

DESCRIPTION OF
AREA CONTROL ERROR (ACE) CALCULATION
(Automatic Time Error control)

The expression used to calculate the Area Control Error is given as follows:

$$ACE = (NI_A - NI_S) - 10\beta (F_A - F_S) - T_{ob} + I_{ME} + \frac{\prod_{\text{primary}}^{\text{on/off peak}}}{(1-Y) \cdot H}$$

WECC Automatic Time Error Correction Term

The last term in the ACE equation above is the **WECC automatic** time error correction term which is only to be included for AGC control. It is not to be included for **NERC** performance reporting. The procedure to calculate this term is described in the sequel.

In the above **expression**:

ACE is the Area Control Error in MW. Negative values denote a condition of under-generation and positive values denote over-generation.

NI_A is net actual interchange in MW. It is defined as the algebraic sum of the MW flow on the area tie lines, including pseudo tie quantities. Positive net interchange results from delivering excess generation out of the area.

NI_S is scheduled net interchange in MW. ~~It may include dynamic schedules.~~ It is defined as the mutually prearranged intended net MW flow on the area tie lines, including dynamic schedules. Bilateral schedules to correct inadvertent interchange accumulations are not included in this term. Positive scheduled net interchange is due to more MW flow intended to be delivered from the area than received by the area.

- F_A is the actual system frequency in Hz.
- F_S is the scheduled system frequency in Hz, normally 60 Hz. The WECC Time Monitor **can establish a different value of scheduled system frequency during the manual time error correction periods.**
- T_{ob} is scheduled interchange (in MW) used to bilaterally correct inadvertent **interchange** accumulations. Refer to the Bilateral Inadvertent Payback Scheduling Procedure in the Operating Committee Handbook.
- I_{ME} is a manually entered value (in MW) to compensate for known equipment error, whether control or measurement. Examples are as follows:
- Calibration errors in telemetry
 - Calibration errors in AGC algorithm
 - Calibration errors in analog load frequency control system
 - Non-scheduled losses
 - Absence of telemetry (when not used in another part of the equation)

An attempt should be made to keep this term at zero by correcting the errors.

WECC Automatic Time Error Correction Term

H Correction Time period in Hours. (initially $H \geq 2.0$ hours). The Performance Work Group shall determine the value of H.

β is the control area's frequency bias setting in MW/0.1 Hz. It has negative sign.

B_S is the WECC frequency bias setting in MW/0.1 Hz. It has negative sign.

Y is β / B_S , the ratio of the control area's frequency bias setting to the WECC frequency bias setting, **p.u.**

$\Pi_{\text{primary}}^{\text{on/off peak}}$ is the Control Area's accumulated primary inadvertent interchange in MWh. **The On-Peak $\Pi_{\text{primary}}^{\text{on peak}}$ and Off-Peak $\Pi_{\text{primary}}^{\text{off peak}}$ accumulations are calculated separately at the end of each on-peak and off-peak hour using the following recurrent formula:**

$$\text{updated } \Pi_{\text{primary}}^{\text{on/off peak}} = \text{previous } \Pi_{\text{primary}}^{\text{on/off peak}} + \underbrace{(1-Y)}_{p.u.} \times \left(\underbrace{\Pi_{\text{total}}}_{\text{MWh}} - \frac{\overbrace{10 \times \beta}^{\text{MW/Hz}} \times \overbrace{\Delta TE}^{\text{Seconds of Time Error}}}{\underbrace{60}_{\substack{\text{Seconds of Time Error caused by 1 Hz deviation in 1 Hour} \\ \text{Seconds of Time Error} \times \frac{\text{Seconds}}{\text{Hour}}}}} \right)$$

[MWh]

Π_{total} is the area's total inadvertent interchange accumulated during the last operating hour, in MWh:

$$\Pi_{\text{total}} = \int_{\text{Last Hour}} \underbrace{(NI_A - NI_S)}_{\text{MW}} \underbrace{dt}_{\text{Hr}} \quad [\text{MWh}]$$

ΔTE is the hourly change in system time error adjusted for any manual time error corrections **that may be applied during the last hour** and time error adjustments, [Seconds of Time Error]:

$$\Delta TE = TE_{\text{end hour}} - TE_{\text{begin hour}} - TD_{\text{adj}} - \frac{t}{\text{Minutes}} \times \underbrace{\delta F}_{\text{Hz} = 1/\text{sec} \equiv \text{Seconds of Time Error per Minute}} \quad ^1$$

$TE_{\text{end hour}}$ = Time Error (seconds of time error) at the end of the hour

$TE_{\text{begin hour}}$ = Time Error (seconds of time error) at the beginning of the hour

TD_{adj} is any operator adjustment to the control center time error to correct for differences with the WECC time monitor.

t is the number of minutes of manual time error correction that occurred during the hour.

δF is the scheduled frequency offset of +0.02Hz, - 0.02Hz, or 0.0 Hz, as specified by the Time Monitor in the course of the manual time error correction.

The absolute value of the WECC automatic time error correction is limited as follows:

$$\left| \frac{\Pi_{\text{primary}}^{\text{on/off peak}}}{(1-Y) \cdot H} \right| \leq L_{\text{max}} \quad \left[\frac{\text{MWh}}{\text{p.u.} \times \text{Hrs}} = \text{MW} \right]$$

where,

$$0.20 * |\beta| \leq L_{\text{max}} \leq L_{10} \quad [\text{MW}]$$

and L_{10} is the control area CPS2 limit, MW.

¹ Note that one Hertz of frequency deviation means that the time error is changing with the rate of one second of deviation per minute.

References:

- “Effect of Coordinated Correction of Tie-Line Bias Control in Interconnected Power System Operation”, AAFouad, SHKwan, IEEE PAS, Vol. PAS-101, No. 5, May 1982.
- “Decomposition of Time Deviation and Inadvertent Interchange on Interconnected System, Parts I & II.” NCohn, IEEE PAS, Vol. PAS-101, No. 5, May 1982.
- “Generation Control for Deregulated Electric Power Systems”, RPSchulte, IEEE Summer Power Meeting 2000, Seattle, WA.
- “Two-Area Analysis of System Time Error and Inadvertent Interchange Energy in Interconnected Power Systems”, AAFouad, SHKwan, IEEE PAS, Vol. 11, No. 4, November 1996.
- “Modified Automatic Time Error Control and Inadvertent Interchange Reduction for the WECC Interconnected Power Systems”, RPSchulte, WLMcReynolds, DEBadley, III PAS, Vol. 6, No. 3, August 1991.

Approved by Compliance Monitoring and Operating Practices Subcommittee: _____

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