A Report on

Assessing the Need for Introducing Demand Response Functions and Entities to the NERC Reliability Functional Model

Prepared by: Functional Model Demand Response Advisory Team

Executive Summary

The Functional Model Working Group Demand Response Advisory Team (FMDRAT) has completed an assessment of the need to include Demand Response (DR) functions and associated functional entities either in the NERC Functional Model (FM) or as an Applicable Entity for NERC Standards.

The FMDRAT assessed a number of key issues related to the role and reliability impacts of DR in the planning and operation horizons. This assessment leads to the following key conclusions and recommendations:

1) DR is generally considered in BES planning and operations from the perspective of resource adequacy assessment and operating reserve determination. Long-term planners, operational planners and operators do take into account the amount of DR under contractual agreement or participated in operating reserve market to adjust resource needs to meet forecast system demand and reserve requirements. Since DR itself is not an active facility or component like a generator, its "dispatch" action is initiated upon receiving instructions from the operating authorities under pre-determined system conditions. Compared to sudden load increase and generator tripping, DR's spontaneous performance or failure to perform as instructed does not pose adverse reliability impacts on the BES for which there is no recourse. Hence, there is not a need at this time to include DR in the Functional Model to describe its role in contributing to BES reliability.
2) Imposing reliability standards to force entities responsible for DR operations to comply with commercial agreements would be inappropriate, may not achieve the desired outcome, and in fact may discourage entities from participating in DR programs. There is thus no urgency or need to develop reliability standards to ensure compliance with what is essentially a business arrangement with commercial mechanisms already in place to drive the desired outcome.
3) The FMWG should continue to monitor DR development and identify if and when DR technology and penetration levels create a unique impact on BES reliability.

1.0 Introduction

The Functional Model Working Group Demand Response Advisory Team (FMDRAT) has completed an assessment of the need to include Demand Response (DR) functions and associated functional entities either in the NERC Functional Model (FM) or as an Applicable Entity for NERC Standards. The issues considered by the FMDRAT and the key findings after discussing these issues are summarized in this report for consideration by the Functional Model Working Group (FMWG).

The FMDRAT is made up of 14 members appointed by the NERC Standards Committee. The FMDRAT's roster is included as Attachment 1.

2.0 Background

In 2008, the FMWG set up a small advisory team to assess the need to create a DR function and a DR entity. That advisory team concluded that such a function and related functional entity were not justified at that time. The Advisory Team also suggested that the FMWG reconsider the issue when developing Functional Model Version 5 (FM V5). The advisory team recommended consideration of assigning such functions and responsibilities to functions and entities already defined in the FM.

The FMWG reconsidered the issue in its development of FM V5, and again concluded that there was no justification for defining a DR function and entity in the FM V5 Model. The NERC Planning Committee at its December 8-9, 2009, meeting, when approving the FM V5, requested the FMWG reassess the need to include a DR Functional Entity in FM V6. Below is the excerpt from the Planning Committee's meeting minutes:

Functional Model Version 5: FMWG Chair Jim Cyrulewski presented an overview of the Functional Model, version 5. On a motion by John Simpson, the PC approved V5, without modification, the technical content of two documents: Reliability Functional Model, Function Definitions and Functional Entities and Reliability Functional Model Technical Document.

The primary discussion focused on what was not in version 5: a functional entity (or entities) responsible for demand resources. Mr. Cyrulewski noted that when the FMWG presents version 5 to the Standards Committee (SC) in January 2010 for approval, it will be recommending a new subgroup be formed to address the demand resources function so that it can be incorporated in version 6. John Simpson suggested that the PC's Resource Issues Subcommittee be involved in that effort.

The Standards Committee in response to the FMWG's request approved the formation of the FMDRAT to address the Planning Committee's request. The FMDRAT was formed in May 2010, and from September 2010 to February 2011 completed its assignment to assess the need for a DR function and entity. This report presents the FMDRAT's assessment and recommendations.

3.0 Key Issues Addressed by the FMDRAT

The FMDRAT began its tasks by identifying and compiling a list of potential reliability impacts associated with the participation of DR. The issues were important because the Functional Model is a general description of the primary reliability tasks that need to be performed to ensure reliability of the Bulk Electric System (BES).

Presented below is a summary of the FMDRAT's assessment of each of the identified key issues.

3.1 Reliability Impact of DR - *Does the change in energy use from a DR asset or from an aggregation of DR assets create any unique reliability impact?*

Demand Response (DR) is a temporary change in electricity usage by a Demand Resource in response to market or reliability conditions.[1] Demand Response is regarded as a "dispatchable" resource (as opposed to energy efficiency, which is always "on") whose deployment is driven by pre-determined system conditions or reliability event criteria by an operating entity. The system operator typically provides instruction to the DR provider for deployment of DR assets. Additionally, DR providers may self-schedule DR asset deployment, as in the case for economic dispatch in some regions.

A DR asset or aggregator that functions according to operating conditions as defined by prior agreements poses no impact to reliability because its impacts are analyzed and assessed in the Operating Plans of the respective Transmission Operator (TOP) and Balancing Authority (BA).

The TOP and BA plan in advance to meet system load, including load that is represented or controlled by DR entities. TOPs and BAs have knowledge of all relevant conditions and agreements, and plan operations accordingly for the load to be served with or without contribution from DR.

To the BA, load is a composite value (i.e., not locational) and a forecast can be developed for how much capacity is required to meet that load. Contractual arrangements with DR providers are accounted for in the BA's operating plans.

To the TOP, load is locational and it is based on historic load bus values. The DR control of load does not change the location of the basic load; rather, the availability of DR provides the TOP with another option to control congestion and to maintain reliability.

The impacts from a failure of DR to respond on the power system are no different from a situation where a Generator Operator does not generate to its cleared energy quantity or does not respond to requests to raise generation. At present, there are no reliability standards that mandate a Generator Operator to comply with the business agreements. There are mechanisms in some areas (e.g. in some organized markets) to levy a penalty on

[1] North American Energy Standards Board, Wholesale Electric Quadrant definition, 2010

the Generator Operator for not meeting its commitment or requested output, but this is a commercial arrangement which falls outside of the scope of the NERC Functional Model or reliability standards. BAs and TOPs are similarly free to prescribe penalties for comparable failures of DR. Such penalty structures are not currently described in the Functional Model, nor are there reliability standards developed to enforce compliance to such penalties.

Observation 1: DR may be considered a dispatchable resource as compared to energy efficiency, which is always "on"; it is also regarded as a load whose contractual arrangement to be reduced in response to operating instructions or market mechanism is well-known to the operators. At present, there does not appear to be any adverse reliability impact on the BES unique to DR resources where there is no recourse either for the DR's reduction of load as planned or requested, or the DR's failure to reduce load as planned or requested.

3.2 Reliance on DR to provide Operating Reserves

In some organized markets, DR may participate in the reserve market. In non-organized markets, DR may enter into contractual arrangements with the host utility to provide reserve capability. The FMDRAT assessed that the BA was responsible for ensuring adequate reserves in the operations time frame, and the BA was required to understand the characteristics of the DR resources regardless of the market setup, and the BA was required to develop the necessary recourses to guard against DR's failure to perform. Again, this situation is no different than generators not providing operating reserves. At present, there are no reliability standards that mandate a Generator Operator to provide the needed reserves as procured or requested by the Balancing Authority.

To manage the potential risk that DR fails to provide the dispatched or self-scheduled reserve quantity agreed upon, some organized markets apply a discount factor to the amount of reserves offered by a DR resource, while some organized markets limit DR participation to 30-minute reserve services. Still others do not count on the DR to begin with, but as load drops off, the responsible entity backs down the generation loaded in response to the activation in order to maintain adequate operating reserves.

Similar measures were determined by the FMDRAT to be adopted in non-organized markets through contractual arrangements.

Observation 2: TOPs or BAs are responsible for managing the load and supply balance in their control areas. Dispatchable DR resources are generally considered in resource adequacy and operating reserve assessments in the operational planning time frame. However, it does not appear that DR presents any new or different risks to the BES compared to any other dispatchable resource available to the TOP or BA. All responsible entities have measures in place to guard against the possibility that any dispatchable resource does not fulfill its obligations to provide the agreed amount of reserves. There are no adverse reliability impacts on the BES for which there is no recourse when DR resources do not perform as planned or requested to provide the needed reserve.

3.3 DR resources' obligations to support resource planning

Many planning entities consider DR in their mid-term and long-term resource planning processes. Some Planning entities consider DR as a resource to help meet the reserve margin requirement that is determined by either the traditional loss-of-load expectation (LOLE) process or by other commonly used methodologies.

Projected available DR may be applied as an available resource to help meet a reserve margin requirement, or applied as an offset to the long-term load forecast. Some planning entities apply a forced outage rate to the DR, similar to dispatchable generators, and simulate DR performance in LOLE calculations. In each case, some uncertainty exists around long-term DR resource availability due to the short term contractual nature of DR assets as compared to the expected life of a generation asset. Some entities conduct more frequent resource adequacy assessments as the planning horizon approaches the near-term. An additional DR functional entity will not change the current role or responsibility of the planning coordinator or the resource planner.

Observation 3: Some entities consider DR in long-term planning and its treatment varies from one entity to another. However, owing to the long lead time in the planning process, there is uncertainty as to whether or not the status of the DR will remain unchanged as it approaches real time. An additional DR functional entity will not change the current role or responsibility of the planning coordinator or the resource planner.

3.4 Need for reliability standards to enforce compliance with contractual agreements/obligations

At present, DR is usually arranged via contractual agreements or market mechanisms such as pricing thresholds, reserve offerings, or forward capacity auctions. In these arrangements, penalties are levied if commercial or contractual obligations are not met. These mechanisms are similar to generators bidding into and being dispatched in an energy market and getting paid the market price or another pre-determined price based on the amount of generation provided. In such cases generators would not be paid (and in some cases assessed with additional penalties) if they failed to generate at the agreed upon or committed level. Given these contractual or commercial payment/penalty mechanisms, there do not appear to be gaps that would require the development and enforcement of reliability standards to achieve the desired DR performance. Imposing reliability standards to force compliance to commercial agreements is inappropriate, may not actually achieve the desired outcome, and may in fact discourage load from participating in DR programs.

The FMDRAT further assessed whether DR is a fundamental component or product of the BES. DR can provide some flexibility in both the long-term and operational planning time frames, to the extent that the responsible entities can choose which loads continue to be

supplied. As such, DR may be considered a derivative product that should continue to be handled by commercial arrangements, not reliability standards.

Observation 4: Reliability standards are not required to enforce DR to comply with contractual agreements or obligations since DR participation is essentially a commercial arrangement. There are little or no material reliability impacts if DR fails to perform as agreed to or as requested (from Observations 1 and 2, above). Imposing reliability standards to force compliance to commercial agreements may not achieve the desired outcome of ensuring long-term reliability and may discourage entities from participating in DR programs.

3.5 DR Ownership and Operations – roles and relationships with others

In consideration of the possibility of introducing DR functions and entities to the Functional Model, the FMDRAT developed a draft set of tasks describing a Demand Response Ownership function and the relationship between the DR Owner and others. The FMDRAT also developed a draft set of tasks for a Demand Response Operations function and the relationship between the DR Operator and others. The objective of this exercise was to compare the primary functions between the two types of resource providers.

The FMDRAT concluded that a parallel to the tasks and relationships developed for the Generator Ownership and Generator Operations and their respective functional entities could be drawn for DR. The draft list of tasks and relationships for the DR Ownership and Operation functions and for the DR Owner and DR Operator is provided in Appendix A for information only. The FMDRAT did not finalize or accept the list provided in Appendix A in light of the FMDRAT's assessment that introducing DR functions and associated entities to the Functional is not required at this time. The list is provided herein only as a matter of record for future reference and is not part of the FMDRAT's recommendation at this time.

3.6 Conclusion of Majority Position

A near-unanimous consensus of the FMDRAT agreed with the analysis made for each of the key issues and the corresponding assessments detailed in this section of this report. The same majority agreed that that there is not a demonstrated need to introduce DR functions and entities to the Functional Model at this time.

4.0 Minority Position

The key counter-arguments centre on the comparable obligations between DR Owner/Operator and Generator Owner/Operator (GO/GOP). At present, there are a number of reliability standards that apply to GOs and GOPs. DR providers may offer their product into energy or ancillary services markets and receive compensation for successful performance. They should bear the same obligations as their generation counterparts and hence should have a comparable set of reliability standards imposed on the DR Owners and

Operators. However, if DR is not introduced to the Functional Model and if DR were required to meet the same reliability standards, then a number of standards currently applied to GO and GOP, as listed in Appendix B, should be removed from the NERC reliability standards.

The FMDRAT assessed these minority views and arrived at the following assessments:

Apart from the fact that both generation and DR provide resources to the BES, there are some fundamental differences between them. Generators are a fundamental part of the integrated power system; they provide primary products for BES reliability – energy and ancillary services. Generators do change output in reaction to system changes and their changes are largely governed by their inherent physical characteristics and auxiliary device settings. These characteristics and settings need to be verified and modeled, and the simulated generator performance needs to be assessed against specific standards criteria to ensure that any adverse effects are self-contained or isolated without propagating to other parts of the BES which could result in uncontrolled or cascade tripping. It is largely on this basis, to ensure acceptable generator performance, that reliability standards are developed and imposed on GO and GOP.

DR is a derivative or supplementary part or product of the power system, with specific rules for participation in BES operations. DR augments the capabilities of the BES thus increasing the effective utilization of the BES, but it does not expand the capability of the system to serve more loads, unlike its generator counterpart.

DR changes in load are inherently independent of system changes. Therefore, reliability standards are not needed to ensure acceptable performance as in the case of their generator counterpart. Commercial arrangements and compensation/penalty mechanisms are in place to govern DR contractual obligations and are sufficient to drive the desired behaviour when DR is called upon to act. Imposing reliability standards to enforce such behaviour is inappropriate and unnecessary and may not actually achieve the desired outcome.

As to the request to remove the listed reliability standards for the GO and GOP, the FMDRAT did not agree to a position since such a determination was not part of our charter.

5.0 Conclusions and Recommendations

The FMDRAT assessed a number of key issues related to the role and reliability impacts of DR in the planning and operation horizons. The assessment leads to the following conclusions:

1. DR is generally considered in BES planning and operations from the perspective of resource adequacy assessment and operating reserve determination. Long-term planners, operational planners and operators do take into account the amount of DR under contractual agreement or participated in operating reserve market to adjust resource needs to meet forecast system demand and reserve requirements. Since DR itself is not an active facility or component like a generator, its “dispatch” action is initiated upon receiving instructions from the operating authorities under pre-determined system conditions. Compared to sudden load increase and

generator tripping, DR's spontaneous performance or failure to perform as instructed does not pose adverse reliability impacts on the BES for which there is no recourse.

2. All responsible entities have some measures in place to guard against the possibility that a DR resource does not fulfill its obligations to provide the agreed amount of reserves.

3. For long-term planning, most entities include contributions from DR to some extent. Uncertainties associated with DR's long-term commitment to remain "dispatchable" are typically addressed by applying a discount factor or probability analysis to DR's availability in resource adequacy assessments.

4. In operational planning, there are no known entities that count on DR as a critical component of their operational plans. An additional DR functional entity will not change the current role or responsibility of the planning coordinator, resource planner, or operations planner.

5. Reliability standards are not required to enforce DR compliance with contractual agreements or obligations. There are little or no reliability impacts caused by the failure of DR resources to perform as agreed to or as requested. Therefore imposing reliability standards to force compliance with commercial agreements would be inappropriate, may not achieve the desired outcome, and in fact may discourage entities from participating in DR programs.

6. DR is a reactive component and a derivative product of the power system; it augments the capabilities of the BES thus increasing the effective utilization of the BES but it does not expand the system's capability to serve more load and does not move spontaneously or in response to system changes for which reliability standards might be needed to ensure acceptable performance. Having commercial arrangements and compensation/penalty mechanisms in place to govern their contractual obligations would suffice to drive DR to achieve the desired behavior. Imposing reliability standards to enforce such behavior is extraneous and unnecessary.

Conclusions (1) to (4) suggest that there is no need at this time to include DR in the Functional Model to describe its role in contributing to BES reliability. Conclusions (5) and (6) suggest that there is no urgency or need to develop reliability standards to ensure compliance with what is essentially a business arrangement with commercial mechanisms in place to drive the desired outcome.

It is on the above basis that the FMDRAT recommends:

1. **DR functions and their associated functional entities not be defined and introduced to the Functional Model at this time.**

2. **The FMWG continue to monitor DR development and identify if and when DR technology and penetration levels create a unique impact on BES reliability.**

Attachment 1

The Functional Model Demand Response Advisory Team

	Name	Company
	Ben Li (Chair/Facilitator)	Ben Li Associates
1	Albert DiCaprio	PJM
2	Phil Davis	Schneider Electric
3	Stephen C. Knapp	Constellation Energy Commodities Group, Inc.
4	John D. Varnell	Tenaska Power Services Co
5	Donna Pratt	NYISO
6	Ken Clark (did not participate)	Consert, Inc.
7	Aaron Breidenbaugh	EnerNOC
8	Wayne Van Liere	EON US
9	Ulric Kwan	Pacific Gas & Electric Company
10	Eric Winkler, Ph.D.	ISO New England
11	Paul Wattles	Electric Reliability Council of Texas (ERCOT ISO)
12	John Simpson	RRI Energy
13	Andy Satchwell	Lawrence Berkeley National Lab
14	Tony Jankowski	We Energy

Appendix A
DRAFT List of Perceived Tasks and Relationships for Demand Response Functions and Entities

(The list is provided for information and for future reference only; it is not part of the FMDRAT's recommendation at this time.)

Generation	Demand Response
Generator Ownership Function **Tasks** 1. Establish generating facilities ratings, limits, and operating requirements. 2. Design and authorize maintenance of generation plant protective relaying systems, protective relaying systems on the transmission lines connecting the generation plant to the transmission system, and Special Protection Systems. 3. Maintains owned generating facilities. 4. Provide verified generating facility performance characteristics / data. **Functional Entity – Generator Owner** The functional entity that owns and maintains generating units. **Relationships with Others** 1. Provides generator information to the Transmission Operator, Reliability Coordinator, Balancing Authority, Transmission Planner, and Resource Planner. 2. Provides unit maintenance schedules and unit retirement plans to the Transmission Operator, Balancing Authority, Transmission Planner, and Resource Planner.	**Demand Response Ownership Function** **Tasks** 1. Establish demand response facility ratings, limits, and operating requirements. 2. Design and authorize maintenance of demand response facilities and associated control devices. 3. Maintains owned demand response facilities. 4. Provide verified demand response facility performance characteristics / data. **Functional Entity – Demand Response Owner** The functional entity that owns and maintains demand response facilities. **Relationships with Others** 1. Provides demand response information to the Transmission Operator, Reliability Coordinator, Balancing Authority, Transmission Planner, and Resource Planner. 2. Provides demand response facility maintenance schedules to the Transmission Operator, Balancing Authority, Transmission Planner, and Resource Planner.

3. Develops an interconnection agreement with Transmission Owner on a facility basis.
4. Receives approval or denial of transmission service request from Transmission Service Provider.
5. Provides reliability related services to Purchasing-Selling Entity pursuant to agreement.
6. Reports the annual maintenance plan to the Reliability Coordinator, Balancing Authority and Transmission Operator.
7. Revises the generation maintenance plans as requested by the Reliability Coordinator.

Function – Generator Operation

Tasks

1. Formulate daily generation plan.
2. Report operating and availability status of units and related equipment, such as automatic voltage regulators.
3. Operate generators to provide real and reactive power or reliability-related services per contracts or arrangements.
4. Monitor the status of generating facilities.
5. Support Interconnection frequency.

Functional Entity – Generator Operator

The functional entity that operates generating

3. Reports the annual maintenance plan to the Reliability Coordinator, Balancing Authority and Transmission Operator.
4. Revises the demand resource facility maintenance plans as requested by the Reliability Coordinator.

Function – Demand Response Operation

Tasks

1. Formulate daily demand response resource plan.
2. Report operating and availability status of demand response related equipment and control devices.
3. Operate demand response facility control devices or otherwise implement demand reduction or demand increase in response to instructions or according to contract arrangements.
4. Monitor the status of demand response facilities.

Functional Entity – Demand Resource Operator

The functional entity that operates demand

unit(s) and performs the functions of supplying energy and reliability related services.	response facilities and performs the functions of curtailing or increasing demand in response to instructions or in accordance with contractual arrangement.
Relationship with Others **Ahead of Time**	**Relationship with Others** **Ahead of Time**
1. Operate generators to provide real and reactive power or reliability-related services per contracts or arrangements. 2. Provides operating and availability status of generating units to Balancing Authority and Transmission Operators for reliability analysis. 3. Reports status of automatic voltage or frequency regulating equipment to Transmission Operators. 4. Provides operational data to Reliability Coordinator. 5. Receives reliability analyses from Reliability Coordinator. 6. Receives notice from Purchasing-Selling Entity if Arranged Interchange approved or denied. 7. Receives reliability alerts from Reliability Coordinator. 8. Receives notification of transmission system problems from Transmission Operators.	1. Implement demand reduction or consumption increase in response to instructions or according to contract arrangements. 2. Provides operating and availability status of demand response to Balancing Authority, Transmission Operator and Reliability Coordinator for reliability analysis. 3. Provides operational data to Reliability Coordinator. 4. Receives reliability analyses from Reliability Coordinator.

Real Time	Real Time
9. Provides Real-time operating information to the Transmission Operators and the required Balancing Authority.	5. Provides Real-time operating information to the Transmission Operators and the required Balancing Authority.
10. Adjusts real and reactive power as directed by the Balancing Authority and Transmission Operators.	6. Adjusts demand in response to instructions or according to contract agreements.
	Post Real Time
	7. Provide operating information required Balancing Authority for settlement purposes

Appendix B

Minority Views

List of NERC Reliability Standards that should be removed if DR is not Assigned the Same Obligations as GO/GOP

On the basis of comparable treatment of "supply" resources used to balance load and supply in both the planning horizon and the real time operating horizon, a BA may choose between DR and traditional generation resources to meet the load obligations on the grid. As increased use is made of DR to meet certain load requirements, lower commitments are made of traditional generation supply. This is fine as long as the DR "supply" shows up when the BA calls on it.

Penalizing a DR that doesn't perform as agreed to or requested by penalize it via market mechanism is not acceptable from a reliability perspective. If sufficient DR doesn't show up and traditional generation resources have not been committed and cannot get on-line in time to meet the aggregate demand, then some load will have to be curtailed against its desires in order to maintain BES reliability.

If it is indeed our position that whether or not DR responds when called upon that it does not impact reliability, then the following changes ought to be made to the existing reliability standards:

a) CIP Standards: remove Generator Operators from these standards. If it is not important for supply to respond when called on then we don't need these standards applied to any supply resources.

b) COM-002: remove Generator Operators from the Applicability. If DR that is used as a supply resource doesn't need to respond, then GOPs do not need to have communications with the RCs for them to respond either.

c) IRO-001,-004,-005,-010: remove Generator Owners and Generator Operators from these standards. If it is not important that DR used as a supply resource responds to the directives of the RC, then it should not be important that GO/GOPs respond either. They also should not have to provide information on their capabilities in Day Ahead or Current Day time frames. There also shouldn't be a need to coordinate any maintenance outages with the RC. After all, if a DR owner or operator can just sit out for a day, then a generator should be able to do the same thing.

d) MOD-024,-025: delete these standards. If it is not important to know or qualify the capacity of a DR resource, then we should not have to qualify the capacity of a traditional generation resource either.

e) PRC-001,-005: remove Generator Operator and Generator Owner from these standards. If it is not important to reliability that DR operate properly when called on, then we should not have to coordinate protective relays or do protection system maintenance for traditional generation resources either.

f) TOP-001,-002,-003,-006: remove Generator Operators from these standards. If it is not important that DR which is being counted on by the BA to respond to directives from the RC, then we shouldn't need to have GOPs respond either. There shouldn't be a need to coordinate normal operations planning with the RC, or coordinate outage schedules with the

RC, or provide notice to the RC of any resources that are available, or not available for dispatch.

As more and more DR is included in the dispatch stack and the planning and operating horizon, fewer real generation resources are included to meet the aggregate load obligations on the grid. It is certainly important to the BA and the RC that the real generation resources can be counted on to perform when called. As DR replaces those real generation resources, it should be important that they respond as well. Comparable reliability standard requirements should be in place for DR resources as are in place for Generator Owners and Operators.