

Static Var Compensation of DC Arc Furnace and Ladle Furnace



A Static Var Compensator (SVC) rated at 0–110 Mvar (capacitive) and supplied by ABB has been in operation since 1996 in Alabama Power Company's 230/34.5 kV dedicated substation located at the Nucor Steel Tuscaloosa plant in Tuscaloosa, Alabama.

The compensator, supplied as a complete turnkey commitment, has the purpose of providing dynamic control of reactive power, power factor correction and reduction of fast voltage variations (flicker) caused by the operation of a large DC arc furnace rated at 110 MVA as well as an AC ladle furnace rated at 23 MVA.

In addition, reduction of harmonics created from the operation of the furnaces is provided by the SVC. The residual harmonic distortion at the point of common coupling (P.C.C.) at 230 kV is kept below the values stipulated in IEEE 519, with total voltage distortion not exceeding 1,5%.

The remaining flicker level at the P.C.C. is in accordance to IEC standards, with Pst=1 as design criterion.

The SVC was put into operation in less than 11 months from signing the contract.

The SVC is an important component in the upgrading of the steel plant's capacity for coil and plate from originally 300.000 tons output to 800.000 tons annually, as it enables as well as improves the operation of the plant's large DC arc furnace and ladle furnace.

Electric arc furnaces constitute heavy and troublesome loads on their supply networks, with large, rapidly fluctuating consumption of reactive power. This gives rise to voltage dips and fluctuations in the plant as well as on the surrounding network, with detrimental impact not only on power quality but also preventing the furnaces from being utilized to their fully rated capacity. Arc furnaces are also large sources of harmonics.

With the installation of the SVC, acceptable power quality in conjunction with the operation of the arc furnaces has been safeguarded for Alabama Power Company's grid as well as for Nucor Steel Tuscaloosa's plant. The steel plant benefits from the SVC by a high and stable bus voltage which allows optimum process conditions and thereby also improved economy. The power factor improvement enabled by the SVC also contributes to process economy by decreasing the system losses and enabling more favourable power rates.

The SVC at Tuscaloosa Steel operates directly on the 34.5 kV arc furnace bus. It comprises a TCR (Thyristor-Controlled Reactor) rated at 110 Mvar and five Harmonic Filter branches with an overall rating also of 110 Mvar. The filter branches are tuned to the 2nd, 3rd, 4th, 5th and 7th harmonics.

A major source of harmonics is the thyristor converter of the DC arc furnace. The filter set-up in the SVC has been selected to accommodate 12-pulse operation (normal mode) as well as 6-pulse operation (emergency / back-up mode) of the thyristor converter. The 7th harmonic filter is large (32 Mvar, or close to 30% of the overall installed filter rating) as well as damped, to give it a suitable characteristic for filtering the 11th harmonic and higher to a sufficient degree as well.

The control system of the SVC consists primarily of an open-loop reactive power controller which operates on control signals directly from the DC furnace thyristor converter to enable optimum flicker abatement, plus additionally a three-phase, closed-loop power factor control. The control system

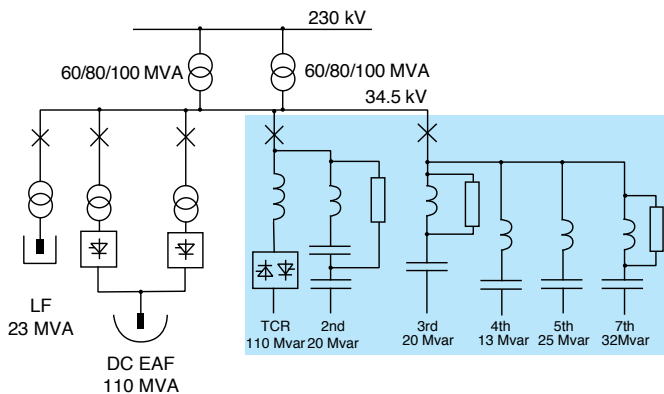
is fully redundant, giving an availability of well over 99%. The var control functions have been built up in a programmable microcomputer system using standardized program modules for the different control functions of the SVC.

With the SVC in operation, the power factor at the 34.5 kV bus is kept at P.F.= 0.9 or better for all operating conditions of the plant.

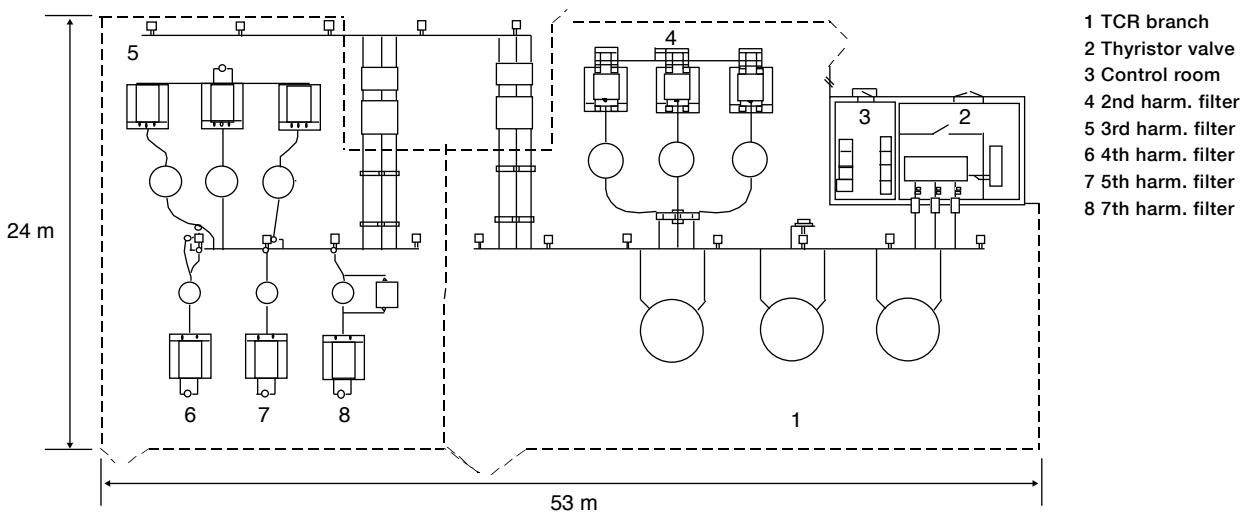
Technical data

Controlled voltage	34.5 kV
Dynamic range	0-110 Mvar capacitive
Flicker correction	Acc to IEC; design criterion Pst=1
Power factor correction	P.F. ≥ 0,90
Harmonic filtering	Total voltage distortion ≤ 1,5%
Control system	Redundant microprocessor system for 3-phase reactive power control by means of fast acting open-loop control plus closed-loop power factor control.
Thyristor valves	3-phase water-cooled valve with indirect light triggering.

Single-line diagram



Layout



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