

# HIGH VOLTAGE SWITCHGEAR \& AUTOMATION EQUIPMENT 

## SECTION 4 Specialty Switches

CAT. NO: 040930G
May, 2008


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## Specialty Switches

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NBS, 5 kV - 38 kV Non-Interrupting
Regulator/Bypass, Overhead Switch

The LineBOSS ${ }^{\text {m" }}$ NBS, Nielsen Bypass Switch, was originally designed in 1972 by Carl Nielsen, P.E. to allow non-interrupting bypassing and energizing (cutin or cut-out) fixed booster transformers. The NBS switch now provides continuous power to load-side customers when energizing or de-energizing one, two, or three phase fixed booster, auto-booster and regulator transformers as required by voltage conditions or for routine maintenance or replacement.

The conventional combination bypass-disconnect switch used for de-energizing multi-step regulators; first requires the regulator be placed in the neutral position. As the switch opens, a shorting bar is inserted across the main line leads and the regulator series winding. If the regulator tap changing mechanism or the position indicator has malfunctioned and the regulator is not in the neutral position, attempting a by-pass operation can result in excessively high circulating current in the series winding which can damage or destroy the series tap changer mechanism, the switchgear, bus work and endanger personnel.

The NBS bypass switch eliminates this safety hazard by controlling the series winding circulating current by use of a current limiting resistor, while providing uninterrupted service to load side customers. The transfer series resistor assembly permits bypassing multi-step regulators in the buck or boost position (refer to application calculations).

## TYPICAL APPLICATION:

Cut in a $762 \mathrm{kVA}(7620 \mathrm{~V}, 100 \mathrm{~A})$, single-phase regulator to boost the voltage. The regulator indicates that it is in neutral, but it is actually at step one. The circulating current could be as high as 31 kA during the switching operation using a standard combination bypass disconnect switch. The NBS switch, with its current limiting series resistor assembly, limits the circulating current to less than 24 A without interruption of service.

## THE TWIN FEED NBS:

The NBS-2D is designed for use on fixed boosters and auto-boosters that are on circuits that have preferred and alternate source directions. The NBS-2D allows the booster or auto-booster to boost in the direction of the load when the alternate source is being utilized. The NBS-2D provides a switching method for re-routing the source feed to the booster transformer without


NBS, Single-pole unitized; shown in the Cut-in position.
re-wiring the buswork. The NBS-2D is not required on multi-step regulators.

## STANDARD FEATURES

The NBS shares all of the features of the LBS conventional sidebreak switch. See LineBOSS ${ }^{m m}$ Features \& Benefits for additional information.

## SWITCH RATINGS:

Voltage Class: 5 kV , 15.5 kV , 25.8 kV \& 38 kV
Continuous Current Class: 600 A Transfer \& Continuous

## STANDARD CONFIGURATIONS

- Single-pole units, unitized, reciprocating handle
- Double-pole unit, unitized, reciprocating handle
- Double-pole unit, two-way feed, unitized
- Three-pole unit, unitized, reciprocating handle
- Single-pole, pole mounted (direct to pole), hookstick
- Single-pole, substation (double crossarm) mounted,
- Twist-Assist ${ }^{\text {TM }}$ hookstick operated, direct to pole


## LineBOSS ${ }^{\text {TM }}$ NBS Operating Sequence

## BYPASS POSITION

1. The NBS bypass switch is shown here in the Cut-out or bypass position. The current path is indicated by the dotted line. The regulator is out of the circuit. The actual switch position is shown to the immediate left, while the schematic shows the NBS in the top left of the schematic.


## BRIDGING POSITION

2. The NBS bypass switch is shown here in the bridging position. Notice that the blade is in contact with the bridging contact before breaking contact with the female clip. The impedance of the series winding and the NBS current limiting resistors eliminate the high circulating current in the series winding. The bridged connnection between bridging contact and the female clip insures
 uninterrupted service.

## Back



## INTERMEDIATE POSITION

3. The NBS bypass switch is shown here in the intermediate position. Notice that the blade is in contact with the bridging contact, only. The impedance of the NBS current limiting resistors solely eliminates the high circulating current in the series winding. These resistors are lab and field proven to withstand 600 Amps during the transfer operation.


## CUT-IN POSITION

4. The NBS bypass switch is shown here with the regulator now in service. The blade contacts the female clip while still on the bridging contact. This provides uninterrupted service to the customer. Interruption of voltage can cause magnectic contactors in large motors to drop out, thus requiring restarts.


## LineBOSS ${ }^{\text {TM }}$ NBS Switch Application Guidelines

Using a standard combination bypass disconnect switch, the voltage differential across the series winding in the regulator is shorted out during the switching sequence. This produces an extremely high circulating current when in the lower tap positions (not in neutral). The INERTIA NBS eliminates this high current by placing resistance in series with the regulator series winding. The maximum boost or buck voltage differential is limited to 1200 volts ( 600 A rating $\times 2$ ohms).

The maximum switching position for a given regulator can be determined by the calculations shown:

1. Determine the voltage change per step of the regulator or booster transformer:

Voltage change/step $=\frac{(\text { Line voltage }) \times(\text { Max. boost or buck \%) }}{\text { Number of tap positions }}$
2. Determine maximum boost or buck tap position:

Maximum tap position 1200 volts
Voltage change per tap
3. Determine maximum current at tap position 1 :

Max. Circulating Current $=\frac{\text { Voltage change/step } \mathrm{x} \# \text { tap positions }}{\text { NBS switched series resistance }}$

Example: Line voltage is 13,800 volts, $10 \%$ max. boost or buck with 16 positions boost or 16 positions buck.
$\frac{13,800 \mathrm{~V} \times 0.10}{16 \text { tap positions }}=86.25$ voltage change per tap position
$\frac{1,200 \text { volts }}{86.25 \text { Volts/tap position }}=13.9$ tap positions
$\frac{86.25 \text { Volts } \times 1 \text { tap position }}{2 \text { ohms (NBS resistance) }}=43.1 \mathrm{~A}$ max. circulating current
Conclusion: The NBS will safely switch this $13,800 \mathrm{~V}$ regulator at tap position 13. At step one, where the circulating could be as high as $43,125 \mathrm{Amps}$ based on 0.002 ohms series winding impedance, the current is mitigated to 43.1 amps while switching.

NOTE: Always attempt to return the regulator to neutral before switching. This device is not intended to change the safety or standard operating practice of switching regulators.

The NBS switch allows an added margin of safety when switching regulators. When neutral position can not be definitely confirmed, the NBS will allow safe switching in the "off-neutral" position as long as the differential voltage across the transformer series winding does not exceed 1200 V .

INERTIA's NBS noninterrupting bypass switch, protects personnel and equipment, and eliminates the downtime and other costs associated with taking an outage to switch regulators, fixed or auto-booster transformers. It provides additional personnel and equipment safety in line distribution and substation applications.

LineBOSS ${ }^{\text {M }}$ NBS Selection Guide Non-interrupting
Bypass Switch $\rightarrow$ NGSET R T T

Voltage and Current Rating
5 kV , ( 110 kV B.I.L.) $600 \mathrm{~A}=06$
15.5 kV , ( 110 kV B.I.L.) $600 \mathrm{~A}=16$
25.8 kV, ( 150 kV B.I.L.) $600 \mathrm{~A}=26$
38.0 kV, ( 200 kV B.I.L.) $600 \mathrm{~A}=36$

Insulator Type
Silicone rubber $\left(3.0^{\prime \prime} B C\right)=S$
Porcelain (3.0" BC) $\ldots \ldots .=\mathrm{P}$
Crossarn Material
Galv. steel $=S$
Aluminum $=A$
Fiberglass $=F$
No Crossarm $=X$
(pole mounted or existing structure)




Diagram of Connection, Delta Construction


## Open-Delta Connection

This drawing is for illustrative purposes only and therefore; may, or may not reflect the current revision of this drawing. Please request the current revision from the factory.

| INERTIA ENGINEERING | Material: |  | Description: <br> NBS Schematic Wiring Diagrams Delta Connections |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Finish |  |  |  |
|  | Scale: | NTS | Drawing No:$040927-1 \mathrm{M}$ | Revision: |
|  | Drawn by: |  |  |  |
|  | Date: | 09/27/04 |  |  |

Diagram of Connections, Delta Construction (continued)



Reg 1
Reg 2

This drawing is for illustrative purposes only and therefore; may, or may not reflect the current revision of this drawing. Please request the current revision from the factory.

| /NERT/A ENGINEERING | Material: |  | Description: <br> NBS Schematic Wiring Diagrams Delta Connections |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Finish |  |  |  |
|  | Scale: | NTS | Drawing No:040927-2M | Revision: |
|  | Drawn by: |  |  | $\bigcirc$ |
|  | Date: | 09/27/04 |  |  |



Reg 3

Wye Connection on 4-Wire Circuit


Wye Connection With Stabilizing Bank
This drawing is for illustrative purposes only and therefore; may, or may not reflect the current revision of this drawing. Please request the current revision from the factory.

| /NERT/A ENGINEERING | Material: |  | Description: <br> NBS Schematic Wiring Diagrams Wye Connections |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Finish |  |  |  |
|  | Scale: | NTS | Drawing No:040927-3M | Revision: |
|  | Drawn by: |  |  | 0 |
|  | Date: | 09/27/04 |  |  |

The LineBOSS ${ }^{\text {m" }}$ loadbreak grounding switch, GBS, is uniquely designed to provide loadbreak, open gap clearances and line grounding for applications in substations or pole line switches. The GBS is available for two arm substation construction with switch bases manufactured to adapt to existing structures, or factory unitized on a single steel crossarm. The GBS is available with fused disconnects for additional system safety requirements. Control mechanisms are built with safety key interlocks to prevent the isolator (loadbreak) switch and the grounding switch from errant closure of both switches.

## STANDARD FEATURES

Continuing the INERTIA LineBoss product line, the GBS is made to ANSI and Inertia standards to provide the most rugged switch available with the following features:

- Solid platform with a $1 / 4^{\prime \prime}$ thick steel base
- All ferrous components are hot dip galvanized
- Insulators are station post insulators either silicone or porcelain with 3 " bolt circle
- All components in the current path through the switch are substation grade copper, silver-plated throughout
- Terminal pads are tin-plated for compatability with all types of commonly used connectors (copper, tinned copper, aluminum, bronze etc.)
- Contact clips are reverse loop design for greater contact force during high momentary currents
- Loadbreak options from arc whips, AmpRupterTM expulsion tube interrupter and the $\mathrm{AmpVac}^{\text {TM }}$ vacuum bottle interrupters.
The GBS shares all of the features of the LineBoss" ${ }^{\text {m }}$ conventional sidebreak switch. See LineBOSS LBS Features \& Benefits for additional information.


## SWITCH RATINGS:

Voltage Class: $15 \mathrm{kV}, 25 \mathrm{kV}, 35 \mathrm{kV}, 46 \mathrm{kV}$ \& 69 kV Continuous Current Class: 600 A, 900 A \& 1200 A.

## STANDARD CONFIGURATIONS

- Pole mounted for distribution applications
- Frame mounted for substation applications



Note: Consult the factory for any options not listed, including; arrestors, sensors, support brackets etc..




| PHASE DIMENSIONS |  |  |  |
| :---: | :---: | :---: | :---: |
| DIMENSION | 15 kV | 25 kV | 35 kV |
| A | 20.000 | 24.000 | 28.000 |
| B | 66.500 | 72.500 | 86.000 |
| C | 36.000 | 36.000 | 48.000 |
| D | 62.500 | 68.500 | 82.000 |
| E | 12.000 | 16.000 | 20.000 |



This drawing is for illustrative purposes only and therefore; may, or may not reflect the current revision of this drawing. Please request the current revision from the factory.

| INERTIA ENGINEERING | Material: |  | Description: Fused Grounding Switch |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Finish |  |  |  |
|  | Scale: | NTS | Drawing No: <br> 6400GM | Revision: |
|  | Drawn by: | TV |  |  |
|  | Date: | 09/10/07 |  |  |

