

# Consultant's new galloping-conductor study finds 15-yr old device still offers best control

LEXINGTON, MA—A 15-year old device to reduce the adverse effects of galloping conductors still is the best, most economical solution to the problem, says a consulting engineer located here.

According to A.S. Richardson, Jr., president of Research Consulting Associates, a research study recently completed by his company shows that the device—the Windamper—“...stands out as the best control method available.” Research Consulting Associates conducted its study under a Department of Energy research grant.

“No other method of galloping control has achieved the record of positive control that Windamper has achieved,” Richardson said. “No negative of side effects have been reported after 15 years of single conductor experience.” RCA's report also includes application data for bundled

conductor.

The RCA study was a follow-on effort to a limited EPRI project in 1982. The objective of the EPRI effort was to update the status of existing Windamper installations and to design a controlled experiment. Since funding of the EPRI project was limited, two brief letter reports were issued at the end of 1982, when the project was terminated.

Under the DOE project, additional Windamper experiences and experiences with two other devices, the Ontario Hydro Detuner Pendulum and the interphase spacer, were studied. Recent tests at the Massachusetts Institute of Technology wind tunnel were included. A scenario model for ice and wind effects on conductors, with and without galloping control devices, was developed, along with various mathematical models for static and dynamic effects.

While galloping is an infrequent cause of damage to transmission lines, when it occurs the results can be devastating. A world-wide study of galloping experiences sponsored by CIGRE, and undertaken in 1980 and 1981 with the cooperation of IEEE and CORECH (the European association formed solely to find improved galloping control methods), showed that structural damage and flashovers were the prime result of galloping, despite widespread use of increased phase spacing at towers.

Based on total returns, galloping damage was classed as moderate-to-severe by 55 of the utilities, with 44 percent reporting a frequency of at least once per year. The most prevalent wind speed was less than 22 mph (10 meters per second) and the most prevalent cause was sleet or ice.

The international study showed that galloping occurred most often in flat terrain, but 35 percent of the utilities reported some galloping in hilly or mountainous areas. For 69 percent of the utilities reporting, flashover was the prime consequence. But 55 percent also reported structural damage to be a major problem.

The prime approach to reducing flashover was increased phase spacing, vertical offset, interphase spacers and horizontal configurations. Average, or “ball-park” estimates of the added cost of increased line spacing were in the \$20,000- to \$40,000-per mile range for a double circuit 345-kV steel-tower line.

Actual cost, by types of corrective measure taken, were difficult to determine because of differences be-

tween various national approaches to 1. Mechanical line design aspects, 2. local installation methods, 3. labor costs and material costs, average span lengths and conductor size, according to the RCA report. However, with certain assumptions defined, it was possible to come up with representative costs, in U.S. dollars per single circuit km. This is shown in the accompanying table.

The assumptions referred to above were as follows:

- Prices and salaries at 1983 levels.
- Anti-galloping devices installed on existing lines with twin-bundle conductor.
- Conductors protected with armour rod at clamping points.
- No maintenance costs included.
- Interphase spacers are flexible type with leakage distance of at least 3 cm/kV.

Costs of 150/220-kV line are calculated on the basis of an average span length of 330 meters and for the 400-kV line an average span of 400 meters.

Extra tower height, which results from modified phase spacings that exceeded standard spacing, is calculated for a new line with Danube phase configuration. The extra costs of right-of-way are not included.

Ratio of suspension/angle towers per section is assumed to be five (5). The total cost per km of single-circuit line is the sum of the costs of installation (labor) costs plus material.

The report details a number of individual utilities' galloping experiences.

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## CORRECTIVE MEASURES (In U.S. dollars)

Method	Type	Description	150/220-kV line <sup>1</sup>	400-kV line <sup>2</sup>
1.	Spacer removal	Twin-bundle converted from horizontal configuration to a diagonal configuration	1500	1375
2.	Rotating clamp spacers	Rigid spacers of horizontal twin-bundle replaced by rotating clam spacers	4350	6750
3.	Hoop spacers	Spacers in twin-bundle replaced with hoop spacers	4500	N/A
4.	Interphase spacers	Coupling of 3 phases with 2 flexible spacers per span per pair of phases	6900	8000
5.	Pendulums	4 pendulums along phases in a span	5100	7625
6.	Windampers	2 dampers per span per phase at 1/3-span position	6450	5875
7.	Modified phase-to-phase clearance for new line	Costs extra tower weight due to exceeding phase clearance designed according to design manual	3150	5000

<sup>1</sup> Twin bundle (2 x ACSR conductor — 22 mm)

<sup>2</sup> Twin bundle (2 x ACSR conductor — 31.7 mm)

## Galloping conductor

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At Niagara Mohawk Power Corp., after initial observations of test lines in 1968 indicated that galloping on Windamper-protected transmission lines was held to a magnitude of one foot, the utility has continued to order and install the units. Some 1000 units are now in use on NMP's lines. RCA's investigation indicates that gallop-induced line tripping has been totally eliminated on lines equipped with the devices and operating personnel consistently affirm the effectiveness.

Engineers at the Power Authority of New York, which is interconnected to NMP, verify that breaker operations resulting from galloping on NMP's lines have been eliminated since installation of the Windamper devices.

Ontario Hydro, reporting on 290 independent observations of untreated lines and 72 observations of Windamper-treated lines during three different ice storms, found that 66 percent of untreated lines galloped, compared with 24 percent of the “treated” lines. In addition, 35 spans of untreated line galloped with amplitudes of four meters or more, while no lines equipped with Windampers were observed to gallop with amplitudes above two meters; only 5 percent of Windamper-protected lines had galloping amplitudes of one to two meters.

Further, comparison of the results of Ontario Hydro's observations of Windamper-protected lines and those protected with detuners and phase spacers shows that the Windamper-protected lines that galloped are far less on a percentage comparison and that their amplitude reduction is far greater than either of the other two.

The RCA study then converted the qualitative, observed data to a quantified Performance Index, which also showed a marked superiority for the Windamper.

Interested readers can obtain a copy of the RCA report by circling number 139 on the reader service card in the rear of the issue.



Crew member is shown installing Windamper anti-galloping device on line. Study indicates the 15-year old device still offers the most economic protection.

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