3.7 PREPARE COMMUNICATION PLAN
The purpose of communication plan was to reduce conflict and communication problems and to help in the clarification of the roles and responsibilities of each project team member. Any communication shall be documented on the company’s communication form. Also any communication which is verbally given shall be documented.

3.8 SCHEDULE KICK-OFF MEETING
This was a project kick-off meeting and that included all contractors, vendors, project team leaders and project sponsors. The reason for the kick-off meeting was to address the scope of the project and timeline of the project to make sure everyone is on the same page. After the contract was awarded another meeting was arranged with the successful bidder to go over the scope and schedule. The following was discussed at the kickoff meeting project mobilization, unit shut down, tagging, isolation, turbine-generator disassembly and risk management.

3.9 PROJECT EXECUTION AND CONTROL
Project Team leaders controlled the project to achieve the following project objectives, resources to meet project and the triple constraints cost, schedule, scope statement and quality
This was achieved by controlling the following evaluating daily progress tasks and deliverables by measuring budget, time and quality, proactively resolve project issues and changes to scope, set-up periodic and structured reviews of the deliverables establish a centralized project control file

3.10 TEAM BUILDING/TEAM DEVELOPMENT
Team building started at the project initiation stage and it was at this stage that the team work together and the team leader used day to day informal processes like to help build the team. The informal processes are good communication skills, flexibility and adaptability, responding and adapting to changing situations, ability to influence and improve the performance of the team members, team leader should appreciate and celebrate team achievements.
3.11 PROGRESS MEETING
Meetings are the most effective tools to communicate and control the project. The following are the types of meetings that was conducted throughout the course of the project. In order for these meetings to be effective the following suggestions was applied, a time limit was set for the meeting, meetings were scheduled a day in advance unless it was an emergency meeting, had a purpose for the meeting and created an agenda with team input, distributed an agenda ahead of the meeting time, team members knew in advance what their responsibilities were, the meeting was chaired and led with a set of rules and those rules were known to team members, assigned deliverables and time limits for all tasks that result from the meetings, and assigned follow-up tasks with deadlines to team members.

3.11.1 Stand-Up Meetings
This type of meeting was encouraged and held everyday if possible for a period of 15 minutes. In order not to have a large crowd at the meetings, each team held meetings at different locations. The purpose of the stand-up meeting was just a reminder of safety issues and also going over the work plan for the day. Problems that needs to be investigated further, the team leader followed it up and resolved it with the individual.

3.11.2 Team Meetings
Team Meetings should was held every week on a day selected by the team leader of the various teams and the following issues were discussed, progress reporting, schedule control, change orders, and reviewing of contingency plans should the scope or schedule change

3.11.3 Problem Solving Meetings
The plant manager requested these meetings any time there was a need to have all the various team leaders, vendors and contractors together to discuss pressing issues and the following were some of the issues that was deemed pressing -vendor missing a delivery time, a contractor missing a deadline, unsafe work practice and unsafe work environment.

3.11.4 Meeting with management
Because the project execution time was 12 weeks and in order to keep management well informed.

Project meetings was held with management every week and the following were issues that were discussed with management. Budget- A thorough discussion of the budget situation was communicated with management and Labor and manpower allocation

3.11.5 Meeting with contractors
There was daily meetings between the contractors and team leaders and also weekly meetings between the plant manager, project sponsor, contract administrators, team leaders and contractors to discuss the progress of the project. Any deviation from the scope of the project was addressed.

3.12 RISK MANAGEMENT AND CONTROL
Risk management involved identifying and measuring risk, and developing, selecting and managing option for handling those risks. One of the responsibilities of the team leader was revisiting the risks identified during the planning stage of the project and verified if there has been any change. Most of the risk associated with this type of project is the inability to control change orders. Though changes are inevitable, the team leaders came up with strategy to control the risk. In order to control the risk the team leaders did influence the factors that created change, made sure all changes are necessary before it is approved, and managed the changes when they occur.

When a change was being analyzed, consideration was directed on its impact on the triple constraint (time, cost and quality). The plant manager was responsible for approving all change orders that did impact the cost, schedule and performance of the project.
3.13 PROJECT CLOSE OUT
After the successful completion of the project the following was done all files relating to the project was kept in the project archives, obtained a formal acceptance from the plant manager at the close out meeting, each team leader evaluated the performance of his team and the plant manager evaluated the performance of the team leaders, completed lessons learned and released project team members and re-assigned them to other assignments.

3.14 FORMAL ACCEPTANCE
After the unit was synchronized to the grid, the plant manager called out a project close-out meeting and the purpose of that meeting was to receive a formal acceptance from the plant manager and all that have a stake in the project. At the meeting the project manager solicited for feedback from the project team about the performance of the contractors and also any lessons learned.

3.15 RELEASE TEAM MEMBERS
The team leader clearly communicated to the team leaders when the project will end, so that it will help them to get assigned to other project and also prevent the team members from staying long on the project or coming up with a strategy to prolong the project time. Project team leader had a party as a recognition programs

3.16 PREPARE WORK BREAKDOWN STRUCTURE-GENERATOR
ELECTRICAL INSPECTION AND TESTING
There will be a fall 10 week outage in October 2005 for a generator and exciter inspection and testing. The successful bidder which was Lovegreen provided all the necessary labor with plant union notification, tooling, rentals and all equipment necessary for the complete assembly and disassembly of the generator and removal of field. The generator stator, field and the exciter stator and field was inspected and tested. The detail scope included
Generator Cleaning, Testing and Inspection:

- Mobilized and travel to the site
• Cleaned high voltage bushings, connection rings and stand-up insulators
• Inspected high voltage bushings, connection rings and stand-up insulators for signs of heating, arcing or other damages
• Cleaned and inspect the generator field
• Performed electrical testing of the rotor field and that included insulation resistance, polarization index, winding resistance and pole balance
• Cleaned the collector rings
• Inspected the collector rings for signs of heating, arcing or damage
• Cleaned the stator core
• Inspected the stator core for signs of heating, insulation damage, arcing, water spots, oil deposits, water hose leaking or other damage
• Performed ELCID (ELECTROMAGNETIC CORE IMPERFECTION DETECTION) testing on the stator core
• Performed electrical testing of the stator winding and that included Insulation Resistance (IR), Polarization Index, Winding Resistance, Vacuum decay test, pressure decay test and capacitance mapping
• Performed wedge tightness check by means of manual tap test
• Performed RTD functioning test
• Cleaned generator brush rigging
• Inspected generator brush rigging for signs of heating, arcing or other damage

Alterrex Exciter Cleaning, Testing and Inspection:
• Mobilized and travelled to the site
• Cleaned Alterrex stator and rotor
• Visually inspected Alterrex stator and rotor
• Performed electrical testing of the stator and that included Insulation Resistance, Polarization Index and Winding Resistance

• Performed electrical testing of the rotor and that included the Insulation Resistance (IR), Polarization Index, Winding Resistance

Optional Stator Re-wedge:
• Performed as found electrical testing and that included the Insulation Resistance (IR), Polarization Index (PI), and Winding Resistance

• Performed as found ELCID (Electromagnetic Core Imperfection Detection) testing

• Removed all wedges, top fillers and ripple springs

• Inspected the slot corona protection of the top bars

• Cleaned and prepped the stator for re-wedge

• Installed replacement wedges and fillers

• Checked wedge tightness utilizing dial

• Performed the ELCID (Electromagnetic Core Imperfection Detection) testing on the stator core

• Performed electrical testing of the stator winding

3.17 PREPARE WORK BREAKDOWN STRUCTURE-TURBINE OVERHAUL DURING THE FALL OUTAGE

• HP Turbine section 1st stage nozzle box major repair

• HP turbine section diaphragms refurbishing

• IP turbine section diaphragms refurbishing

• HP-IP turbine section packing boxes N1, N2, N3 refurbishing

• LP “A” and “B” turbine section diaphragms refurbishing

• LP “A” and “B” N4, N5, N6, N7 steam packing casing
3.18 HOW CAN THE PROJECTED 410MW BE ACHIEVED

- Use the Generator Reactive capability curve to determine the maximum MW that can be achieved from the generator operating at a specified power factor
- Evaluate the results of the electrical inspection and testing of the generator during the October 2005 outage to see if the generator can withstand the increase in MW and MVA.
- Determine if the main step-up transformer has the capacity to handle the MVA due to the maximum MW considering losses through the transformer
- Determine if the Isolated Bus Duct has the capability to handle the increase in power (MVA)
- Determine the Turbine Cycle Efficiency, Turbine Cycle Heat Rate and the projected MW from the high pressure section, Intermediate Pressure Section and the Low Pressure section assuming that design steam parameters such as throttle pressure, throttle temperature, hot reheat temperature, reheat change in pressure is to be achieved or the turbine operated to design parameters after the dense package and boiler modification.
- Evaluate all the test data for the boiler, feed water heaters, condenser and air heater data to see if the equipment is still efficient to operate to achieve the projected MW increase.
FINDINGS

4.0 GENERATOR INSPECTION AND TESTING
The job consisted of a complete inspection of the generator and Alterrex inspection including removal of both generator and Alterrex field. The job was completed by the station electricians and Regenco Services, and myself (Plant Electrical Engineer) performed an electrical inspection of the generator stator, field and alterrex exciter field and rotor. The generator field was removed from the stator for inspection and testing. Ultrasonic testing of the rotor dove-tail areas revealed that there fretting and arcing at 85% of most of the areas which was caused by negative sequence current.

Visual inspections were also performed and electrical testing done on the rotor field and stator. The stator was found in good condition and there was minimal amount of greasing found on turbine end and at the nose ring. The end windings had an oil film of minimal amounts. The stator was cleaned and vacuumed out. The bushing box was opened, inspected, found to be in good condition and thoroughly cleaned before being closed. The whole stator, including the end windings, was wiped down with solvent and vacuumed before assembly.

The alterrex field was removed for inspection, cleaning and testing. The #7 and #8 alterrex bearings were cleaned, measured for proper clearances, found to be within tolerances as well as #9 and #10 bearings.

TIL1098 for stator cooling water leaks was performed. The stator bars were blown out with the HIT skid and a vacuum and pressure decay test performed on the stator windings with the stator coolant piping disconnected. The vacuum decay test is performed by drawing a vacuum on the stator coolant system inside the stator and then measuring the rise in pressure (loss of vacuum) in the system after an hour. The pressure decay test is similarly performed by pressurizing the stator system and then measuring the decay over a longer period of 6 to 24 hours. The HIT skid was used to blow down the stator at pressures of 20psig, 40psig, and 60psig for approximately 18hrs with the test hose that was connected to the
YFCD line and having the YCFF line blanked. The test was repeated and connected to the YCFF line and YCFD line blanked. The blow down was repeated. A hygrometer is placed in the YFCD drain line and another in the hit skid compressor discharge piping. This is how the dew point is monitored and by comparing the two readings to determine whether the stator is dry or not. After the stator was determined to be dry a vacuum was then drawn on the unit using the HIT skid pump. The vacuum was then drawn on the unit using the HIT skid vacuum pump. The vacuum was allowed to run all night till the following day 2 vacuum tests were performed. The winding was pressurized to 60psig to start the pressure decay test and the following morning the pressure was measured to be 58.1psig which shows an equivalent leakage of 2.89/day. The leakage rate is considered to be acceptable and not excessive. The stator capacitance test consists of measuring the capacitance of the stator bar end arms from a pre-placed electrode on the bar to the baffle stud. Measurements are taken on all top and bottom bars. The measured values are all compared and any relative high or low readings are all compared (+/-20% from average capacitance readings). Bar insulation that has been saturated due to a leak in the system will show up as an extremely high capacitance value. Saturation can lead to a failure of the insulation while the unit is on line.

The following electrical testing was Insulation Resistance (IR), impedance test, resistance test conducted on the stator and the rotor all showed acceptable values.

**4.2 MANUFACTURER’S DATA FOR THE GENERAL ELECTRIC GENERATOR**

- Rated MW: 416.5MW
- Power Factor: 0.85
- Rated Hydrogen Pressure: 45PSIG
- Rated MVA: 490MVA
- Stator Amperes: 12859A
• Field Amperes: 3893A
• Excitation Volts: 475V
• Rated Volts: 22KV
• Rotational Speed: 3600 RPM

4.4 OPERATING THE UNIT AT 0.85 POWER FACTOR AND 30PSIG
• With Reference to the manufacturer’s Generator Reactive Capability Curve-Reference Appendix AE, Drawing number 411HA356, Rev 0.

• At rated power factor of 0.85 and 45psig, the turbine has the capability to generate 416MW, assuming 30MW auxiliary power consumption, the net real power is 386MW
• At rated power factor of 0.85 and 45psig, the generator field has the capability to produce 260MVARS (Reactive Power). Assume a 10% reactive Var loss through the step-up transformer. Resulting reactive power is 234MVARS.
• Resolving by Power Triangle and with reference to reactive capability, the apparent power that can be obtained from the generator is 451.38MVA
• The maximum MVA of the generator is 490MVA and the resultant MVA is within the capability of the step-up transformer

4.5 OPERATING THE UNIT AT 0.90 POWER FACTOR-IMPROVED POWER FACTOR
• Operating the unit at improved power factor of 0.90 and at 45psig of hydrogen pressure will result in the following

• Increase in MW output to 440MW
• Assuming a 30MW-Auxiliary Power Consumption
• Net MW=Gross Power-Aux Power Consumption = 440-30=410MW
• Decrease in Reactive Vars from 260MVARS to 212MVARS
Assume a 10% var loss through the transformer(21.2MVARs)

Thus the available reactive vars needed to support the system after the losses is 188.8MVARs

Can the inductive loads being supplied from the system with Reactive Vars be sustained with the drop in reactive vars due to the improved power factor operation during peak times possibly summer?

Can the output of the generator and the system voltage be sustained with the drop in Reactive Vars

With reference to the reactive capability curve-Dwg 411HA356, operating at improved power factor of 0.90, the MVA is 451.38MVA (410MW after considering auxiliary power loss and 188.8MVARs after considering losses through the transformer

4.6 UNIT STEP-UP TRANSFORMER DATA

- Manufacturer: General Electric
- Number of phases: 3
- Number of windings:
  - Class: FA/FOA (Forced Air and Forced Oil-Forced Air)
  - Rated KVA:45,000KVA continuous 55 degree forced oil and forced air
  - Rated KVA:51,500KVA continuous 65 degree forced oil and forced air
  - Low side KVA rating:21,000KV
  - High side KV rating:345,000KV
  - Class: FOA-Forced Oil Air

Evaluating the manufacturer’s data for the transformer indicates the transformer has the capability to handle the increase in power
4.7 AIR HEATER PERFORMANCE DATA

UNIT AIR HEATER PARAMETER MEASUREMENTS

Gas side Efficiency of the Air heater = \frac{\text{Temp of Gas in} - \text{Temp of Gas out}}{\text{Temp head of the air heater}}
= \frac{(723.8 - 323)}{(723.8 - 81.8)}
= \frac{400.8}{642.0} \times 100
= 62.42\% 

X-ratio of the air heater = \frac{\text{Temp of Gas in} - \text{Temp of gas out}}{\text{Temp of air out} - \text{Temp of air in}}
= \frac{723.8 - 323}{627.25 - 81.8}
= \frac{400.8}{545.45}
= 0.73

Minimum Average Cold End Temperature (ACET) = \frac{\text{Temp of gas out} + \text{Temp of air in}}{2}
= \frac{81.8 + 323}{2}
= 202.4
Evaluating the calculated air heater parameter indicates that the air heater is highly efficiency.

4.8 TURBINE MANUFACTURER DATA

- Number of Stages: 20
- Number of stage in the high pressure section: 5 to 6
- Number of stages in the Intermediate pressure section: 6 to 7
- Number of stages in Low Pressure section: 6 to 7
- Speed of Turbine: 3600rpm
- Guaranteed Cont. Output: 370 MW
- Pressure of Main or Initial Steam: 2400 PSIG
- Temperature of Main Steam: 1000F
- Back Pressure: 3.5 inches of Hg
- Mass flow of main steam: 3,000,000 lbs/hr
- Reheat Steam Temp: 1000F

4.9 DATA FROM A PERFORMANCE TEST BY GENERAL ELECTRIC ON 5/30/2002

- Average Gross (MW) Generation: 403.3 MW  
  Design: 370.0 MW
- Average Net (MW) generation: 374.5 MW  
  Design: 333.4 MW
- Auxiliary Load (MW): 28.86 MW  
  Design: 36.6 MW
- Unit Gross Heat Rate (Btu/Kwh): 9268.8 Btu/Kwhr  
  Design: 7,803 Btu/Kwhr
- Unit Net Heat Rate (Btu/Kwh): 9982.6 Btu/Kwhr  
  Design: 8,660 Btu/Kwhr
- Unit Thermal Efficiency: 36.8%
- Boiler Efficiency:
  - Input/Output Method: 88.9%  
    Design: 87.5%
  - Heat Loss Method: 87.6%  
    Design: 87.5%
• Turbine Internal Efficiency:
  - High Pressure Turbine: 80.06%  \textbf{Design}: 84.92%
  - Intermediate Pressure Turbine: 94.48%  \textbf{Design}: 87.27%
  - Low Pressure Turbine: 90.04%  \textbf{Design}: 89.8%

• Condenser Cleanliness:

• Percentage Auxiliary Power Consumption: 7.2%

• Unit Thermal Efficiency: 36.8%

• Gross Turbine Cycle Efficiency:

• Main Steam/Throttle Steam Temperature: 986.5F  \textbf{Design}: 1000F
• Main Steam/Throttle Steam Pressure: 2414.1PSIA  \textbf{Design}: 2414.7PSIA
• Hot Reheat Steam Temperature: 953.3F  \textbf{Design}: 1000F
• Hot Reheat Steam Temperature: 497.6PSIA  \textbf{Design}: 438.6PSIA
• Condenser Pressure: 1.61 inches of Hg  \textbf{Design}: 1.00
• Reheater Pressure Drop: 5.6 \textbf{Design}: 10
• Superheat flow: 3,029,120Ibs/hr  \textbf{Design}: 3,000,000Ibs/hr
• Hot Reheat flow: 2,558,397Ibs/hr  \textbf{Design}: 2,188,289Ibs/hr
4.10 BOILER/TURBINE CYCLE

Boiler Side

- Superheater
- Water Walls
- Economizer

Turbine Cycle

- Main Steam: 3,029,120 lbs/hr, 1461 Btu/lb
- Cold Reheat Flow: 2,729,120 lbs/hr, 1360.5 Btu/lb
- Hot Reheat Flow: 2,558.397 lbs/hr, 1522.7 Btu/lb
- Superheat Spray Flow
- Feedwater Flow

4.11 CALCULATIONS

4.11.1 High Pressure Turbine-Flow and Energy Balance

Mass Flow rate Superheat Steam or main steam: **3,029,120 lbs/hr**. *(The mass flow rate of superheated steam obtained during the test date on 5/30/2002 and this is the value used since this value is greater than design of 2,654.848 lbs/hr)*

With reference to the thermodynamic properties of water and steam-1967-Steam Tables, a superheated steam with temp 1000°F and pressure of approx 2400 PSIA has an enthalpy of 1461.6 Btu/lb

Superheat Heat Steam Temperature: **1000°F**

Superheat Steam Pressure: **2414 PSIA**

Enthalpy: **1461 Btu/lb**

**Heat Input** = Energy in MBtu/hr = Enthalpy times mass flow rate of main steam: **4383 MBTU/HR**
Assuming 10% of the main steam is lost through seal leak: **300,000 lbs/hr**

Mass Flow rate of Cold Reheat (High Pressure Exhaust) steam: **2,729,120 lbs/hr**

Temperature of Cold Reheat Steam: **700F**

Pressure of Cold Reheat Steam: **408.6 PSIA**

With reference to the thermodynamic properties of water and steam-1967-Steam Tables, a superheated steam with temp 700F and pressure of approx 408.6 PSIA has an enthalpy of 1360.5 Btu/lb

Enthalpy of Cold Reheat Steam: **1360.5 Btu/lb**

**Heat Output**: Energy in MBtu/hr = Enthalpy times mass flow rate of Cold Reheat Steam:

**3712.96 MBTU/hr**

Difference in MBTU/hr: 4383 - 3712.96 = **670.04 MBTU/hr**

Changing Btu/HR to kilowatt you multiply by **0.000293**

HP Turbine Power: \(0.000293 \times 670.04\) MBTU/hr = **196.3 MW**

Considering 20% losses in high pressure section.

Thus the amount of electrical power expected to be produced from the high pressure section of the turbine is **157 MW**

**4.11.2 Intermediate Pressure Turbine-Flow and Energy Balance**

Hot Reheat Steam: **2,558,397 lbs/hr** (Highest Hot Reheat Steam Value obtained during the test date of 5/30/2002). This value is greater than the design value of 2,188,389 lbs/hr so will use that one.

Hot Reheat Steam Temperature: **1000F**

Hot Reheat Steam Pressure: **438.6 PSIA**

With reference to the thermodynamic properties of water and steam-1967-Steam Tables, a superheated steam with temp 1000F and pressure of approx 438.6 PSIA has an enthalpy of 1522.7 Btu/lb

Hot Reheat Enthalpy from Steam tables: **1522.7 Btu/lb**

**Heat Input**: Energy in MBtu/hr = Enthalpy times mass flow rate of main steam: **3895.67 MBTU/hr**
Assuming 10% of the Hot Reheat steam is lost through internal seal leak and section extraction steam lines: 255,839 lbs/Hr

Mass Flow rate of Intermediate Turbine Exhaust steam: 2,302,558 lbs/hr

Temperature of Intermediate Turbine Exhaust steam: 670F

Pressure of Intermediate Turbine Exhaust Steam: 420PSIA

With reference to the thermodynamic properties of water and steam-1967-Steam Tables, a superheated steam with temp 670F and pressure of approx 420PSIA has an enthalpy of 1355 Btu/lb

Enthalpy of Cold Reheat Steam: 1355 Btu/lb

\[
\text{Heat Output} = \text{Energy in MBtu/hr} = \text{Enthalpy times mass flow rate of Intermediate Turbine Exhaust Steam: 3119.96 MBTU/hr}
\]

\[
\text{Difference in MBTU/hr} = 3895.67 - 3119.96 = 775.71 MBTU/hr
\]

Changing Btu/HR to kilowatt you multiply by 0.000293

\[
\text{IP Turbine Power: 0.000293x775.71MBTU/hr = 227.28MW}
\]

Considering 20% losses in the section of the turbine

Thus the amount of electrical power expected to be produced from the Intermediate pressure section of the turbine is 182MW

4.11.3 Low Pressure Turbine-Flow and Energy Balance

Low Pressure Cross-Over Steam Flow from exhaust of intermediate pressure into Low pressure turbine: 2,302,558 lbs/hr

Temperature of cross-over steam from exhaust of intermediate pressure to low pressure turbine: 670F

Pressure of cross over steam from exhaust of intermediate pressure to Low pressure turbine: 420PSIA

Enthalpy of the cross-over steam from exhaust of intermediate pressure to Low pressure turbine: 1355 Btu/lb
**Heat input***= Energy in MBtu/hr = Mass flow rate of cross over steam- Intermediate Turbine Exhaust Steam time the Enthalpy of the cross-over steam from exhaust of intermediate pressure to Low pressure turbine: 3119.96 MBTU/hr, neglecting the pressure drop across the cross over and temperature drop across the cross over

Assuming 10% Feedwater extraction losses in steam: 230,255lbs/hr

Low pressure Turbine Exhaust flow rate: 2,072,203lbs/hr

Temperature of Low pressure Exhaust Steam: 83.3F

Pressure of low pressure exhausts steam: 1.0PSIA

Enthalpy of Steam: 1097Btu/lb

**Heat output***= Energy in MBtu/hr = Mass Flow rate of Turbine Exhaust Steam times the Enthalpy of the Low pressure steam exhaust: =2273.2MBTU/hr

Difference in MBTU/hr:3119.96-2273.2MBTU/hr=846.76MBTU/hr

Changing Btu/HR to kilowatt you multiply by 0.000293

IP Turbine Power:0.000293x846.76MBTU/hr=248.1MW

Considering about 20% losses

Thus the amount of electrical power expected to be produced from the Low pressure section of the turbine is 200MW

### 4.12 SUMMARY OF TEST RESULTS-NUMBER 3 HIGH PRESSURE FEED WATER

- Terminal Temperature difference:13.1
- Drain Cooler Approach:15.8
- Temperature Rise:57.4
- Effectiveness:19.1
4.13 SUMMARY OF TEST RESULTS-NUMBER 2 HIGH PRESSURE FEED WATER

- Terminal Temperature difference: 4.2
- Drain Cooler Approach: 15.7
- Temperature Rise: 59.8
- Effectiveness: 28.5%

4.14 SUMMARY OF TEST RESULTS-NUMBER 1 HIGH PRESSURE FEED WATER

- Terminal Temperature difference: -0.3
- Drain Cooler Approach: 13.4
- Temperature Rise: 77.5

4.15 SUMMARY OF TEST RESULTS-NUMBER 5 LOW PRESSURE FEED WATER

- Terminal Temperature difference: 4.8
- Drain Cooler Approach: 48.5
- Temperature Rise: 50.3

4.16 SUMMARY OF TEST RESULTS-NUMBER 4 LOW PRESSURE FEED WATER

- Terminal Temperature difference: 4.6
- Drain Cooler Approach: 19.0
- Temperature Rise: 55.1

4.17 SUMMARY OF TEST RESULTS-NUMBER 3 LOW PRESSURE FEED WATER

- Terminal Temperature difference: 6.7
- Drain Cooler Approach: 11.4
• Temperature Rise: 32

4.18 SUMMARY OF TEST RESULTS-NUMBER 2 LOW PRESSURE PRESSURE FEED WATER

• Terminal Temperature Difference: 5.0
• Drain Cooler Approach: 11.8
• Temperature Rise: 39.2

4.19 SUMMARY OF TEST RESULTS-NUMBER 1 LOW PRESSURE PRESSURE FEED WATER

• Terminal Temperature Difference: 2.1
• Drain Cooler Approach: 9.6
• Temperature Rise: 50.7

Evaluating the test data of the feed water heaters indicates they are highly efficient

4.20 NAME PLATE RATING OF THE ISOLATED PHASE BUS DUCT

Voltage rating: 22KV
Basic Insulation Level: 150KV
Current Carrying capability: 14,000 Amperes
Short circuit capability: 136,000 Amperes
Projected MW = 410 MW
Calculation for the current output of generator = 410 MW / SQRT 3 X 22,000 = **10,759 Amperes**

The power factor has already been taken into account to achieve the MW from MVA X power factor
The Isolated Phase bus duct has the capability to withstand the increase in power
CHAPTER 5-SUMMARY AND CONCLUSION
This project has shown that the steam turbine generator can withstand or has the capability for the projected 453MW Gross output power and 410MW being the net output power considering losses and auxiliary power consumption. This is based on the fact that the steam turbine high pressure section has the capability to generate 157MW, the intermediate section has the capability to generate 182MW and the low pressure section has the capability to generate 200MW. Adding the power generation capability of all three sections of the turbine gives a total of 539MW. Evaluating the test data for air heater indicates that the air heater is highly efficient, evaluating the past boiler efficiency data indicates that the boiler is highly efficient and will even be more efficient if the modification takes place in 2007. Also evaluating the manufacturer’s data or nameplate of the main step-up transformer indicates that the transformer has the capability to withstand the increase in megawatt or megavoltampere. Evaluating the test data on the feedwater heater indicates that the feedwater heaters are highly efficient. Evaluating the name plate data of the isolated phase bus duct indicate that it can withstand the increase in megawatt or megavoltamperes which will increase it current carrying capability. This will result in an additional increase of MW from the current net of 366MW to 410MW which is a significant increase of 44MW this will result in increase in revenues for the company

I therefore recommend to upper management to proceed with the implementation of the densepack design in 2007 and boiler modification in 2007 which will allow the unit to operate at design values to achieve the projected 410MW.
SUGGESTIONS FOR ADDITIONAL WORK

Several suggestions for additional work were made during the project implementation stage. The following are the suggested additional work:

- Determine the actual efficiencies of each section of the turbine.
- Design a continuous performance monitoring system which will monitor the performance of each section of the power production process.
- Design a virtual monitoring power plant that will allow performance of each major equipment to be determined on real time basis.
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- **Reference 11:** General Physics *Fundamentals of Power Plant Performance*
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- **Reference 13:** *Thermodynamic Properties of Steam*- Based on 1967ASME Steam Tables
LESSONS LEARNED

My extensive involvement in the Generator Electrical inspection and testing during the last October outage has helped me to thoroughly understand the following issues

- **Project Management**-learned how to plan a project, write a project specification, justification for project, and managing using various communication methods. I also applied most of the material that I learned from EMGT809-Personal Development for the Engineering Manager, EMGT 823-Management of Internal Engineering Projects and EMGT 801-Quality Management.

- **Labor Relationship**-After getting the opportunity to work on the project, my relationship with the union workers both within the plant(plant electricians) and contractors outside the plant improved a lot though I work with them on a daily basis. I utilized most of the plant electricians for the isolation of power feeds to the turbine-generator auxiliaries which is the most critical equipment to make the equipment safe to work on.

- **Risk Analysis**-Utilized company procedures and the material learned from EMGT 810-Applications of Quantitative Analysis in Decision Making to identify the risks associated with the project and how to mitigate and manage the risk associated with the project.

- **Utilized materials learned from Prof Herb Tuttle Class**-EMGT 808-Quality Management which focuses on team formation and management of teams.

GLOSSARY

**MW/KW**- Megawatt/Kilowatt is a unit of measuring energy output of the steam turbine

**HZ**- Is the unit to measure frequency

**RPM**-Revolutions Per Minute

**MVA/KVA**-Mega/KiloVolt Amperes is the unit to measure the output of a generator or transformer

**SH**-Superheated Steam-High temperature steam often 1000F

**RH**-Reheated Steam
ELCID - Electromagnetic Core Imperfection Detection - Procedure used to determine shorts in the core lamination of a generator

RTD - Resistance Temperature Detector - Detectors used to measure the temperature of the stator winding

YFCD - Terminology for the cooling system piping under the belly of the generator

YCFF - Terminology for the cooling system piping under the belly of the generator

YCFC - Terminology for the cooling system piping under the belly of the generator

PSIG - Units for measuring pressure

IBS/HR - Unit for mass flow rate of steam

PSIA - Unit for measuring pressure

BTU/KWHR - Unit for measuring enthalpy

MVARS - Megavolt Amperes - Unit for measuring the reactive power of a generator or transformer
APPENDICES:

APPENDIX A: HIGH PRESSURE AND INTERMEDIATE PRESSURE SECTION OF TURBINE SHOWING LOWER HALF OF DIAPHRAGM
APPENDIX B: LOW PRESSURE SECTION OF THE TURBINE SHOWING THE DIAPHRAGMS
APPENDIX C: DIAPHRAGM AND LABYRINTH SEALS IN PLACE
APPENDIX D: UPPER HALF OF N3 PACKING WITH SEALS
APPENDIX E: UPPER HALF OF THE NOZZLE BLOCK SHOWING THE FIRST STAGE OF DIAPHRAGMS
APPENDIX F: 6TH STAGE UPPER HALF DIAPHRAGM WITH SEALS-AFTER SANDBLASTING
APPENDIX G: 8TH STAGE UPPER HALF DIAPHRAGM AFTER SANDBLASTING
APPENDIX H: LOWER HALF OF THE DIAPHRAGMS AND SEALS OF THE HIGH PRESSURE SECTION AND THE INTERMEDIATE SECTION
APPENDIX I: LOWER HALF OF DIAPHRAGMS OF THE HIGH PRESSURE SECTION AND THE LOW PRESSURE SECTIONS OF THE TURBINE
APPENDIX K: OUTER SHELLS OF THE LOW PRESSURE SECTIONS
APPENDIX L: THE COLLECTOR END OF THE GENERATOR WHERE THE EXCITER IS COUPLED
APPENDIX M: TURBINE ROTOR SHOWING THE HIGH PRESSURE, INTERMEDIATE PRESSURE BLADES
APPENDIX N: ROTOR OF TURBINE AND THE INTERMEDIATE SECTION BLADES
APPENDIX O: NUMBER 7 BEARING OF THE TURBINE SIDE OF THE GENERATOR BEING INSTALLED AFTER MAINTENANCE
APPENDIX P: THE TURNING GEAR TOOTH SYSTEM OF THE GENERATOR
APPENDIX Q: THE HIGH PRESSURE AND INTERMEDIATE PRESSURE ROTOR WITH ROTATING BLADES BEING INSTALLED
APPENDIX R: STATOR OF THE GENERATOR SHOWING THE WINDINGS (COPPER BARS), SLOT SECTION, END WINDING BRACING AND THE CORE ELEMENTS
APPENDIX S: GENERATOR STATOR SHOWING THE ZONE BAFFLES THAT HELP DIRECT THE HYDROGEN FROM THE STATOR CORE THROUGH THE COOLING DUCTS OF THE ROTOR-GENERATOR OPENED FOR INSPECTION AND TESTING TO BE DONE