SUBJECT **C-5 / C-5A SUBSTATION OPERATION**

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PURPOSE

This document will identify the analyzed configurations and switching procedures for operating the C-5 and C-5A substations located at K6-1141 and K6-1141A. An overview of the substation layout per Drwg. 39K6150001, can be seen in the Exhibit 1, C-5 and C-5A Substation Buses and Vacuum Circuit Breaker Layout.

EXHIBIT 1: C-5 and C-5A Substation Buses and Vacuum Circuit Breaker Layout

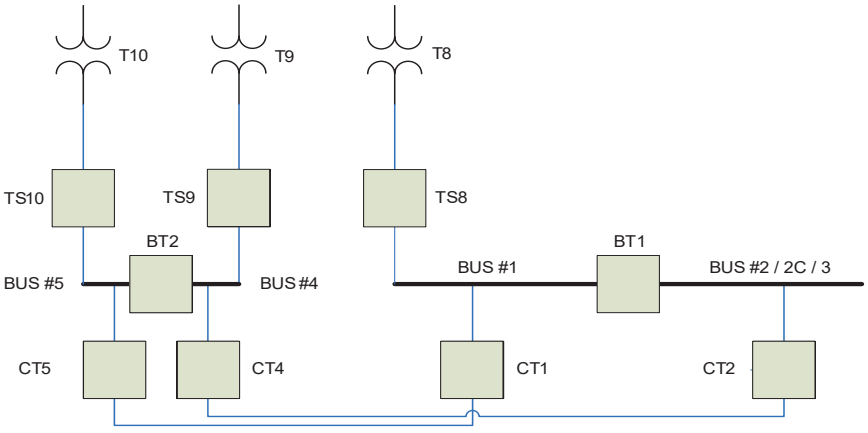


Exhibit 1: C-5 and C-5A Substations, Buses, And Vacuum Circuit Breaker Layout

SCOPE AND APPLICABILITY

This procedure shall be applicable to Base Operations and Spaceport Services (BOSS) Power Systems, including but not limited to: High/Medium Voltage transformers, Vacuum Circuit Breakers and Distribution System Equipment located at C-5 and C-5A Substations on the KSC Power Grid. It is intended to provide this document to customers so they may understand BOSS requirements and obtain the service they need in a timely manner, consistent with codes, standards and BOSS Contract directives.

PROCESS

1. PREAMBLE

Depending on the operational requirements or the status of the C-5 and C-5A equipment one of the configurations in this document shall be selected to support the operation.

Once a configuration has been selected, the BOSS Power Coordinator will prepare a Switching Order for the selected configuration. The BOSS High Voltage Switchmen will

perform the instructions on the Switching Order to place the equipment at the C-5 and C-5A Substations in the selected configuration.

2. C-5 / C-5A CONFIGURATONS

All configurations are acceptable for normal (daily) operations with limitations. Configurations AC5, AC6, and AC7 provide no redundancy in the event of a fault/relay action.

Configurations PC1, AC1A, AC2A, AC2B, AC2C, AC3A, AC4A, and AC4B have been analyzed and evaluated by BOSS Design Engineering and shall be approved for supporting Mission Essential (ME) activities with notification through BOSS management and Duty Office.

2.1. Approved Configurations for All Operations

Table 1, “C-5 and C-5A Configurations Approved for All Operations”, lists all configurations that are approved for ME activities.

Alternate Configurations AC1A, AC2A, AC2B, AC2C, AC3A, AC4A, and AC4B can be used to support ME activities by making changes to the relay settings as found in documents 79K01109 and 81K06541. If any configuration other than the Preferred Configuration is to be used to support KSC launches, the proposed configuration will be presented to the BOSS Facility Engineering Review Board (FERB) for review and to provide the appropriate notifications.

2.2. Approved Configurations for Operations Other than Mission Essential Activities

Alternate Configurations AC3B, AC4C, AC5, AC6, and AC7 may be utilized at the discretion of the BOSS Power Coordinator (without prior management approval) to meet operational or maintenance requirements except during Mission Essential Activities (see Table 2, C-5 and C-5A Configurations Approved for Operations). Examples of these may include, but are not limited to, such conditions as outages of one or more power transformers or associated circuit breakers, isolation disconnect switches, bus-work, etc. These relay settings are listed in 81K06541.

2.3. Approval process for Table 2 Configurations to support Mission Essential Activities

Alternate Configurations AC3B, AC4C, AC5, AC6, and AC7 can only be utilized to support Mission Essential Activities after:

1. Proposed Configuration is presented to the BOSS FERB for review.

2. A waiver is approved.

3. The field relay settings have been changed to the relay settings found in 79K01109 and 81K06541.

TABLE 1: C-5 and C-5A Configurations Approved for All Operations

Configuration	BT1	CT1	CT2	BT2	CT4	CT5	Active Transformers	Active Buses	Double-Ended Substations from Single Transformer
All Transformers									
PC1	C				C	C	T8	1/2	837, 1139
							T9	4	
							T10	5	
AC1A			C		C	C	T8	1	1139
							T9	2/4	1133
							T10	5	
Loss of T8									
AC2A	C	C			C	C	T9	4	
							T10	1/2/5	837, 1100, 1127, 1128, 1139
AC2B		C	C		C	C	T9	2/4	1133
							T10	1/5	1100, 1127, 1128, 1139
AC2C	C		C		C	C	T9	1/2/4	837, 1113, 1114, 1115, 1116, 1133, 1139
							T10	5	
Loss of T9									
AC3A	C		C		C	C	T8	1/2/4	837,1113,1114,1115, 1116, 1133,1139
							T10	5	
Loss of T10									
AC4A	C	C			C	C	T8	1/2/5	837, 1100, 1127, 1128, 1139
							T9	4	
AC4B		C	C		C	C	T8	1/5	1100, 1127, 1128, 1139
							T9	2/4	1133

C = Closed

Notes: Bus 2, 2C and 3 are considered and depicted as one bus (Bus 2)

TABLE 2: C-5 and C-5A Configurations Approved for Operations

Configuration	BT1	CT1	CT2	BT2	CT4	CT5	Active Transformers	Active Buses	Double-Ended Substations from Single Transformer (Highlighted SS's have critical loads)
All Transformers									
Loss of T9									
AC3B	C			C	C	C	T8 T10	1/2 4/5	837, 1139 **800, 802, 803, 804, 806, 807, 808, 809, 810, 811, 820, 830, 858, 928 VAB1/2/3**, 1149
Loss of T10									
AC4C	C			C	C	C	T8 T9	1/2/2C/3 4/5	837, 1139 **800, 802, 803, 804, 806, 807, 808, 809, 810, 811, 820, 830, 858, 928 VAB1/2/3**, 1149
Single Transformer									
AC5	C	C	C		C	C	T8	1/2/3/4/5	No Redundancy
AC6		C	C	C	C	C	T10	1/2/3/4/5	No Redundancy
AC7		C	C	C	C	C	T9	1/2/3/4/5	No Redundancy

C = Closed

Notes: Bus 2, 2C and 3 are considered and depicted as one bus (Bus 2)

FIGURE 1: Preferred Configuration PC1

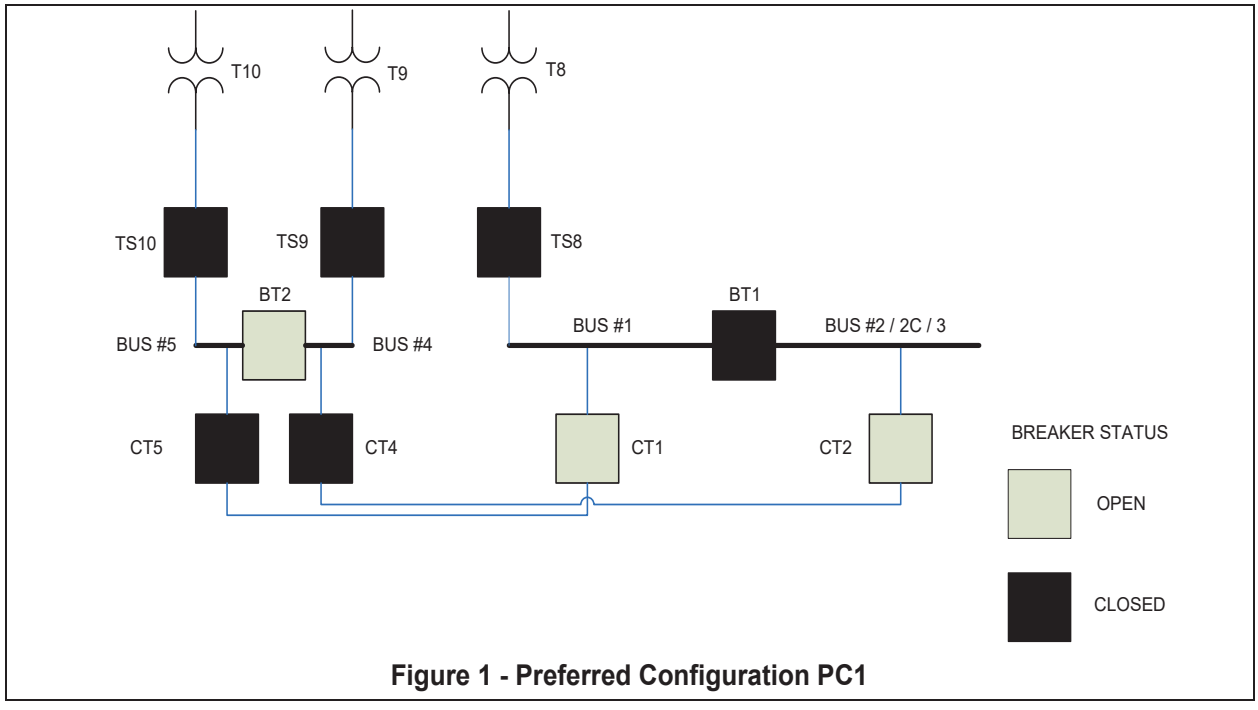


Figure 1 - Preferred Configuration PC1

3. SWITCHING PROCEDURE FOR TRANSFERRING BUS LOADS

The following switching steps are to be used to parallel the power transformers, both at C-5 and C-5A, and then transfer their loads from one bus (or buses) to another bus. These switching procedures must comply with FPL MOU-0001, Rev. Basic – Memorandum of Understanding Power Switching Limitation Policy at KSC/CCAFS Spaceport.

3.1. Switching PC1 to AC1A

NOTE: See Section 2.1 if used for Mission Essential Activities.

Switching steps to transfer bus loads from C-5 Buses #2, 2C, 3 to C-5A Bus #4 (from PC1 to AC1A):

3.1.1. Set C-5 transformer T8 tap changer to manual.

3.1.2. Set C-5A transformer T9 tap changer to manual.

3.1.3. Balance bus voltages on Buses #1, 2, 2C, 3 and Bus #4.

3.1.4. Parallel transformers T8 and T9 by closing breaker CT2.

3.1.5. Open breaker BT1.

3.1.6. Set C-5A transformer T9 tap changer to auto.

3.1.7. Set C-5 transformer T8 tap changer to auto.

FIGURE 1A: Alternate Configuration AC1A

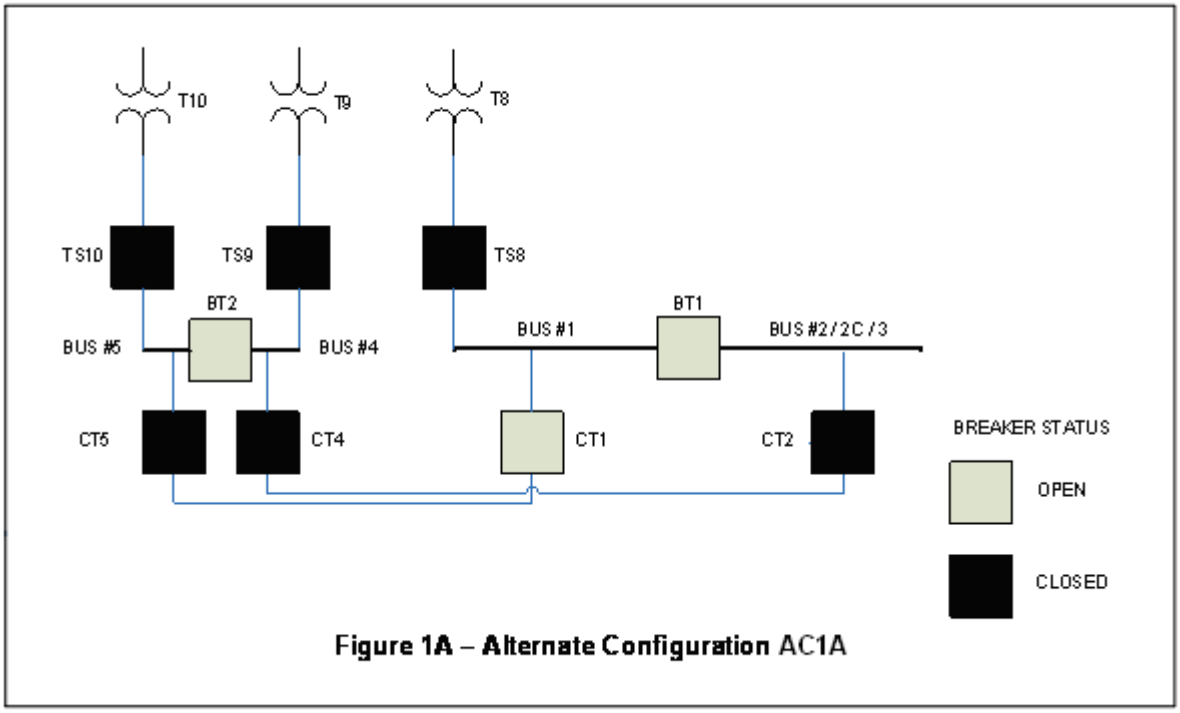


Figure 1A – Alternate Configuration AC1A

3.2. Switching PC1 to AC2A

NOTE: See Section 2.1 if used for Mission Essential Activities.

3.2.1. Switching steps to transfer bus loads from C-5 Buses #1&2, 2C, 3 to C-5A Bus #5 (from PC1 to AC2A):

3.2.2. Set C-5 transformer T8 tap changer to manual.

3.2.3. Set C-5A transformer T10 tap changer to manual.

3.2.4. Balance bus voltages on Buses #1&2, 2C, 3 and Bus #5.

3.2.5. Parallel transformers T8 and T10 by closing breaker CT1.

3.2.6. Open breaker TS8.

3.2.7. Set C-5A transformer T10 tap changer to auto.

3.2.8. Relay and Test technicians verify and install, as required, the relay settings of BT1 to match values addressing in 81K06541.

FIGURE 2A: Alternate Configuration AC2A

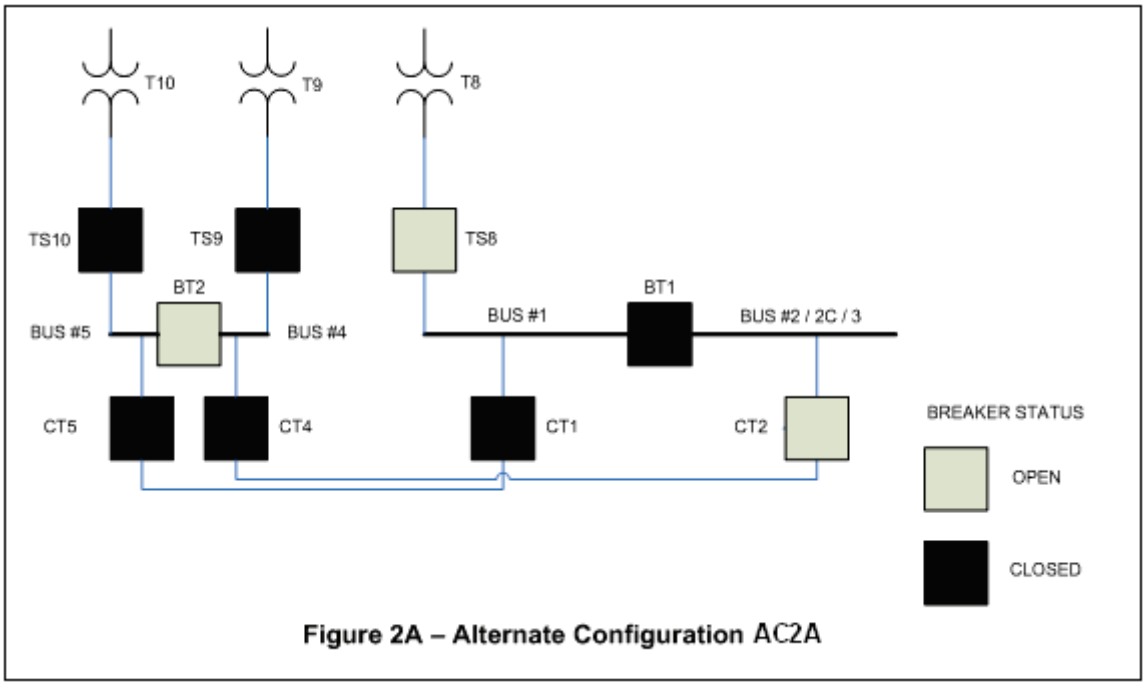


Figure 2A – Alternate Configuration AC2A

3.3. Switching PC1 to AC2B

NOTE: See Section 2.1 if used for Mission Essential Activities.

Switching steps to transfer bus loads from C-5 Bus #1 to C-5A Bus #5 and C-5 Bus #2, 2C, 3 to C-5A Bus #4 (from PC1 to AC2B):

3.3.1. Set C-5 transformer T8 tap changer to manual.

3.3.2. Set C-5A transformer T9 tap changer to manual.

3.3.3. Set C-5A transformer T10 tap changer to manual.

3.3.4. Balance bus voltages on Buses #1&2, 2C, 3 and Bus #5.

3.3.5. Parallel transformers T8 and T10 by closing breaker CT1.

3.3.6. Open breaker TS8.

3.3.7. Balance bus voltages on Bus #5(and 1&2, 2C, 3), and Bus #4.

3.3.8. Parallel transformers T9 and T10 by closing breaker CT2.

3.3.9. Open breaker BT1.

3.3.10. Set C-5A transformer T9 tap changer to auto.

3.3.11. Set C-5A transformer T10 tap changer to auto.

FIGURE 2B: Alternate Configuration AC2B

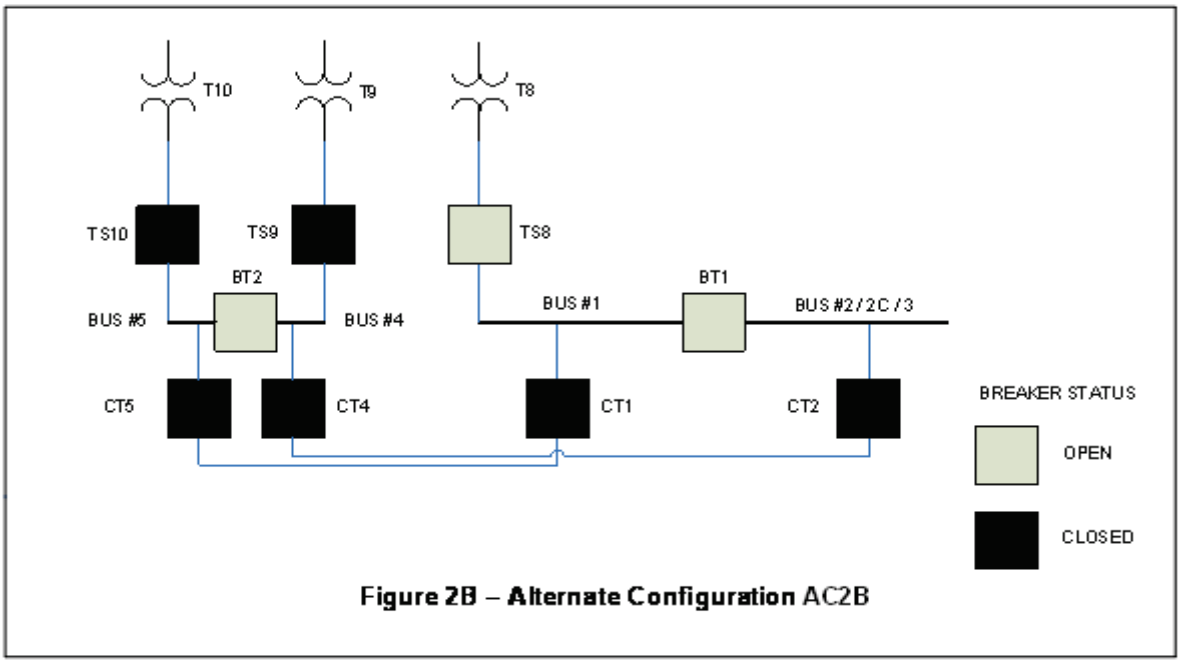


Figure 2B – Alternate Configuration AC2B

3.4. Switching PC1 to AC2C

NOTE: See Section 2.1 if used for Mission Essential Activities.

Switching steps to transfer bus loads from C-5 Buses #1 & 2, 2C, 3 to C-5A Bus #4 (from PC1 to AC2C):

3.4.1. Set C-5 transformer T8 tap changer to manual.

3.4.2. Set C-5A transformer T9 tap changer to manual.

3.4.3. Balance bus voltages on Buses #1, 2, 2C, 3 and Bus #4.

3.4.4. Parallel transformers T8 and T9 by closing breaker CT2.

3.4.5. Open breaker TS8.

3.4.6. Set C-5A transformer T9 tap changer to auto.

3.4.7. Relay and Test technicians verify and install, as required, the relay settings of BT1 to match values addressing in 81K06541.

FIGURE 2C: Alternate Configuration AC2C

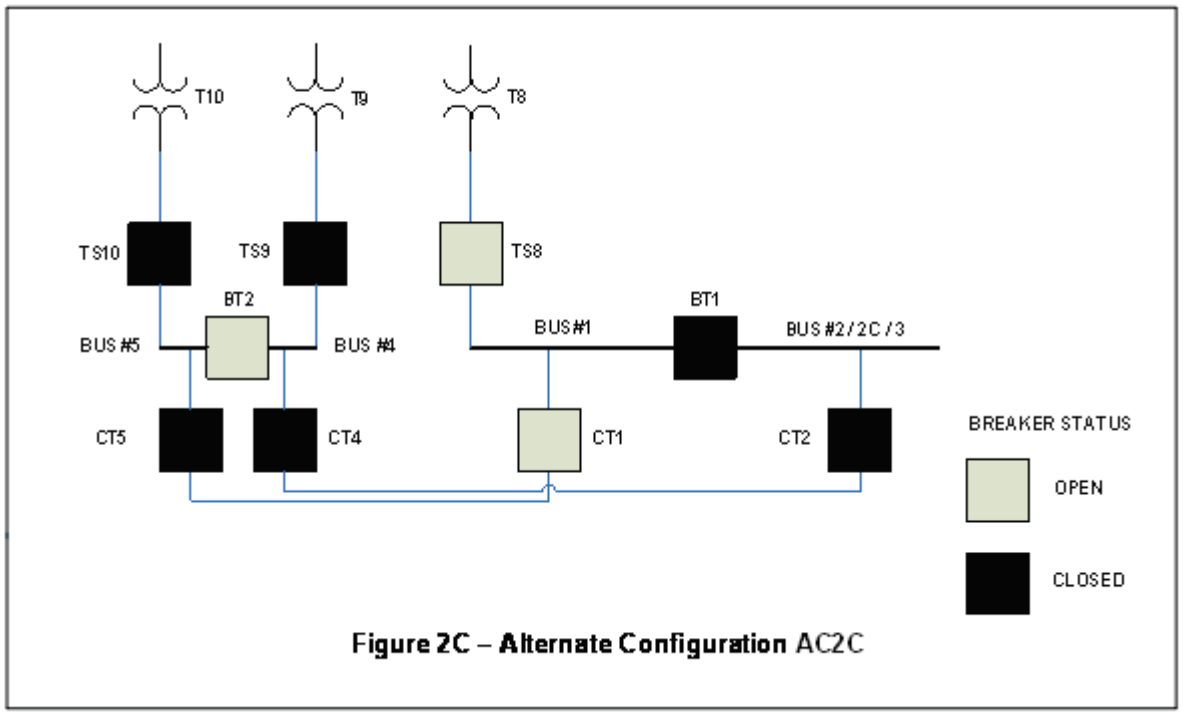


Figure 2C – Alternate Configuration AC2C

3.5. Switching PC1 to AC3A

NOTE: See Section 2.1 if used for Mission Essential Activities.

Switching steps to transfer bus loads from C-5A Bus #4 to C-5 Buses #1, 2, 2C, 3 (from PC1 to AC3A):

3.5.1. Set C-5 transformer T8 tap changer to manual.

3.5.2. Set C-5A transformer T9 tap changer to manual.

3.5.3. Balance bus voltages on Buses #1, 2, 2C, 3 and Bus #4.

3.5.4. Parallel transformers T8 and T9 by closing breaker CT2.

3.5.5. Open breaker TS9.

3.5.6. Set C-5 transformer T8 tap changer to auto.

3.5.7. Relay and Test technicians verify and install, as required, the relay settings of CT2 and CT4 to match values addressing in 81K06541.

FIGURE 3A: Alternate Configuration AC3A

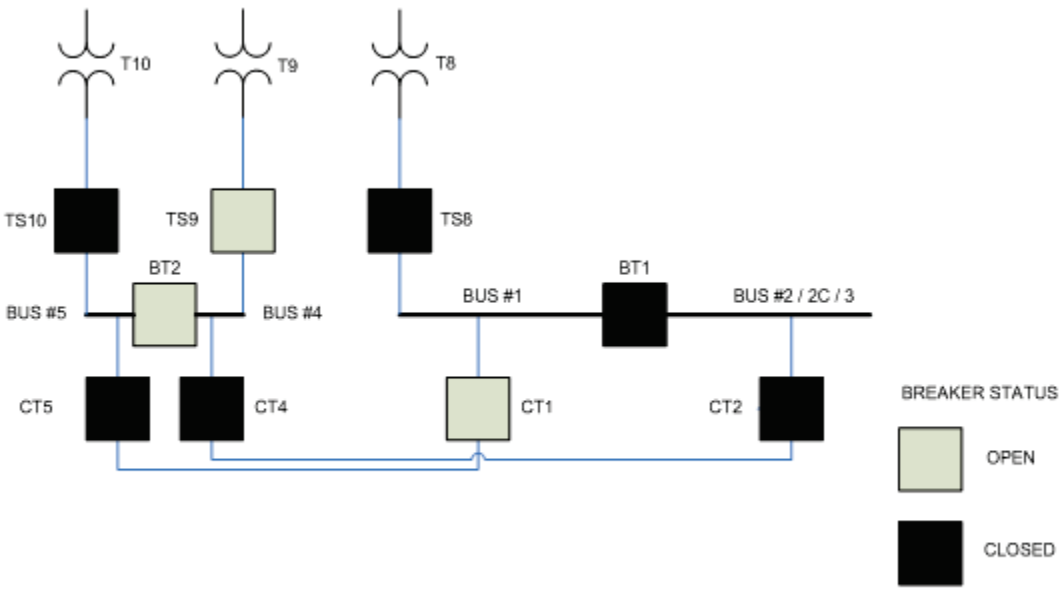


Figure 3A – Alternate Configuration AC3A

3.6. Switching PC1 to AC3B

NOTE: See Section 2.3 if used for Mission Essential Activities.

Switching steps to transfer bus loads from C-5A Bus #4 to C-5A Bus #5 (from PC1 to AC3B):

3.6.1. Set C-5A transformer T9 tap changer to manual.

3.6.2. Set C-5A transformer T10 tap changer to manual.

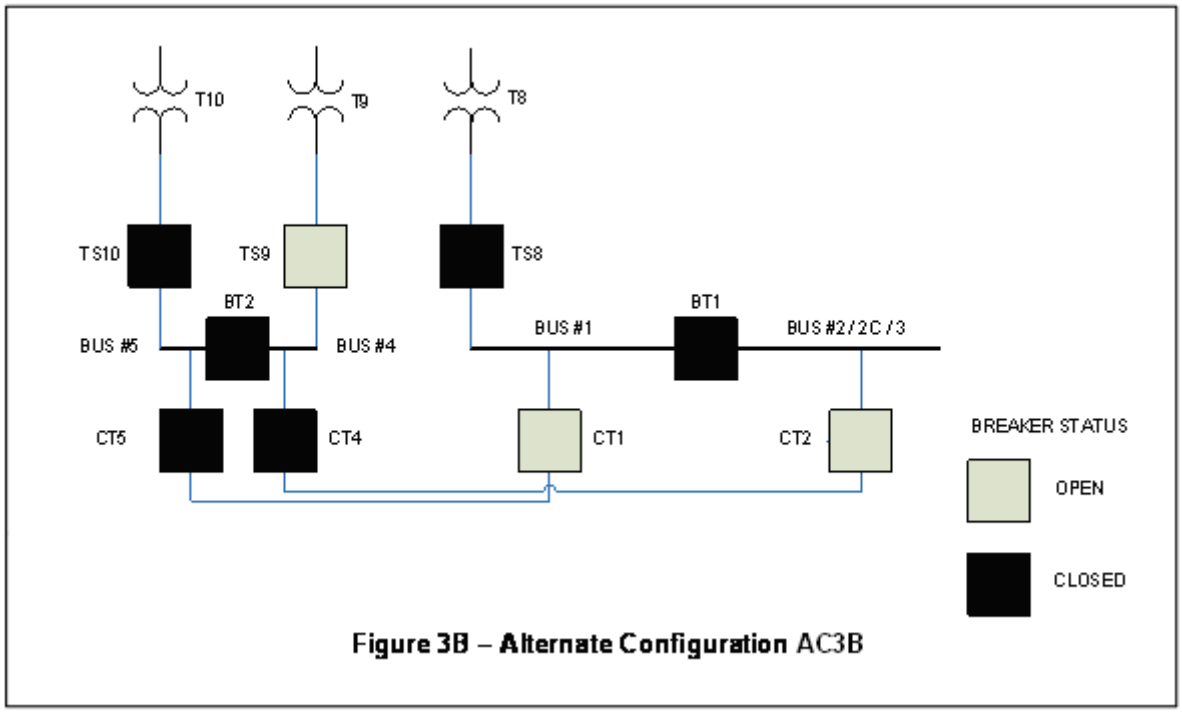
3.6.3. Balance bus voltages on Bus #4 and Bus #5.

3.6.4. Parallel transformers T9 and T10 by closing breaker BT2.

3.6.5. Open breaker TS9.

3.6.6. Set C-5A transformer T10 tap changer to auto.

FIGURE 3B: Alternate Configuration AC3B



3.7. Switching PC1 to AC4A

NOTE: See Section 2.1 if used for Mission Essential Activities.

Switching steps to transfer bus loads from C-5A Bus #5 to C-5 Bus #1, 2, 2C, 3 (from PC1 to AC4A):

3.7.1. Set C-5 transformer T8 tap changer to manual.

3.7.2. Set C-5A transformer T10 tap changer to manual.

3.7.3. Balance bus voltages on Bus #1, 2, 2C, 3 and Bus #5.

3.7.4. Parallel transformers T8 and T10 by closing breaker CT1.

3.7.5. Open breaker TS10.

3.7.6. Set C-5 transformer T8 tap changer to auto.

FIGURE 4A: Alternate Configuration AC4A

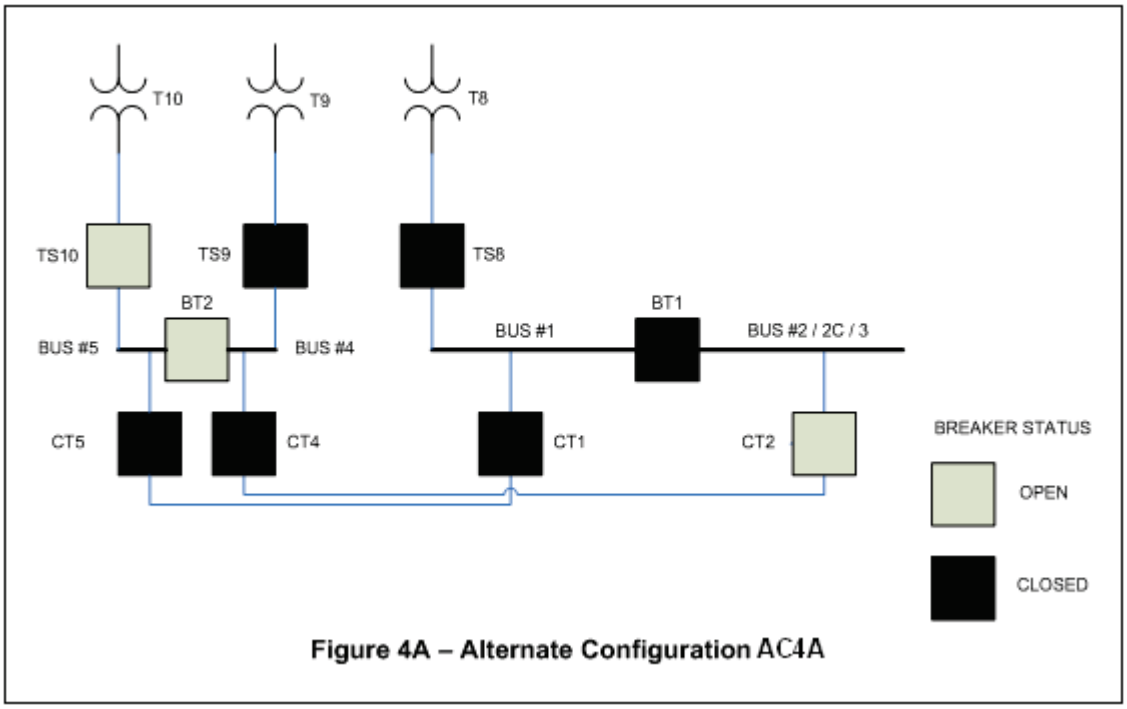


Figure 4A – Alternate Configuration AC4A

3.8. Switching PC1 to AC4B

NOTE: See Section 2.1 if used for Mission Essential Activities.

Switching steps to transfer bus loads from C-5 Bus #2,2C,3 to C-5A Bus #4 and C-5A Bus #5 to C-5 Bus #1 (from PC1 to AC4B):

3.8.1. Set C-5 transformer T8 tap changer to manual.

3.8.2. Set C-5A transformer T9 tap changer to manual.

3.8.3. Set C-5A transformer T10 tap changer to manual.

3.8.4. Balance bus voltages on Bus #1, 2, 2C, 3 and Bus #4.

3.8.5. Parallel transformers T8 and T9 by closing breaker CT2.

3.8.6. Open breaker BT1.

3.8.7. Balance bus voltages on Bus #1 and Bus #5.

3.8.8. Parallel transformers T8 and T10 by closing breaker CT1.

3.8.9. Open breaker TS10.

3.8.10. Set C-5 transformer T8 tap changer to auto.

3.8.11. Set C-5A transformer T9 tap changer to auto.

FIGURE 4B: Alternate Configuration AC4B

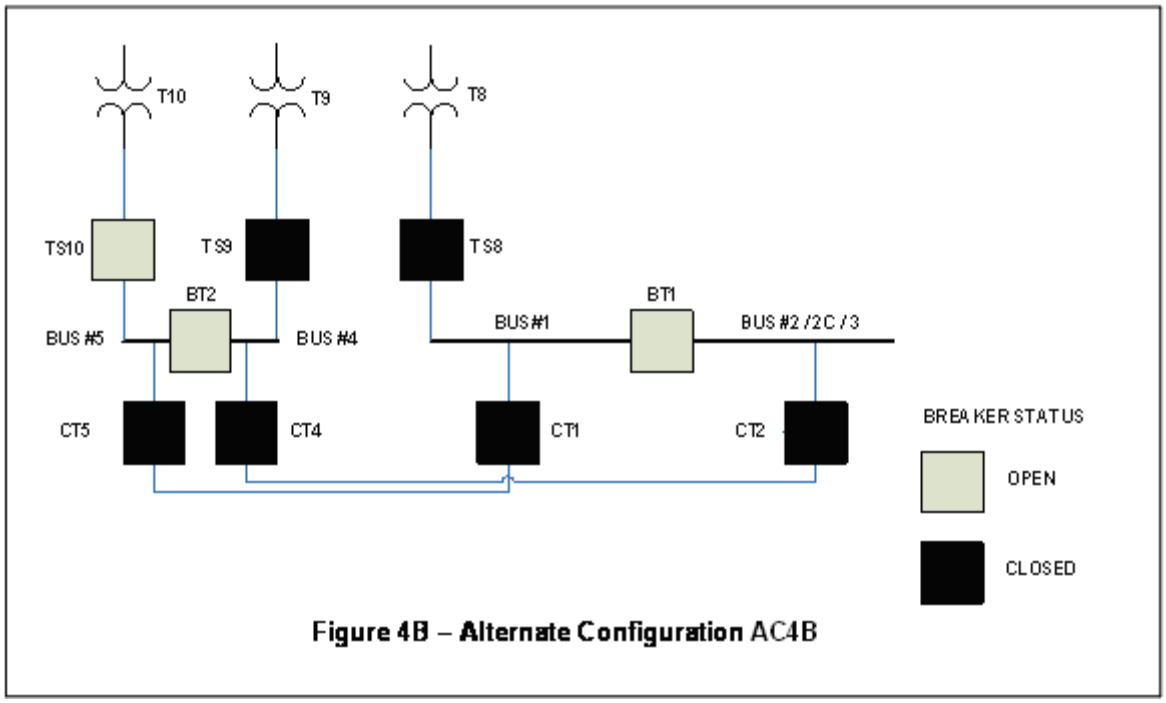


Figure 4B – Alternate Configuration AC4B

3.9. Switching PC1 to AC4C

NOTE: See Section 2.3 if used for Mission Essential Activities.

Switching steps to transfer bus loads from C-5A Bus #5 to C-5A Bus #4 (from PC1 to AC4C):

3.9.1. Set C-5 transformer T9 tap changer to manual.

3.9.2. Set C-5A transformer T10 tap changer to manual.

3.9.3. Balance bus voltages on Bus #4 and Bus #5.

3.9.4. Parallel transformers T9 and T10 by closing breaker BT2.

3.9.5. Open breaker TS10.

3.9.6. Set C-5A transformer T9 tap changer to auto.

FIGURE 4C: Alternate Configuration AC4C

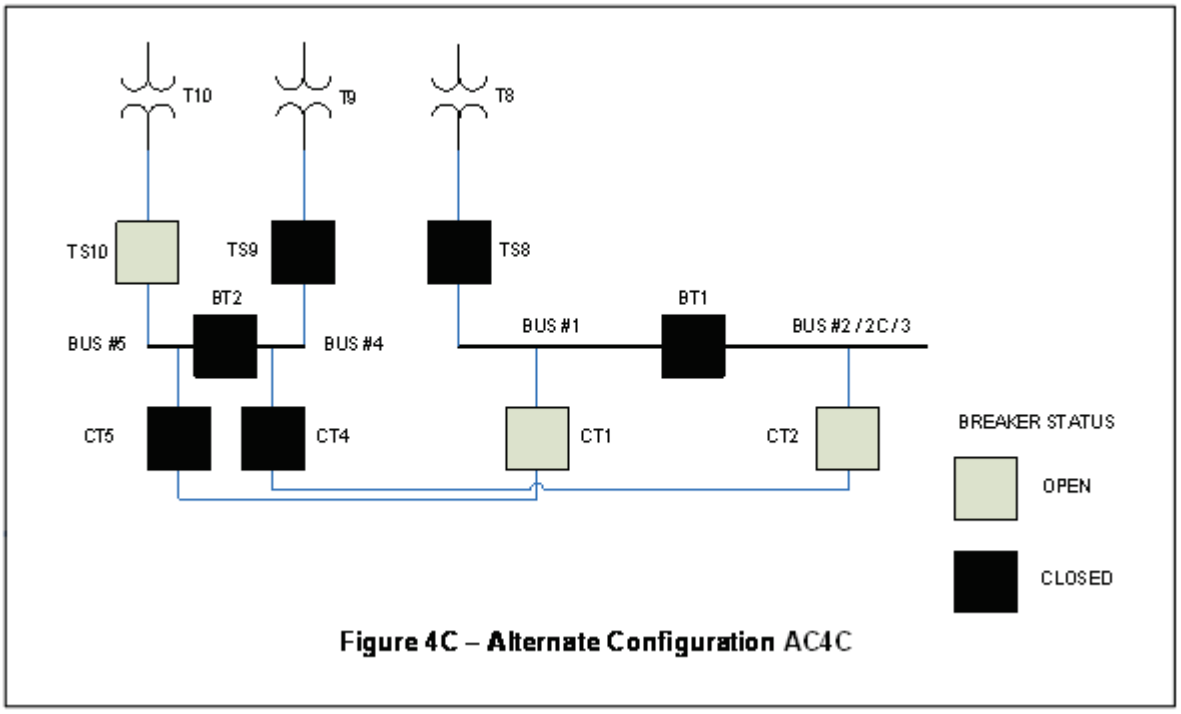


Figure 4C – Alternate Configuration AC4C

3.10. Switching PC1 to AC5

NOTE: See Section 2.3 if used for Mission Essential Activities.

Switching steps to transfer bus loads from C-5A Buses #4 and #5 to C-5 Buses #1, 2, 2C, 3 (from PC1 to AC5):

3.10.1. A. Set C-5 transformer T8 tap changer to manual.

3.10.2. A. Set C-5A transformer T9 tap changer to manual.

3.10.3. A. Set C-5A transformer T10 tap changer to manual.

3.10.4. A. Balance bus voltages on Bus #1, 2, 2C, 3 and Bus #4.

3.10.5. A. Parallel transformers T8 and T9 by closing breaker CT2.

3.10.6. A. Open breaker TS9.

3.10.7. A. Balance bus voltages on Bus #1, 2, 2C, 3 and Bus #5.

3.10.8. A. Parallel transformers T8 and T10 by closing breaker CT1.

3.10.9. A. Open breaker TS10.

3.10.10. A. Set C-5 transformer T8 tap changer to auto.

3.10.11. A. Relay and Test technicians verify and install, as required, the relay settings of CT2 and CT4 to match values addressing in 81K06541.

OR:

3.10.1. B. Set C-5 transformer T8 tap changer to manual.

3.10.2. B. Set C-5A transformer T9 tap changer to manual.

3.10.3. B. Set C-5A transformer T10 tap changer to manual.

3.10.4. B. Balance bus voltages on Bus #1, 2, 2C, 3 and Bus #5.

3.10.5. B. Parallel transformers T8 and T10 by closing breaker CT1.

3.10.6. B. Open breaker TS10.

3.10.7. B. Balance bus voltages on Bus #1, 2, 2C, 3 and Bus #4.

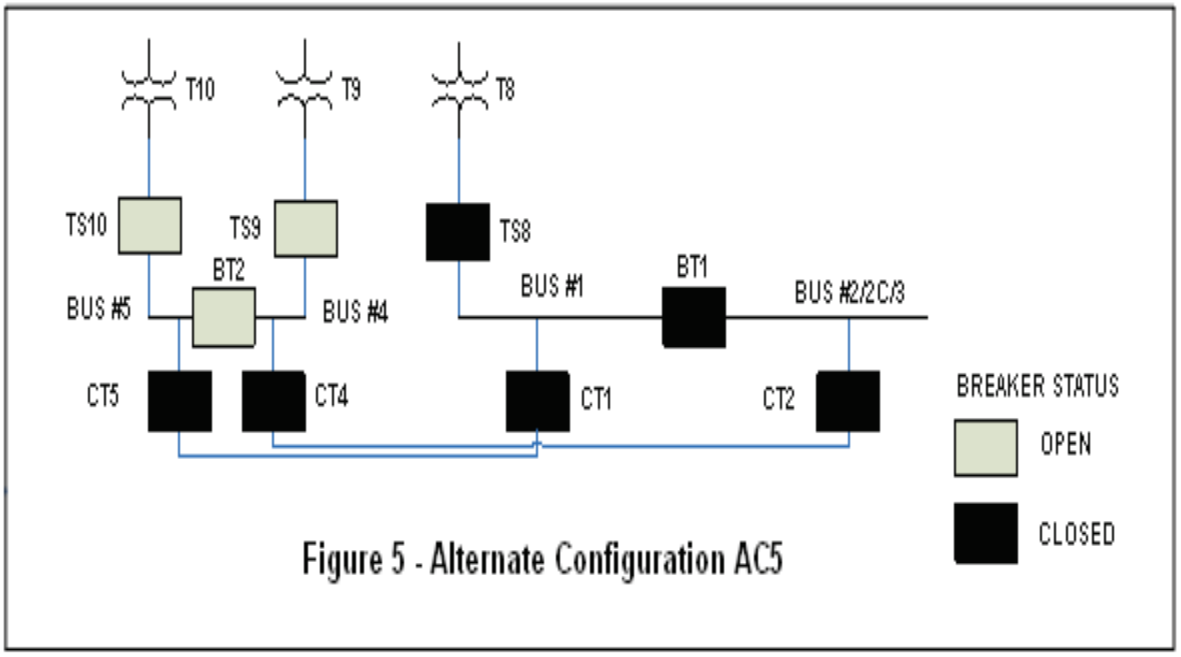
3.10.8. B. Parallel transformers T8 and T9 by closing breaker CT2.

3.10.9. B. Open breaker TS9.

3.10.10. B. Set C-5 transformer T8 tap changer to auto.

3.10.11. B. Relay and Test technicians verify and install, as required, the relay settings of CT2 and CT4 to match values addressing in 81K06541.

FIGURE 5: Alternate Configuration AC5



Switching PC1 to AC6

NOTE: See Section 2.3 if used for Mission Essential Activities.

Switching steps to transfer bus loads from C-5 Buses #1, 2, 2C, 3 and C-5A Bus #4 to C-5A Bus #5 (from PC1 to AC6):

3.11.1. A. Set C-5 transformer T8 tap changer to manual.

3.11.2. A. Set C-5A transformer T9 tap changer to manual.

3.11.3. A. Set C-5A transformer T10 tap changer to manual.

3.11.4. A. Balance bus voltages on Bus #1, 2, 2C, 3 and Bus #5.

3.11.5. A. Parallel transformers T8 and T10 by closing breaker CT1.

3.11.6. A. Open breaker TS8.

3.11.7. A. Balance bus voltages on Bus #4 and Bus #5.

3.11.8. A. Parallel transformers T9 and T10 by closing breaker BT2.

3.11.9. A. Open breaker TS9.

3.11.10. A. Close breaker CT2.

3.11.11. A. Open breaker BT1.

3.11.12. A. Set C-5A transformer T10 tap changer to auto.

3.11.13. A. Relay and Test technicians verify and install, as required, the relay settings of CT2 and CT4 to match values addressing in 81K06541.

OR:

3.11.1. B. Set C-5 transformer T8 tap changer to manual.

3.11.2. B. Set C-5A transformer T9 tap changer to manual.

3.11.3. B. Set C-5A transformer T10 tap changer to manual.

3.11.4. B. Balance bus voltages on Bus #4 and Bus #5.

3.11.5. B. Parallel transformers T9 and T10 by closing breaker BT2.

3.11.6. B. Open breaker TS9.

3.11.7. B. Balance bus voltages on Bus #1, 2, 2C, 3 and Bus #5.

3.11.8. B. Parallel transformers T8 and T10 by closing breaker CT1.

3.11.9. B. Open breaker TS8.

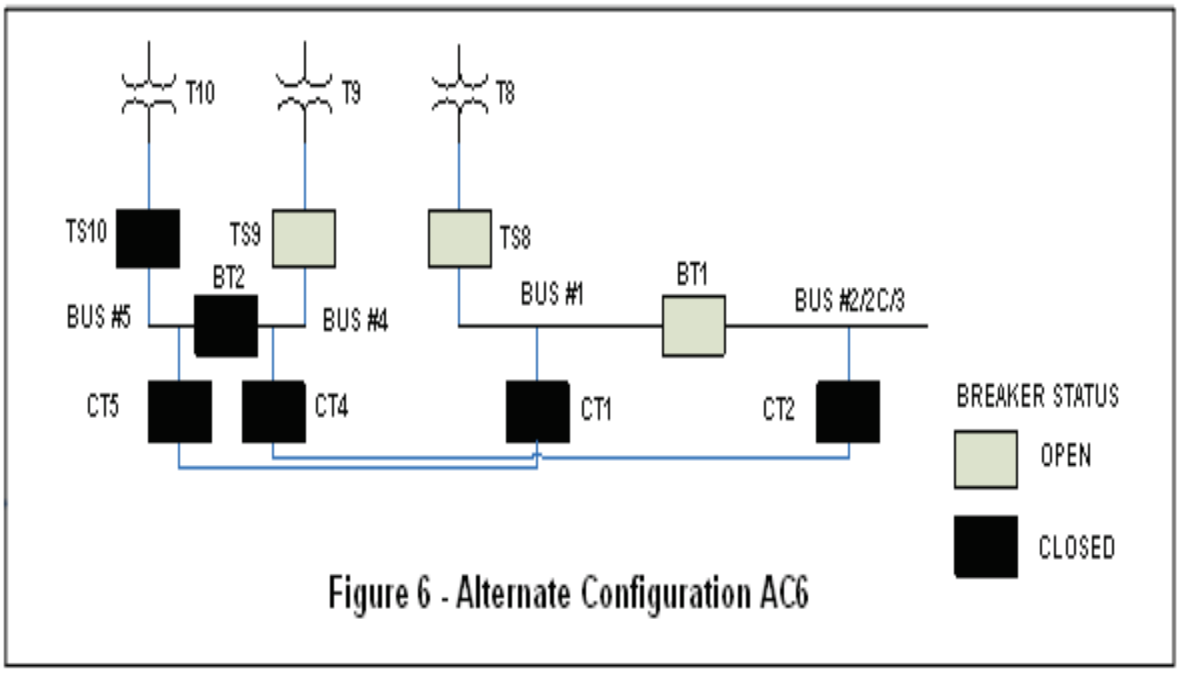
3.11.10. B. Close breaker CT2.

3.11.11. B. Open breaker BT1.

3.11.12. B. Set C-5A transformer T10 tap changer to auto.

3.11.13. B. Relay and Test technicians verify and install, as required, the relay settings of CT2 and CT4 to match values addressing in 81K06541.

FIGURE 6: Alternate Configuration AC6



3.12. Switching PC1 to AC7

NOTE: See Section 2.3 if used for Mission Essential Activities.

Switching steps to transfer bus loads from C-5 Buses #1, 2, 2C, 3 and C-5A Bus #5 to C-5A Bus #4 (from PC1 to AC7):

3.12.1. A. Set C-5 transformer T8 tap changer to manual.

3.12.2. A. Set C-5A transformer T9 tap changer to manual.

3.12.3. A. Set C-5A transformer T10 tap changer to manual.

3.12.4. A. Balance bus voltages on Bus #1, 2, 2C, 3 and Bus #4.

3.12.5. A. Parallel transformers T8 and T9 by closing breaker CT2.

3.12.6. A. Open breaker TS8.

3.12.7. A. Balance bus voltages on Bus #4 and Bus #5.

3.12.8. A. Parallel transformers T9 and T10 by closing breaker BT2.

3.12.9. A. Open breaker TS10.

3.12.10. A. Close breaker CT1.

3.12.11. A. Open breaker BT1.

3.12.12. A. Set C-5A transformer T9 tap changer to auto.

3.12.12. A. Relay and Test technicians verify and install, as required, the relay settings of CT1 and CT5 to match values addressing in 81K06541.

OR:

3.12.1. B. Set C-5 transformer T8 tap changer to manual.

3.12.2. B. Set C-5A transformer T9 tap changer to manual.

3.12.3. B. Set C-5A transformer T10 tap changer to manual.

3.12.4. B. Balance bus voltages on Bus #4 and Bus #5.

3.12.5. B. Parallel transformers T9 and T10 by closing breaker BT2.

3.12.6. B. Open breaker TS10.

3.12.7. B. Balance bus voltages on Bus #1, 2, 2C, 3 and Bus #4.

3.12.8. B. Parallel transformers T8 and T10 by closing breaker CT1.

3.12.9. B. Open breaker TS8.

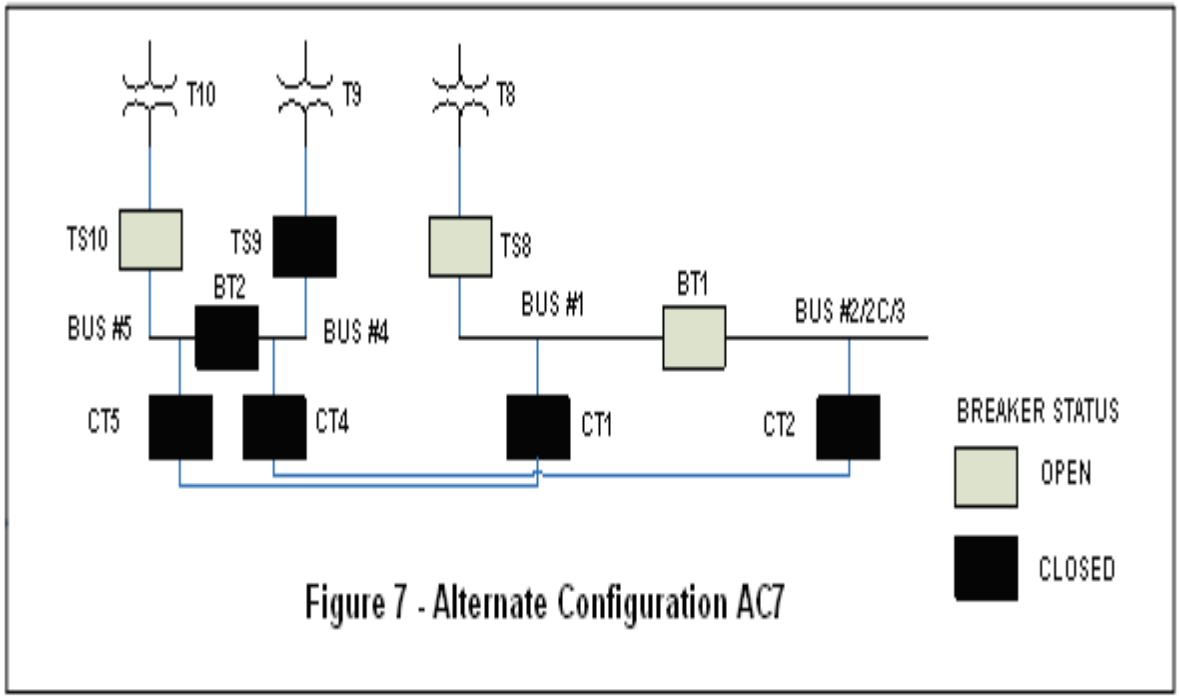
3.12.10. B. Close breaker CT2.

3.12.11. B. Open breaker BT1.

3.12.12. B. Set C-5A transformer T9 tap changer to auto.

3.12.12. B. Relay and Test technicians verify and install, as required, the relay settings of CT1 and CT5 to match values addressing in 81K06541.

FIGURE 7: Alternate Configuration AC7



RECORDS
The following records are retained by the organizations listed below:

Record	Responsible Organization
KSC Form Switching Order	Complex Control Center

AFFECTED DIVISIONS

Engineering Services
FSEU and OM&E
Safety & Mission Assurance

MANAGEMENT ROLES AND RESPONSIBILITIES

Division Manager: Ensures compliance within the Division to the requirements stated in this procedure.

Department Manager: Ensures compliance at the department level to the requirements stated in this procedure.
Power & Electrical Department: The Department Manager and the System Engineers of the BOSS Power and Electrical Branch ensure that this document will be updated to meet the current configurations of the equipment in the C-5 and C-5A Substations. This will ensure that the correct operations will be performed to support Mission Essential Activities, and/or normal operations/maintenance at KSC.

Electrical Design Engineering department: The Electrical Design Engineers shall provide relay settings analyzed for the configurations listed in PPS-P-0030 in support of the C-5 and C5-A operations.

REFERENCE DOCUMENTS

The following documents are referenced in this procedure:

Document Number	Title
80KSC018C0017	Base Operations and Spaceport Services (BOSS) Contract
FPL MOU-0001	Memorandum Of Understanding Power Switching Limitation Policy at KSC/CCAFS Spaceport
KSC-11453	LC-39 Area Load Flow and Fault Study Distribution Power Systems Analysis
79K01109	Overcurrent Protective Device Settings for the 60Hz Power System KSC LC39 Area
81K06541	Overcurrent Protective Device Settings For C5/C5A Substation Alternate Configurations
PPS-P-0004	Electrical System Power Switching Procedure

ACRONYMS

BOSS	Base Operations and Spaceport Services
EO	Engineering Order
FERB	Facility Engineering Review Board
FSEU	Facility, System, Equipment & Utilities
KSC	Kennedy Space Center
ME	Mission Essential
MOU	Memorandum Of Understanding
OM&E	Operations, Maintenance and Engineering
SS	Sub-Station
VAB	Vehicle Assembly Building

DEFINITIONS

None

REVISION RECORD

The following revisions have been applied to this document:

Revision Number	Change Description	Date
0	Initial Release to accept configurations and switching procedures for operating the C-5 and C-5A Substations	11-01-2004

1	This revision changes the “Preferred Configuration” to “Accepted Configuration” for “Launch”.	11-17-2006
2	This revision adds the specific milestones to the “Accepted Configuration” for “Launch” only.	02-15-2007
3	This revision changes the Scope of this document.	05-18-2007
4	This revision removes the statement “SGS Company Proprietary – JBOSC Competition Sensitive” from this document.	05-29-2007
5	This revision changes the configurations to meet the new C-5/C-5A equipment and the new Contractor’s format of this document.	01-05-10
6	Revision incorporates new alternate configurations defined in EO62-SAA09EL02-010.	05-07-10
7	This revision removes all references to Mission Milestones to comply with contract change MOD 140, and add documents SAA09EL02-010 Rev. A and 81K06541.	04-17-2013
8	Administrative change only. Document updated to remove branding of previous contract.	04-01-19
9	Updated to BOSS format. No technical content changes.	09/23/2020

DOCUMENT APPROVALS

Signature on file

10/21/2020

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11/13/2020

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