operators and maintenance personnel on winter preparations, lack of fuel switching training and drills, and failure to ensure adequate fuel.

- Gas curtailment and gas pressure issues did not contribute significantly to the amount of unavailable generating capacity in ERCOT during the event. The outages, derates, and failures to start from inadequate fuel supply totaled 1282 MW from February 1 through February 5, as compared to an overall peak net generating capacity reduction of 14,702 MW.

Recommendations -- Electric

PLANNING AND RESERVES

1. Balancing Authorities, Reliability Coordinators, Transmission Operators and Generation Owner/Operators in ERCOT and in the southwest regions of WECC should consider preparation for the winter season as critical as preparation for the summer peak season.

The large number of generating units that failed to start, tripped offline or had to be derated during the February event demonstrates that the generators did not adequately anticipate the full impact of the extended cold weather and high winds. While plant personnel and system operators, in the main, performed admirably during the event, more thorough preparation for cold weather could have prevented many of the weather-related outages.

Capacity margins going into the winter of 2010/2011, for both ERCOT and the southwest regions of WECC, were adequate on paper. (ERCOT reported a 57 percent margin above forecasted winter peak demand, and the southwest regions of WECC projected a 105.7 percent margin.) But those margins did not take into account whether many of the units counted would be capable of running during the severe cold weather that materialized in February.

While the probability of a winter event in the predominantly summer peaking Southwest appears to be low, shedding load in the winter places lives and property at risk. The task force recommends that all entities responsible for the reliability of the bulk power system in the Southwest prepare for the winter season with the same sense of urgency and priority as they prepare for the summer peak season.

2. Planning authorities should augment their winter assessments with sensitivity studies incorporating the 2011 event to ensure there are sufficient generation and reserves in the operational time horizon.

Both ERCOT and the Southwest regions of WECC undertake planning studies to ensure that sufficient reserves are available to meet seasonal peak loads. However, the forecasted peak demand in the winter assessments for 2010/2011 was not as high as that actually experienced in early February.

Planners should undertake a sensitivity study, using the 2011 actual conditions as a possible extreme scenario, that reflects expected limits on available generation. These limits would include those due to planned outages, limited operations during periods of extreme cold weather, ambient temperature operating limitations, and any likely loss of fuel sources.

This sensitivity study should be used by operational planners to identify various system stress points, and by Reliability Coordinators, Balancing Authorities, and Transmission Operators to improve and refine strategies to preserve the reliability of the bulk power system during an extended cold weather event. These strategies should include procedures relating to utilization of generators with fuel switching capabilities and implementing early start-ups for generators with long start-up times.

3. Balancing Authorities and Reserve Sharing Groups should review the distribution of reserves to ensure that they are useable and deliverable during contingencies.

This recommendation is designed to ensure that Balancing Authorities take into account transmission constraints, other demands on reserve sharing resources, the possibility that more than one reserve sharing group member might experience simultaneous emergencies, and other factors that might affect the availability or deliverability of reserves. ERCOT is currently considering a similar recommendation, which was presented to its Board of Directors in March, 2011.

4. ERCOT should reconsider its protocol that requires it to approve outages if requested more than eight days before the outage, consider giving itself the authority to cancel outages previously scheduled, and expand its outage evaluation criteria.

ERCOT's Protocols provide that it may not forbid an outage request submitted more than eight days prior to the scheduled outage, unless the outage would keep ERCOT from meeting applicable Reliability Standards or Protocol requirements. The Protocols further limit review of outage requests made earlier

than eight days before the outage to the following three things: load forecast, other known outages of both generation and transmission, and the results of a contingency analysis to indicate whether the outages would cause overloads or voltage problems.

The task force recommends that ERCOT consider lengthening the period for which ERCOT may deny an outage request, assuming the conditions for doing so are met. (ERCOT is presently considering a Protocol revision to give itself the authority to deny an outage request that is not scheduled more than 90 days prior to the outage date, a revision which the task force supports.) In addition, ERCOT should consider giving itself the authority to cancel previously approved outages in cases of approaching extreme weather conditions, even up to the time of the event itself. In making this evaluation, ERCOT should take into account the costs that would be imposed on the generator as well as the practical difficulties of returning it to service if plant components are disassembled, as well as the generator's need to perform maintenance at some point while also avoiding the high demand summer season.

In addition to the criteria for outage evaluation currently provided in the Protocols, the task force recommends that ERCOT take into consideration the potential loss of units based on weather conditions beyond their design limits, and the effects likely to result from the totality of scheduled and proposed outages.

In furtherance of these criteria, ERCOT should:

- Have available to it the design temperatures of all generation resources.
- Take into consideration as an extreme weather event approaches which plants will not be available based on their design temperature limits.
- Consider increasing reserve levels during extreme weather events.
- Commit, for purposes of serving load and being counted as reserves, only those plants whose temperature design limits fall within the forecasted temperature range.
- Determine, prior to approving an outage, if the combination of previously approved scheduled outages with the proposed scheduled outages might cause reliability problems.

5. ERCOT should consider modifying its procedures to (i) allow it to significantly raise the 2300 MW responsive reserve requirement in extreme low temperatures, (ii) allow it to direct generating units to utilize pre-operational warming prior to anticipated severe cold weather, and (iii) allow

it to verify with each generating unit its preparedness for severe cold weather, including operating limits, potential fuel needs and fuel switching abilities.

ERCOT data on forced outages during the 50 coldest days between 2005-2011 show a correlation between low temperatures and forced outages. This was demonstrated not only by the February 2011 event but also by the 1989 event; in both cases, extremely low temperatures led to the loss of large amounts of generation and the implementation of rolling blackouts.

Increasing the amount of responsive reserves going into a cold weather event would compensate for the probability that a number of generating units might fail, and would provide better response to system instability in the event of such losses.

Additionally, pre-operational warming would help prevent freezing and identify other operational problems. Running a unit prior to the start of extreme cold weather would utilize the unit's own radiant heat to help prevent freezing. And starting it up would permit correction of any problems that otherwise would not be noticed until the unit was called upon for performance.

While pre-operational warming has considerable value, issues of whether or how generators are to be compensated for taking such actions at ERCOT's direction would need to be addressed.

COORDINATION WITH GENERATOR OWNERS/OPERATORS

6. Transmission Operators, Balancing Authorities, and Generation Owner/Operators should consider developing mechanisms to verify that units that have fuel switching capabilities can periodically demonstrate those capabilities.

Sixteen percent of ERCOT's generation capacity is listed as having fuel switching capabilities. During the February cold weather event, a quarter of the 20 units that attempted to switch fuel were unsuccessful. If a unit represents itself as having fuel switching capability, verification of the adequacy of its capability would provide useful information to the Balancing Authority or Transmission Operator as to the availability of that unit in the event of natural gas curtailments.

Fuel switching verification might consist of the following:

- Documented time required to switch equipment,
- Documented unit capacity while on alternate fuel,
- Operator training and experience,

- Fuel switching equipment problems, and
- Boiler and combustion control adjustments needed to operate on alternate fuel.

7. Balancing Authorities, Transmission Operators and Generator Owners/Operators should take the steps necessary to ensure that black start units can be utilized during adverse weather and emergency conditions.

The task force determined that a combination of scheduled and forced outages of ERCOT's black start units would have put ERCOT's ability to restore the system in jeopardy, had an uncontrolled blackout not been averted by the implementation of load shedding. Balancing Authorities and Transmission Operators should take steps to ensure the availability and reliability of their black start units during adverse weather and emergency conditions, particularly to prevent a gap in this function before 2013, when the provisions of Reliability Standard EOP-005-2 on System Restoration from Blackstart Resources becomes mandatory. These steps should ideally include auditing Generator Owner/Operators, random testing of black start units during temperature extremes (both hot and cold), determining the ambient operating temperature limitations of the black start units, evaluating the effects of extreme temperatures on implementation of the entity's black start plan; and ensuring that operators are trained to start the black start units during extreme weather conditions. ERCOT is presently considering Protocol revisions that would provide for unannounced testing of black start units and "claw back" payments for black start units that fail testing or fail to perform.

8. Balancing Authorities, Reliability Coordinators and Transmission Operators should require Generator Owner/Operators to provide accurate ambient temperature design specifications. Balancing Authorities, Reliability Coordinators and Transmission Operators should verify that temperature design limit information is kept current and should use this information to determine whether individual generating units will be available during extreme weather events.

In order to ascertain actual capabilities during extreme weather conditions, Balancing Authorities and Reliability Coordinators should require Generator Owner/Operators to provide accurate ambient temperature design operating limits for each generating unit that is included in its portfolio (including the accelerated cooling effect of wind), and update them as necessary. These limits should take into account all temperature-affected generator, turbine, and boiler equipment, and associated ancillary equipment and controls.

The Balancing Authorities should take steps to verify that Generator Owner/Operators comply with this requirement, and should prepare for the winter season by developing a catalog of individual generating unit temperature limitations. These should be used to determine if forecasted temperatures place a particular generating unit in a high risk category.

Lastly, Balancing Authorities and Reliability Coordinators should consider the feasibility of counting on a generating unit whose rating falls below forecasted weather conditions, and should consider whether to take into account weather-related design specifications in ranking units in the supply stack during critical weather events.

9. Transmission Operators and Balancing Authorities should obtain from Generator Owner/Operators their forecasts of real output capability in advance of an anticipated severe weather event; the forecasts should take into account both the temperature beyond which the availability of the generating unit cannot be assumed, and the potential for natural gas curtailments.

Balancing Authorities are permitted to request a forecast of real output capability under Reliability Standard TOP-002-02 R15. Doing so would allow operators to make proactive decisions prior to the onset of cold weather, including but not limited to:

- Requesting cancellation of planned outages,
- Directing advanced fuel switching,
- Directing startup of units with startup times greater than one day,
- Requesting startup of seasonally mothballed units, and
- Making advance requests for conservation.

In the case of ERCOT, which does not own the generators in its footprint, consideration needs to be given to ensuring that there is an adequate cost recovery mechanism in place for reliability measures taken by the generators at ERCOT's direction.

10. Balancing Authorities should plan ahead so that emergency enforcement discretion regarding emission limitations can be quickly implemented in the event of severe capacity shortages.

Some generators experienced derates during the event due to emission limitations. The Texas Commission on Environmental Quality (TCEQ) exercised enforcement discretion with respect to its emission restrictions during the event; however, this action, which was taken after the TCEQ received requests during the event itself, did not come in time to prevent all the emissions-related derates that

occurred on February 2. It is recommended that ERCOT work out procedures in advance with the TCEQ for the exercise of its enforcement discretion in the case of severe weather events, and have an internal procedure in place that delegates specific ERCOT personnel as responsible for contacting the TCEQ and other environmental regulatory bodies during the early stages of an event, in order to inform them of the significance of the situation.

WINTERIZATION

11. States in the Southwest should examine whether Generator/Operators ought to be required to submit winterization plans, and should consider enacting legislation where necessary and appropriate.

The task force determined during its inquiry that certain generators were better prepared than others to respond to the February cold weather event. In many cases the entities that performed well had emergency operations or winterization plans in place to provide direction to employees on how to keep their units operating. Although the implementation of a winterization plan cannot guarantee that a unit will not succumb to cold weather conditions, it can reduce the likelihood of unit trips, derates and failed starts.

The state of Texas has provided a starting point for such legislation with SB 1133, which was signed into law on June 17, 2011. This statute incorporates two important components: (1) mandatory reporting of emergency operations procedures, and (2) independent review by the PUCT.

In addition to the matters covered in the Texas statute, the task force recommends that planning take into account not only forecasts but also historical weather patterns, so that the required procedures accommodate unusually severe events. Statutes should ideally direct utility commissions to develop best winterization practices for its state, and make winterization plans mandatory. Lastly, it is recommended that legislatures consider granting utility commissions the authority to impose penalties for non-compliance, as well as to require senior management to acknowledgement that they have reviewed the winterization plans for their generating unit, that the plans are an accurate representation of the winterization work completed, and that they are appropriate for the unit in light of seasonal weather conditions.

NERC staff has concluded there would be a reliability benefit from amending the EOP Reliability Standards to require Generator Owner/Operators to develop, maintain, and implement plans to winterize plants and units prior to extreme cold weather, in order to maximize generator output and availability. Accordingly, NERC intends to submit a Standard Authorization Request, the first

step in the Reliability Standards development process, proposing modifications to the Reliability Standards for Emergency Preparedness and Operations.

Plant Design

12. Consideration should be given to designing all new generating plants and designing modifications to existing plants (unless committed solely for summer peaking purposes) to be able to perform at the lowest recorded ambient temperature for the nearest city for which historical weather data is available, factoring in accelerated heat loss due to wind speed.

The ideal time to prepare a generating unit to withstand cold temperatures is in the design stage. For that reason, the low temperatures and wind chills that can occur during the occasional severe storm should be incorporated in the design process.

13. The temperature design parameters of existing generating units should be assessed.

The task force found that for existing generating units, it is often not known with any specificity at what temperature the unit will be able to operate, or to what temperature heat tracing and insulation can prevent the water or moisture in its critical components from freezing. For that reason, Generator Owner/Operators should conduct engineering analyses to ascertain each unit's operating parameters, and then take appropriate steps to ensure that each unit will be able to achieve the optimum level of performance of which it is capable.

The task force recommends the following:

- Each Generator Owner/Operator should obtain or perform a comprehensive engineering analysis to identify potential freezing problems or other cold weather operational issues. The analysis should identify components/systems that have the potential to: initiate an automatic unit trip, prevent successful unit start-up, initiate automatic unit runback schemes and/or cause partial outages, adversely affect environmental controls that could cause full or partial outages, adversely affect the delivery of fuel to the units, or cause other operational problems such as slowed valve/damper operation.

- If a Generator Owner/Operator does not have accurate information about the ambient temperature to which an existing unit was designed, or if extensive modifications have been made since the unit was designed (including changes to plant site), it should obtain an engineering analysis

regarding the lowest ambient temperatures at which the unit can reliably operate (including wind chill considerations).

- Each Generator Owner/Operator should ensure that its heat tracing, insulation, lagging and wind breaks are designed to maintain water temperature (in those lines with standing water) at or above 40 degrees when ambient temperature, taking into account the accelerated heat loss due to wind, falls below freezing.

- Each Generator Owner/Operator should determine the duration that it can maintain water, air, or fluid systems above freezing when offline, and have contingency plans for periods of freezing temperatures exceeding this duration.

Maintenance/inspections generally

14. Generator Owner/Operators should ensure that adequate maintenance and inspection of its freeze protection elements be conducted on a timely and repetitive basis.

The task force found a number of inadequacies in generating units' preparations for winter performance. These included a lack of accountability and senior management review, lack of an adequate inspection and maintenance program, and failure to perform engineering analyses to determine the correct capability needed for their protection equipment.

The task force recommends the following:

- Each Generator Owner/Operator's senior management should establish policies that make winter preparation a priority each fall, establish personnel accountability and audit procedures, and reinforce the policies annually.

- Each Generator Owner/Operator should develop a winter preventative maintenance program for its freeze protection elements, which should specify inspection and testing intervals both before and during the winter. At the end of winter, an additional round of inspections and testing should be performed and an evaluation made of freeze protection performance, in order to identify potential improvements, required maintenance, and freeze protection component replacement for the following winter season.

- Each Generator Owner/Operator should prioritize repairs identified by the inspection and testing program, so that repairs necessary for

the proper functioning of freeze protection systems will be completed before the following winter.

- Each Generator Owner/Operator should use the recommended comprehensive engineering analysis, combined with previous lessons learned, to prepare and update a winter preparation checklist. Generator Owner/Operators should update checklists annually, using the previous winter's lessons learned and industry best practices.

Specific Freeze Protection Maintenance Items

The task force found that many generating units tripped, were derated, or failed to start as a result of problems associated with a failure to install and maintain adequate freeze protection systems and equipment. Based on these findings, on an examination of freeze protection systems of many of the affected generating units, and in some cases on standards issued by the Institute of Electrical and Electronics Engineers, the task force has prepared a number of recommendations designed to prevent a repeat of the spotty generator performance experienced during the February cold weather event. Of course, specific actions should conform to best industry practices at the time improvements are made, as well as to the requirements of any mandatory winterization standards imposed by regulatory or legislative bodies.

Heat tracing

15. Each Generator Owner/Operator should inspect and maintain its generating units' heat tracing equipment.

Specifically, the task force recommends:

- Each Generator Owner/Operator should, before each winter begins and before forecasted freezing weather, inspect the power supply to all heat trace circuits, including all breakers and fuses.

- Each Generator Owner/Operator should, before each winter begins and before forecasted freezing weather, inspect the continuity of all heat trace circuits, check the integrity of all connections in the heat trace circuits, and ensure that all insulation on heat traces is intact. This inspection should include checking for loose connections, broken wires, corrosion, and other damage to the integrity of electrical insulation which could cause grounds.

- Each Generator Owner/Operator should, before each winter begins, inspect, test, and maintain all heat trace controls or monitoring devices for proper

operation, including but not limited to thermostats, local and remote alarms, lights, and monitoring cabinet heaters.

- Each Generator Owner/Operator should, before each winter begins, test the amperage and voltage for its heat tracing circuits and calculate whether the circuits are producing the output specified in the design criteria, and maintain or repair the circuits as needed.

- Each Generator Owner/Operator should be aware of the intended useful life of its heat tracing equipment and should plan for its replacement in accordance with the manufacturer's recommendations.

Thermal Insulation

16. Each Generator Owner/Operator should inspect and maintain its units' thermal insulation.

Specifically, the task force recommends:

- Each Generator Owner/Operator should, before each winter begins, inspect all accessible thermal insulation and verify that there are no cuts, tears, or holes in the insulation, or evidence of degradation.

- Each Generator Owner/Operator should require visual inspection of thermal insulation for damage after repairs or maintenance have been conducted in the vicinity of the insulation.

- Each Generator Owner/Operator should ensure that valves and connections are insulated to the same temperature specifications as the piping connected to it.

- Each Generator Owner/Operator should be aware of the intended useful life of the insulation of water lines and should plan for its replacement in accordance with the manufacturer's recommendations.

Use of Wind breaks/enclosures

17. Each Generator Owner/Operator should plan on the erection of adequate wind breaks and enclosures, where needed.

Specifically, the task force recommends:

- A separate engineering assessment should be performed for each generating unit to determine the proper placement of temporary and/or permanent wind breaks or enclosures to protect and prevent freezing of critical and vulnerable elements during extreme weather.

- Temporary wind breaks should be designed to withstand high winds, and should be fabricated and installed before extreme weather begins.

- Generator Owner/Operators should take into account the fact that sustained winds and/or low temperatures can result in heat loss and freezing even in enclosed or semi-enclosed areas.

Training

18. Each Generator Owner/Operator should develop and annually conduct winter-specific and plant-specific operator awareness and maintenance training.

Operator training should include awareness of the capabilities and limitations of the freeze protection monitoring system, proper methods to check insulation integrity and the reliability and output of heat tracing, and prioritization of repair orders when problems are discovered.

Other Generator Owner/Operator Actions

19. Each Generator Owner/Operator should take steps to ensure that winterization supplies and equipment are in place before the winter season, that adequate staffing is in place for cold weather events, and that preventative action in anticipation of such events is taken in a timely manner.

Specifically, the task force recommends:

- Each Generator Owner/Operator should maintain a sufficient inventory of supplies at each generating unit necessary for extreme weather preparations and operations.

- Each Generator Owner/Operator should place thermometers in rooms containing equipment sensitive to cold and in freeze protection enclosures to ensure that temperature is being maintained above freezing and to determine the need for additional heaters or other freeze protection devices.

- During extreme cold weather events, each Generator Owner/Operator should schedule additional personnel for around-the-clock coverage.

- Each Generator Owner/Operator should evaluate whether it has sufficient electrical circuits and capacity to operate portable heaters, and perform preventive maintenance on all portable heaters prior to cold weather.

- Each Generator Owner/Operator should drain any non-critical service water lines in anticipation of severe cold weather.

Transmission Facilities

20. Transmission Operators should ensure that transmission facilities are capable of performing during cold weather conditions.

Transmission Operators reported several incidents of unplanned outages during the February 2011 event as a result of circuit breaker trips, transformer trips, and other transmission line issues. Although these outages did not generally contribute materially to any transmission limitations, some transmission breaker outages did lead to the loss of generating units. Many breaker trips were the result of low air in the breaker, low sulfur hexa-fluoride (SF_6) gas pressure, failed or inadequate heaters, bad contacts, and gas leaks.

Specifically, the task force recommends:

- Transmission Owner/Operators should ensure that the SF_6 gas in breakers and metering and other electrical equipment is at the correct pressure and temperature to operate safely during extreme cold, and also perform annual maintenance that tests SF_6 breaker heaters and supporting circuitry to assure that they are functional.

- Transmission Owner/Operators should maintain the operation of power transformers in cold temperatures by checking heaters in the control cabinets, verifying that main tank oil levels are appropriate for the actual oil temperature, checking bushing oil levels, and checking the nitrogen pressure if necessary.

- Transmission Owner/Operators should determine the ambient temperature to which their equipment, including fire protection systems, is protected (taking into account the accelerated cooling effect of wind), and ensure that temperature requirements are met during operations.

COMMUNICATIONS

21. Balancing Authorities should improve communications during extreme cold weather events with Transmission Owner/Operators, Distribution Providers, and other market participants.

During the February event, ERCOT communicated with Transmission Owners and Transmission Service Providers (an ERCOT-specific term) concerning the initiation of load shedding and the subsequent restoration of service. These communications appear to have been made in accordance with applicable ERCOT Operating Guidelines and Reliability Standards. However, ERCOT and several of its Transmission Service Providers that were responsible for curtailing firm load suggested areas for improvement in communications.

Transmission Service Providers are dependent on ERCOT for much of their information on ERCOT-wide system conditions, as they do not have information regarding generator trips beyond those on their own systems, and can only track ERCOT-wide system status by monitoring ERCOT's posted Physical Response Capability levels or monitoring frequency levels. Some of these Transmission Service Providers suggested that ERCOT should have communicated concerns about deteriorating conditions much earlier than it did.

A task force appointed by ERCOT's Board of Directors to look into the February 2 rolling blackouts concluded that there was a need for earlier dissemination of operational information to Transmission Service Providers and Distribution Service Providers (an ERCOT-specific term) during the period leading up to a possible emergency, a conclusion with which this task force agrees.

22. ERCOT should review and modify its Protocols as needed to give Transmission Service Providers and Distribution Service Providers in Texas access to information about loads on their systems that could be curtailed by ERCOT as Load Resources or as Emergency Interruptible Load Service.

Some ERCOT Transmission Service Providers expressed concern that they have virtually no information regarding loads on their own systems that may be deployed by ERCOT as Load Resources or Emergency Interruptible Load Service resources. These loads contract directly with ERCOT, and the Transmission Service Provider does not receive information about their status. When these loads are shed by ERCOT without prior notification to the Transmission Service Providers and Distribution Service Providers, they have the potential to cause localized imbalances in line flows, voltages, and other system parameters that may be problematic.

The task force suggests that ERCOT share information about the status of these loads with Transmission Service Providers on a daily basis, and study the effects of the loss of large blocks of these loads on the transmission grid.

23. WECC should review its Reliability Coordinator procedures for providing notice to Transmission Operators and Balancing Authorities when another Transmission Operator or Balancing Authority within WECC is experiencing a system emergency (or likely will experience a system emergency), and consider whether modification of those procedures is needed to expedite the notice process.

The Task Force observed a lag in communicating a declared system emergency in WECC. In one instance, a Reliability Coordinator did not issue an EEA 3 declaration until seven minutes after the decision had been made to do so; the delayed declaration appeared to have been the first official notice by the Reliability Coordinator to other WECC entities of the seriousness of the generation failures on the system of the Balancing Authority in question.

24. All Transmission Operators and Balancing Authorities should examine their emergency communications protocols or procedures to ensure that not too much responsibility is placed on a single system operator or on other key personnel during an emergency, and should consider developing single points of contact (persons who are not otherwise responsible for emergency operations) for communications during an emergency or likely emergency.

The task force's review of incidents during the event, as well as of operating procedures and protocols in place at the time, indicated that critical employees such as operators had numerous responsibilities that, while manageable in non-emergency situations, could prove impossible to meet during the often-compressed time frame of an emergency situation. In at least one instance, overloading a single on-call operations representative appears to have led to a delay in making emergency power purchases.

LOAD SHEDDING

25. Transmission Operators and Distribution Providers should conduct critical load review for gas production and transmission facilities, and determine the level of protection such facilities should be accorded in the event of system stress or load shedding.

Keeping gas production facilities in service is critical to maintaining an adequate supply of natural gas, particularly in the Southwest where there is a relatively small amount of underground gas storage. And keeping electric-

powered compressors running can be important in maintaining adequate pressure in gas transmission lines.

The task force suggests that a review of curtailment priorities be made, to consider whether gas production facilities should be treated as protected loads in the event of load shedding.

26. Transmission Operators should train operators in proper load shedding procedures and conduct periodic drills to maintain their load shedding skills.

The task force found that at least one Transmission Operator in WECC experienced a minor delay in initiating its load shedding sequence, due to problems notifying the concerned Distribution Provider. Another Transmission Operator experienced delay in executing its load shedding because the individual operators had never shed load before and had not had recent drills. These incidents underscore the necessity of adequate training in load shedding procedures.

B. The Natural Gas Industry

Key Findings -- Natural Gas

- Extreme low temperatures and winter storm conditions resulted in widespread wellhead, gathering system, and processing plant freeze-offs and hampered repair and restoration efforts, reducing the flow of gas in production basins in Texas and New Mexico by between 4 Bcf and 5 Bcf per day, or approximately 20 percent, a much greater extent than has occurred in the past.

- The prolonged cold caused production shortfalls in the San Juan and Permian Basins, the main supply areas for the LDCs that eventually curtailed service to customers in New Mexico, Arizona, and Texas.

- Wellhead freeze-offs normally occur several times a winter in the San Juan Basin but are not common in the Permian Basin, which is the supply source that LDCs in the Southwest region typically rely upon when cold weather threatens production in the San Juan Basin.

- Electrical outages contributed to the cold weather problems faced by gas producers, processors, and storage facilities in the Permian and Fort Worth Basins, with producers being more significantly affected by the blackouts; however, based on information obtained from a sampling of producers and

processing plants in the region, the task force concluded that the effect of electric blackouts on supply shortages was less important than the effect of freezing temperatures.

- Although producers in the New Mexico and Texas production areas implemented some winterization measures such as methanol injection, production was nevertheless severely affected by the unusually cold weather and icy road conditions, which prevented crews from responding to wells and equipment that were shut in.

- The extreme cold weather also created an unprecedented demand for gas, which further strained the ability of the LDCs and pipelines to maintain sufficient operating pressure.

- The combination of dramatically reduced supply and unprecedented high demand was the cause of most of the gas outages and shortages that occurred in the region.

- Low delivery pressures from the El Paso Natural Gas interstate pipeline, caused by supply shortages, contributed to gas outages in Arizona and southern New Mexico.

- Some local distribution systems were unable to deliver the unprecedented volume of gas demanded by residential customers.

- No evidence was found that interstate or intrastate pipeline design constraints, system limitations, or equipment failures contributed significantly to the gas outages.

- The pipeline network, both interstate and intrastate, showed good flexibility in adjusting flows to meet demand and compensate for supply shortfalls.

- Additional gas storage capacity in Arizona and New Mexico could have prevented many of the outages that occurred by making additional supply available during the periods of peak demand. Natural gas storage is a key component of the natural gas grid that helps maintain reliability of gas supplies during periods of high demand. Storage can help LDCs maintain adequate supply during periods of heavy demand by supplementing pipeline capacity, and can serve as backup supply in case of interruptions in wellhead production. Additional gas storage capacity in the downstream market areas closer to demand centers in Arizona and New Mexico could

have prevented most of the outages that occurred by making additional supply available in a more timely manner during peak demand periods.

Recommendations – Natural Gas

1. Lawmakers in Texas and New Mexico, working with their state regulators and all sectors of the natural gas industry, should determine whether production shortages during extreme cold weather events can be effectively and economically mitigated through the adoption of minimum, uniform standards for the winterization of natural gas production and processing facilities.

The Texas and New Mexico production basins experienced unusually sharp declines due to the prolonged freezing weather of early February 2011. Although these areas typically experience occasional freeze-offs during periods of sub-freezing weather, and although natural gas producers and processors in those regions employ some winterization techniques, to a significant degree those measures were inadequate to meet consumer demand during this event. Production difficulties were compounded by icy road conditions, which disrupted routine maintenance and delayed repairs.

Some industry representatives stated that producers and processors already have strong economic incentives to keep gas flowing at all times, and that increased winterization would not have prevented many of the shortfalls that occurred in the Southwest production basins in early February 2011. Others stated that the levels of winterization typically employed in these areas are designed to deal with less severe, more typical winter weather conditions, and that additional winterization could protect the system from the effects of unusually harsh weather. Many expressed the view that along with increased reliance upon natural gas for energy, steps should be taken to improve the reliability of gas supply during extreme cold weather events.

Whether the adoption of uniform winterization standards for natural gas facilities is the right way to meet the goal of increased reliability is a complex question. Among the issues that need to be resolved are the following:

- Determining the costs of increased winterization and balancing those costs against the need for increased reliability,
- Determining who should ultimately bear the costs of additional winterization, and whether ratemakers would be willing to pass the costs of increased reliability along to consumers,
- Determining whether it is practical to design for very low temperatures, which may not recur for years or even decades,

- Ensuring that standards are uniformly applied, and determining whether state commissions would have adequate resources or authority to promulgate and enforce those standards, and
- Identifying possible incentives for industry that could improve the reliability of winter supply without government regulation.

Because the Commission does not have jurisdictional authority over this sector of the natural gas industry for these purposes, we recommend that state lawmakers and regulators in Texas and New Mexico investigate whether minimum standards for the winterization of gas production and processing facilities should be adopted, by way of legislation, regulation, or the adoption of voluntary industry practices, and whether such standards would be likely to effectively and reliably improve supply during extreme weather events.

2. The gas and electric sectors should work with state regulatory authorities to determine whether critical natural gas facilities can be exempted from rolling blackouts.

The natural gas industry depends in many instances on electric utilities for the power that helps move gas from the production fields to end users. Electric-powered instrumentation, compression, pumps, and processing equipment are essential links in that process, and in some instances, even the brief, temporary loss of electric power can put a gas production, processing, compression, or storage facility out of service for long periods of time, especially where weather conditions delay access to those facilities. The resulting gas outages can contribute to electricity shortages by cutting off or reducing fuel supply to gas-fired generating plants.

Gas producers, processors, pipelines, storage providers, and LDCs should identify portions of their systems that are essential to the ongoing delivery of significant volumes of gas, and which are dependent upon purchased power to function reliably under emergency conditions. State regulatory authorities should work with the gas industry and electric transmission operators, balancing authorities and reliability coordinators to determine whether such facilities can be shielded from the effects of future rolling blackouts.

3. State utility commissions should work with LDCs to ensure that voluntary curtailment plans can reduce demand on the system as quickly and efficiently as possible when gas supplies are disrupted.

One tool available to LDCs faced with supply disruptions during periods of high consumer demand is the implementation of voluntary curtailment plans, which seek reductions or curtailment from large commercial users. State

regulators, who review and approve the voluntary curtailment plans of LDCs, should assess whether they are designed and implemented in a way that maximizes their potential effect in emergency situations.

Voluntary curtailment plans should include multiple points of contact for large customers and up to date, 24-hour contact information. Where appropriate, the plans should provide for pre-event planning, training, and customer education. Large customers should be contacted prior to emergencies and efforts should be made to explain the circumstances under which reductions or curtailments would be sought and to obtain advance commitments for possible reductions, giving LDCs a clearer idea of the amount of demand that can be reduced in an emergency. While voluntary curtailment does nothing to increase supply, in light of the importance of reducing demand when distribution systems are near collapse, regulators and the LDCs should ensure that planning for voluntary curtailments is as thorough and well-thought out as possible.

4. State utility commissions should work with balancing authorities, electrical generators, and LDCs to determine whether and under what circumstances residential gas customers should receive priority over electrical generating plants during a gas supply emergency.

Gas-fired generation provides much needed electrical power during a weather emergency, but also consumes large amounts of natural gas. Although restoring residential electricity service after a rolling blackout is a fairly simple process, restoring gas service after an outage is both labor-intensive and time-consuming.

State utility commissions should work with LDCs to identify situations where consumption by gas-fired generators could contribute to residential gas customer outages, and should consult with those generators and the relevant Balancing Authority to determine whether alternative power suppliers or fuel supplies could be used in emergency situations. The state commissions should also evaluate the relative importance, for human needs customers, of gas-fired generation and residential use, and should assess the relative impacts of curtailing generating plants versus gas supply to residences.

5. State utility commissions and LDCs should review the events of early February 2011 and determine whether distribution systems can be improved to increase flows during periods of high demand.

In some instances during the winter storm event, LDC distribution systems were unable to flow scheduled volumes, suggesting that downstream parties may not have had sufficient capacity or facilities to handle historically high demand.

Accordingly, state commissions and distribution companies should determine whether system enhancements can be made to improve volume handling capacity, such as additional distribution valving, looping, more compression, or reconfigured compression. Although such system improvements would probably not compensate for the level of supply shortfalls that occurred in early February 2011, they might allow LDCs to take higher volumes for longer periods of time.

6. State utility commissions should work with LDCs to determine whether the LDC distribution systems can be improved so that curtailments can be implemented, when necessary, in a way that improves the speed and efficiency of the restoration process.

The events of early February 2011 demonstrated that once operational pressures and line pack begin to fall beyond normal tolerances, little time may be available to evaluate, locate, and shut off portions of the pipeline systems of the LDCs to avoid system collapse. Regulators should work with LDCs, as part of the annual system review process, to determine whether the systems under their regulatory authority should be further sectionalized to provide more options when involuntary curtailments are necessary.