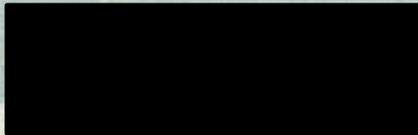


Station Service Generators

Southwestern Federal Hydropower Council

USACE District Office, Kansas City

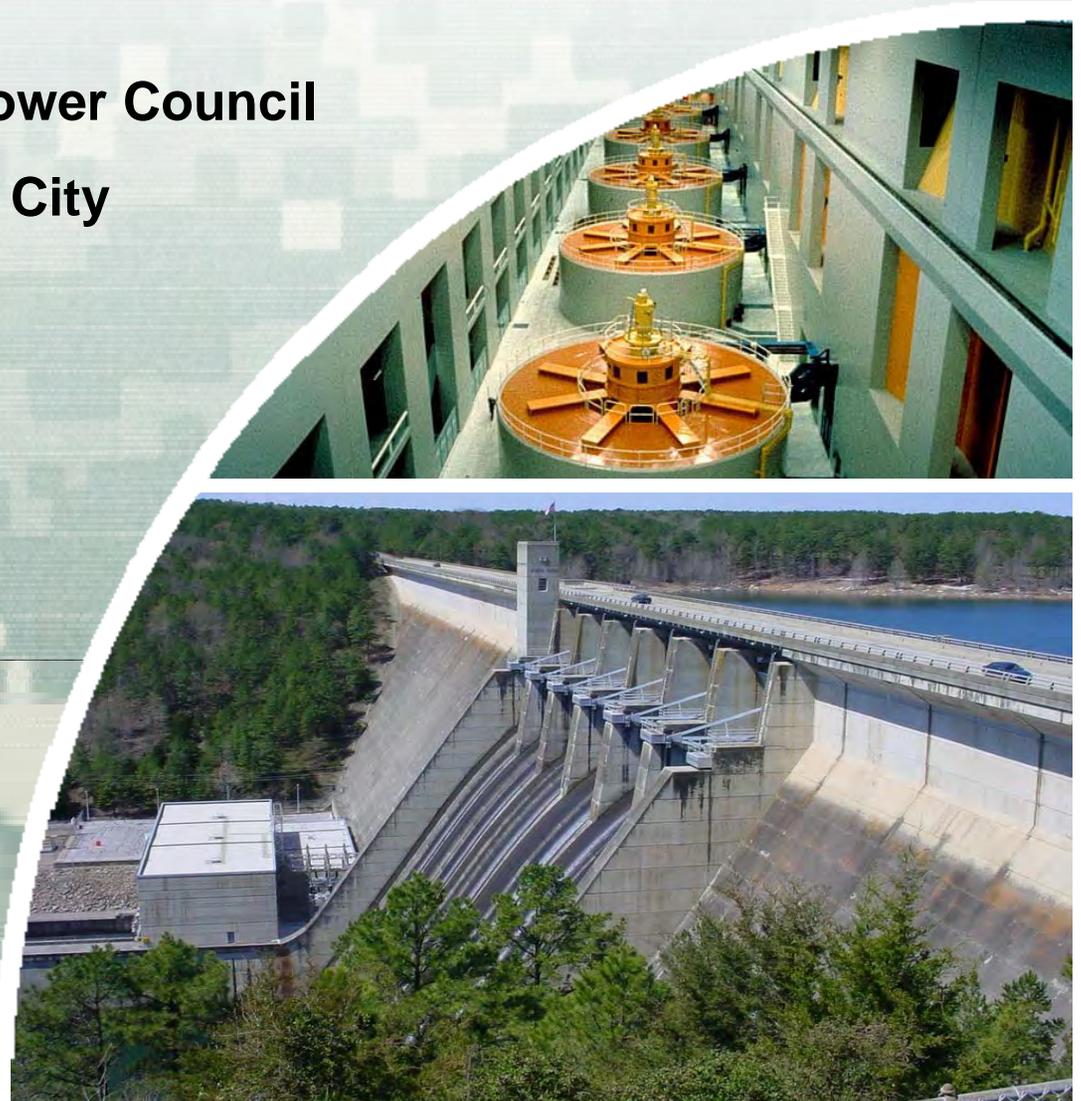
June 22, 2016



Hydroelectric Design Center



US Army Corps of Engineers
BUILDING STRONG[®]



Outline

1. Station Service System
2. Sources
3. Benefits and Alternatives
4. Advantages of SS Generator
5. Comparison of Alternatives
6. Summary



Outline

1. Station Service System

- ▶ Definition
- ▶ Components
- ▶ Design Goals

2. Sources

3. Benefits and Alternatives

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6. Summary



1. Station Service System - Definition

- A station service system ...
 - ▶ Is the electrical distribution system within the power plant
 - ▶ Provides power to run the plant
 - ▶ Is essential to plant operation
 - ▶ Includes a variety of components



1. Station Service System - Components

- Power Supplies
 - ▶ Internal – Main generator, Station Service generator, Diesel Generator
 - ▶ External – Transmission system
- Power distribution equipment
 - ▶ Transformers
 - ▶ Switchgear
 - ▶ Motor control centers
 - ▶ Cable, bus, and wire
 - ▶ Controls and relays



1. Station Service System - Components

- Powerhouse Loads
 - ▶ Unit Auxiliary Equipment
 - Pump motors – governor, bearing oil, cooling water, unwatering, etc.
 - ▶ Loads common to all units
 - Battery chargers, HVAC, cranes, hoists, elevators, air compressors, lights and power, security and controls systems, etc.
- Non-powerhouse loads:
 - ▶ Switchyard, spillway, navigation locks, recreational facilities, visitor centers



1. Station Service System – Design Goals

- Primary Design Goals:
 - ▶ High Reliability
 - Multiple independent sources
 - No single point of failure
 - ▶ Adequate Capacity
 - ▶ Redundant service for critical loads, including automatic switching



1. Station Service System – Design Goals

“The dependability of the station service power supply is of prime importance since on it depends the reliability and continuity of the station operation. No reasonable effort should be spared to ensure its uninterrupted operation”

EM 1110-2-3006

Hydroelectric Power Plants - Electrical Design



Outline

1. Station Service System
- 2. Sources**
 - ▶ **SS Generator(s)**
 - ▶ **SS Transformer**
 - ▶ **SS Diesel Generator**
3. Benefits and Alternatives
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2. Sources

- SS Generator(s)
- SS Transformer
- SS Diesel Generator
 - ▶ *Usually not designed for continuous duty*
 - ▶ *May not be full capacity*



2. Sources – SS Generator(s)



Shown with the SS Governor



2. Sources – SS Transformer



Shown with the SS Switchgear



2. Sources – SS Diesel Generator



Outline

1. Station Service System
2. Sources
- 3. Benefits and Alternatives**
 - ▶ **Base - Rehabbing the SS Generator**
 - ▶ **Alt 1 - SS Transformer**
 - ▶ **Alt 2 - Back-up Diesel Generator**
4. Advantages of SS Generator
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3. Alternatives

- Base - Rehabbing SS Generator
- Alt 1 - Installing another SS Transformer
- Alt 2 - Converting to a Back-up Diesel Generator

- Considerations
 - ▶ Location for Installing Equipment
 - ▶ Electrical Connectivity
 - ▶ Maintenance
 - ▶ Environmental
 - ▶ Operational Concerns
 - Equivalent reliability, availability, and capacity
 - Continuity of service to load



3. Base – Rehabbing SS Generator

Benefits of

Rehabbing the SS Generator



3. Base – Rehabbing SS Generator

- **Location**

- ▶ No additional space required

- **Electrical Connectivity**

- ▶ No changes or modifications to existing electrical connectivity required

- **Maintenance**

- ▶ Less than current levels due to new or rehabilitated components



3. Base – Rehabbing SS Generator

- **Environmental**

- ▶ No added environmental concerns
- ▶ Helps meet minimal flow requirements

- **Operational**

- ▶ Maintain current level of operational flexibility
- ▶ Can be operated independent of main units and grid
- ▶ Can be turned on without any outage



3. Alternatives – SS Transformer

Considerations for

Alt 1. Installing another SS Transformer



3. Alternatives – SS Transformer

- **Location**

- ▶ SS Transformer and oil containment
- ▶ Generator bus tap, current limiting reactor, disconnects and/or switchgear

- **Electrical Connectivity**

- ▶ Medium voltage cable runs
- ▶ Parallel runs of large conductors for low voltage

- **Maintenance**

- ▶ Least amount maintenance of the options



3. Alternatives – SS Transformer

- **Environmental**

- ▶ May need to spill to maintain minimum flows

- **Operational**

- ▶ Inherent interruption in power supply
- ▶ Availability depends on connectivity
 - Unit vs. transmission system
- ▶ Operation of main unit at low loads would be required if line is unavailable
 - Causes cavitation damage



3. Alternatives – Back-up Diesel Generator

Considerations for Alt 2. Converting to a Back-up Diesel Generator



3. Alternatives – Back-up Diesel Generator

- **Location**

- ▶ Outdoors, physical protection
- ▶ Spill containment structure

- **Electrical Connectivity**

- ▶ Parallel runs of large conductors

- **Maintenance**

- ▶ Monthly testing (need a load bank)
- ▶ Fuel Costs
- ▶ Overall maintenance effort may not be any less than with station service generator



3. Alternatives – Back-up Diesel Generator

- **Environmental**

- ▶ Spill containment for fuel tank
- ▶ May need to spill to maintain minimum flows

- **Operational**

- ▶ Inherent interruption in power supply
- ▶ Can be operated independent of main units and grid



Outline

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4. **Advantages of SS Generator**
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4. Advantages of SS Generator

- Complete small hydro-electric generator
- Operates independently of
 - ▶ Main units
 - ▶ External power system
- Benefits of main unit in a smaller package
 - ▶ Good load control
 - ▶ Good voltage/reactive power control
 - ▶ Can operate continuously
 - ▶ “Free” fuel
 - ▶ Better able to operate with small loads



4. Advantages of SS Generator

- Provides flexibility in station service operation
 - ▶ Operation not dependent on external power system - does not need to be on the grid
 - Black start capable
 - ▶ Able to carry all of the station service load
 - ▶ Typically on-line and carrying load,
 - if not, starting reliability higher than other choices
 - ▶ Renewable energy source
- Helps meet minimum flow requirements for the plant



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5. Comparison of Alternatives

	Rehab SS Gen	Alternative 1: Add SS XFMR	Alternative 2: Diesel Gen
Initial Rehab/ Installation Cost		Equal	Lower
Anticipated Maintenance Effort		Lower	Equal or higher
Non-Monetary Benefits	Excellent	Medium	Poor



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6. Summary

- Rehabbing SS Generators is best alternative
 - ▶ Rehab cost is of the same magnitude as adding a SS transformer
 - ▶ No additional physical space required
 - ▶ Maintenance will be reduced over current levels
 - ▶ Provides project with best operational flexibility
 - ▶ Provides black start capability

