SCOPEER – Project Proposal Form

☒ **New Standard** ☐ **Existing Standard – Standard Number : _____**

PROJECT PROPONENT / CHAMPION:	**PROJECT TITLE:**
BC Hydro – Constantin Pitis	**Energy Efficiency Switching Devices for AC Low Voltage Loads**
DATE SUBMITTED:	**DATE ENDORSED BY TC:**
26th Nov. 2009	

1. PROJECT PROPOSAL

(a) Definition of the problem or need:

AC Low voltage loads are defined as 3-phase and single phase electric motors and resistive loads performing at voltages of 600 V, 60 Hz and under. The switching devices are used for protection and control of these loads and are regulated by NEMA. For electric motors these devices are generically denominated as "motor starters".
Traditional motor starters are composed by 3 (three) equipments series connected: Circuit Breaker (Electro-dynamic protection), Thermal Protective Device (Overload Relay) and Contactor as shown in figure 1.
These devices incorporate 2 (two) circuits working at two different voltages (currents):

- Power Circuit used to connect the load at the power supply that is part of the power line ("heavy currents circuit")
- Control Circuit that is an electromechanical device activated by a coil that could be excited at lower voltages ("light currents circuit")

These devices do not consume "standby power". They consume power (P_{loss}) only when the loads are energized:

- Active power losses due to resistances of those three equipments inserted in Power Circuit when traversed by "heavy currents" and dissipated as heat (I^2R losses)
- Power losses on the control circuit ("light currents") used to keep energized the electromechanical control device.

These power losses are counted as demand losses with consequential generation of energy losses.

(b) Energy related limitations/opportunities:

Schneider and Siemens are the current manufacturers of these new devices (motor starters).
Schneider product (presented in attachment) is denominated as TeSys U (denomination further used in the FFP).The new switching devices (TeSyS U) incorporate all three series equipments (three in one), as shown in figure 1.
The new device has therefore a **reduced number of power contacts** comparing to traditional devices.
Traditional electromechanical control circuit is replaced by an **electronic control device**.
Important reduction of power losses have been obtained as a result of introducing these 2 (two) major modifications.

1. Reduction of P_{loss} dissipated as heat by Switching Devices for AC Low Voltage Loads will enable:
- Notable power demand savings and energy savings in on all commercial and industrial applications.
- Reduction of temperature rise of the equipments, inside of Distribution Boards and in Motor Control Centers.
- Reduced intensity of insulation degradation process in DB circuitries
2. By reducing temperature rise of switching devices, the energy consumed by HVAC installation in Motor Control Centers will be reduced, too.
3. Influence on electric motors:
- Reduction of the number of power contacts will reduce the probability of unbalanced DC resistance on the power contacts occurrence; this will result in reduction of unbalanced voltages applied to loads with direct improvement on electric motor efficiency
- Electronic control will enable reduction of overvoltage spikes and other transients occurring during device trip.
4. The new equipments withstand to 2...3 consecutive load tripping (and reclosure); that will enable reduction on materials and energy spent to manufacture power contacts by reducing 2...3 times the material consumption on power contacts used to be replaced after tripping or re-closures.
5. Other Non-Energy benefits:
- Reduction of dimensional sizes of DBs (this will influence Canadian Electrical Code) and NEMA standards.
- Reduced manpower costs to fit new equipment
- Reduced maintenance costs by changing contacts.
- Easy interface connection on control circuit (useful for Smart Meter Initiative)

Currently, new switching devices (motor starters) are available for 20 HP, 600 V motors and under.
Due to existent regulations the market penetration on the Northern continent is very low (10%...15%).
The prices are competitive with existent devices (IEC traditional) enabling a good leverage with incentives related to incremental cost.

2. BACKGROUND

a) General

The switching devices spend power (demand) as losses: $P_{loss} = P_{loss,\ power} + P_{loss,\ control}$
$P_{loss,\ power}$ counts for power losses dissipated as heat by the main contacts on the power circuit.
$P_{loss,\ control}$ counts for power losses dissipated as heat by the control circuits (electromechanical or electronic devices).
This project will deal with reduction of both power losses types of switching devices by measuring and reporting these losses on traditional (NEMA) or IEC) and new switching devices used for AC low voltage loads.
According to Schneider (see attached document, in Appendix) for two 460 V, 50 Hz motor types at full load the following values on **power dissipation in [Watts]** are occurring at ambient temperature:

Line current [A]	**NEMA traditional**	IEC traditional	**New Equipment**	AC Drive
12	**34.86 W**	5.18 W	**2.54 W**	440 W
32	46.57 W	18.18 W	9.42 W	600 W

There is a notable similarity between proposed project and existent regulations referring to Electric Motor Efficiencies: standard and energy efficient vs. NEMA Premium motors.

b) Expected Results **(Estimations are done for BC)**:

Assumptions (1):

- Considering existent availability of the new devices (up to 20 HP, 600 V) it results that a line current of 12 A represents an average value of all range of equipments (20 HP and bellow). The average value of power demand savings per one equipment at ambient temperature:

$$PS_{1,0} = 34.86 - 2.54 = 32.32 \text{ W}$$

- Average load factor of electric motors is LF = 0.65
- Average annual usage T = (6000 x 0.8 + 2500 x 0.2) = 5300 h/year

Estimated energy saved per one equipment:

$ES_{1,0} = PS_1$ x 0.65 x 5300 = 0.1113 MWh/year per device (equipment)

- Considering existent availability of the new devices (up to 20 HP, 600 V) it results that a 7.5 HP motor power represents the median value of the entire motor population (20 HP and under).

Assumptions (2):

- Estimated installed power of electric motors (20 HP and bellow) in BC $P_{install}$ = 3,439,000 HP x 1.25 (including all motors) x 0.37 (electric motors bellow 20 HP) = 1,590,537 HP
- Average motor size (based on energy figures) is 10 HP
- A line current of 12 A represent the corresponding value at 460 V, 60 Hz.
- The motors are working at average **load factor LF = 0.65**.
- It result motor power demand specific savings in [W/HP] at ambient temperature:

$$PS_{spec} = (34.86 - 2.54) \times 0.65 = 21 \text{ W per 10 HP} = 2.1 \text{ W/HP}$$

- Estimated power demand savings **$PS_0 = P_{install} \times PS_{spec}$ = 3,340 kW**
- **Average annual usage T = 5300 h/year**

Estimated annually energy savings (at ambient temperature): ES_0 = 17.703 GWh/year

Assumptions (3):

- Considering the average temperature rise of the motor starter
  TR = 40 degrees Celsius x 0.65 (load factor) = 26 degree Celsius
- Considering an increase of resistance of 0.3916 % per Celsius degree, that will result in an additional estimated power demand savings of: PS_{Trise} = 26 x 0.3916% x 3,340 = 340 kW

Estimated annually energy savings due to temperature rise: ES_{Trise} = 1.802 GWh/year

Assumptions (4):

- Considering MCC mechanically cooled (HVAC) are about 20 % of total loads
- Considering a COP = 2.5 for HVAC
- Considering HVAC annually operating time of T_{HVAC} = ½ x 5300 h/year

Energy savings due to reduction of energy spent to acclimatize MCC by using HVAC are:

$$ES_{HVAC} = [(ES_0 + ES_{Trise}) / 2.5] \times 0.2 \times ½ = [19.5/2.5] \times 0.2 \times 1/2 = 0.78 \text{ GWh/year}$$

Total estimated annually energy saved in BC, ES = 20.285 GWh/year

Note: A part of this project will be to undertake a more through assessment of the potential energy savings achievable by introducing such devices.

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c) Project Scope / Objective:

1. Undertake a complete report on such new product (technology) and market assessment
2. Extend researches to resistive loads.
3. Determine/confirm energy savings assessment (by using R&D activity, laboratory research and statistical methods)
4. Establish a test method and reporting protocol for such devices, market penetration and energy savings
5. Elaborate specific regulations and/or standard modifications
6. Elaborate directives on PIP program
7. Elaborate on further energy savings and Non Electric Benefits (as presented in 1b)
8. Encourage market for further development of such products for bigger load sizes
9. Connect to Smart Meter Initiative as an easy way of on line communication in controlling specific equipments

d) Potential Alternative Solutions:

Failure to examine this product and area of application for potential power loss reduction and energy savings could result in un-economic promotion of traditional equipments.

e) Existing Regional and/or International Standards:

This is to be researched prior to embarking on this project.

f) Research: (Is there any research available or being done; if so by who and when is will it be complete?)

A research is to be undertaken leading up to the development (or modification) of a comprehensive standard

g) Seed Documents: (Are seed documents available or will they be; if so by when?)

Seed document will be generated by BC Hydro – Power Smart in connection with Schneider.
Further research and investigations to be performed together with Schneider Laboratories based in North Carolina

3: PROJECT PLAN (in consultation with CSA Staff)

a) Estimated Schedule: (Estimated duration to complete the standard : from Project Approval to Publication)

18...24 months

b) Potential Stakeholders / Committee Members / Chairs:

Utilities, regulators, manufacturers, user-industry representatives

c) Projected Costs (Including provisions for research and/or seed documents):

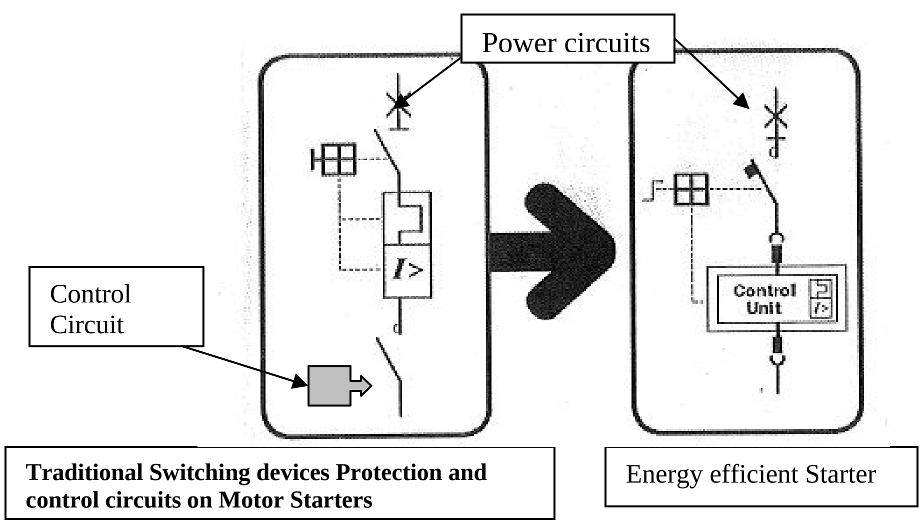
Standard	$95,000	18...24
Amendments	$25,000	12

Guidance table: Approximate development cost & duration by standards project type

* *Note: Project costs shown are estimates. Actual figures may vary and depend on TC direction, subcommittee work, complexity, etc.*

† *Note: Estimated project duration is approximate from the date of the first committee meeting*

Estimated cost for this project: *FY10/11 - 80k research and investigations, trips*
FY11/12 - 50k



Appendix: Power losses on traditional and new motor starters (Courtesy of Schneider)

Power Dissipation Study - 12Amps (7.5Hp)

Power Dissipation [Watts]	TeSys U 12A Advanced	GV+D (IEC Style Solution)		NEMA		
		GV	TeSys D12	Circuit Breaker	NEMA Size 0	Melting Alloy
Power Poles	1.10	1.10	1.08	0.57	0.57	25.92
Control Circuit	1.44	0.00	3.00	0.00	7.80	0.00
Total	2.54		5.18			34.86

TeSys U vs GV 50.97%

TeSys U vs NEMA 92.71%

Power	Watts
Resistance	Ohms
Current	Amps

Resistance TeSys U 0.00764

Resistance GV 0.00764

Resistance TeSys D 0.0025

Resistance NEMA 0 and Breaker 0.00131

Resistance Melting Alloy 0.06

Power Dissipation Study - 32Amps (20Hp)

Watts	TeSys U 32A Advanced	GV+D (IEC Style Solution)		NEMA		
		GV	TeSys D32	Circuit Breaker	NEMA Size 1	Melting Alloy
Power Poles	7.50	7.50	7.68	4.02	4.02	30.72
Control Circuit	1.92	0.00	3.00	0.00	7.80	0.00
Total	9.42		18.18			46.57

TeSys U vs GV 48.18%

TeSys U vs NEMA 79.77%

Resistance TeSys U 0.00732

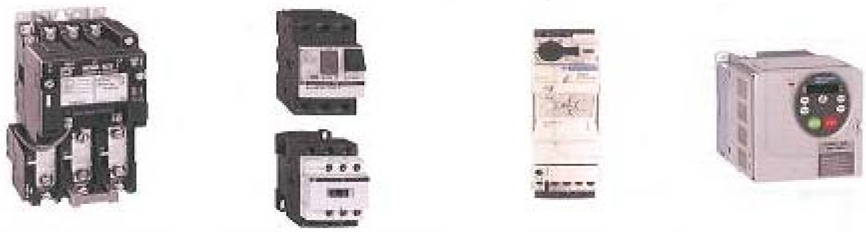
Resistance GV 0.00732

Resistance TeSys D 0.0025

Resistance NEMA 1 and Breaker 0.00131

Resistance Melting Alloy 0.01

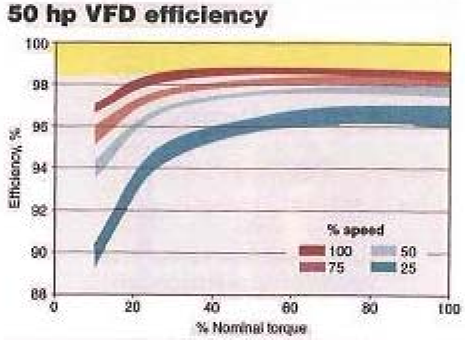
TeSys U – Power Dissipation Comparison
20 HP @ rated speed



Traditional NEMA	Traditional IEC	TeSys U IEC and NEMA Rated	AC Drive
45 W	18 W	9 W	600 W
500%	100%		6660%

AC Drive (VFD) or Combination Starter?

50 hp VFD efficiency



Source: Institute of Research, Hydro-Québec and Control Engineering.

If you need variable speed from the motor shaft... Use an AC Drive

If not, ***use a Combination Starter***

Do not waste 1.5% of your energy in heat dissipation (Yellow Area)