# IRR AVR testing expectations

## Purpose and Intent

The purpose of this overview is to document the criteria that ERCOT Resource Integration uses when evaluating AVR test submissions from IRR units. This is not a test procedure or a binding document.

## AVR Test Overview

* The basic form of the AVR test is to change the AVR setpoint and to observe the response of the associated units and reactive devices



* + At each stage in the test, the AVR setpoint should be maintained until the plant (unit and reactive devices) respond and reach a steady-state (have fully settled)
	+ Each setpoint change should be in one instantaneous (not stair-stepped or ramped)
	+ The test should begin with a few minutes of data with the AVR setpoint at its neutral or nominal setting
	+ The AVR setpoint should be increased by 3% and allowed to settle
	+ The setpoint should be returned to the nominal setting an allowed to settle
	+ The setpoint should be reduced by 3% and allowed to settle
	+ The setpoint should be returned to the nominal setting and allowed to settle
* The test data should be recorded in the AVR test template from the Resource Integration webpage and submitted to NDCRC

## Test Evaluation

* The AVR test is evaluated with the following purposes in mind:
	+ To demonstrate that the project is capable of controlling voltage at the POI
	+ To verify that the unit will be able to respond to system events or voltage problems in a timely fashion
	+ To check that the telemetry data from the unit and any associated reactive devices being sent to ERCOT by the QSE are correct and in agreement with the test data.

The subsequent sections elaborate on the criteria used to determine whether or not the test meets these objectives

### Voltage control verification

The AVR system should be configured so that the POI voltage is controlled in accordance with Nodal Operating Guide 2.7.3.5(4). This stipulates that any Resource Entity that is required to provide VSS should maintain the voltage at the POI to within 2% of the voltage setpoint (KVT telemetry point). It should be noted that the approved NOGRR195 changes the 2% requirement to a kV range based on the transmission voltage. The voltage control requirement defined by Table I will be effective upon system implementation of NOGRR195.

Table I: Proposed change to voltage tolerance band in NOGRR195

|  |  |
| --- | --- |
| Nominal Voltage | ToleranceBand KV |
| 345 | +/- 4kV |
| 230 | +/- 3kV |
| 138 | +/- 2kV |
| 115 | +/- 2kV |
| 69 | +/- 1kV |

In order to verify that the Resource meets these requirements, ERCOT looks for the following criteria, based on the 2% requirement (if NOGG195 is approved, these criteria will be updated accordingly):

* The voltage droop plus the voltage deadband should sum to less than 2%. These values are reported in the NDCRC test form.
* During the test, if the voltage deviation greater than 2% away from the setpoint, the unit and all its reactive devices should respond fully.
	+ *Note: the reference voltage used for the test evaluation is usually the MPT high-side bus voltage, since this is usually input to the AVR control system. Keep in mind that the compliance requirement is at the POI so the droop and deadband should be set accordingly and the target voltage should take into account any line drop when the unit is not under test.*
	+ All units and dynamic reactive devices should be at maximum leading or lagging output.
	+ All associated switched shunts should have switched to the appropriate state to provide support.
* If the voltage at the controlled bus is within 2% of the setpoint, the Resource should be observed to respond based on its droop and deadband setting.
	+ In general, a strong response should be observed due to 3% step, but the Resource doesn’t need to be at maximum leading or lagging output
	+ Reactive devices should switch in in a timely manner if they are needed (more on this in the next section).

### Dynamic response and shunt timing

* Full dynamic response in 30 seconds or less.
	+ Does not necessarily mean max MVAr output if setpoint reached or voltage is within droop+deadband.
	+ If the OLTC needs to change taps in order for max MVAr output or setpoint to be reached, this is not expected to happen
* Static reactive devices (shunts) should be observed to switch in a timely manner
	+ Shunt devices should be able to switch promptly in order to preserve the dynamic capability of the unit. Shunt devices should not be the last line of voltage response from the AVR system. Per Nodal Protocols 3.15(17), the purpose of the shunt device is to compensate for reactive losses between the generators and the POI. With this in mind, the reactive devices should be programmed with the goal of responding quickly so that the dynamic reactive capability of the unit can be preserved for fast response to voltage events. The figures below illustrate this concept.





* + The first shunt device should switch within a minute of the setpoint change
	+ Subsequent shunt devices should switch within a minute of the previous device switching
	+ Under some test conditions, shunt devices aren’t able to switch due to voltage limits.
		- If the second and subsequent device must wait for OLTC tap switching to complete before switching in, this may be acceptable
		- If the devices cannot switch at all due to voltage limitations, then this should be documented in the comments section of the test form, along with a description of the shunt switching logic and confirmation that the shunts would switch in accordance with the timing described above under normal circumstances.
		- Any exceptions to shunt switching will be evaluated on a case-by-case basis.

### Data requirements and telemetry

* Data should be submitted in evenly-spaced intervals between 1 and 4 seconds using the tests template downloaded from the [ERCOT Resource Integration webpage](http://www.ercot.com/services/rq/integration).
* Timestamps should be in Central Time (CDT or CST) and the clock should be calibrated to GPS time before recording the test data.
* The submitted data will be compared with data that is telemetered to ERCOT to check for discrepancies.
	+ If any inconsistencies are found in telemetry, a retest may or may not be required based on the severity of the issue.
	+ If no retest is required, the data issues should be resolved and demonstrated to ERCOT before the test can be approved.

## Illustrative figures

The figures below are for illustrative purposes only and are not to scale. The responses depicted are not the only possible acceptable responses, but do illustrate AVR system step-up response that would be considered acceptable. The illustrations only show step-up response. Step down response should follow the same principles.



