



IRIS Rotating Machine Conference 2019
**Qualification of Stator Coils
and Bars at Hydro-Québec**

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PRESENTATION OUTLINE

- MOTIVATION
- OBJECTIVE
- QUALIFICATION OF STATOR COILS AND BARS
- CONCLUSION

MOTIVATION

GLOBALIZATION

- WINDING SHOP SHUTDOWN
- RELOCATION OF WINDING SHOP TO OVERSEAS
- LOSS OF EXPERIENCED STAFF



- DESIGN
- MATERIALS
- MANUFACTURING PROCESS
- MANUFACTURING ENVIRONMENT
- STAFF

QUALITY



OBJECTIVE

- 1) Determine whether the supplier's manufacturing plant is qualified to produce stator windings for Hydro-Québec.
- 2) Onboard new suppliers while ensuring the stator winding reliability and maintain good quality of the coils and bars from the existing suppliers.

QUALIFICATION OF STATOR COILS AND BARS

WHAT DOES HYDRO-QUEBEC'S QUALIFICATION PROGRAM CONSIST OF?

1. Pre-Audit
2. Manufacturing Audit
3. Qualification Tests

QUALIFICATION OF STATOR COILS AND BARS

WHAT DOES HYDRO-QUEBEC'S QUALIFICATION PROGRAM CONSIST OF?

1. Pre-Audit – Technical Questionnaire

- Insulation system
- Manufacturing capability
- Testing capability
- Subcontractors and their implication
- List of reference projects with MVA, kV, core height, VET, TCT.
- Typical documents such as ITP, stator coil/bar drawing.

2. Manufacturing Audit

3. Qualification Tests

QUALIFICATION OF STATOR COILS AND BARS

WHAT DOES HYDRO-QUEBEC'S QUALIFICATION PROGRAM CONSIST OF?

1. Pre-Audit – Technical Questionnaire

2. Manufacturing Audit – Checklist

- Materials storage
- Environmental conditions
- Manufacturing process
 - Subcontractors
- Testing facility

→ Recommendations and Follow-up

3. Qualification Tests

GENERAL	Prerequisite: Audited shop must be in real production.	Project (powerhouse): MVA: kV: Coils or bars:
PRODUCTION	Environment conditions	Cleanness: RH control: Temperature control:
	Dimensional control	Visual inspection: Criteria: Go-NoGo, dummy core, etc.: Measurement and recording: Calibration of the instrument: On all coils/bars or sampling:

QUALIFICATION OF STATOR COILS AND BARS

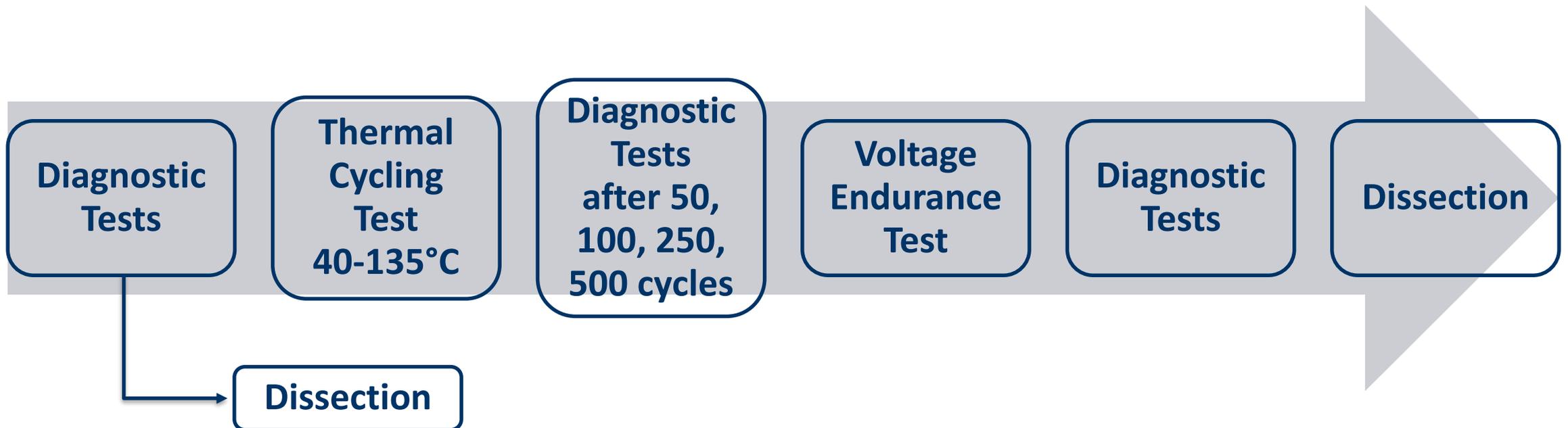
WHAT DOES HYDRO-QUEBEC'S QUALIFICATION PROGRAM CONSIST OF?

1. Pre-Audit – Technical Questionnaire
2. Manufacturing Audit – Checklist
3. **Qualification Tests**
 - 4 coils or 8 bars
 - Rated voltage: 11 to 15 kV

QUALIFICATION OF STATOR COILS AND BARS

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3. Qualification Tests



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		ACCEPTANCE CRITERIA PRE TCT	ACCEPTANCE CRITERIA POST TCT
1	Dimensional check	Per drawing	$\Delta(\text{post TC} - \text{pre TC}) \leq 0,2\text{mm}$
2	DF and tip-up (0.2Un and 0.6Un) IEEE 286	$\tan\delta < 1,5\%$ $\Delta\tan\delta \leq 0,6\%$	$\tan\delta < 1,5\%$ $\Delta\text{tip-up} \leq 0,3\%$
3	PD measurement with coupling capacitor IEEE 1434, Table 3, Case 1	$\leq 2\text{nC}$	$\leq 2\text{nC}$
4	PD measurement with electromagnetic probe IEEE 1434	$\leq 5\text{mA}$	No criteria
5	Visual corona with uv camera, IEEE 1799	No corona	N/A
6	Turn insulation test, IEEE 522	Pass	Pass
7	Hipot	$1,4(2\text{Un}+1) \text{ kV}$	N/A
8	Surface resistance measurement	$200 - 7000 \Omega/\square$	$200 - 7000 \Omega/\square$
9	Tap test	IEEE 1310, Section 7.5	IEEE 1310, Section 7.5

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WHAT DOES HYDRO-QUEBEC'S QUALIFICATION PROGRAM CONSIST OF?

3. Qualification Tests

**Diagnostic
Tests**



PD measurement with electromagnetic probe

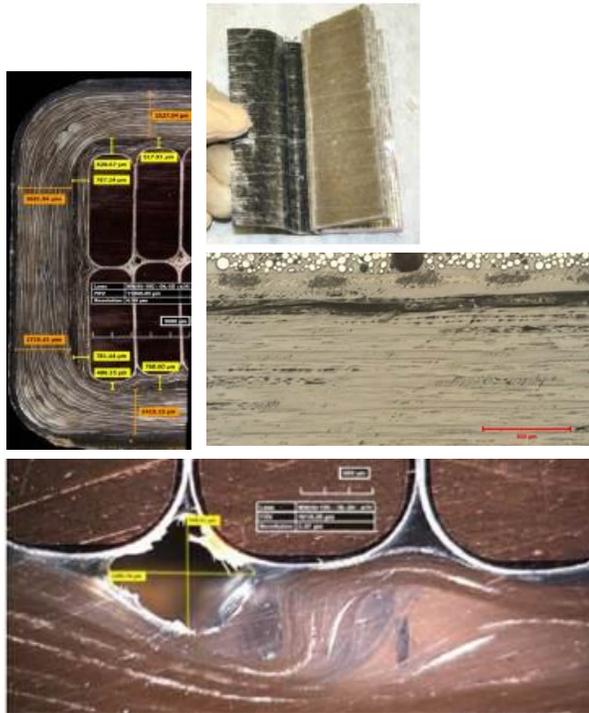
- Scan the grounded straight semiconductive portion of the coil/bar.
- Probe connected to its own reading device (in mA).
- Locate abnormal PD → Identify dissection sites.

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Dissection

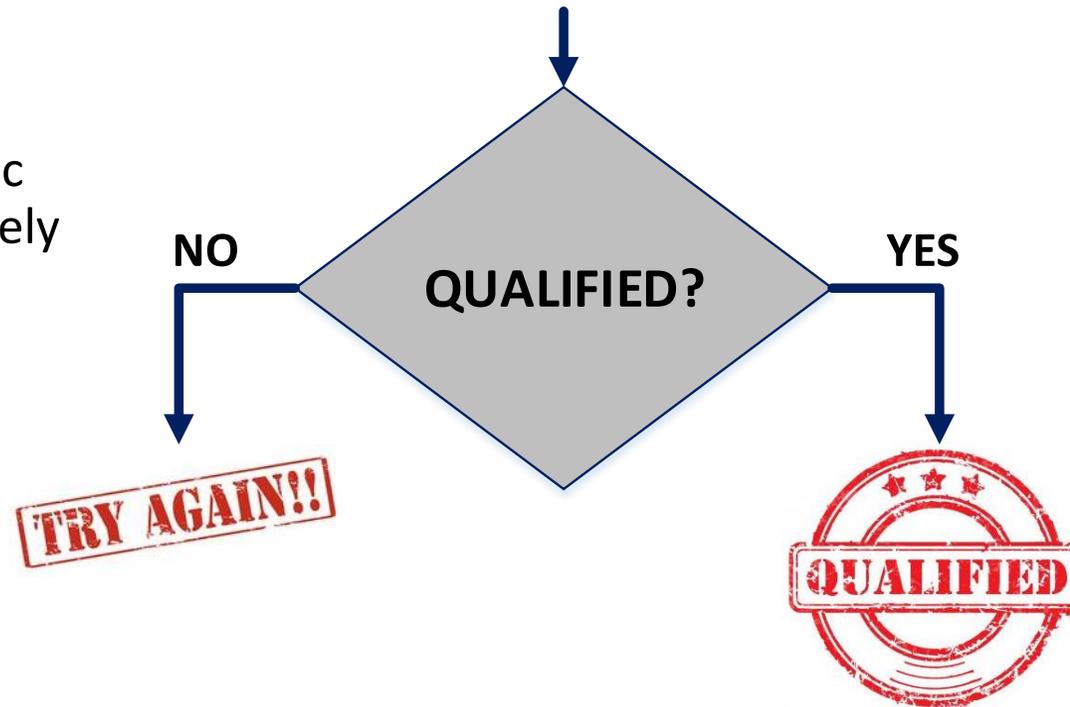


- Dissection sites determined by an electromagnetic probe.
- Adhesion strength evaluation between
 - Semiconductive coating & Groundwall insulation
 - Groundwall insulation layers
 - Groundwall insulation & Turn insulation
 - Turn insulation layers
 - Turn insulation & Copper
- Microscopic analysis
 - Delamination
 - Voids
 - Discoloration
 - Insulation thickness variation
 - Alignment of the copper strands
 - Debonding

QUALIFICATION OF STATOR COILS AND BARS

WHAT'S NEXT?

Supplier and Hydro-Québec work together collaboratively to achieve a solution. Supplier makes the corrections and then undergo the qualification.



Suppliers are allowed to bid subsequent contracts as long as they do not change manufacturing plant or process.

CONCLUSION

- 1) Prior to the contract award, Hydro-Québec can be assured of the supplier's stator winding quality and thereby reducing the risk of costly delays.
- 2) Qualification program does not replace normal quality control efforts, but supplements them.



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