



Market Rule Amendment Proposal

PART 1 – MARKET RULE INFORMATION

Identification No.:	MR-00359-R00		
Subject:	Generation Facility Requirements		
Title:	Changes to Facilitate Connections		
Nature of Proposal:	<input checked="" type="checkbox"/> Alteration	<input type="checkbox"/> Deletion	<input type="checkbox"/> Addition
Chapter:	4	Appendix:	4.2
Sections:			
Sub-sections proposed for amending:			

PART 2 – PROPOSAL HISTORY

Version	Reason for Issuing	Version Date
1.0	Draft for Technical Panel Review	November 20, 2009
2.0	Publish for Stakeholder Review and Comment	November 26, 2009
3.0	Submitted for Technical Panel Review and Vote	January 19, 2010
4.0	Recommended by Technical Panel; Submitted for IESO Board Approval	January 26, 2010
5.0	Approved by IESO Board	February 11, 2010
Approved Amendment Publication Date:	February 12, 2010	
Approved Amendment Effective Date:	March 6, 2010	

PART 3 – EXPLANATION FOR PROPOSED AMENDMENT

Provide a brief description of the following:

- The reason for the proposed amendment and the impact on the *IESO-administered markets* if the amendment is not made.
- Alternative solutions considered.
- The proposed amendment, how the amendment addresses the above reason and impact of the proposed amendment on the *IESO-administered markets*.

Summary

This amendment proposes changes to simplify and clarify generator technical requirements in order to:

- Facilitate the integration of embedded generation;
- Improve the administrative efficiency of the market entry process;
- Improve the IESO’s effectiveness in assessing proposed connections.

Background

Refer to amendment submission MR-00359-Q00 for further details.

Discussion

Facilitating the Integration of Embedded Generation

Under the existing market rules, almost all of the requirements listed in Chapter 4, Appendix 4.2 apply to embedded generation facilities with net output greater than 50 MVA and embedded generation units rated at 10 MVA or higher. It is proposed to simplify the requirements for these facilities by removing all but three requirements.

To make it easier for generators that are not directly connected to the IESO-controlled grid to know their facility requirements under the market rules, it is proposed to move the three remaining applicable provisions to the beginning of Appendix 4.2. These three requirements also represent a subset of the requirements that apply to generation facilities directly connected to the IESO-controlled grid. The proposed changes to these requirements can be summarized as follows:

- Off nominal frequency operation: No material changes;
- Speed/Frequency regulation: Extend the requirements to all generation types and add measurable requirements for governor performance ;
- Ride through: Add a requirement for generators to have the capability to ride through routine switching events and design contingencies.

The introductory paragraph in the existing Appendix 4.2 indicates that each generation facility must comply with requirements in the appendix (with a few exceptions). As a result of the proposed changes, it’s no longer appropriate that the proposed version of Appendix 4.2 apply to existing facilities. Rather, Appendix 4.2 would apply to new installations or to existing generation facilities when equipment is replaced. An existing generator would be required to meet and maintain, as a minimum, the requirement that was in effect at the time it was authorized to connect to the IESO-controlled grid or as agreed to by the market participant and the IESO (i.e. the “original performance

PART 3 – EXPLANATION FOR PROPOSED AMENDMENT

requirements”. If a generator replaces equipment or significantly modifies a piece of equipment, the generator would have to meet the requirement in effect at the time of the replacement. That new requirement could be higher or lower. An existing generator could take advantage of a lower requirement, even if they weren’t replacing or modifying equipment, by submitting a new connection assessment (in accordance with Chapter 4, section 6).

Improving the Market Entry Process and the IESO’s Effectiveness in Assessing Proposed Connections

The proposed changes to generation facility requirements would afford greater clarity through measurable performance requirements and added flexibility to allow emerging technologies to be evaluated on a fair basis. Experience has shown that more clarity is needed in some areas to make the connection assessment process more efficient.

To further simplify Appendix 4.2, it is proposed to re-organize the contents (through an entire re-write). The proposed amendments to the requirements that apply only to generation facilities that are directly connected to the IESO-controlled grid can be summarized as follows:

- Active power: Editorial change for clarification;
- Reactive power; Specify requirements at the point of connection. Express the requirements in a more concrete manner. Reduce capability for continuous withdrawal;
- Automatic voltage regulation: Add a capability requirement for droop systems consistent with present requirement for non-droop systems;
- Excitation system: Clarify voltage response time requirements apply to both positive and negative ceilings. Add performance requirements for high exciter load conditions;
- Stabilizer: Add measurable requirements to provide better guidance and specify the type of stabilizer ($\Delta P\omega$) to avoid less stable designs;
- Phase unbalance: Add a measurement location to avoid too onerous a restriction;
- Armature and Field Limiters: Make explicit that limiters must not unduly restrict equipment capability; and
- Technical characteristics: Add a requirement for performance to be consistent with an equivalent synchronous machine with characteristic parameters within typical ranges.

Consequential Amendments

Chapter 4, section 3.1.3 specifies that Appendix 4.2 applies to an embedded generation unit rated at 10 MVA or higher or an embedded facility whose net output is greater than 50 MVA. However, the Chapter 11 definition of “connection applicant” refers to generators seeking approval to establish a new or modified connection for a facility that is directly to the IESO-controlled grid or for an embedded facility greater than 10 MW. For the sake of consistency, it is proposed to change the thresholds in section 3.1.3 such that they align with the connection applicant definition (refer to R01). Revising these threshold values would have no impact on the set of requirements that apply to existing facilities under the current and proposed rules.

PART 4 – PROPOSED AMENDMENT

Appendix 4.2 – Generation Facility Requirements ~~(Embedded and Non Embedded)~~

~~Each generation facility shall comply with the following requirements, provided that a generation facility that was in service or that existed and was licensed on the date of coming into force of this Chapter 4 shall preserve original excitation system design capabilities and shall not be required to comply with the requirements set forth in rows 12 to 15 of this Appendix until its exciter is replaced. Such generation facility shall, until that time, be required to operate in accordance with the design capabilities applicable in respect of each of the items referred to in rows 12 to 15 of this Appendix.~~

Ref	Item	Requirement
4	Reactive Power Capabilities	<p>1. A synchronous generation unit shall have the capability to supply at its terminal reactive power within the range 90% lagging (overexcited) to 95% leading (underexcited) power factor based on rated active power at rated voltage. Rated active power shall be the lesser of registered maximum continuous real power and 90% of the unit nameplate MVA.</p> <p>2. A non-embedded generation unit within a generation facility shall have the capability to supply its entire range of reactive power for at least one constant voltage at a connection facility terminal greater than 50 kV. A non-embedded generation unit within a generation facility for which a licence has first been issued on or before the date of coming into force of this Chapter 4, and lacking the capability to meet this requirement, shall maintain its existing capability and shall establish the capability to supply its entire range of reactive power for at least one constant voltage at a connection facility terminal greater than 50 kV upon upgrading of all of the limiting components of its connection facilities.</p> <p>3. Where modifications to a generation facility made before the date of coming into force of this Chapter 4 make it no longer possible to meet these reactive requirements at a new higher active power, generation units within such generation facility shall, if so requested by the IESO, satisfy reactive power requirements based on rated active power before this modification.</p> <p>4. An induction generation facility that is injecting electricity at a nominal voltage of greater than 50 kV, shall have, as measured at its connection point, the same capability to supply reactive power as required of a synchronous generation unit of the same apparent power.</p> <p>— The IESO may permit a lower requirement for an induction generation facility if the IESO identifies during the connection assessment for the facility that the lower requirement will not adversely affect the reliable operation of the IESO-controlled grid. At any time after the connection assessment is complete, the IESO may impose a higher requirement than that identified at the time of the connection assessment, up to the capabilities required of a synchronous generation unit of the same apparent power, if the IESO determines that the higher requirement is necessary to maintain reliable operation of the IESO-controlled grid.</p> <p>5. An induction generation facility that is injecting electricity at a nominal voltage equal to or less than 50 kV, shall have, as a minimum, the capability to reduce its reactive power flow to zero, as measured at the facility's connection point.</p> <p>— The IESO may impose additional reactive power capability requirements, up to the capabilities required of a synchronous generation unit of the same apparent power, if the IESO identifies during the connection assessment for the facility that the additional capability is required to maintain reliable operation of the IESO-controlled grid.</p>
2	Voltage Variations	Each generation facility shall be capable of operating continuously at full output within $\pm 5\%$ of the generation facility's rated terminal voltage. All plant auxiliaries shall be capable of running continuously

Ref	Item	Requirement	
		within this range. Each <i>generation facility</i> shall not be expected to operate continuously outside this voltage range to satisfy reactive power requirements.	
3	Frequency Variations	Each <i>generation facility</i> shall be able to operate continuously at full power in the range 59.4 to 60.6 Hz. Each <i>generation facility</i> shall be capable of operating at full power for a limited period of time at frequencies as low as 58.8 Hz. Each <i>generation facility</i> shall not trip for underfrequency excursions that are above a straight line defined on a linear-log plot of time and frequency by the points (300s, 59.0Hz) and (3.3s, 57.0 Hz) unless the <i>IESO</i> accepts other trip settings. Immediate tripping is allowed below 57.0 Hz.	
4	Phase Unbalance	Phase voltage unbalance of <i>generation facilities</i> shall be limited to 1% measured with the units operating unsynchronised. <i>Generation facilities</i> shall be able to continuously operate with a phase unbalance of 2%.	
5	Connection Equipment	All equipment connecting the <i>generation unit's</i> terminal to the <i>IESO-controlled grid</i> shall be able to conduct for at least 4 hours the <i>generation unit's</i> rated apparent power, being the product of root-mean-square (rms) voltage and the rms current, minus auxiliary power requirements necessary to operate the unit at maximum output and minus a fair portion of the common service load required to run the entire <i>generation facility</i> .	
6	[Intentionally left blank]		
7	Protective Systems and Relaying System Requirements	Protection systems shall be constructed and maintained in accordance with all applicable <i>reliability standards</i> .	
8	[Intentionally left blank] Line		
9	<i>IESO</i> Monitoring and Telemetry Requirements	<i>Generation facilities</i> that are required by this Chapter 4 to be monitored shall provide suitable space and facilities for the installation of telecommunications equipment to interface with the <i>generator's</i> data acquisition equipment. Data monitoring equipment shall be compatible with the <i>IESO</i> telecommunications interface and meet the requirements of this Chapter 4 and of Appendix 2.2 of Chapter 2, if such equipment is not already installed on the date of coming into force of this Chapter 4. Any such new installation shall be done at the <i>generator's</i> cost.	
10	Communication Facilities	Communication facilities are required for several or all of the following functions: protective relaying, SCADA, <i>IESO energy</i> management system, voice communication, <i>automatic generation control (AGC)</i> , and <i>special protection systems (generation rejection or runback)</i> . Details depend on the size and specific location of the generating plant under consideration	
14	Testing/ Compliance Monitoring	<i>Generators</i> shall test and maintain their equipment in accordance with all applicable <i>reliability standards</i> .	

Ref	Item	Requirement
	Generator Controls	
12	Excitation System Performance	<p>1. Each synchronous <i>generation unit</i> rated at 10 MVA or higher shall be equipped with an excitation system with:</p> <ul style="list-style-type: none"> • A voltage response time not longer than 50 ms for a voltage reference step change not to exceed 5%; • A positive ceiling voltage of at least 200% of the rated field voltage, and • A negative ceiling voltage of at least 140% of the rated field voltage. <p>— This performance requirement would not apply to a <i>generation unit</i> rated at 10 MVA or higher where the <i>IESO</i> determines through the <i>connection assessment</i> for that <i>generation unit</i>, that a lower requirement would not adversely impact the <i>reliable</i> operation of the <i>IESO-controlled grid</i>. In these circumstances, the synchronous <i>generation unit</i> shall be equipped with an excitation system with:</p> <ul style="list-style-type: none"> • An excitation system nominal response of at least 0.50 and • A positive ceiling voltage at least 150% of rated field voltage <p>2. Each synchronous <i>generation unit</i> rated at less than 10 MVA shall be equipped with an excitation system with:</p> <ul style="list-style-type: none"> • An excitation system nominal response of at least 0.50 and • A positive ceiling voltage at least 150% of rated field voltage <p>— This performance requirement would not apply to a <i>generation unit</i> rated at less than 10 MVA where the <i>IESO</i> determines through the <i>connection assessment</i> for that <i>generation unit</i>, that a higher requirement is required to maintain <i>reliable</i> operation of the <i>IESO-controlled grid</i>. In these circumstances, the synchronous <i>generation unit</i> shall be equipped with an excitation system with:</p> <ul style="list-style-type: none"> • A voltage response time not longer than 50 ms for a voltage reference step change not to exceed 5%; • A positive ceiling voltage of at least 200% of the rated field voltage, and • A negative ceiling voltage of at least 140% of the rated field voltage.
13	Automatic Voltage Regulator	<p>Each synchronous <i>generating unit</i> shall be equipped with a continuously acting automatic voltage regulator (AVR) that can maintain terminal voltage under steady state conditions within $\pm 0.5\%$ of any set point within $\pm 5\%$ of rated voltage.</p> <p>Each induction <i>generation facility</i> that is injecting electricity at a nominal voltage of greater than 50 kV shall be equipped with a voltage regulation system (VRS) that provides comparable performance to that of the AVR of a synchronous <i>generation unit</i> of the same apparent power.</p> <p>Each AVR and VRS shall regulate voltage except where permitted by the <i>IESO</i>.</p> <p>Automatic set point adjustments shall be suspended when terminal voltage deviates from a fixed set point by an amount not to exceed $\pm 2\%$ of the fixed set point.</p> <p>Where multiple <i>generation units</i> are connected to a common bus, each <i>generation unit's</i> AVR reference shall be compensated to a point as close as practicable to but not farther than this common bus. The reach of AVR compensation shall not exceed 10% of the <i>generation unit's</i> synchronous direct axis impedance from the common bus. <i>IESO</i> approval is required for all other schemes that compensate the AVR to a point other than the <i>generation unit's</i> terminals.</p>
14	Power Factor Regulator	<p>Each synchronous <i>generation unit</i> connected to the system at a voltage under 50 kV shall be provided with a power factor regulator or VAR regulator. A power factor regulator shall be capable of maintaining a power factor within $\pm 1\%$ between 90% lagging and 95% leading. A VAR regulator shall be capable of maintaining reactive power within $\pm 2.5\%$ of rated MVA. The power factor or VAR regulator shall have an adjustable effective response time between 10 to 60 seconds.</p>
15	Power System Stabilizer	<p>Each synchronous <i>generating unit</i> that is equipped with an excitation system that meets the performance requirements specified in sub-section 1 of section 12 above, shall also be equipped with a power system stabilizer. The power system stabilizer shall, to the extent practicable, be tuned to increase damping torque without reducing synchronizing torque.</p>

Ref	Item	Requirement
16	Speed Governor	<ul style="list-style-type: none"> • Each synchronous generation unit with a nameplate rating of greater than 10 MVA shall be operated with a speed governor. The governor shall have a permanent speed droop that can be set in the range between 3% and 7% and the intentional deadband shall not be wider than ± 36 mHz. • The above droop and deadband requirements shall apply to an entire combined-cycle generation facility. • The governor shall be able to arrest the unit's speed, following full load rejection to prevent a trip due to overspeed, and shall demonstrate stable performance with adequate damping under all operating conditions. • Governors shall control speed in a stable fashion during both island and interconnected operation. • To the extent practical governors shall provide immediate, appropriate and sustained response to abnormal frequency excursions. • Control systems that inhibit governor response shall be automatically disabled by frequency deviations not larger than ± 100 mHz.

The performance requirements set out below shall apply to generation facilities subject to a connection assessment finalized after March 6, 2010. Performance of alternative technologies will be compared at the point of connection to the IESO-controlled grid with that of a conforming conventional synchronous generation unit with an equal apparent power rating to determine whether a requirement is satisfied.

Each generation facility that was authorized to connect to the IESO-controlled grid prior to March 6, 2010 shall remain subject to the performance requirements in effect for each system at the time of its authorization to connect to the IESO-controlled grid was granted or as agreed to by the market participant and the IESO (i.e. the "original performance requirements"). These requirements shall prevail until the main elements of an associated system (e.g. governor control mechanism, main exciter) are replaced or substantially modified. At that time, the replaced or substantially modified system shall meet the applicable performance requirements set out below. All other systems, not affected by replacement or substantial modification, shall remain subject to the original performance requirements.

Category	<u>Generation facility directly connected to the IESO-controlled grid, generation facility greater than 50MW, or generation unit greater than 10MW shall have the capability to:</u>
<u>1. Off-Nominal Frequency</u>	<u>Operate continuously between 59.4Hz and 60.6Hz and for a limited period of time in the region above straight lines on a log-linear scale defined by the points (0.0s, 57.0Hz), (3.3s, 57.0Hz), and (300s, 59.0Hz).</u>
<u>2. Speed/Frequency Regulation</u>	<u>Regulate speed with an average droop based on maximum active power adjustable between 3% and 7% and set at 4% unless otherwise specified by the IESO. Regulation deadband shall not be wider than $\pm 0.06\%$. Speed shall be controlled in a stable fashion in both interconnected and island operation. A sustained 10% change of rated active power after 10s in response to a constant rate of change of speed of 0.1%/s during interconnected operation shall be achievable. Due consideration will be given to inherent limitations such as mill points and gate limits when evaluating active power changes. Control systems that inhibit governor response shall not be enabled without IESO approval.</u>
<u>3. Low Voltage Ride Through</u>	<u>Ride through routine switching events and design criteria contingencies assuming standard fault detection, auxiliary relaying, communication, and rated breaker interrupting times unless disconnected by configuration.</u>
Category	<u>Generation facility directly connected to the IESO-controlled grid shall have the capability to:</u>
<u>4. Active Power</u>	<u>Supply continuously all levels of active power output for 5% deviations in terminal voltage. Rated active power is the smaller output at either rated ambient conditions (e.g. temperature, head, wind speed, solar radiation) or 90% of rated apparent power. To satisfy steady-state reactive power requirements, active power reductions to rated active power are permitted.</u>
<u>5. Reactive Power</u>	<u>Inject or withdraw reactive power continuously (i.e. dynamically) at a connection point up to 33% of its rated active power at all levels of active power output except where a lesser continually available capability is permitted by the IESO. A conventional synchronous unit with a power factor range of 0.90 lagging and 0.95 leading at rated active power connected via a main output transformer impedance not greater than 13% based on generator rated apparent power is acceptable.</u>

6. Automatic Voltage Regulator (AVR)	Regulate automatically voltage within $\pm 0.5\%$ of any set point within $\pm 5\%$ of rated voltage at a point whose impedance (based on rated apparent power and rated voltage) is not more than 13% from the highest voltage terminal based. If the AVR target voltage is a function of reactive output, the slope $\Delta V / \Delta Q_{max}$ shall be adjustable to 0.5%. The equivalent time constants shall not be longer than 20 ms for voltage sensing and 10 ms for the forward path to the exciter output. AVR reference compensation shall be adjustable to within 10% of the unsaturated direct axis reactance on the unit side from a bus common to multiple units.
7. Excitation System	Provide (a) Positive and negative ceilings not less than 200% and 140% of rated field voltage at rated terminal voltage and rated field current; (b) A positive ceiling not less than 170% of rated field voltage at rated terminal voltage and 160% of rated field current; (c) A voltage response time to either ceiling not more than 50ms for a 5% step change from rated voltage under open-circuit conditions; and (d) A linear response between ceilings. Rated field current is defined at rated voltage, rated active power and required maximum continuous reactive power.
8. Power System Stabilizer (PSS)	Provide (a) A change of power and speed input configuration; (b) Positive and negative output limits not less than $\pm 5\%$ of rated AVR voltage; (c) Phase compensation adjustable to limit angle error to within 30° between 0.2 and 2.0Hz under conditions specified by the IESO, and (d) Gain adjustable up to an amount that either increases damping ratio above 0.1 or elicits exciter modes of oscillation at maximum active output unless otherwise specified by the IESO. Due consideration will be given to inherent limitations.
9. Phase Unbalance	Provide an open circuit phase voltage unbalance not more than 1% at a connection point and operate continuously with a phase unbalance as high as 2%.
10. Armature and Field Limiters	Provide short-time capabilities specified in IEEE/ANSI 50.13 and continuous capability determined by either field current, armature current, or core-end heating. More restrictive limiting functions, such as steady state stability limiters, shall not be enabled without IESO approval.
11. Performance Characteristics	Exhibit connection point performance comparable to an equivalent synchronous generation unit with characteristic parameters within typical ranges. Inertia, unsaturated transient impedance, transient time constants and saturation coefficients shall be within typical ranges (e.g. $H > 1.2$ Aero-derivative, $H > 1.2$ Hydraulic less than 20 MVA, $H > 2.0$ Hydraulic 20MVA or larger, $H > 4.0$ Other synchronized units, $X'd < 0.5$, $T'do > 2.0$, and $S1.2 < 0.5$) except where permitted by the IESO.

PART 5 – IESO BOARD DECISION RATIONALE

These changes will facilitate the integration of embedded generation, improve the administrative efficiency of the market entry process, and improve the IESO's effectiveness in assessing proposed connections.



Market Rule Amendment Proposal

PART 1 – MARKET RULE INFORMATION

Identification No.:	MR-00359-R01		
Subject:	Generation Facility Requirements		
Title:	Changes to Facilitate Connections		
Nature of Proposal:	<input checked="" type="checkbox"/> Alteration	<input type="checkbox"/> Deletion	<input type="checkbox"/> Addition
Chapter:	4	Appendix:	
Sections:	3.1.3, 3.4.1		
Sub-sections proposed for amending:			

PART 2 – PROPOSAL HISTORY – REFER TO MR-00359-R00

Version	Reason for Issuing	Version Date
Approved Amendment Publication Date:		
Approved Amendment Effective Date:		

PART 3 – EXPLANATION FOR PROPOSED AMENDMENT

Provide a brief description of the following:

- The reason for the proposed amendment and the impact on the *IESO-administered markets* if the amendment is not made.
- Alternative solutions considered.
- The proposed amendment, how the amendment addresses the above reason and impact of the proposed amendment on the *IESO-administered markets*.

Summary

These amendments are consequential to the changes proposed under MR-00359-R00.

Background

Refer to MR-00359-R00

Discussion

- Chapter 4, section 3.1.3 specifies that Appendix 4.2 applies to an embedded generation unit rated at 10 MVA or higher (or an embedded facility whose net output is greater than 50 MVA). However, the Chapter 11 definition of “connection applicant” refers to generators seeking approval to establish a new or modified connection for a facility that is directly to the IESO-controlled grid or for an embedded facility greater than 10 MW. A “connection applicant” would be required to satisfy the requirements in Appendix 4.2. Therefore, for the sake of consistency, it is proposed to change the thresholds in section 3.1.3 such that they align with the connection applicant definition. In addition, Appendix 4.2 contains requirements, not standards, so the reference to “standards” in section 3.1.3 should be replaced with “requirements”.
- Since section 3 of Chapter 4 is being amended, it is also proposed, as a matter of clean-up, to delete the reference to section 3.4.1.1 in section 3.4.1.9, since section 3.4.11 is blank.

PART 4 – PROPOSED AMENDMENT

Chapter 4, section 3.1.3

3.1.3 Each *embedded generator* whose *embedded generation facility* ~~includes~~ comprises either a generation unit rated at greater than 10 MVA-MW or higher or ~~whose embedded generation facility is comprised of~~ generation units whose net output is greater than 50 MVA-MW shall ensure that its equipment meets all applicable performance ~~standards-requirements~~ requirements in Appendix 4.2.

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Chapter 4, section 3.4.1

3.4 Obligations of Generators

- 3.4.1 Each *generator* that participates in the *IESO-administered markets* or that causes or permits electricity to be conveyed into, through or out of the *IESO-controlled grid* shall:
 - 3.4.1.1 [Intentionally left blank]
 - 3.4.1.2 [Intentionally left blank]
 - 3.4.1.3 permit and participate in any commissioning, inspection, and testing that the *IESO* requires of its equipment that is or is to be *connected to the IESO-controlled grid*;
 - 3.4.1.4 [Intentionally left blank]
 - 3.4.1.5 [Intentionally left blank]
 - 3.4.1.6 operate its equipment in accordance with its *connection agreement*;
 - 3.4.1.7 [Intentionally left blank]
 - 3.4.1.8 complete and return to the *IESO* those portions of the *IESO catalogue of reliability-related information* relevant to its *facilities*; and
 - 3.4.1.9 notify the *IESO* upon the submission of a *connection request* to a *transmitter* ~~pursuant to section 3.4.1.1.~~

PART 5 – IESO BOARD DECISION RATIONALE – REFER TO MR-00359-R00

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