Subj:	**[revised] Mark Lively's WOLF contradicts the engineering and economics of Tie-Line Bias Control**
Date:	8/8/03 1:48:56 PM Central Daylight Time
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To:	WEQ Inadvertent Interchange Payback Task Force

Mark Lively's WOLF mechanism of automatically instantaneously adjusting load-demand imbalance to price is ever vulnerable to criticism about system stability and the economics of system stability. The mechanism seems built for the world of "Constant-Frequency Control" or "Constant Net-Interchange Control" practiced mid-century. Under those methods the ACE (Area Control Error) term measured just a Control Area's Inadvertent with the Interconnection, or just frequency, but not both. Metering error under these methods caused serious system stability problems which were solved by replacing those practices by Tie-Line Bias Control (TBC). TBC includes both the Inadvertent and a term for frequency response obligation (called "bias") by the Control Area to "jointly" share in stabilizing Interconnection frequency by counteracting, or stopping, big frequency deviations before they are in turn reversed by the discretionary control actions of individual generators.

Why did Constant Net-Interchange Control or Constant Frequency Control fail? Because error by a Control Area in metering Inadvertent or frequency, that showed too much Inadvertent or too low frequency, caused that Control Area to increase generation while all the other Control Areas backed down generation in response, prompting the Control Area with the metering error to increase generation as he reached his generation limit or frequency steadily declined. Tie-Line Bias Control is a fault-tolerant method introduced by Nate Cohn in
which "bias" provided "slope" to the control equation that allowed metering to be a little off but still provided reasonable control, in other words better system stability,

The WOLF mechanism does not specify the physical mechanism of "instantaneously" varying generation output in response to the continuous variation in price of Inadvertent energy driven by frequency change. In particular, it does not differentiate between varying the generator speed by instantaneous governor response which stabilizes but does not change frequency, or varying the generator output by adjusting the governor set-point and deploying Automatic Generation Control (AGC), Regulation, Load Following, Reserves. None of these is instantaneously acting; so, it is difficult to understand the engineering used to produce the instantaneous per-second continuous reaction to frequency-driven price changes by generators under WOLF. If the WOLF mechanism attempts to deploy governor response to adjust generators, WOLF needs to be extremely finely tuned, because "too much" MW governor response per millihertz would make system frequency oscillate from "too much of a good thing" too soon.

Under TBC, for every correction action by AGC there is a simultaneous counteracting stabilizing action by instantaneous governor response to limit that correction. So, the engineering of the smooth instantaneous adjusting actions by WOLF to generators in response to continuously changing price driven by frequency is hard to understand in a TBC world. Rather than using the instantaneous governor-response mechanism, the slower WOLF mechanism would be struggling against it for each change in frequency that it drives by slower-acting AGC/Regulation. That instantaneous "counteracting" stabilizing action by governors is a key component of the cost of control in terms of generator wear and tear, and pushes the economics of control
toward minimizing instantaneous increases or decreases in generation in favor of responding to "average" changes in frequency, say over an hour, rather than instantaneous changes in frequency, in violation of the instantaneous action by WOLF. This economics of TBS control is due to former AEP engineers Nasser Jaleeli and Louis VanSlyck of Priority Control Engineering Inc.(PCE) who developed it in their 1996 study for EPRI financed by Entergy that laid the groundwork for NERC's Control Performance Standard.

Governor response was not included in the control term used in the Constant Net-Interchange Control woods evidently still inhabited by WOLF.