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The National
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Technical Assistance Briefs: Utility and Network Interdependencies: What State Regulators Need to Know

Prepared by
The Institute of Public Utilities

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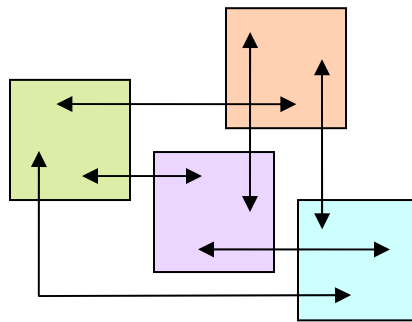
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TECHNICAL ASSISTANCE BRIEF ON CRITICAL INFRASTRUCTURE PROTECTION

UTILITY AND NETWORK INTERDEPENDENCIES: WHAT STATE REGULATORS NEED TO KNOW

NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISSIONERS
AD HOC COMMITTEE ON CRITICAL INFRASTRUCTURE

APRIL 2005



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**NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISSIONERS
AD HOC COMMITTEE ON CRITICAL INFRASTRUCTURE**

Letter from the Chair

Commissioner Connie O. Hughes, New Jersey Board of Public Utilities
March 2005

As Chair of the NARUC Ad Hoc Committee on Critical Infrastructure, I am proud to present to public utility regulators, policymakers, utility industry leaders, and consumers, this landmark series of technical briefs on a complex set of issues pertaining to our nation's critical utility infrastructures. These documents identify key strategies for our consideration as we meet ongoing challenges within each of the electricity, natural gas, water, and telecommunications sectors.

I trust that the documents will enhance the understanding and appreciation of critical infrastructure protection, particularly with respect to the role of state public utility commissions, as well as assist in the development of appropriate policies and strategies in this vital area.

The Committee appreciates and is grateful for the assistance in preparing these reports by Dr. Janice A. Beecher, Institute of Public Utilities at Michigan State University and Dr. James B. Atkins, Regulatory Heuristics. I also acknowledge the support and funding provided by the U.S. Department of Energy's Office of Electricity and Energy Assurance under the leadership of Mr. Alex de Alvarez and assistance of Ms. Alice Lippert. I also thank the National Association of Regulatory Commissioners, the NARUC Staff Subcommittee on Critical Infrastructure, and our other state partners including the National Association of State Energy Officials, the National Conference of State Legislatures and the National Governors Association.

Commissioner Connie O. Hughes
Chair, Ad Hoc Committee on Critical Infrastructure

This Technical Brief (Paper No. 2) is part of a series of reports prepared under the direction of the NARUC Ad Hoc Committee on Critical Infrastructure. Funding for this project was provided to NARUC by the U.S. Department of Energy in cooperation with the National Association of State Energy Officials.

The purpose of these complementary and reinforcing papers is to provide public utility commissioners and other participants in the regulatory policy community with introductory overviews, suggested protocols, and additional resources on critical infrastructure protection issues.

Paper 1. *Issue Paper on Critical Infrastructure Protection.* The federal and state roles in critical infrastructure protection are introduced and explored, with a special focus on the role of the state agencies and public utility commissions.

Paper 2. *Utility and Network Interdependencies: What State Regulators Need to Know.* As explored here, almost all utilities operate networks, and these sector networks are highly interdependent, which in turn relates to consideration of vulnerability and planning which takes on an added dimension of complexity needs, as well as regulatory considerations.

Paper 3. *A Primer on Energy Assurance for Public Utility Commissions.* The primer provides an introduction to energy assurance planning, which broadens traditional energy emergency response and planning to include critical infrastructure protection and energy and fuel shortage mitigation.

Paper 4. *State Government Organizational Issues, Roles, and Policy.* This discussion paper explores state governmental roles with respect to critical infrastructure protection, with a focus on the state public utility commissions and regulatory policy considerations.

Paper 5. *Regional Coordination and Intergovernmental Communication in the Energy Sector.* This paper highlights the importance of regional coordination and communication, focusing in particular on the protocols developed for the Energy Emergency Assurance Coordinators (EEAC) system that has identified state level energy experts for petroleum, gas and electricity.

Paper 6. *Critical Infrastructure Information Sharing Rules: Model Protocols for States.* The paper discusses both federal and state actions to date regarding the sharing of critical infrastructure information and provides a framework for future cooperation and efforts to harmonize information sharing among state commissions, the FERC and the Department of Homeland Security.

Paper 7. *NARUC Inventory on State Energy Assurance Planning.* The paper reports in detail the findings of a 2004 assessment of state commissions regarding energy assurance planning and related policy issues.

Paper 8. *NARUC Inventory on Gas Curtailment Planning.* The paper reports in detail the findings of a 2004 assessment of state commissions regarding gas curtailment planning and related policy issues.

INTERDEPENDENCY

Public utilities in the electricity, natural gas, water, and telecommunications sectors provide services essential to the quality of life and the functioning of the economy. Utility service providers within the sectors are usually networked to one degree or another through transmission systems, and the networks across the sectors can also be highly interconnected.

Interdependency refers to the mutual functional reliance of essential services—namely networked utility services—on other networks, utilities, services, or auxiliary nonutility systems. While the underlying concept of *dependence* recognizes the reliance of one system's operations on another, *interdependence* suggests that systems operate synergistically. The criticality of infrastructure systems is thus intertwined and intensified.

Interdependency can exist with or without physical interconnection. For utilities, key classes of interdependency are physical, cyber, geographical, and institutional:

- Physical interdependency occurs when the operational output of one infrastructure affects the status of another and vice versa. An example is a natural gas pipeline that supplies power generation facilities and also feeds the electrically-powered compressor stations along the gas pipeline.
- Cyber interdependency occurs when the status of an infrastructure depends on the data transmitted through the information infrastructure. An example is the interaction between the utility sectors and financial markets.
- Geographical interdependency involves the locational proximity of infrastructures such that a single event would be simultaneously disruptive to multiple operations. An example would be a shared transmission or distribution corridor or node with multiple service conduits for energy, water, and communications facilities.
- Institutional interdependency occurs when the status of an infrastructure is dependent upon another with respect to policy considerations. Both regulation and deregulation, for example, affect utility operations and interactions across the energy and communications sectors.

Interdependency refers to the mutual functional reliance of essential services—namely networked utility services—on other networks, utilities, services, or auxiliary nonutility systems. Interdependency suggests that a disruption or outage in one operation will affect another, *and vice versa* (see Exhibit 1).

Utility networks are comprised of interconnected utility service providers offering essential services that include heating, cooling, light, power, safe drinking water, sanitation, and residential and commercial communications. As used here, an auxiliary system is a nonutility system that provides an essential input or function to a network or utility and for which a disruption or outage has serious consequences for utilities.

Public utility services are interdependent with one another and also interdependent with other networks and services including but not limited to: information and internet access, agriculture and food, public health care, government and emergency services, national defense, postal and shipping functions, transportation, banking and finance, fuel and chemical supply and transmission, and hazardous materials handling (see Exhibit 1).

Interdependency suggests that a disruption or outage in one operation will affect another, *and vice versa*. When power systems fail, water pumps cease to operate; when communication systems fail, energy utilities lose monitoring capability; when pipelines fail, fuel supplies dwindle. Although electricity plays an obvious and essential role across virtually all modern utility and nonutility functions, computing and communications are increasingly important as well. Absent redundancy and backup capability, even apparently isolated failures can be cascading and catastrophic because of interdependency.

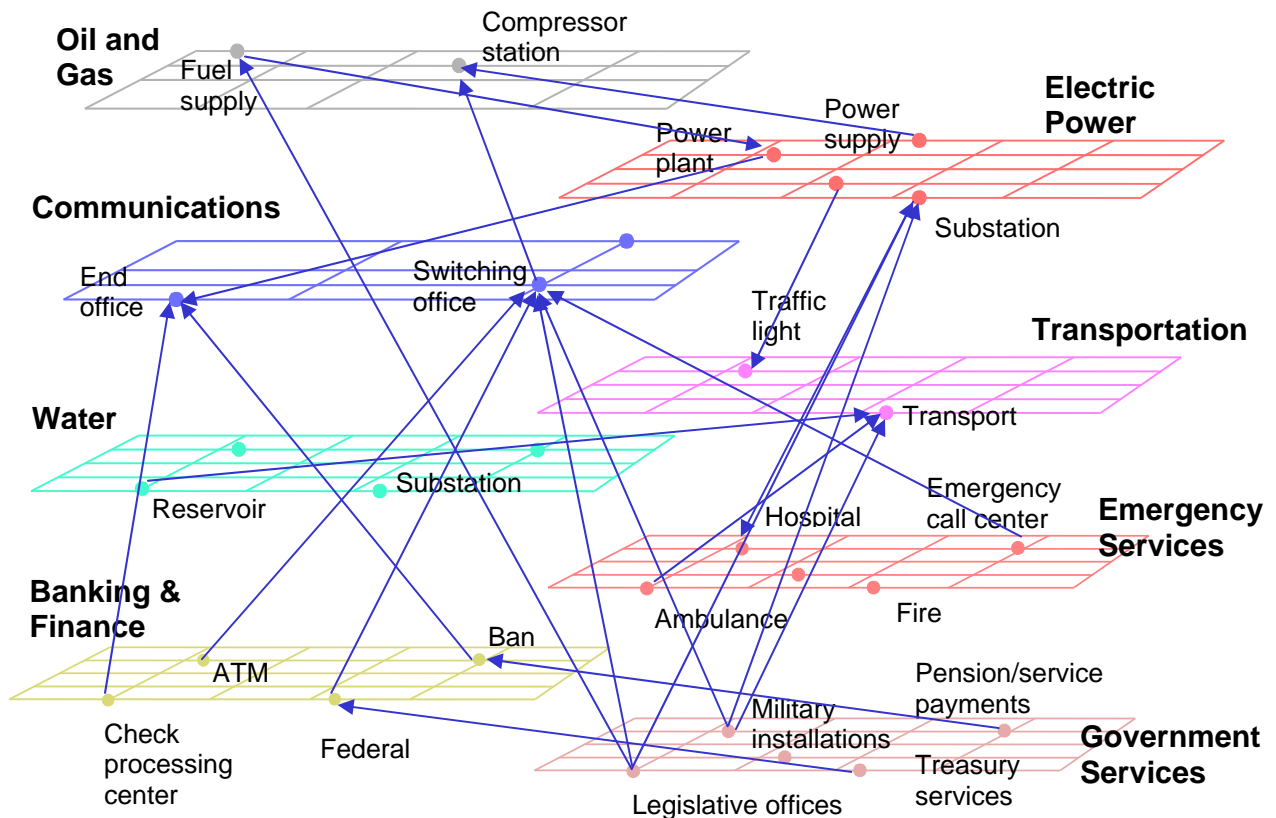


Exhibit 1. Utility Network Interdependencies Illustrated.

DISCUSSION

Interdependency issues have been brought into focus by catastrophic events. Significant failures with lessons learned include the 1988 central telephone office fire in Chicago and the Northeast-Midwest Power Blackout of 2003. Preparation for Y2K highlighted cyber-interdependency. Utility service failures can be evaluated along several dimensions: temporal (duration), spatial (affected area), customer-class differences, health and safety impacts, cost effectiveness, and public awareness and acceptance.

Furthermore, the 2001 terrorist attack in the U.S. and subsequent global conflicts have placed critical infrastructure protection and interdependency squarely within the realm of national security. The concepts of security, reliability, and interdependency all fall within the broader spectrum of *infrastructure integrity*.

Assessments of risks and vulnerability are central to the analysis of interdependencies. Risk analysis considers both the probability of an event and the potential severity of its impact. Threats to the functioning of interdependent infrastructures include design flaws, human error, natural disasters, and acts of war or terrorism.

Existing and new institutions at various levels are responsible for addressing these issues. In some instances, offices responsible for managing catastrophic events have seen their roles evolve in response to increasing complexity and interdependency of utility networks, as well as new forms of potential disruption. The U.S. Department of Energy leads the federal government's effort to ensure a robust, secure, and reliable energy infrastructure in the new threat environment that includes malevolent threats and increasing complexity due to interdependencies. Within each of the major utility industry sectors—electricity, oil and gas, water, and telecommunications—Information Sharing and Analysis Centers (ISACs) also emphasize interdependency awareness. Some national programs, such as InfraGard, promote awareness of interdependencies across utility and other critical infrastructures. States and state public utility commissions also are developing strategies for protecting critical and interdependent infrastructures.

“The facilities, systems, and functions that comprise our critical infrastructures are highly sophisticated and complex. They include human assets and physical and cyber systems that work together in processes that are highly interdependent. They also consist of key nodes that, in turn, are essential to the operation of the critical infrastructures in which they function... [C]hallenges and uncertainties [are] presented by critical nodes and single-points-of-failure within infrastructures, as well as increasing interdependencies that exist among the various infrastructure sectors both nationally and internationally. These interdependencies and key nodes are often difficult to identify and resolve, as are the cascading and cross-sector effects associated with their disruption” (The White House, *National Strategy*, 2003).

Interdependencies can be analyzed through analytical models, simulations, and exercises. A starting point is to characterize network services along key dimensions (see Exhibit 2), which in turn can be used to construct an interdependency matrix that can help prioritize attention and guide additional and more rigorous analysis. In the U.S., the National Laboratories and Technology Centers of the Department of Energy are advancing analytical approaches to both security and interdependency.

Interdependency can be managed, and adverse impacts of service disruptions can be mitigated, through a variety of tools: increased redundancy (e.g., backup power); reserve margins (capacity); procedures for service degradation and substitution; technical and managerial network safeguards; improvements to planning, coordination, and communications; expansion of some forms of networking (opportunities for switching); and limits on other forms of networking (resulting in less interdependency).

Exhibit 2. Characterization of Networks

	Network classes				
	A	B	C	D	E
Intermeshing	Intermeshed infra-structures	Intermeshed infra-structures	Intermeshed infra-structures	Shared infra-structures	Share or intermeshed infra-structures
Material transported	Service	Material	Materials	Service	Service or material
Interaction among networks	Very many	Many	Few	Variable	Variable
Impact on people	Indirect	Indirect	Direct	Direct	Indirect
Classification of networks	<ul style="list-style-type: none"> ▪ Electric ▪ Telecom ▪ Computers ▪ Public transportation 	<ul style="list-style-type: none"> ▪ Natural gas ▪ Liquid fuels ▪ Rail ▪ Sewage 	<ul style="list-style-type: none"> ▪ Water 	<ul style="list-style-type: none"> ▪ Food ▪ Hospital 	<ul style="list-style-type: none"> ▪ Highway ▪ Airport ▪ Marine transportation ▪ Financial ▪ Public security ▪ Government

Source: [Public Safety and Emergency Preparedness Canada. *Characterization and Ranking of Links Connecting Life Support Networks* \(April 2004\), 11.](#)

RECOMMENDED PROTOCOLS

State public utility regulators bear a distinct and expanding responsibility for ensuring that regulated firms prudently meet their obligations to provide safe, adequate, and reliable utility services, particularly to captive customers without access to reasonable service substitutes. The commissions can consider a number of practices to both raise attention to interdependencies and to promote better practices on the part of regulated utilities in planning for potential service impacts due to service disruptions affecting the networks and services on which they are dependent. Regulators can:

- Participate in private/public and cross-sector collaborative efforts that promote the economic stability, national security and infrastructure integrity (see the complete NARUC resolution in the Appendix to this paper).
- Become more informed about the interdependencies among critical jurisdictional and nonjurisdictional utilities and networks.
- Engage in outreach activities that promote awareness of interdependencies and appropriate responses.
- Establish minimum standards of performance, security, and reliability for regulated utilities.
- Require jurisdictional utilities to have emergency management and contingency plans in place that consider interdependencies with other utility and nonutility services.
- Develop procedures to deal with sensitive company and customer information that is used to assess security and interdependency issues.
- Ask jurisdictional utilities to provide the information necessary to evaluate emergency preparedness, taking interdependencies into account.
- Ensure that the agency has adequate technical capacity and resources to evaluate utility plans and information.
- Consider infrastructure integrity and interdependency fully in the context of not only rate reviews, but other proceedings—such as those concerning certification, facility siting, infrastructure investment, and planning.
- Develop and participate in emergency preparedness exercises that recognized interdependencies among utility networks.
- Have a communication and information sharing strategy that recognizes interdependencies and improves response effectiveness.
- Coordinate regulatory policies and activities with those of other state agencies, as well as local, regional, and national agencies.

RESOLVED, That the National Association of Regulatory Utility Commissioners (NARUC) convened in its 2004 Annual Convention in Nashville, Tennessee, strongly recommends that the States participate in private/public and cross-sector collaborative efforts that promote the Nation's economic stability, national security and infrastructure integrity.

*Sponsored by the Ad Hoc Committee on Critical Infrastructure, Committee on Water, Committee on Telecommunications, and Committee on Gas.
Adopted by NARUC November 17, 2004.*

APPENDIX: NARUC RESOLUTION ON UTILITY SECTOR INTERDEPENDENCIES (2004)

WHEREAS, The National Association of Regulatory Utility Commissioners (NARUC) recognizes that public utilities—telecommunications, electricity, natural gas and water and wastewater—in all States and regions provide essential services to consumers; and

WHEREAS, Individual utility services do not function without support from other industry sectors and are therefore interdependent; and

WHEREAS, Due to this interdependency, a disruption or outage in one utility sector can have a profound impact on other critical services, including information systems, healthcare, national defense, finance, shipping, and manufacturing; and

WHEREAS, The interdependency and vulnerability of public utility sectors and the National economic well-being has been brought to the forefront by catastrophic events such as the 2001 terrorist attack and the Northeast-Midwest power blackout of 2003; and

WHEREAS, A vast majority of the Nation's utilities and services are owned and operated by the private sector, and these businesses continue to develop, implement and update response and recovery plans for all critical service elements, including business continuity and contingency plans; and

WHEREAS, Robust response and recovery plans must be applied to our Nation's critical infrastructures so that each sector has a recovery plan that clearly defines sector responsibilities, articulates interdependencies and provides for communications with other critical sectors, as appropriate; now therefore be it

RESOLVED, That the National Association of Regulatory Utility Commissioners (NARUC) convened in its 2004 Annual Convention in Nashville, Tennessee, strongly recommends that the States participate in private/public and cross-sector collaborative efforts that promote the Nation's economic stability, national security and infrastructure integrity.

Sponsored by the Ad Hoc Committee on Critical Infrastructure, Committee on Water, Committee on Telecommunications, and Committee on Gas. Adopted by NARUC November 17, 2004.

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