



Blackout prevention based on experience

- The weak points of the power systems are never where you expect them to be
- A power system can collapse within seconds
- Blackouts cannot be avoided
- People forget blackouts after less than 10 years (design criteria)
- Security strategies have been developed after blackouts
- Decentralization and intermittency will add new weaknesses to the power system
- It will require an extremely careful planning to avoid a wave of blackouts
- **How we learned from blackouts (the never ending story):**

The Great Northeast Blackout

9 November 1965 at 5:16 pm



WWW?

- Cause:
 - Faulty back-up relay trips line at Niagara
- Course of events:
 - Cascading loss of lines
- Consequences:
 - 30 million people affected
 - 600 trains stopped
 - 600.000 persons stranded
 - 13 hours to normal operation
- Outcome:
 - A national strategy for system security
 - Establishment of NERC
 - The N-1 rule

ail.dk

THE WHITE HOUSE
WASHINGTON

November 9, 1965

MEMORANDUM FOR

Honorable Joseph C. Swidler
Chairman, Federal Power Commission

Today's failure is a dramatic reminder of the importance of the uninterrupted flow of power to the health, safety, **and well** being of our citizens and the defense of our country.

order to **prevent a** recurrence.

+45 75 5

federal government **and directing the Federal Bureau of Investigation, the Department of Defense and other agencies to support you in any way possible. You are to call upon the top experts in our nation in conducting the investigation.**

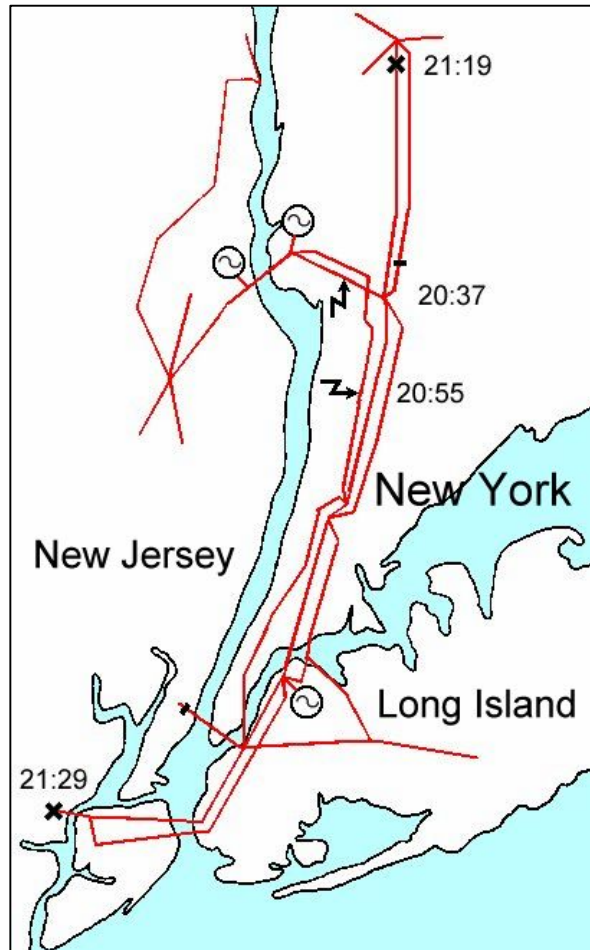
A report is expected at the earliest possible moment as to the causes of the failure and the steps you recommend to be taken to prevent a recurrence.

Paul-Fr



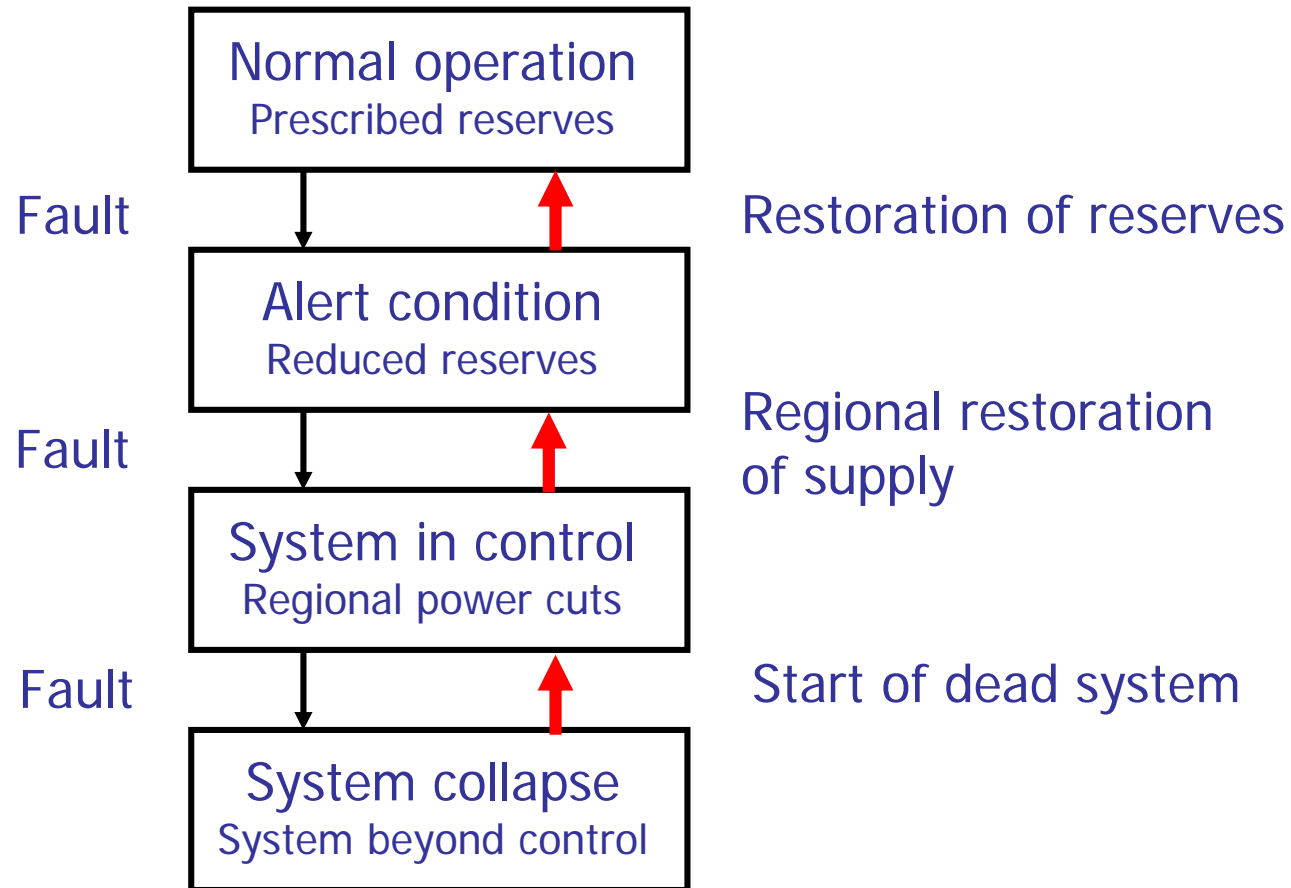
The 1977 Con Ed Blackout

13 July 1977 at 8:37 pm



- Cause:
 - Severe thunderstorm
- Course of events:
 - Loss of important lines to city center
 - Remaining lines overloaded
 - Collapse at 9:36 pm (after 59 minutes)
- Consequences:
 - 9 million people affected
 - 25 hours to normal operation
- Outcome:
 - N-1 rule insufficient
 - Re-examination of strategies for prevention, system control and restoration after faults
 - Focus on voltage control in cable networks

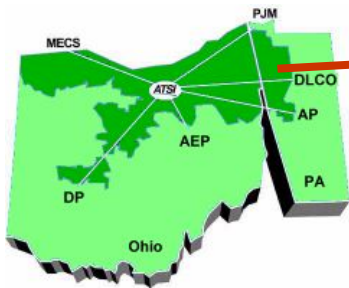
New lines of defence



Maintaining control is more important than maintaining load

USA
August 14,
2003

FirstEnergy



Ohio

USA TODAY Blackout 2003

Navigation: BLACKOUT AFFECTED AREAS | NORTHEAST POWER GRID | GENERATING ELECTRICITY | POWER DISRUPTIONS KEY MOMENTS

Map labels: MICHIGAN, Lake Huron, Lansing, Detroit, Toledo, Cleveland, OHIO, Lake Erie, CANADA, VT., MAINE, N.H., MASS., CONN., Rhode Island, Atlantic Ocean, N.Y., PA., N.J.

What happened [ROLLOVER CITIES FOR MORE](#)
 The blackout began with a power surge that most likely started in the Midwest and cascaded to power stations across the USA's northeastern tier and parts of southern Canada.

Satellite images
 From U.S. Air Force Weather Agency
[CLICK TO VIEW IMAGE](#)
 • [Before blackout \(Aug. 13\)](#)
 • [During blackout \(Aug. 14\)](#)
 • [Hide images](#)

11 MISO/Keith Mitchell: Okay. I was just
1 12 wondering. Did you guys need anything from here, MISO,
2 13 in addition to what you have already got?

3 14 MISO/Ron Mihbachler: Let me check with
4 15 Jason here. Hang on. Yeah, Keith?

5 16 MISO/Keith Mitchell: Uh-huh?

6 17 MISO/Ron Mihbachler: I don't know if you
7 18 have been watching, if you have been staying up or not,
19 but I guess New York City or New York is out,
21 Cleveland, and I think Detroit.

22
23 21 MISO/Keith Mitchell: Okay. Toronto, too.

22
1 22 MISO/Ron Mihbachler: Yes, I think Toronto
23 is out as well.