R&M OF 220KV / 132KV SWITCHYARD ....an Experience
The TTPS switchyard was commissioned during 1967-69 for 14 bays in 132KV system and 5 bays in 220KV system. The balance 8 bays in 220KV system commissioned during 1979-83.

This switchyard is heart of the Orissa Grid for which state load dispatch center (SLDC) was functioning from TTPS till take over of plant by NTPC in June-1995.

The Switchyard was operated and maintained by M/s GRIDCO (former OSEB) till take over by NTPC in Sept.2000 ( S/Y was taken over in Sept’2K).
132KV SYSTEM HAS 2-BUS EQUIPPED WITH

- Bulk Oil circuit breaker, Westing House, USA make.
- Vertical operating single break manual isolator, Westing House make.
- Main & stand by Bus (stranded cupper conductor of overall dia 34 mm)
- CTs are OCB bushing mounted, No line CT or CVT provided. Only coupling condenser with wave trap provided for carrier communication & inter tripping.
- Bus PT of GE, USA makes.
- Protection provided was of Westing House make electromechanical type.
220KV SYSTEM HAS 2-BUS EQUIPPED WITH

- BULK oil CB Westing House USA make for 2 ICT Bays.
- Vertical ABCB HBB make for 6 bays.
- Horizontal ABCB HBB make for 2 bays.
- SF6 breaker ABB make for 3 bays.
- The isolators are of vertical break (WH) & horizontal double break of Hivelm make with manual operation.
- Main & stand-by Bus (ACSR Twin zebra)
- In case of OCB the CT were bushing mounted for balance 11 bays CTs were ABB/BHEL make.
- Bus PTs were BHEL make.
- Protection provided are of Westinghouse make electrometrical relay/English Electric make MM3V scheme/English Electric make MM3T scheme.
PROBLEM FACED IN SWITCHYARD BEFORE R&M.

**HOT SPOT:**
- The 132 KV Bus conductor was getting heated up.
- The Bus conductor strings were snapping.
- Isolator contacts were getting heated up.

**CIRCUIT BREAKERS:**
- 2nos. 132KV OCB and 01 no. vertical ABCB failed.
- Contact resistance, breaker timing was beyond the limit.
- Air leakage common problem in pneumatic drive mechanism.
- No spare available of both OCB & ABCB.
- No service personnel available for OCB. ABB has stopped service support for ABCB.
- **ISOLATOR:**
  - The proper closing/opening of the isolator was operating person dependant.
  - Isolator contacts were getting heated up.
  - Contact resistance was too high.
  - The driving mechanism couplers were breaking.
PROBLEM FACED IN SWITCHYARD BEFORE R&M.

- PROTECTION-
  - Multiple units tripping with station blackout has occurred several times due to non-proper operation of relays. (43 tripping resulting 60.70 MU loss in 95-04)
  - No Bus Bar/LBB protection available.
  - No Event Logger, Disturbance recorder.
  - Line synchronisation not possible from TTPS end
**PROBLEM FACED IN SWITCHYARD BEFORE R&M.**

- **CT/PT-**
  - One number of PT and a number of CT has failed during 1995-2000 resulting multiple unit tripping. Energy metering accuracy was very low.

- **GENERAL:**
  - The proper drawing and documents are not available. Number of site modification has been done in control, protection, metering circuits without any change in the original drawing. It was very much time consuming for fault finding.
Considering the above problems it was decided to go for the complete R&M of TTPS switchyard and order was placed on M/s BHEL Ltd.(TBG) on 15.10.2004.
FACTORS CONSIDERED DURING AWARD:

- Old structure to be retained.
- Old earth mat to be retained.
- Old LAs to be retained.
- Old PLCC panels are to be shifted to new Control Room.
- CB, Isolators are to be replaced at original position due to space constraint.
- New CT, CVT are to be provided.
- Bus conductor to be changed to ACSR double-MOOSE with associated clamps and connectors.
FACTORS CONSIDERED DURING AWARD:

- Control, protection, metering panels are to be procured and install in newly constructed control room building which will accommodate ACDB, DCDB, Battery, Battery charger, Air conditioning system and fire fighting system.

- Separate cable trenches are to be made for new system, so that there will not be problem with old system.

- Bus post insulators with lattice structure to be replaced by solid core insulators with pipe structure.

- The protection scheme changed to state of art numerical relays with Bus bar protection, GPS, EL & DR.
After award of contract it was decided to replace the Duplex control Board of 4 x 60 MW Stage-I units. This duplex board contains the protection of G, GT, UAT(Westinghouse make electromechanical relay 87G, 87GT, 87UAT, 40G, 64G, 21G, 51NGT, 60G) and electrical controls of Unit, Unit Aux, Station Aux.
THE MAJOR IDENTIFIED CHALLENGES

- Erection is to be done keeping **one bus live**.
- There is no space for vehicle movement inside the switchyard.
- Isolators are installed at an elevation of 21mtrs, 14mtrs and 10mtrs without any support structure on top.
- All equipment erection to be done manually using derrick. Derrick support stay ropes movement restricted by live line clearance.
- Availability of shutdown of adjacent bay from M/s GRIDCO.
THE MAJOR IDENTIFIED CHALLENGES

• Foundations to be made after dismantling of existing equipment.
• Rock is encounter after a depth of 300-800mm and to be excavated using pneumatic breakers.
• The line breakers are under Bus-II and Unit, Stations Tr. Breaker are under Bus-I. So it is not possible to do the simultaneous work on both though they are in same cluster to keep one Bus in service.
• Frequent Bus change over is required for erection of equipments.
THE MAJOR IDENTIFIED CHALLENGES

- GRP is to be located at old switchyard control room after R&M of 220 KV line bays.
- ECP to be erected after removal of old DUPLEX panels.
- Additional structure to be made for cable routing from switchyard to GRP (Road Crossing in between Switchyard & TG hall).
- In existing DUPLEX panel only one number Sync relay provided for all 04 units.
- Due to Sync Relay constrain #3 & #4 R&M has to be done first.
As the R&M is to be carried out in live switchyard and keeping one BUS live brain storming was done involving NTPC CC-PE, COS, Site & BHEL Engineering, BHEL site & Erection agency to finalise the duration & sequence of shutdown.

The pre shutdown activities are identified and planned to complete before availing shutdown.

Bus-bar protection planned to be commissioned after completion of all bays in one voltage level.
ERECTION PLANNING

- The pre-shutdown activities such as commissioning of 415 V AC & 220 V DC system, erection of Bay Marshalling Kiosk, control cable laying termination from Control Room to Site
- The clusterisation of bay was done considering the bays which are under single bus conductor. The tentative sequence and period of S/D as decided in the above meeting was as follows.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of the Bay</th>
<th>Bay No.</th>
<th>Duration of S/D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>220 JODA# 1 &amp;2</td>
<td>26,27</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>220 KV KANIHA &amp; ST # 2A</td>
<td>24,25</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>220 KV BUS COUPLER</td>
<td>19</td>
<td>26</td>
</tr>
<tr>
<td>4</td>
<td>220 AT#1, 2, 132 KV AT#1,2 &amp; 132 KV ANGUL</td>
<td>12,13,14,15 &amp;16</td>
<td>35</td>
</tr>
<tr>
<td>5</td>
<td>220 KV MERAMUNDLI #1 &amp; UNIT # 5</td>
<td>17,18</td>
<td>26</td>
</tr>
<tr>
<td>6</td>
<td>132 KV BUS COUPLER</td>
<td>9</td>
<td>35</td>
</tr>
<tr>
<td>7</td>
<td>220 KV NALCO, UNIT # 6, MERAMUNDLI #2, ST # 2B</td>
<td>20,21,22,23</td>
<td>51</td>
</tr>
<tr>
<td>8</td>
<td>132 KV UNIT #3 &amp; 4</td>
<td>10,11</td>
<td>35</td>
</tr>
<tr>
<td>9</td>
<td>132 KV DUBURI - 1 &amp; 2, CHAINPAL, UNIT #1 &amp; 2</td>
<td>3,4,5,6,7&amp;8</td>
<td>62</td>
</tr>
</tbody>
</table>
EXECUTION

- **CLUSTER-1 (Bay no 26,27) TTPS-JODA_I &II lines**
  - Started on Date: 10.11.08
  - Finished on Date: 27.11.08
  - Problems faced during Execution:
    - Isolator base frame holes are not matching with the existing structure
    - BPI foundation bolts which are to be reused sheared during removal of lattice structure
EXECUTION

- Cluster-2 (Bay no 24,25) TTPS-Kaniha line & ST-IIA
  + Started on Date: 20.12.2008
  + Finished on Date: 21.01.09
  + Problems faced during Execution:
    + Isolator base frame holes are not matching with the existing structure
    + Both the bay equipments are under different bus simultaneous job not possible keeping one bus live
EXECUTION

Cluster-3 (Bay no 19) 220 KV bus coupler

- Started on Date: 28.01.09
- Finished on Date: 04.03.09
- Problems faced during Execution:
  - As bus change over is to be done in phase-I Bus-1 isolator replaced and change over done with old breaker & protection.
  - Bus PTs are in this bay and needs to be removed. Hence new BUS CVT installed in other suitable location and secondary supply extended up-to the non-renovated bays.
Cluster-4 (Bay no 20, 21, 22, 23) ST-IIB, Meramundli-II, Unit#6, Nalco line

- The shutdown was synchronized with the COH& DDCMIS renovation of unit#6.

- **Started on Date:** 20.06.09, **Finished on Date:** 27.07.09

- **Problems faced during Execution:**
  - The shutdown of bay no 21 (TTPS-Meramundli-II line) & 23 (TTPS-NALCO line) could not be issued byGRIDCO. However, the Bus conductor for all 4 bays in both Buses replaced with contingency arrangement for bay 21 & 23.
  - Isolators are at a height of 21 mtr,
  - Live line clearance to the Isolator operating down pipe was only 1700 mm inplace of required 2300mm.
EXECUTION

- **Cluster-5 (Bay no 17&18 ) Meramundli-I,Unit#5**
  - The shutdown was synchronized with the COH & DDCMIS renovation of unit #5.
  - **Started on Date:** 26.07.09 , **Finished on Date:** 18.08.09

- **BUS CONDUCTOR REPLACEMENT**
  - After completion of R&M of above mentioned bays the 132 KV Bus-I & part of 132 Bus-II were replaced during the AOH in f.y. 2009-10 of the 60 MW stage-I units with contingency arrangement for old isolator jumpers.
EXECUTION

- Cluster-6 (Bay no 12,14&15) 132 kv TTPS-Angul line & Auto-Transformer-I (1no 220 KV & 2 nos 132 KV bay)
- As the shutdown of both the ICTs could not be issued by GRID it was separated
- Started on Date: 11.11.09, Finished on Date: 24.12.09
  + Problems faced during Execution:
- Removal of 220 KV OCB (approx wt 34 MT) was challenging. Oil (14 MT) was drained. All six bushings are dismantled & all poles and base frames were separated. Approach made for hydra crane by dismantling isolator structures.
EXECUTION

- Cluster-7 (Bay no 13,&16 ) Auto-Transformer-II(1no 220 KV & 1 nos 132 KV bay)
  - Started on Date: 31.12.09 , Finished on Date: 08.02.10
    - Problems faced during Execution:
  - Removal of 220 KV OCB (approx wt 34 MT) was challenging. Oil (14 MT) was drained. All six bushings are dismantled & all poles and base frames were separated.
**EXECUTION**

- Shifting of control & protection panels of 2 nos. of 132/3.3 KV 20 MVA Station transformer (ST-12 & ST-34) to new CRB
- Started 01.03.2010 finish 30.03.2010
- As the control panel for both the transformers are common & both can not be taken under shutdown simultaneously ST12 relay panel was shifted and commissioned with contingency control arrangement.
- After completion of shifting of ST34, The contingency arrangement of ST12 normalised.
EXECUTION

- Shutdown on 220 KV balance 2 lines (NALCO & Meramundli-II) issued May’2010 and R&M executed without any constraint as such type feeders has already been renovated earlier.

- Only constraint was erection of a beam on the gantry for accommodation of bypass isolator in NALCO bay as originally it was not there.

- 132 KV balance 03 line bays shutdown issued individually and R&M completed in 21 days each.

- 132 KV Bus coupler bay renovation done during June-July 2010
EXECUTION (UNIT ECP,GRP,BAY EQUIPMENT)

- 132 KV unit bays renovation along with ECP & GRP replacement has been synchronised with AOH plan of F.Y.2010-11.
- Accordingly shutdown on #3 & #4 taken on 19.08.2010.( 21 days plan).
- To achieve the target the following activities has been done.
- Scheme of ECP,GRP studied and all logics, cable schedules, interconnection with Turbine, Boiler was finalised with CC-OS,CC-PE,BHEL site, BHEL Engineering.
EXECUTION (UNIT ECP, GRP, BAY EQUIPMENT)

- ECP equipments, Internal & interpanel wirings were checked and kept ready for erection and termination.
- GRP was erected and all cabling and possible terminations were completed. Relay configuration & healthiness checked.
- Cables for ECP were laid and kept below the Unit Control Room.
- All the 3.3 KV, 415v control & instrumentation are arranged for local operation from switchgear.
- The isolation of existing duplex panel for DC/AC, Bus PT were identified and marked for quick isolation.
EXECUTION (UNIT ECP, GRP, BAY EQUIPMENT)

- In switchyard Cable laid and terminations where possible completed. BMK commissioned.
- After shutdown Duplex panel was isolated. Supply rechecked and permitted BHEL for dismantling.
- All jobs were listed, distributed with responsibility and explained up to the level of electrician for trouble free execution.
- Constraints:
  - Only one person can work at a time in each panel.
  - Breaker foundation to be made after dismantling of old OCB.
EXECUTION (UNIT ECP, GRP, BAY EQUIPMENT)

- #3 & #4 renovation completed in 21 days.
- In spite of all precaution we faced synchronisation problem due to limitation of the Sync relay provided. The relay provided in ECP was SKE-11 phase Angle 10 deg. Though the voltage and frequencies were matching the relay was not permitting sync. The waveforms for incoming & running voltages were checked found a phase angle shift of 18 deg. Crosschecked with the original Westing house sync relay (XT7-C) which was found to be of phase angle 20 deg. Relay replaced with 20 deg SKE-11 and unit synchronised.
EXECUTION (UNIT ECP,GRP,BAY EQUIPMENT)

- #2 shutdown taken on 01.11.10 and completed on 18.11.2010.
- #1 shutdown taken on 02.11.10 and synchronised on 10.12.2010. (delayed due to Turbine job)
- The learning of #3 & #4 ECP,GRP replacement helped to reduce the shutdown by 3 days.
**Benefits of Switchyard R&M**

- Avoid multiple unit tripping & station outage
- No Hot-spot in renovated bays
- Isolator operation is reliable
- Complete System became reliable.
- Ease of Fault analysis due to EL & DR.
- Energy metering can be achieved as per the Electricity Act-2003 i.e. at point of connection with GRIDCO
LEARNINGS

- Use of old structure to be avoided as dimensional matching of structure to new equipment is very difficult.
- Possibilities of making new switchyard to be explored rather than going for Complete R&M of switchyard to save time and duration of shutdown.
- Before awarding detail engineering to be completed to avoid changes in scope. In TTPS switchyard R&M already 9 amendment to contract has been made and final amendment is required for contract closing.
PHOTO GALLERY
SAFETY PEPTALK BEFORE START OF JOB EVERYDAY MORNING
Damaged bus conductor with PG clamp

Damaged bus conductor repaired with PG clamp
OLD ABCB 220 KV

NEW SF6 BREAKER 220 KV
220KV BULK OIL CIRCUIT BREAKER
OLD OCB 132 KV

NEW SF6 BREAKER 132 KV
BUS CONDUCTOR REPLACED WITH CONTINGENCY ARRANGEMENT
OLD ISOLATOR 220KV

NEW ISOLATOR ON OLD STRUCTURE
NEW CONTROL PANELS
THANK YOU...