New York Blackout: Weak Links Tie Con Ed to Neighboring Utilities

Europeans said it could never happen to them, Midwesterners said it would be very unlikely, and many New Yorkers apparently thought they could be assured that the blackout of 1965 would not be repeated.

But the Consolidated Edison power system that serves New York City suffered its second total failure in a dozen years last week, and many people—in the streets, in the mayor's office, in the White House, and around the country—wanted to know why. No fewer than five investigations have been requested at the latest count, and hearings will be occurring daily for months. The 1965 blackout paralyzed not only New York City but also parts of Canada, New England, and the rest of New York State. What happened this summer was confined to New York City and Westchester County. The final word on the causes of the recent power failure—and the extensive property damage that accompanied it—will await the completion of current investigations. But there is already enough information available to indicate that improvements made since 1965 did work to minimize the area of the blackout, although they were not sufficient to save the city known as the Big Apple.

One of the improvements made in the wake of the last blackout was to streamline communications within regional power networks so that the decision-making necessary to disconnect a troubled utility could be speeded up. This part of the emergency regional power control plan worked well—probably saving most of Long Island from being darkened along with New York.

On the other hand, the post-1965 improvements made in the Con Ed system were not sufficient to protect it—particularly not from the coincident occurrences of 13 July. Automatic switching equipment called "under-frequency relays" that had been installed since 1965 to cut out portions of the electrical load inexplicably did not operate. According to plans filed with the Federal Power Commission, up to 42 percent of Con Ed's load should have tripped off automatically. In addition, the Con Ed system is set up so that up to 50 percent of its load can be shut off manually, but apparently the system controllers on duty were hesitant to do that. "Perhaps they should have shed more load sooner," said a spokesman for the New Jersey–Pennsylvania–Maryland power network. "It's hard on a hot night, but sometimes it may be best to be ruthless—push a button and drop a whole district."

The blackout was initiated by a series of two, or arguably three, "worst case" failures of different components in the Con Ed system, which brought about a cascade of increasingly serious difficulties that within an hour brought the system down with a crash. The standard of reliability commonly followed in the United States is that a system should be able to withstand a single or a "credible" double contingency. Whether the rain of lightning bolts that hit the Con Ed power lines in upper Westchester County constituted more than a credible double contingency is uncertain. But it is clear that the Con Ed system, surrounded by water on three sides, is more isolated than most utilities while it supports the highest load density. Partly for geographical reasons, the connections that couple New York to neighboring utility grids are remarkably weak. Even though they have been improved since 1965, those ties proved inadequate when lightning hit last week.

New York Stayed Cool for One More Hour

In power trading, as in international commerce, importers are more vulnerable than exporters. Just before the blackout Con Ed was a big importer, largely because one of its twin 900-megawatt nuclear stations at Indian Point on the Hudson River had been shut down for two weeks because of a pump leak. The utility company was importing 2000 megawatts of power early in the evening of 13 July, most of it coming in via four overhead cables that approach the city from Pleasant Valley in the north—the principal overland route to Manhattan. On a sweltering summer night, the city's five boroughs and up-county suburbs were consuming the imported 2000 megawatts plus 3800 megawatts that Con Ed was generating from its own plants, principally the twin of the shut-down nuclear plant at Indian Point and the system's largest coal-fired plant, Ravenswood 3—better known as Big Allis after its manufacturer Allis Chalmers.

With early evening, the peak of the day's power load had passed and the system was drawing considerably less than its 7600-megawatt projected peak load for the year. At 8:30 the problems first occurred in Westchester County as a thunderstorm passed over the northern part, particularly a key substation at Buchanan. Apart from the overland lines coming from Pleasant Valley in the north, Con Ed's strongest link to the rest of the electrical world is a pair of overhead lines from Ramapo, New Jersey, that cross the Hudson above Stoney Point and tie into the Buchanan substation. Buchanan was a crucial point that night. Not only was it the strongest link to the large New Jersey–Pennsylvania–Maryland grid, but it was also the point where the Indian Point nuclear plant plugged into the system.

Apparently the first things that the quickly moving lightning storm knocked out were the tie from New Jersey to Buchanan and the lines from Buchanan to New York. The disruption activated circuits at the Indian Point nuclear plant which shut it down—a successful SCRAM that saved the plant but cut out 900 megawatts cooling midtown Manhattan. Next the storm hit the main lines connecting to the New York State power pool in the north. The 2000 megawatts of imported power was cut off as lightning pulled open circuit breakers right and left.

Within 10 minutes, Con Ed had lost its only operating nuclear plant and its only strong ties to the two regional electric grids it bordered. The only remaining links were a weak tie eastward through Jamaica to the Long Island Lighting Company, and a medium-strength westward tie to New Jersey that runs across Staten Island from Goethals to Linden. A strong 345-kilovolt westward tie across the Hudson to Farragut in Brooklyn, which could have aided enormously, had unfortunately been out of service for nine months because of a faulty phase regulator.

Afflicted by the loss of its most steadfast regional ties, it is surprising that the New York system was able to keep going for the extra hour that it did. The controller on duty in Con Ed's command center immediately cut the voltage in the system to reduce the load—5 percent at first, then 8 percent. In addition, selected parts of Westchester were blacked out, and an undetermined number of the system's standby gas turbines were fired up. The amount of time it took to get the turbines started has not been announced, but Con Ed has announced that in the

future it will keep technicians on duty at those turbines around the clock.

New York, hardly knowing the trouble it was in, stayed cool for one more hour by bringing in increasingly large amounts of power through its remaining utility ties. But it ultimately proved impossible to bring the system back into balance.

The city was soon drawing 500 megawatts through the two small 138-kilovolt lines connecting it to Long Island—which is hardly a giant power source in any case. The current was well over the rated capacity of the two lines, and the New York power pool headquarters in Schenectady—which had been watching Con Ed's plight closely—decided that something had to be done to save the lines. At 9:30, the power pool ordered Long Island Lighting to sever itself from New York City, and the end followed quickly. Within 10 minutes, Big Allis shut down "by its own protective device," and the system lost a 1000-megawatt generator. The only tie to the outside left was the link across Staten Island. With virtually the entire city hanging on that tie, it overloaded and tripped almost instantly. At its heroic peak it was feeding New York 1000 megawatts, 250 megawatts more than it was nominally capable of providing. When it tripped, the city plunged into darkness and power failure, from which it took 26 hours to recover.

Could such a thing happen in other parts of the country or in Europe? In most quarters, the answer was a thankful "no, probably not." Utility spokesmen in many different European countries said that their well-interconnected power grids and heavy expenditures on fail-safe devices would avert a New York–style blackout.

The British grid system has a reserve of 30 percent over the peak recorded demand. The common reserve in American utilities is 20 percent for regional networks. "We're criticized for being overcapitalized," said a spokesman for the British Central Electric Generating Board, "but now you can see the difference." Extra capacity would no doubt have put Con Ed in a better position on 13 July, but it does not appear to be the reason the system was unable to compensate. If the system could only have shed enough load to bring itself into balance, it would have affected far fewer people and have taken much less time to bring the power back to normal. New York might have been spared if the automatic equipment in its system had tripped soon after the lightning hit, but preliminary findings indicate that the equipment did not trip until too late.

Con Ed's Emergency Plan

When the load on a system is too great, the effect on the system is generally to slow the speed of the generators from 60 to 59 cycles per second and so on. Under-frequency relays are set to trip at specific frequencies, reducing the load automatically. All regional utility grids are required to file "load shedding" plans with the Federal Power Commission, and the plan filed by Con Ed in April 1977 shows that its schedule is a mild one. In fact, it is less aggressive than the requirements of its own regional coordinating council. The northeast council specifies that members be able to shed 25 percent of their load automatically when the frequency dips to 58.8 cycles per second and shed 50 percent of it manually within 10 minutes. In fact, the Con Ed system will automatically shed only 20 percent of its load at that frequency, according to the April report. At 57.8 cycles per second, indicating that the system is in even worse shape, the Con Ed system will cut out 42 percent of its load.

Apart from the question of the workability of its internal protection systems, is the New York system peculiarly vulnerable to power failure? A number of utility engineers think that a scarcity of interconnections is the heart of Con Ed's problem.

Whereas the largest tie line available to Con Ed is rated at 345 kilovolts, the lines that couple utilities in the Midwest are typically 500- or 765-kilovolt cables. The network that serves Wisconsin, Illinois, and Missouri has one intersystem tie that can carry 7000 megawatts—substantially more than Con Ed's entire load on 13 July. "Their ties to the rest of the world are a lot skinnier than ours," says a spokesman for the Midwest network. One limitation facing New York is that it must rely on underground cables to go underwater. In the past, the technology of underground cables has been limited to lower voltages and therefore lower power ratings. This is undoubtedly the reason the Linden-Goethals tie is only a 230-kilovolt line. But the technology of underground cables is improving, and the strength of a tie can be increased by multiplying the number of cables.

It is too early to draw conclusions, but the circumstances of the blackout raise important questions. Why didn't the automatic equipment activate? When it did not, why didn't someone push the buttons to shed load manually? The violence, damage, and property loss would almost certainly have been reduced greatly if part of the system had been kept intact. Finally, why is a city of 7 million closely packed people dependent on such fragile electrical ties to the rest of the country for so many essential services?

The United States generates about one-third of the world's electricity. It is a pity that the country could not share more of it with New York on 13 July.

—WILLIAM D. METZ

Executive Office Reorganization: OSTP and CEQ Are Still In

The latest installment in the saga of science in the White House has concluded with the Office of Science and Technology Policy (OSTP) surviving the perils of reorganization. In the reorganization plan which President Carter sent Congress on 15 July, OSTP is continued as a separate office in the Executive Office of the President (EOP), and OSTP's director, Frank Press, retains an inner-circle assignment as a special assistant to the President. Some of OSTP's statutory functions will be shifted away under the plan, but the consensus is that the science office has held its own. There had been speculation that Carter might opt for merging OSTP into an enlarged policy-planning unit in his executive office.

More attention had been attracted by reports that the Council of Environmental Quality (CEQ) might be abolished or have some of its functions transferred outside the White House bureaucracy (*Science*, 15 July). The reorganization plan, however, retains CEQ intact and in place. Reports that CEQ was endangered had stimulated strong protests from environmental groups and from