System operator responsibility in power system restoration in open electricity markets

**Base knowledge for system restoration**
- Size and extension of the black-out zone
- Amount of generation provided with black-start capability
- Location of generation provided with black-start capability
- Amount, location and dynamic nature of load

**Planning phase**
- Qualification of operators for supplying different services
- Definition of areas of influence of each operator
- Definition of contractual requirements
- Definition of supply priorities

**Operational phase**
- Recognition of black-out extension
- Breakers set up to arrange restoration islands
- Respect of contractual agreements by engaged operators
- Build up of restoration islands
- Interconnection of restored islands

**Qualification of generating unit**
- Autonomous start up
- No load performance
- Connection energisation capability
- Cold load pick up response
- Regulation facilities in isolated operation
- Ramping rates versus power generation

**Influence areas of operators**

**Hydro power plants**
- Quick start with limited required power
- Flexible response to network contingencies
- Insufficient dynamic characteristics of standard speed governor and fluid admission valves
- Additional regulation channels required

**Geothermal plants**
- Outstanding reliability and availability
- Improvement of unit emergency performance by advanced black start devices (SWVC)
- Possibility of separate feeding of auxiliaries during frequency and voltage crises

**Steam units**
- Black start up is a complex and dangerous procedure
- Load rejection becomes a usual last resort
- Interest on load islands creation close to generation plants
- Need for combined configurations (e.g. repowering)

**Cogeneration plants**
- Promising black start sources since located in industrial areas
- Possible configuration for producers to provide restoration ancillary services
- Concern about parallel black out effects on thermal and electric uses

**Open cycle gas turbine**
- Reduced amount of the sized power
- Limited duration of start up procedure
- Large inertia time constant
- Embedded regulation facilities
- Highly recommendable application

**Combined cycle**
- Extreme configuration flexibility in coping with various emergency conditions
- Multiple prime movers as “redundancy” to improve black start performance
- Need of exhaust by-pass system to decouple gas and steam cycles

**Remarks**
- Protection tripping logic influences connection energisation capability
- Specific regulation equipments and prime mover limits affect cold load pick up

**System operator responsibility in power system restoration in open electricity markets**

**Planning phase**
- Qualification of operators for supplying different services
- Definition of areas of influence of each operator
- Definition of contractual requirements
- Definition of supply priorities

**Operational phase**
- Recognition of black-out extension
- Breakers set up to arrange restoration islands
- Respect of contractual agreements by engaged operators
- Build up of restoration islands
- Interconnection of restored islands

**Qualification of generating unit**
- Autonomous start up
- No load performance
- Connection energisation capability
- Cold load pick up response
- Regulation facilities in isolated operation
- Ramping rates versus power generation

**Influence areas of operators**

**Hydro power plants**
- Quick start with limited required power
- Flexible response to network contingencies
- Insufficient dynamic characteristics of standard speed governor and fluid admission valves
- Additional regulation channels required

**Geothermal plants**
- Outstanding reliability and availability
- Improvement of unit emergency performance by advanced black start devices (SWVC)
- Possibility of separate feeding of auxiliaries during frequency and voltage crises

**Steam units**
- Black start up is a complex and dangerous procedure
- Load rejection becomes a usual last resort
- Interest on load islands creation close to generation plants
- Need for combined configurations (e.g. repowering)

**Cogeneration plants**
- Promising black start sources since located in industrial areas
- Possible configuration for producers to provide restoration ancillary services
- Concern about parallel black out effects on thermal and electric uses

**Open cycle gas turbine**
- Reduced amount of the sized power
- Limited duration of start up procedure
- Large inertia time constant
- Embedded regulation facilities
- Highly recommendable application

**Combined cycle**
- Extreme configuration flexibility in coping with various emergency conditions
- Multiple prime movers as “redundancy” to improve black start performance
- Need of exhaust by-pass system to decouple gas and steam cycles

**Remarks**
- Protection tripping logic influences connection energisation capability
- Specific regulation equipments and prime mover limits affect cold load pick up