minsk, who returned via Moscow last week. Although some of the party's clothing was contaminated with local fallout, ingestion of airborne radioactivity was apparently not sufficient to cause risk of thyroid cancer. An account of the fallout over Poland during the past week, given by a group of Polish experts in Vienna, has led the Polish authorities to the conclusion that there is "no significant risk to the health of any person".

Other estimates of the total quantity of radioactivity released from the Chernobyl reactor have been derived from computer models normally used in the assessment of the risks of nuclear accidents. These suggest that the release from the plant may have been upwards of two orders of magnitude greater than from the British accident at Windscale in 1957, previously the worst nuclear accident on record.

The Swedish measurements, the first clue (on 28 April) to the accident at Chernobyl, suggest that airborne activity over Scandinavia peaked on Tuesday last week at about 10 to 20 times the normal level, mostly because of iodine-131 and caesium-137.

Fallout in the neighbourhood of the plant has been much more serious. Close on 50,000 people have been evacuated from a 30 km radius. Soviet spokesmen visiting the West have spoken of radiation doses at the plant which were initially 200 roentgens an hour, falling to 100 roentgens an hour after a week. In this light, the Soviet statement that 200 people were hospitalized (of whom a quarter were discharged) probably refers to those showing symptoms of radiation sickness.

The cause of the accident remains a matter for speculation. The most common suggestion is that a leak in the steam-raising water circuit which contains the fuel elements and interpenetrates the 1,000-tonne graphite moderator would have produced water gas (carbon monoxide and hydrogen), which might then have caused the explosion that destroyed the roof of the reactor building. It is not known whether Soviet statements that "human error" was responsible for the accident refers to the execution of an improper operation or to an inadequate response to warning signals.

Another possibility is that the accident arose during an operation to anneal the graphite moderator in the reactor to remove structural defects accumulated during prolonged neutron irradiation, and which entails heating the graphite above the normal operating temperature for more than a day.

Although the Chernobyl accident may have been less serious than first reports in Western Europe suggested, most Western governments have been indignant that so little information has been available from Soviet sources to suggest how governments elsewhere might best deal with the fallout from the plant. More detailed information about conditions at Chernobyl began appearing only earlier this week. On Tuesday *Pravda* carried a long article describing conditions around the reactor site.

Perhaps more significantly, an apparently painful interview last Wednesday between the director-general of the International Atomic Energy Agency, Hans Blix, and the Soviet envoy in Vienna had led, by Sunday, to an invitation for Blix to visit Moscow. He left the same day, accompanied by Maurice Rosen, the agency director of nuclear safety.

According to a spokesman of the agency on Tuesday this week, the intention is that the visitors will have full access to what information there is available in Moscow, although it is not known whether the party will be able to visit the reactor site. Blix's companions may stay in the Soviet Union for several days.

Within the Soviet Union, a commission of enquiry under a deputy prime minister is said to be hard at work on an investigation of the causes of the accident and into its aftermath. On the assumption that the reactor building can itself eventually be made safe, the most haunting problem will be that of managing the health of the population in the neighbourhood of the accident over the next three decades. □

Soviet nuclear reactors

Ambitious plans with red tape

UNTIL 26 April, the Soviet Union had a nuclear generating capacity of 28 GW, 11 per cent of total electricity output, but the new five-year plan (1986–90) includes the commissioning of a further 41 GW of nuclear capacity.

Guarded comments by Soviet officials last week suggest that there will be no change in these plans, even though it has for the first time been admitted that the use of nuclear power, even for peaceful purposes, cannot be totally safe. Previously, the Soviet line has been that incidents such as Three Mile Island were the result of corner-cutting by capitalists bent on profit.

Soviet plans specifically suppose the construction of nuclear stations close to major cities. Although, a few years ago, a leading party monthly carried an article suggesting that nuclear stations should be confined to the remoter areas of Siberia, they are now considered so safe that they can serve as thermal generators for city district heating systems, but with a green belt of 1–3 km radius around each station, which would be used for recreational purposes and allotments.

Current plans call for several such "atomic-thermal-power" stations to be commissioned during the next five years, including Gor'kii, Voronezh, Odessa and Minsk, while the construction of several more is to be started. If the Chernobyl accident has any effect on Soviet nuclear policy, it is in this sphere that it is most likely to be felt.

The resiting of at most 10 or 12 power stations (and the quiet dropping of the district heating part of the programme) would be far less difficult, both logistically and politically, than a total reversal of Soviet commitment to nuclear energy. There is likely, too, to be an increased impetus to the fusion energy research programme, which for years has been formally hailed as the ultimate solution to Soviet energy problems.

The Chernobyl station had four RBMK reactors with a fifth under construction. This is a light-water-cooled uranium-graphite channel system, with zirconium alloy fuel cans. As a number of commentators have noted, this type of design has been rejected in Western countries as unsafe, and the presence of the earliest example of this type near Leningrad has, during the past few days, evoked considerable concern in Finland.

The Soviet designers seem to have relied on the regular ultrasonic and acoustic monitoring of the metal coolant loops, which, it was claimed in the technical journal *Atomnaya Energiya* (**50**,

253; 1981) "guaranteed that sudden rupture of the pipes could not occur" and, as a measure of last resort, the incorporation of an automatic emergency water cooling system. This was designed to cope with the worst possible case foreseen, the transverse fracture of a 900-mm turbine pressure collector. On 26 April, however, this system clearly failed to work.

If the Soviet atomic energy commission preserves the reticence it has shown so far, it may be difficult to discover not only what caused the initial fault but also why the emergency system failed to operate. (Earlier this year, the daily *Sovetskaya Rossiya* called for greater openness in the reporting of natural disasters, but the atomic energy commission could well reply that the Chernobyl accident was not "natural".) One possible explanation, however, may lie in Soviet construction procedures which are prone to produce shoddy and hazardous results, in spite of the fact that there is no "capitalist" profit motive.

The Soviet practice of laying down quarterly, annual and five-year production targets (with pay and bonuses dependent on their fulfilment), coupled with a highly bureaucratic supply system and a transport network too overloaded to ensure prompt deliveries, has led to the practice of "storming" — last-minute speed-ups and overtime to catch the target date.

Hasty construction is further exacerbated by the emphasis placed on fulfilling targets ahead of plan, and, in particular, the making of "voluntary" pledges by the workers to reduce their target time in honour of major patriotic events. Although, in 1976, a glowing description of the construction work at the Chernobyl site merited front-page treatment in *Pravda*, an article that appeared in the weekly *Literaturna Ukrayina* just a month before the accident gave a very different picture.

According to the author, Lyubov Kovalevs'ka from the town of Prypyat', building standards have from the very beginning been neglected. The construction of a project such as a nuclear power station, she says, must be "a continuous flow on the basis of the strictest adherence to building technology. But this did not happen here."

The various problems that arose with the first unit (Kovalevs'ka does not specify what they were) were never properly solved, but simply "transferred" to the second, and then to the third and fourth units.

What this meant in practice is seen from her description of current construction work on the fifth unit. The project, she says, is beset by constant shortages; materials are delivered in inadequate quantities and are frequently substandard, yet the planned construction time has been cut from three years to two. The workforce therefore has no option but to try to fulfil its targets by neglecting the specifications and "stretching" such materials as there are as far as possible, and accepting defective supplies even when so vital an item is concerned as the case she cites, the roof-plate for the spent fuel bunker. Quality and inspection of the finished construction moreover, seems to connive at the situation which, Kovalevs'ka warned a month ago, will have to be "paid for over the course of decades". Has this bill yet been paid? **Vera Rich**

Nuclear prognostications

Estimating gravity of problem

ALTHOUGH several agencies in the West have been hard at work during the past week trying to estimate the seriousness of the accident at the Soviet nuclear reactor north of Kiev, nobody is confident of the outcome of their calculations. As part of the now-standard process of calculating the consequences of hypothetical nuclear accidents, several computer models have been developed for estimating what happens to radioactivity released from a damaged reactor. But, as one modeller explained last week, "usually we start with something that we know".

Part of the problem is meteorological. One of the team at the British Radiological Protection Board, an independent government agency based at Harwell, Oxfordshire, explained last week that there is relatively little experience of even models of the spread of radioactive materials from sources remaining active for several days, and that the calculation of the consequences of Chernobyl have been complicated by the rapidly changing wind patterns.

Data from Sweden and elsewhere in Europe have thrown some light on the composition of the fallout from the Soviet reactor. It seems to be agreed that the concentrations of volatile materials such as radioactive iodine and caesium are in the proportions to be expected from fresh fission products. The modellers are, however, unable to estimate with any certainty what proportion of the total emission from the damaged plant will have been deposited in its immediate locality.

This uncertainty bears most directly on the difficulty of estimating the damage that may have been done to the population in the immediate vicinity of the plant, which will become apparent there only in the next few days and even weeks. One of those concerned says the uncertainties are such that the data from outside the Soviet Union are consistent both with the assumption that many people will have been exposed to damaging doses of radiation and that there will be no casualties from radiation sickness even in the neighbourhood of the plant.

There is, however, general scepticism about some of the estimates of Soviet casualties such as that given to a congressional committee by Dr Kenneth Adelman, director of the US Arms Control and Disarmament Agency. It is pointed out that calculations of the consequences of releases of radioactivity from pressurized water reactors, such as the estimates prepared for the public inquiry into the British plan to build such a plant at Sizewell in Suffolk, suggest that acute deaths (within a few weeks) would be counted in hundreds, not thousands. The longer-term consequences — excess cancer deaths — would usually be greater in number.

The generalized effects of the radioactivity observed in Sweden will be much smaller. If atmospheric radioactivity was last week six times greater than the natural background for two or three days, the result will be increased exposure to radiation by a few per cent of the annual dose arising naturally. But this reassuring yardstick does not exclude the possibility that some people may ingest exceptional amounts of artificial radioactivity by the accumulation and concentration of particular radionuclides in foodstuffs.

Attempts to estimate the total amount of radioactivity released at Chernobyl are similarly uncertain. The source of the estimate that a total of 10^{18} bequerel were released at Chernobyl was most of all anxious that the uncertainties, which must be several orders of magnitude, should be clearly appreciated. By this yardstick, the Chernobyl accident may be 100 times potentially more damaging than that at Windscale in 1957, when an air-cooled graphite reactor caught fire. That accident was in turn much more serious, as measured by the total quantity of radioactivity released, than the accident at Three Mile Island eight years ago.

Among those with military and arms control interests, some importance is attached to the likelihood that reactors of the "Leningrad" type such as those at Chernobyl would have been a useful source of military plutonium.

According to the International Atomic Energy Agency's survey of the world's reactors published at the end of last year, there were 26 light-water-cooled graphite-moderated reactors in operation in the Soviet Union at the end of 1984, producing between them a total of 13.7 GW of electricity. A further nine reactors of this type were being built at that stage, although the bulk of the reactors now under construction in the Soviet Union are pressurized-water reactors. □