December

Readiness Report for MRTU

Market Redesign & Technology Upgrade

Federal Energy Regulatory Commission

December 8, 2008

1. Executive Summary

This status report updates the Federal Energy Regulatory Commission (FERC) regarding preparation activities underway by the California Independent System Operator Corporation (ISO) and market participants for the Market Redesign & Technology Upgrade (MRTU) launch. The ISO Board of Governors set a new MRTU target *go live* date of March 1, 2009 at its November 24, 2008 meeting, following a recommendation by ISO management and participants indicating a February 1 date was unattainable.

We are pleased to present this report detailing the progress toward readiness since the November Readiness Report. The ISO and market participants collaborated extensively to close gaps concerning MRTU readiness status. The ISO management appreciates the tremendous spirit of cooperation afforded by the participants. These discussions also enabled the ISO and participants to agree upon the main areas of concern that require attention for a successful *go live*:

- **Quality of Solution** – Questions persist regarding pricing solutions from MRTU market simulation. The ISO and market participants have conducted progressive and evolving market simulations for 17 months. This represents a longer and more involved period of testing than similar software implementations to make sure a high-quality implementation is achieved. Simulation set-up has proven very challenging -- notwithstanding integration of a production energy management system, installation of robust production-quality hardware, and receipt of complete and accurate bid sets from participants – overall, both the ISO and participants benefited and gained invaluable experience and results that supported training and issue discovery.

  Frequent price anomalies in the simulation are explainable by ISO staff and consultants based on the peculiarity of the various scenarios. However, they remain a major source of reservation for market participants. We have closed this gap considerably with intensive participant collaboration through a variety of forums and system changes such as increased parameter tuning and model enhancement. We recognize, however, that more efforts are needed to close the gap completely. In this regard, market participants requested the development and execution of a more structured operational scenario where simulation variables were minimized to the extent possible to establish a baseline for comparison. This test scenario required nearly three weeks of preparation and significant effort to execute. Results for the day-ahead market runs were good but, as expected, the real-time simulations were very challenging. The ISO is assessing the environment settings and making adjustments, however we are unsure at this time if this will be successful eliminating problems caused by simulation (as opposed to production). The ISO continues to work with participants to conduct additional quality of solution testing to assist with root cause analysis. Concerns regarding quality of solution are three-fold:

  - **Price anomalies in real-time:** Additional testing will focus on the relationship of hour-ahead prices relative to day-ahead prices, price

volatility and high prices in the northern California Load Aggregation Point (LAP).

- **Residual Unit Commitment (RUC) prices –** Participants need greater understanding about the RUC process and the dispatch of non-Resource Adequacy generation. RUC prices and awards appear to be in line with the market design but are not consistent with certain participant expectations and require further evaluation.
- **Dispatch anomalies –** The simulation is producing unit dispatch anomalies that seem aberrant to participants. For example, the set of the Energy Management System (EMS) restarts unit positions and results in "swinging" of plants. This is likely related to simulation systems.

Additional quality of solution detail is provided in section 2.3 of this report.

- **Settlements –** Progress has been made with MRTU settlements, most upstream data issues are resolved and a new Quality Assurance team is verifying payloads and results. November daily statements are improving by the day and where there are issues, they are stated upfront when statements are published. A complete and accurate monthly statement for all days of a month is virtually impossible given the limitations of the simulation environment; therefore the ISO is producing mini-monthly statements in November to help expedite participant validation processes. The final assessment of statements will be made by participants according to their ability to validate and confirm data accuracy across all external facing applications. We anticipate our efforts to provide additional data and increased accuracy will help build participant confidence in the MRTU settlements process. More information about MRTU settlements is available in section 2.5 of this report.

The significance of these issues, coupled with lost time for system testing due to connectivity issues experienced at the beginning of November, prompted a Board resolution[1] that:

- Directs the ISO to be prepared to file the 60-day readiness certification with FERC by December 30, 2008 for a March 1, 2009 *go live* date.
- Affirms the Board's intention to continue to monitor the status of MRTU readiness and further evaluate readiness for a March 1, 2009 *go live*.

As discussions about MRTU *go live* continue, the ISO and market participants are working in partnership to achieve a successful program launch. Together we evaluate progress daily in regards to open issues as well as newly discovered ones. Moreover, the ISO prepared a Parallel Operations and Pre-Production plan[2] to ensure proper integration with the EMS and other production systems. Furthermore, a Cutover and Reversion plan[3] is in place should unforeseen, unmitigated problems arise following *go live*. More information about pre-production and contingency plans is available in sections 2.7 and 2.8 of this report. In summary, all parties are making every possible effort to gain market confidence and achieve successful implementation.

[1] The full text of the Board motion is available at: http://www.caiso.com/2089/2089e2e75bc80.pdf

[2] The MRTU Pre-Production Simulation plan is provided as Attachment 8.2.

[3] The MRTU DRAFT Cutover and Reversion Plan is provided as Attachment 8.3.

2. MRTU Integrated Market Simulation (IMS)

2.1. System Performance & Testing – At the end of October, we transitioned to new production grade hardware in the simulation environment. When market simulation resumed, connectivity problems and other issues adversely impacted participant ability to take part in simulation testing. The problems were not related to the functionality or performance of MRTU software systems. Instead, they related to changes in system access that were necessary to tighten up system security in alignment with North America Energy Reliability Corporation (NERC) Critical Infrastructure Protection requirements. Ultimately, the ISO resolved the issues.

Despite the good performance of the software, we continue to experience a variety of environment-related issues that impact achieving the simulation exit criteria (current status is provided in section 2.6 of this report). Simulation systems require a high level of support and maintenance that is very difficult to sustain. In addition to normal production requirements, ISO staff supports five separate testing and simulation computing environments for MRTU. In addition to the one being finalized for MRTU production, we are supporting environments for testing, staging, market simulation, grid operation simulation and several backups. There are inherent complications associated with managing this many environments and the opportunities for human error are significant. We are further tightening controls and implementing business processes around MRTU systems to minimize problems, but cannot eliminate all such risks until we begin pre-production. Market participants are very understanding and have simply requested that we be as transparent as possible about the situation. The ISO recently reached agreement with participants that some elements of the exit criteria, established some time ago, are not feasible within the simulation environment. An increased level of system confidence will come from progress with testing and addressing variances and additional results analysis.

Additionally, a production-like change management process was instituted in October. Bi-weekly system patches are installed on the weekends to reduce testing disruptions. To date, we have deployed four releases to address known system variances.

Early in the MRTU development process, the ISO and market participants agreed to test MRTU systems progressively, enabling participant software development to mirror the functionality and performance of ISO systems. In 2007, the ISO conducted 33 weeks of market simulation testing and as of this report facilitated another 37 weeks of simulation this year. In total, the ISO coordinated more than 17 months of MRTU system testing with participants and their systems.

Early testing confirmed connectivity between participant systems and the main ISO external facing applications – Scheduling Infrastructure Business Rules (SIBR), the Market Results Interface (CMRI), and Open-Access Same-time Information System (OASIS). Recent simulation testing, since August 2008, was robust and included all 24 MRTU applications from bid-to-bill. In the last few weeks, testing expanded to include data exchanges with specific systems for scheduling, automatic dispatch and schedule tagging.

The ISO contracted with Science Applications International Corporation (SAIC) in September 2007 to verify and document that new MRTU applications were developed, built and tested in accordance with the MRTU Tariff. The ISO is the first independent system operator/regional transmission organization (ISO/RTO) to validate its software in advance of implementation by an independent entity. SAIC evaluated SIBR, the Market Quality System (MQS), Congestion Revenue Rights (CRR) and the Integrated Forward Market/Real-Time Nodal (IFM/RTN) software to be used under MRTU. SAIC utilized both a "top-down" and "bottom-up" audit approach. The top-down approach determined whether the MRTU Tariff accurately reflected the software business rules. The bottom-up approach analyzed test results to ensure consistency with the business rules and the MRTU Tariff.

SAIC published its certification results[4] on May 12, 2008 and uncovered no major issues with software functionality or the relationship between systems and the MRTU Tariff. SAIC identified clarifications to the MRTU Tariff to more accurately track MRTU Tariff business rules and recommended additional validation test cases. The ISO completed literally hundreds of validation tests that included the comparison of Tariff provisions with the software business requirements and then compared the results with market simulation test cases. As of this filing, validation is complete on all applications except IFM/RTN, which has two test cases pending validation and nine business requirements to be mapped to test cases.

The ISO agreed to the majority of SAIC-proposed Tariff amendments and will submit them for Commission approval in December. The ISO also explained to stakeholders the reasons for not adopting further Tariff amendments for certain about SAIC-proposed changes.

2.2. Scenarios – An integral component of market simulation testing is operational scenario testing. The ISO and market participants developed a total of 28 scenarios to test various operating contingencies within the simulation environment. Many scenarios include operational conditions that test and push system performance to an extreme, while others represent normal operating conditions. The status of scenario testing and the associated reports[5] is:

- Preliminary reports issued: 28
- Final reports issued: 27
- ISO scenario results: Initial runs of all 28 are complete with 4 to be rerun

2.3. Quality of Solution – Over the past month, the ISO worked closely with market participants to address their questions about MRTU market simulation prices. In particular, the ISO ran several base-line market scenarios for the day-ahead market to confirm pricing results. Similar tests for the real-time market were attempted but unsuccessful because real-time bidding scenarios could not be duplicated. The day-

[4] SAIC Module Certifications are provided as Attachment 8.5.

[5] Preliminary and final scenario reports are available at: http://www.caiso.com/2004/2004997f49230.html

ahead scenarios, which the MRTU project team developed with the Department of Market Monitoring (DMM) and market participant review, eliminated outside influences on prices (system conditions, bidding behavior, etc) and gave visibility to how the prices behave in a "pristine" environment. While the ISO successfully confirmed pricing results and reduced gaps in understanding, questions from market participants persist, regarding real-time prices in particular.

There is some concern about LAP prices in the north. The ISO remains confident in the underlying MRTU pricing engines and their output based on simulations to-date, the base-line tests and the LECG analysis. While pricing issues are observed they are explainable by simulation conditions or operational constraints. Having said that, the issues at hand are complex and market participants need additional time for further analysis. The ISO will continue to investigate and explain MRTU simulation prices to ensure participants are more confident that the software is producing reasonable price solutions consistent with the approved MRTU Tariff.

Participants also have questions about RUC prices and the underlying market design. The structured base-line results confirmed that RUC requirements are largely satisfied using resource adequacy capacity. However, the ISO observed that the reliance on non-resource adequacy capacity to meet local needs is related to binding constraints and the software is performing as designed and consistent with the accepted MRTU Tariff. Note that both the structured tests and market simulation results highlight the need to review modeling and load distribution factors in some areas to ensure that the observed congestion is consistent with actual conditions. Participants seem to agree that policy discussions on this issue can proceed on a separate track from systems readiness.

We conducted the base-line tests in a dedicated environment using day-ahead bids created by the ISO. In the Day 0 case, the setup was designed to clear 95% of the load in the integrated forward market, while in the Day 1 case, the setup was designed to clear only 80% of the loan and put more pressure on the need for residual unit capacity. In the Day 1 case, we see much more RUC procurement, as expected. However, the non-resource adequacy portion of RUC is low.

The ISO committed to perform additional pricing analysis and evaluation of the underlying software engines, as reflected in the tasks listed below.

- **Additional quality of solution tests executed in the market simulation environment December 3-10, 2008.** The objectives of these structured tests are to uncover the root cause of extreme Locational Marginal Prices (LMPs) (both high and low) and RUC outcomes, investigate dispatch anomalies, assess the effectiveness of Local Market Power Mitigation (LMPM) measures and explain price convergence between the day-ahead, HASP and real-time markets. Test results will be presented to market participants in mid-December.

- **Continue to perform weekly pricing reviews and explain the causes of price excursions.** The MRTU Program Team holds weekly, hour-long conference calls[6] to review and explain market simulation pricing results. On Friday, November 21, the ISO hosted a day-long stakeholder meeting[7] to discuss results from the structured base cases and quality of solution observations.

- **Continue to analyze and validate pricing results using LECG tools and processes.** In response to concerns that LECG had not tested RUC to the extent of other pricing mechanisms, the ISO engaged LECG to test those cases as well. LECG testing uncovered a potential ramp rate issue that was resolved by a system patch applied in November.

Upcoming price analysis efforts will focus on:

- **Analyze operational conditions and options to address high prices related to binding constraints**. The ISO is increasing its efforts to review cases with the grid operators and planning engineers. This effort identified areas that need load distribution factors modified, ratings corrected and the appropriate contingencies and nomograms enforced. This normal maintenance activity ensures model quality and is ongoing as system conditions change from day-to-day and from season-to-season.

- **Ensure all available resource adequacy capacity is offered into RUC consistent with obligations.** In conjunction with the structured test case, the ISO updated its resource adequacy capacity based on July 2008 resource adequacy showings. This added approximately 2,000 megawatts of resource adequacy capacity and better reflected the actual market conditions expected in production.

- **Improve convergence of forecast and modeled conditions between HASP and real-time dispatch**. The ISO modified its real-time forecasting tools to better ensure convergence of the forecasts and is testing the new tools in market simulation.

- **Address DMM recommendations.** Four of the five DMM recommendations for additional analysis of certain aspects of MRTU market performance (already discussed in this section) are addressed through the structured base case tests executed in November and on-going in December. DMM is deeply involved in defining the test cases and assessing the outcomes.

  The fifth recommendation from the DMM report[8] dated October 22, 2008 dealt with skipped or failed LMPM procedures. The issue seems to be less frequent in

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[6] Presentations from price analysis calls are available at: http://www.caiso.com/1c96/1c96acdd1d710.html#207fddfb1e330

[7] Materials from the Nov. 21, 2008 Quality of Solution stakeholder meeting are available at: http://www.caiso.com/docs/2005/06/21/2005062113583824742.html

[8] DMM report on pricing results from September MRTU market simulation can be found at: http://www.caiso.com/2068/2068ad206a9b0.pdf

subsequent analysis. The improvement is likely attributable to recent software patches. The MRTU Program Team and DMM will continue to monitor LMPM procedures as they work together on pricing analyses.

It should also be noted that the ISO retained LECG to review the results[9] from MRTU dispatch and pricing software and to assess a series of cases used to test particular features of the software and whether it operated correctly during certain conditions. The LECG preliminary report dated April 16, 2008 found no indication of substantial unresolved problems that prevent ISO software systems from calculating prices consistent with the MRTU Tariff and the LMP methodology used for MRTU. The report pointed to a number of minor issues with price calculation and dispatch optimality that appear to be related to rounding differences and modeling issues. A system patch applied in November fixed these issues.

The LECG final report dated October 20, 2008 certified that ISO software calculated day-ahead and real-time LMPs consistent with the MRTU Tariff and stated: *Based on the analyses we have performed, we have not observed substantial unresolved problems that would prevent the ISO software systems from calculating prices consistent with the ISO tariff and LMP pricing methodology and have not observed material unresolved problems that would prevent the software systems from committing and dispatching load and generation based on least bid cost. Our review of the class B cases found that the features of the ISO software being tested in these cases performed as intended in each instance.*

During the October 28-29, 2008 Board meeting, Dr. Scott Harvey of LECG reported that MRTU software functions as well or better than market software implemented by other ISOs and RTOs implementing LMP-based markets. While this expert assessment provides some comfort, we base final conclusions on achieving critical mass with participant support of the MRTU markets.

2.4. Issue Resolution – As of December 3, the number of remaining open participant issues was 157, a number that changes hourly based on incoming participant inquiries and on-going ISO issue resolution. The open issues include both variances (software fixes, data payload issues, and documentation issues that impact clients/vendors) and non-variances. Of the 157 open issues, 83 are related to software modifications scheduled for deployment in mid December. The remaining questions are under analysis and likely will result in few or no additional software changes. The 157 open issues are characterized as: 154 high, 3 very high and 0 critical.

A Quick Response Team (QRT) is assembled to address participant issues submitted during market simulation testing. The QRT works with internal subject matter experts to resolve or mitigate issues quickly and efficiently. To date, the ISO has logged and managed more than 2,000 participant issues, some affecting a single participant and others impacting several. The QRT will continue to address and

[9] LECG final report on Analysis Track Testing of MRTU Pricing and Dispatch is provided as Attachment 8.4. Preliminary reports and other related materials can be found at: http://www.caiso.com/1fc5/1fc5d12b5460.html.

solve participant issues and migrate toward a production level of participant inquiries and questions.

2.5. Settlements – Since the November report, through close collaboration with the participants, we concluded that our definition of charge code validation was not the same as the market participant's definition. For the ISO, validation was based on whether the charge code calculated correctly in our settlement system. For the participants, it is based on whether they could fully trace the data bid-to-bill from our external facing reporting systems and their settlement statement. This misunderstanding was the fundamental reason for our differing views on the status of settlements. We now agree that the participant approach is correct and should be used for future assessments of settlement status. Accordingly, we believe that November statements provide the first truly useable bid-to-bill settlement statements with full data traceability. To date, daily statements for trade dates November 1-20 and two mini-monthly statements for November 1-11 and 1-18 are available. The ISO is working one-on-one with participants to answer questions and ensure that ISO systems and participant systems use statement data consistently.

Settlements statements prior to November 1 are missing data from upstream MRTU systems, resulting in incomplete statements that are difficult for participants to understand and validate. The ISO has addressed most of the data issues affecting past settlements statements and is in the process of producing daily settlement statements that are of a much higher quality. We also implemented a thorough quality assurance process around the statement production process and hold statements until they are as correct as possible. Even so, a handful of variances impact November charge codes and therefore, statements. November statements are substantially complete but have some known data issues, which are pending final resolution. We are making significant progress with settlements on a daily basis as issues continue to be corrected. To assist the participant validation process, comments are included on each statement referencing charge code issues and the reason for any missing data. To facilitate an iterative process for settlements evaluation by participants, the ISO is producing mini-monthly statements in November that calculate the monthly charge codes for a given time period. The publication schedule for November mini-monthly statements is:

Mini-Monthly Settlements Statements	
Settlements Period	**Publication Date**
November 1 – 4	November 18
November 1 – 11	November 25
November 1 – 18	December 2
Settlements Period	**Target Publication Date**
November 1 - 25	December 5
November 1 – 30	December 9

The MRTU settlements team is now producing daily statements[10] every nine business days, whereas the current production timeline is more than 38 business days. The shortened timeline is contributing to quality problems because the team does not have as long as usual to review and correct results. It is important to note that the complex and relatively fragile nature of the simulation environment together with the extremely tight time window of producing and proofing simulation statements, make the production of a complete and clean monthly statement virtually impossible. We have discussed this with market participants and they agreed to reserve judgment until enough statements are produced and validated. We have no doubt that settlement related issues will be fully resolved through continued close collaboration.

PricewaterhouseCoopers (PwC) is engaged to provide an audit opinion confirming the Settlements & Market Clearing (SaMC) software calculates quantities and prices in compliance with the MRTU Tariff. PwC is working with ISO staff and is on track to issue, by the MRTU *go live* date, its certified audit opinion regarding the SaMC software.

2.6. Market Simulation Exit Criteria – The ISO is in the final stage of MRTU market simulation, namely the Integrated Market Simulation - Update 2 (IMS-U2). When IMS-U2 commenced in February 2008, 19 exit criteria were identified to ensure the readiness needs of both the ISO and market participants are met before entering pre-production testing. In November, the ISO and market participants revisited the market simulation criteria to clarify the intentions and agree on measurements to evaluate their successful completion. The revised list includes two new criteria for a total of 21, along with clarified descriptions and precise measurements for them all.

The following table summarizes the progress made on the market simulation exit criteria since the November status report. The ISO continues to monitor and report on criteria results to substantiate the consistent and stable operations of MRTU systems.

Criteria	November Report Status	December Report Status
PARTICIPATION		
ISO will make all externally facing MRTU applications available for 100% of scheduling coordinators to participate.	**MET**	**MET**
ISO will publish the daily list of scheduling coordinators participating in market simulation.	**MET**	**MET**
VARIANCES		
Simulation concludes without any open *critical* and *very high* software variances. All *high* variances will be resolved or mitigated. (NOTE: numbers include variances and non-variances.)	**ON TRACK** 0 *critical* 17 *very high* 188 *high* issues	**ON TRACK** 0 *critical* 3 *very high* 154 *high* issues

[10] A publication calendar for MRTU settlements statements is available at: http://www.caiso.com/203d/203de6aacf80.pdf

Criteria	November Report Status	December Report Status
Patches in ISO systems to address *critical*, *very high*, or *high* variances that require market participant software changes will be fully tested, installed by ISO and validated by participants.	**ON TRACK** A production level release process was put in place for most applications on 10/1.	**ON TRACK** To date, four releases have been delivered using the new process.
MARKET OPERATIONS		
Day-Ahead Market successfully solves and results are published by 1:00 PM (within a 30 minute window) for at least seven consecutive trading days.	**ON TRACK**	**MET** Will continue to monitor and report status. 11 consecutive days (11/4-14/08) & 7 consecutive days (11/16-22/08)
No more than five consecutive 5-minute real-time cases fail for seven consecutive trading days.	**ON TRACK**	**MET** Will continue to monitor and report status. 8 consecutive days (11/5-12/08)
Market Portal, SIBR, CMRI, OASIS, SLIC, ADS, BAPI, OMAR, and programmatic interfaces are available 97.5%.	**MET**	**MET**
All operational scenarios agreed to by market participants and the ISO will be successfully completed and participants affirm completion in accordance with the scenario schedule and reports[11].	**ON TRACK** 28 scenarios run 24 preliminary reports published 2 final reports published	**ON TRACK** 28 scenarios run 28 preliminary reports published 27 final reports published
Market result data is traceable based on market inputs and awards and consistent across external market applications CMRI, OASIS, ADS, SLIC, OMAR, BAPI.	**RECEIVING ATTENTION** Extensive traceability issues impacting settlement validation.	**RECEIVING ATTENTION** All known traceability issues are fixed and we continue to work with participants as issues are identified.

[11] Scenario materials are available at: http://www.caiso.com/2004/2004997f49230.html

Criteria	November Report Status	December Report Status
HASP market successfully solves and publishes within timing guidelines 95% of the time for seven consecutive trading days.	**ON TRACK**	**MET** Will continue to monitor and report status. 9 consecutive days (11/6-14/08) & 10 consecutive days (11/25-12/4/08)
Real-time market successfully solves and publishes within timing guidelines 95% of the time for seven consecutive trading days.	**ON TRACK**	**MET** Will continue to monitor and report status. 15 consecutive days (11/1-14/08)
QUALITY OF SOLUTION		
Quality of solution to be 90% AC solution over the last four weeks of simulation.	**MET**	**MET** Will continue to monitor and report status. AC solution daily for several months
Day-ahead and real-time markets produce dispatches based on inputs and operational rules are consistent with operating characteristics or results justified.	**NEW**	**RECEIVING ATTENTION** Some dispatch issues are still being addressed.
Day-ahead and real-time prices are consistent with solution or justified. High prices in and of themselves are not necessarily violations of criteria; however need to be explained as to the cause.	**NEW**	**RECEIVING ATTENTION** Quality of solution tests were run in November and updated tests are being executed in early December. Discussion and deliberation will continue until a reasonable level of confidence is achieved.

Criteria	November Report Status	December Report Status
SETTLEMENTS		
ISO publishes settlement statements consistent with the settlement code and all supporting settlements documentation including Business Practice Manuals, Configuration Guides and the Bill Determinant Matrix relevant for each trade date within TD+15 BD for each initial settlement statement through 2/8/2008 for each SC that participated in IMS U2 consistent with the respective SC's participation.	**ON TRACK**	**RECEIVING ATTENTION** Most data issues are fixed and we are focusing on the quality of November statements. A QA Team and additional processes are in place. We are working with participants to validate Nov. statements published to date. Refer to section 2.5 of this report for more information.
ISO publishes settlement statements consistent with the settlement code and all supporting settlements documentation including Business Practice Manuals, Configuration Guides and the Bill Determinant Matrix for month end within TD + 25 BD for each scheduling coordinator that participated in IMS U2 consistent with the respective to the SC's participation.	**ON TRACK**	**RECEIVING ATTENTION** See note above and refer to discussion in section 2.5 of this report.
ISO publishes settlement statements consistent with the settlement code and all supporting settlements documentation including Business Practice Manuals, Configuration Guides and the Bill Determinant Matrix for the CRR auction for each SC that participated in IMS-U2 consistent with the respective SC's participation	**MET** Remaining issues are addressed as found.	**MET** Remaining issues are addressed as found.
ISO publishes accurate invoices and supporting settlements documentation for a Trade Month based on respective monthly Settlement Statements for each SC that participated in IMS U2.	**RECEIVING ATTENTION**	**RECEIVING ATTENTION** See note above and refer to discussion in section 2.5 of this report.

Criteria	November Report Status	December Report Status
Every charge type must be exercised and valid by the ISO in accordance with the Business Practice Manual for Settlements & Billing and the ISO Tariff during IMS trade dates with possible exceptions per day, per charge code but not every SC will necessarily be assessed the charge type. Known exceptions with any charge code will be corrected and revalidated.	**RECEIVING ATTENTION**	**RECEIVING ATTENTION** ISO validation of charge types is complete. We are now supporting participants with their endeavors to do the same.
BUSINESS CONTINUITY		
Backup and restore plans executed for 100% of the market simulation impacted servers deemed operational critical during normal operating hours.	**ON TRACK**	**ON TRACK** Completion expected by mid-December.
Archiving and data retention plans for all market simulation systems performed for each day.	**MET**	**MET** Completed daily

2.7. Parallel Operations and Pre-Production Testing – The ISO presented a draft plan[12] for pre-production testing to participants at a November 13 MRTU Implementation Workshop. Pre-production testing focuses on preparing the ISO and participants for MRTU market launch and includes elements of parallel operation, cutover/reversion testing and ultimately cutover for launch. Parallel operations include the execution of defined test cycles where some aspect of the simulation parallels business production and/or technical processes (*i.e.*, real-time operational support, following production load forecasts, etc.).

Parallel operations testing, consisting of simulated closed loop testing and a progressive series of open loop tests, begins in December. Simulated closed loop testing exercises all MRTU business processes and systems with 24x7 inputs from participants similar to production. This testing phase incorporates a State Estimator solution, simulator telemetry, load forecast for the full network model, and both generation and transmission outages. Once the network model is upgraded to the version to be used for *go live*, testing can also use the actual production load forecast and outages.

[12] The MRTU Pre-Production Simulation plan is provided as Attachment 8.2.

2.8. Contingency Planning

2.8.1. Cutover & Reversion Plan – The ISO posted an updated draft of the MRTU Cutover and Reversion plan[13] on December 8, 2008. Several participant workshops walked participants through the cutover and reversion process and a comprehensive list of ISO and participant activities associated with a successful cutover/launch. On November 20, ISO subject matter experts presented the detailed project plan for the MRTU cutover process[14]. Similarly, the ISO will present the reversion process to participants on December 18. In January 2009, the ISO will finalize the Cutover and Reversion plan during a participant walkthrough to confirm plan changes/additions.

2.8.2. Rapid Response Team – A Rapid Response Team is assembled to swiftly address market issues that may arise after market launch. This team is made up of ISO staff from many departments, including DMM, Operations, Information Technology, Legal, Communications and Client Relations. The team meets regularly to identify key areas of risk, which are categorized into three general areas: 1) market systems stability, 2) market design, and 3) market participant behavior. For each recognized risk, the team identified monitoring metrics, procedures and to the extent practical, contingency plans.

The Rapid Response Team intends to use a broad range of tools available under the MRTU Tariff or Commission precedent to mitigate cutover and post-launch issues. These tools include the administrative pricing and exceptional dispatch provisions of the MRTU Tariff and the ability to modify Business Practice Manuals (BPMs) in exigent circumstances. If necessary, the ISO may also file with the Commission for changes to the MRTU Tariff or a temporary waiver of Tariff provisions (with a request for expedited consideration if warranted). To the extent more fundamental concerns arise after MRTU implementation, the ISO can also exercise its authority under the MRTU Tariff to revert to the prior Tariff and market design during the first 30 days after MRTU *go live*.

3. Internal Readiness

3.1. ISO Staff and Business Unit Readiness – ISO employees and business units are prepared or on track for MRTU implementation on March 1, 2009. As of June 2008, all 19 ISO business units completed a detailed readiness process including phases for planning, analysis, design, build and implementation. All units are currently on course for a successful program launch, with only a few readiness activities pending completion.

[13] The MRTU DRAFT Cutover and Reversion Plan is provided as Attachment 8.3.

[14] Materials regarding MRTU cutover, presented on Nov. 20, 2008 are available at: http://www.caiso.com/docs/2005/06/21/2005062113583824742.html

ISO personnel training regarding MRTU systems, processes and timelines is complete. Classes[15] covered topics such as market operations/timelines and the settlements process at multiple levels of detail -- introductory, intermediate and advanced. In addition, Level 400 courses with hands-on training were required for staff in certain areas of responsibility, such as Grid Operations and Information Technology. Having the ability to practice and observe the systems during market simulation has been a great benefit for personnel to continue learning and practice their skills.

3.2. MRTU Process Development – Core Business Units (such as Operations, Market Services, DMM and Information Technology) planned, created, documented and approved their MRTU business processes. Process flows capture the end-to-end functionality of the new markets by identifying the data and data streams, decisional points and interfaces between process and business units. The documented business processes provides a seamless flow from initial interfaces with market participants through the final settlement of market transactions. Processes were assessed and fine-tuned through numerous staff walk-throughs and use within market simulation tests.

Non-core business units also identified the necessary changes to their MRTU processes. Staff used the same methodologies to identify and create MRTU processes and document the business flows and interfaces. Market simulation does not afford the same opportunity for testing these processes; however, where possible the non-core business units have performed walk-throughs and reviews of their processes so that they too will be ready for the MRTU *go live* date.

The ISO will continue to review MRTU processes and procedures both internally and with market participants, to identify areas for continuous improvement.

3.3. Grid Operations Readiness – Work schedules for grid operations crews incorporate a week's training within the operations test lab where operators conduct the daily activities associated with running the day-ahead and real-time markets for MRTU market simulation. In addition, on November 3, Grid Operations staff began monitoring the results of market simulation on a 24x7 basis. Beginning December 1, grid operations staff will be manning the market simulation desk, facilitating 24x7 simulation operation and providing participant support similar to what is experienced in the control room in production. Operations teams are also providing support and answering participant questions about outage scheduling, intertie schedule tagging and resulting dispatch instructions.

Grid operators will run more than 40 operational scenarios to test new MRTU systems. This provides operators with hands-on practice dealing with normal operating conditions and contingency situations. The team is also working to test and confirm revised operating procedures and finalize system functionality and displays in the ISO control room.

[15] MRTU training information is available at: http://www.caiso.com/docs/2005/10/07/200510071157559066.html

3.4. Department of Market Monitoring (DMM) Readiness – Last month's readiness report stated that DMM is ready for MRTU implementation with a fully trained staff and an adopted monitoring approach consistent with other ISOs/RTOs operating LMP-based markets. The capabilities are in place to monitor general market performance using procedures and metrics targeted to specific areas of the MRTU market design. These include, but are not limited to, LMPM bid parameters relating to unit operating characteristics, uninstructed deviations, activities on the interties, market up-lifts and load under scheduling. In developing its monitoring approach and areas of focus, DMM frequently consulted and received recommendations from the ISO Market Surveillance Committee and met repeatedly with participants for their input and priorities.

The team is also equipped with the necessary monitoring tools, including a highly automated monitoring system and a dedicated market simulation environment. The market simulation environment allows DMM to replicate actual market outcomes in an off-line study mode and re-run the markets with modified inputs (e.g., bids) to conduct "what if" analyses for assessing the market impacts of bidding behavior or other key market inputs (e.g., transmission or generator outages). DMM has used the day-ahead market simulation environment over the past several months to develop automated simulations using different supply bids (e.g., cost-based bids to produce competitive bench mark prices) and in testing the effectiveness of the day-ahead local market power mitigation procedures. A key area of focus for DMM over the next month is to work with Information Technology to implement processes for better ensuring the market simulation environment is consistently available and working for all markets (day-ahead, hour-ahead scheduling and real time) and is consistently updated and synchronized with the same version of market software used in production. In the time leading up to *go live*, DMM will also focus on further developing and testing monitoring metrics through shadow monitoring the market simulations, completing the calculations for frequently mitigated units and finalizing the competitive path assessments used in the LMPM procedures.

4. External Readiness

4.1. Readiness Support & Training – The ISO facilitates a wide range of workshops, teleconferences, planning sessions, and user group meetings to partner with market participants and help them prepare for MRTU implementation. The ISO observes a consistently high participation rate in monthly implementation workshops, daily market simulation teleconferences and weekly user group meetings that deal specifically with MRTU system issues and settlements processes and systems. A market simulation hot line is answered by the ISO Client Relations team who stand ready to answer questions, troubleshoot inquiries and log issues that require research for resolution.

A large curriculum of MRTU training courses[16] is offered by the ISO, including 100-level introductory through 400-level "hands on" sessions. Several topic-specific

[16] MRTU training course information is available at: http://www.caiso.com/docs/2005/10/07/200510071157559066.html

workshops regarding settlements processes and the cutover and reversion plan are also offered to market participants. Training delivery is through more than 60 instructor-led sessions and from computer-based modules available on the ISO website. In the last two years, more than 3,500 representatives from participant organizations attended instructor-led training sessions hosted at the ISO and throughout the country.

4.2. Participant Readiness Assessments – In addition, the ISO conducted four readiness assessments to survey participants regarding people, process and technology in the areas of communication, market simulation, training and organizational/technical readiness. The initial participant assessment concluded in January 2007 and set a baseline for the resources needed to prepare participant organizations for a successful MRTU launch. A follow-up assessment that gauged readiness progress and identified additional participant needs was completed in August 2007. An additional element about MRTU systems was added to the third participant assessment completed in July 2008. In addition to their readiness status, participants were asked to comment on the usability of MRTU system interfaces.

The fourth participant readiness assessment was distributed in October 2008 and to date 60 responses were received. Most of the responding participants are on track for a January 31, 2009 *go live* date in the categories of people, process, technology and market operations. Self-assessments regarding settlements and charge code validation indicate less progress, with approximately 50 percent on track.

The ISO is committing additional resources to assist market participants with their readiness efforts. For instance, participant organizations present unique and specific questions around settlements processes and charge code validation. To provide personalized assistance, more than ten participant organizations have come to the ISO offices to work directly with MRTU subject matter experts.

In between survey assessments, the ISO readiness team also completed several informal touch-points, providing additional opportunities to answer participant questions and address their readiness needs. A final MRTU readiness assessment will be conducted with market participants in January 2009.

4.3. Congestion Revenue Rights (CRRs) – The initial four tiers of the annual allocation process are complete and participants received requested allocations that were feasible. Distribution of annual CRRs concluded when 2009 annual auction results posted on December 2. The ISO will initiate the process for monthly CRRs in January 2009.

5. Readiness Activities to Date

5.1. Readiness Summary – The ISO developed and executed a methodical, participatory and thorough preparation effort to ensure the successful launch of the new MRTU markets. Market participants input was incorporated at all levels and the ISO appreciates the spirit of teamwork that infused the MRTU development and implementation process. Many hours of general session meetings and workshops

coupled with individual attention from and issue resolution by MRTU subject matter experts support the readiness process for both the ISO and participants.

The MRTU Readiness Criteria[17] tracked by the ISO and participants for the last two years includes initiatives such as:

- Production of BPMs to document implementation details of the administrative, operating, planning and settlement rules and procedures contained in the MRTU Tariff.
- Development, testing and allocation of CRRs, financial instruments that help participants manage the variability of congestion costs that occur in MRTU's location-based pricing model.
- Regular survey assessments and informal check-ins with participants about their organization's readiness status and needs.
- Trained more than 3,500 representatives from participant organizations and provided an extensive training curriculum via live course presentation and DVD recordings.
- Implementation of a detailed readiness process with ISO Business Units to ensure people, process and technology aspects are addressed and ready for MRTU launch.
- Development of specialized systems and tools for ISO grid operators and DMM.
- Testing and validation of MRTU systems for the ISO and participants, including more than a year and a half of market simulation.
- Analysis of pricing results from MRTU market systems to ensure that the quality of solution is high and the introduction of LMP-based pricing is successful.
- Validated charge codes and produced settlements statements that are accurate, complete and verifiable.

5.2. Completed Initiatives – These activities are done and ready for MRTU market launch.

Activity	Date Completed
LECG report on analysis track testing[18].	Oct. 20, 2008
Allocation & auction of annual 2009 CRRs	Tier 1 – Sept. 26, 2008 Tier 2 – Oct. 13, 2008 Long-Term - Oct. 28, 2008 Tier 3 – Nov. 11, 2008 Auction – Dec. 2, 2008

[17] MRTU Readiness Criteria are provided in Attachment 8.6 of this report.

[18] LECG final report on Analysis Track Testing of MRTU Pricing and Dispatch is provided as Attachment 8.4. Preliminary reports and other related materials can be found at: http://www.caiso.com/1fc5/1fc5d12b5460.html.

6. Looking Ahead

6.1. Major Remaining Issues – MRTU readiness continues to improve as remaining issues are diminished and resolved. As of this report, we are tracking a few major issues that must be addressed prior to *go live*.

- **Exceptional Dispatch –** In order to implement the exceptional dispatch bid mitigation tariff amendment, which is subject to a FERC-established investigation, the ISO must implement additional types of exceptional dispatch that may require system modifications by the ISO and participants.

- **Pricing Issues –** Two significant pricing issues remain. The first is associated with shift factors that are being reversed and impacting pricing. A system patch is in vendor development and is expected for December application. The second involves the handling of load distribution factors, which is part of the normal maintenance/fine-tuning processes.

- **Additional Information for Grid Operations –** As the grid operators advance their readiness to operate MRTU systems, they have requested additional displays for the applications. Development of these displays will not impact market participants but are required for effective grid operation. A MRTU vendor is currently assembling the necessary displays.

- **Final SIBR Rules –** Several additional SIBR rules providing requested functionality and report additions are required for *go live*. We expect these changes to be in the final major system release scheduled for December 13, 2008.

- **Simplified Ramping –** The simplified ramping solution smoothes ramping across hours and better manages capacity and energy related to operational and reserve ramp rates. This solution is currently in test and will deploy sometime in December.

6.2. Next Steps – The following key activities are on track for completion by the March 1, 2009 MRTU market launch.

Target Completion	Activity
December 2008	Satisfy market simulation exit criteria
December 2008	Complete operational scenario tests and publish final reports
December 2008	Continue to resolve/mitigate market simulation issues
December 2008	Publish mini-monthly settlements statements for Nov.
December 2008	Initiate parallel operations testing
December 2008	Upgrade the network model used in simulation testing for consistency with current production.
December 2008	Conduct structured quality of solution tests in market

	simulation
December 18, 2008	Conduct detailed walk-through of MRTU reversion process with participants
December 30, 2008	File 60-day Readiness Certification with FERC
January 2009	Distribute final participant readiness assessment
January 2009	Initiate distribution of CRRs for March 2009
January 2009	Finalize Cutover & Reversion Plan
February 2009	Initiate pre-production testing
February 2009	Finalize Business Practice Manuals and post production versions
February 21, 2009	Open MRTU Day-Ahead Market and begin accepting bids.
February 28, 2009	Receive PwC audit opinion regarding settlements system
February 28, 2009	Close and run first MRTU Day-Ahead Market
March 1, 2009	*Go live* -- first day of MRTU real-time operations

7. Risk Mitigation – Prudent program planning includes risk identification and mitigation. The following summarizes the risk mitigation measures in place for the MRTU program launch:

Risk	Mitigation
Internal Readiness	All ISO Business Units continue to be monitored to ensure their readiness for March 1, 2009 *go live*. The Readiness Team works closely with each one to review their initiatives around people, process and technology and identify any gaps requiring attention. Grid operations crews are now completing weekly training sessions with new MRTU systems and tools. For several weeks, they have run the day-ahead market during market simulation activities and recently began managing real-time testing activities too. The Grid Operations Focus Team remains on task for coordinating training activities, working to implement suggestions for improvement, and resolving issues/questions. Market Monitoring is now fully staffed and trained, and equipped with the systems and tools needed to monitor the MRTU markets. In addition, the team's analytical approach and metrics were reviewed and confirmed with other market monitoring units as well as the ISO Market Surveillance Committee.

Risk	Mitigation
Application and Infrastructure Monitoring	IT continues to work with the infrastructure team and application owners to refine monitors and alerts, and the communication processes surrounding them. Additional monitoring and processes for the new integration layer guarantee message delivery is tested for and added to the new MRTU production environment.
Participant Readiness	We continue to publish daily market simulation status reports summarizing day-ahead and real-time results[19], system status, and settlements publications. A series of daily, weekly and monthly meetings are also hosted to address MRTU issues that are both big picture as well as technical in nature. Daily conference calls discuss market simulation results[20], weekly user group meetings[21] address the specifics of system operations and the settlements process and monthly day-long workshops review program schedule and status. The ISO continues to publish settlement statements and documentation. We are also working one-on-one with participants and their settlement vendors to help them validate charge codes and settlement statements using their shadow systems. A series of check-ins with participants were conducted regularly over the last two years to track their readiness status. Written surveys and follow-up discussions helped identify issues and expedite preparation in the areas of people, process and technology. The most recent assessment was conducted in October (results are summarized in section 4.2) and a final assessment is scheduled for January 2009.
Issue resolution and mitigation	Throughout the market simulation, participants have submitted questions and issues about system operation, market results, training and more. The Quick Response Team works with internal subject matter experts and raises issues to management as needed to resolve issues

[19] Daily market results summaries are available at: http://www.caiso.com/1c96/1c96acdd1d710.html

[20] Market simulation briefing and debriefing presentations are available at: http://www.caiso.com/1c96/1c96acdd1d710.html

[21] Meeting summaries for weekly user group meetings are available at: Settlements User Group -- http://www.caiso.com/docs/2004/05/11/2004051109590258 65.html and Systems Interface User Group -- http://www.caiso.com/docs/2005/06/13/2005061313393322539.html

	quickly and efficiently.
Risk	**Mitigation**
Market or operational issues during MRTU Cutover and Post-Launch	A detailed cutover and reversion plan[22] is drafted and participant walk-through meetings were conducted to review and finalize it. A Rapid Response Team is assembled to monitor and quickly resolve market issues experienced post launch. This team is made up of cross-divisional representatives from throughout the ISO – from Market Monitoring, Operations, Legal, Communications and others – to enable effective issue assessment and response during cutover and initial MRTU operations.

8. Attachments

8.1. Budget Status – A high-level summary of expected completion costs is provided as Attachment 8.1.

8.2. MRTU Pre-Production Simulation plan – As taken from Section 11 of the MRTU Market Simulation Guidebook, which can be found in its entirety at: http://www.caiso.com/18d3/18d3d1c85d730.pdf

8.3. MRTU DRAFT Cutover and Reversion Plan (dated 12/8/2008)

8.4. LECG Analysis Track Testing of MRTU Pricing and Dispatch (final report dated 10/20/2008)

8.5. SAIC Module Certifications for MRTU Congestion Revenue Rights, Integrated Forward Market/Real-Time Nodal, Market Quality System and Scheduling Infrastructure Business Rules (all dated 5/12/2008).

8.6. MRTU Readiness Criteria – In collaboration with stakeholders, the ISO developed a total of 33 MRTU readiness criteria that include specific tasks to be completed pre-launch. A high-level summary of the current status follows:

Status Change for Readiness Criteria	December	November
Complete (signified by a blue circle)	13	11
On track (signified by a purple circle)	16	19
Not on track (signified by an orange circle)	4	3

A detailed report of the 33 criteria established to ensure internal and external readiness for the March 1, 2009 MRTU market launch is provided as Attachment 8.2.

[22] The DRAFT MRTU Cutover and Reversion Plan is provided as Attachment 8.3.

The four initiatives reported as "not on track" are:

- Settlements:
  STL2: ISO will test and implement final charge code configuration.
  STL3: ISO will publish accurate and complete settlements statements and invoices during Update 2 of Integrated Market Simulation.
- DMM Readiness
  ORG-1: ISO will establish the tools and environments required to support the market monitoring enforcement and compliance functions.
- Participant Readiness
  PRT-1: ISO will monitor the readiness of market participants through a series of MRTU Readiness Assessments to assist in ensuring at least 80% of active market participants are ready prior to market launch.

The ISO is working diligently to get these initiatives back on track for MRTU launch:

- Settlements is the main area of focus for both the ISO and participants, a full account of related activities is provided in section 2.5 of this report.
- DMM has possession of all required tools and systems, however some operational and documentation issues are pending with the sandbox test environment. A concerted effort is underway with the IT support team and resolution is expected by the end of December.
- In regards to overall participant readiness, recent discussions are helping the ISO to better understand and respond to participant readiness needs. One-on-one meetings with MRTU subject matter experts will continue to help expedite participant readiness efforts.

Attachment 8.1

MRTU Budget Status

California Independent System Operator
Summary of Expected Completion Costs vs. September 2008 Budget
October 31, 2008
(In Thousands) *

	Project	Re-baselined Project Costs Dec. 2006	Revised Budget Sept. 2008 (a)**	Actual Costs Through 2007 (b)	Paid Invoices To Date 10/31/08 (c)	Estimated Costs to Complete (d)	Cost of Project at Completion (e)=(c+d)	Increase (Decrease) from Baseline (f)=(e-a)
	Market Redesign	$ 64,807	$ 70,439	$ 59,344	$ 65,513	$ 4,926	$ 70,439	$ -
1	Automatic Mitigation Procedures/Phase 1A	773	773	773	773	-	773	-
2	Real Time Markets/Phase 1B	16,297	16,297	16,297	16,297	-	16,297	-
3	Integrated Forward Markets/Real-Time Market (IFM/RTM)	33,372	39,622	29,749	35,395	4,227	39,622	-
4	Congestion Revenue Rights (CRR)	4,516	4,855	4,681	4,855	-	4,855	-
4A	Market Quality System (MQS)	6,261	5,687	4,640	4,988	699	5,687	-
11A	Hardware & Software Purchases	3,588	3,205	3,205	3,205	-	3,205	-
	Technology Upgrade	$ 74,179	$ 73,771	$ 70,079	$ 72,762	$ 1,008	$ 73,771	$ -
5	Scheduling Infrastructure Business Rules (SIBR)	13,323	11,745	10,860	11,181	564	11,745	-
6	Settlements and Market Clearing (SaMC)	18,030	20,545	18,995	20,210	335	20,545	-
6	Master File (MFRD)	2,300	2,528	2,528	2,528	-	2,528	-
9	Post Transactional Repository (PTR) - CMRI	2,461	2,563	2,563	2,563	-	2,563	-
10	Legacy Systems	7,785	7,303	7,179	7,228	75	7,303	-
10A	State Estimator/Full Network Model	1,345	1,170	1,170	1,170	-	1,170	-
11	Technology Infrastructure/ Portal	2,065	2,946	2,946	2,946	-	2,946	-
11B	Hardware & Software Purchases	6,923	7,881	6,748	7,846	35	7,881	-
12A	System Integration/Enterprise Architecture	17,989	16,018	16,018	16,018	-	16,018	-
12B	Technology Architecture	1,957	1,073	1,073	1,073	-	1,073	-
	Common Projects ***	$ 41,214	$ 53,291	$ 42,274	$ 52,708	$ 583	$ 53,291	$ -
13	Training/Readiness Projects	9,709	10,391	9,318	10,322	69	10,391	-
14A	Project Management	17,666	17,390	15,045	17,039	351	17,390	-
14B	Testing	13,840	25,510	17,912	25,347	163	25,510	-
	Ongoing Scope Adjustments	$ 1,523	$ -	$ -	$ -	$ -	$ -	$ -
	Pending MRTU Scope Changes	1,523		-	-	-	-	-
	Contingency	$ 7,500	$ 2,000	$ -	$ -	$ -	$ 2,000	$ -
15	Program Contingency	7,500	2,000	-	-	-	2,000	-
	Total MRTU Project	$ 189,223	$ 199,500	$ 171,697	$ 190,983	$ 6,517	$ 199,500	$ -

* Columns and rows may not total due to rounding.

** Project costs are comprised primarily of direct third party costs for: Consultant Labor, Vendor Costs, Travel & Meals Expenses, Training, Hardware, Software, Maintenance. Employee Labor, Backfill costs and Interest are excluded.

*** Common Projects Allocation to Systems will be: 47.9% to Market Redesign; 52.1% to Technology Upgrade Projects

Attachement 8.2

MRTU Pre-Production Simulation plan

As taken from Section 11 of the

MRTU Market Simulation Guidebook

11 Pre-Production Simulation (DRAFT)

11.1 Overview

The Pre-Production period follows the completion of IMS Update 2, and provides Market Participants with both a significant duration of parallel operations and the time required for production cutover activities. Similar to IMS Update 2, Pre-Production is designed to support market system operations including but not limited to the Day Ahead Market, the Hour Ahead Scheduling Process, the Real Time Market, and Settlements. In addition, Pre-Production Simulation will be used as the final phase of preparation with respect to internal people, processes, and technology for the MRTU market launch.

The functional scope of Pre-Production Simulation will be very similar to that of Integrated Market Simulation Update 2. All applications and functionality that were in scope for IMS Update 2 will remain in scope for Pre-Production, with the major difference between the two phases being that Pre-Production contains a significant duration of parallel operations. Additionally, software deployment during Pre-Production will be limited to emergency deployments.

Similar to Integrated Market Simulation Update 2, Pre-Production provides a production-like simulation across people, processes, and technology. In certain cases, technology workarounds may need to be created in order to feed existing production data into the MRTU applications for Pre-Production. To the extent feeds can be integrated into the production MRTU applications, all parties will be better prepared for MRTU market launch. More details on the MRTU application configurations will be provided in the complementary detailed documentation related to MRTU cutover.

For Pre-Production, the CAISO intends to staff individuals scheduled to execute MRTU business functions post-Go-Live. To the extent possible, individuals performing the business functions will be following the MRTU business processes. A significant difference between Update 2 and Pre-Production is that Pre-Production Simulation will be fully supported on a 24 hour, seven day a week testing schedule.

Pre-Production is scheduled for an estimated eight week period prior to Go-Live and will use all MRTU applications. Market Participants are expected to submit their own data using production certificates throughout the test phase. Participant interaction will be unscripted throughout this test phase.

The CAISO does not plan on submitting data for the Day Ahead or Real Time Market as performed in previous Simulation phases unless bids are required to begin Pre-Production. The CAISO will ask for advance submission of bids to ensure that the Pre-Production begins smoothly. Similar to IMS Update 2, CAISO and Market Participants will need to come to agreement on the open issue of Meter Data submittals for Market Simulation and their relationship to Settlements. Additionally, Settlements timelines and discussions will be detailed within the cutover activities.

Executing Pre-Production in a full production like manner introduces a series of questions that will be addressed in further discussions with Market Participants and versions of this document. Some of these issues include:

- Closing the testing loop without having generation follow dispatch
- Integration of parallel operations testing (1–2 hour generation following SCED dispatch), including integrating existing production feeds (interacting with MRTU systems)
- Integration with cutover activities

Please note that this is not a comprehensive list of issues and resolutions/mitigations relating to Pre-Production. Resolutions to these questions will be further discussed with Market Participants and published either in an updated Guidebook or separate cutover documentation.

The California ISO has conducted extensive simulated closed loop testing starting within the Integrated Market Simulation Update 2 phase (IMS-U2). The EMS simulator (GOTS) was integrated in the Market Simulation environment during IMS-U2 to provide a modeled closed-loop test, whereby a simulated Trade Day and Trade Week were modeled and integrated between the EMS and Real-Time Market systems. This simulated closed-loop provided the most accurate topological and market representation, solution and interaction that could be achieved in a closed test system. The California ISO is contemplating a closed-loop test with a specific set of resources to be defined.

Parallel Operations is the next progressive step in the external testing phase in preparation for cutover and go-live activities. The scope and schedule of parallel operations is detailed in subsequent sections of this document.

Finally, cutover and reversion plan activities are also discussed in Section 11.3.4, below, which provides a high-level description and reference to CAISO's detailed planning and approach in preparation for MRTU.

11.1.1 Business Functions

The Pre-Production phase will focus on the production-like execution of internal applications based upon data provided by external Market Participants. Business functions will be executing based upon Market Participant and internally-generated data (state estimator, demand forecasts, etc.). The business functions considered in scope for this phase are consistent with that approach.

Business Function	Comments
Compliance	In scope for this phase
Congestion Revenue Rights	CRR Allocations or Auctions are considered in scope for this phase. The results of the latest CRR Auction and Allocation will be taken and made operational for IMS Update 2. These results will be translated such that they are applicable for the dates of the Market Simulation. Results will also be passed to Settlements so that participants may view auction clearing results on a statement.
Day Ahead Market	In scope for this phase, including MPM-RRD, IFM, and RUC execution with all applicable constraints
Existing Contracts	In scope for this phase
Forecasting	In scope for this phase. Production Load Forecast will be paralleled during parallel operations.
Hour Ahead Scheduling	In scope for this phase
Interchange Scheduling	In scope for this phase
Intermittent Resource Management	In scope for this phase
Invoicing	In scope for this phase. Mitigation actions will be necessary in order to accelerate the timeframe between Settlements execution for a full calendar month and invoicing.
Market Information	In scope for this phase
Market Monitoring	In scope for this phase. Market Monitoring team will monitor data and execute appropriate business processes.
Meter Data Management	In scope for this phase.
MNS	In scope for this phase
Outage Management	In scope for this phase. Increased and prolonged testing of Generation and Transmission outages will be phased in during parallel operations
Real Time Market	In scope for this phase, including RTUC, STUC, RTED, RTMD, and all applicable constraints.
Resource Dispatching Instruction	In scope for this phase
Settlements	In scope for this phase. Mitigation actions will be necessary in order to accelerate the timeframe between trade day and settlement statement posting date. The mitigating actions will be largely dependent upon steps taken with meter data. CAISO anticipates full charge type availability.
Credit Management	In scope for this phase. Settlements will produce a weekly 7 day credit report for internal market exposure purposes. The process of accurately calculating and tracing credit limits and exposures for each SC and will be exercised from the ISO business processes perspective.

11.1.2 Intended Audience

Pre-Production focuses on the execution of business functions in an integrated environment. The intended audience for this phase is primarily Scheduling Coordinators (SCs). Situations in which interactions are needed for non-SCs will be communicated to Market Participants as necessary.

11.1.3 Simulation Structure

The Pre-Production phase focuses on preparing people, process, and technology for MRTU market launch. Given this context, the simulation structure for Pre-Production will be largely unscripted and largely unstructured.

Pre-Production will consist largely of Parallel Operations testing. Details of the simulation structure, if necessary, will be discussed with Market Participants and provided at a later date.

11.2 Objectives

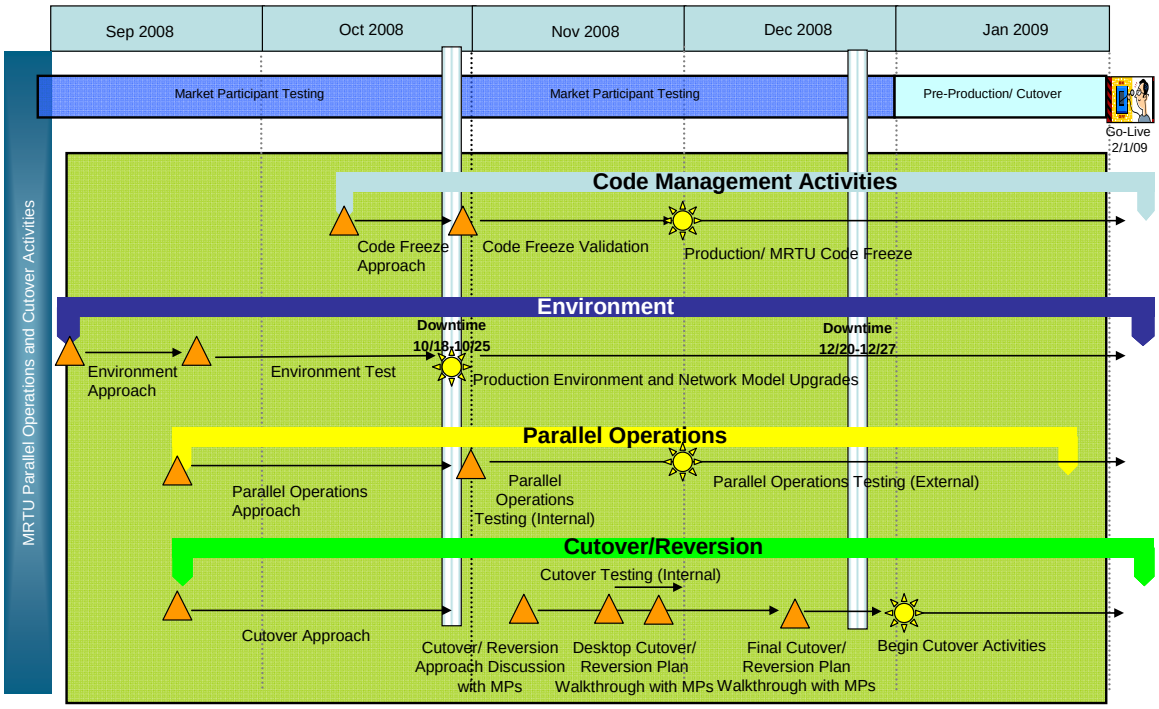
The objectives of Pre-Production Simulation are to:

- Prepare internal people, processes, and technology for the MRTU market launch
- Facilitate a phase for external parties to prepare for the MRTU market launch
- Integrate as many production technology interfaces / data feeds prior to MRTU market launch
- Provide participants the opportunity to interact with CAISO's MRTU production applications in an effort to prepare for MRTU market launch
- Demonstrate the infrastructure required for the California ISO to support the Cutover/Reversion Plan

11.3 Key Activities

The key activities for Pre-Production will be parallel operations and cutover. In general, during parallel operations, Market Participants will put in bids and trades consistent with the trade day load forecast and trades being made in non-MRTU production that day (i.e. mirror how Market Participants will actually meet their load for a specific Trade Date).

The following depicts a high-level timeline of four key efforts and associated activities with each of these efforts. These efforts will be coordinated and communicated with Market Participants throughout the balance of Market Simulation until MRTU production cutover.



The following table lists the efforts and activities associated with MRTU Parallel Operations and Cutover / Reversion. These dates are subject to revision as events and circumstances progress through the balance of Market Simulation.

Activity	Start	Stop	Environment	Comments
Code Freeze	**13-Oct**	**1-Mar**		Includes Production and MRTU Systems
Approach	13-Oct	24-Oct	N/A	
Validation	27-Oct	15-Nov	N/A	
Implementation	6-Dec	1-Mar	Production & NFP	
Environment & Connectivity	**6-Oct**	**26-Oct**		Includes support for ECN and Production Digital Certificates
Approach	6-Oct	17-Oct	N/A	
Test	6-Oct	17-Oct	NFP	
Implementation	26-Oct	26-Oct	NFP	
Parallel Operations	**30-Sep**	**18-Jan**		
Approach	30-Sep	1-Nov	N/A	
Test	3-Nov	14-Nov	Test/Stage	
Implementation	1-Dec	18-Jan	NFP	
Cutover/Reversion	**1-Sep**	**1-Dec**		
Approach	1-Sep	4-Nov	N/A	MP Meetings: 11/13- Initial Discussion 11/20- Detailed Walkthrough 12/18- Finalized Planning
Test	17-Nov	1-Dec	Alhambra	
Implementation	1-Jan	1-Feb	NFP	

The following sections detail each of the four efforts and associated activities.

11.3.1 Code Freeze

This section describes the CAISO guidelines for coordinating and managing current Production and “to-be” production (MRTU) code sets prior to, during and after MRTU cutover activities.

11.3.1.1 Prior to Code Freeze

On or about 60 days prior to MRTU Go-Live, the CAISO will cease updating functional changes to both its current production and MRTU Market Simulation Systems.

11.3.1.2 During Code Freeze

On or about 60 days prior to MRTU Go-Live, the CAISO will continue to implement fixes, as needed, to the MRTU systems to remediate critical software variances. On a case-by-case basis, the CAISO will work with Market Participants on fixes that impact Market Participants’ systems.

11.3.1.3 After Code Freeze

On or about 45 days post MRTU Go-Live, the CAISO will reengage its normal production release management process.

11.3.2 Environment and Connectivity

11.3.2.1 Production Digital Certificates

Each company will be able to adjust user certificates in advance of Pre-Production. The CAISO will commence communications with Market Participants during the month of October to harden the production users’ list from each SC post go-live. In recognition that each Market Participant may want to review the users who have had access to the MRTU Market Simulation environments during testing and that his list may be disparate from the users each Market Participant has utilized with Market Simulation.

CAISO will contact MPs prior to 60 days before Go-Live to amend, at the direction of the Market Participants, the users that are associated for production access of MRTU systems. Further details of digital certificates are in Section 1.5 of this document.

11.3.2.2 Production Environment Communication

CAISO will facilitate testing of the Energy Communications Network (ECN) communications backbone in the Market Simulation Environment starting in November. The Market Simulation environment will have both ECN and Internet connections available to access MRTU applications. Both of these methods will be available via configuration of domain names within the Market Participants interfacing systems. For Market Participants continuing to utilize the public Internet communications network to connect to MRTU systems, the CAISO.com domain will be maintained throughout the balance of simulation and post cutover. Market Participants choosing to connect via the ECN and have current infrastructure support and agreements in place with CAISO for ECN use, may utilize the ECN.WEPEX.NET domain. The ECN will be available throughout the balance of simulation starting in early November and post cutover.

For further URL detail regarding connecting to MRTU applications via the Internet, please refer to: http://caiso.com/1cc2/1cc2c4833ea00.pdf

Additional information regarding how to establish connectivity with CAISO via the private ECN, as well as security requirements, reference:

- **Establish ECN Connectivity Connected Entity Service Guide** at: www.caiso.com/1c19/1c19ea7573820.pdf
- **CAISO Information Security Requirements for the Energy Communications Network** at: www.caiso.com/docs/2003/10/13/2003101311415119 69.pdf

Additionally, Market Participants will need to provide the CAISO with its production endpoint configurations, if different than what is configured currently within the Market Simulation environment. In particular, Market Participants subscribing to the Market Notification Service (an alert service that pushes messages pertaining to daily market timeline events) will need to alert CAISO of their new listener URL if Market Participants are changing their endpoint configuration from current Market Simulation. For Market Participants not planning to change their endpoint configuration, no notification should be required.

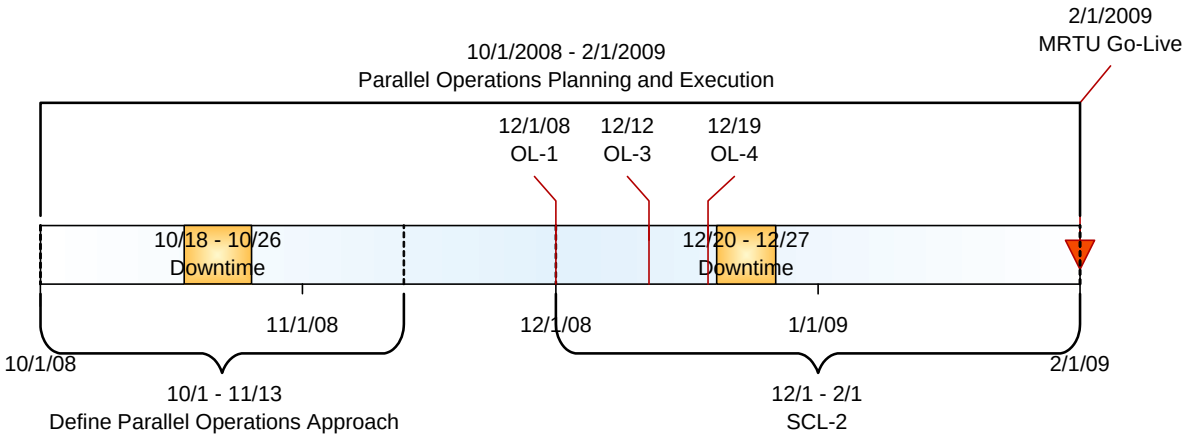
More information regarding the **Market Notification Service** can be found at: http://caiso.com/1c18/1c18cf1028670.pdf

11.3.2.3 Acceptable Use Policy

CAISO will work with Market Participants to define a MRTU systems acceptable use policy. This will need to be in place prior to cutover activities and will include such details as system request frequency. For further information regarding the **Acceptable Use Policy**, please see: http://www.caiso.com/docs/2005/06/13/2005061313393322539.html

11.3.3 Parallel Operations

Parallel Operations is a series of tests intended to parallel production data feeds from systems such as the Energy Management System, Outage Management, Control Area Scheduling and Load Forecasting, to the extent that feasible. This series of tests will be conducted in order to ensure that cutover activities prior to the launch will be tested in advance of actual cutover and that issues are resolved. A proposed schedule for the execution of parallel operations testing is included below:



The following table contains details regarding the scheduled parallel operations test cycles. **Additional detail, including timing of events and communications prior to, during and after each test cycle will be communicated in a Parallel Operations Test Guide supplement. This guide will be posted to the Market Simulation website by Tuesday, November 11, 2008.**

Test Cycle ID	Description	Duration	Test Circuit-Resource Feedback Loop	SE Solution	Load Forecast	Outages (SLIC)	Intertie Schedules (OATI)	Bidsets (SIBR)	Dispatch Instructions (ADS)
OL-1	Open loop testing with a single SC for a single resource. Production EMS will feed MRTU Market Simulation environment only.	30 minutes	Open	EMS	Production	MRTU	MRTU	MRTU	Production
SCL-2	Simulation of all MRTU business processes and systems with 24x7 inputs from Market Participants. Current Production Load Forecast is fed into MRTU ALFS in order to more accurately simulate transition between operating days. ISO provides 24x7 Grid Operations support.	60 days	Simulated Closed	GOTS	Production	MRTU (Open)	MRTU (Open)	MRTU (Follow Production Load Forecast)	MRTU
OL-3	Open loop test, where the MRTU environment shadows Production as closely as possible but units do not adhere to MRTU dispatches (therefore EMS feeds back in do not mirror MRTU results). Network model descprepencies will be handled on a case-by-case basis	30 minutes	Open	EMS	Production	MRTU (Shadow Production)	MRTU (Shadow Production)	MRTU (Shadow Production)	Production
OL-4	Synchronize network model with Production	60 minutes	Open	EMS	Production	MRTU (Shadow Production)	MRTU (Shadow Production)	MRTU (Shadow Production)	Production

During parallel operations testing, Market Participants may be asked to "translate" between production and MRTU market systems for purposes of open loop parallel test cycles and, ultimately for cutover activities.

Market Participants will be asked to align their bid sets in MRTU with their production balanced schedules during the open loop phases of Parallel Operations and, ultimately, at cutover in order to minimize impacts to reliable grid operations. A series of parallel tests will be conducted prior to cutover to analyze the pre- and post- MRTU market solutions and dispatches. The following table describes a draft guideline for translating current production balanced schedule resources and obligations to the MRTU Resources and Products. This is put forth as a guideline and may be updated for completeness prior to and during the parallel operations test cycles.

Similarly, INTERCHANGE SCHEDULE MAPPING and OUTAGE MAPPING guidelines from current production paradigm to the MRTU paradigm may be developed and provided to MPs to assist in specific parallel operations test cycles.

MRTU Resource	MRTU Market	MRTU Product	Interval Amount	Current Production Resource	Current Production Market	Current Production Product	Interval Amount
TOTAL	MRTU		0		PRODUCTION		0
Internal Generator	DA	Energy		Generation	N/A		
		Regulation			DA	Regulation	
		Spinning				Spinning	
		Non-Spinning				Non-Spinning	
		LFU			N/A		
		LFD					
	RT	Energy			HA	Energy	
		Regulation				Regulation	
		Spinning				Spinning	
		Non-Spinning				Non-Spinning	
		N/A				Replacement Reserve	
		LFU			N/A		
		LFD					
Pump Storage Generator	DA	Energy			N/A		
		Regulation			DA	Regulation	
		Spinning				Spinning	
		Non-Spinning				Non-Spinning	
		LFU			N/A		
		LFD					
	RT	Energy			HA	Energy	
		Regulation				Regulation	
		Spinning				Spinning	
		Non-Spinning				Non-Spinning	
Participating Load	DA	Energy			DA	Supp Energy	
		Regulation			N/A		
		Spinning					
		Non-Spinning			DA	Non-Spinning	
	RT	Energy			HA	Supp Energy	
		Regulation			N/A		
		Spinning					
		Non-Spinning			HA	Non-Spinning	
TOTAL Generation			0				0
Intertie Generator (Dynamic System Resource)	DA	Energy		Import	N/A		
		Regulation			DA	Regulation	
		Spinning				Spinning	
		Non-Spinning				Non-Spinning	
	HASP	Energy			HA	Energy	
		Regulation				Regulation	
		Spinning				Spinning	
		Non-Spinning				Non-Spinning	
		N/A				Replacement Reserve	
Intertie Resource	DA	Energy			N/A		
		Spinning					
		Non-Spinning					
	HASP	Energy					
		Spinning					
		Non-Spinning					
TOTAL Import			0				0
Intertie Resource	DA	Energy		Export	HA	Energy	
	RT	Energy					
TOTAL Export			0				0
Participating Load	DA	Energy		Load	HA	Energy	
	RT	Energy					
Non-Participating Load	DA	Energy			HA	Energy	
TOTAL Load			0				0

11.3.4 Cutover/Reversion

This section provides an overview of the system cutover approach for the launch of the MRTU program. The primary objective of the cutover phase is to transition CAISO and Market Participant systems to support the new MRTU business processes and functionality.
In an effort to efficiently transition to the systems required to support MRTU, the cutover phase employs the following guiding principles:

- The tests should avoid the technical risk of transitioning all the applications at midnight on the day that the updated tariff is binding. Wherever possible, software and data should be transitioned into the target environment as early as possible.
- Cutover tasks should be tested beforehand. Internal and relevant external dry runs will be planned and executed in test environments, as described in the Parallel operations section, above.
- Market Participant Implementation meetings will be the primary venue for discussing cutover activities. Dedicated cutover discussions are also anticipated with Market Participants
- Ensure minimization of effects to current production as there will be some impacts to current operations but these impacts will be communicated and predictable.

This section is not intended to address tasks associated with the cutover of Market Participant systems. CAISO recognizes that Market Participants will need to transition their systems in concert with the CAISO. The separate Cutover/Reversion Plan will include activities associated with Market Participant cutover activities, as they relate to CAISO system activities. Feedback and discussion regarding the dynamics and coordination of ISO and MP system cutover planning will be discussed in dedicated forums prior to Pre-Production. It is important to note that this section does not address the reversion plan. The reversion plan will be documented separately and will be coordinated with cutover activities.

For most systems, there are two steps involved with the Cutover. The first step is to migrate and configure the application for production, including purging test data as needed. The second step is to start using the system and treating it as the system of record for MRTU. Actual dates for each system are described in detail in the CAISO Cutover/Reversion plan.

Cutover and Reversion activities are described in detail in the **CAISO Cutover and Reversion Plan** located at: http://www.caiso.com/200c/200c82b849e30.pdf. The CAISO plans to conduct a detailed walk-through of cutover activities with Market Participants approximately 75 days prior to MRTU launch.

11.4 Simulation Schedule

Pre-Production will be executed over an estimated eight-week timeframe prior to Go-Live; however, some of the preparation for Pre-Production, including test iterations as described in Section 11.3.3, will commence prior to this timeframe. The phase will be executed 24 hours a day, seven days a week. The full calendar for Pre-Production is under development and will be published to the MRTU website once it is finalized and reviewed with Market Participants.

The timing of Pre-Production Simulation runs up against the start of the MRTU market. Given this, CAISO will reduce the amount of business functions and applications available in the final weeks prior to market launch, as described in Section 11.3.4.

Similar to IMS Update 2, mitigating actions will be needed by both Market Participants and CAISO in order to develop Settlement Statements and Invoices in an accelerated timeframe. The

approach developed for Integrated Market Simulation will be leveraged for Pre-Production Simulation. Reference the Simulation Schedule within Integrated Market Simulation Update 2 for details into the approach.

11.5 Guiding Documents

The guiding documents of the Pre-Production Simulation phase are:

- **Market Simulation Guidebook** – This guidebook serves as a guiding document for information related to understanding the scope of the phase, audience, schedule, documentation, communication approach, and reporting approach.
- **Business Practice Manuals (BPM)** – The BPMs provide definition of MRTU business functions and processes. Over the course of the simulation, the BPMs are the primary business reference. Market Simulation-specific BPMs are posted in the Market Simulation section of the CAISO website and are only intended to be used as a reference during Market Simulation phases.
- **Technical Interface Documentation** – Technical interface documentation will be the source of information as it pertains to developing internal participant applications and the structure of data files. These documents will provide the detail necessary to interface with CAISO.
- **CAISO Cutover/ Reversion Plan** – The detailed technical timings and tasks for each legacy and new MRTU system are documented in the CAISO MRTU Cutover and Reversion Plan.
- **MRTU Parallel Operations Test Supplement** – Details regarding each phase of parallel operations, as well as a more detailed schedule, can be found in this document.

11.6 Participant Preparation

Participant preparation for MRTU is being measured by the MRTU Readiness Team. The Readiness Criteria are available on the CAISO website at:
http://www.caiso.com/18d0/18d0e11f139b0.html

11.7 Entry / Exit Criteria

The key entry criterion for Pre-Production is the completion of IMS Update 2. No additional entry criteria will be defined for entry into Pre-Production. However, the CAISO has certain items that need to be complete prior to cutover. The systems will include an updated model that contains the most recently registered network data.

CAISO Prerequisites:

- Software – Final delivery and completed testing of all systems (Release 1.x)
- Staff – MRTU functions fully integrated into organization
- Business Practice – BPMs are finalized with Go-Live functions and functionality
- Infrastructure – Production Environment Build-out complete

- System Access – User Interfaces for MRTU Markets system are online and accessible by CAISO staff and Market Participants
- Reversion Plan – This will be created and reviewed with Market Participants prior to Pre-Production
- Readiness Plan – Although some cutover activities may need to be conducted prior to the filing of the Readiness Plan, the plan must be filed with FERC 60 days prior to MRTU startup

11.8 Communication

The Pre-Production Simulation phase will be supported through various channels. A kick-off session specifically for the phase will be held prior to the test.

During the execution of the phase, conference calls will be held with participants on a regular basis. The exact days and times will be published closer to the start of Pre-Production. These calls will be held with the primary purpose of reviewing relevant execution information, issues, and highlighting activities to take place over the following days. CAISO will remain flexible with its communication plan as it relates to cutover. As the Go-Live date approaches, CAISO anticipates the need to have more frequent conference calls and/or meetings and anticipates using the Pre-Production conference calls as a medium to discuss cutover activities.

Issues throughout the testing day will be handled as though they are production issues. Technical issue resolution within a testing day will be routed to the appropriate IT individuals across the organization depending on the type of issue. Functional and Pre-Production-specific issues within a testing day will be routed through the External Affairs Team. More information will be provided at a later date with regards to the appropriate phone numbers, email, or website mailboxes to access.

11.9 Reporting

CAISO will monitor participation throughout each of the simulation phases. As it pertains to Pre-Production Simulation, reporting will be modified from IMS Update 2. The reports planned to be published in Pre-Production include, but are not limited to:

1. Daily and Weekly Issues and Variance Reports
2. Briefing / Debriefing Presentations (or the equivalent of)
3. Real-Time Data Exchange Report
4. Day-Ahead and Real-Time Pricing Reports
5. MRTU Market Watch

CAISO will also investigate the need to publish additional information throughout the course of the phase.

Attachment 8.3

MRTU DRAFT

Cutover and Reversion Plan

DRAFT

MRTU Cutover and Reversion External Overview & Detail

Version 3.1

Rev: December 8, 2008

ISO Market Redesign and Technology Update

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Revision History

Version	Date	Description
0.1	5/29/07	Initial draft
0.2	6/7/07	Edits incorporated
0.3	10/17/07	Additional graphs and clarifications
0.4	1/11/08	Incorporate stakeholder comments
1.0	2/25/08	Incorporate stakeholder comments
2.0	7/11/08	Added detail items
2.0.1	7/16/08	Added Settlement reversion language
2.1	7/21/08	Additional edits
3.0	11/20/08	Significant updates since July
3.1	12/8/08	Updated per comments received from 11/20/08 workshop

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1 INTRODUCTION

This document is intended to provide California ISO (CAISO) Market Participants with a description of the timeline and procedures used to transition the CAISO's market and supporting applications in an orderly and reliable manner from the existing systems to the new Market Redesign and Technology Upgrade (MRTU) systems. This transition is referred to as the MRTU cutover. This document is intended to provide an overview of the cutover and more detail into the activities which involve Market Participants.

This document is also intended to provide the criteria for and description of procedures for the reversion of systems back to the previous market systems in the event that unforeseen circumstances prevent reliable operation of MRTU shortly after go-live. Version 3.0 of this document is produced with updated information regarding cut-over transition phase details. A subsequent version of this document will be released shortly after release of version 3.0 which will include updated information regarding reversion details.

1.1 Objectives

The objectives of this document are as follows:

- Present the communications plan for MRTU cutover.
- Provide a plan for transitioning the systems to MRTU.
- Outline the roles of Market Participants and the CAISO during the cutover period.
- Define at a high level the criteria and decision process used in determining whether a reversion to the previous market system is necessary.
- Outline the process and the roles of Market Participants and the CAISO if a reversion is called for.

1.2 Overview

This document includes the following cutover and reversion related items:

- A communications plan for the cutover is included in section 2. The communication plan covers the methods of communications as well as responsibilities of the CAISO staff and Market Participants.
- An overview of the cutover transition timeline is contained in section 3.
- A description of notable planning activities including internal planning and the table top exercise is included in section 4.
- A description of notable preparation activities including final documentation and data freezes is included in section 5.
- A description of notable cutover activities, including special bidding rules, procurement targets, and transition from existing systems to new MRTU systems is included in section 6.

- A description of notable post-production activities is included in section 7.
- Special operations and settlement rules that may be required during the cutover are contained in section 8.
- Reversion planning items are included in section 9. This section includes a general criteria for reverting back to pre-MRTU systems, an escalation process which must be followed before a reversion is considered, the sequence in which a reversion would be executed, and minimum time to notify participants if a reversion is called. In addition, this section describes the reversion "window," the period under which a reversion would be considered.

2 TRANSITION COMMUNICATIONS PLAN

ISO staff will employ a structured approach to communicating with participants and other stakeholders throughout the cutover (or reversion) process. This plan will be implemented in support of the MRTU cutover. Later sections (section 9.8) include processes to address communications during a reversion.

2.1 Purpose

The CAISO will foster an effective cutover (or reversion) with prompt, accurate, and timely communication to Market Participants and other key stakeholders.

2.2 Responsibilities

External Affairs will:

- Assign a primary liaison to the MRTU team to coordinate messaging and activities with Market Participants.
- Act as one of the ISO's communications conduits between the ISO and Market Participant key contacts (as designated by the Market Participant)
  - External Affairs will create and maintain a list of market participant Transition and Reversion contacts.
  - External Affairs will work with the MRTU Team to analyze incoming requests for information, and will help identify opportunities for FAQ updates.
  - External Affairs will transmit critical high-level announcements to Market Participants' communications designee(s), as mutually determined by External Affairs and the MRTU team.

MRTU Team will:

- Craft information and messages, using predetermined modes of communication (email, Market Notices, website, phone calls, conference calls, open bridges, etc.).

- Coordinate with External Affairs on all communications to Market Participants, ensuring the most efficient and practical form of communications for each sequence of outreach.
- Communicate urgent messages to External Affairs or, as mutually agreed, directly to Market Participants.
- Conduct a “table top” exercise of cutover and reversion, including testing with External Affairs the communications protocols, roles and responsibilities.
- Conduct daily status calls in the days immediately before and after transition. Daily status calls after transition will be conducted as long as necessary, in consultation with Market Participants.
- Hold an open conference bridge to convey up to the minute status of the transition effort. The conference bridge will be open the day before, the day of, and the day after the transition.

Stakeholders will:

- Provide contact information to the ISO that enables the ISO to communicate quickly and accurately with the appropriate person(s) or group(s) within stakeholder organizations.

2.3 Methods to be used

The following methods will be used during the cutover period, tailored to the needs of each audience:

- Final confirmation notification (10-15 days before go live)
  - Participant communications
    - Market Notice
    - Personal outreach as needed
  - Other Parties
    - Web posting
- Pre-implementation (within 7 days of go live)
  - Participant communications
    - Market Notices as each system comes on line
    - Conference Calls - each day up to the day before go-live
    - Conference Bridge – starting the day before go-live
- Implementation (DAM and Real-Time)
  - Participant communications
    - Conference Bridge
    - SI message (pre-MRTU), MDS message (MRTU)
    - Market Notice
  - Other Parties
    - Web posting

- Post Implementation
  - Participants
    - Conference Bridge – ending the day after go live
    - Conference Call – daily starting two days after go live, then weekly when necessary
    - Assessment reports posted on web site

3 TRANSITION TIMELINE OVERVIEW

The CAISO has formulated a work plan to indicate the process that the CAISO will follow performing its activities before, during, and after the transition period. While the line-by-line detailed cutover plan is available under separate publication, following is a summary discussion.

The main sections of the work plan are:

- Planning phase
- Preparation phase
- Transition phase
- Settlements and post-production phase

3.1 Planning Phase

This phase consists of presenting this plan before Market Participants and regulators and developing detailed cutover and reversion plans for each system, including any necessary settlement methodologies and contingency plans used during the reversion process. In addition, this phase will include table-top exercises with Market Participants going over both the cutover process and the reversion process.

3.2 Preparation Phase

This phase includes the preparatory activities for cutover, including notification to regulators, freezing changes to applications and static data repositories, communication with Market Participants on mutual progress, and installation of systems

3.3 Transition Phase

This phase includes the cutover of the production applications including IFM, RTM, SIBR, and supporting applications. A comprehensive list of applications and business processes involved in the Transition Phase are discussed in detail in Section 6 below. Activities include close communication with market participants, submittal of binding bids, and posting binding results for the forward and real-time markets.

This phase includes the cutover of the Settlements and post process systems such as LMP validation and expected energy calculation. This phase also includes post-production items such as reports and conference calls with Market

Participants. A schedule of such reports and conference calls will be established prior to go-live.

3.4 Closure

Closure of the MRTU Cutover and Reversion project includes the execution of legacy system plans. This phase also includes a lessons learned exercise to improve the cutover process for future releases such as MAP.

4 PLANNING PHASE NOTABLE ACTIVITIES

4.1 Development of detailed plans

As part of the cutover and reversion planning process, the CAISO has developed a set of detailed cutover and reversion plans, one each for each software application and associated business processes. These detailed plans will remain CAISO confidential, however, they are described with sufficient detail in Section 5 with pertinent and necessary external touch points and information

In addition, the CAISO is developing a set of contingency plans for loss of internal systems, in order to reduce the chance of a system loss resulting in a reversion. These plans will be included in the updated section(s) covering reversion details, which will be included in a subsequent release of this version 3.0 document.

4.2 November 20 exercise

The workshop exercise scheduled for November 20, 2008 is intended for Market Participants and the CAISO to discuss the detailed cutover plans and to practice a simulated cutover and reversion event. The format of the event will be for representatives of the CAISO and Market Participants to gather in one location (conference call will be available too) and proceed step by step through the CAISO plan and discuss the ramifications of each step. The results of this exercise will be used by the CAISO to fine tune the internal and external plans.

The table top exercise is intended to be performed once focusing on the internal and external cutover plans, then a second exercise to discuss reversion planning, and a third meeting (currently scheduled for December 18, 2008) to complete these discussions and finalize internal and external plans.

Although the CAISO will internally practice aspects of the cutover and reversion plan on its systems, and the CAISO will likewise encourage Market Participants to do so, the workshop exercise is not intended to actually practice a cutover or reversion using systems.

5 PREPARATION PHASE NOTABLE ACTIVITIES

The preparation phase covers the final activities before the transition phase, including final documentation, data and system freezes, etc.

5.1 Data and system freezes

For MRTU systems and pre-MRTU Legacy systems, each application has specific timeframes and policies governing the freezes of data and processes. Section 6 discusses these application/process specific criteria.

5.2 Certificates

Access to the CAISO systems is allowed through the use of certificates. MRTU Production Access Requests Form (AARF) allows submission of all users for an application or set of applications on a single form. A separate AARF is used for server certificates and allows for all servers to be listed on a single form also.

User Access Timeline

- November 15, production user access requests are due back from POCs.
- December 1, all production user access permissions are configured in both market simulation and Folsom production for forms returned by 11/15.

System Certificates Timeline

- December 1, production server access requests are due back from POCs.
- December 15, all production server certificates are configured for Folsom production for forms returned by 12/1.

All external non-production access will be removed from Folsom production on or before the beginning of Pre-Production. This will allow us to identify any "missed" people or systems. AARFs received after December 15, for users or systems are at risk of loosing access when the non-production access is removed no later than January 2.

Process

- If a user already has production access (ADS, SLIC, PIRP, and OMAR), an AARF is not needed. Access will be granted in production MRTU for these applications for existing users.
- If production access is needed for new MRTU systems (SIBR, CMRI, BAPI and CRN), the MRTU production AARF must be submitted.
- Existing market simulation users will not receive new certificates as production certificates are currently in use in market simulation.
- Existing market simulation users that require test/market simulation access only will be granted access to the new market simulation environment when Folsom production access is eliminated.

5.3 Final documentation

Final documentation includes any special rules for operating under MRTU systems. These include scheduling and tagging rules and templates, metering rules, etc.

5.4 System access

During this time some of the systems will be opened for access, including the Market Participant Portal, and the BAPI. CAISO has provided answers to frequently asked questions regarding access and certificates in the document "CAISO Access FAQ" on the CAISO website at http://www.caiso.com/2093/2093724a6ca90.pdf

6 TRANSITION PHASE NOTABLE ACTIVITIES

The transition phase represents all activities, both CAISO internal and Market Participants, to achieve a smooth cutover on the target date transition date. In this Section, cutover activities and goals are described for each application and/or business process. A more detailed representation of these steps is represented in the line-by-line detailed Cutover Plan spreadsheet.

Note, in these discussions of timelines, the letter "T" is used to represent midnight on the transition date. T-1 day indicates midnight the day before transition, and T-1 hour indicates the top of the hour ending 24 on the day prior to the transition date, etc.

Following are activities of note to Market Participants during the transition phase. The purpose of these activities is to ensure a smooth transition between the existing and new systems.

6.1 Overview

Backing up from the cutover date and time, actions must be taken as early as January 2 in preparation for a smooth transition between market platforms. Between the first of the cutover activities and the execution of the first MRTU market run, many critical steps must be well planned and tightly orchestrated between CAISO and Market Participants.

6.2 Communications and Regulatory

Following are milestones related to MRTU readiness and procedural notifications:

- T-60 days : Readiness filing to FERC
- T-30 days : Readiness update to FERC

- T-30 days : CAISO begins weekly readiness and launch countdown messages to Market Participants
- T-15 days : MRTU Tariff filing : operations complete for 2/1 Go-Live

6.3 Transition from Parallel Operations / Pre-Production to Cutover

Prior to the beginning of the cutover activities, the MRTU systems will be available to Market Participants to exercise MRTU market participation. During this same period, CAISO will transition into a Pre-Production phase of market simulations intended to prepare people, processes, and technology for MRTU market launch. One key element of this phase is the planned activities referred to as Parallel Operations, which consist of defined test cycles where some aspect(s) of the MRTU simulation parallels production business and/or technological processes (e.g. RT operational support, MRTU AGC, following production load forecasts, etc.

For the final stretch of production-like Market Participant sand-box experimentation on MRTU systems will begin with deployment of the final network and market model DB37 in the CAISO New Folsom Production (NFP) environment, which is the ultimate production environment for MRTU.

During this final stretch of simulated MRTU market operations, Market Participants are expected to utilize the final production MRTU environment for their benefit to refine their participation processes and examine market results.

As elements of the transition phase of cut-over begin, Market Participant experimentation in the final production MRTU environment will transition to an emulation of their current production market participation. Some key elements of this transition are noted below:

- During this time, CAISO will be performing certain Pre-Production activities, including but not limited to EMS/State Estimator (SE) integration testing and data purging. These activities will be planned and noticed to market participants.

- Beginning in T-30 days, CAISO will begin a final pre-production phase with a goal to achieve consistency between current production conditions and MRTU market inputs. On the CAISO side, production load forecast will be fed to the MRTU markets, and EMS telemetry will be phased in as operationally feasible. During this period, CAISO requests that Market Participants begin emulating their current production scheduling practices and other market participation touch-points in the MRTU market environment. This will serve two purposes (i) it will allow for all participants to practice and refine bidding and scheduling activities that are consistent with normal business conditions and practices, and (ii) it will

allow for a true (real world) examination of market outcomes based on normal (non-experimental) market participant behavior.

- Beginning on T-14 days (January 17, 2009), the emulation of current production scheduling in the MRTU simulation environment becomes mandatory.

- For the final week prior to day T, the emulation of current production market participation and CAISO pre-production elements in the MRTU environment takes on a new significance. For the seven days prior to Trade Day T, certain of the market bids and market solutions may materially impact the production MRTU markets on or after day T. This affect is most significant in the Trade Day T-1, and to a somewhat lesser extent in Trade Day T-2, and so on. The elements of pre Trade Day T MRTU markets that have implications on production MRTU market runs include:

    a) HASP bids submitted for Trade Days T-7 through T-1 may be used as input to in RUC markets on Trade Day T through T+7. RUC has a feature to use a weighted average of previous HASP self schedules from the preceding seven days as an estimate for HASP self schedules for the current Trade Day.

    b) DA market solution for Trade Day T-1 will establish unit commitments used in RTM, which will become critical market assumptions for the real time market transition in the hours leading up to the first hour of MRTU production. Similarly, unit commitment decisions made in DA IFM and RUC for Trade Day T-2 for long start resources may have a material impact to DA solution for Trade Day T-1, and so on. As the final week prior to Trade Day T progresses, the MRTU market solutions begin to set the stage for the initial conditions that will feed the first production MRTU market runs.

    c) Similarly as item (b) above, pre-dispatch market runs (HASP, RTPD, and STUC) beginning T-5 hours will establish unit commitments and resource initial conditions which are used as input to the first production MRTU RTM market runs.

CAISO will closely monitor the MRTU market inputs and associated results during this critical period (T-14 days to T) to ensure that the MRTU market inputs and results represent operationally viable initial conditions for the first MRTU production market runs.

6.4 Application and Business Process-Specific Cutover Plans

These specific cutover plans are high level views of the detail cutover plan refere3d to earlier in this document. These are discussed below in roughly a chronological order leading up to cutover time T.

6.4.1 Market Participant Portal

A new Market Participant portal will be cutover during Pre-Production MRTU operations to incorporate legacy and MRTU systems. Upon this cut-over, the current MRTU portal used for Market Simulations will no longer be used for cut-over MRTU activities

6.4.2 Outage Scheduling: SLIC (Legacy and MRTU System)

To help ensure a smooth cut-over transition and minimize risk to reliability during cutover, CAISO requests that (a) Market Participants plan for minimal outages for the Trade Dates surrounding the cutover period, and (b) make a special effort to ensure that all known outages are updated as completely as possible prior to the execution of the first MRTU DA market run, at 09:00 on TD-1.

Through T-30, outages may continue to be submitted to MRTU simulation environment. These outages will only affect MRTU simulation markets, with no cross-over to production MRTU market runs, including outages submitted in this environment for effective Trade Dates on or after Trade Day T.

All outages that affect production markets, both current production for Trade Days T-1 and prior, and MRTU production markets beginning Trade Day T, are to be submitted to the current production SLIC system. These outages may be submitted as early as T-30 days.

Beginning at T-30 days, outages submitted through current production SLIC will begin to stream over to MRTU simulation SLIC database. Following are some details of this streaming process:

- MRTU simulation SLIC database will be purged of all outage data prior to beginning this streaming process, for all trade dates both before and after day T.
- For resources whose Resource ID is changed from current production to MRTU, resource outages entered into SLIC will need to be performed redundantly, one card for each of the two Resource IDs. Current Production will ignore cards entered using the MRTU IDs and MRTU markets will ignore cards entered using “old” IDs.
- Temporary changes to resource operating parameters submitted through SLIC for current production operations will be streamed to MRTU markets along with transmission outage information.

Just after the last opportunity for Market Participants to submit outages that will be picked up in the last production run of current production real time market (RTMA), which is 23:30 on T-1, CAISO will cut-over from the current production SLIC to MRTU SLIC. At this time, the URL for the current production SLIC will become inactive, and the URL formerly used for MRTU simulation SLIC will become production MRTU SLIC URL.

Note, because CAISO will begin migrating current production SLIC outages to the MRTU SLIC market simulation database beginning on T-30, Market Participants should take care to ensure MRTU pre-production bids and schedules are consistent with any outages affecting the associated resources.

At T+30 days, MRTU production SLIC will be purged of all data for Trade Days preceding day T.

6.4.3 Load Forecast

Incorporation of the production load forecast from the CAISO legacy system ALFS into MRTU Pre-Production is transparent to Market Participants from an activity perspective. However, the timing of incorporation of production load forecasts into MRTU simulations is to be coordinated with Market Participants for the Pre-Production testing activities, and also beginning at T-30 days. During these activities, CAISO expects MRTU bidding and scheduling to be consistent with production load forecasts.

The timing of these Pre-Production open loop and closed loop exercises are included in the Parallel Operations schedule discussed at the November 13, 2008 MRTU Workshop meeting, and are dependent on the successful incorporation of the final FNM and market model DB37 into the New Folsom Production environment.

6.4.4 Transmission Rights Registry

The CAISO legacy system for maintaining contract transmission rights (Existing Transmission Contracts Calculator) is utilized for MRTU with basically the same functionality as current production. ETC and TOR rights are calculated for the current transmission system conditions (using the latest TRTC instructions and system outage de-rates from SLIC), and passes these to the MRTU market applications.

The deadline to submit TRTC instructions to CAISO that will be used in the cutover period is T-60 days.

6.4.5 Reference Level Calculator

The CAISO legacy system for calculating the Default Energy Bids (DEBs) utilized under MRTU, with appropriate updates to account for MRTU bidding formats.

The RLC process does not involve activity by Market Participants. It is included in this cutover document simply to note an exception to the DEB options available for the cutover to MRTU.

DEB options available include (i) variable cost, (ii) negotiated rate, and (iii) LMP options. The LMP option requires 90 days of market LMP prices in the development of DEBs used for Market Power Mitigation (MPM) purposes. Because of the non-production-like bidding practices (experimental) by Market Participants in the MRTU simulations for up to T-90 days, the LMP's produced from pre-Go-Live MRTU markets will not be applicable for this DEB option. Thus, Option (iii) will not be available until after T+90 days.

6.4.6 Masterfile

CAISO maintains independent Masterfile databases for (i) current production and (ii) MRTU. Cutover activities for these databases has no direct involvement of Market Participants, however, following are informational elements of this cutover process:

- T-15d days : CAISO freezes masterfile – no new masterfile data accepted until after the reversion window is past.

- There is a date (TBD) which represents the last opportunity for Market Participants to submit new resources or transmission elements that can be included in model DB37. CAISO will determine this date and notify Market Participants thereafter.

6.4.7 Participating Intermittent Resource Program (PIRP)

There are no cut-over business processes elements associated with the PIRP, except to note that for the first day of MRTU, Market Participants should take note of changes in the timelines for day ahead and hour ahead forecast schedule submission by the Forecast Service Provider (FSP) will be as follows:

- Day ahead: Submissions occur at 05:30 Hrs on the day preceding the forecasted Operating Day.

- Hour ahead (HASP): Submissions occur 105 minutes preceding the start of the forecasted Operating Hour (30 minutes prior to the close of the HASP market bidding).

6.4.8 OASIS

MRTU OASIS and current production OASIS are distinct and separate applications running in parallel through pre-production and cutover periods. Inasmuch, minimal cutover activities are required by Market Participants.

Transmission Outage data for the MRTU Transmission Interfaces will publish at T-30 for data relevant to the first MRTU binding trade date in MRTU OASIS. The next relevant data for the MRTU OASIS site will post at T-7. At T-1, MRTU OASIS will be accessible for GUI users at: http://oasis.caiso.com
(The current URL is http:// http://oasissta.caiso.com/mrtu-oasis) From the home page, there will be a "History" link to access all pre-MRTU data. This URL will be applicable for both (i) pre-production MRTU and (ii) production MRTU

The following URLs will be used for downloading data from OASIS, beginning at 30 days prior to MRTU go-live.

Example URL for the MRTU Market Simulation and MRTU Production Environment:
http://oasissta.caiso.com/mrtu-oasis/SingleZip?queryname=AS_REQ&
startdate=20061002&enddate=20061002&market_run_id=DAM&as_type=ALL&as_region=ALL

Example URL for the Legacy Environment:
http://oasis.caiso.com/servlet/SingleZip?nresultformat=5&queryname=SLD_LOAD_MW&sxslname=SLD_LOAD_MW&dstartdate=20010810&denddate=20010810&sload_type='ASL','SSL'&sschedclass=N
(Same as today, will not change)

6.4.9 MRTU Bidding and Scheduling (SIBR)

The SIBR system is the MRTU replacement for the current production SI system. No application related cutover activities are required for Market Participants. Pre-production data contained in the SIBR system will not be purged. The SIBR system by design contains a rolling 7-day window of historic bid data. Data for trade days older than 7 days will be archived. However, some information within the SIBR system is preserved outside the 7 day rolling window, such as portfolio definitions. Following is a discussion of the cutover business elements associated with MRTU market bid submittal.

The last 7 days prior to cutover are critical to establish stable and operationally consistent (with current production) market solutions. Dispatch levels, unit commitments, and market bids from preceding MRTU runs of IFM, HASP, STUC,

and RTD all impact the assumptions and initial conditions for the first execution of production MRTU markets. Because of this, CAISO is requiring Market Participants to bid and schedule into MRTU during the final 14 days of Pre-Production MRTU simulated markets consistently with current production operations. This requirement begins at T-14 days to allow for 7 days of monitoring and coordination to achieve full market participation in the emulation of production operations by T-7 days.

Bidding for the first production run of DAM will open at T-7 days. However, cutover activities for the DAM begin at T-14 days, effectively beginning at the opening of the DAM for T-7 days. This is because the bidding activities for the T-7 Trade Day are part of the critical MRTU Pre-Production period, described above.

Similarly, HASP bidding and scheduling for the first MRTU production run of RTM opens after the publication of DAM for trade day T-1. However, cutover activities for HASP begin after the publication of DAM for Trade Day T-7.

Following are itemized cutover milestones for MRTU bidding and scheduling activities for Market Participants:

- T-14 days : First MRTU Day Ahead Market bids that may have a material impact on the first MRTU production runs, in the sense that MRTU market applications must achieve stable and operationally realistic solutions for the entire week preceding actual cutover.

- 10:00 on TD-1 : Market closes for first production run of MRTU DAM

- 13:00 ON TD-1 : First DAM results published

- 19:45 on TD-1 : Closure of first HASP bids that will be used in STUC at 20:07 to yield binding unit commitment instructions for Hour Ending 01 on Trade Day T.

- 22:45 on TD-1 : Market closes for the first production run of MRTU Hour Ahead Scheduling Process (HASP) for Hour Ending 01 on Trade Day T.

- T-7.5 minutes: The first production MRTU RTD run begins, and binding dispatch instructions for the period T to T+5 minutes will be sent out by MRTU ADS at T-4 minute.

- The last RTMA run will begin at T-10 minutes and binding dispatch instructions will be sent out at T-7 minutes for period T-55 minutes to T.

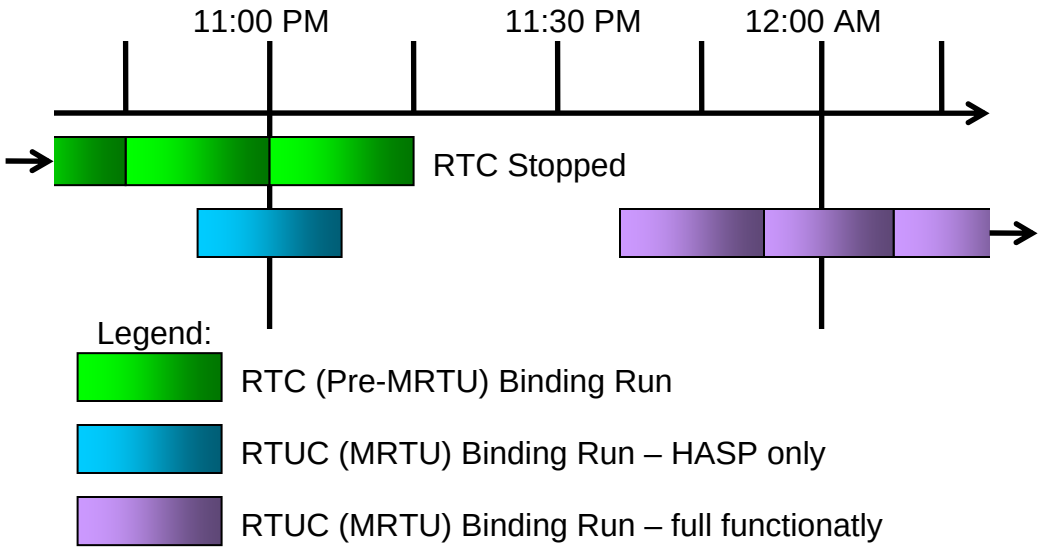

Figure 1: Commitment and HASP instruction transition – Pre-MRTU to MRTU

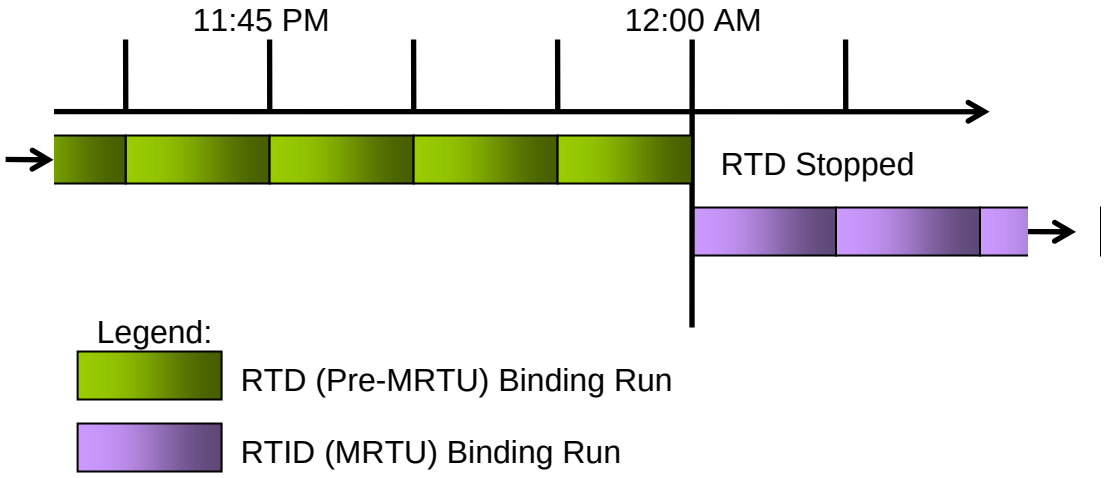

Figure 2: 5-Minute dispatch transition – Pre MRTU to MRTU

6.4.10 ADS

CAISO will work to ensure all Market Participants have obtained, installed, configured, and run the new ADS Client in parallel with their current ADS client. As a backstop measure, Market Participants must verify they are able to receive dispatches from ADS by T-14 days.

CAISO Parallel Operations exercises are being planned to test MRTU ADS to not only receive dispatch instructions from MRTU RTM, but also to be physically moved by the MRTU instructions.

Following criteria are applicable to the cutover from current production ADS instructions and MRTU ADS instructions:

- Current production ADS resource commitment instructions from RTMA with start-up date/time before 20:15 on day T-1 and shut down time before the end of day T-1 shall be considered outside the ADS cutover window, thus considered binding per normal ADS authorities.

- Current production ADS resource commitment instructions from RTMA with either (a) start-up date/time after 20:15 on T-1 days or (b) shut-down time is on or later than 00:00 on day T shall be considered advisory until confirmed with CAISO Grid Operations (generation dispatcher).

- MRTU ADS resource commitment instructions shall be considered non-binding if the last interval of the commitment period falls before the end of the T-1 day, regardless of when the commitment period begins. This is the default position, however, such a commitment instruction may become binding if CAISO Grid Operations communicates such to the associated SC.

- MRTU ADS resource commitment instructions shall be considered binding if the last interval of the commitment period falls on 00:15 on day T or later. This is the default position, however, such a commitment instruction may become non-binding if CAISO Grid Operations communicates such to the associated SC.

- All intertie pre-dispatches through HE24 on day T-1 shall be instructed through current production ADS

- All intertie pre-dispatches through beginning HE1 on day T shall be instructed through MRTU ADS. These instructions will begin to be published from the HASP run published at T-60 minutes.

- All AS awards from the current Hour Ahead Market up to and including the Trade Hour ending 24:00 on T-1 shall be binding. These shall be the final AS awards from the current production markets.

- The first binding AS awards from the MRTU markets shall begin to be published in the HASP run at 22:45 on T-1 for pre-dispatched interties, and in the RTUC run at 23:30 on T-1 for all dispatchable resources.

- All RTMA 5-minute resource dispatches are to be followed through the interval beginning 23:55 on day T-1.

- All MRTU 5-minute resource dispatches are to be followed for the interval beginning 00:00 on day T.

Pre-production MRTU ADS data will not be purged from the systems.

6.4.11 Tagging (CAS system)

Scheduling tags (e-Tags) will continue to be submitted to MRTU simulation environment Control Area Scheduler (CAS) system through 23:00 on day T-1. These e-Tags will only affect MRTU simulation markets, with no cross-over to production MRTU market runs, including e-Tags submitted in this environment for effective Trade Dates on or after Trade Day T.

e-Tags associated with schedules cleared in current production markets through the last hour of Trade Day T-1 are to be submitted to the current production CAS system.

The first production MRTU e-Tags may be submitted beginning T-7 days for schedules beginning on Trade Day 1. These e-Tags shall be submitted through the current production CAS system.

For the period beginning T-7 though 23:00 on T-1, the current production CAS system will accept both (a) current production e-Tags for schedules through HE24 on T-1, and (b) MRTU production e-Tags for schedules beginning HE01 on day T. During this seven day window, CAISO will take measures to prevent MRTU e-Tags from being rejected by disabling the tag validation feature that would otherwise reject MRTU e-tags.

Similar to the SLIC cut-over plan, a to-be production database will be installed on MRTU CAS to receive data for binding MRTU trade dates submitted prior to the cutover. To execute cutover, the CAISO will true-up the data immediately before go-live and redirect the MRTU CAS system to the production OATI e-Tag system. This will be transparent to Market Participants. E-Tag validation will then be turned on in the MRTU CAS environment to ensure that all e-Tags are following the new MRTU Formats.

The cut-over to the new MRTU production OATI e-Tag system will occur just after the last opportunity for Market Participants to submit e-Tags in the current production CAS that will be picked up in the last production run RTMA, which is 23:00 on T-1. At this time, the URL for the current production CAS will be re-directed to point to the new MRTU production OATI e-Tag system.

Any new tags for HE24 and changes to dynamic tags will be manually entered into the legacy CAS by the CAISO.

Because having valid tagging for schedules during the critical T-7 to T Pre-Production period is critical to achieve successful RT market solutions, CAISO will stress the importance of this simultaneous current productions and MRTU e-Tagging by Market Participants. The backstop script currently used to create e-tags in a simulated environment for intertie schedules not otherwise appropriately tagged will be disabled at T-14 days (at the latest), or sooner if possible. Note: this backstop script will also be turned off for the Pre-Production closed loop test exercises prior to T-30 days.

6.4.12 RMR

The Discussion Board will still continue to provide the communication channel between CAISO and Market Participants for the RMR related transactions.

6.5 Additional noteworthy activities

The following additional activities are requested in order to assure a smooth transition:

- To be able to handle operational control issues that may arise during the transition and the period immediately following, the CAISO may request more capacity and ancillary services to be on line than would be required on a normal day. This would be implemented in the form of additional RUC and Ancillary Services requirements, which would be input to the Day-Ahead Market for the first two days, and longer if the CAISO determines there is a lingering issue which could affect system reliability. The actual additional requirements, if any, would be determined closer to the go-live date taking into account system conditions.

- CAISO Grid Operations is developing a reliability plan for cutover that will address resource specific commitment plans and AGC cut-in strategies.

- CAISO requests that, to the extent possible, self scheduled quantities bid into the DAM and HASP for the first several hours of the market transition be not greater than 90% of what would be self scheduled quantities in current production markets for the same Trade Hour. This is to ensure that the market optimization engine has sufficient economic ranges to solve any transitional modeling differences.

- Participants should have key staff on hand during the cutover, to handle any technical or operational issues that might arise.

- The CAISO will enforce WECC Day Ahead scheduling standards such that all day-ahead import and export schedules are tagged by 3:00 PM Pacific time the day before the trade date. Again, this will help smooth the transition.

- In preparation for a reversion, Participants should have their default supplemental bids and generation and import/export templates submitted to the CAISO on or before T-10. See section 9.6 for details.

7 SETTLEMENT PHASE NOTABLE ACTIVITIES

Most of the items on the plan cover communication items which are covered in the communications plan in section 2, or describe the first day in which a required task will be complete.

8 TEMPORARY RULES FOR MARKET TRANSITION

The CAISO, based on input from internal operating departments, other control areas, and Market Participants, may identify additional activities not already mentioned in this document in order to reduce the risk of system reliability issues that may result from cutover activities.

At the current time, no temporary rules are required for the cutover activities. Note: in general, temporary rules would require tariff authority, and thus would go through the usual stakeholder processes prior to approval.

9 REVERSION PLANNING

[SPECIAL NOTE FOR VERSION 3.0 OF THIS DOCUMENT : The discussion below regarding reversion principles remain un-modified relative to version 2.1. These sections will be updated before the reversion oriented detailed workshop, currently scheduled for December 4, 2008.]

Although the CAISO will do everything possible to assure a successful transition to the new market, problems may arise which require return back to the pre-existing market, or a reversion. This section of the overview is intended to provide Market Participants with an understanding of the criteria used to arrive at the decision to revert back to the previous market, and to provide a high level plan to ensure a reliable and orderly transition back to the old market systems.

9.1 Reversion Criteria

In general, the CAISO will use the following policy in determining whether or not to call for a reversion.

> A reversion may be called for during an event which would compromise the CAISO's ability to reliably and accurately dispatch and settle the market in accordance with the CAISO tariff and BPM's, AND there is no viable work-around that can be implemented until the underlying system functionality is resolved, AND the underlying condition cannot be resolved within a reasonable time frame.

It is expected that a reversion would only be implemented under extreme circumstances such as the following:

- Major systems are chronically unavailable or are unable to be restored.
- Major systems contribute to significant failure to meet reliability control performance standards.
- Over the reversion period, major systems consistently contribute to failure to meet average reliability control performance standards.

It is not expected that a reversion be implemented due to non-grid threatening issues such as pricing anomalies. To the extent that software issues result in prices which are inconsistent with the Tariff and/or BPM's, the CAISO will attempt to resolve the underlying software issue and manually correct the prices. In extreme cases the CAISO will set an administrative price but a reversion is not envisioned.

In general, the CAISO will use the following options first before consideration of a reversion.

1. Troubleshoot and resolve.
2. Use contingency plans if available.
3. If time allows, develop code modifications, test, and implement.
4. Develop automated workarounds.
5. Develop manual workarounds.
6. Working with other departments, determine whether resolution can be shifted to another department.
7. Working with Market Participants, verify that impact is urgent enough to warrant a reversion.

Finally, if all else fails, and based on input from various departments and Market Participants, the executive level will make the decision whether to revert.

9.2 Reversion Templates

The reversion templates, which are explained in more detail in section 9.6.1, are posted on ther CVAISO website at **http://www.caiso.com/18ae/18ae96b71f1a0.html**. Approximately one month before go-live, the CAISO will publish the expected peak load during the reversion period, which the Scheduling Coordinators will use in their template development. Completed templates must be submitted to the CAISO 10-15 days

before go-live, to allow CAISO operators time to review and respond with any concerns.

9.3 Escalation Process for Market Participants

The above reversion criteria is expected to deal with operational or application difficulties resulting from issues arising from the CAISO market systems. Market Participants may encounter critical system, financial, or other issues which place an extreme burden on their operations and may precipitate a need to revert. The CAISO offers the following escalation process for dealing with these issues:

1. Market Participant logs problem with the CAISO Quick Response Team (QRT).
2. The QRT will assess the problem, and attempt to determine the root cause and severity of the issue.
3. CAISO will attempt to resolve using options available.
4. If problem is severe or is common to many participants, the CAISO will:
    a. develop cross functional teams to resolve.
    b. Work with regulators as necessary.
    c. Develop interim workarounds if necessary.
5. The CAISO will propose changes to market rules if necessary.
6. If workarounds or market rules are not available to resolve the issue, CAISO executives will confer with market participants and/or regulators and may make call to revert.

9.4 Escalation Process for Other Affected Parties

Although not expected, other groups such as neighboring balancing authorities may be unnecessarily affected by MRTU operations. The CAISO offers the following escalation process for dealing with these issues:

1. Problem is communicated to the CAISO.
2. The CAISO will assess the problem, and attempt to determine the root cause and severity of the issue. It will also determine whether problem is attributed to MRTU operations, other unrelated issues, or is an existing problem.
3. CAISO will attempt to resolve using options available
4. If problem is not resolved, the CAISO will:
    a. Develop cross functional teams to resolve.
    b. Work with WECC and other balancing authorities as necessary.
    c. Develop alternative operating procedures if necessary.
5. The CAISO will propose changes to market rules if necessary.
6. If workarounds or market rules are not available to resolve the issue, CAISO executives will confer with market participants, balancing authorities, reliability entities and/or regulators and may make call to revert.

9.5 Effective Dates for Reversion Criteria

Once the cutover to MRTU has been made, the reversion criteria will be effective for one month. This period will allow time for operational problems to be surfaced. After the one month period is over, the CAISO will no longer consider reversion as an option to resolve issues and instead focus on the options typically available in a production environment.

It should be noted that, once a reversion is called, operations under the pre-MRTU systems may last for several weeks or months, depending on the nature of the problem that precipitated a reversion. Thus, the reversion itself may extend beyond the one-month period in which the reversion criteria may be considered.

9.6 Plan of Reversion

9.6.1 Operational

To the extent possible, the CAISO will attempt to provide advance notice to Market Participants in the event of a reversion. However, the CAISO worst-case assumption is that a reversion may be called with as little as 30 minutes notice to address urgent operational issues which may arise. This means that a reversion can occur at any time of the day. To support this requirement and reduce the operational burden on Market Participants, the CAISO would revert starting with the real-time systems* using pre-determined bids and schedules (see "Preparation for Real-Time" later in this section for more information). Later, and with advance notice to Market Participants, the CAISO would allow bidding in the Supplemental Energy Market and conduct the Day-Ahead and Hour-Ahead markets. The sequence is as follows:

- In the event a reversion is called, the CAISO will transition to the old real-time market systems as soon as possible, but giving at least 30 minutes notice to Market Participants. The CAISO will confirm receipt of notification through verbal communication with each Scheduling Coordinator's real-time desk.
- Market participants will begin to receive 5-minute dispatch instructions from the old ADS system approximately 30 minutes after the call.
- Market participants will begin to receive unit commitment and pre-dispatch instructions from the old ADS system approximately 45-90 minutes after the call.

* Real-Time includes the Real-Time Commitment (RTC) application which commits short start peaking units and pre-dispatches hourly inter-tie bids, and the Real-Time Dispatch application which dispatches resources on a 5-minute basis.

- Scheduling Coordinators with hourly Inter-Tie bids will be able to submit their e-tags within 45-90 minutes after the call. This would include initially those SC's who submitted standing Inter-Tie bids for use in reversion, and in subsequent hours those SC's who submitted bids in the Supplemental Energy market once it opened (see below).
- The CAISO will open up the Supplemental Energy market 60-90 minutes after the call to allow for bid adjustments and for marketers to participate on the ties.
- Once the real-time is stable, the CAISO will issue instructions on determining the next possible date to hold the pre-MRTU Day Ahead market. The CAISO will provide a minimum of 24 hours notice from the time of the reversion call to the time of the DA market closing time. Whatever the date, the closing time will be 10:00 AM.
    - Example: for a reversion call at 10:00 AM on day X, the first DA market will close at 10:00 AM on day X+1 for Trade Date X+2.
    - Example: for a reversion call at 11:00 AM on day X, the first DA market will close at 10:00 AM on day X+2 for Trade Date X+3.
- The CAISO will begin conducting the pre-MRTU Hour Ahead market beginning for Hour Ending 1 on the first Trade Date for which the pre-MRTU Day Ahead market was run.

It should be noted that all bids submitted into the pre-MRTU systems and dispatch instructions and market results received from the pre-MRTU systems shall be in pre-MRTU format, using the Resource ID's, Interchange ID's, zones, Contract Reference Numbers, etc. which prevail in the pre-MRTU market.

A detailed task list which covers the reversion process is located in section **Error! Reference source not found.** of this document.

System restoration matrix

The following matrix represents the existing CAISO systems which interface with Market Participants. If the CAISO were to revert and restore the pre-MRTU systems, the matrix indicates the minimum time to make the pre-MRTU systems ready, close the associated market and post results. Market participants should be prepared to have their interfacing systems ready within these timelines.

System	System on-line First opportunity for MP's to check interface and submit bids	First market close / results MP systems must be on-line by this time
ADS	30 minutes	30 minutes
OASIS (Real-Time)	30 minutes	35 minutes
SLIC	30 minutes	
SI GUI (Real-Time)	30 minutes	60-90 minutes
e-Tag	30 minutes	105 minutes
RMR client	20-44 hours	20-44 hours
SI GUI (Day-Ahead)	1-24 hours	24-48 hours
SRS	1-24 hours	24-48 hours
OASIS (Day-Ahead)	30 minutes	27-51 hours
SI GUI (Hour-Ahead)	27-51 hours	36-60 hours
OASIS (Hour-Ahead)	30 minutes	36-60 hours
BBS	N/A*	N/A*
OMAR	N/A*	N/A*

* Pre-MRTU data will be settled throughout the reversion timeline, thus the BBS and OMAR system will already be on-line.

Preparation for Real-Time

In order to start the real-time market as quickly as possible, the CAISO would need a ready source of a) self-schedules for Imports, Exports and Generation; b) Ancillary Services awards; and c) a source of Supplemental Energy bids. Imports and Export schedules are important because they make up a significant portion of the energy served. Internal Generation schedules are important because they signal which resources are on-line.

a) Handling of self-schedules, including imports, exports, and internal generation: On the first day of reversion, the CAISO will take the schedules finalized in the MRTU Day-Ahead Market and, for dispatch purposes, convert them to self-schedules in the old format as indicated in Figure 3. This work on the first day, including gleaning of data from e-tags or other sources, will be performed by the CAISO. On the second day (and third day, depending on when the pre-MRTU DA market runs) the CAISO will use schedules provided by Scheduling Coordinators in the event of a reversion. These schedules will be provided in the form of a templates filled out (using the pre-MRTU Resource ID's and Interchange ID's) and submitted ten to fifteen days before the transition date to allow for CAISO review. In the event of reversion, CAISO operators will

construct a master schedule from these templates. They may have to rely on Must-Offer waiver denials to fill in gaps if necessary. The resulting schedules will be communicated back to SC's. SC's will have to submit e-tags for the resulting interchange schedules.

b) Handling of Ancillary Services: On the first day of reversion, the CAISO will take the Ancillary Services awards finalized in the MRTU Day-Ahead Market and, for dispatch purposes, convert them to Ancillary Services awards in the old format. This work on the first day, including gleaning of data from e-tags or other sources, will be performed by the CAISO. On the second day (and third day, depending on when the pre-MRTU DA market runs) the CAISO will also make use of Ancillary Services templates filled out and submitted ten to fifteen days before the transition date to allow for CAISO review. In the event of reversion, CAISO operators will construct a master awards schedule from these templates. CAISO operators may have to rely on out of market calls to the extent that Day Ahead awards are not sufficient to run the grid on the first day of reversion. The resulting schedules will be communicated back to SC's. SC's will have to submit e-tags for A/S to be delivered on the ties.

c) Handling of Supplemental Energy Bids: The CAISO will request from market participants ahead of MRTU go-live, a pre-made list of Supplemental Energy Bids, using pre-MRTU Resource ID's and Interchange ID's, for use during a reversion event. This bid list will be used as the default bids for the first 2 (or 3) days of operations. The CAISO will open the Supplemental Energy market within 60-90 minutes of the reversion call to allow Market Participants to modify their bids, and to allow participants who cannot submit provisional bids, such as marketers, to participate in the market.

About the Templates

The Scheduling and Ancillary Services templates described above would have the following attributes:

- Would contain a preferred operating level in MW for each hour and for each generator (and import/export schedule to the extent possible) in a Scheduling Coordinator's portfolio. For Ancillary Services, the template would contain the preferred supply including generation and capacity.
- Three templates would be required: one for a weekday, one for a weekend, and one for a holiday.
- Each template would have the preferred operating level under the highest load anticipated for the reversion period, as it applies to a weekday, weekend, or holiday. Each template would include instructions for altering the portfolio if load is reduced by 500 MW, 1000 MW, etc.
- Scheduling Coordinators would have the ability to re-submit templates as necessary to reflect changes in weather and generation patterns. However, the CAISO will require 10 days for CAISO operators to review changes.

9.6.2 Firm Transmission Rights

To cover the possibility of a reversion, the CAISO will retain the unused monthly auction results and funds for the April 2008 – March 2009 timeframe. The CAISO will use these results if a reversion is called. The CAISO would refund on a pro-rata basis the rights that were unused, i.e. for the period in which MRTU was in effect, and of course refund all funds covering unused rights if a reversion is not called and the reversion window passes.

In the event that a new cutover date is scheduled beyond the time period in which auction results exist, the CAISO will conduct a new FTR Auction for the remaining months.

9.6.3 Settlement

The CAISO must operate and settle the results under one tariff. Therefore, settlement reversion will occur on the same timeline as reversion of operations. For example, if a reversion to pre-MRTU operational systems occurred at 6:00 AM on 10th day after the transition, days one through nine and up to 6:00 AM on day 10 will be settled under MRTU. The period after 6:00 AM on day 10 will be settled under pre-MRTU.

Settlements reversion first involves walling off the problem period, clearing the markets using estimated dollars, and then re-setting the walled off period at a later date to true up the dollar obligations. The SaMC Settlements system can perform the necessary functions, and has been tested to do so. Correcting the wall off period may involve rerunning upstream systems to cover the impacted time period so Settlements will have actual data at true up date. The time period could be hours or days, or both hours and days. This will take significant time and effort, so the true up would be expected to occur after all other reliability and financial issues have been resolved.
Settlements also faces and additional challenge in that the scope of this reversion plan is 30 days, yet the first settlement statement isn't generated until 38 business days after the applicable trade date. Due to this challenge, Settlements has to focus on balancing data accuracy under an accelerated timeline. Some form of estimation must be used to mitigate potential market financial exposure.

9.6.3.1 Contingency Event Publication of Settlement Statements and/or Invoices/Payment Advices

In accordance with CAISO Tariff Section 11.29.10.1 through 11.29.10.5, CAISO may generate and publish estimated Settlement Statements and Invoices/Payment Advices during a contingency event based on estimated data.

The process for payments against estimated Invoices/Payment Advices is also provided in the identified CAISO Tariff sections. Additional details such as the method chosen to produce estimated data, Settlement Statements, and Invoices will be published on the CAISO website on an as needed basis.
Contingency events may include, but is not limited to, a failure of any CAISO software. Should the production Settlement system fail, prior to using estimated data, the Billing and Settlements unit will fall back to a redundant system to generate Settlement Statements and/or Invoices or Payment Advices. In the event that the worksite is inaccessible, contingency procedures would be implemented to transfer work efforts to the Alternate Work Location (AWL) in order to continue with daily business functions.

9.6.3.2 Estimated Settlement

An estimated Settlement Statement, published on the Credit Settlement Statement, is created through a Settlement Run that is executed approximately one week after the Trading Day has ended (T+7B) for the relevant Trading Day using all data available at that time. The results are estimated because some of the input data required to execute a complete set of calculations is not available for the run timeline requirements. The data is estimated by the calculations executed during the (Daily and Monthly) Initial Credit Runs and the results published to both Business Associates and CAISO Finance via the Credit Settlement Statement. The CAISO Finance group uses these Credit Settlement Statement results, along with other inputs to determine the amount of collateral to be provided by each Business Associate.

9.6.3.2.1 Estimation Objectives

There are three objectives that an emergency estimation process would be designed to achieve:

- A margin of error for estimated settlement charges and/or payments that is approximately 80% of actual Initial settlement charges and/or payments,
- Leverage existing calculation logic that avoids complicated algorithms and manual workarounds such that work can be supported in an emergency.
- All estimated values, and the resulting charges generated by execution of the run, are terminated prior to calculation of actual Settlement charges for a re-issue/re-calculation Settlement Statement in order to prevent these values from being subsequently captured on an Invoice/Payment Advice.

The process used to estimate the missing meter data, execute the (Daily and Monthly) Initial Credit Settlement Run, and calculate the results can be summarized and used to generate emergency Settlement statements, invoices and payment advices based on the estimated amounts during cutover/reversion

conditions. The later actual true-up statement would include the reversal of all estimated amounts to ensure market obligations are reflected accurately.

9.6.4 Special Rules for the first 2-3 days after reversion

Starting with the first Trade Date in which a pre-MRTU DA market has run, ie 3-4 days after reversion, there should be little change from how settlement is done today. However, given the settlement transition and operational sequence, with delayed startup of pre-MRTU Day Ahead market results, settlements will be slightly different for the first 2-3 days of reversion. The CAISO has attempted to come up with a methodology that is as equitable as possible to all parties.

- Although the CAISO is planning on using final MRTU DAM Generation and Import/Export schedules for operations, the CAISO cannot use these for settlement purposes because the CAISO would need to have offsetting balanced load/trade schedules under the pre-MRTU tariff.
    - Therefore, all energy in the market will be treated as if it was procured in the real-time market as indicated in Figure 3.
    - All generation, whether cleared in the MRTU DAM, traded to another SC or not, will be paid the real-time 5-minute MCP, aggregated to a 10-mintue price in Settlements.
    - All load will be charged the real-time 5-minute MCP, aggregated to a 10-minute price in Settlements.
    - The CAISO will review the 5-minute MCP's and, to the extent a data or software anomaly results in an incorrect price, the CAISO will make price corrections as necessary.
- Imports/Exports participating in the Supplemental Energy market will be paid or charged as-bid, as pre-dispatches are settled under real-time under pre-MRTU rules. Import/Export energy coming from the DAM or templates will be paid the real-time 5-minute MCP, aggregated to a 10-mintue price in Settlements
- Ancillary Services will be paid the average of the ASMP's resulting from the MRTU DAM for the first day. For the second (and third days), the CAISO will pay an administrative price.

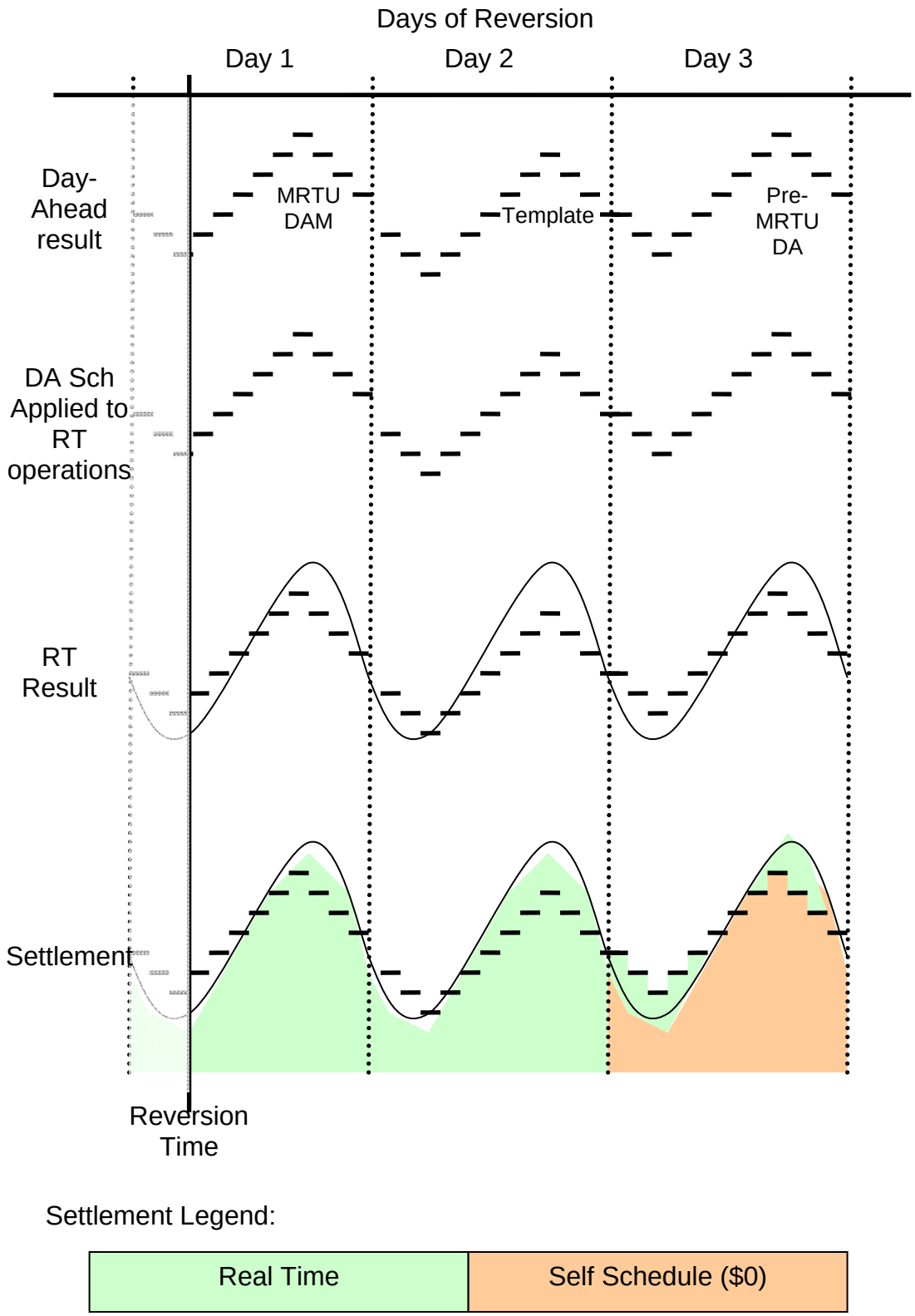

Figure 3: Settlement and Application of Schedules to Real-time
(Assumes pre-MRTU DA market is run starting on day 3)

9.7 Responsibilities

In order to ensure a smooth transition in the unlikely event of a market reversion, the CAISO and Market Participants are expected to take the following steps to be prepared for this contingency.

9.7.1 CAISO

The CAISO will maintain existing systems and business processes throughout the reversion effective period such that they can activated within the timelines specified in section 9.6.

9.7.2 Participants

Market Participants must maintain existing systems and business processes throughout the reversion effective period such that they can be called upon if necessary. They must be aware that, under a reversion scenario, schedules will be based on results obtained from the Day-Ahead Market and pre-submitted templates. They must be able to maintain staff and equipment to be capable of receiving dispatch instructions in the pre-MRTU format and on pre-MRTU applications within 30 minutes of a reversion call.

9.8 Communication During Reversion

The CAISO will utilize the following methods if a market reversion becomes necessary:

- Notification of reversion
  - Participant communication
    - Verbal communication to each Scheduling Coordinator
    - MDS message (MRTU), SI message (pre-MRTU)
    - Market Notice
  - Other parties
    - Web posting
- Implementation of reversion
  - Participant communications
    - Conference Bridge
    - SI Message
  - Other parties
    - Web

9.9 Recommencement of MRTU Market Operations

In the event of a reversion, the CAISO will treat the subsequent recommencement of the MRTU market systems as a new implementation. The CAISO would develop a new schedule, dependent on the changes that will be required, conditions on the grid and Market Participant needs.

The new cutover date would be on a month boundary, with at least 10 days of operation on the pre-MRTU system before transition back to MRTU, or a minimum of 30 days if changes to MRTU systems that affect Market Participants were required.

Attachment 8.4

LECG Analysis Track Testing of MRTU Pricing and Dispatch

Final Report
Analysis Track Testing of CAISO MRTU Pricing and Dispatch
Scott M. Harvey, Matthew Kunkle, Benjamin Hagberg and Shaun Glassman[1]
October 20, 2008

EXECUTIVE SUMMARY

LECG was retained by the California ISO to review the results of the CAISO's analysis track testing of its MRTU dispatch and pricing software for the day-ahead market, real-time pre-dispatch, and real-time dispatch. The purpose of the CAISO analysis track testing was to test the software that has been developed for operating the CAISO MRTU electricity markets under the pricing rules described in the CAISO tariff.

The analysis track testing allowed the CAISO and LECG to test the day-ahead market (IFM), real-time pre-dispatch and unit commitment (RTUC) and real-time dispatch (RTD) software and associated pricing modules that will be used to coordinate the CAISO day-ahead and real-time electricity markets under MRTU. LECG's assignment was to assess the economic consistency of the results produced by the day-ahead market, real-time pre-dispatch and real-time dispatch software and pricing modules, and verify that any inconsistencies identified did not arise from errors in the calculation of settlement prices or reflect substantial deviations from the least-cost dispatch. This report summarizes the results of our analysis to this point in the testing process.

The CAISO MRTU software systems are designed to make optimal commitment and dispatch decisions based on market participant bids, subject to a variety of physical equipment constraints and power system reliability considerations. We have taken advantage of this property in testing the software, as the prices and schedules developed by the software should satisfy a series of internal consistency and equilibrium conditions if the software is functioning properly in both calculating prices and developing schedules. Inconsistencies are then reviewed to determine whether they reflect an error in the calculation of prices, an error in the process of determining the least cost unit commitment and dispatch, a data export error or other factors. In addition to the analysis track cases, this report also covers the results of our review of a series of cases used by the CAISO to test whether particular features of the software operated correctly, or to test

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[1] Scott Harvey (sharvey@lecg.com) is a director with LECG. Matthew Kunkle is a managing consultant, Benjamin Hagberg an associate and Shaun Glassman a research analyst. Alexis Maharam and Christine Offerman were involved in the preparation of the initial and interim reports but did not participate in the preparation of the final report.

whether the software operated correctly during certain kinds of conditions. These are referred to as Class B cases, and are discussed in Section III of this report.

Since the completion of our interim report issued on July 1, 2008, we continued our evaluation, focusing on issues with the implementation of forbidden regions, intertie price calculations, energy limits, and the cascading of ancillary service prices, and testing cases that included binding nomogram and contingency constraints, wheeling transactions, and multi-hour block transactions. All of these issues are resolved in the most recent test cases. We carried out a complete review of these recent test cases to ensure that no new problems arose or old problems returned as a result of the software changes. Based on the analyses we have performed, we have not observed substantial unresolved problems that would prevent the CAISO software systems from calculating prices consistent with the CAISO tariff and LMP pricing methodology and have not observed material unresolved problems that would prevent the software systems from committing and dispatching load and generation based on least bid cost. Our review of the class B cases found that the features of the CAISO software being tested in these cases performed as intended in each instance.

Final Report
Analysis Track Testing of CAISO MRTU Pricing and Dispatch

Scott M. Harvey, Matthew Kunkle, Benjamin Hagberg and Shaun Glassman[2]

October 20, 2008

I. INTRODUCTION

LECG was retained by the California ISO to review the results of the CAISO's analysis track testing of its MRTU dispatch and pricing software for the day-ahead market, real-time pre-dispatch, and real-time dispatch. The purpose of the CAISO analysis track testing was to test the software that has been developed for operating the CAISO MRTU electricity markets under the pricing rules described in the CAISO tariff.

The analysis track testing allowed the CAISO and LECG to test the day-ahead market (IFM), real-time pre-dispatch (RTUC) and real-time dispatch (RTD) software and associated pricing modules that will be used to coordinate the CAISO day-ahead and real-time electricity markets under MRTU. LECG's assignment was to assess the economic consistency of the results produced by the day-ahead market, real-time pre-dispatch and real-time dispatch software and pricing modules based on the analysis track test cases provided to us by the CAISO and verify that any inconsistencies identified did not arise from errors in the calculation of settlement prices or reflect substantial deviations from the least-cost dispatch. This report summarizes the results of our analysis to this point in the testing process. This report describes the scope of the testing we have carried out and that is covered by this report, relative to other testing carried out by the CAISO that may be reported elsewhere.

The CAISO MRTU software systems are designed to make optimal commitment and dispatch decisions based on market participant bids, subject to physical equipment constraints and power system reliability considerations. We have taken advantage of this property in testing the software, as the prices and schedules developed by the software should satisfy a series of internal consistency and equilibrium conditions if the software is functioning properly in both calculating prices and developing schedules. Inconsistencies are then reviewed to determine whether they reflect an error in the calculation of prices, an error in the process of determining the least cost unit

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commitment and dispatch, a data export error or other factors. These tests do not assess the accuracy of the underlying transmission grid model, the accuracy of the powerflow solution, or the accuracy of the generation shift factors or loss penalty factors used in the dispatch. This test process also serves to identify gaps in the data saved by the MRTU software that would hinder price validation and analysis of market performance under MRTU operation. In addition to the analysis track cases, this report also covers the results of our review of a series of cases used by the CAISO to test whether particular features of the software operated correctly, or to test whether the software operated correctly during certain kinds of conditions. These are referred to as Class B cases, and are discussed in Section III of this report.

Since the completion of our interim report issued on July 1, 2008, we continued our evaluation, focusing on issues with the implementation of forbidden regions, intertie price calculations, energy limits, and the cascading of ancillary service prices, and testing cases that included binding nomogram and contingency constraints, wheeling transactions, and multi-hour block transactions. All of these issues are in the most recent test cases. We carried out a complete review of these recent test cases to ensure that no new problems arose or old problems returned as a result of the software changes. Based on the analyses we have performed, we have not observed substantial unresolved problems that would prevent the CAISO software systems from calculating prices consistent with the CAISO tariff and LMP pricing methodology and have not observed material unresolved problems that would prevent the software systems from committing and dispatching load and generation based on least bid cost. Our review of the class B cases found that the features of the CAISO software being tested in these cases performed as intended in each instance.

II. TESTS OF MRTU SOFTWARE

We conducted several rounds of tests on CAISO analysis track test cases[3] in order to validate the price calculations, unit commitment and dispatch solutions and identify potential economic inconsistencies in the prices and schedules produced by the CAISO day-ahead market, and real-time pre-dispatch and unit commitment software, and the real-time dispatch software (RTD).

The initial round of analysis track testing entailed evaluation of 51 cases. The results of our evaluation were reviewed with the CAISO and problems with the initial software version were identified for correction by Siemens. A second partial round of analysis track testing was carried out between November 20 and December 18 on 7 IFM and 5 RTUC cases to assess whether the problems identified in the initial round of testing

[3] A description of Analysis Track Testing scope of work can be found on the CAISO website at: http://www.caiso.com/1f8d/1f8d80dc2c580.pdf

had been corrected and to verify that the process of correcting these problems had not introduced new problems. During January, February, March and early April a single IFM and RTUC base case were tested and retested on each software patch until all anomalies were resolved. Finally, a third round of analysis track testing was carried out beginning on April 2, 2008.[4] The April-June 2008 testing covered 11 IFM cases, 11 RTUC cases, and 4 RTID cases, including all of the situations tested by the original 51 cases and some additional situations.[5] In addition, during June 2008 3 IFM and 3 RTUC cases were rerun using the then most recent software version and re-evaluated to verify that previously identified errors have been corrected. Finally, during July, August and September we tested and retested software functionality relating to forbidden regions wheeling transactions, export pricing, block transactions, energy limits, ancillary service pricing, and binding contingency and nomogram constraints.

A. Test Methodology

We carried out a series of tests on the analysis track cases in order to validate the price calculations, unit commitment and dispatch solutions and identify potential economic inconsistencies in the prices and schedules produced by the MRTU software. We then reviewed the inconsistencies to determine whether they reflected errors in the calculation of prices or material departures from the least cost unit commitment and dispatch. As described below, our tests of the day-ahead market and predispatch software included a review of energy and ancillary service prices and schedules. We also tested the energy schedules produced by the real-time dispatch software. The ancillary services included in the testing were regulation up, regulation down, 10-minute spinning reserves and 10-minute (or non-spinning) reserves.

Our tests of the economic consistency of the day-ahead market and real-time predispatch software verified that the correct relationship existed between resource and load schedules (including imports and exports), energy and ancillary service prices, and energy and ancillary service bid and offer prices.[6] Our tests of the economic consistency of the real-time interval dispatch software verified that the correct relationship existed between the schedules of dispatchable resources, their offer prices, and real-time energy

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[4] The 26 cases tested in the third round of analysis track testing were designed to cover all 51 of the cases included in the initial round of testing. The initial 51 cases included many cases with very minor differences to facilitate identification of the source of software performance issues. This level of disaggregation was not necessary in the third round which was intended to verify that the software was operating as intended.

[5] Some cases have been reviewed at more than one MIP gap level and run on more than one computer system.

[6] These tests were generally based on the prices and resource schedules in the pricing dispatch, rather than the physical dispatch. However, in the case of resources not eligible to set prices, we verified that their schedule in the pricing dispatch was identical to their schedule in the physical dispatch and that their schedule in the physical dispatch was consistent with the prices in the physical dispatch.

prices. In those instances in which the tests detected anomalies, we worked with CAISO staff and/or Siemens to determine whether the anomalies reflected incorrect software performance, incorrect data, reflected false positives (i.e., the anomalies in fact reflected the correct operation of the software), or reflected isolated instances of imperfect optimization over integer variables (termed MIP gap, discussed further below).[7] As a general matter, the tests were designed to find flaws in the dispatch and pricing logic, not to systematically test the underlying transmission system data or powerflow solutions. In practice, however, the tests also identified other types of flaws, such as incorrect data modeling for some generation and connectivity to the network model. These data issues were either addressed during testing or will be corrected as the model and master file are updated.

1. Replicate LMP Energy Prices

For the day-ahead market, real-time predispatch and real-time interval dispatch software, this test verifies that we can replicate the calculation of the LMP prices from the components. For each generator and load bus for which a LMP price is calculated (Pnodes) and each aggregated generator or load bus for which a LMP price is calculated (Apnodes) we verify that we can calculate the LMP price from the distributed reference bus price, constraint shadow prices and penalty factor and generation shift factors for that location, as calculated by the day-ahead market, real-time predispatch and real-time dispatch models based on the underlying transmission grid model. This test not only serves to identify potential errors in the calculated prices, it also serves to verify that the correct shift factors, constraint shadow price, and penalty factors are being saved and exported, and thus will be available for analysis of performance issues.

2. Validate LMP Energy Prices Based on Marginal Generators

This test verifies that the appropriate number of marginal generators can be identified for the determination of LMP energy prices for each hour (in the day-ahead market), each 15-minute interval (in the real-time predispatch) and each 5-minute dispatch interval in the real-time dispatch. In an interval with no binding transmission constraints, at least one generator or price capped load bid should be on the margin (i.e., partially dispatched and not ramp constrained or at an upper or lower operating limit)[8] and the LMP price at

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[7] False positives in the initial testing were in part an intentional design feature to facilitate identification of problems and in part reflected limitations in the software output which in some cases made it difficult to verify that resource schedules were affected by certain kinds of constraints. For example, we initially have screened for anomalies without regard to ramp rate constraints and manually verified that units were ramp rate constrained. This process served to test the accuracy of the indicator for ramp constrained units.

[8] This condition will hold unless a load balance constraint or ancillary service requirement is not satisfied, in which case all resources could be at their upper or lower limits. We understand that at present, prices should be set in these situations by the highest cost accepted offer. Units with binding energy limits are on the margin if

this location should be equal to the energy offer price of the marginal generator or the bid of the marginal price capped load at its dispatch level plus any relevant opportunity costs.[9] Similarly, in an interval with n binding transmission constraints, at least n+1 generators or price capped load bids should be on the margin.[10] The marginal generators and load bids are identified in the pricing dispatch in which some resources have schedules fixed in the physical dispatch and are not eligible to set price and in which fixed block units such as gas and combustion turbines are treated as if they are dispatchable at any level between zero and their upper operating limit. If the number of marginal units is less than the number of binding transmission constraints plus one, this is reported by the price validation tool for further review.

Because of the complexity and number of the potential tradeoffs between energy and ancillary service schedules and intertemporal tradeoffs, units that are marginal due to these trade-offs are not directly identified by the price validation software. Trade-offs between energy and ancillary service schedules are validated by verifying that the energy dispatch and ancillary service schedules correctly reflect the opportunity cost of energy ancillary service tradeoffs.

3. Evaluate Energy Schedules for Consistency with LMP Energy Prices

This test reviews the energy schedules for generating units and loads submitting price capped bids in the day-ahead market, real-time pre-dispatch and real-time dispatch and verifies that they are consistent with the LMP prices at those locations. For the purpose of

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the sum of their offer price and the shadow price of the energy constraint is equal to the LMP price at their location. We have applied tests to verify that the daily schedules of energy limited resources do not exceed their maximum energy limit nor fall below the minimum energy limit and to verify that the constraint shadow price is correctly reflected in prices when the energy limits are binding.

[9] In the IFM and real-time pre-dispatch, energy prices can reflect the opportunity cost of providing energy instead of ancillary services and can also reflect the opportunity cost of using energy limited resources with binding daily energy limits. Energy prices can also be set by intertemporal opportunity costs on ramp-constrained units in IFM, real-time pre-dispatch and the real-time dispatch. For example, in one RTPD case, prices were high in one 5-minute interval then low in the following four intervals. One unit is ramp-constrained down throughout the first three low-priced intervals, so if it is dispatched up an additional megawatt in the high priced interval, its output will be 1 megawatt higher in each of the next three intervals in which it would be operating uneconomically. The resource's opportunity cost in the high priced interval is therefore equal to its losses in the following three periods in which it operates uneconomically and this opportunity cost sets the incremental cost of meeting load at some locations during the high-priced interval.

[10] This condition should hold unless a transmission constraint cannot be solved in which case all resources could be at their upper or lower limits on one or both "sides" of the constraint. Constraint shadow prices would then be determined by constraint violation costs and energy and ancillary services prices could be determined in part by these constraint violation costs. We have applied tests to verify that constraint shadow prices are set to the appropriate value when a transmission constraint cannot be solved. Units with binding energy limits are on the margin if the sum of their offer price and the shadow price of the energy constraint is equal to the LMP price at their location.

this test, generating units and price capped load bids are divided into five categories based on their schedules: (1) generating units or load bids that were on the margin;[11] (2) generating units that were scheduled to operate at their upper limit (given their ancillary service schedules) or were ramp constrained up; (3) price capped load bids that were dispatched down to their lower limits; (4) generating units that were scheduled to operate at their lower limit (given their ancillary service schedules) or were ramp constrained down; and (5) price capped load bids that were dispatched to their upper limit.

The next step is to verify that: (1) the LMP at the location of each marginal resource or price capped load bid was equal to the resource or load's energy bid at its dispatch point (the same as test 2);[12] (2) the LMP at the location of each resource scheduled at its upper limit or that was ramp-constrained up was greater than or equal to the unit's energy bid at its dispatch point; (3) the LMP at the location of each price capped load scheduled to its lower limit was greater than or equal to the load's bid at its dispatch point; (4) the LMP at the location of each unit scheduled at its lower limit or that was ramp-constrained down was less than or equal to the unit's energy bid at its dispatch point; and (5) the LMP at the location of each priced capped load scheduled at its upper limit was less than or equal to the load's bid at its dispatch point.

4. Replicate Ancillary Service Prices from Shadow Prices

This test verifies that ancillary prices could be replicated from appropriately calculated shadow prices. The application of this test evolved in the course of testing with changes in the number and nesting structure of ancillary service regions and with changes in the way ancillary service shadow prices are reported.

5. Validate Ancillary Service Prices Based on Marginal Suppliers

For the day-ahead market and real-time pre-dispatch, this test identifies the marginal ancillary service suppliers whose offers determined the market-clearing prices for spinning reserves, 10-minute reserves, regulation up and regulation down, in each ancillary service region in each hour, and validates the cascaded market clearing prices for each ancillary service. The offer of the marginal ancillary service supplier may have an energy market opportunity cost that sets the ancillary service price.

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[11] This could include generation or load self-schedules that were curtailed at the penalty value in the pricing pass of the IFM or RTUC software.

[12] In the case of energy limited units with binding energy constraints, we verify that the sum of their offer price and the shadow price of the energy constraint is equal to the LMP price at their location.

6. Examine Ancillary Service Schedules for Consistency with Prices

For the day-ahead market and real-time pre-dispatch, this test verifies that the ancillary service schedules for ancillary service suppliers were consistent with the market clearing prices for energy, spinning reserves and 10-minute reserves, regulation up and regulation down in each region and in each hour or pre-dispatch period. This evaluation includes verification that the sum of the ancillary service offer price and energy market opportunity cost is less than or equal to the price of ancillary services for all resources scheduled to provide each ancillary service.

7. Examine Unit Commitment for Consistency with Prices

The day-ahead market unit commitment results are validated by applying two tests to generating unit schedules. First, we determine whether there were units that were not committed that could have profitably operated at the day-ahead LMPs, taking into account the resource's minimum load cost and start-up costs over the commitment period. Second, units whose schedules would require uplift payments because their day-ahead energy and ancillary service revenue is less than their as bid costs are identified. These tests were also applied, but less comprehensively, to the real-time unit commitment decisions by RTUC.

Because of the non-convexities inherent in unit commitment decisions, not all anomalies identified by these tests indicate software flaws or limitations. Our review focused on identifying material anomalies or patterns involving a large number of smaller anomalies within a single test case. We did not attempt to definitively resolve individual small discrepancies within a given test case that would be consistent with small changes in loss factors or prices associated with changes in the unit commitment.

B. Scope of Testing

This report covers the testing of certain elements of the CAISO market software that we have carried out. It does not cover all testing that has been carried out by the CAISO. In particular, this report does not cover the performance of various associated systems. For the purpose of the testing covered in this report:

- The IFM Cases analyzed have not been run in conjunction with RUC or market power mitigation.[13]

- Some of the real-time cases were taken from the market simulation process and the input data went through SIBR and the market power mitigation steps.

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[13] The CAISO is independently testing RUC and the market power mitigation process.

Other real-time cases were run in a test environment without market power mitigation, without going through SIBR, and without real-time events such as operator actions and generator and transmission outages.

- The RTUC and RTD cases have been tested independently of the IFM cases so we have not tested issues relating to the relationship between IFM, RTUC and RTD schedules.

- We have not tested associated processes such as the load forecaster.

The results of testing these other elements of the CAISO market software will be covered elsewhere.

C. Test Cases Analyzed

In the third stage of analysis track testing, LECG has fully reviewed 11 IFM cases:

(1) base case .5% and .01% MIP gap

(2) high load base case fc_ifm_patch190_case1c_highdemand_S617263182

(3) fc_ifm_ a2 test7a_e032408_ s917271260 (referred to as case 7a below)[14]

(4) fc_ifm_t3_test108_ e032208_s617263382 (referred to as case 108 below)[15]

(5) fc_ifm_t3_case104_p197_ e032808_S617263462 (referred to case 104 below)

(6) fc_ifm_t3_test102_e032808_ S617263443 (referred to as case 102 below)

(7) case fc_ifm_a2_case106_ e032408_s917271280 (referred to as case 106)

(8) case fc_ifm_a2_case107_ e032408_s917271240 (referred to as case 107)

(9) fc_ifm_t3_test109_patch231_ e050608_s617264882 (referred to as case 109)

(10) fc_ifm_t3_test110_patch231_ e042308_s61726484 (referred to as case 110) and

(11) fc_ifm_t3_test111_patch228_ e042308_s617264602 (referred to as case 111).

Three of these cases were rerun on patch 284 in June to verify that previously identified problems had been corrected. These were case 7a, case 110 and the base

[14] This is also sometimes described as case 105 in recent CAISO case documentation. We have continued to refer to it as case 7a, as in our Preliminary Report.

[15] This case was initially run with a .5% MIP gap and was subsequently rerun with a .01% MIP gap.

case.[16] Cases 7a and 110 were completely reanalyzed, the base case was only reviewed to confirm that the changes in the definition of the objective function caused the solution to converge to the expected unit commitment solution within the intended MIP gap specification.[17]

Since the Interim report dated July 1, 2008, LECG has received and fully analyzed an additional ten IFM cases:

(1) ifm_test_p324_e071608_mktsimanalysis_517269024 (referred to as the marketsim case below)

(2) fc_ifm_t3_wheeling_p324_e072408_617266263 (referred to as the wheeling1 case below)

(3) fc_ifm_t3_wheeling_p324_e072408_617266323 (referred to as the wheeling2 case below)

(4) fc_ifm_t3_test110_patch321_e071308_s617266082 (referred to as case 110-3 below)

(5) fc_ifm_t3_highdemand_fz_p323_e071608_s617266163 (referred to as the forbidden zone case below)

(6) fc_ifm_t3_test110_patch360_e081508_s617266462 (referred to as case 110-4 below)

(7) fcreg_ifm_t3_case105_var5990_validation_p363_e082108_617266763 (referred to as case 7a-3 below)

(8) fc_ifm_test_block_bid_p20031_e091108_s517280961 (referred to as block2 case below). This case is a rerun of the original block transaction case (C in the section below on cases that were not fully analyzed).

(9) fc_ifm_staging_fbzcase_patch20040_e091408_s417209455 (referred to below as forbidden2 case.)

(10) fc_ifm_staging_fbzcase_patch20050_e092308_s417209936 (referred to below as forbidden3 case.)

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[16] The rerun of case 7a is called case 105 in CAISO documentation. The rerun is not exactly the same as the original case 7a, which could not be reloaded because of the number of intervening changes. The rerun 7a uses a more recent database but tests the same issues as the original case 7a.

[17] Cases will not necessarily solve to the specified MIP gap, as they may time-out before achieving that value.

In addition, we have received three other cases for which a full analysis has not been carried out:

A) ifm_e072408_217266622_mktsim_contingencies – This case was run so that we could test the recalculation of prices in a case where contingency constraints were binding.

B) fc_ifm_test_nomo_p315_e070908_517268664 (referred to as the nomogram case below) – This case was provided to test prices in a case where nomogram constraints were binding. We only looked at the price recalculation in this case.

C) fc_ifm_test_block_bid_e062908_s517268343 – This case was generated to provide an example of a block transaction. We did not do a complete evaluation of this case.

D) fc_ifm_test_block_bid_p20031_e091108_s517280961 – This case is a re-run of the block2 case that was provided to determine if a software patch fixed a dispatch error at a pump storage unit in the block2 case.

We also reviewed portions of four additional cases:

A) fc_ifm_a2_case2001_patch208_e917271501_rerun and fc_ifm_t3_patch231_ e050608_lap_s617265042. These cases were only reviewed to validate the prices calculated for aggregate nodes.

B) fc_ifm_t3_case4001_p228_e042308_s617264003 and fc_ifm_t3_case4001_p228_ e042308_s617264804. These cases were used for verifying the "Distributed Generation Slack" functionality vs. "Distributed Load Slack." We were asked to verify that we could replicate the prices reported for these cases.

We have to date reviewed 17 RTUC cases:

(1) fc_rtpd_t3_patch208_ e302808_ mipgap.01% and mipgap .5% (referred to as the base case)[18]

(2) fc_rtpd_t3_test201_patch208_e032808_s617282281 (referred to as case 201)

(3) case fc_rtpd_t3_case203_patch208_e_032808_s617282321 (referred to as case 203)

(4) case fc_rtpd_t3_case204_p208_e032808_s617282324 (referred to as case 204)

[18] This case is also described as case 202 in some CAISO documentation.

(5) case fc_rtpd_t3_case205_patch208_e_032808_s617282323 (referred to as case 205)

(6) case fc_rtpd_t3_case206_patch208_e_032808_s617282341 (referred to as Case 206)

(7) case fc_rtpd_t3_test207_patch208_e032808_s617282322 (referred to as Case 207)

(8) case fc_rtpd_t3_test208(1)_patch228_e042308_s617282621 (referred to as Case 208(1))

(9) fc_rtpd_t3_test208(2)_patch228_e042308_s617282622 (referred to as Case 208(2))

(10) fc_rtpd_t3_test209_patch231_e050608_s617282801 (referred to as Case 209)

(11) fc_rtpd_case210_patch262_e052308_s617282981 (referred to as Case 210) and

(12) fc_rtpd_test_case206_p353_e080108_s519043870 (referred to as Case 206b).

(13) fc_rtpd_staging_export_binding_patch20058_e100208_s427291852 (referred to as export case below)

(14) fc_rtpd_u2_export_binding_patch20058_e100208_s217487268 (referred to as export2 case below)

(15) fc_rtpd_staging_lap_patch20058_e100208_s427295501 (referred to as lap3 case below)

(16) fc-rtpd-u2-stuc-patch20065-e100208-s217493325-rerun427291852 (referred to as stuc case below)

(17) fc-rtpd-u2-lap-patch20065-e100208-s217493326-rerun429295501 referred to as u2_lap case below)

Three of these cases were rerun, two on patch 283 and one on patch 284, in June to verify that previously identified problems had been corrected.[19] These were cases 202, 203 and 204.

We also reviewed one additional case, fc_rtpd_t3_lap_p283e061508 s617283049. The purpose of this case was to provide a complete set of data for testing the recalculation of Apnode pricing for RTUC. Finally, we reviewed fc_rtpd_test_hourly_ dispatch_e060908_s519014598 (referred to as hourly dispatch case) to evaluate whether a multi-hour block transaction was scheduled correctly.

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[19] Patch 283 includes most changes but did not include the reformulated objective function.

During May and June 2008 we reviewed four RTD cases:

(1) fc_rtd_t3_basecase_patch269_e060108_s617283024 (referred to as the Base Case)

(2) fc_rtd_t3_test301_patch269_e060108_s617283028 (referred to as Case 301)

(3) fc_rtd_t3_test303_patch273_e060108_s617283035 (referred to as Case 303) and

(4) fc_rtd_t3_test304_patch273_e060108_s617283033 (referred to as Case 304).

We reviewed case fc_rtd_t3_test301_patch284_e061508_ s617283048, which provided a complete set of data for testing the recalculation of Apnode pricing for RTD.

We also reviewed three additional cases in order to validate LAP prices: fc_rtd_t3_test301_patch297_e062408_s617283068 (referred to as case 301 LAP), fc_rtd_t3_lap_patch297_e062408_s617283074 (referred to as patch 297 LAP), and fc_rtd_t3_lap_patch324_e072208_617283127 (referred to as patch 324 LAP).

The test cases we have reviewed to date have a number of features that have helped verify that particular features of the CAISO software are working as intended. The conditions we have observed in testing, and in which the pricing software operated correctly, include:

- Unsolved internal transmission constraints with shadow prices equal to the constraint violation penalty.
- Binding external tie-line scheduling constraints with shadow prices as high as $2,000 in RTUC cases during the scheduling and price setting hour.[20]
- Regional ancillary service prices reflecting minimum ancillary service requirements.
- Price-capped load bids[21] setting prices in the day-ahead market.

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[20] We observed tie-line constraint shadow prices as high as $30,000 in a number of RTUC cases during the first few intervals of the case in which tie-line schedules are fixed at the level in the prior hour. These high shadow prices arise because the tie limits are lower than those enforced in setting schedules for those intervals and the intertie constraints were violated by the fixed schedules. Such $30,000 constraint shadow prices were never observed in the second hour of the RTUC case in which the tie-line schedules were determined, precisely because tie-line schedules could be adjusted to avoid violating the constraints.

[21] We use the term “price capped load bids” to refer to bids to buy power in the day-ahead market that are conditioned on the price at the specified location being less than or equal to the price specified by the buyer (i.e., less than or equal to the buyer’s bid price).

- Binding intertemporal limits on energy limited resources in the day-ahead market.

- Reserve shortages within particular ancillary service subregions in the day-ahead market, real-time pre-dispatch or real-time dispatch.

- CAISO-wide reserve shortages in the day-ahead market, real-time pre-dispatch or real-time dispatch.

- Changes in transmission limits over the analysis period.

- Exports curtailed at the price cap in the day-ahead market.

- Self-scheduled load that could not be met.

- Forbidden region constraints enforced.

- Wheeling transactions present.

- Multi-hour block transactions offered and scheduled.

- Binding Nomogram and Contingency Constraints

Not all elements of the market software have been tested by the conditions included in the test cases reviewed for this report. Some of the conditions not verified in this report include:

- No RTUC test cases have included uneconomic COG units running due to minimum run time constraints.

D. Test Results

1. Replicate LMP Energy Prices

IFM

Pnode LMP Replication

We are able to replicate the congestion component and overall LMP price for all prices reported by the IFM software in the cases tested. The issues that were identified in the preliminary and interim reports relating to the prices reported for disconnected units, the prices in some cases with very high constraint shadow prices, or on export constrained interties have been addressed and were not observed in cases run or rerun on the latest software patches. The only remaining anomalies appear to arise from master file

network model issues. In addition, we were able to replicate prices in the 4001 cases used for testing the distributed generation and load slack buses. Until recent changes, our replication of LMP prices was based on shift factors rounded to six decimal places and loss factors rounded to four decimal places to be consistent with the degree of precision in the CAISO market software. Recent changes to the software have resulted in shift factors being rounded to five decimal places. Loss factors are still rounded to four decimal places. The resolution of price calculation issues is reviewed below.

We were initially unable to replicate the congestion component of prices reported by the IFM software for seven disconnected Pnode IDs in IFM cases 7a, 106 and 107 using shift factors, offsets, and transmission constraint shadow prices reported by the IFM software. The prices we calculated differed from the prices reported by the IFM software by as little as a few cents or as much as $48/MWh in case 7a, as much as $95/MWh in case 106, and as much as $523/MWh in case 107. We observed price calculation errors on the same seven Pnodes in the base test case run with patch 157. The message files for these cases indicated that these seven Pnodes were electrically disconnected from the grid in these cases, while connected in the remaining cases in which the Pnode prices for these locations could be replicated. It appears that we were unable to replicate the prices from the shift factors and offsets because the shift factors exported from the IFM for these seven locations were non-zero, while the prices reported by the IFM software for these locations were calculated with a zero shift factor (presumably reflecting the disconnection from the grid) and a non-zero offset.[22] Case 7a was rerun on the latest patch in June, none of these units were reported to be disconnected from the grid, and there were no price calculation errors.

We were also initially unable to replicate the congestion component of prices reported by the IFM software for IFM case 110. This inability appears to be a result of inconsistent rounding of shift factors in the calculation of prices. Siemens indicated that resources that received non-zero schedules in the IFM have their shift factors rounded to six decimal places before calculating prices, while resources that did not receive an energy schedule did not have their shift factors rounded. As a result, we were able to replicate prices for all resources using either the rounded or unrounded shift factors, but not using any single rule. Changes were made to address these inconsistencies and when we evaluated a rerun of IFM case 110, almost all of these discrepancies were eliminated, the number of discrepancies falling from 20,710 to 5. The five remaining anomalies appear to be due to inconsistent shift factor rounding for shift factor values between .00001 and .000001. The shift factor dropping issue for shift factors between .00001 and

[22] The penalty factor for these locations is non-zero and we are able to replicate the loss component of these prices using that penalty factor, so these locations do not appear to be disconnected from the grid in determining the loss factor.

.000001 was also seen in the wheeling1 case, wheeling2 case, forbidden region case, and case 100-3. Siemens began rounding to the precision of the SF_THRESHOLD variable, currently set to .00001 in patch 360. Since this change was implemented, we have been able to replicate all congestion components.

We initially observed a problem with the reporting of LMP prices for Pnodes on export constrained interties in the marketsim case and the nomogram case. The shadow price on binding interties was being added with the wrong sign to the prices reported for these locations. This was a price calculation error; the dispatch was correct and consistent with the correctly calculated price. The software issue was corrected and CAISO re-ran type B case 2006 which had an export constraint binding. We have confirmed that the export constrained intertie prices are calculated correctly with the correct sign.

We initially observed an issue in the forbidden2 case in which one Pnode was reported as having congestion in an hour during which there were no binding nomogram or flowgate constraints. This Pnode was located on an inter-tie, however, that inter-tie was not binding and no other inter-tie was binding with a shadow price equal to this Pnode's congestion component. This problem was not present in the forbidden3 case run on a later patch.

We initially observed an apparent data issue in the rerun case 7a in which one Pnode was linked to two interties. CAISO has verified that this issue has been fixed in the master file, but cases 7 and 7a-3 are re-runs of an old case using old master file data. In this case some resources on the Pnode were linked to one intertie while others were linked to another intertie. This resulted in inconsistent prices for resources at the same Pnode when one intertie was binding and the other was not. A similar mapping issue was seen in the marketsim case where two resources on the same Pnode were not mapped to the same intertie ID. CAISO believes this issue is arising from a data mapping problem that will be resolved in a master file update. A similar instance was seen in case 7a-3.

Apnode LMP Replication

We were initially unable to recalculate a variety of Apnode prices in IFM test cases. This problem was eventually traced to incorrect nodal weighting data being exported from the IFM program. Case 105[23] was rerun with changes to ensure that the correct nodal load weights were saved and exported and we were able to exactly replicate all Apnode prices, including the default LAP prices. This process is reviewed below.

[23] fcreg_ifm_t3_case105_p297_e062408_617265884

We were initially unable to recalculate certain Apnode LMPs in the base cases, cases 7a, 102, 104, 106, 107,108, 109, and 111 due to missing data for the relevant load weights. The affected Apnode LMPs were those for LAPs and LAFs.[24] The rerun IFM case 110 was also missing data for the relevant load weights. The case 110-3, wheeling1 case, wheeling2 case, and forbidden region case were also missing data for the relevant load weights. This is a master file data issue not related to the pricing software.

We were initially unable to calculate the Apnode price with static participation factors at one Apnode in the marketsim case, wheeling1 case, and wheeling2 case because they had component Pnodes that were affected by the price recalculation errors described in the Pnode LMP Replication section above relating to the dropping of small shift factors or the incorrect reporting of LMPs on Pnodes located on export constrained interties. These issues have been resolved with the changes to rounding precision discussed above.

The CAISO provided us with data from IFM case 2001 which included the load weights required to replicate Apnode prices. We recalculated the SCE, PG&E and SDG&E LAP prices from the component Pnode prices and were able to replicate the SCE and SDG&E LAP prices. We were not able to replicate the PG&E LAP price in any hour. The differences ranged from a penny up to about $.75/MWh. We observed the same inability to replicate PG&E prices in case fc_ifm_t3_patch231_ e050608_lap_s617265042. We were not able to carry out replication of all of the aggregated generator nodes for case 2001 because the relevant Apnode prices were not correctly exported, resulting in the export of zero prices for Apnodes that clearly had non-zero prices. We were able to replicate the trading hub prices for case 2001. We also observed Apnode price recalculation errors in case 110 for aggregate generators, loads, and LAPs. The recalculated prices differed from the prices reported in the software by several cents. All off these issues were traced to the export of incorrect load weight data as noted above. This was corrected and we have been able to correctly calculate these Apnode prices in all subsequent cases.

LECG is unable to replicate certain Apnodes prices with types Aggregate System Resource and Aggregate Generator. The prices for these Apnodes are reported as blanks in pricing data files. CAISO has determined that this is due to a master file issue not related to the pricing software in which some Apnodes have multiple IDs in the master file and only one is being populated with prices.

As noted above, all of the apparent price calculation errors for aggregate nodes appear to have simply reflected the export of incorrect nodal load weights and we have

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[24] The emm_scuc_imm_laf.csv and emm_scuc_imm_lap.csv files for the IFM test cases other than case 2001 are blank.

been able to recalculate every Apnode price in the rerun of case 105 in which the correct weights were exported.

RTUC

Pnode LMP Replication

We are able to replicate the reported Pnode LMP prices at almost every location in every rerun test case. The few remaining inconsistencies appear to arise from master file network model issues.

When we initially carried out the replication of Pnode prices for a number of RTUC cases, we were able to replicate the prices at some Pnodes using unrounded shift factors and to replicate Pnode prices at other Pnodes using shift factors rounded to 6 decimal places. The issue was caused by the inconsistent dropping of shift factors between .00001 and .000001. As discussed in the IFM section above, Siemens changed their rounding of shift factors from six decimal places to five decimal places and we were able to verify all congestion components in the IFM cases. The export, export2, and lap3 cases that were processed after this change was added to the code confirmed that this issue has also been fixed in RTUC.

We initially observed numerous instances in which we were unable to recalculate the loss component of the LMP price in cases 208(1) and 208(2). After the CAISO determined that loss penalty factors had been rounded in the calculation of the LMP, we revised our tests to account for the specified rounding and are now able to recalculate the loss components as reported by the RTUC software. We did not observe any loss component recalculation issues in the rerun of the RTUC basecase or in cases 203 or 204.

We observed two instances in the rerun of the RTUC basecase and one instance in the rerun of RTUC case 204 in which we were unable to recalculate the congestion component of the LMP at a Pnode location located on an intertie. The reported price differs from our calculated price by over $200 in some cases. This Pnode is only linked to one intertie and there is no binding intertie with a shadow price equal to the price difference between calculated and reported, therefore this does not appear to be related to an intertie mapping issue. The CAISO was going to write a variance on this issue to correct a master file network model issue.

We initially observed the same problem with the reporting of LMP prices for Pnodes on export constrained interties in the hourly dispatch case that was identified in the IFM marketsim and nomogram cases. The shadow price on the binding interties is of the wrong sign in the prices reported for these locations. As in IFM, this was a price calculation error; the dispatch was correct and consistent with the correctly calculated price. As discussed above, we have rerun IFM cases to verify that export prices are

correctly calculated in IFM. We have also tested this in the RTUC export and export2 cases, and verified that the export shadow price was correctly applied in calculating the intertie prices.

Apnode LMP Replication

We were initially unable to recalculate a variety of Apnode prices in RTUC test cases. As in IFM, this problem was eventually traced to incorrect nodal weighting data being exported from the RTUC program. The RTUC lap case[25] was rerun with changes to verify that the correct nodal load weights were saved and exported and we were able to exactly replicate all Apnode prices.

We were initially unable to recalculate Apnode LMPs for a number of Apnodes in the RTUC base case and case 206b that were composed of Pnodes whose prices cannot be recalculated as noted above. In addition, we were unable to recalculate the LAP prices for the RTUC basecase due to a lack of mapping data.[26] In the RTUC Case 210, mapping data was provided, but certain Apnode prices could not be recalculated from the underlying Pnode prices, including the PG&E default LAP price.[27] These discrepancies were due the export of incorrect nodal load weights. With the correct nodal load weights exported, we were able to recalculate all Apnode prices in the export2 case and the rerun lap3 case.

CAISO also provided case fc_rtpd_t3_lap_p283_e061508_s617283049 for the purpose of validating Apnode prices. We identified 28 instances in which we could not replicate the prices at aggregate generator or LAP locations. These price recalculation errors ranged from $0.01 to $19.43/MWh. In addition, we calculated a non-zero price at two Apnodes in this case for which the CAISO software reported a $0 price. This issue was resolved when the correct nodal load weights were exported, as noted above.

We are unable to replicate certain Apnodes prices with types Aggregate System Resource and Aggregate Generator. The prices for these Apnodes are reported as blanks in pricing data files. CAISO has determined that this is due to a master file issue in which some Apnodes have multiple IDs in the master file and only one is being populated with prices.

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[25] fc_rtpd_t3_lap_closeuconn_p297_e062408_s617283070

[26] We were unable to recalculate the Apnode prices for numerous aggregate load and LAP locations in rerun RTUC cases 202, 203, and 204 because of missing data for the relevant load weights.

[27] The discrepancies ranged from a few cents up to $1.66 per MWh.

We were unable to recalculate some Aggregate Generator prices in the export case. This is related to the incomplete export of dynamic participation factors and does not reflect an incorrect calculation of prices.

As noted above, all of these apparent price calculation errors for aggregate nodes appear to have simply reflected the export of incorrect nodal load weights and we have been able to recalculate every Apnode price in the rerun of the LAP test case in which the correct weights were exported.

RTD

Pnode LMP Replication

All Pnode LMP prices could be recalculated except for two Pnode LMP prices in the RTD base case. These prices could not be recalculated because the Pnodes are mapped to two different interties having different congestion components. LECG is able to validate the reported LMP price using one of the constraint shadow prices but not the other. The CAISO is aware of the apparent mapping problem and is working to correct it. All other Pnode LMP prices in the other RTD cases could be recalculated.

Apnode LMP Replication

We attempted to recalculate Apnode LMP prices in cases 301, 303 and 304. In each case, there were a handful of Apnodes for which we initially could not validate the LMP as a result of nodal load weight data issues.

CAISO also provided case fc_rtd_t3_test301_patch284_e061508_s617283048 for the purpose of validating Apnode prices. LECG observed 28 instances where we could not replicate the prices at aggregate generator or LAP locations. These price recalculation inconsistencies ranged from $0.04 to $474.00. After the RTD software was modified to export the correct load weights, wee examined RTID case patch 324 LAP in order to validate LAP prices. We were able to correctly recalculate the all Apnode prices, including the LAP prices in this case.

2. Validate LMP Energy Prices based on Marginal Offers/Constraint Violation Costs

Analysis of marginal units determining LMP prices was not carried out for the November cases, but was included in the evaluation of the April and June 2008 analysis track cases.

IFM

The number of marginal units appropriately exceeded the number of binding transmission constraints in every hour of the base cases, and analysis track cases 7a (rerun), 102 104,

106, 107, and 111, and in all hours of case 108 except hours 22, 23, 0 and 3 (GMT), and all but one hour of cases 109 and the original case 7a. The appropriate number of marginal units also appears likely to exist in the remaining three hours of case 108 and one hour of case 109; however, because of the shift factor rounding issues discussed in Subsection 3 below, there were a number of units which should be marginal whose offer prices appear to differ by a penny or so from the LMP price at their location. There is one hour of the original case 7a in which curtailed generator self-schedules set prices in the scheduling pass, and we were not able to identify one of the tradeoffs determining prices in the pricing pass. The number of marginal resources appropriately exceeds the number of binding transmission constraints in every hour of case 110-3, 7a-3, the block2 case, forbidden2 case, and forbidden3 case.

In case 108 the 30970_MIDWAY_230_30973_SUNST _230_BR_1 _1 flowgate is violated and appears in the emm_scuc_output_flowgate_v.csv file with a shadow price equal to $3,000 per megawatt (either $1,000 or $3,000 in cases 109 and 110). This constraint violation cost correctly sets prices in the relevant hours.

There are also some flowgates that are overloaded in the pricing pass, and have shadow prices in excess of pricing pass constraint violation penalty ($3,000) in cases 109 and 110. This outcome is a result of the way constraints are relaxed in the pricing pass. Transmission constraints that are violated in the scheduling pass are relaxed in the pricing pass at the specified constraint violation cost for a small range beyond their scheduling pass value. If the violated constraint were the only such constraint in the scheduling pass, one would expect that the constraint would be violated to the same or lesser extent in the pricing pass and the constraint violation penalty would set prices.[28] If there is more than one constraint violated in the scheduling pass, this intuition may not hold in the pricing pass solution, and constraints can bind in the pricing run at values well in excess of the pricing run constraint violation cost. This was not observed in rerun IFM cases 7a and 110 because pricing run constraint violation costs were set at the same level as in the scheduling run.

The observed outcomes with some transmission constraint shadow prices above the pricing pass constraint relaxation penalty price are consistent with the intended software implementation of transmission constraint relaxation in the scheduling and pricing passes. Because constraint shadow prices in the pricing run can exceed the pricing run constraint violation cost, it is possible for prices to be set by constraint

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[28] If the incremental cost of the resources dispatched to solve the constraint in the scheduling pass was greater than the constraint violation cost, one should expect the constraint to be binding in the pricing pass at a price in excess of the pricing pass constraint violation cost. If the incremental cost of the resources dispatched in the scheduling pass was less than the pricing pass constraint violation cost, then one would expect the price in the pricing pass to be set by the pricing pass constraint violation cost.

shadow prices that are in excess of the pricing run constraint violation cost, up to the value of the scheduling run constraint violation cost. In these cases, prices are not set by the constraint violation costs but by the bids and offers of marginal buyers or sellers and assure that the LMP prices recover the actual cost of meeting load or accommodating transmission schedules. In wheeling1 case there was one instance in which the shadow cost on a violated constraint was greater than the high pricing run penalty and was also higher than the scheduling run penalty. This outcome was likely related to the program timing out before an optimal solution was found. This did not occur in the wheeling2 case.

In cases 108, 109 and 110 some flowgates are not violated, but are at their limit, and also have shadow prices in excess of the pricing run constraint violation cost. For example in case 108, the METCALF_MORGANHL_ BG flowgate in HB 15 PST is binding with a shadow price of $12,993.90 in the pricing pass.[29] As explained above, in the current design constraints that are not violated in the scheduling pass are not eligible to be relaxed at the constraint violation cost in the pricing pass (i.e., they are hard constraints in the pricing pass) and this accounts for the observed outcome. This was also observed in rerun IFM case 110.

RTUC

The number of marginal units plus violated transmission constraints appropriately exceeded the number of binding transmission constraints in all of the RTUC cases.[30] As in IFM case 108, there were transmission constraints that could not be solved and were violated in the RTUC base case. The same kind of outcomes that were identified in IFM case 108 were present in this base case, in particular, there were a number of constraints that were violated or binding in the pricing pass with shadow prices in excess of $1,000 (the constraint violation cost for constraints relaxed in the pricing pass). We believe these outcomes are the expected result of the way constraints are currently relaxed in the pricing pass. These outcomes for violated constraints were also present in the rerun of the RTUC basecase and in cases 203 and 204.

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[29] The analysis track cases included cases with varying constraint violation penalties, including some with higher penalties than currently envisioned for MRTU implementation. Later analysis track cases had penalties set so that constraint shadow prices did not exceed $5,000.

[30] Marginal units were identified for the second hour of the RTUC case which sets interchange and ancillary service prices. The dispatch consistency test, discussed in Section 3, was applied to all intervals of the RTUC cases.

RTD

The correct number of marginal units has been identified in the RTD basecase and cases 301, 303 and 304.

3. Examine Energy Prices for Consistency with Energy Dispatch

IFM

We have verified that in the cases we reviewed that resources are being dispatched consistent with their bids, the LMP prices at their location, and the CAISO market design in almost all instances, and none of the unresolved inconsistencies indicates the existence of a flaw in the calculation of prices. The process of resolving issues is reviewed below.

In case 108, 110, and 111 we initially observed instances in which generating units are dispatched to a point on their bid curve that is uneconomic by more than $0.01, but less than $0.02.[31] The threshold that LECG, the CAISO and Siemens have agreed should be applied to distinguish dispatch and pricing issues from the effect of rounding conventions is $.01, so these errors, while small, are outside the bounds we have used to identify software issues for review. The very high transmission constraint shadow prices in this case raised the possibility that this discrepancy was a result of a difference in shift factor rounding within the IFM software that only becomes apparent with such high shadow prices. As explained above, the shift factors used for the optimization are being rounded to six decimal places while our replication of prices was originally based on unrounded shift factors. This rounding does not account for the dispatch inconsistencies in these cases, however, as the prices we use for the comparison are based on the rounded shift factors used in the optimization and the rounding in these cases only changes prices by a fraction of a cent. These issues were addressed by Siemens and were not present in the rerun IFM cases 7a or 110.

There were no load schedule anomalies in the base cases or cases 102, 104, 106, 107, or 111. Price capped load was also correctly scheduled in both the scheduling pass and the pricing pass of the rerun of case 7a. Price capped load was also correctly scheduled in both the scheduling pass and the pricing pass of case 110-3, wheeling2 case, and the forbidden region case.

We initially observed a price-capped load bid in case 7a that was scheduled to a level that was inconsistent with its bid and the price at its location. This load had a bid price of $5/MWh and a LMP of $0.00 at its location, but the schedule in the pricing pass

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[31] These price and dispatch inconsistencies were present in both the .5 and .01% MIP gap runs for case 108.

was 0.033 MWs below the unit's bid MW value, which should have been fully dispatched. The dispatch inconsistency was very small, but it should not exist and it did not appear to be related to any of the other issues that had been identified. The load bid was scheduled to the appropriate level in the scheduling pass. The cause of this anomaly was never identified and it is not clear which software change eliminated the anomaly, but as noted above it was not present in the rerun of case 7a.

We identified one instance in the initial run of case 110 of a unit turning on and ramping up to its lower limit but no further during the hour, despite having an incremental cost that was lower than the price at its location and having sufficient ramp capability to reach a higher output.[32] This unit was ramped correctly in the rerun of case 110.

We also initially observed instances in cases 108, 109, and 110 in which load bids were dispatched to a place on their bid curve that was uneconomic by more than $0.01, but less than $0.02. This pattern was likely related to the observation regarding generation units and shift factor rounding noted above and these inconsistencies were not present in the rerun of cases 7a or 110.

There were no wheeling transactions in the base cases, or in analysis track cases 7a, 102, 104, 106, 107, 108, 109, 110, 111, or the rerun of cases 7a or 110, so no wheeling transaction anomalies were identified. There were also no wheeling transactions in case 110-3 or the forbidden region case. There were wheeling transactions in the wheeling1 case, wheeling2 case, and marketsim case. In all instances, valid wheeling transactions were scheduled correctly. These cases contained some invalid wheeling transactions, unbalanced wheels, because the data used to create the cases was not entered through SIBR.

We identified a data issue in the base cases and cases 7a, 102, 104, 106, 107,108, 109, 110, and 111 in which units are committed for regulation and are ramp constrained using their regulation ramp rate, but are not flagged in the data as ramp constrained. Since the original report, it has been determined that the upper and lower limits in another table (emm_scuc_output_bid) can also be used to identify units that are not dispatched marginally because of limits, but use of this table does not resolve all of the omissions, which were also seen in rerun IFM cases 7a and 110. This was also seen in the wheeling1 case, wheeling2 case, marketsim case, forbidden region case, case 110-3, forbidden2 case, and forbidden3 case. This issue does not reflect any price calculation

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[32] Our understanding of the prescribed start-up ramp rule is that a unit can ramp during the hour in which it comes on-line to its lower limit plus one-half of its ramp rate times, either 20 minutes or 60 minutes, depending on whether it's a fast or slow ramping unit.

error or dispatch issue but should be corrected prior to market implementation to speed price verification.

In rerun IFM case 7a, we initially observed resources on interties that were dispatched as though they were marginal within their self-scheduled region although the LMP at their location was between $0.10 and $0.30 greater than the self-schedule penalty price. We also observed two resources on interties that had energy schedules that were inconsistent with their bids and prices. These units were dispatched as though they were marginal on an economic portion of their bid curve; however, the LMP prices at their locations were several dollars different than their offer price in some instances. These resources had the same schedule in as each other in these hours.[33] After a software patch was implemented, case 7a-3 was run and analyzed to confirm that both problems were corrected. We verified that in case 7a-3 there were no inconsistencies between bids, prices and schedules for any intertie resources.

In rerun IFM case 7a, the prices for one resource were inconsistent between two data files. The prices used in the dispatch do not appear to be consistent with the prices that are re-calculated using the underlying shift factor, shadow price, and penalty factor data. This kind of anomaly was not identified in rerun IFM case 110, but also occurred in case 7a-3. CAISO determined that this issue is related to a mapping issue within the master file and has been fixed in the master file; however, case 7a-3 was a re-run of an old case using old master file data.

There were several new issues found in the cases processed after the completion of the Interim Report. These issues are discussed below.

In case 110-3, we observed 1 resource that was economic for energy and was ramping up, but only ramped at 20-minutes, rather than 60-minutes. This unit was not providing reserves and ramped up more than 20-minutes in the next interval. The CAISO opened a variance on this issue. This issue was also seen in case 110-4. Further review of this anomaly has been postponed pending possible changes to the treatment of 20- and 60-minute ramp constraints.

In the wheeling1 case and the marketsim case, we observed a resource that was scheduled to its upper limit for energy when it is uneconomic by $0.06 and $0.18/MWh, respectively, for energy in each case. It is unclear why the unit did not ramp down in this interval. The CAISO opened a variance on this issue. It was conjectured that this was due to the case timing out before reaching an optimal solution. This issue was not seen in the wheeling2 case which was re-run with a longer time-out time.

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[33] These anomalies were not present in rerun IFM case 110.

In the forbidden region case, we initially observed several resources that were ramping further than their ramp rates and forbidden region crossing time would allow. After the CAISO reviewed the methodology used for changing bid ramp rates and corrections were made, the issue was not seen in the forbidden2 case or forbidden3 case.

In the forbidden region case, we initially observed numerous instances of resources that were scheduled for regulation even though their total schedules were not inside their bid in regulation ranges. The CAISO opened a variance on this issue and the problem corrected. This issue was not seen in the forbidden2 case or forbidden3 case.

In the wheeling1 case, LECG observed one price capped load bid that was scheduled economically to a break point in its bid curve in the scheduling pass, but its pricing pass schedule was 0.1 MW higher than the scheduling pass schedule even though the margin for this 0.1 MWs was -$63.75. It is unclear why the load was scheduled higher in the pricing pass. It was conjectured that this was due to the case timing out before reaching an optimal solution. This issue was not seen in the wheeling2 case which was re-run with a longer time-out time.

In the marketsim case, an export bid was scheduled partially in the scheduling pass with an LMP at its location equal to the self-schedule penalty. In the pricing pass, the price was lower than the pricing pass penalty, but the export's schedule was not increased from its scheduling pass schedule. This apparent dispatch inconsistency was a result of the initial incorrect calculation of prices on export constrained interties. The dispatch was consistent with the correctly calculated price.

In case 110-3, the marketsim case, and the forbidden region case we observed resources that were scheduled to a level that was greater than their daily energy limit. Siemens explained that this was due to the penalty for violating energy limits being set to zero in this case. With the penalty set to correct value, no violations of daily energy limits were identified in the forbidden2 case or forbidden3 case.

A special case – fc_ifm_test_block_bid_e062908_s517268343 – was run to test the scheduling of block schedules in IFM. We observed that the block schedule was marginal over its block period in the scheduling pass, however, in the pricing run the average pricing pass price was greater than its bid over the block period. The resource's pricing run schedule remained equal to the scheduling pass schedule even though it appeared economic to be scheduled to a higher point. Siemens explained that for block transactions, the software initially blocked the pricing run schedule at the level of the scheduling run schedule regardless of the price in the pricing run. CAISO determined that it did not intend for block transactions to be fixed at the scheduling run level in the pricing run. A software change was made to correct this and the block2 case was run on

the new software patch. We confirmed that block transactions are now correctly scheduled and are flexible in the scheduling and pricing runs.

In the forbidden2 case, we initially identified instances in which block transactions had offer prices that changed during a block period. This was a result of an error in the treatment of block transactions with one hour min run times. This was corrected and operated as intended in the forbidden3 case.

Our preliminary and interim reports noted that we observed a number of instances in which the scheduling of resources was not completely optimal but within the tolerance specified for the software (the MIP gap). While these instances continue to exist, changes that have subsequently been made in the way the objective function is defined have reduced the frequency of these instances as discussed below.

We initially observed a number of instances in the base cases and cases 7a, 102, 104, 106, 107, 108, 109, 110, and 111 in which units were dispatched to a breakpoint on their ramp capability curve, rather than to the point at which price equaled incremental cost or at which the unit would have been ramp constrained.[34] Thus, it would have been profitable to dispatch these resources to a different location on their energy bid curve.[35] These outcomes appear to be the result of the specified MIP gap, given the design of the software and the shape of the ramp rate curve submitted by these units. As a result of the complexities in the ramp rate curves, these units are treated as ramp constrained in the optimization although they actually should not be ramp-constrained at those dispatch points. In some instances, units are treated as ramp constrained in the dispatch without any change in dispatch from hour to hour.[36] All of the units treated as ramp constrained in this manner submitted ramp rate curves that can be described as W shaped, many associated with combined cycle modeling. These instances continued to be present in rerun IFM cases 7a and 110 but with reduced frequency.

There were 55 instances of MIP Gap in the wheeling1 case. These were associated with this case timing out before it could get to the .5% MIP Gap. The case

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[34] .5% mip gap base case – 9 instances; high load base case – 13 instances; Case 7a – 4 instances; case 102 – 10 instances; case 104 – 6 instances; case 106 – 31 instances; case 107 – 3 instances; case 108 – 62 instances; case 109 – 8 instances; case 110 – 6 instances; case 111 – 20 instances. The number of MIP gap issues fell from 4 to 2 in the rerun of case 7a and from 6 to 1 in the rerun of case 110. Wheeling1 case – 55 instances; wheeling2 case – 14 instances; case 110-3 – 4 instances; marketsim case – 0 instances; forbidden region case – 8 instances; case 7a-3 – 0 instances; block2 case – 1 instance.

[35] This both includes instances in which units ramp to a break point and stop when it would have been optimal to ramp further and instances in which it would have been optimal to not ramp as far in that interval.

[36] At present, none of these units was flagged as ramp constrained in the output data, indicating that the ramp constrained flag is still not completely reliable.

was re-run with a longer time out period and in wheeling2 case there were only 14 MIP Gap instances.

In the .5% MIP gap base case there are two instances of MIP gap issues involving the scheduling of units for regulation. The units in question have different ramp rates depending on whether they are providing regulation and their commitment to provide regulation causes them to forgo larger profits in the energy market by reducing their ramp rate. One of these instances remained in the .01% MIP gap base case; the other resource was correctly scheduled in the case run at the lower MIP gap.

The instances of non-optimal dispatch identified above have been attributed to "MIP gap." The underlying issue is that when there are integer choices in the unit commitment and dispatch optimization problem, there is an inherent potential, given the resulting non-convexities, for the optimization to select a solution which is optimal given the choice of these zero one variables, but is not globally optimal. In the Siemens day-ahead market and RTUC software there are a number of such integer choices, involving unit commitment state, the ability of the resource to provide particular ancillary services, and the unit's ramp range. As a result, as noted above, there are a number of instances in which the solution is not globally optimal, and instances in which the dispatch is not optimal given the unit commitment. Virtually all of the MIP gap issues identified in this report arise, directly or indirectly, from the degree of flexibility in specifying ramp rates provided by the CAISO market design, and in many cases arises from the shape of the ramp rate curve specified by the market participant.

Our review has verified that these dispatch inconsistencies do not reflect erroneous price calculations, but simply reflect limitations on the optimality of the dispatch given the trade-off between performance and additional iterations. The prices are correctly calculated given the unit commitment, the ramp rate used in the dispatch solution, and the constraints which were binding in the dispatch solution. The calculation of LMP prices from a dispatch which is not fully optimal has precedent in PJM's operation from 1998 into 2002, when PJM had a limited set of dispatch tools and PJM calculated prices based on the dispatch, but the settlement prices were not everywhere consistent with the dispatch because the dispatch was not fully optimal.

The CAISO testing included runs of test cases using both 0.5% and 0.01% MIP gap. Review of the differences between these cases and the formulation of the objective function in the IFM software engine since preparation of our preliminary report identified elements of the calculation that were inflating the value of the objective function. The inflated value of the objective function interacted with performance criteria defined as a percentage of the value of the objective function (the "MIP gap") to cause iteration to stop further from the optimum that was intended by the design specifications. The formulation of the objective function was modified by Siemens, resulting in objective

functions that typically have a much lower absolute value, implying a lower absolute mip gap for a given percentage standard. IFM cases 7a, 110 and the base case were rerun using the revised objective function formulation. The MIP gap in the reruns was much lower than in the original .5% MIP gap solutions in IFM cases 110 and the base case. This was not the case for the rerun of case 7a, but as noted previously, the case used to retest case 7a is not exactly the same case as the original case 7a, having different offer prices for some units.

RTUC

As in IFM, our review of the CAISO RTUC test cases has found that resources are dispatched consistently with their bids, offers and the LMP prices at their location in almost every instance, and none of the unresolved inconsistencies indicates the existence of a flaw in the calculation of prices. The inconsistencies that were identified and their resolution are described below.

In the basecase, we initially observed that a unit ramped up to 246 MW when its bid was more than $0.01 above the LMP price at its location, which is outside the rounding tolerance. We observed one import whose schedule was set in the scheduling pass and treated as though it were marginal, but its offer differed from the LMP by more than $0.01, which is again outside the rounding tolerance. Since there are small errors in replicating LMP prices in this case, both of these dispatch inconsistencies may reflect the impact of those price calculation errors. Similar occurrences of the dispatch and LMP being off by between $0.01 and $0.02, in cases in which we could replicate the calculated LMPs, occurred in cases 208(1) and 208(2). This issue was not observed in the rerun of the RTUC basecase or in cases 203 and 204.

There continue to be resources that appear to be dispatched uneconomically, and that we can manually calculate to be ramp constrained, but that are not listed as ramp constrained in the emm_scuc_output_valid_ramp.csv file. This occurred in the base case and in all the additional RTUC cases in IFM. Use of the cmm_scuc_output_ bid table to identify ramp or limit constrained units has resolved some but not all of these instances. This issue was present in rerun RTUC cases 202 and 203. These are not pricing errors but these kinds of omissions will slow price validation once MRTU is implemented.

We observed 10 units that were dispatched to breakpoints in their ramp rate curve, rather than to their economic dispatch point, in the .5% MIP gap basecase and 4 such units in the .01% MIP gap basecase.[37] Similar instances were found in all the other RTUC cases. As discussed above in the context of IFM, these reflect the effect of the

[37] There were seven instances in the rerun of the base case (case 202).

non-convexities in these ramp rate curves and the way the objective function was originally defined. A related instance occurred in case 204, in which a unit with a regulation schedule ramped to a breakpoint in its energy dispatch ramp curve, while it would have been more profitable to continue ramping down. While units ramping to a breakpoint on their ramp capability curves is a normal MIP gap outcome, in this case the resource was stopping at a breakpoint on the wrong ramp capability curve. These MIP gap issues were also observed in the rerun of cases 203 and 204.[38]

We also observed in cases 201, 204, 207, 209 and 210 units with self-schedules for energy that were not dispatched consistent with their self-schedules, although the price in both the pricing and scheduling passes exceeded the self-schedule penalty price. In case 210, the minimum and maximum energy levels were missing from the bid data, causing the energy self-schedules to be reset to 0 MW. This issue was not observed in rerun RTUC cases 202, 203, or 204. We also observed units in case 210 that did not submit an energy self schedule, but received one nonetheless. This was because the units had Must Run designations for regulation and the software will create an energy self-schedule at the units minimum regulation range for such units.

We observed an instance of a unit with a $0 incremental energy bid and a $0 no load cost being decommitted in case 207.

We noted that one unit in case 209 was constrained by its regulation ramp rate even though the unit was not providing regulation and would have been more profitable had it been scheduled using its energy ramp rate. This unit is listed as being on regulation in EMS so it is subject to the more constraining of it regulation and energy ramp rates during the current hour. Siemens has confirmed that the software is implemented such that EMS regulation status affects both hours spanned by an RTUC interval, while the CAISO has stated that this status should only affect the ramp rate during the current hour. There is on-going discussion of this issue. Instances of EMS regulation status affecting ramp rates during the second hour of an RTUC interval were also observed in rerun RTUC cases 202 and 203 and in case 206b.

We observed three instances in Case 210 (a HASP case) of imports, which should have been scheduled to the same level in all four intervals of an hour, being uneconomically scheduled in the first interval of the hour. The CAISO has submitted a variance on this issue.

In case 206b, four pre-dispatch imports were scheduled down into their self schedules during the scheduling pass for the second hour of the case. However, in the

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[38] The number of such MIP gap issues was unchanged in the rerun of case 203 and rose from 8 to 9 in the rerun of case 204.

pricing pass, their schedules returned to the full amount of the self schedule for two non-consecutive intervals though the schedule change was uneconomic, and also caused the schedules for the pre-dispatch imports to vary over the hour. The CAISO was to create a variance on this issue.

There was one load schedule anomaly in Case 210. An export was scheduled at 0.1 MW when the price in the scheduling run was above the export's bid. The CAISO has written a variance on this issue.

In the export case, there were instances in which where imports have a 0MW schedule even though they had an operating mode of must-run, were listed as online, and had a non-zero self-schedule. In all cases, the LMP at these resources' locations were greater than the -$30 self-schedule penalty in the pricing pass. This issue was resolved with patch 20065, and tested in the stuc and u2_lap cases.

In the export case, there were also instances in which exports have a 0MW schedule even though they had an operating mode of must-run, were listed as online, and had a non-zero self-schedule. In all cases, the LMP at these resources' locations were less than the $500 self-schedule penalty in the pricing pass.[39] This issue was also resolved with patch 20065 and tested in the stuc and u2_lap cases.

There were 48 instances in the export2 case in which resources were scheduled to turn off before the end of their minimum run time. In all cases these resources had an initial status of online and turned off in the first interval of the RTUC run even though the minimum run time had not been satisfied. The way minimum run time constraints are honored across RTUC intervals is being reviewed by the CAISO and Siemens.

We observe an inconsistency in the resource limits for RTUC that are output from the software. In the lap3 case these limits appear to constrain the energy plus upward ancillary service schedules, however in the export2 case this limit constrains the energy schedule and spin is scheduled above the limit.

There were wheeling transactions present in the export case and export2 case. In all instances, valid wheeling transactions were scheduled correctly. These cases contained some invalid wheeling transactions, unbalanced wheels, because the data used to create the case was not entered through SIBR.

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[39] A perhaps related issue was observed in the class B case 2006-4 discussed in section III. In this case, there is one export that is economic to be scheduled higher, but is not. The bid price for the export exceeds the price at that location by $410, so the export is clearly economic. There do not appear to be any unit derates on the export load and the export load is not at a limit in the output bid file.

RTD

We identified a number of minor issues involving the scheduling of units in RTD but none of these issues indicated the existence of a flaw in the calculation of prices. The issues that have been identified are described below.

We observed 12 instances in the base case of units providing regulation in real-time, but not having a regulation schedule, ramping at the lower of their energy ramp rate or their regulation ramp rate as if considered to be providing regulation in intervals in the next hour in which they also lack a regulation schedule. CAISO has reviewed the requirements and determined that this is appropriate.

We noted two instances in the base case of a unit's energy plus ancillary services up schedules being greater than its maximum capacity. We observed 10 instances of this in case 301, four instances in case 303 and 22 instances in case 304. The CAISO has an outstanding variance on this issue.

We initially identified a unit in case 301 that is awarded a 1 MW schedule for regulation down in the RTUC market, but is scheduled for energy at 0 MW in RTD. The regulation down schedule was therefore disqualified. The same pattern occurred on one unit in case 304. CAISO identified this as a data issue, reran case 301, and the unit received a 2 MW energy schedule and a 1 MW regulation down schedule.

Four units were dispatched in the scheduling pass of case 301 in a manner inconsistent with the scheduling pass prices. One similar instance was identified in case 303. All of these units had self-schedules that were modified in the scheduling pass. There do not appear to be any pricing inconsistencies in the pricing pass, so the settlement prices were correctly calculated given the constraints on modification of the self-schedules in the pricing pass.

We identified one unit in case 303 that was ramping down over the entire time horizon, although its operation at a higher output level was economic in every interval and the unit was not constrained by a changing maximum limit. The CAISO submitted a variance on this issue.

There were no dispatchable loads and hence no load schedule anomalies in any of the RTD cases.

We identified a data issue all the RTD cases in which units are ramp constrained, but are not flagged in the data as ramp constrained. This occurred 24 times in the base case, three times in case 301, and three times in case 304. This issue does not reflect any price calculation error or dispatch issue but should be corrected prior to market implementation to speed price verification.

We observed six instances attributable to “mip gap” in the base case in which units were dispatched to a breakpoint on their ramp capability curve, rather than to the point at which price equaled incremental cost or at which the unit would have been ramp constrained. There were five occurrences of this in case 301 and four in case 304.

Conclusion

While we have identified a number of inconsistencies between the calculated prices and the dispatch in various IFM, RTUC and RTD test cases, none of the inconsistencies reveal any kind of fundamental error in the calculation of prices in these cases. All of the issues identified appear to involve inconsistent truncation or rounding or minor imperfections in the dispatch, not fundamental pricing issues.

4. Replicate Ancillary Service Prices from Shadow Prices

IFM

As a result of reporting changes, a manual process was used to replicate the ancillary service prices for the .5% MIP gap base case, the high load base case, cases 7a, 102, 104, 106, 107, and 108. This manual calculation derived prices for regulation up by subtracting the SAS generated spinning reserve price from the regulation up price, and arrived at a spinning reserve price by subtracting the non-spinning price from the spinning reserve price. We then compared these calculated prices with the prices presented in the CAISO's emm_scuc_output_bid.csv file. No errors were identified when we performed this analysis on the base cases, case 7a, 102, 104, 106, 107, or 108. We accounted for the reporting charges and incorporated this test into the SAS price validation tool and it identified no errors for cases 109, 110, 111, or rerun cases 7a and 110. There were no errors in the wheeling1 case, wheeling2 case, marketsim case, forbidden region case, forbidden2 case, or forbidden3 case.

An issue regarding the reporting of incorrect $0 ancillary service clearing prices in the emm_scuc_output_bid.csv file for units that were not scheduled to provide ancillary services was resolved prior to the preliminary report. In cases 7a, 102, 104, 107, 108, 109, 110 and 111, this file is populated with the correct clearing prices for all commodity types that were offered by a resource. However, in case 110 and rerun case 110, LECG was unable to verify that ancillary service prices were correctly calculated because no shadow prices were reported for ancillary service regions in which no resource offered ancillary services.

IFM Case 110 was designed such that there are shortages of ancillary services at any price both in the CAISO as a whole, and in some subregions. In the initial run of

case 110 in some hours, ancillary service prices were set by shortage values and shortage values were cascading from region to region,[40] but in other hours in which the ancillary service could not be met, this cascading did not appear to be implemented and prices were set by the highest offer price rather than shortage values.

The apparent cause of these anomalies was that the version of the IFM and RTUC software used to run case 110 carried out an initial calculation to identify instances in which insufficient ancillary services are offered to meet a regional requirement and then relaxed the requirement to be equal to the amount offered. This accounts for the instances in which there was a shortage of ancillary services within a region but the price was set by the highest offer price, rather than by the shortage value. Prices were sometimes set by the shortage values, however, because not all shortages of ancillary services were identified in this initial calculation. The CAISO requested that the vendor remove this feature and achieve the intended result by setting the penalty value for ancillary service shortages to zero in the pricing pass. Several test cases were run to test whether this change in the handling of ancillary service shortages was correctly implemented. Test case 110-4 verified that a code change produced the intended result in a case with cascading turned off across ancillary service products, but the code change has not yet been implemented in a software patch.[41]

In verifying that the cascading of ancillary service prices was working as intended, we observed that on-line units are able to submit offers to provide both spinning reserve and non-spinning reserve from the same capacity at distinct offer prices. Moreover, the entire rampable capacity of such a unit could be offered either to provide spinning reserve or non-spinning reserve with the overall ramp limit enforced when the market was cleared. Price cascading therefore operates somewhat differently than in other markets, as rampable capacity on an on-line unit could clear either as spinning or non-spinning reserve and would only trigger cascading if cleared as spinning reserve. Price cascading operated correctly in the base cases, case 7a, 102, 104 and 108, given these features. We observed instances in the test case bid data in which non-spinning reserves were offered at higher offer prices than spinning reserves on the same unit and

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[40] For example, in case 110 there is insufficient spinning reserve scheduled to satisfy the CAISO spinning reserve requirement in all 24 hours and there is also insufficient spinning reserve scheduled in regions 2 through 5 in all 24 hours. With cascading based on shortage values, the price of spinning reserve for region 2 would be the sum of the shortage value for spinning reserve for the CAISO region and for region 2. This cascading is observed in the scheduling and pricing passes in hours beginning 8 through 10 and 14 through 18 PST, in which the shadow price of spinning reserves is $12,000 for the CAISO region in the scheduling pass and $1000 in the pricing pass. However, in the remaining hours, it appears that the shadow price of spinning reserve in the CAISO region is set by the highest accepted offer price.

[41] The export case also has violated ancillary service requirements and has some dispatch inconsistencies that likely reflect incorrect calculation of ancillary service prices that the CAISO will want to reexamine once a software patch is available.

instances in which non-spinning reserves were offered at lower offer prices than spinning reserves. There were no instances in the test cases in which non-spinning reserve prices exceeded spinning reserve prices, however, it may be possible for market participant offers to produce this outcome.

RTUC

We were able to recalculate all ancillary service prices in the RTUC base case and in cases 210 and 206b, however, all spinning and non-spinning reserve shadow prices were equal to zero. We were also able to recalculate all ancillary service prices in cases 201, 203, 204, 205, 206, 207, 208(1) and 208(2) and in the rerun of the RTUC basecase and cases 203 and 204. The spinning and/or non-spinning reserve shadow prices were not equal to zero in these cases.

RTD

The LECG SAS price validation tool does not test the recalculation of ancillary service prices based on shadow prices in RTD because RTD does not schedule ancillary services.

5. Validate Ancillary Service Prices based on Marginal Offers

IFM

We were able to identify the correct number of marginal ancillary service suppliers in IFM case 106. A marginal ancillary service resource was identified for every binding ancillary service constraint in the rerun of case 7a. This analysis was not carried out for the rerun of case 110 because of the inconsistencies involving the way ancillary service shortage values appear to be setting price as noted in the preceding section. The correct number of marginal resources was identified in case 110-4.

RTUC

We are able to identify a marginal ancillary service resource for every binding ancillary service constraint in the reruns of RTUC cases 202, 203 and 204.

In case 208(2), the regulation down requirement was not being met and the price of regulation down in the pricing pass was $250, far above the highest accepted bid of $20. In both 208(1) and 208(2), the regulation up requirement was not met, and the regulation price was set by the highest accepted bid. As in the case 110 rerun, these inconsistencies probably result from the way the ancillary service requirements were relaxed when the requirement cannot be met and the pricing run penalty is set to zero.

RTD

The LECG SAS price validation tool does not identify marginal ancillary service suppliers in RTD because RTD does not schedule ancillary services.

6. Examine Ancillary Service Prices for Consistency with Ancillary Service Schedules, Energy Schedules and Energy Prices

IFM

Our review of the base cases and analysis track cases determined that resources scheduled to provide ancillary services are being scheduled to provide an amount that is consistent with the ancillary service prices, and energy market opportunity costs, in almost every instance. None of the inconsistencies identified revealed a flaw in the calculation of ancillary service prices. The inconsistencies that were initially identified and their resolution are noted below.

We initially observed seven instances in case 108 in which the co-optimization of energy and ancillary services appeared to be incorrect by more than $0.01, but less than $0.02, based on the reported energy and ancillary service prices. These anomalies were likely related to the large constraint shadow prices in case 108, combined with the rounding of transmission constraint shift factors discussed above in Section 3. This also occurs in three instances in case 109 and three instances in case 110. After Siemens corrected the inconsistent rounding, this issue was not observed in rerun cases 7a or 110.

We initially observed instances in cases 109, 110, and 111 in which offline units were scheduled to provide amounts of non-spinning reserves that were not feasible given the resource's start-up time, lower operating limits, and non-spin ramp rates.[42] This issue was corrected and was not observed in rerun IFM cases 7a or 110.

We observed instances in case 108 in which units were not scheduled for their full self schedule for non-spinning reserves, because they had an economic bid with a larger margin than the self-schedule modification penalty for non-spinning reserves. We believe that the software is scheduling these units correctly based on economics.

In the rerun IFM case 7a, we observed instances in which units were scheduled non-optimally between two ancillary services. These units were scheduled for one ancillary service up to the resources 10-minute ramp limit and then scheduled to provide

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[42] It is our understanding that offline resources cannot be scheduled to more than their: lower operating limit + (10 – start-up time)*non-spinning ramp rate. This issue occurred in 27 instances in case 109, 19 instances in case 110, and 93 instances in case 111.

another lower valued ancillary service for a fraction of a minute of ramp capability. We did not see this issue in rerun IFM case 110.

In the class B case 2006-4, we have observed some resources that are not providing regulation, but whose schedules are constrained by the upper regulating range, although they is economic to be scheduled to a higher energy output based on their offer prices. These resources are not at any other limits.

In the forbidden region case, we observed a new anomaly involving numerous instances of resources that were scheduled for regulation even though their total schedules were not inside their as-bid regulation ranges. The CAISO opened a variance on this issue and it was corrected. This issue was not seen in the forbidden2 case or forbidden3 case.

We observed one resource in the block2 case that was scheduled for non-spin during its minimum down time. This unit did not have a self-schedule for non-spin. CAISO opened a variance on this error and fixed it but we have not yet received a rerun.

While resources scheduled to provide ancillary services are almost always scheduled to provide the correct amount of ancillary services, we have identified instances in which resources were not scheduled to provide ancillary services when it would have been economic for them to have done so. These MIP Gap issues in the base case, and cases 7a, 102, 104, 106, 107, 108, 110, and 111 arise from the binary commitment decision for regulation (commitment = 0 or 1), as well as the commitment decision for non-spinning reserves when the unit is offline (commitment = 0 or 1). These binary decisions can cause units not to be scheduled for regulation or non-spinning reserves when they are in fact economic to provide that ancillary service. In the base cases, and cases 7a, 102, 104 and case 108, a varying number of units were scheduled to provide 0 MWs of an ancillary service, were not committed to provide that ancillary service, but it would have been profitable for the units to have provided that ancillary service.[43] These generally appear to be instances of non-optimal commitment due to the MIP gap.

One of these instances in case 108 included a resource that was forgoing a margin of nearly $1000/MWh by not being scheduled to provide regulation. This rather large departure from the optimal dispatch appears to have been a result of the value of the objective function for this case. The CAISO reran this case at a .01% MIP Gap level to

[43] 9 instances in the base case, 92 in the high demand base case, 7 in case 7a, 25 units in case 102, 7 in case 104, 38 in case 106, 29 in case 107, 113 in case 108, 2 in case 110, and 18 in case 111, 2 in rerun case 110, 5 in rerun case 7a, 74 in wheeling1 case, 13 in wheeling2 case, 16 in marketsim case, 23 in forbidden region case, 1 in case 110-3, 8 in case 7a-3, and 27 in the block2 case.

determine if these instances of non-optimal scheduling would disappear. The number of instances of non-optimal ancillary service scheduling in case 108 fell from 113 to 28 at the lower MIP gap level, and the instance of the unit forgoing the large regulation margin that was present in the .5% MIP gap case was eliminated with the unit correctly scheduled to provide regulation. The changes that were made to the way the objective function is defined addressed the potential for such material departures from optimality by materially reducing the absolute MIP gap.

There were 74 MIP gap-related dispatch errors in the wheeling1 case. These were associated with this case timing out before it could get to the .5% MIP Gap. The case was re-run with a longer time out period and in wheeling2 case there were only 13 MIP Gap instances.

RTUC

We observed in the RTUC base case and in case 210 that there continued to be instances of resources that are in their minimum down time being scheduled to provide non-spinning reserves. This situation appears to arise because minimum down time constraints are relaxed on units that are self-scheduled to provide non-spin and these resources have 0 MW non-spin self-schedules. With the minimum downtime constraint relaxed, these units received non-zero non-spin schedules based on their economic bids. CAISO has determined that the minimum down time constraint should be relaxed in this situation and therefore, the software is acting as intended.

We noted one instance in case 203 of an off-line unit being scheduled to provide non-spinning reserves although it had a 30-minute startup time. This issue was not observed in the rerun of the RTUC basecase, nor in the rerun of cases 203 or 204.

We noted an issue in cases 203, 204 and 206 in which units were offering more megawatts of spinning reserve than they could provide. CAISO indicated that this was a result of how the test data were prepared.

We observed one unit in case 210 that was not awarded its self-schedule of regulation down, although the unit was in its regulating range, was economic, and had the capacity to provide it. The resource was qualified to provide its full self-schedule in the day-ahead market, but was only scheduled partially in the day-ahead market. In this case, it appears that the RTUC schedule was limited to the quantity that cleared in the day-ahead market, rather than the quantity that was it was qualified to provide. CAISO is investigating why the RTUC dispatch appears to be constrained to be consistent with the day-ahead market schedule in this instance. This was also observed in rerun RTUC cases 202 and 204.

LECG identified four instances in case 204 of offline units not being scheduled to provide non-spinning reserves, despite having a non-spinning reserves self-schedule and not being in their minimum down times. Such instances were not observed in the rerun cases 202, 203, and 204.

In cases 201, 204 and 207 and 210, we identified instances of units scheduled to provide regulation despite being scheduled to generate energy outside their regulation ranges. CAISO has determined that there is a hierarchy of choices the software can make for regulation status and all of the apparent anomalies in these and other cases are consistent with the intended rules.

In rerun RTUC case 204, we observed instances in which units were scheduled non-optimally between two ancillary services. These units were scheduled to provide one ancillary service up to the resources 10-minute ramp limit and then scheduled to provide another lower valued ancillary service using a fraction of a minute of ramp. This issue was also seen in the rerun IFM cases and Siemens explained that it is related to a small threshold added to the ramp time of the combined upward AS ramp time allowed. CAISO and Siemens believe that this threshold should be removed, but are verifying that there is not a reason for it before doing so.

As in IFM, we observed instances of non-optimal commitment of resources providing ancillary services. There were four such MIP gap observations in the RTUC base case.[44] There was one example of this MIP Gap issue in case 203, 62 examples in case 204, two examples in case 207, three examples in case 209 and two examples in case 210. There were no such instances in the rerun of RTUC basecase or in cases 203 and 204.[45]

RTD

The LECG SAS price validation tool does not review ancillary service prices for consistency with ancillary service schedules in RTD because RTD does not schedule ancillary services.

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[44] The number of such instances fell from 4 in the .5% MIP gap base case to 2 in the .01% MIP gap base case.

[45] Thus, the number of MIP gap non-optimalities fell from 62 in the original 204, to zero in the rerun with the new objective function.

7. Examine Unit Commitment for Consistency with LMP Prices

IFM

The calculation of uplift costs by resource was not carried out for the November cases, but was included in the final evaluation of analysis track cases. The uplift evaluation was carried out considering both pricing pass and scheduling pass prices.

There were no instances of substantial uplift costs on units committed on economics in either of the base cases, cases 7a, 102, 104, 108, 109, 110, or 111. There were no substantial uplift costs in the wheeling1 case, wheeling2 case, marketsim case, or forbidden region case. There were instances of self-scheduled units being committed uneconomically based on their pricing pass penalty values, but all of these units were correctly committed based on their self-schedules in the scheduling pass. Uplift charges on other units were within the range that we would normally expect to see in such a unit commitment problem.

There were substantial uplift costs on 4 resources in case 110-3, over $200,000 per resource. These resources were not must-run, self-scheduled, nor were they providing a large amount of reserves (and in two cases no reserves). CAISO provided a re-run of this case and we confirmed that overall production cost increased when one of the 4 resources was de-committed for the entire horizon, indicating that the original solution was lower cost, despite the large uplift.

We calculated large forgone energy revenues for one resource in case 107 and 7 resources in case 106. All of these resources are among the resources for which we were unable to replicate the calculated LMP prices and all are indicated in a message file to be electrically disconnected from the grid. In some instances, the resources were scheduled to provide non-spinning reserves despite not being connected to the grid. As noted above, the CAISO and Siemens are reviewing various aspects of the modeling of these resources.

In the wheeling1 case, large forgone energy revenues were calculated for many resources. It is believed that these were associated with this case timing out before it could get to an optimal dispatch. The case was re-run with a longer time out period and in wheeling2 case the level forgone energy revenues were in line with expectations

The rerun of the IFM base case and 110 using an improved formulation of the objective function resulted in lower absolute MIP gaps than in the original cases. The absolute value of the MIP gap in the base case rerun was less than half the value in the .01% MIP gap case and far lower than in the .5% MIP gap case. The prices in the basecase rerun were similar to those in the .01% MIP gap case and the prices for one

LAP were materially lower than in the original .5% MIP gap case and were consistent with those in the .01% MIP gap case.

We calculated relatively large forgone energy revenues for two resources in rerun IFM case 7a. CAISO has indicated that these resources are located in a small load pocket, such that the LMP prices within the pocket change drastically if the units are online or offline. The resources at issue were committed during some hours in case 7a and their operation was slightly uneconomic during those hours.

RTUC

There was one unit with a must run operating mode that was not committed for energy in any of the RTUC test cases (except case 206b), including the reruns. This appears to have been the result of a data issue in which the unit was not modeled as connected to the grid in any of these cases.

In the export case, export2 case, and lap3 case there were 50, 249, and 38 instances, respectively of self-scheduled resources that were not committed and had a status of "offline." All of these resources were in their minimum down time. It is our understanding that self-schedule resources should always be committed even if in their minimum down time.

RTD

The SAS price validation tool does not review unit commitment in RTD because RTD is not commitment software.

III. CLASS B

The CAISO also asked us to carry out a limited review of several class B cases. These cases were structured to test the performance of certain elements of the IFM or RTUC software under particular conditions. For these cases, we did not carry out the complete set of tests described in Section IIA; instead we:

1. Verified that the CAISO's test methodology was conceptually appropriate for the test objectives.

2. Verified the CAISO's observations regarding the test results using the test case data provided by the CAISO or, if necessary, by obtaining additional data.

Cases 2001 and 2002 were designed to test whether the relative constraint relaxation priorities between specific hard constraints (unit minimums) and specific penalty priced constraints (transmission limits and self-schedules above the unit minimum) were operating as intended such that the hard constraints would be enforced in

the scheduling pass while the penalty constraints would be relaxed. The software operated with the correct priorities in both cases, enforcing the unit minimums, curtailing self-schedules, and violating the transmission limit.

Cases 2003 and 2004 tested whether the priority of transmission constraint relaxation was correctly applied between branch group constraints and line constraints with different penalty prices. The correct priority for relaxation of constraints was observed in the scheduling pass for constraints with different penalty prices.

Case 2005 tested whether if no self-schedules are curtailed in the scheduling pass and no other constraints are violated (e.g., there no transmission constraints are relaxed), overall energy and ancillary service schedules will be the same between the pricing pass and the scheduling pass. This outcome was observed. As expected, in instances in which there were multiple schedules with identical bid or offer prices at the same location, the specific schedule accepted could change between the scheduling and pricing passes.

Case 2006 tested whether LAP clearing prices are correctly set when there are uneconomic adjustments and that the LAP price can be recalculated from the underlying constraint shadow prices, shift factors and loss penalty factors. This could not be confirmed until the LAP price calculation issues were resolved. Now that they have been resolved, Case 2006 was re-run[46] and the Pnode and Apnode recalculation analyzed. We identified the Pnode issue associated with the incorrect sign being applied to the export constrained shadow price. There was a Pnode mapping issue relating to a Pnode that was mapped to two interties. We found one Apnode recalculation error related to the above Pnode export error. We identified an issue where it appears small Apnode participation factors are being dropped from the analysis and treated as disconnected nodes. CAISO and Siemens were looking into this issue.

The CAISO provided a third case 2006[47] that was run on a software patch with the fix for the incorrect sign getting used on the export constrained shadow prices. We confirmed that the pricing and dispatch of export constrained nodes was working correctly. The third case 2006 still contains the Pnode mapping issue where two resources on the same Pnode are not linked to the same inter-tie location. Also, we continue to identify an issue where it appears that small Apnode participation factors are being dropped from the analysis and treated as disconnected nodes. CAISO and Siemens were looking into this issue.

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[46] fc_ifm_test_case2006_lapadj_p353_e081508_517270244

[47] fc_ifm_test_case2006_p200020_e090108_517280540

A fourth 2006 case[48] was provided on a new patch. We confirmed that small Apnode participation factors are no longer dropped from the Apnode price recalculation. We identified one price recalculation issue on a Pnode where reported prices differed by $30 from the calculated price. We identified a large number of dispatch inconsistencies in the pricing pass involving self-scheduled load bids which were curtailed in the scheduling pass. These LAP load bids were dispatched consistent with the intended prorata curtailment in the scheduling pass which produced the relevant day-ahead schedules. However, some load bids were dispatched materially above their scheduling pass level in the pricing pass, although the pricing pass LMP at their LAP exceeded (by more than $1000 per megawatt in some hours) the $500 pricing run bid cap. This apparently relates to the way prorata curtailment was implemented in the pricing pass. Analysis of this case is hindered by an extremely large MIP gap, greater than 80%, and units which apparently should have been committed but were not. It has not yet been determined if there is some error in setting up the case that is leading to these problems.

Conversely, in the 2006-4 case, there are load resources at the same lap whose self-schedules were correctly curtailed in the scheduling pass, but then were dispatched materially down (i.e. more than just an epsilon) below their scheduling pass level in the pricing pass. These loads should not have been dispatched more than one epsilon below their scheduling pass level in the pricing pass. This observation also appears to be related the way the pro-rata curtailment was implemented in the pricing run.

Case 2012 validates LMP prices on both sides of a transmission constraint based on shift factors and shadow prices. This outcome was observed.

Cases 4004 (DLS) and 4004 (DGS) were used to compare the LMP decomposition between a Distributed Load Slack bus (DLS) and a Distributed Generation Slack bus (DGS). LECG only analyzed these cases from the standpoint of identifying price calculation errors. LECG was able to recalculate all of the Pnode prices. However, we were unable to recalculate some of the Apnode prices, including each of the default LAP prices in one or more hours. Now that the Apnode price recalculation issues have been resolved, it should be possible to rerun these cases and confirm the expected result. Case 4004 was re-run and we were able to recalculate Apnode prices, including all default LAP prices.

Cases 5003 and 5004 included changes in transmission limits within the time frame of the optimization. We verified that the change was correctly applied and reflected in the dispatch and prices.

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[48] fc_ifm_staging_case2006_e10132008_417210560

Attachment 8.5

SAIC Module Certifications

Congestion Revenue Rights
Integrated Forward Market/Real-Time Nodal
Market Quality System
Scheduling Infrastructure Business Rules

Certification of the Congestion Revenue Rights (CRR) Module

Introduction

Science Applications International Corporation (SAIC) has been contracted by the California Independent System Operator (CAISO) by way of Service Order No. 9 to CAISO Contract No. 05-00782, to assist CAISO in its effort to transition from the zonal market structure to the nodal market structure known as the Market Redesign and Technology Upgrade (MRTU). SAIC's task was to review portions of the Congestion Revenue Rights Module (CRR Module) that was developed, built and tested by CAISO and representative software vendors pursuant to the MRTU Tariff, ER06-615-00, (Tariff) filed by CAISO with the Federal Energy Regulatory Commission (FERC) and conformed through November 15, 2007. Review of subsequent Tariff amendments or any other submissions, filed with FERC was not in the scope of Service Order No. 9.

Congestion Revenue Rights (CRRs)

Per CAISO, the Congestion Revenue Rights (CRRs) are financial instruments that enable holders of such instruments to manage variability in Congestion costs that occur under Congestion Management protocol that is based on locational marginal pricing. CRRs are acquired by qualified entities primarily, but not solely, for the purpose of offsetting costs associated with IFM Congestion costs that occur in the Day-Ahead Market. They can also be used for other legitimate activities, many of which will increase the liquidity of the CRR market. Only CRR Obligations can be acquired through the CRR Allocation and CRR Auction processes. CRR Options are not available through the CRR Allocation and CRR Auction processes and are only available for Merchant Transmission Facilities.

The CRR Module is designed to allow market participants to participate in the CAISO's CRR allocations, CRR auctions and CRR secondary market. It allows the CAISO to conduct long term and short term allocations and auctions. Through the CRR Module, the market participants have the ability to nominate on allocations, bid on auctions and bilaterally trade CRRs via the web-based CRR Market User Interface (MUI).

SAIC provided Tariff analysis and certification services, as approved by CAISO, to ensure that SAIC's review of CRR software components complied with certain portions of the Tariff. A thorough review of the Tariff as outlined in the "Scope of Review" section of this document was used to produce a matrix of one-time and ongoing mapping of CRR requirements and testing metrics. The mapping matrixes were reviewed and approved by CAISO to ensure they were in line with CAISO's operational goals and strategy.

Scope of Review

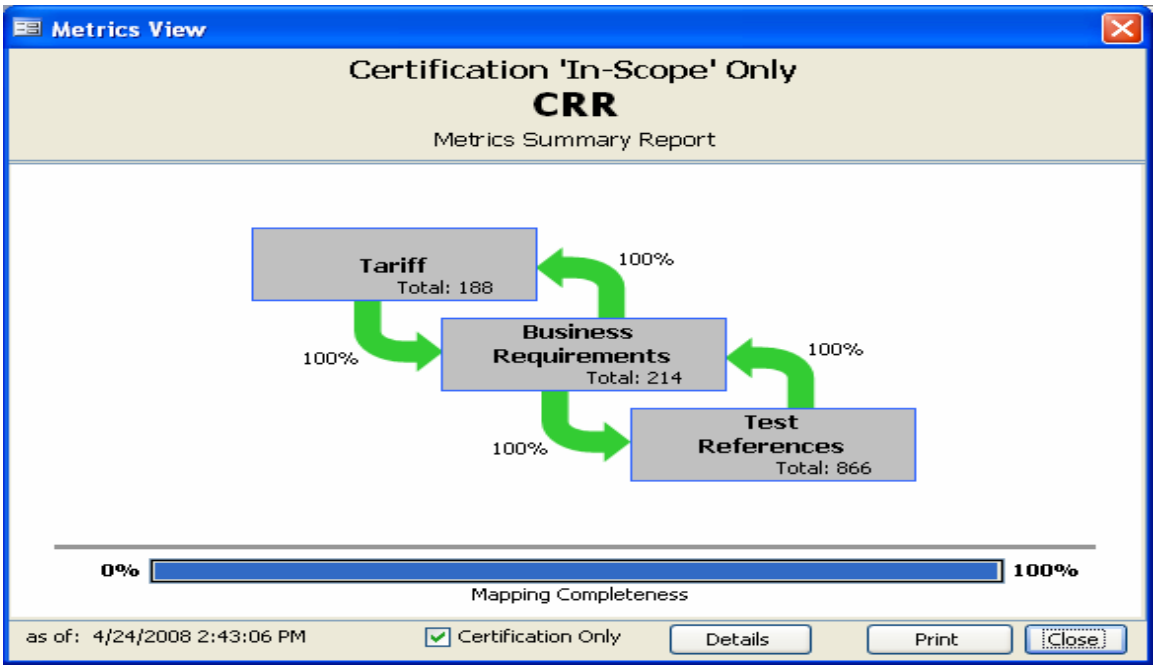
SAIC and CAISO developed a structured approach to reviewing documentation and the documentation's relationship to the Tariff by identifying certain Tariff provisions, mapping Tariffs to the documented specifications, reviewing test books, and reviewing the validated test results.

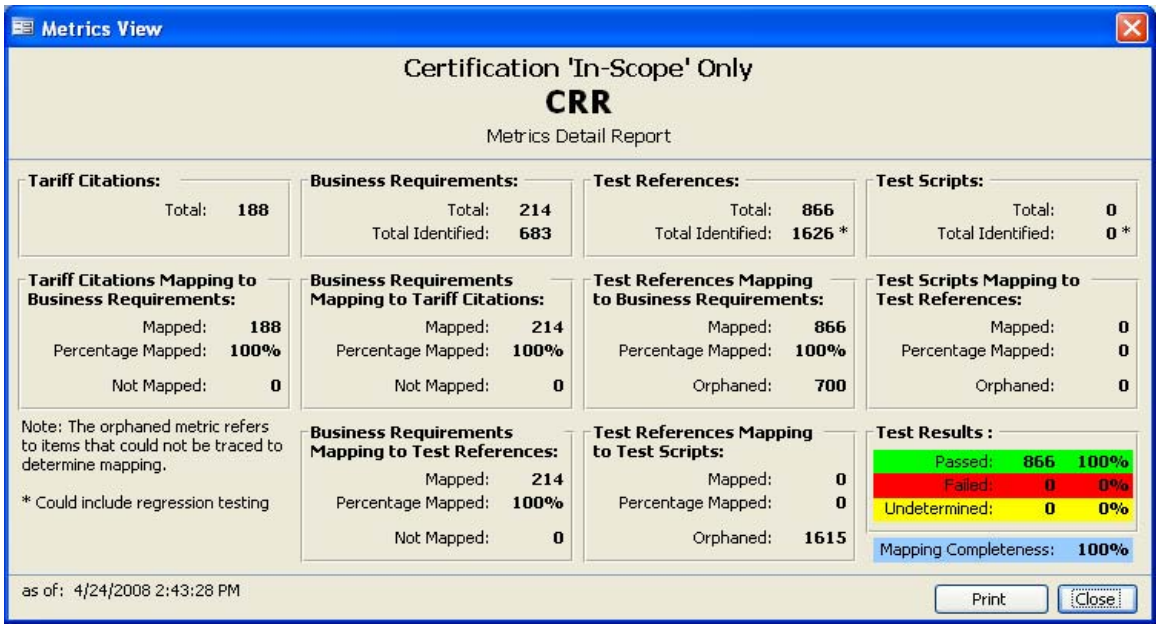
SAIC reviewed data to ascertain whether specific portions of the CRR Module passed certain acceptance tests developed and performed by CAISO to test particular portions of the related criteria stated in the Tariff and CRR documentation. However, such testing was not intended to be and is not a guarantee by SAIC of the CRR Module's compliance with the Tariff. Error-free use and compliant results in a production environment over time will be the best indicator as to whether the CRR Module is in accordance with the Tariff filings and CRR documentation.

At the direction and approval of CAISO, the scope of SAIC's certification services were limited to the following documents and tasks that are the baseline of SAIC's certification representation made within this document:

- ER06-615-000 MRTU Tariff, as conformed through November 15, 2007, was used as the baseline. Subsequent versions of the Tariff filed with FERC were not reviewed by SAIC.
- CAISO directed SAIC to review the following specific Tariff sections:
  - Section 6.5.1 – Communication with Market Participants, Congestion Revenue Rights Participants, and the Public.
  - Section 36 - Congestion Revenue Rights
- Tariff review was conducted by SAIC on the specified Sections listed above. A process was utilized to identify all Tariff citations that were deemed in-scope by CAISO based on whether the citation pertained directly to a business function (in-Scope) or pertained to non-business (reporting, memory usage, etc.) functions (out-of-scope). In-scope items were initially identified by SAIC then reviewed and approved by CAISO personnel.
- CAISO's Business Practice Manual for Congestion Revenue Rights (Version 2 dated 7/2/2007) was used to clarify language of the above described in-scope Tariff citations.
- As-Built System Documentation for Congestion Revenue Rights (CRR), Version 1.1 dated 1/30/2008. A process was utilized to identify all requirements that were deemed in-scope by CAISO based on whether the requirement pertained directly to a business function (in-Scope) or pertained to non-business (reporting, memory usage, etc.) functions (out-of-scope). In-scope items were initially identified by SAIC then reviewed and approved by CAISO personnel.
- CRR Test Books and Results. 2.0 SAT is the latest round of testing.

- A mapping matrix was developed by SAIC and utilized during the scope of work. The matrix traced Tariff provisions to CRR Requirements to CRR Test Books to Test Results. Empirical metrics were derived from the mapping matrix. Graphical depictions of summary and detailed metrics are outlined below.





Certification

Pursuant to the contract between SAIC and CAISO referenced above and subject to the limitations and caveats expressed herein, SAIC hereby certifies that the CRR Module achieved a 100% mapping completeness rating and 100% passed test rating based on the methodology generally outlined in the "Scope of Review" section of this document, as of the completion of these services on March 26, 2008

Submitted By:

Science Applications International Corporation

By: _____

Name: Bob Kinsella

Title: Project Manager

Date: May 12, 2008

Attachment 8.6

MRTU Readiness Criteria