PMSTPCOL PEmails

From: Misenhimer, David
Sent: Thursday, August 15, 2013 5:13 PM
To: STPCOL
Subject: FW: STP 3 & 4 Draft of Bulletin 2012-01 Presentation Scheduled for August 21, 2013
Attachments: STP Bulletin 2012-01 Presentation 8-21-13 DRAFT C .pdf

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From: Richard Bense [mailto:RHBense@ninallc.net]
Sent: Wednesday, August 14, 2013 10:15 AM
To: Misenhimer, David
Subject: STP 3 & 4 Draft of Bulletin 2012-01 Presentation Scheduled for August 21, 2013

Dave,

Attached is a draft of the presentation that STP 3 & 4 will make on August 21, 2013.

This draft is for discussion during the Open Items call scheduled for August 14.

Thanks

Dick Bense
NINA Licensing Engineer

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Hearing Identifier: SouthTexas34Public_EX
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From: Misenhimer, David

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South Texas Project Units 3 & 4 Presentation on Single Phase Event NRC Bulletin 2012-01

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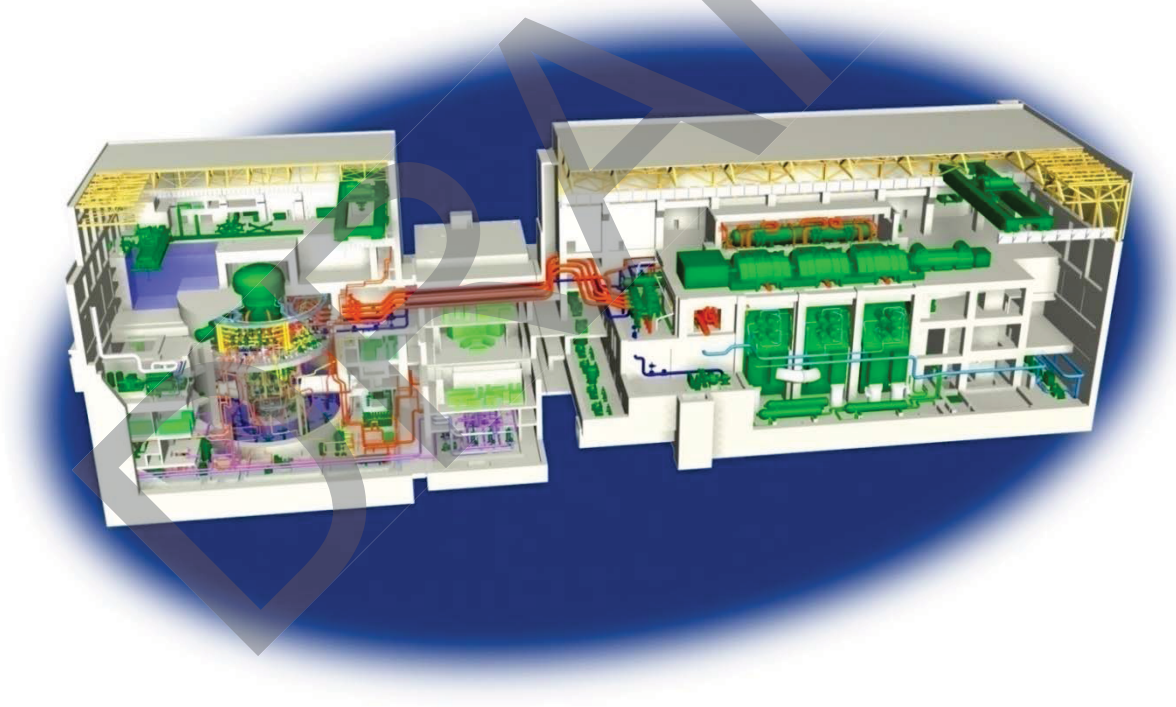

Attendees

- Scott Head, Regulatory Affairs Manager, STP 3&4
- Bill Mookhoek, Licensing Supervisor, STP 3&4
- Steve Thomas, Engineering Manager, STP 3&4
- Evans Heacock, Electrical Engineering, STP 3&4
- Al Gutterman, Morgan, Lewis & Bockius LLP
- Richard Bense, Licensing, STP 3&4

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Agenda

- Provide an overview of the STP 3 & 4 Electrical Distribution System
- Describe STP 3 & 4 response to NRC Bulletin 2012-01
- Describe STP Unit 2 Loss of Single Phase 2001 Event
  (LER 01-002, ML011200051)
- Discuss Forsmark 2013 Event
- Describe ETAP, Rev 12, Study for STP 3 & 4
- Summary and Questions

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Desired Outcomes:

- Demonstrate how a single-phase open circuit or high impedance ground fault on an off-site power circuit has no impact on STP 3 & 4 safety related functions.
- Describe how STP 3 & 4 ESF buses are protected from a single-phase open circuit or high impedance ground fault on an off-site power circuit.
- Describe how the STP 3 & 4 design will ensure that a single-phase open circuit or high impedance ground fault is detected in a timely manner.

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NRC Bulletin 2012-01: Design Vulnerability in Electric Power System

NRC Bulletin 2012-01 :

- Offsite power supply circuits were rendered inoperable by single-phase open circuit that was undetected by surveillances.
- Design of electric power system did not take into account possibility of loss of a single phase between the transmission network and the onsite power distribution system.

STP 3 & 4 is not susceptible to the issues described in Bulletin 2012-01

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NRC Bulletin 2012-01:
Design Vulnerability in Electric Power System

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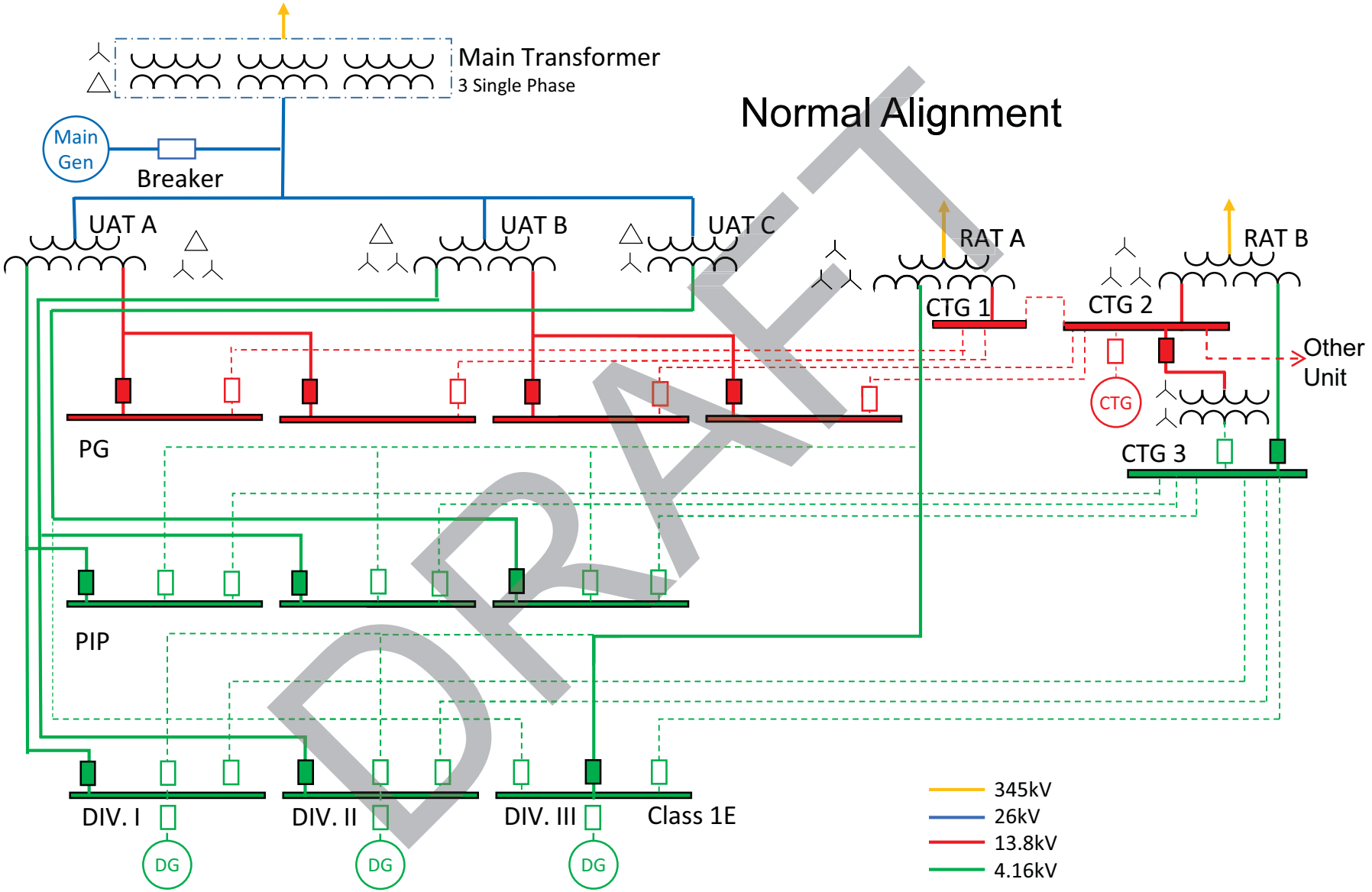
NRC Bulletin 2012-01 requested information:

1. Describe how protection scheme for ESF buses (Class 1E) is designed to detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on credited off-site power circuits.

2. Describe the operating configuration of the ESF buses (Class 1E) at power (normal operating condition).


Normal Alignment
Main Transformer
3 Single Phase
Main Gen
Breaker
UAT A
UAT B
UAT C
RAT A
RAT B
CTG 1
CTG 2
CTG
CTG 3
Other Unit
PG
PIP
DIV. I
DIV. II
DIV. III
Class 1E
DG
DG
DG
345kV
26kV
13.8kV
4.16kV

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STP 3 & 4 Electrical Distribution System

- Four 13.8 kV Power Generation (PG) buses
- Three, 4.16 kV non-Class 1E Plant Investment Protection (PIP) buses
- Three, 4.16 kV Class 1E Divisional buses
- Designed with a Main Generator Breaker which opens on trip of the generator or reactor
  - Allows for immediate backfeed of power without need for either fast or slow bus transfer.

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STP 3 & 4 Electrical Distribution System cont'd

- Main and Unit Auxiliary Transformers normally feed two divisions of Class 1E ESF buses.
  - Also normally feed the PG buses and PIP buses
  - Main Transformer connected wye high side and delta low side
  - 3 Unit Auxiliary Transformers connected delta/wye

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STP 3 & 4 Electrical Distribution System cont'd

- Two Reserve Auxiliary Transformers
  - Three winding, 345 kv/13.8 kV-4.16 kV
  - Both RATs are connected wye/wye with resistance grounding on secondary
  - One RAT normally feeds the remaining Class 1E bus
  - Class 1E bus is normally loaded

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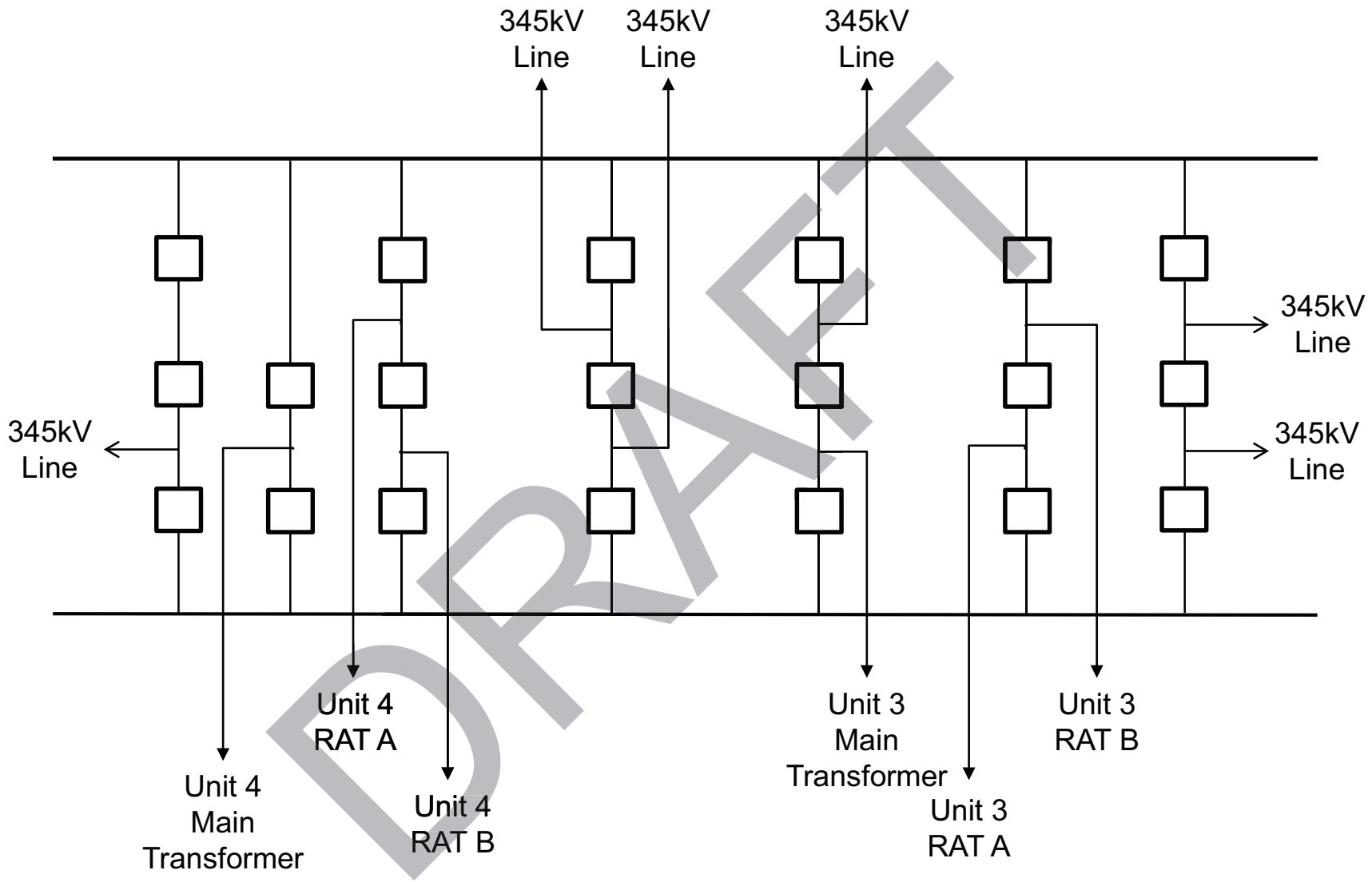

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STP 3&4 345kV Switchyard

STP 3 & 4 Electrical Distribution System cont'd

- STP design does not use fast or slow bus transfers on loss of offsite power.
- On loss of Main/Unit Auxiliary or Reserve Auxiliary transformers, Class 1E buses transfer to the Emergency Diesel Generators

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STP 3 & 4 Electrical Distribution System cont'd

- Undervoltage and Degraded detection
  - Uses 3 independent undervoltage relays
  - Primary side of PTs are connected phase-to-phase in a delta configuration
  - Loss of single phase will cause two of the three relays to trip
  - Actuation of undervoltage and degraded voltage isolates the ESF bus and starts the EDG.

Reference section FSAR section 8.3.1.1.7

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STP 3 & 4 Electrical Distribution System cont'd

- Main Transformer backfeed
  - The wye/delta connection recreates the lost phase in the delta connected secondary
  - The transformer MVA rating is about 15 times greater than the load needed
  - STP Unit 2 experienced a single phase event on high side of Main Transformers in 2001
    - Generator tripped, safety loads operated without issue

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STP 3 & 4 Electrical Distribution System cont'd

- Reserve Auxiliary Transformer
  - Three winding, shell wye/wye low impedance grounded on secondary windings
  - Is affected by a single-phase open circuit
  - Degraded voltage scheme will detect the condition

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STP 3 & 4 Electrical Distribution System cont'd

Reserve Auxiliary Transformer expected secondary voltages

Wye-G/Wye-G, 5 Legged Shell Form Xfmr, opened phase, some Ph-N loading					
B phase lost (middle phase) (voltages in per unit)					
VAN	1.00 ∠0	VAB	1.00 ∠30	DVR	Does not trip
VBN	~0	VBC	0.578 ∠-120	DVR	Tripped
VCN	1.00 ∠120	VCA	0.578 ∠180	DVR	Tripped
C phase lost (outside phase)					
VAN	1.00 ∠0	VAB	1.00 ∠30	DVR	Does not trip
VBN	1.00 ∠-120	VBC	0.578 ∠-120	DVR	Tripped
VCN	~0	VCA	0.578 ∠180	DVR	Tripped

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Reference - "A Practical Guide for Detecting Single-Phasing on a Three-Phase Power System" by John Horak and Gerald F. Johnson (Basler)

STP Unit 2 – Loss of Single Phase Event

- STP 1 & 2 switchyard and distribution are similar to STP 3 & 4
- STP Unit 2 experienced single phase event on high side of Wye/Delta connected Main Transformers in 2001:

  (LER 01-002, ML011200051).
  - Switchyard breakers Y600 and Y610 were opened to remove the "Skyline" feed disconnect link.
  - After disconnect link removed, breakers Y600 and Y610 were closed. However, C phase pole of breaker Y600 remained opened (indicated fully closed).
  - When breaker Y590 was opened, STP Unit 2 experienced loss of single phase.
  - Control Room received electrical panel alarms, three operating Circ. Water Pumps tripped and a reactor trip was manually initiated.
  - All actuated safety equipment operated as required.
- This event demonstrated that voltages are recreated on loss of a single phase on main transformer.

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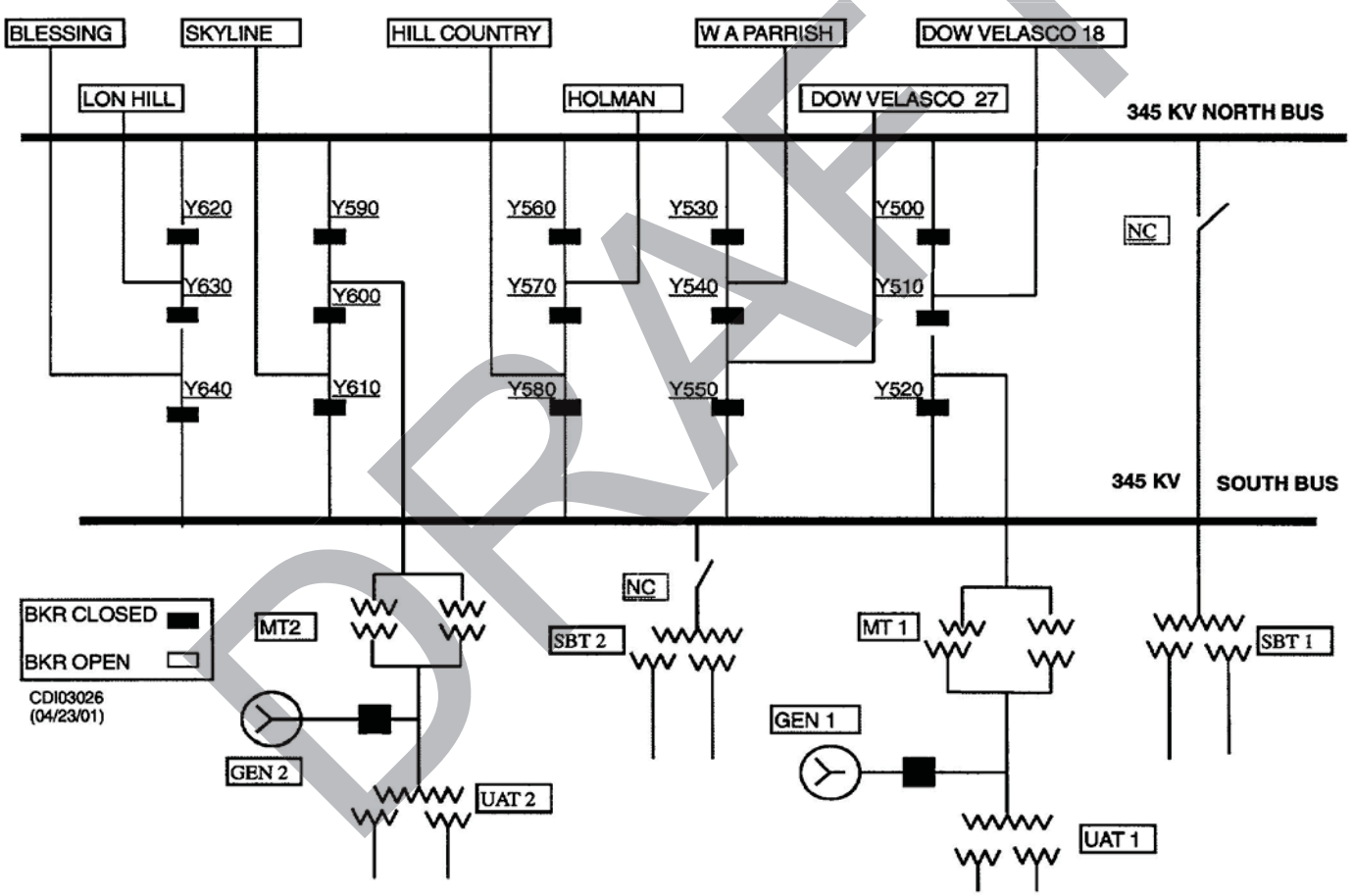
STP Unit 2 – Loss of Single Phase Event

STP 1 & 2 Switchyard



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Forsmark – Loss of Two Phases

- In 2013, plant was in an outage utilizing a feed from the 400 kV offsite power source
- The feed was tripped accidentally and two phases opened and the third phase stayed closed
- Onsite emergency diesel generators did not start automatically since induced voltage on the open phases was higher than the undervoltage relay settings
- Loss of two phases at STP would actuate loss of voltage trip to initiate EDG start.

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Forsmark – Loss of Two Phases cont'd

STP Reserve Auxiliary Transformer expected secondary voltages after loss of two phases:

Wye-G/Wye-G, 5 Legged Shell Form Xfmr, opened phase, some Ph-N loading					
Loss of A and C Phases (Voltages in per unit)					
VAN	~0	VAB	0.578 ∠60	DVR	Tripped
VBN	1.00 ∠0	VBC	0.578 ∠-120	DVR	Tripped
VCN	~0	VCA	0	DVR	Tripped
Loss of B and C Phases					
VAN	1.00 ∠0	VAB	0.578 ∠0	DVR	Tripped
VBN	~0	VBC	0	DVR	Tripped
VCN	~0	VCA	0.578 ∠180	DVR	Tripped

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Reference - "A Practical Guide for Detecting Single-Phasing on a Three-Phase Power System" by John Horak and Gerald F. Johnson (Basler)

Forsmark – Loss of Two Phases cont'd

STP Main Transformer expected secondary voltages after loss of two phases:

Wye-G/Delta, Transformer, B and C phases opened					
Primary Voltages					
VAN	1.00 ∠0	VAB	0.867 ∠0		
VBN	~0.5 ∠180	VBC	~0		
VCN	~0.5 ∠180	VCA	0.867 ∠180		
Secondary Voltages					
VAN	0.866 ∠0	VAB	0.500 ∠0	DVR	Tripped
VBN	0	VBC	0.500 ∠0	DVR	Tripped
VCN	0.866 ∠180	VCA	1.00 ∠180	DVR	Does not trip

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Reference - "A Practical Guide for Detecting Single-Phasing on a Three-Phase Power System" by John Horak and Gerald F. Johnson (Basler)

Forsmark – Loss of Two Phases cont'd

- The loss of two phases on an offsite circuit at STP 3 & 4 will be detectable by the bus degraded voltage relaying for both the Main and Reserve Auxiliary Transformers

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STP 3 & 4 ETAP Rev 12 Studies

- ETAP Studies on loss of phase on the Reserve Auxiliary Transformer and Main Transformer
- Model is the same as single line shown earlier
- Studies included
  - 5 legged Shell form, wye/wye-wye transformer for the RAT with low resistance ground on secondary neutral connection
  - 3 x 1 Shell form, wye/delta transformer for the Main Transformer

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STP 3 & 4 ETAP Rev 12 Studies cont'd

ETAP Study results for Reserve Auxiliary Transformer expected secondary voltages

Wye-G/Wye-low impedance, 5 Legged Shell Form Xfmr, A phase lost					
	High Side		Low Side		
Light loading (Voltages in per unit)					
VAN	1.00 ∠0	VAB	0.869 ∠6	DVR	Tripped
VBN	~0	VBC	0.599 ∠-91	DVR	Tripped
VCN	1.00 ∠120	VCA	0.995 ∠150	DVR	Does not trip
Design Loading					
VAN	1.00 ∠0	VAB	0. 875 ∠1	DVR	Tripped
VBN	~0	VBC	0. 555 ∠-101	DVR	Tripped
VCN	1.00 ∠120	VCA	0. 936 ∠145	DVR	Does not trip

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STP 3 & 4 ETAP Rev 12 Studies cont'd

ETAP Study results for Main Transformer expected secondary voltages

Wye-G/Delta, 3 x 1 Shell Form Transformer, A phase lost					
	High Side		Low Side		
Light loading (Voltages in per unit)					
VAN	1.00 ∠0	VAB	1.01 ∠-30	DVR	Does not trip
VBN	~0	VBC	1.00 ∠-150	DVR	Does not trip
VCN	1.00 ∠120	VCA	.999 ∠90	DVR	Does not trip
Design Loading					
VAN	1.00 ∠0	VAB	0.998 ∠-33	DVR	Does not trip
VBN	~0	VBC	0.994 ∠-154	DVR	Does not trip
VCN	1.00 ∠120	VCA	0.978 ∠86	DVR	Does not trip

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STP 3 & 4 ETAP Rev 12 Studies cont'd

- Reserve Auxiliary Transformer
  - Studies show that an undervoltage will occur on either a lightly loaded or a heavily loaded bus for 5 legged shell transformer
  - Transformer construction/configuration matters
  - Voltage will be low enough to be detected by the bus degraded voltage relays (DVR)
  - Two out of three DVR logic will actuate
- Main Transformer
  - On loss of single phase on high side of transformer, secondary voltages is recreated on secondary
  - Transformers have capacity to produce adequate voltages with the design load

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Questions and Comments

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