NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

COM-003-1

Operating Communications Protocols White Paper

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RELIABILITY | ACCOUNTABILITY




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Introduction

Communication (COM) Standard COM-003-1 features requirements, the purpose of which is to provide clear, formal and universally applied communication protocols that reduce the possibility of miscommunication that could lead to action or inaction that is detrimental to the reliability of the Bulk Electric System (BES). Significant events have occurred on the BES when unclear communication created or exacerbated misunderstandings that led to instability and separation. Communication protocols used in many industries, militaries and government departments have added clarity to oral and written communications and have prevented potential errors that would have resulted in catastrophic events.

Purpose

The Operations Personnel Communications Protocol Standards Drafting Team (OPCP SDT) drafted a Standard Authorization Request (SAR) for Project 2007-02. The purpose of the proposed standard is to: "Require that real time System Operators use standardized communication protocols during normal and emergency operations to improve situational awareness and shorten response time."

The purpose of this paper is to establish the reliability value of requiring three-part communication for all operations on the BES described in the proposed definition of COM-003 - 1 "Operating Communications." Additionally, it addresses the reliability benefit of other communication protocols featured in COM 003-1 that provide addition clarity for "Operating Communications."

Background

NERC Project 2007-02 was created from the 2003 Blackout Report, Recommendation 26. In April 2004, the "Blackout Report" was submitted to the President of the United States of America and the Prime Minister of Canada.

The Blackout Report stated that:

> "Ineffective communications contributed to a lack of situational awareness and precluded effective actions to prevent the cascade. Consistent application of effective communications protocols, particularly during alerts and emergencies, is essential to reliability."

The report also recommended that industry,

> "Tighten communications protocols, especially for communications during alerts and emergencies. Upgrade communication system hardware where appropriate."

FERC Order No. 693, Paragraph 532 directs the ERO and the industry to develop communication protocols based on the following guidelines:

> "532. While we agree with EEI that EOP-001-0, Requirement R4.1 requires communications protocols to be used during emergencies, we believe, and the ERO agrees, that the communications protocols need to be tightened to ensure Reliable Operation of the Bulk-Power System. We also believe an integral component in tightening the protocols is to establish communication uniformity as much as practical on a continent-wide basis. This will eliminate possible ambiguities in communications during normal, alert and emergency conditions. This is important because the Bulk-Power System is so tightly interconnected that System impacts often cross several operating entities' areas."

In response to this recommendation in FERC Order No. 693, a SAR team was established in April of 2007. These reports, directives and approved guidance documents provide the framework from which the OPCP SDT derived the concepts that contributed to the development of the COM-003-1 requirements.

Three-Part Communication

Overview

Three-part communication, sometimes known as the "repeat back" method of communications, is used to communicate changes to physical Facility equipment during work activities via face-to-face, telephone, or radio communications. This communication protocol requires three oral exchanges between a sender and a receiver to promote a reliable transfer of information and understanding. The person originating the communication is the sender and is responsible for verifying that the receiver understands the message, as intended. The receiver makes sure he or she understands what the sender is saying and repeats back the message to the sender.

Steps for Three Part Communication

COM-003-1 requires the use of three-part communication for "Operating Communications," which is defined as, "Communication of instruction to change or maintain the state, status, output, or input of an Element[1] or Facility[2] of the Bulk Electric System."

This is a general description of how three-part communication functions:

1. First - The sender orally transmits information (face-to-face, telephonic or other electronic equivalent) clearly and concisely to the receiver, directing them to alter an element that could impact the BES.

2. Second - The receiver orally acknowledges the communication by repeating the message back to the sender. The receiver does not need to repeat every part of the communication verbatim, but he or she must restate the equipment-related information exactly as spoken by the sender. If the receiver does not understand the message, he or she must ask for clarification.

3. Third - The sender acknowledges the reply and confirms to the receiver that the message is correct and properly understood by stating the communication was correct. If the sender does not understand the receiver's reply, the sender must then respond by saying, "That is wrong," (or words to that effect) and then restate the original message. If corrected, the receiver must acknowledge the corrected message and repeat back the message to the sender.

[1] In the NERC Glossary of Terms, Element is defined as, "Any electrical device with terminals that may be connected to other electrical devices such as a generator, transformer, circuit breaker, bus section, or transmission line. An element may be comprised of one or more components."

[2] In the NERC Glossary of Terms, Facility is defined as "a set of electrical equipment that operates as a single Bulk Electric System Element (e.g., a line, a generator, a shunt compensator, transformer, etc.)"

Verbal three-part communication should be used during the operation or alteration of Facility equipment. Applicable entities are to use three-part communications when performing steps or actions using an approved procedure that impact equipment or activities, the safety of personnel, the environment, or the Facility. Finally, three-part communication should be implemented for tasks where the consequences of a mishap are unacceptable and could lead to instability, uncontrolled separation, or Cascading.

As a best practice, it may also be used when discussing the condition of Facility equipment or the value of an important parameter in utility operations.

Phonetic Alphabet or Alpha-numeric Clarifiers

Overview

Several letters in the English language sound alike and can be confused in stressful or noisy situations. For example, some letters sound alike when spoken, and can easily be confused; such as “D” and “B.” The phonetic alphabet specifies a common word for each letter of the English alphabet. By using a word for each letter, there is less chance that the person listening will confuse the letters. Using the phonetic alphabet, “Delta” and “Bravo” are more easily differentiated. The effects of noise, weak telephone or radio signals, and an individual's accent are reduced through the use of the phonetic alphabet.

People use the phonetic alphabet and unit designators when describing unique identifiers for specific components. When the only distinguishing difference between two component labels is a single letter, then the phonetic alphabet form of the letter should be substituted for the distinguishing character. For example, 2UL-18L and 2UL-18F would be stated, “two Uniform Lima dash one eight Lima” and “two Uniform Lima dash one eight Foxtrot.”

COM-003-1 Featured Phonetic Alphabet

Letter - Word	Letter - Word	Letter - Word	Letter - Word
A - Alpha	H - Hotel	O - Oscar	V - Victor
B - Bravo	I - India	P - Papa	W - Whiskey
C - Charlie	J - Juliet	Q - Quebec	X - X-ray
D - Delta	K - Kilo	R - Romeo	Y - Yankee
E - Echo	L - Lima	S - Sierra	Z - Zulu
F - Foxtrot	M - Mike	T - Tango	
G - Golf	N - November	U – Uniform	

Number	pronounced as:	Number	pronounced as:
1 - One	(wun)	6 - Six	(six)
2 - Two	(too)	7 – Seven	(sev-en)
3 - Three	(tree)	8 – Eight	(ait)
4 - Four	(fow-er)	9 – Nine	(nin-er)
5 – Five	(fife)	0 – Zero	(zee-row)

The phonetic alphabet or a correct alpha-numeric clarifier is to be used for any, “Communication of instruction to change or maintain the state, status, output, or input of an Element or Facility of the Bulk Electric System.”

COM-003-1 Operating Personnel Communication Protocols

The nature of communication between people can be complex and subject to many variables. Accents, moods, regional jargon, cultural interpretations, multiple languages, individual skill sets, and physiological conditions are but a few of the universe of factors that can and do have an impact on the clarity of two-party, person-to-person communication. Until the human factor is completely eliminated, there will be the risk of human error due to miscommunication.

Miscommunication has created unintended results on the Bulk Electric System (BES) that have led to outages and, in some cases, the inability of an operator to prevent the spread of Cascading. Although the potential for human error can never be completely eliminated, successful, proven communication protocols from other industries that also deal with critical processes and systems can be implemented to reduce the risk to BES reliability. The successful implementation of these widely-accepted communication protocols from other industries into the requirements of COM-003-1 will have a significant, positive impact on the reliability of the BES.

COM-003-1 requires the use of three-part communication for all Operating Communications. The reliability benefits of using three-part communication is threefold:

1. The removal of any doubt that communication protocols will be used and when they will be used. This will reduce the opportunity for confusion and misunderstanding among entities that may have different doctrine. An example is: One entity uses three-part for emergencies, and the other uses it for all operating conditions.

2. There will be no mental "transition" when operating conditions shift from normal to Emergency. The communication protocols for the operators will remain standard during transitions through all conditions.

3. The formal requirement for three-part communication will create a heightened sense of awareness in operators that the task they are about to execute is critical, and recognize the risk to the reliable operation of the BES is increased if the communication is misunderstood.

Electric Utility Industry Communication Practices

The risk of BES failure due to miscommunication is very significant in the electric power industry. Blackouts that affect millions of customers in major cities are guaranteed to create undesirable media attention. The public at large in North America is heavily dependent on technology and is intolerant of massive blackouts. The public is conditioned to 24/7 access to technology, climate control and lighting. A sudden loss of service quickly causes immediate public frustration. If the root cause was determined to be industry operating miscommunication instead of uncontrollable environmental factors, criticism increases even more dramatically. Other industries that currently deal with risks, challenges and potentially widespread consequences similar to the electric utility industry have successfully reduced miscommunication by implementing uniform communication protocols similar to those identified in and required by COM 003-1.

Table of Communication Practices of the Electric Utility Industry

The examples listed in the table below represent the communication practices of many major registered entities that engage in three part communication when altering the operating state of the BES. These registered entities account for a large amount of the generation, load and customers served in North America.

Table 1-A Registered Entities that Currently Use Three-Part Communication during Both Emergencies and Non-emergencies[3]

Registered Entity Location and Description	Generation Operations	Transmission Operations	Distribution Operations	Normal Operations	Emergency Operations	Customers Impacted	Load
South/Central US Entity (large)	Yes	Yes	Yes	Yes	Yes	23 Million	82 GW
Large Southern Entity #1	Yes	Yes	Yes	Yes	Yes	4.4 Million	43 GW
Large Mid Atlantic RTO Entity	Yes	Yes	NA	Yes	Yes	60 Million	185 GW
Large Southern Entity #2	Yes	Yes	Yes	Yes	Yes	2.8 Million	30 GW
Large West Coast Entity#1	Yes	Yes	Yes	Yes	Yes	5.1 Million	Not Available
Large Canadian HYDRO	Yes	Yes	Yes	Yes	Yes	1.3 Million	27 GW
Large	Yes	Yes	Yes	Yes	Yes	3.4	17 GW

[3] Industry use of three part communication analysis is based on publicly published documents, policies, procedures and internal standards.

Registered Entity Location and Description	Generation Operations	Transmission Operations	Distribution Operations	Normal Operations	Emergency Operations	Customers Impacted	Load
Midwestern/ Western Utility						Million	
Large Florida TOP	Yes	Yes	Yes	Yes	Yes	4.5 Million	43GW
Midwestern RTO Entity	Yes	Yes	NA	Yes	Yes	39 Million	110 GW
DOE	Yes	Yes	Yes	Yes	Yes	NA	NA
INPO	Yes	Yes	Yes	Yes	Yes	NA	NA

This is strong evidence of an embedded electric utility practice that establishes, without doubt, the significant element of reliability value of three-part communications and the other communications protocols. The fact that the majority of BES entities already employ three-part (or repeat back) communications for routine, alert and Emergency operations (and document it in very strong language in their policy and procedures) demonstrates that the electric utility industry recognizes this significant element of value.

Human Factor Considerations

As previously discussed, there are a myriad of reasons that miscommunications occur. Beyond the typical environmental concerns (loud background noise, radio static, dialects, etc.), humans are very likely to have misunderstandings based on other factors. Humans are susceptible to expectation errors, relating to context and meaning, which will often drive understanding. People often discern what they want to hear, usually at a subconscious level. The importance of verifying what is heard becomes the first step in assuring that the message was understood.

When a person hears a message, an interpretation emerges from the different pieces of conversation data; this is called data-driven or bottom-up processing. Perception can be largely data-driven because one wants to make sure their understanding accurately reflect events in the outside world; in this case, the message from the sender. A person wants the interpretation of a message to be determined mostly by data (perception), then to understand the information in the environment (comprehension), and to make the appropriate decision from the senses; not by the listener's expectations. This data-driven processing can lead to miscommunications and may affect situational awareness because if the perception of the information is wrong, the chances of correct understanding and making proper future decisions are dramatically reduced.[4]

Situation awareness is fundamentally based on one's understanding of a system, how it operates, its characteristics, and performance parameters; couplings within itself and other systems and how one interacts with it. This understanding is referred to as one's mental model. It is a representation of the surrounding world, the relationships between its various parts and a person's intuitive perception about his or her own actions and their consequences. One's mental model helps to shape one's behavior and define one's approach to solving problems (a personal algorithm) and carrying out tasks, especially within a system. Mental models can be partially or completely right or wrong, complete or incomplete, and most often are unique for each individual. Sometimes mental models are carried throughout an organization through operating norms and commonly understood practices. Part of building a mental model for a particular problem or event is to gain information through active communication with others. Miscommunication can hamper immediate decisions and can also lay in waiting as a latent error, which can expose itself later when the incorrect information is retrieved or used in the processing of decision making.

[4] Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems. Human Factors, 37(1), 32-64.

Communication Practices External to the Electric Utility Industry

The purpose of effective communication is to create mutual understanding between two or more people. Effective communication is an important defense in the prevention of errors and events. Many industries mandate communication protocols due to the high potential for catastrophic results if an important communication is misunderstood. While the effects of critical mishaps from ineffective communications differ, the offending organization and associated industry will find itself dealing with legal, regulatory, financial, market and political consequences.

Medical Field Industry

Ineffective communication is a root cause for nearly 66 percent of all sentinel events (events that signal the need for immediate investigation and response) reported in the medical industry. In other words, 66 percent of all reported deaths or serious injuries (accidents) in healthcare from 1995-2005 were related to ineffective communication.[5]

One step the medical industry is implementing to solve ineffective communication problems in the healthcare industry is to implement a "read-back" process for taking verbal or telephone orders.

Oral communication possesses a greater risk of misunderstanding compared to written forms of communication. Misunderstandings are most likely to occur when the individuals involved have different understandings, or mental models, of the current work situation or use terms that are potentially confusing. Therefore, confirmation of verbal exchanges of operational information between individuals must occur to promote understanding and reliability of the communication. In addition, the medical industry is standardizing abbreviations, acronyms, and symbols used throughout the field, to include compiling a list of those abbreviations, acronyms, and symbols that are not to be used.

Commercial Air Transportation Industry

Based on available data, in the last 67 years there have been 274 commercial airline accidents involving at least 60 fatalities or more. Miscommunication between pilots and controllers can clearly be identified as a causal factor in 36 (13 percent) of these tragedies. Based on this analysis, the aviation community has implemented interpersonal communication tools like three-part communications and language standardization.

[5] JCAHO1 Root Causes and Percentages for Sentinel Events (All Categories) January 1995–December 2005.

Military Communication Protocols

Military organizations have a long history of communication protocols that they have developed and have improved over time. Firing orders, shipboard orders to the helm, aircraft launch and recovery contain elements of three-part communication and alpha numeric clarifiers. The reasons these communication protocols are required are due to the extreme risks and consequences that exist if miscommunication occurs. Military organizations also make use of the NATO alphabet and various shorthand codes to provide a status or update.

Railroad Operations

Rail operations have similar risks of catastrophic results due to miscommunication. Switching rails, moving cars, coupling, decoupling and loading freight necessitate clear communication and require three-part communication and formal protocols.

Other Organizations

Police and fire dispatch, the Department of Energy, and The Institute of Nuclear Power Operations (INPO) are among other organizations that value and mandate communication protocols similar to those in COM-003-01.

Performance of the Electric Utility Industry

Of all of the System events that NERC has either analyzed or investigated, 50 percent of those have involved findings of a deficiency of clear, concise communications. These events have either impacted, or potentially impacted, a significant amount of Load and/or generation.

Significant blackout events, such as the Northeastern Blackout of 2003 and the Florida Blackout of 2008, have communication issues listed among the top contributors to loss of Load and generation.

This analysis highlights the fact that industry Operating Communication performance over the last 10 years still has room for significant improvement. The lack of clear standard communication protocols when operating the BES will continue to create unacceptable levels of risk for large-scale failures.

Table 1 indicates that, across electric power industry, internal policies specify three-part communications for all BES operations, including routine or normal operations. This high level of compliance can be associated with the history of enforcement of COM 002-2a, R2, which requires three-part communication for all directives. This requirement has been mandated and has been enforceable for several years. When compared to COM 002-2a, COM 003-1 features improved approaches and structure for three-part communication that assigns proper responsibility for the "issuer" (sender) and for the "receiver." When combined with the proposed definition of "Operating Communications," COM 003 clarifies the circumstances of when to use three-part communication. The other improvement COM 003-1 offers, to improve the reliability of the BES, is the addition of several proven communication protocols that will clarify Operating Communications to reduce the risk of mistakes Clarifying several key elements of an "Operating Communication;" such as time, time zone, equipment identifiers, a common language and alpha-numeric clarifiers, all contribute to reducing misunderstandings and reduce the risk of a grave error during BES operations.

Summary

The BES across North America is a "tightly" interconnected System where instability can spread quickly. When a decision is made to alter the state of an Element on the BES, there is an increased threat to reliability, no matter what type of operating condition (normal, alert, Emergency) exists. The transition from normal to Emergency operation can be sudden and indistinguishable until recognized, often after the damage is done. There are multiple human factors during communication that occur naturally and contribute to unclear communication, which increases the risk to reliable operation of the BES.

The electric power industry widely deploys communication protocols such as three-part communications for all BES Operating Communications. The uniform deployment of these protocols in the three Interconnections is in part due to Requirement 2 in the mandatory and

enforceable Reliability Standard COM-002-2a. Industry's widespread utilization of three-part communications for BES Operating Communication is a confirmation of the reliability value of the protocol.

The official results of the 2003 Blackout Report cites unclear communications as a major factor in the cause, spread, and impedance of restoration of major BES failures. Other industries have successfully implemented universal communication protocols, which have resulted in fewer accidents and fatalities caused by miscommunications. Preventable blackouts or widespread loss of generation or load continues to be politically, socially and economically unacceptable in North America.

Conclusion

The critical nature of BES configuration and its impact on reliability demands, that any action planned to alter the System under any condition should be systematically and clearly conveyed. Given the extent of human involvement in the process, the risk of miscommunication increases based on our own human tendencies and perceptions.

COM 003-1 takes communication protocols for the BES to the next level of reliability by requiring protocols that will reduce the risk of miscommunication. It clarifies when to use three-part communication. It provides a superior requirement structure that properly assigns the elements of three-part communication to the "issuer" (sender) and "receiver" and requires additional communication protocols that provide greater clarity when engaged in operating communication on the BES. Based on the facts listed above, communication protocols, as contained in proposed Standard COM-003-1, will provide a strong and much improved reliability benefit to address existing communication reliability gaps that continue to negatively impact the reliable operation of the BES.

The proposed communication protocols in COM 003-1 have been successfully developed and proven in other organizations' processes. The use of repeat backs and the added layer of value they provide to BES reliability make them essential to all "Operating Communications." The OPCP SDT endorses the use of these protocols.