System Planning & Control

PLANNING, ORGANIZING, DIRECTING, CONTROLLING

“The ancestor of every action is a thought.” - Ralph Waldo Emerson
The Company’s Safety Policy in a Nut-Shell

- No Schedule is of such Consequence
- No Service so Urgent
- No Emergency so Great
- No Job so Important
- That we can’t take the time to work safely
System Planning and Control Division

Our Objectives

1. To develop operational, medium term and strategic plans for the optimal development and operations of the Generation, Transmission and Distribution Systems.

2. To provide and maintain a safe, stable and reliable power supply to our customers through the efficient utilization of all available generation, network resources, technology and effective load management.
Who do we interact with?

- I.P.P.s
- External Emergency Centers
- Large Customers
- Senior Management
- Corporate Comm. Dept.
- Power Stations
- Operation Personnel
- CALL CENTRE

System Control
What do we do?

- Managing the delivery of the product over the transmission and distribution network
- Ensuring the quality and cost effectiveness of the product to our customers
- Planning for and managing the implementation of the expansion of the production and delivery capability of the business
Electricity from the generating stations is transported via the transmission and distribution network to our customers.

Customer Operations manage and maintain these networks as well as managing the day to day relationship with the customers.
Our Organization

SPC Division is organized into four crucial functional areas, geared to achieving our Business Mandate.
Grid Management and Planning

System Planning & Control

SYSTEM PLANNING DEPARTMENT

Integrated Expansion Plans
- Develop Short, Medium and Long term expansion plans for Gen, Trans and Dist

Decisions taken have the largest cost impact on the business

- Five Engineers – Gen and T&D Group

SYSTEMS CONTROL DEPARTMENT

Daily System Operations
- Network Optimization
- Fuel Management – over US$200M/yr Fuel Cost
- Emergency Operations (EOC)

- Fifteen Control Engineers operate in a Five (5) Shift system

OPERATIONS PLANNING AND IPP ADMIN

Daily Demand Forecast
- Outage Planning and Coordination
- Private Power Purchase Contract Administration – fixed cost value of over US$50M/yr
- SCADA/EMS & Application Support

- Five Engineers – Operations Planning and IPP Group
- Systems Administrator

ADMIN. SUPPORT

Daily administration, Clerical, Janitorial
System Planning

Activities can generally be classified in one of five broad areas, namely:

1. Research
2. Performance Monitoring and Analysis
3. Training and support
4. Planning, Forecasting and Modeling of the power system
5. Policy Formulation

Transmission Planning Activities

Distribution Planning Activities

1. Develop Distribution Medium Term Expansion Plan
   - Twenty year (10 yr. Detailed) long term plan that outlines the size, timing, and increment of future generating capacity required
2. Distribution Load Flow Analysis (Synergy – Stoner & Associates)
   - Conduct load flow analysis and recommend best approach under contingency situations
   - Analyze and resolve distribution system constraints and optimize feeder configuration for good power quality
   - Determine fault levels across the system for major system changes.
3. Under-frequency Scheme and Reserve Margin reviews
Operational Planning & IPP Administration

- Long term plans filter into medium and short term plans
  - Here we work in the annual plans of the Generation, IPP and T&D Groups
  - From the annual plans we focus on the monthly plans

- We evaluate the plans based on the following criteria
  - Safety and Security of Systems and Personnel – simulations are done at this stage and contingency analysis (what if scenarios).
  - Economics – least cost of operations to the company’s bottom line targets managing power quality and guaranteed standards of supply
Operational Planning & IPP Administration

- Load forecasting

Load Forecast and Unit Commitment Schedule is sent to the control room for execution.

Wednesday 01/10/17
System Control – Nerve Centre of JPS Operations

- **MINIMIZE THE VARIABLE OPERATING COST (FUEL-AND NON-FUEL) BY EFFICIENTLY DISPATCHING GENERATING UNITS**
- **IMPLEMENT PLANT OUTAGES TO ENSURE CONTINUOUS ADEQUACY OF POWER SUPPLY AND MINIMIZE THE IMPACT AND COST OF INTERRUPTION TO CUSTOMERS**
- **PRESERVE THE QUALITY AND RELIABILITY OF THE POWER SUPPLY**
- **MINIMIZE THE IMPACT OF SYSTEM EMERGENCIES TO CUSTOMERS**

**Transmission & Distribution Duties**

- **MONITORING LOADING ON INDIVIDUAL CIRCUITS**
- **FACILITATE / DIRECTING PLANNED OUTAGE**
- **RESTORING SYSTEM TO NORMAL AFTER FAULTS**
- **ACCEPTING NEW EQUIPMENT ON SYSTEM**
- **RE-CONFIGURING SYSTEM TO ENSURE GOOD POWER QUALITY & BOOST SYSTEM SECURITY**
- **REPORTING SYSTEM DEFECTS TO RESPONSIBLE DEPARTMENTS**

**Generation Duties**

- **DISPATCHING MW & MVARS TO MAINTAIN QUALITY POWER SUPPLY TO CUSTOMERS**
- **REAL-TIME ECONOMIC LOAD DISPATCHING**
- **DIRECTING RUNNING HOURS OF INDIVIDUAL GENERATORS ECONOMICALLY TO ENSURE SYSTEM SECURITY & SPINNING SPARE**
- **PREPARING PLANT CAPABILITY REPORT**
- **COORDINATING EMERGENCY & PLANNED OUTAGES**

**Monitoring Activities**

- Equipment loading
- Voltage levels
- System frequency
- Generating units’ performance
- Equipment failure rate
- System load growth
- Individual circuits’ performance
- Adherence to operational policies
- Adherence to safety rules
- Telecommunication performance

**Controlling Activities**

- All switching on high voltage system 650V - 138 KV
- Commissioning of new equipment onto the power grid.
- Synchronizing/removal of generating units.
- Load shed/restore exercises.
- System restoration after fault condition.
- Technical updates to senior management.
- Fault analysis.
- Switching Authorization Exercises.
SCADA/EMS – How it works

Scada Functionality
- Equipment loading - volts, amps, MW, Mvar
- Operating voltages
- System frequency
- Limits violation
- Switchgear status
- Relay operation
- Communication failure
- Supervisory control (open/close)
- Trending
- Alarm logging
- Event retrieval
- Automatic load shed / restoration

EMS Functionality
- **Generation Control**
  - Economic Dispatch (ED)
  - Automatic Generation Control (AGC)
- **Production Planning**
  - Resource Scheduling (RS)
  - Neural Network Load Forecasting (NNLF)
- **Network Analysis**
  - Contingency Analysis (CA)
  - Dispatcher Load Flow (DLF)
  - Optimum Power Flow (OPF)
  - State Estimator (SE)
# DISPATCH VARIANCE CHART

## Generation Current Performance

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>50.0888 Hz</td>
<td>92.66 US$/MWHr</td>
<td>592.34</td>
<td>525.34</td>
<td>40.42</td>
<td>32,021.96</td>
<td>32,276.56</td>
<td>(254.60)</td>
</tr>
</tbody>
</table>

### Details

<table>
<thead>
<tr>
<th>Dispatch Mode</th>
<th>Output</th>
<th>Economic Dispatch (MW)</th>
<th>Economic Dispatch Mode</th>
<th>Economic Dispatch Variance (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
<td>485.09</td>
<td>154.53</td>
<td>0.95</td>
<td>592.34</td>
</tr>
<tr>
<td><strong>JPSCo.</strong></td>
<td>392.44</td>
<td>105.76</td>
<td>0.96</td>
<td>474.10</td>
</tr>
<tr>
<td><strong>iPP</strong></td>
<td>92.65</td>
<td>48.77</td>
<td>0.84</td>
<td>118.24</td>
</tr>
</tbody>
</table>

### Recommendation(s):

- Dispatch Hunts Bay GT5 Down
- Dispatch JPPC Up
- Dispatch Hunts Bay B6 Up
- Dispatch Old Harbour OH2 Down

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**Note:** Remember: Press F9 to refresh the chart.
Tools and Capability

- **Tools Used in Day to Day Operation**
  - ABBNM Ranger VIII SCADA/EMS SYSTEM
  - WesCouger Unit Commitment and Dispatch Programme

- **Control Capability**
  - Monitor and control 88% of the transmission network down to the feeder recloser.
  - Have Some control of feeder sections through DA switches.

- **Long term planning Optimization tools**
  - WASP-Generation
  - CYME-Transmission
  - Synergy-Distribution
Load Shedding – Under-frequency

Under-frequency Load Shedding
A. For loss of large generator, an under-frequency scheme has been implemented.
B. As load exceeds generation, frequency reduces from 50Hz. Some demand must be curtailed to restore the generation-load balance
C. Scheme has four (4) stages which shed various demand increments at predetermined frequency set-points
D. Distribution Feeders are chosen and equipped with automatic disconnect mechanisms that operate at these frequency set-points
E. Since it is more likely that first two stages operate more frequently than the last two stages, rotation of the feeders is done to limit the impact on any one set of customers

<table>
<thead>
<tr>
<th>Stage</th>
<th>Frequency Set-point</th>
<th>Est. MW Shed at Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49.2 Hz</td>
<td>52.4</td>
</tr>
<tr>
<td>2</td>
<td>48.9 Hz</td>
<td>54.6</td>
</tr>
<tr>
<td>3</td>
<td>48.5 Hz</td>
<td>59.5</td>
</tr>
<tr>
<td>4</td>
<td>48.1 Hz</td>
<td>71.3</td>
</tr>
</tbody>
</table>

Scheme crucial since a progressive generation – load imbalance if not corrected leads to a total system shutdown
Load Shedding – Block (Manual)

Block (Manual) Load Shedding

A. During periods of known generation shortfall, manual load shedding (demand curtailment) is applied to maintain a generation-demand balance.

B. ALL distribution feeders are assigned in one of nine (9) blocks A to I.

C. Depending on the magnitude of the generation shortfall and the demand, single (up to 25MW), double (25 to 50MW) or triple (> 50MW) block load shedding is applied.

D. The extent of disturbance to critical loads (hospitals etc.) is minimized.

E. The duration of the interruption depends on the magnitude and duration of the generation shortfall.

F. Rotation of the blocks is predetermined by the scheme design.

G. Depending on the # of customers on each feeder, this type of demand interruption can significantly impact SAIDI and SAIFI.

<table>
<thead>
<tr>
<th>Triple Block (&gt; 50MW)</th>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
</tr>
</thead>
<tbody>
<tr>
<td>6am – 11am</td>
<td>GBA</td>
<td>AFI</td>
<td>EBH</td>
<td>IHF</td>
<td>DAC</td>
<td>HFB</td>
<td>GBA</td>
</tr>
<tr>
<td>11am – 3pm</td>
<td>EFI</td>
<td>BGD</td>
<td>FCA</td>
<td>AGD</td>
<td>EHB</td>
<td>ICD</td>
<td>EFI</td>
</tr>
<tr>
<td>3pm – 6pm</td>
<td>ACD</td>
<td>CHE</td>
<td>GDI</td>
<td>BIH</td>
<td>FCA</td>
<td>AGF</td>
<td>ACD</td>
</tr>
<tr>
<td>6pm – 11pm</td>
<td>BGE</td>
<td>DIG</td>
<td>HAB</td>
<td>CFE</td>
<td>GIH</td>
<td>BDE</td>
<td>BGE</td>
</tr>
</tbody>
</table>
The EOC Central

Main Functions

- Storm Tracking
- System Shutdown
- System Restoration
- System Stability
- Provide System Updates
- Co-ordinate work plan

Organized in Teams

- Administration Team
- Generation and IT Support Team
- EOC Operations Team
- T&D Support Team
Thank You

Questions?