Revised

Initial Analysis of Operational Events during the September 2013 Heat Wave

September 23, 2013
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Synopsis

This report provides a detailed account of grid conditions during unseasonably hot weather in the PJM Interconnection service area September 9 through September 11, 2013. It also describes actions taken by PJM and others to minimize impacts on electricity consumers. In essence, PJM operators had to address unusual hot weather conditions and the impacts of certain planned and unplanned transmission and generator outages. The outages that are described in this event were significant but limited both in scope and duration. As detailed below, these targeted outages, although never desirable, prevented much more extensive customer outages occurring and thus allowed PJM operators to maintain the overall reliability of the grid during a period where the system was extremely stressed.

During the three-day heat wave, temperatures in the mid-90s – up to 20 degrees above normal – pushed the demand for electricity to all-time September highs in parts of PJM’s footprint. Electricity demand is typically light to moderate in September, allowing generating plants and transmission equipment to be released for maintenance after heavy summer use and in preparation for winter. As operators began receiving forecasts for extremely hot weather, PJM called available equipment back into service. Wherever possible, equipment was returned to service.

As detailed in the pages that follow, extremely heavy electrical demand for September—combined with a number of planned and unplanned transmission and generation outages—resulted in localized areas of stress on the grid. As PJM operators analyzed conditions, they recognized that any additional unplanned losses of generation or transmission in some areas could result in significant uncontrolled interruptions. Operating in the most conservative manner, and consistent with national reliability standards, they ordered limited, controlled interruptions in four areas of southern Michigan, northern Ohio, Indiana, and Northwestern Pennsylvania. In accordance with procedures, PJM called for local transmission providers to reduce demand by the amount necessary to ensure reliability, while the transmission providers determined how the reductions could be accomplished in the safest and most efficient manner.

During the first two days of the heat wave, a total of five interruptions were necessary. One location in southern Michigan was interrupted twice. The duration of each event ranged from several minutes to over eight hours and a total of about 44,000 customers were affected. Meanwhile, due to conservative operating actions, reliability across the remainder of PJM’s 60,000-square-mile territory was maintained. To put the scale of the interruptions in perspective, on September 10 PJM and its members met a near-record September demand totaling more than 145,000 megawatts. The five controlled, local interruptions totaled about 154 megawatts representing 0.1 percent of the total load on that day.

The decision to interrupt customers—or shed load—is a highly unusual action of last resort, taken only to avoid the possibility of more widespread, prolonged interruptions. PJM and its members recognize that any interruption of electric service is disruptive to customers and sincerely regret the inconvenience experienced by those affected. During September 9 to 11, however, prudent and decisive action was necessary to prevent grid problems in local areas from becoming more widespread and affecting larger numbers of customers.

PJM and its members are committed to preserving the reliability of PJM-monitored Bulk Electric System facilities. Part of that commitment is to analyze system events or problems (in accordance with Manual 13, Attachment K, http://pjm.com/~/media/documents/manuals/m13.ashx) for the purpose of implementing corrective actions and sharing knowledge to improve operations at PJM and Member companies. The attached report is PJM’s initial events analysis. All findings and conclusions should be considered preliminary.
Purpose/Intent

The purpose of this document is to provide an overview of the system conditions, operations and key events that occurred between September 9 and September 11, 2013, in the PJM Interconnection regional transmission organization. This document is not intended to be a response to any specific questions that may already have been submitted to PJM by individual states, utilities or other PJM stakeholders and policymakers. This document is meant to provide PJM stakeholders an overview of the operational events as well as the actions PJM took in its role as the RTO, reliability coordinator, transmission operator, and balancing authority.

Pre-operating day conditions

From a high level perspective, system conditions for the beginning of the week starting Monday, September 9, 2013, were forecasted to be continually warmer across the PJM footprint as the week progressed and well above normal for September (Figure 1). In preparation for the warmer weather, beginning Sunday, September 8, PJM issued a Hot Weather Alert for the ComEd zone, followed by Hot Weather Alerts, on Monday for the Western Region of PJM (Illinois, Indiana, Michigan, Ohio, West Virginia, and Kentucky), and on Tuesday for the entire RTO. A Hot Weather Alert is used to prepare personnel and facilities for extreme hot weather conditions which may cause operational problems. The alert allows for the cancelling of non-essential transmission and generation maintenance scheduled, recalling of available transmission and generation equipment currently out for maintenance, and triggers PJM to carry additional generation reserves and develop operational plans to prepare for known areas of concern.

The PJM RTO “unrestricted” peak load on Monday was 119,969 megawatts, on Tuesday, September 10, 145,076 MW, and on Wednesday, September 11, 147,450 MW. Wednesday was the highest peak load day ever recorded for a September in the PJM footprint. Figure 2 shows historical September peaks for the PJM footprint. September 11 not only was the highest September peak load day ever seen in PJM, it also occurred the furthest into the month. All prior peak September days occurred in the first few days of the month.

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1 These actuals are “unrestricted.” Unrestricted means that reductions to the overall load provided by demand side response on each day have been added back in to the total load number. This provides a picture of what the peak load would have been without the load reductions.
Figure 1 - RTO Temperatures

Figure 2 - RTO Actual Loads
PJM forecasts load multiple times each day for a period of 7 days into the future. The actual loads realized on September 10 are estimated to be in the 90th percentile of expected September peak loads. In other words, these high September loads are expected to occur about once every ten years\(^2\). Such unusually high peak loads in September impacted the PJM load forecast error (under forecast) since the PJM load forecasting tool has a reliance on historical loads. Additionally, actual temperatures exceeded forecasted temperatures by approximately 4 - 5 degrees in the Fort Wayne/Cleveland/Akron/ Canton areas. The temperature forecast error negatively impacted the load forecast error as well.

The unusual peak loads observed were also significant because September is the beginning of the planned maintenance outage season for PJM and many grid operators. PJM Outage Scheduling Guidelines indicate transmission owners should avoid scheduling any outage in excess of 5 days during the summer peak period. Beginning in September, PJM begins to accept planned maintenance outage requests. PJM performs detailed outage studies on the Bulk Electric System transmission elements (above 100 kV) and generators to be removed from service for scheduled maintenance and upgrades. Outage requests will be approved if they do not cause reliability problems in the forecast study conditions. September is the beginning of this outage season because loads historically are lower than during the peak summer and winter periods. PJM has an extensive outage analysis coordination process designed to avoid conflicting outages (generation and transmission) while looking for opportunities to combine generation and transmission outages. Load forecasts play a part in determining the amount of outages that PJM will allow.

Below is a summary of the transmission and generation outages for the PJM RTO for September 9 - 11, 2013, (Figure 3 and 4). Outages are categorized as either planned (i.e. scheduled and studied prior to the equipment coming out of service) or unplanned (forced), that can occur at any given time as a result of equipment issues. The unplanned outages are noted below as forced outages and may have occurred prior to the operating day.

\(^2\) This estimate is based on a probabilistic assessment of September weather conditions in the AEP and PJM regions over the last 40 years.
Initial Analysis of Operational Events
During the September 2013 Heat Wave

**Transmission Outages**

<table>
<thead>
<tr>
<th></th>
<th>9/9/13</th>
<th>9/10/13</th>
<th>9/11/13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned</td>
<td>108</td>
<td>40</td>
<td>36</td>
</tr>
<tr>
<td>Forced</td>
<td>87</td>
<td>70</td>
<td>67</td>
</tr>
<tr>
<td>Total</td>
<td>195</td>
<td>110</td>
<td>103</td>
</tr>
</tbody>
</table>

**Figure 3 – Transmission Outages**

Over 80 transmission outages were cancelled or rescheduled for the period of September 9-11, 2013.

**Generation Outages**

As stated previously, as a result of the Hot Weather Alerts issued, transmission and generation equipment out of service, that could be recalled by PJM and restored to service, was requested to do so. PJM was able to recall a number of outages in these areas but not all. Analysis has shown that the generation which remained offline for maintenance, would not have had enough impact on the system conditions to prevent load from being shed. PJM was able to recall a number of outages in these areas but not all. The generation which remained offline would not
have been enough to prevent us from interrupting customers on Tuesday based on their electrical effect on these areas.

To account for unforeseeable system events, such as unplanned outages, PJM carries reserves on the system, known as Synchronous Reserves, to maintain the generation needed to balance load. PJM is required to carry sufficient reserves on the system to handle the largest contingency on the system at that time. PJM had reserves available to meet the requirement for the week including the three operating days being reviewed. (Figure 5).

**Figure 5 – Synchronous Reserves**

PJM can also call for Demand Response to reduce the load on the system during emergency conditions. For September 9, 10 and 11, PJM had the following amount of demand response resources available.

**Figure 6 – Demand Response Available and Called**
September 9 through 11 Operating Day Events

The key operating events that will be covered for the September 9-11 operating days are the load shed event on Monday, September 9; the four load shed events on Tuesday, September 10; the one-hour spin event on Tuesday, September 10; the Demand Response activities on September 10 and 11; as well as the Transmission Loading Relief (TLR) 5 event on September 11. Each load shed event had its own unique causes and each required unique responses. Accordingly, a description of each event will be provided separately and include a summary of the event, the regional conditions and the actions taken by PJM as the RTO, reliability coordinator, transmission operator and balancing authority. A high-level time frame of these key operations events is provided below (Figure 7).

Figure 7 Key Operations Events

The following table summarizes the load shed events. There were a total of five events: one on Monday, September 9, and four on Tuesday, September 10. In total, over the two days, approximately 154 MW were shed, affecting a total of approximately 44,000 customers in the American Electric Power, American Transmission Systems Inc. and Mid-Atlantic zones of PJM.
Table 1 – Summary of Load Shed Events

Below is a geographic display of the impacted areas.

Figure 8 – Geographic display of load shed events
Load Shed Events

**Pigeon River 1 – September 9 Load Shed Event**

The first load shed event, Pigeon River 1, occurred on Monday, September 9, at 16:07 in the Pigeon River substation area in the AEP zone in Southern Michigan close to the Indiana border. The amount of load shed was 3.1 MW, which affected approximately 1,066 customers from 16:07 - 16:31 (24 minutes).

![Diagram of system conditions](image)

**Figure 9 – System conditions that contributed to the Pigeon River event**

The local and regional conditions prior to the Pigeon River 1 load shed event that contributed to its cause were:

1. notification to PJM and subsequent PJM modeling of the impact of the relay trip set point on the LaGrange-North Lagrange (NIPSCO in MISO) 69 kV line;

2. an existing planned outage on the Moore Park Tap-Industrial Park 69 kV line (AEP in PJM) that was unable to be recalled by AEP because it went out on maintenance on September 5 for reconductoring; and
3. High loads and flows on the 69 kV system between Lagrange (MISO) and Corey (AEP). (See Figure 8)

Although there was a joint PJM/MISO standing operating guide for the area, the guide did not identify the relay limit nor that there would be a need for pre-contingency load shed\(^3\). The Operating Guide was reviewed and accepted by PJM, MISO, NIPSCO and AEP with the intent to take post contingency load shed actions. This guide has been made available for operators in all four control rooms. Upon notification at approximately 14:20, of the limit, PJM modeled the relay limit as well as the outage of the Moore Park Tap-Industrial Park 69 kV line. The Moore Park Tap-Industrial 69 kV line is considered sub-transmission, which means that AEP is not required to provide notice of this outage to PJM for review/approval. With the relay limitation and Moore Park Tap-Industrial Park 69 kV line outage modeled, PJM and AEP studies showed that with the next contingency (the potential tripping of the Corey-Montville Tap-East Elkhart 138 kV line and the Lagrange-Sturgis 69 kV line, because of post-contingency flows above the relay trip point) the voltage on the 138 kV lines feeding from Valley IM substation to Corey substation would dip to 95 kV, which is too low to support area load. If the contingency had occurred, PJM’s and AEP’s analysis tools indicated there would be a potential local area voltage collapse and the loss of approximately a 60-160 MW load pocket at Corey.

PJM and AEP operators began immediately coordinating to determine any operating actions that could be taken to prevent the potential collapse, including looking for acceptable switching options, transfer load out of the area without shedding it, and starting up any available generation. PJM was aware of a switching solution (closing a 69 kv switch at Howe and establishing a second 69 kv feed into the area) and requested MISO contact NIPSCO to have the Howe switch closed. It took approximately 1.5 hours for a switchman to get to Howe station. Based on the real-time security analysis results (a tool that performs the contingency analysis), established operating procedures, and considering all operational options available, PJM directed AEP to shed 3 MW of load. In order to avoid post-contingency voltage collapse and potential equipment damage, PJM will shed load before the contingency occurs, consistent with PJM Manual M-13 Section 5\(^4\). To avoid a larger loss of load, PJM worked with AEP to determine the appropriate area to shed load. The Pigeon River load in Michigan was chosen because it was remotely controllable and had the largest impact (38.7 percent affect) on relieving power flows on the constrained line. At 16:31, after 24 minutes, once a NIPSCO lineman was dispatched and able to close a switch providing a second feed into the area, the load was restored.

**Pigeon River 2 – September 10 Load Shed Event**

The second load shed event, Pigeon River 2, occurred on Tuesday, September 10, at 12:49 in same location, the Pigeon River substation area in the AEP zone. The amount of load shed was 8 MW in total, in increments of 5 MW at 12:49 and an additional 3 MW at 13:14. Approximately 1,000 customers were affected until 21:23.

The regional conditions from the previous operating day remained:


\(^4\) PJM Manual M-13 Section 5
1. relay trip set point on the LaGrange-North Lagrange (NIPSCO in MISO) 69 kV line (now modeled in the PJM system);

2. an existing planned outage on the sub-transmission system of the Moore Park Tap-Industrial Park 69 kV line (AEP in PJM); and

3. approximately 10 percent higher loads and flows on the 69 kV system between Lagrange (MISO) and Corey (AEP) (Figure 10).

Although the switching option used the previous day at the Howe 69 kV station was still employed, the additional feed into the area was not sufficient to mitigate the increased load concerns. As a result, the operating condition reoccurred in which the next contingency (the potential tripping of the Corey-Montville Tap-East Elkhart 138 kV line and the Lagrange-Sturgis 69 kV line because of post-contingency flows above the relay trip point) would not allow sufficient time to perform a controlled post-contingency load shed. Not being able to perform a post-contingency load shed could have meant the loss of the entire Corey load pocket of approximately 60-160 MW.

Figure 10 – AEP Loads

PJM, AEP, the MISO and NIPSCO worked together throughout the day Tuesday, September 10, to find additional switching options. No additional switching solutions were identified. PJM also investigated the use of sub-zonal emergency demand response. It was determined that the demand response rules, the notification requirements and long lead time to implement do not allow the flexibility or provide the granularity required to identify subzonal Demand Response regions. With no other options available, at 12:49 on September 10, PJM directed AEP to shed 5 MW of load. Pigeon River remained the remotely controllable location with the greatest impact to alleviate the constraint. That amount of load shed was still not enough to alleviate the constraint, and PJM directed AEP to shed an additional
3 MW of load at 13:14. Until the end of the load shed event, PJM and AEP continued to assess other switching options, for example opening the Florence 69 kV “G” circuit breaker at the Corey 69 kV substation; however, doing so would have resulted in actual low voltages and actual thermal overloads. With no other options, the load shed directives remained in effect until 21:23 when the actual load started to come down. The length of the load shed this day was driven mainly by the extremely hot conditions as compared to Monday.

PJM and AEP continued to explore options in preparation for Wednesday, September 11, and, with the City of Sturgis, identified 6 MW of behind-the-meter generation not currently participating in PJM markets, which voluntarily came on line. This additional generation eliminated the need for any load to be shed on Wednesday, September 11, in the Pigeon River area.

**FirstEnergy Tod Load Shed Event**

The third load shed event, FirstEnergy Tod, occurred on Tuesday, September 10, at 15:07 in the ATSI zone. This load shed event occurred near Warren, Ohio, at the Tod 138 kV substation. The amount of load shed was approximately 16 MW which affected approximately 4,500 customers from 15:07 to 16:42 (1 hour 35 minutes).
The local and regional conditions prior to the FirstEnergy Tod load shed event that contributed to the cause were:

1. an unplanned loss of the South Canton #1 345/138 kV transformer and the remaining 345 kV bus at the South Canton substation (on September 9), which contributed to high post-contingency flows on Highland to Tod by removing a feed into the affected area;

2. planned and approved outages on a South Canton 765 kV line and the associated 345 kV bus at South Canton, required to isolate the line, that were unable to be recalled because the equipment was being replaced;

3. a forced outage on September 5 of a 138 kV switch at the nearby Hanna substation; and

4. high loads in the Akron and Cleveland areas.
In preparing for the increased loads, at 13:50 PJM implemented Long Lead Emergency Load Management in the ATSI zone for a total of approximately 652 MW of requested relief as well as the voluntary demand response in the South Canton subzone. At 13:50 PJM also issued a Maximum Emergency Generation Alert for the ATSI zone.

At 18:49 on Monday, September 9, the South Canton #1 345/138 kV transformer tripped out of service. This event resulted in the additional loss of four 345 kV lines at South Canton. Two of these 345 kV paths were restored at 08:34 Tuesday, September 10,(South Canton – Star and South Canton – Southeast Canton 345kv lines). PJM and ATSI determined that following a contingency (loss of the Hanna #1 345/138 kV transformer) flows on the Highland-Tod 138 kV line would exceed limits. PJM issued a Post Contingency Local Load Relief Warning at 11:46 to develop a load shed plan with ATSI. The procedure was a warning to alert ATSI that it would need to shed load in the Highland-Tod area within five minutes if the Hanna transformer were to trip. ATSI developed plans for which load to shed and ensured the plan was in place and ready to be executed. Around 14:47, the post-contingency flow on the Highland-Tod 138kV line was projected to exceed 115 percent of the maximum limit in the event of the loss of the Hanna #1 345/138 kV transformer. The results of studying this contingency using the PJM Manual 13 N-5 process\(^5\) indicated the potential for a cascading outage.

As the Reliability Coordinator, PJM follows an emergency procedure when facilities could exceed 115 percent of their 15-minute maximum ratings on a post-contingency basis. Briefly, if after studying a maximum of five contingencies, there is either no solution (i.e. no ability to rebalance generation and load) or facilities continue to exceed 115 percent of their maximum limit, then there is considered to be a potential cascade situation. In accordance with PJM Manual M-03 section 4, the PJM operator will review the results with the transmission owner and direct a pre-contingency load shed after results are confirmed between PJM and the TO. At 15:01 on Tuesday, September 10, PJM directed ATSI to shed 16 MW of load. ATSI began restoring load at 16:28 after the South Canton #1 transformer returned to service at 16:00. All load was restored at 16:42.

**Penelec Erie South Load Shed Event**

The fourth load shed event, Penelec Erie South, occurred on Tuesday, September 10, at 17:49 in the PJM Mid-Atlantic Zone. The load shed event occurred near Erie, Pa. The amount of load shed was 105 MW in total, shed in increments of 70 MW at 17:49 and an additional 35 MW at 18:22. Approximately 35,000 customers were affected during the event. FirstEnergy began restoring customer load at 23:01 with all load restored by 00:02 on September 11.

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\(^5\) detailed in PJM Manual 13, Section 5.4.1, [http://pjm.com/~/media/documents/manuals/m13.ashx](http://pjm.com/~/media/documents/manuals/m13.ashx)
The local and regional conditions prior to the Penelec Erie South load shed event that contributed to the cause were:

1. the unplanned loss of the Erie West-Ashtabula-Perry 345 kV line;
2. a scheduled and approved outage of the Geneva – Wayne 115 kV line (to replace relays and substation conductor)
3. a scheduled and approved outage of the Wayne-Geneva 115 kV line for scheduled maintenance;
4. an unplanned loss of one generator unit (218 MW) on September 9; and
5. an unplanned loss of a second generator unit (203 MW) on September 10.

Figure 12 – Area of the Penelec Erie South Load Shed Event
The Erie West-Ashtabula-Perry 345 kV line went out of service at 13:36 on September 10 (based upon preliminary analysis the line tripped for a fault caused by a conductor failure near a T-Tap connection). FirstEnergy unsuccessfully attempted to restore the line at 13:45. PJM and FirstEnergy analysis of the unplanned outage, coupled with the other planned and unplanned outages of transmission and over 400 MW of generation in the local area, identified extreme low voltages throughout the area for the next contingency, loss of the Erie West-Wayne 345 kV line. The loss of the Erie West-Wayne 345 kV line became a non-converged (unsolvable) contingency around approximately 16:47, indicating a potential wide area or cascading outage. At 17:41, to prevent a larger voltage problem, PJM directed FirstEnergy to shed 70 MW of load in the Erie South area of Penelec. Because this amount of load shed was not enough to alleviate the potential cascading outage, at 18:19, PJM directed FirstEnergy to shed an additional 35 MW of load. All load was returned to service by 00:02 Wednesday, September 11, when the overall system load reduced due to the time of day and lower temperatures.

**AEP Summit Load Shed Event**

The fifth load shed event, AEP Summit, occurred on Tuesday, September 10, at 19:13 in Fort Wayne, IN in the AEP zone, around the Industrial-Summit 138 kV line. A total of 25 MW of load was shed that impacted approximately 3,500 customers from 19:13 to 20:16 (approximately 1 hour 3 minutes).

![Diagram of the AEP Summit Load Shed Event](image)

**Figure 13 – Area of the AEP Summit Load Shed Event**

The local and regional conditions prior to the AEP Summit load shed event that contributed to the cause were:
1. high loads in the AEP and ATSI zones;
2. planned and approved outages of the Allen-Lincoln 138 kV line and the Lincoln 138 kV bus (bus work to add new disconnects at Lincoln); and
3. facility ratings on Summit-Industrial 138 kV line that were all the same. (The normal rating (24 hours), emergency (four hours), and maximum (15-minute) limit all had a facility rating of 251 MVA); and
4. long-lead times for generation in the area.

On the afternoon of September 10, PJM and AEP operators both observed potential overloads on the Summit-Industrial 138 kV line for the simulated loss of the Robison Park T-5 345/138 kV transformer. When the simulated flows exceeded the maximum facility rating of 251 MVA at 11:46, PJM issued a Post Contingency Local Load Relief Warning to AEP. The procedure was a warning to alert AEP that it would need to shed load in the Summit area within five minutes if the Robison Park transformer were to trip. AEP developed plans for exactly which load would be shed and ensured that plan was in place and ready to be executed.

Loads continued to rise throughout the day. At 14:45, PJM issued emergency mandatory load management for the ATSI zone and the AEP South Canton subzone. As loads continued to increase in the area, the simulated post contingency flows also increased. At 18:50, the AEP operator notified PJM that AEP’s analysis predicted flows approximately 20 MVA higher than PJM’s estimates. In accordance with the PJM operating procedures, PJM and AEP operated to the most conservative analysis. At the higher flows, this analysis (N-5 as noted above) indicated that, should the Robison Park transformer trip, the transmission system in the area would collapse immediately. Therefore, the plan to shed load after the contingency no longer was a viable option, and action needed to be taken immediately to avoid a potential larger collapse. To prevent a potential uncontrolled cascade and wider area outages, PJM directed AEP to shed 25 MW in the Summit area at 19:13. The Summit load was chosen because it had the most impact relieving the constraint (61.3 percent effect). PJM could not consider load management in this situation because of the required two hour notification time; in addition, load management is not mandatory after 20:00.

Although generation in the area (395 MW) could have been called on to help reduce post-contingency flows (8 percent effect for each unit), it was not considered a viable option due to the long time-to-start parameter of six to 13 hours associated with each unit. The time-to-start parameter is the time it takes for the unit to come on line (produce megawatts) after PJM requests the unit to operate. The load was restored at 20:16 (approximately 1 hour 3 minutes after the outage began) when the overall system load reduced due to the time of day and lower temperatures.

**Synchronized Reserve Event**

As mentioned previously, PJM carries reserves on the system to account for unforeseeable system events, such as unplanned outages. These reserves are referred to as Synchronous Reserves. Going into the operating day on Tuesday, September 10, PJM was required to carry 1,322 MW of reserves. PJM had 1,655 MW of reserves available.
At 15:48 on September 10, PJM requested all synchronized resources to deploy 100 percent of their reserves to help recover from a very quick increase in load. The response the resources provided to this event was significantly less than expected. As a result, PJM kept the signal to the synchronized units at a full raise to continue to incent the appropriate response and keep up with the increasing load. PJM also requested Shared Reserves from NPCC to assist. The reduced response to this event from synchronized resources on September 10 was a direct contributor to PJM’s decision to call for a Maximum Generation Alert and Demand Response on September 11.

**September 11 Operating Day Events**

With a load forecast expected to exceed 148,000 MW, in preparation for Wednesday, September 11, PJM issued a Hot Weather Alert and Maximum Emergency Generation Alert for the entire RTO. Based on the forecasted loads, operating experience with transmission contingencies, available generation and synchronized reserves response from the previous operating day, PJM proactively implemented Long Lead Emergency Load Management in the ATSI, AEP, Mid-Atlantic, Dominion and Duquesne zones; as well as Short Lead Emergency Load Management in the Mid-Atlantic Region for a total of approximately 6,000 MW of reduction. The demand response resources began to affect the system at 13:30 and were released starting at 17:00 (Figure 12 and 13). By 20:00 all Emergency Demand Response had been cancelled as well as all Maximum Emergency Generation alerts.

![Estimated Demand Response for RTO](image)

*Figure 14 –Estimated Demand Response for RTO*

*Notes: Registered emergency demand response amounts adjusted for RPM Commitments (do not represent actual energy reductions). LMPs included to represent energy market conditions on the operating day and not a relationship between dispatched demand response prices. Actual load reductions are not finalized until up to 3 months after event.*
Other emergency procedures issued on Wednesday, September 11, included a voltage reduction warning and reduction of non-critical plant load for the AEP and ATSI zones at 14:00. At 18:30, after coordination with the New York ISO, a Transmission Loading Relief 5 cutting 100 MW of firm transactions on the Neptune DC tie to New York was issued for an actual overload on the Bridgewater-Middlesex line. The transactions were restored at 22:00.

**Conclusion**

This report is PJM's initial analysis of its actions in response to operating events caused by system wide conditions such as historically unseasonable temperatures and peak loads in September, coupled with regional and sub-transmission conditions such as forced outages and reserves that did not meet expectations. PJM and its members are committed to preserving the reliability of PJM-monitored Bulk Electric System facilities. Part of that commitment is to analyze system events or problems for the purpose of implementing corrective actions and sharing knowledge to improve operations at PJM and member companies. These unseasonable loads, coupled with the start of the generation and transmission maintenance cycle, demanded PJM's prudent and decisive response to each operating event to prevent grid problems in the identified local areas from becoming more widespread and affecting larger numbers of customers. As was noted in the Joint US/Canada Task Force Report in 2003, sometimes strategic and limited load shedding, although never desirable, is the only effective means available in real time to prevent a much

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larger cascading event. The outages of September 2013 were undertaken for just this purpose. In each of these operating events, PJM followed its operating protocols and shed the minimum amount of load in the most effective areas to ensure overall system reliability was maintained. Although overall demand response performed well during this period, the restrictions such as the required two hour notification for invoking demand response and the lack of granularity to utilize demand response on a more targeted sub-zonal basis limited the operator’s flexibility in using demand response as a tool in real time to prevent some of these events. PJM will examine that issue as well as other issues surrounding generator and transmission system performance through its stakeholder process.