

## Standard Development Timeline

*This section is maintained by the drafting team during the development of the standard and will be removed when the standard becomes effective.*

### Development Steps Completed

1. SAR [and supporting package](#) posted for comment on July ~~19XX~~, 2013.
2. [Draft standard posted for initial comments and ballot from July 19, 2013 to September 3, 2013.](#)

### Description of Current Draft

[This is the second posting of the proposed draft standard. This proposed draft standard will be posted for a 45-day formal comment period and parallel ballot.](#)~~This draft standard is concluding informal development and will move to formal development when authorized by the Standards Committee.~~

Anticipated Actions	Anticipated Date
<del>SAR Authorized by the Standards Committee</del>	<del>July</del>
<del>Additional 45-Day SAR Comment Period with and Initial Ballot Open</del>	<del>October/November 2013</del> <del>July</del>
<del>Nomination Period Opens</del>	<del>July</del>
<del>Standard Drafting Team Appointed</del>	<del>July</del>
<del>Initial Comment and Initial Ballot Closes</del>	<del>August</del>
<del>Final Ballot Opens</del>	<del>December 2013</del> <del>October</del>
<del>Final Ballot Closes</del>	<del>October</del>
<del>NERC Board of TrusteesBOT Adoption</del>	<del>December 2013</del> <del>November</del>
Filing to Applicable Regulatory Authorities	December <u>2013</u>

**Effective Dates**

~~In those jurisdictions where regulatory approval is required, this standard shall become effective on the first day of the first calendar quarter after applicable regulatory approval or as otherwise made effective pursuant to the laws applicable to such ERO governmental authorities. In those jurisdictions where no regulatory approval is required, this standard shall become effective on the first day of the first calendar quarter after Board of Trustees approval.~~

**Version History**

Version	Date	Action	Change Tracking
1	5/1/2006	Added "(R2)" to the end of levels on non-compliance 2.1.2, 2.2.2, 2.3.2, and 2.4.3.	July 5, 2006
1a	12/19/2007	Added Appendix 1 – Interpretation of R1 and R2 approved by BOT on August 1, 2007	Revised
1a	1/16/2007	In Section A.2., Added "a" to end of standard number. Section F: added "1."; and added date.	Errata
1.1a	10/29/2008	BOT adopted errata changes; updated version number to "1.1a"	Errata
1.1b	3/3/2009	Added Appendix 2 – Interpretation of VAR-002-1.1a approved by BOT on February 10, 2009	Revised
2b	4/16/2013	Revised R1 to address an Interpretation Request. Also added previously approved VRFs, Time Horizons and VSLs. Revised R2 to address consistency issue with VAR-001-2, R4. FERC Order issued approving VAR-002-2b.	Revised

## Definitions of Terms Used in the Standard

*This section includes all newly defined or revised terms used in the proposed standard. Terms already defined in the Reliability Standards Glossary of Terms are not repeated here. New or revised definitions listed below become approved when the proposed standard is approved. When the standard becomes effective, these defined terms will be removed from the individual standard and added to the Glossary.*

None.

## A. Introduction

1. **Title:** Generator Operation for Maintaining Network Voltage Schedules
2. **Number:** VAR-002-3
3. **Purpose:** To ensure generators provide reactive support and voltage control, necessary to ensure voltage levels, reactive flows, and reactive resources are maintained within generating applicable Facility capabilities, in order Ratings to protect equipment and maintain the reliable operation of the Interconnection.
4. **Applicability:**
  - 4.1. Generator Operator
  - 4.2. Generator Owner

### 5. Effective Dates

All requirementsThe standard shall become effective on the first day of the first calendar quarter after the date that the standard is approved by an applicable governmental authority or as otherwise provided for in a jurisdiction where approval by an applicable governmental authority is required for a standard to go into effect. Where approval by an applicable governmental authority is not required, VAR-002-3 shall become effective on the first day of the first calendar quarter after the date the standard is adopted by the NERC Board of Trustees or as otherwise provided for in that jurisdiction.

## B. Requirements and Measures

Rationale for R1: This requirement has been maintained due to the importance of running a unit with its automatic voltage regulator (AVR) in service and in voltage controlling mode. However, the requirement has been modified to allow for testing, and the measure has been updated to include some of the evidence that can be used for compliance purposes.

~~Rationale for R1: This requirement has been maintained due to the importance of running a unit with its automatic voltage regulator (AVR) in service and in voltage controlling mode. The measure has been updated include some of the evidence that can be used for Compliance purposes.~~

- R1.** The Generator Operator shall operate each generator connected to the interconnected transmission system in the automatic voltage control mode (with its automatic voltage regulator (AVR) in service and controlling voltage) unless the Generator Operator 1) is exempted by the Transmission Operator, or 2) has notified the Transmission Operator of one of the following: [*Violation Risk Factor: Medium*] [*Time Horizon: Real-time Operations*]
- That the generator is being operated in start-up,<sup>1,2</sup> ~~or~~ shutdown,<sup>3</sup> or testing<sup>4</sup> mode pursuant to a Real-time communication or a procedure that was previously provided to the Transmission Operator; or
  - That the generator is not being operated in the automatic voltage control mode for a reason other than start-up, ~~or~~ shutdown, or testing.
- M1.** The Generator Operator shall have evidence to show that it notified its associated Transmission Operator any time it failed to operate a generator in the automatic voltage control mode as specified in Requirement R14. If a generator is being started up or shut down with the automatic voltage control off, or is being tested, and no notification of the ~~AVR automatic voltage regulator~~ status is made to the Transmission Operator, the Generator Operator will have evidence that it notified the Transmission Operator of its procedure for placing the unit into automatic voltage control mode. Such evidence must include, but is not limited to, dated evidence of transmittal of the procedure such as an electronic message or a transmittal letter with the procedure included or attached. If exempted, the Generator Operator shall also have evidence that it is exempted from being in automatic voltage control mode (with its AVR in service and controlling voltage).

<sup>1</sup> Start-up is deemed to have ended when the generator is ramped up to its minimum continuously sustainable load and the generator is prepared for continuous operation.

<sup>2</sup> Start up is deemed to have ended when the generator is ramped up to its minimum continuously sustainable load and the generator is prepared for continuous operation.

<sup>3</sup> Shutdown is deemed to begin when the generator is ramped down to its minimum continuously sustainable load and the generator is prepared to go offline.

**Rationale for R2:**

Requirement R2 details how a Generator Operator (GOP) operates the system to maintain a voltage schedule and when the GOP is expected to notify the Transmission Operator (TOP). In an effort to remove prescriptive notification requirements for the entire continent, the VAR standard drafting team (SDT) opted to allow each TOP to determine the notification requirements for each of its respective GOPs based on system requirements. A new part 2.3 has been added to detail that each GOP shall monitor voltage based on its existing facility equipment.

Conversion Methodology: There are many ways to convert the voltage schedule from one voltage level to another. Some entities may choose to develop voltage regulation curves for their transformers; others may choose to do a straight ratio conversion; others may choose an entirely different methodology. All of these methods have technical challenges, but the studies performed by the TOP, which consider N-1 and credible N-2 contingencies, should compensate for the error introduced by these methodologies, and the TOP possesses the authority to direct the GOP to modify its output if its performance is not satisfactory. During a significant system event, such as a voltage collapse, even a generation unit in automatic voltage control that controls based on the low-side of the generator step-up transformer should see the event on the low-side of the generator step-up transformer and respond accordingly.

Voltage Schedule Tolerances: The bandwidth that accompanies the voltage target in a voltage schedule should reflect the anticipated fluctuation in voltage at the GOP's Facility during normal operations and be based on the TOP's assessment of N-1 and credible N-2 system contingencies. The voltage schedule's bandwidth should not be confused with the control dead-band that is programmed into a GOP's AVR control system, which should be adjusting the AVR prior to reaching either end of the voltage schedule's bandwidth.

**Rationale for R2:**

R2 details how a Generator Operator (GOP) operates the system to maintain voltage schedule and when the GOP is expected to notify the Transmission Operator (TOP). Sub-requirement 2.1 provides guidance on a non-compliance window in the event a unit is deviating from schedule, and the GOP must notify the TOP if it is unable to return to schedule. Thus, the non-compliance window allows for notifications when a unit is unable to provide additional VAR support (e.g., when hitting an operational limit) or when the unit is too small to raise voltage. In both instances, the TOP may then provide some type of temporary exemption as outlined in VAR-001.

**R2.** Unless exempted by the Transmission Operator, each Generator Operator shall maintain the generator voltage or Reactive Power schedule<sup>5</sup> (within each generating Facility's capabilities<sup>6</sup> provided by the Transmission Operator, or otherwise shall meet the conditions of notification for deviations from the voltage schedule provided by the Transmission Operator, applicable Facility Ratings<sup>7</sup>) ~~as directed by the Transmission Operator.~~ [Violation Risk Factor: Medium] [Time Horizon: Real-time Operations]

~~2.1.~~ If a GOP drifts out of schedule, each Generator Operator shall notify its associated Transmission Operator within 15 minutes when both of the following conditions are met: 1) the GOP is operating outside of the prescribed voltage or Reactive Power schedule tolerance band<sup>8</sup> for 15 minutes; and 2) the GOP is no longer able to return to its voltage or Reactive Power schedule.

~~2.2.2.1.~~ When a generator's AVR automatic voltage regulator is out of service or the generator does not have an AVR, the Generator Operator shall use an alternative method to control the generator reactive output to meet the voltage or Reactive Power schedule directed by the Transmission Operator.

~~2.3.2.2.~~ When directed to modify voltage, the Generator Operator shall comply or provide an explanation of why the schedule cannot be met.

2.3. Generator Operators that do not monitor the voltage at the location specified in their voltage schedule shall have a methodology for converting the scheduled voltage specified by the Transmission Operator to the voltage point being monitored by the Generator Operator.

**M2.** In order to identify when a unit is deviating from its schedule, the Generator Operator will monitor voltage based on existing equipment at its Facility. The Generator Operator shall have evidence to show that the generator maintained the voltage or Reactive Power schedule provided by the Transmission Operator, or shall have evidence of meeting the conditions of notification for deviations from the voltage schedule provided by the Transmission Operator. Evidence may include, but is not limited to, operator logs, SCADA data, phone logs, and any other notifications that would alert the Transmission Operator or otherwise demonstrate that the Generator Operator complied with the Transmission Operator's instructions for addressing deviations from the voltage schedule.

For part 2.1, when a generator's AVR is out of service or the generator does not have an AVR, a Generator Operator shall have evidence to show an alternative method was used to control the generator reactive output to meet the voltage or Reactive Power schedule directed by the Transmission Operator.

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<sup>5</sup> The voltage or Reactive Power schedule is a target value with a tolerance band or a voltage or Reactive Power range communicated by the Transmission Operator to the Generator Operator ~~establishing a tolerance band within which the target value is to be maintained during a specified period.~~

<sup>6</sup> Generating Facility capability may be established by test or other means, and may not be sufficient at times to pull the system voltage within the schedule tolerance band. Also, when a Generator is operating in manual control, reactive power capability may change based on stability considerations.

<sup>7</sup> ~~When a Generator is operating in manual control, reactive power capability may change based on stability considerations and this may lead to a change in the associated Facility Ratings.~~

<sup>8</sup> ~~GOPs monitor and control voltage based on their equipment limitations. GOPs will monitor their voltage or Reactive Power schedule tolerance bands either at the high side or low side/terminal voltage.~~

For part 2.2, the Generator Operator shall have evidence that it complied with the Transmission Operator's directions to modify its voltage or provided an explanation of why the Generator Operator was unable to comply with the direction. Evidence may include, but is not limited to, operator logs, SCADA data, and phone logs.

~~**M2.**—For part 2.3, for units that do not monitor the voltage at the location specified on the voltage schedule the Generator Operator shall document or be able to demonstrate the method of conversion from the voltage level monitored to the voltage level specified on the voltage schedule. Generator Operators will still make all attempts to operate within the tolerance bands provided by the TOP, but natural drifting may occur. In instances where there is an event occurring to pull a unit out of the tolerance band, the Generator Operator will not be held in non-compliance with this requirement if the sub-requirements 2.1, 2.2, and 2.3 are met. In order to identify when a unit is deviating from its schedule, GOPs will monitor voltage based on existing equipment at its facility. Therefore, GOPs have the option to operate on a voltage schedule on either the high side or convert the high side schedule to a low side schedule at the GOP's discretion. For units that monitor on the low side/terminal voltage, Generator Operators shall provide evidence of the method of conversion from the high side schedule to low side monitoring. For sub-requirement 2.1, most units will not be able to return to schedule due to a limiting factor. Such limiting factors may include, but are not limited to: 1) terminal voltage, 2) bus voltage, 3) equipment temperature, 4) transformer, 5) auxiliary equipment, 6) Volts/Hz limits, and 7) excitation or regulator limits. GOP shall have evidence to show compliance with requirement R2 by providing 1) Communications with the TOP when the Generator Operator was operating outside of the prescribed voltage or Reactive Power schedule tolerance band for 30 minutes or less (the 30 minutes allow for 15 minutes to call and 15 minutes to be outside of the tolerance band) AND Generator Operator is no longer able to return to its voltage or Reactive Power schedule; 2) Generator Operator implemented an alternative method to control reactive output when the AVR was out of service or unavailable; 3) compliance with directive to modify voltage or a notification that the directive could not be met. Evidence may include, but is not limited to Generator Operator logs, SCADA data, phone logs, and any other alarming notifications that would alert the Transmission Operator that both conditions were met. Timing for Requirement R2.1 is crucial, and Generator Operators are expected to begin timing an event as soon as the unit is operating outside of the tolerance band. Further, voltage documentation during a system event maybe requested by an auditor to show measures were taken to bring the unit back into schedule.~~



**Rationale for R3:**

This requirement has been modified to limit the notifications required when an AVR goes out of service and quickly comes back in service. Such notifications provided little to no benefit to reliability. Fifteen (15) minutes have been built into the requirement to allow a GOP time to resolve an issue before having to notify the TOP of a status or capability change. The requirement has also been amended to remove the sub-requirement to provide an estimate for the expected duration of the status change. The 15-minute window should resolve most issues.

**Rationale for R3:**

This requirement has been modified to reduce the number of violations for when an AVR goes out of service and then comes back in service. Fifteen (15) minutes have been built into the requirement to allow a Generator Operator time to resolve an issue before having to notify the Transmission Operator of a status or capability change. The requirement has also been amended to remove the sub-requirement to provide an estimate for the expected duration of the status change. The 15-minute window should resolve most issues, and further trouble-shooting will probably be required if the status change is unresolved within 15 minutes.

- R3.** Each Generator Operator shall notify its associated Transmission Operator of a status ~~or capability~~ change on ~~the AVR, any generator Reactive Power resource, including the status of each automatic voltage regulator and~~ power system stabilizer, ~~or alternative voltage controlling device and the expected duration of the change in status or capability~~ within 30 minutes of the change. If the status has been restored within the first 15 minutes of such change, then there is no need to ~~notify~~ the ~~Transmission Operator~~ TOP. [Violation Risk Factor: Medium] [Time Horizon: Real-time Operations]
- M3.** The Generator Operator shall have evidence it notified its associated Transmission Operator within 30 minutes of ~~any of the~~ ~~changes~~ identified in Requirement ~~R33~~. If the status has been restored within the first 15 minutes, no ~~notification~~ is necessary; therefore, if a status ~~or~~ ~~Reactive Power resource has changed, and that~~ change lasts ~~more~~ ~~greater~~ than 15 minutes, the GOP must notify its associated ~~Transmission Operator~~ TOP within 30 minutes of when the change first occurred.

**Rationale for R4:**

This requirement and corresponding measure language has been maintained due to the importance of having accurate tap settings. If the tap setting is not properly set, then the amount of VARs produced by a unit can be affected.

**Rationale for R4:**

This requirement has been bifurcated from the earlier Requirement R3. This requirement allows GOPs to report reactive capability changes after they are made aware of the change. The current standard requires notification as soon as the change occurs, but many GOPs are already in non-compliance situations by the time it is known that a reactive capability change has taken place.

- R4.** Each Generator Operator shall notify its associated Transmission Operator within 30 minutes after becoming aware of a change in reactive capability due to factors other than a status change described in Requirement R3. If the capability has been restored within the first 15 minutes of such change, then there is no need to notify the Transmission Operator. *[Violation Risk Factor: Medium] [Time Horizon: Real-time Operations]*
- M4.** The Generator Operator shall have evidence it notified its associated Transmission Operator within 30 minutes of the recognition of a reactive capability change identified in Requirement R4. If the capability has been restored within the first 15 minutes, no notification is necessary; therefore, if a capability change lasts more than 15 minutes, the Generator Operator must notify its associated Transmission Operator within 30 minutes of when the change first occurred.

**Rationale for R5:**

This requirement and corresponding measure language has been maintained due to the importance of having accurate tap settings. If the tap setting is not properly set, then the amount of VARs produced by a unit can be affected.

**Rationale for R5:**

This requirement and corresponding measure have been maintained due to the importance of having accurate tap settings. If the tap setting is not properly set, then the amount of VARs produced by a unit can be affected. The original sub-requirement 4.1.4 (the +/- voltage range with step-change in % for load-tap changing transformers) has been removed.

~~R4,R5.~~ The Generator Owner shall provide the following to its associated Transmission Operator and Transmission Planner within 30 calendar days of a request. *[Violation Risk Factor: Lower] [Time Horizon: Real-time Operations]*

~~4.1.5.1.~~ For generator step-up transformers and auxiliary transformers with primary voltages equal to or greater than the generator terminal voltage:

~~4.1.1.5.1.1.~~ Tap settings.

~~4.1.2.5.1.2.~~ Available fixed tap ranges.

~~4.1.3.5.1.3.~~ Impedance data.

**M5.** The Generator Owner shall have evidence it provided its associated Transmission Operator and Transmission Planner with information on its step-up transformers and auxiliary transformers as required in Requirements [R5 part 54.1.1](#) through [part 54.1.3](#).

#### **Rationale for R6:**

This requirement and corresponding measure have been maintained due to the importance of having accurate tap settings. If the tap setting is not properly set, then the amount of VARs produced by a unit can be affected.

~~R5,R6.~~ After consultation with the Transmission Operator regarding necessary step-up transformer tap changes, the Generator Owner shall ensure that transformer tap positions are changed according to the specifications provided by the Transmission Operator, unless such action would violate safety, an equipment rating, a regulatory requirement, or a statutory requirement. *[Violation Risk Factor: Lower] [Time Horizon: Real-time Operations]*

~~5.1.6.1.~~ If the Generator Operator ~~cannot~~ comply with the Transmission Operator's specifications, the Generator Operator shall notify the Transmission Operator and shall provide the technical justification.

**M6.** The Generator Owner shall have evidence that its step-up transformer taps were modified per the Transmission Operator's documentation as identified in Requirement [R65](#). The Generator Operator shall have evidence that it notified its associated Transmission Operator when it ~~could not~~ [could](#) comply with the Transmission Operator's step-up transformer tap specifications as identified in Requirement [R6 part 65.1](#).

## C. Compliance

### 1. Compliance Monitoring Process:

#### 1.1. Compliance Enforcement Authority:

As defined in the NERC Rules of Procedure, “Compliance Enforcement Authority” ~~refers to~~<sup>means</sup> NERC or the Regional Entity in their respective roles of monitoring and enforcing compliance with the NERC Reliability Standards.

#### 1.2. Evidence Retention:

The following evidence retention periods identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the Compliance Enforcement Authority may ask an entity to provide other evidence to show that it was compliant for the full time period since the last audit.

The Generator Owner shall keep its latest version of documentation on its step-up and auxiliary transformers. The Generator Operator shall maintain all other evidence for the current and previous calendar year.

The Compliance Monitor shall retain any audit data for three years.

#### 1.3. Compliance Monitoring and Assessment Processes:

As defined in the NERC Rules of Procedure, “Compliance Monitoring and Assessment Processes” refers to the identification of the processes that will be used to evaluate data or information for the purpose of assessing performance or outcomes with the associated reliability standard.

#### 1.4. Additional Compliance Information:

None

Table of Compliance Elements

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
R1	Real-time Operations	Medium	N/A	N/A	N/A	<del>Unless exempted, the</del> The responsible entity did not operate each generator in the automatic voltage control mode and failed to notify the Transmission Operator as identified in <a href="#">Requirement R1</a> .
R2	Real-time Operations	Medium	N/A	N/A	N/A	The responsible entity did not perform any of the sub-requirements.
R3	Real-time Operations	Medium	N/A	N/A	N/A	The responsible entity did not make the notification within 30 minutes.
R2R4	Real-time Operations	<del>Medium</del> Lower	N/A When directed by the Transmission Operator to maintain the generator voltage or reactive power schedule the Generator Operator failed to meet the directed values for up to and including 45 minutes.	N/A When directed by the Transmission Operator to maintain the generator voltage or reactive power schedule the Generator Operator failed to meet the directed values for more than 45 minutes up to and including 60	The responsible entity did not have <a href="#">conversion methodology when it monitors at a location different from the schedule provided by the Transmission Operator</a> . When directed by the Transmission Operator to maintain the	The responsible entity did not maintain voltage or Reactive schedule as <a href="#">When directed by the Transmission Operator and did not make the necessary notifications required by the Transmission Operator</a> generator voltage or reactive power schedule the Generator Operator failed to meet the directed values for more than 75 minutes.  OR

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
				<p>minutes. OR When a generator's automatic voltage regulator is out of service, the Generator Operator failed to use an alternative method to control the generator voltage and reactive output to meet the voltage or Reactive Power schedule directed by the Transmission Operator. OR The Generator Operator failed to provide an explanation of why the voltage schedule could not be met.</p>	<p>generator voltage or reactive power schedule the Generator Operator failed to meet the directed values for more than 60 minutes up to and including 75 minutes.</p>	<p>The responsible entity did not have an operating AVR, and the responsible entity did notWhen a generator's automatic voltage regulator is out of service, the Generator Operator failed to use an alternative method for controlling voltage. OR The responsible entity did not modifyto control the generator voltage when directed, and the responsible entity did notand reactive output to meet the voltage or Reactive Power schedule directed by the Transmission Operator and the Generator Operator failed to provide anyan explanation of why the voltage schedule could not be met.</p>
<u>R3</u>	<u>Real-time Operations</u>	<u>Medium</u>	<u>N/A</u>	<u>N/A</u>	<u>N/A</u>	<u>The responsible entity did not make the notification within 30 minutes.</u>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
<a href="#">R4</a>	<a href="#">Real-time Operations</a>	<a href="#">Medium</a>	<a href="#">N/A</a>	<a href="#">N/A</a>	<a href="#">N/A</a>	<a href="#">The responsible entity did not make the notification within 30 minutes.</a>
<a href="#">R5</a>	<a href="#">Real-time Operations</a>	<a href="#">Lower</a>	<a href="#">N/A</a>	<a href="#">N/A</a>	<a href="#">The responsible entity failed to provide to its associated Transmission Operator and Transmission Planner one of the types of data specified in Requirements R5 parts 5.1.1 or 5.1.2 or 5.1.3.</a>	<a href="#">The responsible entity failed to provide to its associated Transmission Operator and Transmission Planner two or more of the types of data specified in Requirements R5 parts 5.1.1 and 5.1.2 and 5.1.3.</a>
<a href="#">R6R5</a>	<a href="#">Real-time Operations</a>	<a href="#">Lower</a>	<a href="#">N/A</a>	<a href="#">N/A</a>	<a href="#">N/A</a>	<a href="#">The Generator Owner did not ensure the tap changes were made according the Transmission Operator's specifications.</a>  <a href="#">OR</a>

R #	Time Horizon	VRF	Violation Severity Levels			
			Lower VSL	Moderate VSL	High VSL	Severe VSL
						<p><a href="#">The Generator Operator</a><del>GOP</del> failed to perform the tap changes, and the <a href="#">Generator Operator</a><del>GOP</del> did not provide technical justification for why it cannot comply with the <a href="#">Transmission Operator</a><del>TOP</del> directive.</p>



**D. Regional Variances**

None.

**E. Interpretations**

None.

**F. Associated Documents**

None.

## Guidelines and Technical Basis

For technical basis for each requirement, please ~~review~~[see](#) the ~~rationale provided~~[VAR White Paper](#) for ~~each requirement.~~ ~~further technical information.~~