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INDEPENDENT REVIEW OF SOUTHERN CALIFORNIA GAS HYDRAULIC MODELING

Draft Report Prepared For the California Energy Commission (CEC), California Public Utilities Commission (CPUC), California Independent System Operator (CaISO), and the Los Angeles Department of Water and Power (LADWP)

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1 INTRODUCTION/PROJECT OVERVIEW

On October 23, 2015, Southern California Gas Company (SCG) discovered a leaking well at its Aliso Canyon underground gas storage field necessitating significant changes to the operating characteristics of the field and its future use. In preparing an Action Plan to preserve reliability for Summer 2017, the Aliso Canyon Technical Assessment Group (ACTAG) entities—California Energy Commission (CEC), California Public Utilities Commission (CPUC), California Independent System Operator (CaISO), and the Los Angeles Department of Water and Power (LADWP)—worked with SCG to understand how SCG utilizes the Aliso Canyon field and other gas storage fields and the impact that the loss of Aliso Canyon would have on electric system operations and reliability. Developing that understanding required use of hydraulic modeling. None of the ACTAG Assessment Team (hereafter referred to as the "assessment team") participants are proficient in using and applying hydraulic modeling, although one member is familiar with its use for planning.

The ACTAG entities requested assistance from experts in transient modeling and gas system planning at Los Alamos National Laboratory (LANL), in conjunction with Walker & Associates (Walker), to provide more detailed and complete independent review of SCG hydraulic modeling to better assure the public that the team is not relying solely on SCG to perform the needed modeling and analysis.

The Independent Review Team (IRT) evaluated the hydraulic modeling and reliability analysis methodology, as well as the recommendations made by the ACTAG. This report discusses the IRT review. While the findings of the independent review will be public, some of the modeling information is confidential and must be maintained. Members of the IRT have signed non-disclosure agreements with SCG. These non-disclosure agreements do not impede or limit the review.

2 HYDRAULIC MODELING AND SYSTEM CAPACITY ANALYSIS

For the 2017 Summer Reliability Assessment, SCG chose to perform a system capacity study using transient hydraulic simulation. The intent of this type of study is to determine the maximum achievable gas send-out for the SCG system. The CaISO and LADWP used the results of the system capacity study to assess impacts on electric reliability using the available gas send-out from the SCG system.

The natural gas industry typically performs a reliability analysis by simulating one or more specific peak gas load days using expected or historically realized conditions on those days, e.g., weather patterns, gas system outages, and outlier gas usage issues. SCG has regularly performed this type of assessment in the past but the unknown nature of the electric generation needs suggested the transient hydraulic simulation for a system capacity study. This approach requires that the CaISO and LADWP interpret the system capacity study results carefully to ensure sufficiently accurate extrapolation of the results to gas pipeline conditions that were not modeled but may be present for Summer 2017, e.g., expected pipeline or storage outages, available gas storage withdrawal rates, and the daily operating balance of gas receipts and gas loads.

The 2017 Summer system capacity analysis is based on models, boundary conditions, and assumptions, including:

- The hydraulic model of the SCG pipeline system
- The quantity of flowing supplies available at SCG receipt points
- The maximum available storage withdrawal rates at storage fields other than Aliso Canyon

- The achievable storage withdrawal rates based on storage inventory at storage fields other than Aliso Canyon
- The incorporation of real-time gas control decision making into the system capacity study
- The presence and impact of unplanned outages of pipelines and storage facilities on gas system capacity
- The interpretation of the system capacity study in the joint electric reliability analysis by the assessment team.

The following subsections present the IRT reviews each of these items.

2.1 HYDRAULIC MODEL OF THE SCG PIPELINE SYSTEM

Accurate hydraulic modeling and simulation is key to assessing system capacity accurately. The assessment of the SCG hydraulic modeling and simulation requires a clear understanding of what is included in the hydraulic model and how it is included. The hydraulic model has detailed representations of many pipeline components, including:

- The flow and compression of gas in the individual pipe segments
- The control of and flow in the interconnections and valves between the individual pipe segments
- The control and operation of city gate/pressure reduction control stations
- The control and operation of gas compression stations
- The control and operation of gas storage fields

The same IRT reviewed these aspects of the SCG hydraulic model in the 2016 Summer and Winter Reliability Analyses. The physical pipeline system has not changed significantly since the last IRT review and SCG reports that no significant changes have been made to the hydraulic model.

Finding: Based on these observations, the IRT believes the representation of these aspects of the transient hydraulic model are sufficiently representative of the gas system network for the 2017 Summer Reliability Assessment.

In contrast, the hydraulic model represents other key gas system components in a simplified form.

- Gas storage reservoirs and the surrounding operational systems are not modeled in detail. Instead, they are represented as “boundary conditions” on the hydraulic model that place constraints on the maximum rate of withdrawal from storage and supply into the pipeline system. Consistent with standard industry practice, these boundary conditions are provided as curves of maximum storage withdrawal rate as a function of storage inventory.
- Flowing gas supplies are modeled as constant-in-time gas receipts at the pipeline receipt points; they do not account for the transient hydraulic properties of the upstream pipelines transporting the gas to the SCG receipt points.

Implementation of the SCG Storage Safety Enhancement Plan (SSEP)[1] led to changes in the configuration and operation of SCG gas storage fields that have resulted in modifications to these maximum withdrawal curves, which we review later in this report. Stricter SCG gas balancing requirements implemented for Summer 2016 have resulted in changes in the behavior of the flowing gas supplies relative to pre-2016 historical data. The assumptions by both SCG and the assessment team regarding flowing gas supplies will be reviewed later in this report.

2.2 FLOWING GAS SUPPLIES AT THE SCG RECEIPT POINTS

The SCG system capacity study maximized the flowing supplies at the SCG receipt points to maximize the send out of the SCG pipeline system while maintaining system constraints and other reliability conditions. The maximum flowing supplies in the capacity study are a measure of the maximum gas supply that could be scheduled into the SCG pipeline system. Here, scheduling happens before actual gas system operations and control. In real-time operations, if actual physical gas deliveries meet the scheduled gas deliveries, then the system capacity study is a good representation of the achievable gas pipeline send out. Differences between scheduled and actual deliveries require modification or interpretation of the system capacity study to estimate the actual gas send out capacity.

Mismatch between scheduled and actual gas deliveries

Prior to 2016, the availability of the Aliso Canyon storage field provided a significant degree of flexibility on the SCG pipeline system enabling relatively easy compensation of daily and hourly imbalances between actual flowing gas supply receipts and scheduled receipts. Although there are monthly balancing requirements, the flexibility provided by Aliso Canyon and the lack of daily balancing requirements often resulted in many SCG gas customers not scheduling sufficient gas on a daily basis to cover their daily consumption. As expected, the monthly average gas receipts balanced the average gas load, however, the pre-2016 daily gas receipts do not provide clear guidance on determining a typical relationship between daily scheduled gas deliveries and actual daily gas deliveries for the 2017 Summer Reliability Assessment.

The assessment team investigated the daily actual versus scheduled gas imbalance data under the tighter gas balancing requirements in place during and following the Summer 2016 Action Plan, which are in place as of the date of this report. The investigation of these limited data suggests that under the new requirements imbalances have been reduced from historical levels. When imbalances occur, they approximate 5% of total scheduled gas. The root cause of the typical 5% imbalance has not been investigated in detail.

In the 2017 Summer Joint Reliability Assessment, the assessment team included an extra degree of conservatism by incorporating an additional 5% to represent unplanned outages, resulting in a 10% total shortfall. The conservatism from the additional 5% shortfall and its relationship to other sources of uncertainty are discussed in Section 2.5

[1] Schwecke, Rodger R. "Re: Storage Safety Enhancement Plan." Letter to Edward Randolph, California Public Utilities Commission. 17 Feb. 2017. Aliso Canyon Well Failure. California Public Utilities Commission, 17 Feb. 2017. Web. accessed 19 May 2017.

Finding: Based on investigation of recent historical data under tighter gas balancing rules, the 2017 Summer Reliability Assessment estimates that actual gas receipts may fall short of SCG system capacity study receipts by 5%. The 2017 Summer Joint Reliability Assessment includes an additional 5% shortfall for conservatism, resulting in a 90% receipt point utilization. Based on discussions with SCG and analysis of data during low operational flow order on the SCG system, the IRT is in agreement with this approach, however, explicit consideration of unplanned outages as discussed in Section 2.5 is suggested.

Interpretation of the SCG system capacity study

Under guidance from SCG on how the gas system will respond to a shortfall of actual gas supplies relative to scheduled gas supplies, the assessment team extrapolated the SCG system capacity study by assuming that daily gas send out and the maximum supportable gas load during the peak hour is reduced by 10%. The IRT believes that this 1:1 reduction is a worst case and could potentially be less, depending on the spatial distribution of the gas supply shortfall across the supply points and possible mitigations through gas storage operations. For example, if the outage occurs in the Wheeler Ridge area, the Honor Rancho storage facility could provide mitigation and the reduction would be less than a 1:1 reduction. Location is a key variable in determining the impact of a reduction in gas supply and discussions between the IRT and SCG revealed plausible scenarios where this worst case of a 1:1 reduction in send out would be realized.

Finding: Because neither the assessment team nor SCG know a priori where the gas supply will fall short of scheduled gas, the IRT agrees with the use of a 1:1 reduction in the assessment team's extrapolation of the 2017 Summer system capacity analysis.

2.3 Maximum Storage Field Withdrawal Rates

Maximum storage field withdrawal rates are not directly modeled in the hydraulic simulation. The SCG Storage Underground Engineering Group develops curves of maximum withdrawal rates versus storage field inventory, which are provided as inputs to the hydraulic modeling and simulation. Although these curves are developed outside of the hydraulic modeling and simulation, they are key to the SCG system capacity study. When combined with SSEP-driven changes at the storage fields, these curves and their development require some level of review by the IRT.

The maximum storage withdrawal at any particular storage field or well within a storage field is limited by a complex combination of many factors, including avoiding sand production in the well and causing permanent damage to the geologic structures, hydraulic limitations in the well bore tubing or in the gathering system on the surface, and local pipeline pressure constraints and competition for pipeline transportation with other gas sources. Although the combination of constraints is complex, the storage operators are able to periodically calibrate the storage withdrawal capacity by using flow, pressure, and well configuration status data gathered during normal storage field operations. The storage engineers calibrate anytime the field is on withdrawal and ask Gas Control to hold certain rates so they can confirm their empirical calculations based on the current inventories.

SSEP-driven modifications to the storage fields have created changes to the maximum withdrawal rates. Since those changes, not all of the storage fields have experienced gas inventories near to the target inventories used in the 2017 SCG system capacity study. The SSEP-driven changes are primarily to the hydraulic conditions in the well bores and tubing used to extract the gas from the storage fields. The well bores and tubing are a subsystem of the gas storage field that can be well represented using simulation. In discussions with the assessment team and SCG, SCG has stated that the SCG Underground Storage Engineering Group has used a combination of historical data and

simulation to estimate maximum withdrawal capability at target inventory levels for 2017 SCG system capacity study.

Finding: For those gas storage fields that have not operated at gas inventories near the targets assumed in the 2017 Summer system capacity study, the IRT is in agreement with the SCG approach to use a combination of simulation and historical data to estimate the maximum storage withdrawal capacity at the target gas storage inventories.

2.4 ACHIEVABLE GAS STORAGE WITHDRAWAL RATES

The Energy Division and California Energy Commission Maximum specified the storage withdrawal rates used in SCG's hydraulic analysis based upon expected levels of inventory achieved at each of the SCG storage fields prior to the peak electric generating season. Achieving the gas storage withdrawal rates assumed in the 2017 Summer system capacity study requires the actual gas storage inventories reach the target levels. These inventories are determined by the cumulative outcome of gas scheduling and gas pipeline operations until the simulated day. The process or understanding of the cumulative outcomes is beyond the scope of intraday hydraulic modeling. However, the status of the storage inventories and the available storage fields is key to the 2017 Summer Reliability Assessment and requires some level of review by the IRT.

- Playa del Rey—The Playa del Rey storage field has relatively small storage capacity, but it is key to gas control operations and reliability of gas supply in the Los Angeles Basin during a day of peak gas send out. These storage field operations are reflected in both the 2017 Summer system capacity study and in actual gas control operations. As of the date of this review, the Playa del Rey storage field is at full gas capacity, meeting the requirements set out by the CPUC in March 16, 2017 letter to SCG regarding the Storage Safety Enhancement Plan to increase system-wide withdrawal capacity to 2.065 Bcf per day by June 1, 2017.[2]
- La Goleta—The La Goleta storage field has access to limited pipeline transportation capacity. On peak-day operation, pipeline constraints limit the ability of this storage field to support peak gas loads to the south in the Los Angeles Basin. This field can be used in a "base load" manner to support the overall recovery of system-wide line pack, but any peaking storage withdrawal from this field is used primarily to support peak gas loads in the coastal region of the SCG pipeline system. This use is reflected in both the 2017 Summer system capacity study and in actual gas control operations.
- Honor Rancho—Compared to La Goleta, the Honor Rancho storage field has better access to pipeline transportation capacity into the Los Angeles Basin. It is key to supporting peak gas loads in the Los Angeles Basin, however, the full withdrawal capacity of Honor Rancho may not be achievable during the expected 2017 Summer peak day conditions because the withdrawal from Honor Rancho storage competes with gas receipts from Wheeler Ridge for pipeline capacity. If both storage withdrawal and Wheeler Ridge receipts are maximized, pipeline pressure would exceed maximum allowable operating pressures, which would violate safety and compliance requirements. Although Honor Rancho could be used to mitigate Wheeler Ridge receipt point shortfalls, withdrawals from Honor Rancho may not

[2] Schwecke, Rodger R. "Re: Storage Safety Enhancement Plan." Letter to Edward Randolph, California Public Utilities Commission. 17 Feb. 2017. Aliso Canyon Well Failure. California Public Utilities Commission, 17 Feb. 2017. Web. accessed 19 May 2017.

achieve peak storage field capability during peak day operation because of these pipeline constraints.

Finding: The limited gas storage injection capacity and tighter balancing system-wide rules have resulted in reduced storage injections at the non-Aliso Canyon gas storage fields. The IRT recommends that a gas storage injection plan be developed and implemented that, at a minimum, includes:

- *Weekly and monthly gas storage injection goals that will achieve storage inventories consistent with the gas storage withdrawal rates used by the assessment team*
- *Definition of and an implementation plan for weekly and monthly monitoring of progress towards the gas storage inventory goals*
- *A clearly identified party or organization responsible for achieving the injection goals*

2.5 Impact of Pipeline and Storage Unplanned Outages on System Capacity

The 2017 Summer Reliability Assessment did not explicitly consider either pipeline or gas storage outages in the system capacity simulation. The additional 5% shortfall in gas discussed in Section 2.2 would mitigate the uncertainty related to a pipeline or gas storage unplanned outage that results in a reduction in gas send out of up to approximately 200 mmcfd. As noted in Table 3 of the "Aliso Canyon Risk Assessment Technical Report", reductions in total send out may exceed 500 mmcfd for unplanned pipeline outages and may exceed 400 mmcfd for unplanned gas storage outages. The additional 5% shortfall in actual versus scheduled gas receipts included as an extra degree of conservatism in the 2017 Summer Reliability Assessment partially mitigates the effect of these unplanned pipeline and gas storage outages, but some residual risk of remains. The IRT believes that these issues require some review in this report. The timing and gas supply impacts of planned pipeline and storage outages are routinely coordinated with CaISO and LADWP. The review by IRT in this section is, therefore, restricted to unplanned pipeline and storage outages.

For this discussion, the IRT believes is it useful to break unplanned pipeline and storage outages into the following subgroups:

- Unplanned pipeline outages in the low pressure loop in the Los Angeles Basin—The pipeline network in the Los Angeles Basin is meshed and interconnected, which provides a high level of redundancy so that the distributed SCG loads can continue to be served during planned or unplanned pipeline outages. In contrast to the majority of the core loads, gas-fired electric generation create point loads with high gas-draw. Unplanned outages of individual pipeline segments in this part of the SCG network may requirement curtailment of gas-fired generation in the immediate area of the pipeline outage, but network redundancy will likely enable gas to continue to be supplied to the other generation connected to the low pressure loop. In the related electrical assessment, dispatch of gas-fired generation connected to the SCG system is already minimized making it very likely that other gas-fired generation, inside or outside the Los Angeles based, will be able to utilize the gas no longer used the curtailed generator and replace the electrical energy. Based on this reasoning, the IRT believe that individual pipeline outages within the low pressure loop in the Los Angeles basin will have limited to no effect on joint system reliability.

- Unplanned Pipeline outages in the high pressure gas supply lines—In the 2017 Summer system capacity study by SCG, these high pressure supply lines are already at full capacity. Therefore, full or partial outages on one line cannot be compensated by increased gas deliveries on the other high pressure gas supply lines, and a nominal reduction in gas system send out equal to the reduction in pipeline capacity is expected (referred to as a 1:1 reduction in gas send out in the 2017 Summer Reliability Assessment). *In general, the IRT agrees with this analysis as a worst case impact of outages on these pipelines, however, certain mitigation measures are possible.*
    - Relative to the 2017 Summer system capacity study, modifications to the operation of city gates serving the Los Angeles Basin and the timing of the startup and shut down of storage withdrawals at the Playa del Rey storage field could increase the total withdrawal from this field to partially offset the reductions in gas deliveries due to a high pressure pipeline outage. The viability of this mitigation would require additional study beyond the 2017 Summer system capacity analysis. It would likely require a multi-day analysis because Playa del Rey is a small volume storage field. It takes several days to replace the gas in Playa del Rey for each day of withdrawal. Increased withdrawals over sequential days would eventually reduce the maximum withdrawal rates and offset any benefits gained from extension of the daily withdrawal period to mitigate a high pressure pipeline outage.
    - An outage of either the SCG system or the Kern/Mojave Pipeline that impacts deliveries to the Wheeler Ridge receipt point would reduce supplies in this area of the SCG system and partially relieve the pipeline constraint that limits the maximum storage withdrawal rate from Honor Rancho with maximum receipts from Wheeler Ridge. Under these conditions, SCG gas control operators could potentially increase withdrawals from Honor Rancho up to the maximum withdrawal capacity of the field to fully or partially mitigate the pipeline outage if the maximum withdrawal rate is greater than what was usable in the simulation, although an overall supply shortfall could still be likely.
- Unplanned Storage outages—Full or partial outages of any of the available storage fields result in a complex gas control operational environment. A detailed transient hydraulic simulation is required to assess whether reduced gas supply from the other storage facilities can be mitigated by using other storage facilities. Increased receipts on the high pressure pipelines is not a mitigation because these receipts are already maximized and cannot be increase further. In these scenarios, a 1:1 reduction is a reasonable worst case assumption for the impact on both daily and peak hour gas send out.

In the 2017 Summer Reliability Assessment, the approach to a shortfall in gas receipts relative to gas schedules was to assume a 1:1 reduction in both daily and peak hour gas send out. This 1:1 reduction was used to extrapolate the 2017 Summer system capacity analysis to assess the impact on the CaISO and LADWP electric system. In that section, the IRT recommendation was that because neither CaISO and LADWP nor SCG know a priori where the gas receipt shortfalls will occur, the IRT agrees with the use of a 1:1 reduction in the assessment team's extrapolation of the 2017 Summer system capacity analysis. Alternatively, a risk based approach to unplanned outages, in which the probability of an electric power outage is combined with the probability of a gas supply shortfall would likely determine the probability of the need to withdraw from the storage facilities during unplanned outages.

Similar reasoning could be applied to both pipeline and storage unplanned outages.

Finding: The effect of unplanned gas pipeline and storage outages should be included in the 2017 Summer Reliability Assessment. Because neither the assessment team nor SCG know a priori where the pipeline or storage unplanned outages will occur, the IRT suggests that the impact of potential unplanned outages be assessed using the same 1:1 reduction in the assessment team's extrapolation of the 2017 Summer system capacity analysis. Alternatively, using a risk based approach to address the unplanned outages is also suggested.

2.6 Interface Between the SCG Gas System Capacity Analysis and the Assessment Team's Electric System Reliability Assessment

In the 2017 Summer Joint Reliability Assessment, the interface between the gas system capacity analysis and the electric system reliability analysis is composed of two main approaches that are related but used for different purposes:

- A gas system peak load factor is defines the ratio of the hourly peak gas send out to the average hourly gas send out over the entire day. In the 2017 Summer system capacity assessment, a peak load factor of 1.47 was used
- If gas receipts fall short of scheduled gas at the SCG receipt points, there is a 1:1 reduction in daily total gas send out and in peak hourly gas supply capability

Earlier in Section 2.2 of this report, the IRT discussed the applicability of the 1:1 in reduction in gas send out in relation to shortfalls in gas deliveries and in Section 2.5 in relation to unplanned gas system outages. Some additional discussion is required to justify the use of this approach relative to the shape of the intraday gas loads curve and the use of peak load factors.

When a specific peak load factor is used, there are implicit assumptions about the intra-day shape of the gas system load curve, especially in the hours preceding and following the hourly peak. In the 2017 Summer system capacity analysis, SCG used historical gas load data to develop a nominal system-wide total gas load profile. The resulting gas load curve had a peak load factor of 1.47. This fixed time profile was uniformly scaled up in magnitude until the transient hydraulic simulation could no longer be successfully technically executed, even after considering modifications of gas storage withdrawals and city gate operations. Consultations with SCG gas control operators resulted in further modifications of the scaling of load curve and simulated system operations to better match the behavior of the simulated system to real-time operations. The final outcome of this effort was a supportable gas load curve under all of the assumptions summarized in the 2017 Summer Reliability Assessment and in this report.

In principle, assessments of gas system behavior and reliability for deviations from this daily gas load curve require additional hydraulic simulations for the modified boundary conditions. An example of this type of modification is the assessment team's investigation of the potential 10% shortfall of actual gas deliveries relative to scheduled gas. Instead of repeating a detailed hydraulic analysis for the new deliveries, the assessment team scaled the daily gas load curve down 10% at all time points on the curve and assumed that the electric power generation gas burn would also scale down by the same hourly amounts. Although not a rigorous analysis, the deviations considered by the assessment team are relatively small and are not likely to result in significant changes to the simulated daily gas load curve that would affect the ability of the SCG pipeline to meet the hourly gas send out.

Finding: The deviations in daily gas load conditions from the 2017 Summer system capacity study are small enough that the IRT believes the assessment team's approach of scaling the supportable gas load by the same factor uniformly across each hour of the day is sufficiently representative of the response of the SCG gas system to these conditions.

3 FINDINGS

The following is a listing of the detailed findings noted in this report:

- *(IRT Agreement) Based on IRT observations, the IRT believes the transient hydraulic model is sufficiently representative of the gas system network for the 2017 Summer Reliability Assessment.*
- *(IRT Agreement) Based on investigation of recent historical data under tighter gas balancing rules, the 2017 Summer Reliability Assessment estimates that actual gas receipts may fall short of SCG system capacity study receipts by 5%. The 2017 Summer Joint Reliability Assessment includes an additional 5% shortfall for conservatism, resulting in a 90% receipt point utilization. Based on discussions with SCG and analysis of data during low operational flow order on the SCG system, the IRT is in agreement with this approach, however, explicit consideration of unplanned outages as discussed in Section 2.5 is suggested.*
- *(IRT Agreement) Because neither the assessment team nor SCG know a priori where the gas supply will fall short of scheduled gas, the IRT agrees with the use of a 1:1 reduction in the assessment team's extrapolation of the 2017 Summer system capacity analysis.*
- *(IRT Agreement) For those gas storage fields that have not operated at gas inventories near to the targets assumed in the 2017 Summer system capacity study, the IRT is in agreement with the SCG approach to use a combination of simulation and historical data to estimate the maximum storage withdrawal capacity at the target gas storage inventories.*
- *(IRT Recommendation) The limited gas storage injection capacity and tighter balancing system-wide rules have resulted in reduced storage injections at the non-Aliso gas storage fields. The IRT recommends that a gas storage injection plan be developed and implemented that, at a minimum, includes:*
    - *Weekly and monthly gas storage injection goals that will achieve storage inventories consistent with the gas storage withdrawal rates used by the assessment team*
    - *Definition of and an implementation plan for weekly and monthly monitoring of progress towards the gas storage inventory goals*
    - *A clearly identified party or organization responsible for achieving the injection goals*
- *(IRT Recommendation) The effect of unplanned gas pipeline and storage outages should be included in the 2017 Summer Reliability Assessment. Because neither the assessment team nor SCG know a priori where the pipeline or storage unplanned outages will occur, the IRT suggests that the impact of potential unplanned outages be assessed using the same 1:1 reduction in the assessment team's extrapolation of the 2017 Summer system capacity analysis. Alternatively, using a risk based approach to address the unplanned outages is also suggested.*
- *(IRT Agreement) The deviations in daily gas load conditions from the 2017 Summer system capacity study are small enough that the IRT believes the assessment team's approach of scaling the supportable gas load by the same factor uniformly across each hour of the day is sufficiently representative of the response of the SCG gas system to these conditions.*

In summary, the IRT finds that the hydraulic modeling and simulation of the SCG gas system and the modeling of SCG gas control operations are representative of the gas send out capability of the SCG

gas system under the boundary conditions used in the 2017 Summer system capacity study performed by SCG and discussed in the 2017 Summer Reliability Assessment.

The IRT also finds that the gas system boundary conditions used in the 2017 Summer system capacity study and discussed in the 2017 Summer Reliability Assessment are representative of the actual boundary conditions, assuming that the target storage inventories required to meet the CPUC-required gas storage withdrawal rates can be achieved.

The IRT also finds that, under current operating conditions, the required gas storage levels to meet the CPUC-required gas storage withdrawal rates are unlikely to be achieved.

The IRT also finds that the effects of gas system outages should be included in the 2017 Summer Reliability Assessment to provide a more complete understanding of the risks to the combined CaISO and LADWP electrical system.

4 RECOMMENDATIONS

The IRT makes the following recommendations:

- The IRT recommends a gas storage injection plan be developed and implemented that, at a minimum, includes:
    - Weekly and monthly gas storage injection goals that will achieve storage inventories consistent with the gas storage withdrawal rates used by the assessment team
    - Definition and an implementation plan for weekly and monthly monitoring of progress towards the gas storage inventory goals
    - A clearly identified party or organization responsible for achieving the injection goals
- SCG should consider ways to incorporate transient hydraulic modeling into gas control operations to improve their ability to support gas injections into their underground storage facilities
- SCG should develop contingency plans that involve gas supplies alternative or in addition to drawing gas from Aliso Canyon to mitigate extreme gas system operating conditions
- The 2017 Summer Reliability Assessment should be updated to address SCG gas system unplanned outages on the combined CaISO and LADWP electrical systems.

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