



PJM TO Connection User Guide

For PJM Member Transmission Operations Personnel

22 Feb 2021

For Public Use

This page is intentionally left blank.

Contents

TO Connection application	1
<i>TO Connection purpose</i>	1
<i>TO Connection location</i>	1
<i>TO Connection user base</i>	1
<i>TO Connection history</i>	1
<i>TO Connection features</i>	2
Framework	2
Banner messaging	2
Heartbeat	3
Application areas	5
Post Contingency Local Load Relief Warning sub-tool	6
<i>PCLLRW purpose</i>	6
<i>PCLLRW features</i>	6
SA Exceedances	6
Behind-the-Meter DER	6
<i>PCLLRW interfaces</i>	7
Stability Viewer sub-tool	8
<i>Stability Viewer purpose</i>	8
<i>Stability Viewer features</i>	8
Stability Limits	8
Stability Areas	10
Historian	11
<i>Stability Viewer interfaces</i>	11
Questions or Feedback	12
Version History	12

TO Connection application

TO Connection purpose

The *TO Connection* application serves as a tool suite for a select set of PJM sub-applications which PJM and its member Transmission Owners utilize in coordination with, or provides as awareness to, its member Transmission Owners.

TO Connection location

Homepage:

- breadcrumb path: [pjm.com](#) ► Markets & Operations ► PJM Tools ► TO Connection
- url: <https://www.pjm.com/markets-and-operations/etools/to-connection.aspx>
- release notes: <https://www.pjm.com/markets-and-operations/etools/to-connection/to-connection-release-notes.aspx>

Production Environment Login: <https://toconnection.pjm.com>

TO Connection user base

The *TO Connection* application intended audience is transmission system operations / dispatcher focused, including internal PJM Dispatchers / Reliability Engineers, tool administrators, and PJM member Transmission Owner system operator staff directly involved in the underlying tool.

TO Connection history

In 2014, the *Post Contingency Local Load Relief Warning* [PCLLRW] tool release provided a common tool designed to streamline the need, development and communication of Load Shed Plans between PJM Dispatch and its member Transmission Owners in relation to PJM System Operating Limits [SOL]. At that time, the tool only provided load impact distribution factors related to thermally impacted SOL.

In 2018, the *PCLLRW* tool was further expanded to provide Voltage Distribution Factors [VDFax] and thus allowing Load Shed Plans around low voltage impacted SOL to be shared in a common manner to that of thermal SOL.

In 2021, the *PCLLRW* tool was incorporated into a new *TO Connection* tool suite along with a new *Stability Viewer* tool.

Current plans around *TO Connection* development include views around PJM's *Real-Time Topology Control* and *Intelligent Event Processor* to enhance TO member situational awareness and PJM - TO coordination.

TO Connection features

Framework

The *TO Connection*, application leverages a common framework with that of other PJM Tools, allowing users the ability to:

- Link to the PJM Tools Homepage;
- Transfer between PJM Tools using Single Sign On (SSO);
- Move to PJM.com;
- Sign Out of the application, with visibility to their individual connection timeout via a Session Expiration countdown;
- Adjust the application between a Light & Dark Theme.

Banner messaging

TO Connection's applications have the capability of sharing information across the sub-applications leveraging Banner messages to direct a user to critical input failures and event status changes. Banner messages are intended to be both informative and yet unobtrusive to the end user's experience.

Banner messages trigger conditionally and are not omnipresent within the tool.

The set of potential Banner messages, by sub-application type, within TO Connection are as follows:

- PCLLRW
 - Status Change: "NEW: <MessageType> for <Area> to control <B1> <B2>. Click [here](#) to go to PCLLRW."
 - Status Change: "UPDATED: <MessageType>for <Area> to control <B1> <B2>. Click [here](#) to go to PCLLRW."
 - Status Change: "CANCELED: <MessageType> for <Area> to control <B1> <B2>. Click [here](#) to go to PCLLRW."
 - Load Shed Plan: "A valid load shed plan has been submitted for <AREA>. Click [here](#) to go to PCLLRW."
 - Load Shed Plan: "A deficient load shed plan has been submitted for <AREA>. Click [here](#) to go to PCLLRW."
 - PJM EMS SA: "SA Exceedances are stale. Click [here](#) to go to PCLLRW."
 - PJM EMS SA: "SA Exceedances are up to date. Click [here](#) to go to PCLLRW."
 - PJM VDFAX: "VDFAX is unavailable. Click [here](#) to go to PCLLRW."
 - PJM VDFAX: "VDFAX is available. Click [here](#) to go to PCLLRW."
- Stability Viewer
 - New Limit: "A new Stability Limit has been issued for <Area Name>. Click [here](#) to go to Stability Viewer."
 - Edited Limit: "Stability limit for <Area Name> has been modified. Click [here](#) to go to Stability Viewer."

- Closed Limit: "Stability limit for <Area Name> has been closed. Click [here](#) to go to Stability Viewer."



Figure 1. Sample Banner message (standalone, orange) showing a PCLLRW status change, and directing user to the PCLLRW tool.

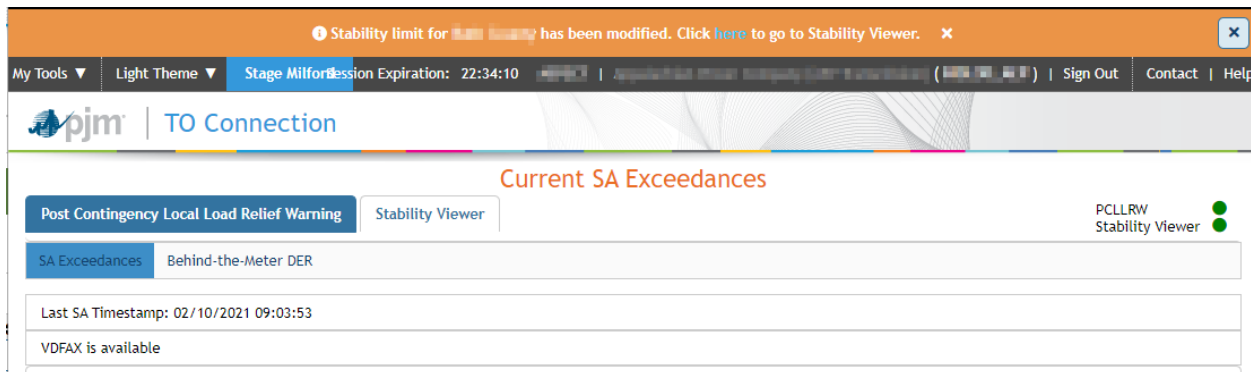


Figure 2. Sample Banner message (top, orange) showing a stability limit edit, and directing user to the Stability Viewer tool.

Heartbeat

The heartbeat area provides status information around input to a given sub-application of *TO Connection*. The *TO Connection* heartbeat area is continuously displayed regardless of the user's location within a given Application or Sub-application tab.

On "mouse over", the individual heartbeat will provide tooltip timestamp information relative to the given area.

Red heartbeats are an indication of a system failure. Green heartbeats are an indication of a system operating within appropriate time parameters.

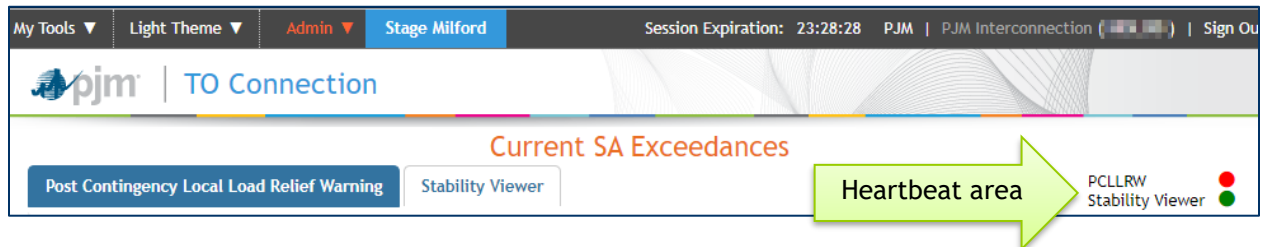


Figure 3. Sample heartbeat showing a *PCLLRW* system in a failed state (red) and *Stability Viewer* as operational (green).

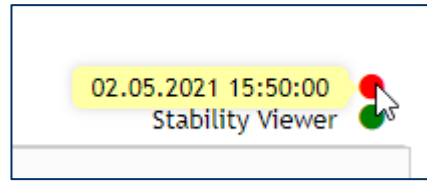


Figure 4. Tooltip (“mouse over”) showing timestamp related to an individual Heartbeat message.

Application areas

The *TO Connection* suite opens by default into the *SA Exceedances* tab of the *Post Contingency Local Load Relief Warning* sub-tool.

Navigation within the *TO Connection* application suite is done by [See Figure 4 below for visual references] :

- Either selecting [left mouse-click] another sub-tool tab:
 - Options shown below include *Post Contingency Local Load Relief Warning* and *Stability Viewer* sub-tools;
 - Designated as area **A**.
 - The highlighting of the sub-tool tab denotes which sub-tool the user is within presently;
 - Selecting a non-highlighted sub-tool, such as *Stability Viewer* in area **A**, will change the available functional area tabs, designated as area **B**.
- Or, selecting [left mouse-click] another sub-tool functional area within the existing tool;
 - Options shown below include the “SA Exceedances” and “Behind the Meter DER” tabs (functional areas) within the *Post Contingency Local Load Relief Warning* tool.
 - Designated as area **B**.
 - The highlighting of the sub-tool area tab denotes which sub-tool functional area the user is within presently;
 - Selecting a non-highlighted sub-tool area in area **B** will change the functional area title, designated as **C**, as well as changing the main application body of the sub-tool functional area, designated as **D**.

Selecting a sub-tool dynamically drives changes to availability of functional areas.

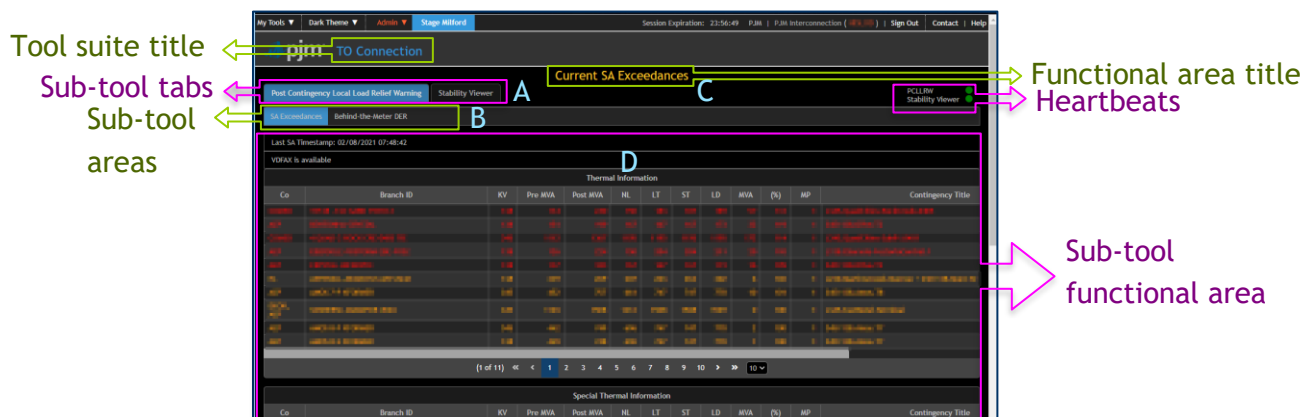


Figure 5. Application area layout with callouts for descriptions and dynamic area reference designations (A-D).

Post Contingency Local Load Relief Warning sub-tool

PCLLRW purpose

PJM Dispatch and impacted (as monitored element owner(s) OR with load at risk) Transmission Owners utilize the *Post Contingency Local Load Relief Warning [PCLLRW]* sub-tool within the *TO Connection* application in the development and coordination of load shed plans in mitigating thermal and voltage contingency-based (N-1) SOL exceedances.

PCLLRW functionality was unchanged as of the 2021 release of TO Connection. Further refinement to the User Guide with respect to PCLLRW functionality will take place as part of the 2021 Q3 PCLLRW enhancement release.

PCLLRW features

SA Exceedances


SA Exceedances tab reflects the PJM Security Analysis (aka, Contingency Analysis) results related to thermal and voltage related trends and exceedances. This includes the PJM default active contingency analysis, as well as “Special” contingencies for both thermal and voltage, used for monitoring conditions such as sectionalizing scheme failures.

TO members equipment (Branch ID) visibility within PCLLRW is limited to their equipment ownership of the designated branch. As part of PCLLRW enhancement release plans for Q3 2021, PJM will dynamically expand the member view to include areas where the TO member’s load is at risk based off being issued a load shed plan or exceeding a distribution factor threshold for a given Mon/Con pair.


The tab also provides a timestamp around the status of PJM’s most recent Security Analysis results sent to PCLLRW, as well as the availability state for PJM’s Voltage Distribution Factor (VDFAX) tool.

The tab serves as a secondary method (primary being direct operator to operator communication) for PJM Operators to receive notice around PCLLRW issuances, and begin to develop post-contingency Load Shed plans for those conditions.

Behind-the-Meter DER

The tab provides detail around all known Behind-the-Meter / Distributed Energy Resources [BtM / DER] within PJM, including the closest associated PJM Bulk Electric System [BES] substation. Additional information, where provided, related to an individual BtM / DER can be found by leveraging the Details dropdown icon .

Details		EIA860 Name	Muni/Coop (Y,N,N/A)	EIA860 Total Summer Plant Capacity (MW)	Closest Electric BES Substation	State	County			
			N	12	Road					
EIA860 Code	Notification on + Time-to-Start (Hrs)	Normal Must Run (Y,N,N/A)	DER Utility Name	DER Transmission or Distribution System Owner	Zip	Contact Name	Contact Number	Contact Email	Latitude	Longitude
101		Y					(000)-12345678912			

Figure 6. BtM / DER example image along with expanded Detail (collapsible by clicking the  icon) showing additional fields.

PCLLRW interfaces

For issuance via the PCLLRW tool writes direct to the following PJM tools:

- *SmartLogs* – PJM internal tool leveraged for logging PJM operator daily events.
- *Emergency Procedures* – PJM internal/external tool utilized in the sharing of PJM Emergency Procedure events covered within PJM’s Emergency Procedures manual, M-13.

PCLLRW receives input from the following PJM tools:

- *EMS SA* – Provides contingency analysis (aka, Security Analysis or SA) results, as well as thermal distribution factors (DFAX) which determine load reduction benefit for a given thermal monitored element + contingency pair.
- *VDFAX* – Tool which generates voltage distribution factors (VDFAX) used to determine load reduction benefit for a given voltage monitored element + contingency pair.

Stability Viewer sub-tool

Stability Viewer purpose

PJM Dispatchers utilize the *Stability Viewer* sub-tool as a logging and historian for unit or area stability restrictions throughout PJM. PJM member Transmission Owners are provided visibility around the *Stability Viewer* sub-tool within the *TO Connection* application as awareness around unit or area stability restrictions in the PJM footprint.

Known stability impacted areas with calculated limits are captured within PJM's Transmission Operating Procedures manual, M-03B. ([PJM Manuals](#)) In addition to the predefined area limitations, PJM has additional internal tools which allow for the study or Real-time adjustment to certain limits based upon the topology of the system for the given time space. PJM shares these limitations as they manifest themselves directly to impacted PJM Generation Owners. Stability Viewer provides additional visibility to PJM Transmission Owners.

Stability Viewer features

Stability Limits



Stability Limits are made up of three components:

$$\text{Stability (Unit or Area) + Stability Type + Stability Value = Stability Limit}$$

Stability Limits are either established against a single unit; Or, against a set of units grouped into a single Stability Area.

Stability Limits restriction *Types* are defined as follows:




Type	Units	Areas	Description
<i>MW.Max</i>	✓	✓	A megawatt (MW) maximum (Max), or real power, restriction for a given single unit or a defined unit group. Once established, the unit, or unit collective, is not to exceed that value until PJM lifts the restriction.
<i>MVAR.Max</i>	✓	✓	A megavar (MVAR) maximum (Max), or lagging reactive power, restriction for a given single unit or a defined unit group. Once established, the unit, or unit collective, is not to exceed that value until PJM lifts the restriction.
<i>MVAR.Min</i>	✓	✓	A megavar (MVAR) minimum (Min), or leading reactive power, restriction for a given single unit or a defined unit group. Once established, the unit, or unit collective, is not to exceed that value until PJM lifts the restriction.
<i>Pumps.Max</i>	✗	✓	A pumped storage facility restriction defined by a maximum number of units for a given area that can operate in a pumping mode. Established against a Stability Area, not against a single unit.

<i>Gens.Max</i>			Defines a maximum number of units for a given area that can operate in a generating mode. Established against a Stability Area, not against a single unit. Utilized for non-pumped storage facilities as well as pumped storage facilities.
-----------------	---	---	---

Stability Limit restriction *Values* are expressed as a positive or negative integer. For both MVAR.Min and MVAR.Max restrictions, the value being negative would be an indication of a Leading reactive limit, and likewise a positive integer would indicate if the Min or Max restriction was a Lagging reactive limit.

Table 1. Stability Limit restriction Types.

The Stability Limits tab/table shows the active stability limits in place across the PJM RTO. Columns represented for the TO member view include:

- **History:** A right arrow icon () that when clicked, will convert () and display a sub-table for the given Stability Limit event showing the evolution over time.
- **TO Company:** Represents a given TO transmission zone as reflected in PJM's EMS.
- **Area Name:** Defines the Stability Area name, which can either reflect a single unit, as a combination of the PJM EMS B1 & B3 names, or as a PJM defined Stability Area. Further information around the units that comprise either of these can be found via the "View Units" function in the Actions column.
- **Limit Type:** Stability limit restriction type as defined in Table 1 above.
- **Limit Value:** Either a positive integer reflecting a real or reactive power restriction, or a maximum number of units for a given area; Or, a negative (-) integer reflecting a reactive power restriction.
- **Effective Start:** Reflects the initial time associated with a given Stability Limit
- **Comments:** Any comments provided by PJM staff to help define the Limit/change.
- **Status:** Given that the main page only shows limits that have not reached an end state, *Active* or *Pending* statuses are the only options presented for the given limit. *Active* is in place. *Pending* is slated for a future date.
 - The [Historian](#) tab expands the options and includes *Closed* or *Cancelled* statuses. Active limits will reach a *Closed* end Status. Pending limits that never become Active may reach a *Cancelled* end Status.
- **Actions:** Selecting the eye icon () allows the user to view further detail around the unit(s) that are associated with the given limit such as NA Name, B1 Name, B2 Name, B3 Name, B3 Text, Unit ID, Installed Capacity (MW), GO Name, Province/State, TO Name.

Fields reflected within Stability Limit's individual event history.

- **Limit Value:** Covered above.
- **Event Start Time:** Beginning timeframe for the given log.

- **Event End Time:** End timeframe for the given log. (NOTE: Pending limits effectively are provided with the identical Event Start Time and Event End Time. The limit is only proposed for a given start time. Active limits are expected to have a delta between their Event Start Time and Event End Time.)
- **Event Start Time:** Populates when the Stability Limit (Unit/Area + Type) ends.
- **Comments:** Covered above.
- **Status:** Covered above.
- **(Event) State:** Displays the state associated with an event. Options include:
 - *Pending* → A proposed limit for a future date. Associated with *Pending* Status only. Subsequent changes, prior to reaching an Active Status, are also marked as *Pending*.
 - *Cancelled* → A proposed *Pending* limit that never reached an *Active* state.
 - *Initial Limit* → The first activation for a given limit having reached an *Active* Status.
 - *Revised – Comment* → Any *Active* Status limit with an update to the Comment field ONLY and thus does not substantively change the limit.
 - *Revised – Limit* → Any *Active* Status limit with an update to the Limit field (may also include an update to the Comment field).
 - *Closed* → An *Active* Status limit which reaches end state.
- **Updated:** The timestamp associated with the event state update.

History	TO Company	Area Name	Limit Type	Limit Value	Effective Start	Comments	Status	Actions
			MW.Max	40	03.31.2021 08:47		Active	
			MVAR.Max	-10	03.31.2021 08:41	Leading mvar restriction.	Active	
			MVAR.Max	15	03.31.2021 08:30	MVAR restrictions	Active	

Limit Value	Event Start Time	Event End Time	Comments	Status	State	Updated
15	03.31.2021 08:30		MVAR restrictions	Active	Revised - Limit	03.31.2021 08:30
12	03.31.2021 08:28	03.31.2021 08:30	MVAR restrictions	Active	Revised - Limit	03.31.2021 08:28
10	03.25.2021 14:40	03.31.2021 08:28	MVAR restrictions	Active	Initial Limit	03.25.2021 14:41

Figure 7. Example showing event History changes for a MVAR.Max restriction starting at 10 MVAR (lagging) on 3/25 @ 14:40 and increasing to 12 MVAR on 3/31 @ 08:28, then increasing again on 3/31 to 15 MVAR lagging limit maximum restriction. (i.e., The unit must remain below 15 MVAR lagging.)

Stability Areas

Stability Areas are made up of two or more units and defined to be as one of two Types:

- **M03B** – Those areas that are predefined by operating procedure around stability within the PJM Transmission Operating Procedure manual, M-03B.
- **User** – Those areas that are defined by a PJM operator ad-hoc in order to alleviate a given system condition.

Stability Areas are defined by the following fields, as well as the units that they contain.

- **Name** – Unique name to capture the essence of the area.
- **Description** – Provides further clarity, as needed to help define the area.
- **Type** – Either *M03B* or *User*, as defined above.
- **Created** – Initial creation timestamp for the given area.
- **Active** – Indicates availability. If “true”, the area remains available. If “false”, the area is retired.
- **Actions** - Selecting the eye icon (👁️) allows the user to view further detail around the units that are associated with the given Area such as NA Name, B1 Name, B2 Name, B3 Name, B3 Text, Unit ID, Installed Capacity (MW), GO Name, Province/State, TO Name.

Historian

Changes (events) over time that have an *Event End Time* are shown by default in a reverse chronological order based on *Updated* timestamp and *Event End Time*. The *Historian* tab will thus provide a history over time of all the proposed and effective stability limits issued via the tool. *i.e., What has changed?*

The *Historian* leverages the same fields described in earlier sections.

Its presentation varies from the *Stability Limits* tab in that it shows a mix of what has transpired through time at PJM, including both *Closed & Cancelled* Statuses, whereas the *Stability Limits* tab focuses only on *Active & Pending* Statuses.

To narrow down the *Historian* to a single area/unit consideration, leveraging the *Area Name* and *Limit Type* while focusing the *Occurring During: Start* and/or *End* fields to the date(s) of your concern will help to hone in on a specific Stability Limit and its changes through time are portrayed in the remaining fields.

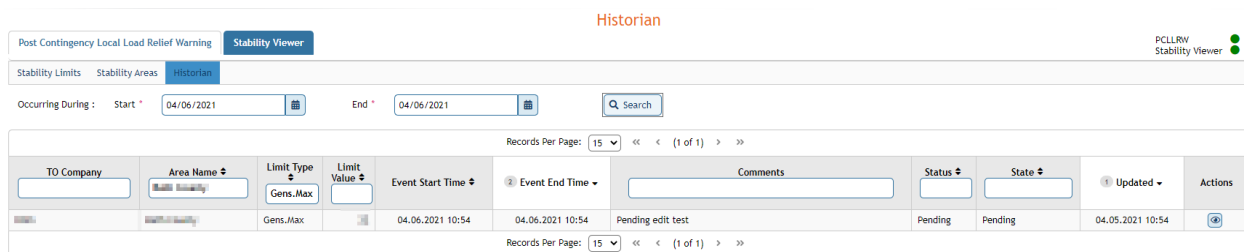


Figure 8. Example showing Historian honing in on a single Limit pair by leveraging the **Area Name** and **Limit Type** in concert with the **Occurring During: Start** and **End** fields.

Stability Viewer interfaces

Issuance via the Stability Viewer tool writes direct to the following PJM tools:

- *SmartLogs* - PJM internal tool leveraged for logging PJM operator daily events.

Stability Viewer receives input from the following PJM tools:

- *Dart* – Dart (aka, eDART) provides unit detail information used in the identification of units and within Stability Area definitions.

Questions or Feedback

For questions or feedback around tool functionality, or suggested improvements to this guide, please utilize the following to direct your question:

TOConnection.Admin@pjm.com – Catch all, will reach the administrators of all tools within the TO Connection framework, including those listed below.

PCLLRW.Admin@pjm.com – For inquiries related to PCLLRW.

StabilityViewer.Admin@pjm.com – For inquiries related to Stability Viewer.

Version History

Version	Final Draft Date	Description
2	18 May 2021	Minor typos and clarifications.
1	13 May 2021	Inserted a new Figure 6, and expanded DER/BtM information.
0	05 May 2021	First publishing in alignment with Stability Viewer & TO Connection introduction.