V. Design, Application, Maintenance & Operation Technical Requirements

V.P PJM Design & Application of Static Var Compensators 69 kV & Above

1.0 Scope

1.1 These design criteria have been established to assure acceptable reliability of the bulk transmission system facilities. Specific component requirements are listed in their own sections. The criteria listed are requirements or recommendations for system voltage rated 69 kV and above.

1.2 With loss of local generation, dynamic VAR support for the transmission system may be required. For certain system conditions Static Var Compensators (SVC) along with other alternatives should be considered if instantaneous / dynamic reactive support is a requirement.

1.3 This document presents some guidelines / consideration for the application of SVCs.

2.0 General Requirements

2.1 The nominal voltage ratings of the effectively grounded transmission systems are 69 kV, 115 kV, 138 kV, 230 kV, 345 kV, 500 kV, and 765 kV. The above systems can operate continuously up to 72.5 kV, 121 kV, 145 kV, 245 kV, 362 kV, 550 kV, and 803 kV continuously respectively. Refer to PJM Manual 03, Section 3.3.1 for detailed operational voltage limits.

2.2 The SVC shall provide dynamic reactive power to support the transmission system requirements.

3.0 <u>Topics for Specification Considerations</u>

3.1 All the major components of SVC shall meet or exceed the latest applicable ANSI, IEEE, NEMA, NFPA, ASME, ASTM, NESC, NERC and OSHA standards and loading guidelines.

3.2 Refer IEEE Std 1031-2011 *IEEE Guide for the Functional Specification of Transmission Static Var Compensators* for additional specification requirements.

3.3 SVC system shall be rated to provide leading and/or lagging reactive power requirements.

3.4 The following table lists modeling and studies which should be commonly performed in order to specify the SVC System. Working closely with the SVC manufacturer will be required to achieve proper design.

	Common Modeling and Study Tasks	TO/RTO	Vendor
1	PSS/E Load Flow studies to determine required sizing and operational performance	*	
2	Dynamic Performance Studies to determine required sizing and operational performance	(*)	*
	Stability model	*	
	EMT Model	*	
3	Harmonic Performance Study (vendor) and harmonic filter design		*
	AC Harmonic Filters and Thyristor Switched Capacitors (TSCs)		*
	Network harmonic impedance study	*	
	Harmonic Voltage Measurements	*	
4	Insulation Coordination Studies	(*)	*
	Surge and Lighting Protection Design		*
5	Interference studies for Radio Interference, Audible Noise and Broadband		*
6	SVC Reliability, Availability and Maintenance		*
	Availability requirement	*	
	Specify Maximum Failure Rate of the SVC system		

3.5 Fixed switched capacitors and Thyristor Switched Capacitors (TSC) should be considered.

3.6 Fixed switched reactors and Thyristor Controlled Reactors (TCR) should be considered.

3.7 SVC Reliability, Availability and Maintenance (RAM) Requirement

3.8 Specify Maximum Failure Rate of the SVC system

3.9 SVC system power loss evaluation criteria should be established/considered. Refer to IEEE STD-1031, Section 8.6 for details.

3.10 Dead-band specification of SVC system should be provided to PJM for modeling review.

4.0 Application and Special Considerations

4.1 Typical SVC Systems are equipped with the following major equipment

4.1.1 Thyristor Valves and associated control system.

4.1.2 Cooling Systems

Auxiliary power supply for cooling system of BES interconnected SVCs should have redundant design to eliminate single point failure.

4.1.3 Switchgear

4.1.4 Insulators, Bus and Bushings

4.1.5 Shunt Capacitors and Thyristor Switched Capacitors (TSC)

4.1.6 Shunt Reactors and/or Thyristor Controlled Reactors (TCR)

4.1.7 Surge Arresters

4.1.8 Measuring Devices

4.1.9 Power Transformers

4.1.10 Electrical Auxiliary Power System / Redundant Auxiliary Power System

4.1.11 Control, Metering and Relaying Devices and Schemes

5.0 Maintenance

5.1 Maintenance for most equipment (such as circuit breakers, disconnect switches, reactors, capacitors, transformers) associated with the SVC should be similar or the same as other equipment already installed at other substations. The control systems, power electronic, cooling systems will require special attention and it is advisable to work with the SVC manufacturers until maintenance personnel become familiar with the SVC system maintenance requirements.