Issue Paper

Data Release & Accessibility

Phase 1: Transmission Constraints

November 5, 2009

Data Release & Accessibility in ISO Markets

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1. Introduction

With the start up of the California Independent System Operator Corporation's (the ISO) new market system based on Locational Marginal Pricing (LMP) on April 1 of this year, stakeholders have expressed a desire for the release of additional information that would enable them to better understand market results and participate more effectively in the ISO markets. In response the ISO committed to conduct a stakeholder process to explore the issue of data release and accessibility in ISO markets, and to implement appropriate enhancements to its current data provision practices. This issue paper is intended to initiate discussion with stakeholders regarding the specific types of information they would like the ISO to provide and the potential enhancements the ISO should consider implementing.

The Data Release & Accessibility Initiative will consist of three phases:

- Phase 1: Transmission Constraints (the topic of this issue paper),
- Phase 2: Convergence Bidding Information Release (issue paper expected to post before Thanksgiving), and
- Phase 3: Other types of market data to support well-functioning, competitive ISO spot markets, including Price Discovery and Outage Information.

This issue paper focuses on information related to transmission constraints; specifically, it addresses the question of what additional visibility can be provided to market participants regarding the ISO's management of transmission constraints and the impacts of network conditions and the ISO's constraint management practices on market results. On October 2, 2009, the Federal Energy Regulatory Commission (FERC) issued an order (129 FERC ¶ 61,009 (2009) (October 2 Order)) in Docket No. ER09-1542-000, requiring the ISO to convene a stakeholder process with an aim to address concerns raised by parties in that proceeding regarding what additional transparency and visibility can be provided with respect to the ISO's transmission constraint enforcement practices to account for system conditions in managing the limits of the transmission system. In addition, FERC directed the ISO to consider in this stakeholder process ways in which the ISO can provide (1) the list of the constraints that are not enforced in ISO markets and (2) the list of contingencies that are enforced in ISO markets. Finally, FERC also directed the ISO, "through its stakeholder processes, to develop guidelines for its constraint management process, and, within 90 days of issuance of this order, submit tariff sheets setting forth those principles that significantly affect rates, terms or conditions."

The ISO had originally intended to structure its *Data Release & Accessibility* initiative as a single comprehensive process to consider all types of market information needed to support the efficiency of its spot markets. As a result of this order and the directive that the ISO commence the stakeholder process as expeditiously as possible, however, the ISO determined that the best course of action was to segment the *Data Release & Accessibility* initiative in three phases. The first phase will focus on directives of the *October 2 Order* so that the ISO may meet the near term December 31, 2009 deadline for a compliance filing. The second phase will address the concerns raised by market participants regarding convergence bidding data release. Phase 3 will consider any other types of market information that would be appropriate and feasible for the

ISO to provide to market participants to foster market efficiency and competitiveness, including Price Discovery and Outage Information.

Phase 1: Develop Guidelines on ISO's Constraint Management Process.

This first phase will address FERC's specific directives in its *October 2 Order*.

Constraint Enforcement Practices: What additional information and visibility can be provided with respect to the ISO's transmission constraint enforcement and practices to account for system conditions in managing the limits of the transmission system?

Constraint & Contingency Lists: Determine how the ISO can provide the list of (1) enforced and unenforced constraints and (2) active contingencies.

Tariff Guidelines on Constraint Management: Develop high level guidelines for the ISO's constraint management process to be included in the ISO tariff in compliance with FERC's *October 2 Order*.

This discussion paper is the first step in the ISO's stakeholder process to explore Phase 1 of the ISO's *Data Release and Accessibility* initiative. Its purpose is to identify issues and, where appropriate, discuss possible approaches to address such issues. This paper will be followed by a conference call on November 12, 2009. After the call, stakeholder comments on Phase 1 issues are requested by November 23, 2009 to the Data Release & Accessibility Project Mailbox, Phase1TC@caiso.com

2. Process and Proposed Timetable

The following timeline is for the stakeholder process and FERC filing related to Phase 1. The timing for implementation of the data release developed in Phase 1 will be determined later in this process. Specific timelines for Phase 2 and 3 will be released with the issue papers for those phases. At this time the ISO anticipates completing the stakeholder processes for Phases 2 and 3 in the first quarter of 2010.

Phase 1 Timetable

Tentative Date	Milestone
November 5, 2009	Publish Issue Paper
November 12, 2009	Stakeholder Conference Call
November 23, 2009	Due Date for Stakeholder Comments
On or before December 3, 2009	Publish data release proposal and draft constraint management tariff language
December 10, 2009	On-Site Stakeholder Meeting
December 16, 2009	Stakeholder comments on data release proposal and draft tariff language
December 31, 2009	FERC Compliance Filing in ER09-1542-000

3. Phase 1: Overview & Objectives

The ISO's current transmission constraint management practices are described in parts in several areas including the tariff, the Business Practice Manuals (BPMs), Technical Bulletins, and in various operating procedures. As noted above, in an effort to complete the directives in FERC's *October 2 Order* as expeditiously as possible, the first phase of the *Data Release and Accessibility* initiative will focus on determining what additional data or information can be provided to ISO market participants regarding the ISO's transmission constraint enforcement and management practices to account for system conditions in managing the limits of the transmission system. In Section 4 of this paper, we provide a description of the ISO's current practices in this area. This section is intended to provide the lay of the land so that the ISO and its stakeholders can productively discuss what additional information is needed and may be provided regarding its transmission constraint enforcement and practices.

In an effort to enhance visibility into the ISO constraint enforcement, in Phase 1, the ISO will also resolve the more discrete task of determining how the ISO can provide the (1) list of enforced and unenforced constraints and (2) the list of active contingencies. This directly addresses the issue raised by stakeholders previously and reflected in the *October 2 Order* requesting that the ISO address "ways in which the CAISO can provide (1) either the list of the constraints that are not enforced in the CAISO market or more visibility into how they are established and (2) the list of contingencies that are enforced in the CAISO market process." In

Section 5, the ISO discusses the provision of the constraint and contingency enforcement information for ISO markets.

In addition, with regard to binding constraints, the ISO has conducted a preliminary review of the other ISO/RTO practices in this area and provides a summary in section 6 of this paper. While the practices vary, as discussed further in Section 6 below, the ISO has determined that in addition to providing the shadow price associated with a binding constraint for any given market interval, as the ISO does on its OASIS, other ISOs/RTOs also provide additional information regarding the cause for the binding constraint. For example, if a constraint becomes binding in the market contingency analysis the applicable contingency is identified.

Finally, while this issue is not directly related to the *Data Release and Accessibility*, in Phase 1, the ISO will also address the development of high-level guidelines regarding its transmission constraint management to be included in its tariff. In its *October 2 Order* FERC concluded that it would be "impractical to list in the tariff all instances in which the CAISO will relax, enforce, or manually adjust constraints, [but that] it is reasonable for the tariff to include the general guidelines explaining the CAISO's constraint management practices" (p.18).

In summary, in the Phase 1 stakeholder process the ISO intends to discuss and resolve the following three items:

Constraint Enforcement Practices: Determine what additional information and visibility can be provided with respect to the ISO's transmission constraint enforcement and practices to account for system conditions in managing the limits of the transmission system.

Constraint & Contingency Lists: Determine how the ISO can provide (1) the list of enforced and unenforced constraints and (2) the list of active contingencies.

Tariff Guidelines on Constraint Management: Develop high-level guidelines that describe the ISO's constraint management processes and include the appropriate level of detail in the tariff.

This issue paper discusses the first two items; the third item will be included in the next paper the ISO releases for Phase 1.

4. Constraint Enforcement Practices

Determine what additional information and visibility can be provided with respect to the ISO's transmission constraint enforcement and practices to account for system conditions in managing the limits of the transmission system.

4.1. Description of Current ISO Constraint Enforcement Practices

Over the past year, in preparation for the start of its new market, the ISO responded to requests for additional information regarding the ISO's transmission constraint enforcement and management under LMP-based markets. However, several market participants have expressed, in various forums at the ISO and with the FERC, the need for additional information and visibility regarding the ISO's transmission constraint enforcement and its practices for accounting for system conditions in managing transmission system limits.

The ISO operates its day-ahead and real-time markets through the use of a market software system that calculates and mitigates transmission congestion, establishes load and resource schedules and dispatch instructions, procures ancillary services and calculates LMPs and ancillary service marginal prices (ASMPs). The market system utilizes various inputs to model the physical transmission grid, associated flows and congestion, and interconnected load and generation resources. In order to properly function, the market software requires a model of the physical transmission network, one that provides a detailed and accurate representation of the physical power system on which the energy scheduled by the ISO markets will flow. This underlying representation of the power system is provided through the Full Network Model (FNM). The purpose and development of the FNM is described in significant detail in the business practice manual (BPM) for Management of the Full Network Model which can be found here: https://bpm.caiso.com/bpm/bpm/version/000000000000004.

It is important to understand the relationship between the FNM and the market software. The FNM is essentially a network topology data set that is a crucial *input* to the market optimization software, but it is not software, and does not perform any of the required optimization or market clearing functions of the market software. In particular, the FNM does not enforce or manage transmission constraints, it simply represents the constraint in a data format that the market software can use to perform its congestion and constraint management functions. Thus, the FNM is a snapshot of the CAISO Controlled Grid and that snapshot is in data set form, which exists in a large text file and a series of data tables.

The FNM used in the ISO markets undergoes a major update or release every six to eight weeks; these are the "DB-xx" releases with which most market participants will be familiar. While each of the ISO markets runs daily and uses essentially the same, current FNM release, there are continual changes to the physical network occurring due mainly to outages and derates of transmission facilities, and these changes must be incorporated into the market network model

data set that is provided to the market software in order to ensure that the resulting market schedules are feasible and the market prices accurately reflect current system conditions. Therefore, the market network model actually used in each ISO market run is based on the current DB-xx FNM release and is then tailored by the ISO to accurately reflect real-time characteristics of the transmission network.

Even with the daily adjustments to the FNM to reflect current outages and derates, the resulting market network model is still only a data set snapshot of the grid at a particular point in time and cannot by itself guarantee that the market software results will accurately reflect all the factors that contribute to actual real-time flows on the ISO grid consistent with good utility practice. The ISO, therefore uses, other tools, practices and applications for managing network and resource constraints to produce market results that better align with real-time physical conditions on the grid. These tools, practices and applications are what is referred to as the transmission constraints setting and management practices and is the area of activity that the ISO believes stakeholders seek to have greater visibility.

Section 2.1.1 of the BPM for FNM provides a detailed description of these practices and the principles that guide the actions the ISO operators and operating engineers will take in preparing the market network model for the market optimization software. In that document, we indicate that there are several instances in which it is not appropriate for the IFM/RTM Systems (*i.e.*, the market optimization software that is used in running the energy and ancillary services in the Day-Ahead Market (DAM), which includes the Integrated Forward Market (IFM) and the Residual Unit Commitment (RUC), and the Real-Time Market (RTM), which includes the Hour Ahead Scheduling Process (HASP), and the Real-Time Dispatch)) to enforce all constraints that are specified in the raw FNM. For example, for grid facilities where there is insufficient visibility to ensure the accuracy required for congestion management through the IFM/RTM System, the constraints will not be enforced by the market software. In these cases the operators will examine all available information, including State Estimator solutions, reliability tools, and available telemetry, to operate the system. For such circumstances the operators will follow the relevant ISO operating procedures[1] where applicable.

The BPM for FNM and the ISO Operating Procedure M-401[2] provide additional information on a process through which on any given day the ISO staff reviews the results of power flow analyses run (1) for the next Trading Day (D-1, within the DAM process), (2) for one day past the next Trading Day (D+2), and (3) for two days out past the next Trading day (D+3). This process is intended to allow the ISO to validate the market network model, including any changes to topology or ratings due to planned or forced outages, and evaluate the feasibility and reliability implications of market commitments and schedules. This process also allows the ISO

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[1] CAISO operating procedures define constraints other than thermal limits of individual network branches, and state the conditions in which the constraints are valid, including variation by season, time of day, temperature, wind speed, existence of outages, market time horizon, etc.

[2] M-401 Day Ahead Market Operating Procedure, http://www.caiso.com/docs/2000/07/19/200007191535315040.pdf

to consider any of the factors described further below that may require changes to the enforcement status of certain constraints or contingencies.

While described more fully in the BPM for the FNM, below are the five main guidelines that describe what transmission limits (flowgates, constraints, nomograms, or intertie limits) are generally not enforced in one or more of the ISO Market processes:

(1) Facilities that Lack Sufficient Telemetry and Visibility

> "Certain transmission facilities lack sufficient telemetry to provide accurate data for market dispatch and pricing purposes [which] … may lead to spurious congestion or infeasible schedules. The CAISO therefore generally *does not* enforce constraints on the facilities where there is not sufficient telemetry and visibility. This applies to many facilities below 115 kV and to a small number of facilities at 115kV, but does not apply to any of the facilities above 115 kV."[3]

(2) Intertie Constraints

> "Each intertie between the CAISO and an adjacent Balancing Authority Area has both a flow limit and a scheduling limit. … The CAISO Markets are operated on a flow-based congestion management design, whereas the joint scheduling practices with neighboring Balancing Authorities continue to be based on enforcement of the scheduling limits. … The CAISO … does not enforce intertie flow limits in the DAM and will continue to rely only on the scheduling limits for congestion management in the DAM.[4] … The CAISO does, however, enforce flow limits in real-time for WECC rated interties as required by WECC, and monitors the actual real-time intertie flows to identify any situations where enforcing and/or adjustment of a flow limit that was not enforced would be appropriate based on actual conditions, and can turn on an intertie flow limit if necessary. [However,] adjustment to the flow limit may be necessary to account for differences in actual flow and flows resulting from market schedules …."[5]

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[3] *See* BPM for FNM at p.15.

[4] There are some exceptions to this general rule. Intertie scheduling limits are enforced either through an Intertie Constraint (ITC) or a Market Scheduling Limit (MSL). Market Scheduling Limits are a flow based intertie constraint that completely encircles one or more Scheduling Points, while an Intertie Constraints a mathematically constraint limit the net energy, ancillary services scheduled from one or more Scheduling Points while also accounting for Existing Transmission Rights. In some instances, if the a Scheduling Point participates in more than one intertie scheduling limit and therefore is already associated with one ITC the ISO will use an Market Scheduling Limit to ensure that the intertie scheduling limit is adhered to.

[5] *See* BPM for FNM at p.16.

(3) Management of Use Limited Resources

"Enforcement of certain constraints and contingencies in the DAM may result in the start-up of one or more use-limited resources, such as combustion turbines (CTs) and hydro facilities located in the area of the affected constraints, in anticipation that the contingency or other event causing the constraint to bind would occur in real time. … The CAISO, therefore, does not enforce certain constraints and contingencies in the Day-Ahead Market, but will enforce them in the RTM and utilize operating procedures if necessary to commit and dispatch the use-limited resources only when needed." [6]

(4) Management of Transmission Outages

"Planned transmission outages present another situation where there is a need for the ISO to exercise judgment as to whether to enforce a contingency-based constraint. … The CAISO may determine that alternative constraints should be applied instead of the originally defines ones for the duration of the planned outage work." [7]

(5) Lessons from Market Results

"Market solutions may demonstrate that enforcement of certain constraints repeatedly produces inaccurate results either because they frequently indicate congestion in the markets that is not materializing in real time (i.e., false positives), or because they tend not to register congestion in the markets but become congested in real time (i.e., false negatives). For the false positive cases, CAISO engineering staff compares actual flow data against the flows implied by market schedules and assesses whether modeling improvements can reduce the observed discrepancies. If this is not possible the CAISO may stop enforcing such constraints in the markets while continuing to monitor their associated real-time flows, so that if unscheduled congestion becomes an issue the CAISO can resume enforcing the constraints in the markets. For the false negative cases, CAISO engineering staff assesses the possibility of improving the model, but in these cases if improvements cannot be found the CAISO continues to enforce the constraints in the markets to avoid exacerbating potential schedule infeasibilities. In either situations, the CAISO may utilize an adjustment to a constraint limit as a preferable third alternative to either turning the constraint completely off or enforcing it at its normal limit." [8]

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[6] *See* BPM for FNM at p.16.

[7] *See* BPM for FNM at p.17.

[8] *See* BPM for FNM at p.17.

4.2. Specific ISO Constraint Enforcement Practices

There are several categories or types of transmission constraints specific to the ISO: (1) flowgates, (2) nomograms in ISO Operating Procedure M-405 Nomograms, corridors, and Contingencies, (3) any temporary nomograms used to reflect specific outages, and (4) all intertie limits, which include Intertie Constraints (ITCs) and Market Scheduling Limits (MSLs). At the interties, there are flow-based constraints and scheduling limit constraints. Scheduling limit constraints (or ITCs) are constraints that limit the quantity of scheduled energy and ancillary service at one or more Intertie Scheduling Points, also taking into consideration the Existing Rights. MSLs are flow based intertie constraints.

Several distinctions can be made between enforced and unenforced constraints. An unenforced constraint is not considered in the optimization dispatch solution even if the constraint's limit is reached or exceeded and, therefore, will not lead to the redispatch of resources. Essentially, an unenforced constraint does not exist in the market network model. In contrast, an enforced constraint is modeled and considered in the optimization, which may lead to a different resource commitment and/or dispatch than would have been dispatched had the constraint not been enforced. When a constraint results in a different economic dispatch than what would have been dispatched had the constraint not been enforced, the constraint is considered to be "binding," and such binding constraints may affect prices.

The ISO operators and operating engineers review the list of potentially enforceable and unenforced constraints for use in market runs and determine if any constraint enforcement adjustments are necessary in the D+2 and D+3 timeframes. These practices are further described in the FNM BPM in Section 2.1.1 Overview of Constraint Enforcement in the IFM/RTM System.

4.2.1 General Principles for Transmission Constraint Enforcement Practices

Below are a set of general principles that illustrate the elements the ISO enforces, with exceptions as noted further below:

- Normal ratings are enforced all the time with exceptions as noted below.

- Emergency ratings are enforced during market contingency runs with exceptions noted in the next section. ISO Procedure M-405 defines a list of base contingencies that are activated all the time as default. Additional contingencies can be defined and activated in addition to the base contingencies where appropriate, mostly for specific planned or forced outages as captured in the Scheduling and Logging for ISO of California (SLIC) ticket or changes to current topology.

- All Internal Major path limits (corridors) are enforced.

- All Internal Branch Groups (corridors) are enforced.

- Certain 70 kV and lower voltage transmission lines and transformers where appropriate (*i.e.*, where there is telemetry) are enforced.

- All Nomograms in ISO Operating Procedure M-405 *Nomograms, TCORS, & Contingencies*.

- Any temporary nomograms or contingencies used for specific outages.

- All intertie limits (MSLs). Only MSL's that do not have a companion ITC enforced will be enforced.

- All Intertie Constraint (ITC) are enforced.

The following illustrates the types of transmission constraints that are generally unenforced:

- Lines and transformers that are not under the ISO direct control, such as merchant non-utility generation tie lines and step up transformers.

- Lines, transformers, and other ratings outside the CAISO Balancing Authority Area, that are not part of the CAISO Controlled Grid.

- Flow limits across the ISO boundary, in market runs where compensating injections are not calculated or where actual boundary flows are not matching market calculated flows and an Intertie Scheduling Limit is established.

- 70 kV and lower lines and transformers that lack sufficient telemetry. There are also certain 115 kV lines and transformers where telemetry is not available and, therefore, are not enforced.

- When the ISO's practices for conforming transmission constraints conflicts between monitoring normal ratings vs. emergency ratings.[9]

- When real-time temperature adjusted ratings are used for certain lines and transformers.

- Competing Branch Groups or constraints in which the most limiting constraint will be enforced and sufficiently mitigate linear or non parallel constraints.

[9] When a conforming adjustment is made to a transmission element, the percentage adjustment will apply to both the normal and emergency rating. As a result in some cases when trying to make a conforming adjustment to a market emergency limit to reflect a expected flow impact of a contingency, the same conforming adjustment applied to the normal limit causes the transmission element to bind prematurely than actual conditions warrant.

- Select nomograms in the Day-Ahead Market where effective generation may be use limited.

4.3. ISO Practice of Managing Transmission Constraints by Adjusting Transmission Limits

Market participants and stakeholders have expressed concern over insufficient visibility to the ISO operators' practices for adjusting market transmission system limits. ISO operators make adjustments for (1) conforming transmission limits to achieve greater alignment between the energy flows calculated by the market software and those observed or predicted in real-time operation across various paths, and (2) setting prudent operating margins consistent with good utility practice to ensure reliable operation under conditions of unpredictable and uncontrollable flow volatility. In conforming transmission limits the operators and operating engineers seek in part to compensate for the time lag, inherent in the structure of the five-minute real-time dispatch, between first detecting imminent congestion and the response of resources to dispatch instructions. In setting reliability margins, the operators seek to ensure that the market software produces a solution that is reliable and consistent with good utility practice within the general state of the system including potentially unpredictable flow variability and changing congestion patters. The term "biasing" has previously been used to refer to both these practices, but with this issue paper the ISO adopts the preferred term "conforming transmission limits" for the first category because it more accurately reflects the true intent and nature of this practice. The second category we will refer to simply as setting reliability margins.

In response to stakeholders' concerns about transparency, the ISO published a technical bulletin describing the principles that drive these practices conforming transmission limits to better align market flows with actual flows and setting reliability margins.[10] In the technical bulletin these two primary categories of transmission limit adjustment were further broken down by the following four objectives:

- Where real-time market flows are not consistent with actual flows.
- Align calculated market flows with measurable or predictable actual flows.
- Accommodate mismatch due to inherent design differences of DAM, Real-Time Unit Commitment (RTUC) and the Real-Time Dispatch (RTD) runs (such as the time lag between detecting a real-time flow issue and realizing the result of a resource's response to an RTD dispatch instruction).
- Allow reliability margins for certain flowgates.

[10] The technical bulletin was posted on July 2, 2009 and can be found at http://www.caiso.com/23ea/23eae8aef980.pdf.

- Adjust margins for flowgates impacted by telemetry issues.

As explained in the technical bulletin, the act of adjusting transmission limits for any of the purposes discussed above is not a feature new to the LMP-based ISO markets. Conforming transmission limits and setting reliability margins in the market model are prudent and necessary operating practices that were used even under the prior zonal market design. The technical bulletin discusses the differences between the previous zonal market versus the new LMP market with respect to how adjustments to transmission limits affects market results. A key difference is that under the zonal market, the intra-zonal constraint margins were managed through the out-of-sequence real-time dispatches rather than through the market optimization. Consequently, the zonal prices did not reflect the impact of such practices, which were instead reflected in the costs of out-of-sequence dispatching.

In contrast, under the current LMP market design, the nodal prices capture the impact of the actions taken by ISO operators to adjust transmission limits. The advantage of this is that once the ISO operators adjust the relevant transmission limits in the market software, the dispatch instructions issued to manage congestion are generated through the market optimization as opposed to having to rely on non-market operator actions, and therefore the costs are reflected in prices and recovered through the energy settlement. One result of this new relationship between adjustments and market results – prices, schedules, dispatches and awards – has been the additional interest on the part of market participants for visibility into how these practices affect market outcomes. Therefore, the ISO is taking this opportunity to explore what kind of information market participants require in order to have better visibility into the principles behind conforming and margin setting practices and how these actions affect market outcomes.

To provide a framework for this discussion, below is an outline of how transmission limits are conformed and reliability margins are set. The reasons for such actions are more fully discussed in the technical bulletin mentioned above. Here we provide a simple structure so that participants in this discussion can better identify the data that may be made available and for what purpose.

What is adjusted?

- The ISO does not adjust scheduling limits.

- Margins for purposes of conforming limits are only applied to market operating limits for certain branch groups (flowgates/transmission interfaces).

Guidelines for adjusting limits.

- Where real-time market flows are not consistent with actual flows.

- Flowgates that consistently bind in the real-time market and are conformed in the real-time market may also need to be biased in the day-ahead market. But this is not always the case and varies depending on the type of constraints that become binding in the real

time market. If the constraints that bind in the real-time are of the nature that does not consistently appear in the day-ahead market also, the ISO does not translate its real-time conforming practice into the DAM. For example, if it is it is evident that almost all the constraints that were conformed in real-time were actually "conformed up," which means that it was necessary to conform the limit to relieve the otherwise fictitious congestion that the real-time market would have caused, the ISO would not then conform the DAM limits. On the other hand, if the congestion repeatedly appears in DAM, the operating engineers evaluate the validity of this information and may recommend conforming the constraints or unenforce constraints, as appropriate, to better align the DAM results with actual conditions.

- Each constraint is unique and may require different margins when conforming in the DAM based on experiences in the real-time.

- The adequate level of adjustment in the DAM is based on the measureable or predictable difference between actual flows (from telemetry) in the real-time and DAM estimated flows. Review of historical and DAM flow differences inform this process and impact the degree to which the limits are conformed.

- Whether to conform any particular limit is based in part on the conditions leading to flow differences and their interplay with reserves or regulation management and the level of scheduled intermittent resources.

5. Constraints & Contingency Lists

Determine how the ISO can provide (1) the list of enforced and unenforced constraints, and (2) the list of active contingencies.

Currently, the ISO provides a complete list of enforced and unenforced constraints and contingencies in the data it provides under non-disclosure agreement in the Congestion Revenue Rights FNM (CRR FNM). However, because the CRR FNM is released on a timetable to support the monthly and annual CRR release processes, the information regarding transmission constraints and contingencies available in the CRR FNM is not always fully consistent with the enforced and unforced constraints or active contingencies in the DAM or RTM in actual operation.

In this exercise, the ISO seeks to explore more fully the data required and the format, granularity and frequency of feasible data provision by the ISO. These factors are important because they will determine whether, how and when the ISO can provide any additional visibility to these elements. The ISO has not yet conducted a feasibility assessment regarding potential data release approaches given that the full scope of parameters have not been identified. Therefore, any proposed information discussed below is for the purpose of exploring market participants' preferences regarding these parameters, which the ISO can then use as the basis for assessing what may or may not be feasible within the time frame this data is needed. We ask that

stakeholders keep this in mind as they fashion their requests and understand that there will likely be tradeoffs between the volume and complexity of a data release approach versus the time and difficulty involved in creating the systems to provide the desired data.

The CRR FNM data files contain a list of constraints and contingencies for the CAISO Balancing Authority area and the CAISO Controlled Grid, where the latter includes transmission elements outside the ISO Authority Area. Of the ten or so files provided in the CRR data package, several are briefly described here:

1. PTI Raw Data File contains a complete list of network branches in the FNM base case.

2. Monitored Facility data file (*MPDATA_MonFac_.xls)*, starting with DB41, contains the CRR thermal branch limits (normal and emergency). Prior to DB41, the file included both a list of network branch constraints that are enforced, as well as a complete list of enforce and unenforced flowgate constraints.

3. Interface Definitions and Limits files (*MPDATA_Interface_definitions.xls* and *MPDATA_Interface_limits.xls)* contain the list of corridor and nomogram constraints enforced. These are Branch group and Nomogram Constraint Definitions and Limits.

4. Contingency data file (*MPDATA_Contingency data file*.xls) contains the list of contingencies that is consistent with ISO Operating Procedure M-405; however, changes will occur between the CRR process and DAM/RTM due to planned outages or prolonged forced outages which require or identify constraints or contingencies based upon the modeled system.

5.1. List of Constraints

Stakeholders are seeking greater visibility into the actual constraints that are and are not enforced in the ISO markets. Some stakeholders contend that a lack of transparency regarding market processes prevents a clear understanding of market results. In an effort to explore the scope of data and information needed, we ask that while we explore the type of data that may be provided, stakeholders specify in their comments more precisely the specific content, format, and frequency of the desired data transmittal from the ISO to market participants. As already noted, the ISO currently provides a somewhat similar data package to market participants on a monthly basis. Stakeholders may want to express their preferences in terms modifications they would propose to the CRR data package. To be clear, we do not intend to limit stakeholders to the CRR data package, but simply offer the suggestion that it may be helpful to use that package as a reference for identifying additional needs.

To the extent possible, stakeholders are encouraged to draw on the practices of other ISOs in this area and are invited to share in their comments any knowledge they have of how the other ISOs/RTOs convey comprehensive lists of constraints and contingencies to their market participants, if at all. Describe the content, format, and frequency of these data transmissions. Clearly describe any desired modifications from these practices.

At this time, the ISO does not have a specific proposal in mind that addresses all data requirements that may be identified as it seeks first to determine more precisely what data is needed by market participants. The ISO asks that market participants keep in mind that as various forms of data are explored through this process, some may be more difficult to implement than others. As the ISO evaluates specific requests or proposals, it will endeavor to share anticipated implementation requirements so that it may guide the decisions regarding what type of and when additional visibility may be provided.

Two possible approaches to consider are:

Creation of a Daily All Constraints List. This would include a list of all enforced and unenforced constraints (All Constraints List) for a given day of the day ahead market. Recognizing that the CRR data cannot reflect changes in the enforcement status of constraints on a daily basis, the ISO seeks to explore whether the provision of the actual daily constraints list would be helpful. Currently, the ISO does not have the ability to simply provide this data and needs to explore the feasibility and implementation requirements of providing such information. This may depend on the level of granularity requested and frequency with which the data is provided. This information would be extracted directly from the inputs used for the specific day-ahead market. Therefore, it would provide the complete list of constraints and contingencies enforced or not enforced for the given market. It is not possible to provide such information for the real-time market because of the time granularity of the real-time market intervals (i.e., every five minutes). However, because such conditions do not vary significantly between the DAM and RTM, it is questionable whether such information would provide any incremental value. The all constraints list would be provided after the day-ahead market schedules are posted for each day.

Creation of a Default Constraint List and an Incremental Daily Change Report. This would be an alternative to the daily All Constraints List. A default list of enforced and unenforced constraints could be prepared for portal publication and would occur each time a new DB-XX is produced and implemented in the ISO markets, i.e., every six to eight weeks. This approach would also require that a daily incremental change list be prepared relative to the default list, which the ISO's initial thinking suggests could be administratively burdensome.

5.2. List of Contingencies

The ISO currently provides a list of contingencies for the CRR process in the CRR FNM data package. The data provided in the CRR FNM data package represents those contingencies that are normally enforced in the market contingency analysis and those that have associated operating procedures, but due to the static nature of the CRR FNM data set cannot provide information on changes to contingency enforcement status due to daily market conditions or the status of scheduled or forced outages. As events transpire or system conditions changes contingency analysis may determine or identify other limiting components. ISO operators are required to ensure system reliability and would take appropriate actions to enforce and or unenforce constraints that more accurately represent current system conditions.

Stakeholders are encouraged to address the same questions with respect to contingency information that were posed in the constraints section of this paper above.

Similar to the constraints list, the ISO seeks to explore whether a possible data set consisting of the a daily All Contingencies List that are active in any given market would be appropriate, as opposed to a Default Contingency List accompanied by daily incremental changes to the default list. The daily All Contingencies List would include all active and inactive contingencies for a given day or hour, similar in concept to the contingency file supplied in the CRR FNM data package. Similar to the All Constraints List, this would be provided after the day-ahead market closes and only for the day-ahead market.

5.3. Constraint and Contingency Documentation

In conjunction with either of the constraint and contingency approaches described above, some additional supporting information may be required to make the constraint and contingency lists useful to market participants. For example, although the CRR FNM data package does contain constraint and contingency information, there can be some name changes introduced in the market network model that are not consistent with the names used in the CRR FNM, and for which the ISO would need to provide a means to translate between the two. Stakeholders are encouraged to comment on constraint and contingency nomenclature, point out inconsistencies, and suggest improvements where applicable.

Identification of Nomograms: The CRR FNM data package contains transmission related nomograms but does not contain any generation nomogram information, nor does it contain the shorter-term Nomogram/ Branch ID names and definitions shown on OASIS under Prices > Nomogram/Branch Shadow Prices. This discrepancy reflects the more granular timeframe of the DAM/RTM. The ISO seeks feedback as to whether, in addition to the constraints and contingencies lists described above this information would also be necessary. Stakeholders should specify whether this is needed and with what frequency and in what format.

6. Information on Binding Constraint and Cause

A number of other ISOs provide data on monitored constraints, as well as the associated contingencies in the event that a constraint becomes binding under contingency conditions. In contrast, ISO provides the shadow price and identifies the binding constraint but does not provide the cause for a constraint was binding or a description of the associated contingency where applicable. The following is a brief presentation of market transmission constraint information provided by CAISO, MISO, NYISO, ISO-NE, and PJM.

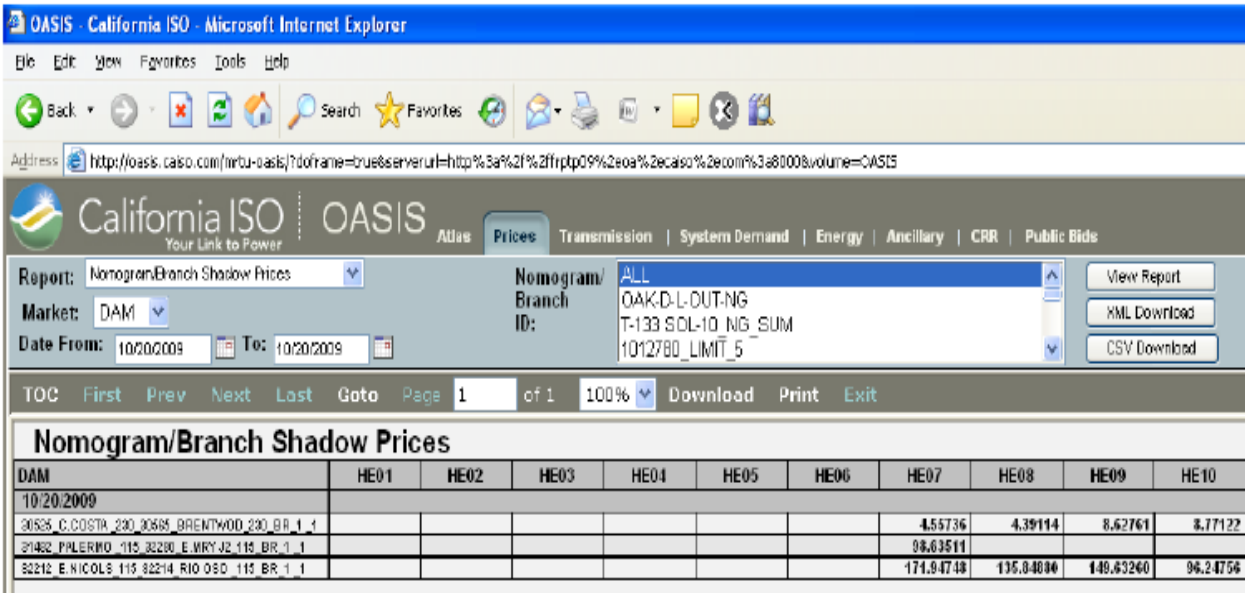
In order to provide information that is comparable to that provided by other ISOs/RTOs, the ISO would provide the cause for each binding constraint by identifying whether the constraint was binding under the base case (no outages or derates) or due to contingency conditions. If the constraint was binding due to a contingency, the ISO would identify the associated contingency; otherwise the binding constraint would be attributable to base case (non-contingency) conditions. Public access to this information would be provided through OASIS, similar to the binding constraints and shadow prices, but a revised format would be required to include a potential

contingency or base case description field for each hour or interval in which a constraint binds. An implementation timeline for the provision of this additional information has yet to be determined. However, stakeholders are encouraged to comment on this approach, suggest alternatives and/or state their preferred content and format for a binding constraint report.

6.1. PJM Contingency Data

Unlike the other ISOs, CAISO only reports monitored single line facilities, as shown in Table 1 below. Although hard to see in the screenshot, the constraint shown in the first line of the CAISO data from OASIS is "30525_C.COSTA _230_30565_BRENTWOD_230_BR_1 _1." This is a 230 kV line from Contra Costa to Brentwood, which was binding during several hours on 10/20/2009. Bus number (30525 and 30565) and some breaker (BR_1_1) information are provided. However, the reason for the constraint is not provided. We do not know what facility is associated with the Binding element – the contingency.

Table 1
CAISO Nomogram/Branch Shadow Prices



This can be compared to the PJM Day-Ahead Transmission Constraints information in Table 2 below. PJM provides an additional data field, "Contingency Facility" as shown in the far right column, and a description, "Day Ahead Congestion Event," in the middle column. The "Monitored Facility" is the constraint and the "Contingency Facility" is the facility associated with that binding element or constraint. The "Day Ahead Congestion Event" description informs the reader that the Cherry Valley-Silver Lake 345 kV line was out and affected the Monitored Facility with bus number 12204 at 138 kV.

Table 2
PJM Day-Ahead Transmission Constraints

Date	Start Hour	End Hour	Dura-tion	Day Ahead Congestion Event	Monitored Facility	Contingency Facility
10/20/2009	1	24	24	12204 138 KV 12204 2 L/O 345L15616 Cherry Valley-Silver Lake 345 kV Line	12204 138 KV 12204 2	345L15616 Cherry Valley-Silver Lake 345 kV Line
10/20/2009	1	7	7	66 E FRN345 KV 6607 L/O DUMONT WILTON CENTER 765KV LINE (L11215)	66 E FRN345 KV 6607	DUMONT WILTON CENTER 765KV LINE (L11215)
10/20/2009	24	24	1	66 E FRN345 KV 6607 L/O DUMONT WILTON CENTER 765KV LINE (L11215)	66 E FRN345 KV 6607	DUMONT WILTON CENTER 765KV LINE (L11215)
10/20/2009	6	6	1	83 GLIDD138 KV 15627 Z1 L/O 345L15616 Cherry Valley-Silver Lake 345 kV Line	83 GLIDD138 KV 15627 Z1	345L15616 Cherry Valley-Silver Lake 345 kV Line
10/20/2009	1	7	7	AEP-DOM L/O Pruntytown-Mt. Storm (510) 500 kV line	AEP-DOM	Pruntytown-Mt. Storm (510) 500 kV line

Source: http://www.pjm.com/markets-and-operations/energy/day-ahead.aspx

6.2. MISO Contingency Data

Similar to PJM, MISO

In the event of a contingency constraint, MISO's Binding Constraints Report Definitions provides a Contingency Description supplying the reason a constraint was needed. The index table below provides the field names used in the report. The Identifier (Row) "D" in Table 4 provides a brief description of the contingency. In the event the constraint is a non-contingency constraint, then no data will be present in the Contingency Description field.

Table 4 rows A through F correspond to six columns in Table 3, where Table 3 shows a portion of the MISO Binding Constraint Report for the Real-Time Market.

Table 3 - MISO Real Time Binding Constraints Report

MidwestISO
Energizing the Heartland

Binding Constraints Report - Real-Time Market
Market Date: 10/19/2009
Publish Date: 10/20/2009

Flowgate NERC ID	Constraint Name	Branch Name (Branch Type / From CA / To CA)	Contingency Description	Hour of Occurrence	Preliminary Shadow Price
522	EFrankfort_Crete345_flo_Dumont_WiltonCenter765	EFRNKFRT 45L6607 1 (LN/CE/CE)	WILTON CENTER-DUMONT 765 (11215)	01	($4.69)
	MECALW04_IAFI_IAFIIA_FA11_1_1	IAFI IAFIIA_FA11_1 1 (LN/ALTW/ALTW)	FLOYD_EMERY161	01	($343.17)
510	Mareng_PValley138_flo_CherryValley_SilverLake345	12204LIN 38L12204_2 1 (LN/CE/CE)	CHERRY VALLEY-SILVER LK 345R(15616	01	($892.36)
9160	ONT_NYIS	INTF: STLAWRE1 SAUND_MOSES__1 A (LN/ONT/NYISO); STLAWRE1 SAUND_MOSES1_1 A (LN/ONT/NYISO); BECK2 BECK_BNIAG_3_1 A (LN/ONT/NYISO); BECK2 BECK_ANIAG_3_1 A (LN/ONT/NYISO); BECK2 BECK2GPACKAR_1 A (LN/ONT/NYISO); BECK2 BECK2GNIAG_3_1 A (LN/ONT/NYISO)		01	($66.98)
15997	Palisades_Argenta_2_flo_Palisades_Roosevelt345	ARGENTA ARGENPALIS34_2 1 (LN/CONS/CONS)	PALISADES-ROOSEVELT 345 (346)	01	($56.66)
	ALEWPS1_ARPIN_ARP_SGL_AR	ARPIN ARP_SGL AR (LN/ALTE/ALTE)	ARPIN-ROCKY RUN 345 (W-8) *	02	($33.90)

Source: http://www.midwestmarket.org/mkt_reports/rt_bc/20091020_rt_bc.pdf

Table 4 - MISO Binding Constraints Report Definitions

Identifier (#)	Field Name	Definition/Description/Calculation
A	Flowgate NERC ID	The NERC ID of the Flowgate that the constraint is occurring on. For the Real-Time market, the NERCID of the flowgate the constraint is occurring on may be blank.
B	Constraint Name	The name of the constraint.
C	Branch Name (BranchType/FromCA/ToCA)	The name of the facility, piece of equipment, or transformer (Branch) that is involved in the constraint along with the Branch Type, the From CA, and the To CA. Multiple Branch Names may be listed in this field.
D	Contingency Description	The reason a constraint was needed. If no data is present for the Contingency Description, then the Constraint is a non Contingency Constraint.
E	Hour of Occurrence	The hour ending during which the constraint was bound for the Real-Time Market.
F	Preliminary Shadow Price	The sum of all preliminary Ex-post Shadow Prices for each Real-Time 5 minute interval occurring in the hour divided by 12, the total number of 5 minute intervals in an hour.

6.3. NYISO Contingency Data

NYISO Day-Ahead Market limiting constraint and shadow price information is provided. A sample of posted information for April 15th Day-Ahead Market is shown in Table 5. Shadow prices are provided in the data field call "Constraint Cost ($)" and are available for both DAM and RTD. "Limiting Facility" is the monitored facility/limiting element. The "Contingency" column provides the contingency when there is a contingency constraint.

Table 5
NYISO Limiting Constraints and Shadow Prices

Time Stamp	Time Zone	Limiting Facility	Facility PTID	Contingency	Constraint Cost($)
10/20/2009 0:00	EDT	GREENWD 138 VERNON 138 1	25337	TWR:GOETHALS 22, 21,A2253	-0.02
10/20/2009 0:00	EDT	CENTRAL EAST - VC	23330	BASE CASE	8.27
10/20/2009 0:05	EDT	DUNWODIE 345 SHORE_RD 345 1	25091	SPRNBRK-EGRDNCTR-Y49	423.07
10/20/2009 0:05	EDT	GREENWD 138 VERNON 138 1	25337	TWR:GOETHALS 22, 21,A2253	-0.02
10/20/2009 0:10	EDT	DUNWODIE 345 SHORE_RD 345 1	25091	SPRNBRK-EGRDNCTR-Y49	51.48
10/20/2009 0:10	EDT	GREENWD 138 VERNON 138 1	25337	TWR:GOETHALS 22, 21,A2253	-0.02
10/20/2009 0:10	EDT	SPRNBRK 345 EGRDNCTR 345 1	25105	BASE CASE	23.77
10/20/2009 0:20	EDT	SPRNBRK 345 EGRDNCTR 345 1	25105	BASE CASE	11.59

Source: http://www.nyiso.com/public/market_data/power_grid_data/limiting_constraints.jsp

6.4. ISO-NE Contingency Data

ISO-NE provides binding constraint information here, http://www.iso-ne.com/markets/hst_rpts/hstRpts.do?category=Hourly#anchor2 Three types of constraint reports are provided: Day-Ahead Constraints, Preliminary Real-Time Constraints, and Final Real-Time Constraints in separate reports. Table 6 provides an example report showing the monitored facility/limiting element listed under "Constraint Name" and the contingency element listed under "Contingency Name".

Table 6
ISO-NE Day Ahead Binding Constraints

Day-Ahead Binding Constraints Report for 10/15/2009 Report generated Wed Oct 14 16:11:06 2009			
Local Date Date	Hour Ending HE	Constraint Name Name	Contingency Name Name
10/15/2009	1	Node_Highgate_Import	Generic Constraint
10/15/2009	8	REBEL_HL_66-2BHE_A_LN	Actual
10/15/2009	9	REBEL_HL66-2BHE A LN	Actual
10/15/2009	10	REBEL_HL_66-2BHE_A_LN	Actual
10/15/2009	11	REBEL_HL_66-2BHE_A_LN	Actual
10/15/2009	12	REBEL_HL66-2BHE A LN	Actual
10/15/2009	13	REBEL_HL66-2BHE A LN	Actual
10/15/2009	14	REBEL_HL_66-2BHE_A_LN	Actual
10/15/2009	15	REBEL_HL_66-2BHE_A_LN	Actual
10/15/2009	16	REBEL_HL_66-2BHE_A_LN	Actual
10/15/2009	17	REBEL_HL_66-2BHE_A_LN	Actual
10/15/2009	18	REBEL_HL_66-2BHE_A_LN	Actual
10/15/2009	19	REBEL_HL66-2BHE A LN	Actual
10/15/2009	20	REBEL_HL66-2BHE A LN	Actual
10/15/2009	21	REBEL_HL66-2BHE A LN	Actual
10/15/2009	22	REBEL_HL_66-2BHE_A_LN	Actual

7. Constraint Management Guidelines

What are our high level guidelines for our constraint management process and what detail should we include in the tariff.

Proposed high level guidelines on CAISO constraint management practices will be posted for stakeholder comment on or before December 3, 2009.

8. Glossary of Terms

- **Biasing**: The practice of adjusting values that are utilized as inputs in the market optimization process to augment the solution in terms of reliability, system security, and good business practices or in response to changes not accounted that are the result of software timing. This practice is generally referred in this document as Adjustments of Transmission Constraints.

- **Binding**: A level as a percentage or attributed value of a system operating limit at which the market software considers dispatch or redispatch of resource schedules to control the overall flow beyond a transmission gate or established cut plane (Transmission Corridor, Branch Group, Nomogram) which best describes system operating limits, engineering studies guide or interconnection reliability operating limit.

    - **MISO Tariff, First Revised Sheet No. 92**
      General Provisions, Definitions
      1.52 Binding Transmission Constraints: A transmission constraint that causes a change in the dispatch or commitment of one or more Electric Facilities to avoid exceeding, or to relieve, the constraint limit.

- **Congestion**: A characteristic of the transmission system produced by a binding Constraint to the optimum economic dispatch to meet Demand such that the LMP, exclusive of Marginal Cost of Losses at different Locations of the transmission system, is not equal."
  Source: CAISO Tariff Appendix A, Master Definitions Supplement, Substitute Third Revised Sheet No. 850.

- **Constraints**: Physical and operational limitations on the transfer of electrical power through transmission facilities. Source: CAISO Tariff Appendix A, Master Definitions Supplement, Substitute Third Revised Sheet No. 851.

    - **Unenforced** – a constraint is not permitted to redispatch resources or considered in the optimization dispatch solution even if the constraint's binding limit is reached or exceeded. Constraint does not exist in the market.

- **Enforced** – a selected constraint is considered and may require resource schedules based upon an optimized solution to be adjusted to within the constraints limits when the associated binding limit has been exceeded.

    - **Constraint Enforcement** - CAISO determines if a constraint is correct, and or if any constraint enforcement is necessary based on D+2 or D+3 studies. CAISO determines the constraint is unexplained and should be un-enforced for the market run and time allows for the DAM to be re-run, Un-enforce the element that is causing the constraint and re-run the applicable portion of market.

- **Contingency**: A potential Outage that is unplanned, viewed as possible or eventually probable, which is taken into account when considering approval of other requested Outages or while operating the CAISO Balancing Authority Area. Source: CAISO Tariff Appendix A, Master Definitions Supplement, Substitute Third Revised Sheet No. 851.

- **Contingency Management** - CAISO Operating Engineers will identify any contingency that should be enforced in both the Day Ahead and Real Time markets based on studies, outages and operating conditions. CAISO dispatchers may choose to enforce a contingency in real time based on real- time operating conditions.

- **Corridors** – All individual lines and transformers that can be used for constructing nomograms and all the operating limits for all the major paths in the form of straight MW values that can be constrained by thermal, voltage or stability limitations.

- **Flowgate** – **MISO Tariff, General Provisions, Definitions: 1.235 Flowgate:** A representative modeling of a facility or group of facilities that may act as a constraint to power transfer on the Bulk Electric System.

    - Predetermined set of constraints on the Transmission System that are expected to experience loading problems in real-time (PDF page 24). Flowgates are facilities or groups of facilities that may act as significant constraint points on the system. As such, they are typically used to analyze or monitor the effects of power flows on the bulk transmission grid (PDF page 1475).

      Source: MISO, Open Access Transmission, Energy and Operating Reserve Markets Tariff (ASM Tariff), Sheet 2304, PDF page 24, http://www.midwestmarket.org/publish/Document/1d44c3_11e1d03fcc5_-7cf50a48324a

- **Nomograms** – A set of operating or scheduling rules which are used to ensure that simultaneous operating limits are respected, in order to meet NERC and WECC reliability standards, including any requirements of the NRC. (ISO Tariff, Third Revised Sheet No. 905)