ETHYLENE TECH CENTER REVIEW
(answers to questionnaire)
July 15-18, 1991

SAFETY:

1.1 - Attached is a description of all incidents or accidents which have occurred at LHC 3 since the last review. If you would like to review any incidents, copies of the actual investigation report are available. John Holloway is included on the LHC 3 safety incident distribution list as is LHC 2 and LHC 7.

1.2 The furnaces at LHC 3 trip on the following criteria:

1. Low fuel gas pressure

2. Low steam drum level. 2 out of 3 transmitters

The furnace burner pressure test, purge, and light off is handled by procedure. Operations pressure tests the fuel gas header through a restricting orifice. If the header will not pressure up or if the pressure drops off after closing the test valve, the startup procedure is discontinued until the cause of the problem is found.

The furnace is purged by allowing it to draft for 10-15 minutes with the stack lid and dampers open.

The box is then checked at several locations and levels with an explosion-meter. If the box checks OK, then the first 4 burners are lit, by hand.

1.3

ACETYLENE HYDROGENATION REACTOR OPERATIONS DESCRIPTION

The purpose of the acetylene hydrogenation reactors is to react the undesired acetylene in the C2 stream with hydrogen to form ethylene. Ethane and green oil are undesirable by-products of the reaction.

The reactants are heated and passed through a DOW TYPE P catalyst system, consisting of preheaters, two catalyst beds in series, intercooling, after cooling and green oil knockout separation.

CO is used as a moderator for the reaction. CO free hydrogen can be supplied for the reaction from either the benzene methanation plant or from the AIR PRODUCTS pipeline. Both of these hydrogen sources are blended with unmethanated hydrogen from the LHC III cold train to control the CO concentration in the combined hydrogen stream to 100 ppm.

The acetylene hydrogenation reaction is exothermic, and the heat is removed after the last bed by cross exchanging the effluent with the reactor feed. Typical operating conditions for the beds are:

Pressure	350 psig
Temperature inlet	50 deg C
Temperature outlet	115 deg.C
C2H2 inlet	1.18 mole %
C2H2 outlet	0.5 ppm
C2H6 inlet	11-13 mole %
C2H6 outlet	12-14 mole %
H2 outlet	50-100 ppm
CO inlet (hydrogen)	100 ppm

The AIR PRODUCTS hydrogen system was installed in 1989. AIR PRODUCTS analyzes the system for the following components and trips the system accordingly:

COMPONENT	TRIP LIMIT
CO	7 ppm
CO2	3 ppm
O2	0.5 mole % entering A/P 10 ppm leaving A/P
CH4	no trip limit

Regeneration of the reactor beds is accomplished by passing steam and air over the spent catalyst. This "burns off" the green oil which has built up from the reaction. Burn off is completed at 20 psig and 490 deg F.

ACETYLENE HYDROGENATION REACTOR TRIP SYSTEM

(1) TEMPERATURE TRIPS

(a) Five profiles
(b) Dual T/C's
(c) Modicon
(d) PICS
(e) Failed T/C's
(f) Two of five to trip

ALARM	TRIP
150 deg C (run)	180 deg C (run)
480 deg C (regen)	510 deg C (regen)

(2) FLOW TRIPS

(a) Low process flow (24,000 kg/hr)
(b) Hydrogen isolation via double block and bleed

(3) BYPASS SWITCHES

(a) Master
(b) High temperature trip bypass
(c) Low flow trip bypass

(4) COLD COILS

(a) Energized to trip
(b) Trickle current

ACETYLENE HYDROGENATION REACTOR
REGENERATION CYCLE STEPS

STEP 1	235 psig steam stripping	24 hours
STEP 2	600 psig steam stripping	72 hours
STEP 3	Oxidation (air with 600 psig steam)	48 hours
STEP 4	235 psig steam purge	4 hours
STEP 5	Drying / Reactivation (hot fuel gas)	72 hours
STEP 6	Cool down (ambient temperature offgas)	12 hours
STEP 7	Nitrogen purge	2 hours

ACETYLENE HYDROGENATION REACTOR
EMERGENCY SHUTDOWN PROCEDURES

STEP 1 Identify problem

(a) Loss of process flow?
(b) High temperature trip?
(c) Loss of hydrogen flow?
(d) Instrument malfunction?

STEP 2 Correct problem

STEP 3 Satisfy run condition on reactor

STEP 4 Coordinate distribution of out of spec product

STEP 5 Reestablish reactor operation

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ACETYLENE HYDROGENATION REACTORS
POTENTIAL PROBLEMS AND PREVENTATIVE MEASURES

(1) RUNAWAY REACTION WITH THE BEDS

Preventative measures:

(A) Automatic control of the inlet feed temperature. If too low the reaction will stop. Generally a reaction will initiate at 35 deg C or higher.

(B) Dual temperature monitors on reactor inlet and outlet and three temperature monitors at five points with each bed.

(C) High temperature alarm on each temperature point (120 deg C on PICS and 150 deg C on MODICON)

(D) High-high temperature trip of the hydrogen to the reactors at 180 deg C. This requires two separate thermocouples to indicate above the trip temperature. The hydrogen to each bed is tripped with an automatic double block and bleed arrangement.

(E) Low process feed flow (24,000 kg/hr) will trip the hydrogen.

(F) The hydrogen to the reactors is ratio controlled versus the feed flow.

(G) Continuous on stream analysis of the reactor feed and effluent for the following:

(a) Acetylene
(b) Ethane
(c) Hydrogen
(d) CO (inlet only)

(I) Continuous monitor and control of the hydrogen differential across each catalyst bed.

(J) Periodic swapping of reactor beds as they become fouled, which leads to high temperatures.

(2) CONTROL OF THE BURN OFF PHASE OF REGENERATION

Preventative measures:

(A) Continuous monitoring of bed profile temperatures, inlet and outlet temperatures to prevent runaway.

(B) High temperature trip of air during regeneration from any one thermocouple is 510 deg C. Air is tripped through a double block and bleed arrangement.

(3) MIXING OF HYDROCARBONS AND AIR

Preventative measures:

(A) Double block and bleeds used on all process streams during a burn off.

(B) Piping is such that regen air or reactivation fuel gas may be used, but not both at the same time. This is accomplished by a break out spool.

(C) On depropanizer / debutanizer steam out header, which is connected to the regen quench column, the systems cannot be cross-tied due to another break out spool.

(4) CONTAMINATION FROM AIR PRODUCTS

Preventative measures:

(A) Temperature trip system on reactors will indicate any contaminant initiating a run away reaction.

(B) Rely on AIR PRODUCTS analysis and trip schemes.

ACETYLENE REACTOR TRIP SYSTEM

INTRODUCTION

The system originally installed for tripping the reactors was a hardwired relay circuit that used one thermocouple on the outlet of each reactor bed and a low flow indication on reactor feed to trip hydrogen to the reactors.

Since it was originally installed, this system had been modified several times to add trip bypass switches, solenoid coil testing circuits, etc. The end result of these modifications was a system that has become unreliable, hard to modify for future needs, and hard to troubleshoot. For this reason, the decision was made to convert the trip system to Modicon.

THEORY OF OPERATION

Instead of using a single thermocouple for each reactor bed, the system uses the five bed profile thermocouples to detect high temperatures. These five thermocouples are dual element, with one element going to Modicon "A", and the other half going to Modicon "B".

Each thermocouple is checked by the trip system, and if it fails, is rejected by the Modicon and will not be used to alarm a high temperature or to trip the reactor (failed thermocouples will be indicated on the PICS displays). Once a thermocouple fails, it will remain rejected from the trip circuit until manually reset using the "TRIP SYSTEM MALFUNCTION RESET" button on the trip panel door.

Assuming all thermocouples are working properly, the trip system will alarm through the PICS system a high temperature on any point (high temperatures are also alarmed on the annunciator - one alarm for each reactor set). To trip the reactor, two of the five temperatures must indicate a temperature above 180 degc (in run mode). (If the bed is being regen'd, any one temperature above 510 degc will trip the regen air). If the temperature should exceed this limit, or if reactor feed flow should drop below 2 units, hydrogen to the reactors will be blocked in and vented to the flare.

After a high temperature trip, the trip system must be manually reset by turning the trip/reset button on the control board . The trips will not reset, however, until all trip alarms are clear (low flow or high temp). The trip solenoids in the field will then swap hydrogen feed back to the reactors.

The new trip system also monitors bed temperature during regeneration. When a reactor set is placed in regeneration mode (using the board selector switch), the alarm and trip setpoints are changed to 480 and 510 degc, respectively. As mentioned above, any high temperature will be alarmed on the PICS graphics, and any one of the five bed temperatures must be above the trip setting before the regeneration, air and ST-140 are tripped.

OPERATING THE TRIP SYSTEM

SWITCH DESCRIPTION AND OPERATION

REACTOR TRIP/RESET SWITCH:

This is a 3 position selector switch. The switch arrow will normally pointup to the neutral, or RUN position.

To trip the on-line reactor, turn the switch to the left, towards the TRIP legend. This will trip hydrogen to the reactors, ring the "REACTOR TRIP" alarm, and turn on the red "TRIP" light on the switch. The light and alarm will stay on until the trip condition is cleared and the trips have been reset.

When all trips are clear, the trip circuit can be reset by turning the switch to the right and releasing. The switch knob will spring return back to the center, neutral position. If all trip conditions are clear, the green "RESET" light will come on at this time.

ON-LINE FURNACE SELECTOR SWITCH:

This is a two position selector switch , which is used to select which furnace (F-6 or F-12) the ST-140 effluent gas is lined up to. This information is required so that in case the furnace trips, the reactor regeneration can be tripped as well.

LOW FLOW TRIP BYPASS SWITCH:

This is a two position selector switch. This switch bypasses only the reactor low feed flow trip.

Under normal conditions, this switch will be in the left or "RUN" position. As long as the flow is above 2 units, the green "RUN" light will be lit.

To bypass the trip, turn the switch to the right or "BYPASS" position. At this time, the red "BYPASS" light will start flashing as a reminder that the trip is bypassed.

When returning the switch to the "RUN" position, the green "RUN" light MUST be on, indicating that the trip condition is clear. If the light is not on and the switch is turned to the "RUN" position, the reactors will trip.

R-1A/R-2A HIGH TEMP TRIP BYPASS:

This is a two position selector switch. This switch bypasses the high bed temperature trips set at 180 degc, which blocks in hydrogen feed to the reactors.

Under normal conditions, this switch will be in the left or "RUN" position. As long as the temperature trip condition is clear, the green "RUN" light will be lit.

To bypass the trip, turn the switch to the right or "BYPASS" position. At this time, the red "BYPASS" light will start flashing as a reminder that the trip is bypassed.

When returning the switch to the "RUN" position, the green "RUN" light MUST be on, indicating that the trip condition is clear. If the light is not on and the switch is turned to the "RUN" position, the reactors will trip.

R-1B/R-2B HIGH TEMP TRIP BYPASS:

This is a two position selector switch. This switch bypasses the high bed temperature trips set at 180 degc, which blocks in hydrogen feed to the reactors.

Under normal conditions, this switch will be in the left or "RUN" position. As long as all trip conditions are satisfied, the green "RUN" light will be lit.

To bypass the trip, turn the switch to the right or "BYPASS" position. At this time, the red "BYPASS" light will start flashing as a reminder that the trip is bypassed.

When returning the switch to the "RUN" position, the green "RUN" light MUST be on, indicating that the trip condition is clear. If the light is not on and the switch is turned to the "RUN" position, the reactors will trip.

R-1A/R-2A OPERATING MODE:

This is a two position switch. This switch selects the operating mode and temperature trip setpoints for the "A" set of reactors.

When in the left or "RUN" position, the alarm and trip temperature setpoints are 150 and 180 degc, respectively, and the trip system will shut off hydrogen to the reactors on a high temperature.

The green "RUN" light is simply a indicator of the switch position from the Modicon.

When in the right or "REGEN" position, the alarm and trip temperature setpoints are 480 and 510 degc, respectively, and the trip system redirects the trip signal to trip regen air and ST-140 on high temperature

The red "REGEN" light is simply a indicator of the switch position from the Modicon.

NOTE

If the mode switch is moved from "REGEN" position to "RUN" position while the beds are being regenerated, hydrogen to the on-line bed will be shut off and the beds may be blocked in and depressured. This is due to changing temperature setpoints when changing switch position.

R-1B/R-2B OPERATING MODE:

This switch changes operating mode for the "B" set of reactors, and its functions are the same as those for the R-1A/R-2A mode switch above.

TRIP SYSTEM MALFUNCTION RESET SWITCH

This switch is located on the trip panel door. Whenever a hardware failure occurs, the alarm will lock out until manually reset by this switch. This switch also resets the thermocouple failure/rejection circuits, putting a failed thermocouple back in the trip circuit once it has been repaired.

NOTE

DO NOT TRY TO RESET A THERMOCOUPLE IF IT HAS NOT BEEN REPAIRED. THERMOCOUPLES FAIL UPSCALE, AND RESETTING A BAD SIGNAL COULD TRIP THE REACTORS.IT IS ADVISABLE TO USE THE TEMPERATURE TRIP BYPASS SWITCH BEFORE RESETTING THE THERMOCOUPLES.

ALARMS:

There are two types of alarms - computer alarms and hardware annunciator alarms. The computer alarms are a great aid in troubleshooting the trip system - bad relays, open thermocouples, etc. Copies of the PICS alarm flowsheets are attached, showing all the alarms. If any device shows "FAIL", it should be repaired ASAP.

The computer will also be used to alarm high reactor temperatures. Because the Modicon "knows" if a reactor is in run or regen mode, it will be able to alarm a high bed temperature based on real operating conditions.

The hardware annunciator alarms operate the same as they have in the past, with the addition of two alarms. The alarm windows and their meaning are listed below:

WINDOW LABEL	ALARM DESCRIPTION/FUNCTION
R-1A/R-2A HIGH TEMPERATURE	A high temperature on any of the 10 temperature points on either reactor set
R-1B/R-2B HIGH TEMPERATURE	A high temperature on any of the 10 temperature points on either reactor set
REACTOR LOW FLOW TRIP	Reactor shutdown on low flow (will not alarm when bypassed)
R-1A HIGH TEMP	Reactor shutdown on 2 of 5 high bed temp (will not alarm when bypassed)
R-2A HIGH TEMP	Reactor shutdown on 2 of 5 high bed temp (will not alarm when bypassed)
R-1B HIGH TEMP	Reactor shutdown on 2 of 5 high bed temp (will not alarm when bypassed)
R-2B HIGH TEMP	Reactor shutdown on 2 of 5 high bed temp (will not alarm when bypassed)
REACTOR SHUTDOWN	Reactor shutdown (alarms anytime reactors trip)
TRIP SYSTEM MALFUNCTION	Problem with trip system hardware bad thermocouple, relay, Modicon hardware, etc.

(Note: this alarm must be manually reset by pressing the "RESET" button on the reactor trip panel door)

END OF ANSWER TO 1.3

1.4 A comprehensive set of piping specs is used at LHC-3 which follow B31.3 piping code. All vessels are designed and built to ASME code Section 8, Division 1. A booklet system is used on all maintenance and small capital projects to ensure that the right materials, design methods, etc., are called for. The booklets are reviewed by several senior staff members before they are approved. Material controllers have piping and valve specs also.

1.5 The P&ID's have not been reviewed for materials and construction recently.

1.6 The EBV's have been painted a bright orange color so that they can be easily identified but there is no list or drawing showing the location of each valve.

1.7 All pumps have tandem seals in hydrocarbon service except the P-10's and P-11's which have single seals. The P-10 pumps are quench oil pumps that pump oil from the bottom of C-10 (quench oil column). The P-11 pumps are pumps that pump flux oil back to the top of C-10 to be used as reflux. Capital is being sought to design, purchase and install new tandem seals in these pumps.

1.8 Plant critical instrument program is currently under review and rework. Instruments are screened by the following questions:
- can failure cause major equipment damage?
- can failure cause personnel safety hazard?
- can failure cause environmental release or hazard?

1.9 No, we do not have a system for testing non-critical instruments.

1.10 - We have detailed procedures for jumpering a furnace trip or a critical instrument. This process begins with discussion between the boardman, instrument man, supervisor, and area engineer. The job scope is defined and a plan of action is composed. The procedures are available from the control room PC's. To by-pass an alarm, the boardman notifies the supervisor, pulls the card, and then labels the window with his name and date pulled.

1.11 - To by-pass a sprinkler system, the fire protection department must be notified and they will isolate the system. Block personnel are not to disable or disconnect any fire protection equipment.

1.11.1 - Cast iron has been eliminated from all sprinkler systems.

1.11.2 - Blast walls are used in the ethylene/propylen storage areas around the sprinkler trip systems. They are also used in other areas of the plant around hydrogen valves.

Permits -General:

1.12.1 - All block operations, maintenance, and technical personnel are required to attend a block safe work permit training class on an annual basis. This requirement has been in place for two years and covers all aspects of permit writing, division Safety & Loss Prevention standards, and block policies. The training is documented and kept on file.

1.12.2 - All points of line opening are required to be positively identified. This includes flange separations or cutting into a line. All cuts must be cold cuts. Each point of entry is marked with an orange "dot" or an orange "tag". The permit writer and the individual receiving the permit are required to initial and date each point of entry being permitted. The identification is good for that day only. It is the responsibility of the permit recipient to have the individuals actually performing the opening to add their initials to the "dot" or "tag". Demolition is considered a line opening and requires the same procedure.

1.12.3 - The only permits which do not require a jobsite visit are general permits in which the permit writer is sure that the on-site inspection will serve no purpose, that the person receiving the permit knows all the hazards and can recognize them, and the permit writer knows for a fact that the area is safe to work in. These type permits are very seldom. If the job involves a safety observer, the observer is required to accompany the permit writer and the requestor on the on-site inspection.

1.12.4 - Most items are listed on the permit. If additional items are required there is a dedicated space to list this information. We also have a LHC 3 Benzene/C4 Line Opening procedure which helps to determine any additional safety equipment required in a potential chemical exposure situation.

1.12.5 - Respiratory fit testing is done on an annual basis. Each individual is tested on each type respiratory protection he may use in the course of his job.

1.12.6 - The safe work permit form does include radiation hazards as well as requiring a separate radiographer permit. Radiation devices can only be handled by, or under the supervision of, the division Radiation Safety Officer and/or the division Radiation Safety Committee.

1.12.7 - The safe work permit form does include asbestos hazards. We do have a block specific asbestos handling procedure and this is covered with all in-coming personnel in their indoctrination.

1.12.8 - Safety and Loss Prevention Standard S-303 requires that all red tags and masters not be reused. Once the tags have been pulled and the master cleared from the computer, they are

disposed of. Permission has been granted to laminate and reuse the furnace decoke and maintenance red tags due to the number of tags involved and the frequency in which they are used. A new red tag master is issued each time and "F" shift is responsible for keeping the furnace red tag procedures up to date.

1.12.9 - The safe work permit forms do not have a close-out section. The block does require that all safe work permits be returned to the appropriate control board at the end of each shift or upon job completion. This allows a status report to be given and housekeeping to be questioned.

1.12.10 - Good communication is essential to assuring a good understanding of the equipment status and its hazards. We assure this by utilizing established preparation procedures and through the on-site inspections. During the on-site, we verify that the equipment is safe to work on and point out the potential hazards in performing the task.

1.12.11 - Yes, there is an existing procedure for swing blind repositioning for routine PSV maintenance. Other work on the flare header requires a separate detailed work procedure.

Safe work permit:

1.13.1 - The supervisor is responsible for determining the capabilities of each eligible writer under his supervision and it is at his discretion that an individual is deemed qualified to issue permits. Hot tap permits are issued by shift supervisors and S.O.S.'s only. Engineers cannot issue vessel entry or hot tap permits. Individuals on progression need written superintendent approval to issue safe work permits.

1.13.2 - All classification are involved in the procedure writing process, but procedures are reviewed and comments made by the technical and support staff before the procedure is put into effect.

1.13.3 - The office areas janitors do not receive a safe work permit. They are required to go through block safety indoctrination.

Hot work permit:

1.14.1 - All personnel eligible to issue safe work permits are eligible to issue hot work permits.

1.14.2 - Generally the technical staff writes all hot work procedures. The maintenance department has written some furnace routine hotwork procedures. Before a hot work procedure may be approved, two signatures and a documented field check are required.

1.14.3 - Safety & Loss Prevention Standard S-201, allows any line to be hot tapped if the proper procedures and approval are obtained except for; ethylene, hydrogen, chlorine, oxygen, air,

any oxide, liquid ammonia, acetylene, carbon steel below 32 F, and greater than 475# steam.

1.14.4 - Safety & Loss Prevention Standard S-201 requires that a separate hot tap permit accompany the safe work permit. This hot tap permit requires that it first be determined if the hot tap can be done safely. It requires detailed procedures and verifications and plant superintendents approval.

Confined space entry permit:

1.15.1 - Shift supervisors and S.O.S's and O.S.'s that have been deemed qualified by their supervision are allowed to issue vessel entry permits.

1.15.2 - The area engineer is responsible for writing confined space entry procedures. Operation personnel may assist but the responsibility rest with the area engineer.

1.15.3 - Yes, the safe work permit does ask if the explosion/oxygen meter reading is acceptable.

1.15.4 - A TLV is run prior to the confined space entry permit being issued. This test is done by the same work shift issuing the permit. No continuous monitoring is done. Additional TLV's have been taken of jobs where the heat of the day may cause concern.

1.15.5 - All "hole watchers" must be certified through the Louisiana Division Maintenance Department. This certification involves a 4 hour training class.

1.15.6 - Only low voltage explosion proof lighting may be used inside a vessel where flammables may be present. On jobs where flammables do not present a hazard, 110-volt equipment with GFCI's may be used with the approval of the Plant Superintendent and the Safety Superintendent.

1.16 - Safety and Loss Prevention Standard S-205 covers the use and inspection of portable ladders.

1.17 - LHC 3 utilizes a scaffold inspection tag which must be completed and approved before any personnel is allowed to use the scaffold. Operations inspects each scaffold prior to approval to assure the scaffold will not limit access or the operation of any process or safety equipment. The scaffold policy is covered in the LHC 3 Block Rules.

1.18 - All guards are in place and in good condition. Operations communicates any problems with guards or covers to the maintenance mechanical coordinator so they may be repaired.

1.19 - Pumps switches in the field which have auto-start capabilities are labeled "auto" to assure proper switch placement. No additional labels or warnings are used.

2. **REACTIVE CHEMICAL:**

2.1 Last reactive chemicals review was held on June 20, 1991. Official letter from reactive chemicals chairman on recommended follow up items just received (6/25/91). Plant response is forthcoming.

3. **INDUSTRIAL HYGIENE:**

3.1 Program was reviewed since last PTR and results are enclosed.

3.2 - 3.13 Skip as per instructions in questionnaire.

4. **ENVIRONMENTAL QUALITY:**

4.1 There are no up to date flowsheets for waste and emissions as the plant exists today. Heat and material balances for the Environmental Upgrade project are enclosed. These HMB's do show some waste streams.

4.2 To be done at review.

4.3 Yes

4.4 Yes. Water permit - OCPSF. Environmental Upgrade Project will allow plant to meet new regulations.

4.5 Yes. SPC/SPCC.

4.6 Benzene air monitors and combustible gas detectors.

4.7 Yes

4.8 Yes

4.9 Yes. Area engineers, plant supervision, operations and Environmental Services are normally present in an investigation.

4.10 No

4.11 Infrared camera used in conjunction with a ratio control of steam to hydrocarbons flared. There are flow meters in the flare header and the steam header (steam to flare tip). The control is accomplished using a Foxboro Videospec system in the Benzene control room.

5. QUALITY ASSURANCE:

A separate questionnaire was received on quality. The answers to this questionnaire are enclosed as a separate section.

6. YIELD:

6.1 The Gulf Coast LP model is used to determine preferred feeds and setpoints for the cracking furnaces. Severity control is used to hold the furnace at the desired conditions. At times decisions are made to vary from the LP model recommendations in order to overcome temporary Plant constraints.

6.2 FURNACES

Coil Revamp:

The furnace revamp project has had the most impact on plant yields. The furnaces coils were replaced with a short residence time Stone & Webster design which, on a propane furnace, increased the 1st pass yield approximately 0.8 weight % for propane and 1.6 % for naphtha. The total ethylene and propylene produced per hour per furnace was increased by 13 and 6 percent respectively, due to increased total throughput.

Conversion Control:

Conversion control has been reintroduced to the furnaces. Severity schemes had been used in the past but the Procomm control equipment that had controlled conversion, was mothballed. The control is presently being done on the Foxboro SMS control computer. The scheme has added stability to the furnace operation and consistency to the furnace yields.

MRU's:

Mechanical refrigeration units were added to the gas turbine scrubber water to increase the horsepower of the gas turbine during the hot months. This eliminated the need to raise the suction pressure of the machine, while pushing the same rates through the plant, thus maintaining higher yields from the furnaces.

7. ENERGY UTILIZATION:

7.1 Conversion energy plot enclosed. The conversion energy trend for the past 3 years can be seen on the following chart. The general trend of increasing production/decreasing conversion energy is evident. Discounting the last 4 months, there is a downward trend in the conversion energy over the last 1.5 years, which can be attributed to the installation of the additional steam generators (USX's) on the furnace outlets. The increase in conversion energy during the past 4 months has been due to a waste heat boiler being out of service for the Environmental

Upgrade modifications. This steam was replaced with 1250 psig steam from the power plant, thus raising the conversion energy requirements.

7.2 After the Environmental Upgrade, the only remaining direct fired heaters are the cracking furnaces. The furnaces run at an 85-87% efficiency, taking credit for the waste heat boilers.

7.3 Two dampers, one on each side of the furnace, are adjusted manually from the control room by the operators to control the percent oxygen in the stack and the furnace draft. Stack temperatures, as well as combustible and CO analyses, are also monitored, and adjustments are made to damper positions as necessary.

An automatic control scheme is being developed to automate the oxygen and draft control using the Foxboro control system. This project will be implemented on all the furnaces after it proves to be successful.

7.4 The following opportunities for saving energy in the plant are being studied and/or installed:

1. Cold Train Revamp - This project has been incorporated into the EUP shutdown and will increase the efficiency of the cooling train.

2. Automatic O2 control on the furnaces - A scheme is under development which will control the combustion of the furnaces and keep them at optimum combustion conditions. The program will run on the Foxboro SMS computer.

3. A Dynamic Matrix control/optimization package is being studied. This would assure that the plant would run against constraints at all times, thus, maximizing profits. This would result in a more energy efficient operation of the entire plant.

4. Optimization of the dilution steam generation - This will reduce the steam generated with 17 bar steam, thus increasing the plant 17 bar export.

8. <u>NEW TECHNICAL DEVELOPMENTS:</u>

8.1 Mass and energy balances for the plant are out of date. The new M&E balances that we do have are for the environmental upgrade project which are enclosed.

8.3 There are no plant research projects in progress at this site. Research is in the process of math modeling the LHC-3 plant.

8.4 Projects 1) The Furnace Modification project (LA-76715) is complete. This project is a Stone & Webster retrofit of existing Selas furnaces.

2) The Cold Train Revamp project (LA-76000) is scheduled to be completed during the 1991 turnaround. This project will improve offgas separation and is consistent with and has become a part of the Environmental Upgrade Project.

3) The Environmental Upgrade project (LA-77755) is scheduled to be completed during the turnaround in October/November 1991. This project will allow LHC-3 to meet OCPSF guidelines for 1992.

9. **Plant problems**

9.1 - 9.4 Production Interruptions:

3/28/89
1. GT-71 Shutdown due to bad modicon relay. See enclosed incident report.
2. Flared product and smoke.
3. No equipment damage
4. No injuries
5. Value of lost production - $731,583
6. See enclosed incident report.

5/12/89 - 6/24/89
1. GT-120 plugged regenerator. See enclose incident report.
2. Flare product and smoke
3. Regenerator needed repair. Decision was made to go into turnaround earlier than was planned.
4. No injuries.
5. Value of lost production - $43,171,159
6 See enclosed incident report.

11/30/89 - 12/15/89
1. K-71 Wreck due to power outage. See enclose incident report.
2. Flared product and smoke.
3. Eleven day outage due to wrecked compressor train and couplings.
4. No injuries
5. Value of lost production - $14,385,470
6. See enclose incident report.

12/24/89
1. TK-130 steam turbine wreck. See enclosed incident report.
2. Flared product and smoke.
3. This incident happened 5 days before GT-120 wrecked. Turnaround started due to multiple machine wrecks.
4. No injuries
5. Value of lost production - combined with outage of 12/29/89 to 1/17/90
6. See enclosed incident report.

12/24/89 - 12/25/89
1. C-30A and C-30B gas spills. See enclosed incident report.
2. See enclosed incident report.
3. See enclosed incident report.
4. No injuries.
5. Value of lost production - combined with outage of 12/29/89 to 1/17/90
6. See enclosed incident report.

12/29/89 - 1/17/90
1. GT-120 compressor wreck due to blade failure. No incident report available.
2. Flared product and smoke.
3. GT-120 overhauled due to blade failure.
4. No injuries
5. Value of lost production - $29,865,016
6. No course of action.

3/29/90
1. GT-71 trip. See enclosed incident report.
2. Flare product and smoke.
3. No damage to equipment.
4. No injuries.
5. Value of lost production - $898,373
6. See enclose incident report.

5/26/90 - 6/2/90
1. Power failure - See enclosed VAX report.
2. Flared product and smoke
3. None
4. No ijuries
5. Value of lost production - $8,142,763
6. See VAX report.

6/17/90 - 7/10/90
1. GT-71 Wreck. See enclosed incident report.
2. Flared product and smoke
3. Blade failure in gas turbine - see incident report.
4. No injuries.
5. Value of lost production - $35,277,510
6. See incident report.

7/16/90 - 7/28/90
1. Cracked flare header. See enclosed incident report.
2. See enclosed report for environmental consequences.
3. See enclosed report for equipment damage.
4. No injuries
5. Value of lost production - $22,045,704
6. See enclosed incident report.

8/27/90 - 8/31/90
1. GT-71 shutdown. See enclosed incident report.
2. Flared product and smoke
3. See enclosed incident report.
4. No injuries.
5. Value of lost production -
6. See enclosed incident report.

12/11/90
1. GT-71 & GT-120 trip. See enclosed incident report.
2. Flared product and smoke
3. No equipment damage.
4. No injuries.
5. Value of lost production -
6. See enclosed incident report.

6/13/91
1. Acetylene Reactor trip. See enclosed incident report.
2. Flared product and smoke.
3. No equipment damage.
4. No injuries
5. Value of lost production -
6. See enclosed incident report.

10. **PROCESS CONTROL:**

10.1 The process control hardware used at LHC III consists primarily of Foxboro Spec 200 series equipment. The majority are analog controllers at the furnace and ethylene control boards. Key process variables on each major piece of equipment can be computer controlled. Two Foxboro SMS computers, one dedicated to the furnace area and the other to the ethylene area, are available for these advanced control applications. Other control systems in the plant include Modicon programmable controllers, which are used for trip systems on various pieces of equipment. Some of the particular types of Foxboro devices used at LHC III are listed below:

FOXBORO ANALOG CONTROLLERS (SPEC 200 SERIES):
Board controllers which take inputs from the field and setpoints from either the operators and/or the Foxboro control computers and send analog outputs to the field.

FOXNET LINKPORT:
Provides communication paths between the process I/O devices and the control computers. The links between all Foxboro devices on the Linkport are redundant.

PROCESS I/O DEVICES:

CCM (CONTROLLER COMMUNICATION MODULE): Allows control computer to interface with analog input and output of Spec 200 controllers for advanced control applications.

UIO (UNIVERSAL INPUT OUTPUT): Provides the communications path for digital I/O between field equipment and the control computers.

UFM (UNIVERSAL FIELD MULTIPLEXER): Used to receive and convert analog signals from field equipment for the control computers.

FIO (FIELD INPUT OUTPUT): Provides a path for all types of signals - digital and analog inputs and outputs - between field equipment and the control computers.

SMS (COMPUTER):
Configurable processor-based computer system for distributed process control and advanced control applications. The control computer communicates to all I/O devices through the Linkport to receive and send data and to the gas chromatographs through the front-end-processor host computer to receive analysis data.

10.2 Last July Foxboro announced it would be discontinuing production of the Spectrum line of control equipment including many pieces of equipment currently in use at LHC III. Support and spare parts would be available on a limited basis for at least five years. Because of the large demand for equipment caused by this announcement, Foxboro has changed its position. They will

continue to manufacture, sell, and support the existing Spectrum line which means LHC III should be adequately supported.

10.3 The Foxboro SMS control computer allows advanced control applications to be implemented using both a Basic programming language (FPB) and the Foxboro Control Package (FCP). The SMS system also include graphics displays for the operator interfaces. Because much of the Foxboro SMS operating system is written in the FPB language, the engineer who develops control applications can also function as the system manager for the computer.

10.4 Currently, there are two control engineers trained on the Foxboro SMS computer assigned to support the LHC III control applications and system needs. There is also a backup control engineer with experience on the Foxboro system who is available if necessary. Other control engineers, currently working on Mod 5 conversions, are also assigned to LHC III. This situation is not expected to change significantly, and therefore, LHC III will be adequately supported in the future.

10.5 MAJOR IMPROVEMENTS/FUTURE PLANS

MAJOR IMPROVEMENTS:

C-51/C-52 PRESSURE MINIMIZATION: Adjusts the pressures in the final separator in the cold train, the primary de-methanizer, and the de-ethanizer by monitoring key valve positions in the process. The overall result was an increase in available horsepower for the cracked gas compressor because its discharge pressure was lowered.

FURNACE CONVERSION CONTROL: Controls the conversion or cracking severity of each furnace by adjusting the coil outlet temperatures. All cracked gas and feed analysis data are validated, conversions or severities are calculated, and control calculations are made based on the furnace feed.

FUTURE PLANS:

FURNACE COMBUSTION CONTROL: This control scheme will adjust furnace damper positions to control furnace draft and stack oxygen analyses. The potential for fuel gas savings on the furnaces is significant.

ENVIRONMENTAL UPGRADE CONTROL PROJECTS: Several advanced control applications are being developed for the Environmental Upgrade Project. These schemes include composition control of the front-end de-propanizer columns; surge control of the "C" case of the cracked gas compressor; and temperature, analysis, and possibly selectivity control of the new acetylene reactors.

DMC (DYNAMIC MATRIX CONTROL) ON FURNACES: Current plans are to begin testing DMC on one of the furnaces. The DMC controller

should improve conversion and combustion control and will adjust furnace feed rates automatically as allowed by constraints in the purification section of the plant.

Mod 5 AUTOMATION OF FURNACES: The English Language Programming for the Mod 5 control of the furnaces is currently being developed. Initial plans are to have one furnace running on Mod 5 by 3rd quarter of 1992.

Mod 5 AUTOMATION OF CONDENSATE POLISHERS: The Dowtran programming, graphics, and simulation has been completed. This project requires significant field equipment modifications that have not been made yet. Plans are to start up the polishers on Mod 5 during the 1st quarter of 1992.

Gas Turbine Control Upgrade: Replace Westinghouse supplied controls with Trisen to improve reliability.

Electronic Governor on K130: Replace existing mechanical Woodward governor with Trisen electronic governor to improve reliability.

11. **PLANT HEALTH/RELIABILITY:**

11.1.1 Plant electrical system was audited in 1988-89. Waiting for I&E contact to return from vacation to get a copy. Will send copy to Arnold Van Der Bie as soon as possible.

11.1.2 Auto switchover on incoming 15kV power. Tested in December 1989.

11.1.3 Yes. For all switchgear.

11.1.4 No

11.1.5 Yes

11.1.6 Yes to all.

11.1.7 Yes

11.1.8 MCC building has a smoke detection system. In addition, smoke detectors are installed in the switchgear itself (THE NEW SECTIONS FOR EUP). Remaining section will be done next year (UNITS FOR WESTINGHOUSE JUST BECAME AVAILABLE).

11.1.9 Yes. Also, motor feeders (RED/BLUE) are field identified.

11.1.10 Yes

11.1.11 Yes

11.1.12 Yes

11.1.13 Yes to both.

11.1.14 Yes - Just reworked field receptacles.

11.1.15 Yes; In process of relamping plant area with sodium vapor.

11.1.16 Yes

11.1.17 Cabel routing:
Electrical: Underground trench, conduit.
Instrument: Underground trench, cable tray, conduit.

11.1.18 Yes. Don't know.

11.1.19 Yes. Standard spec for junction boxes is NEMA 4X

Major Rotating Equipment

11.2-11.2.3

Spare Parts: For the major rotating equipment in the block there are complete spares with the exception of the

reciprocating compressors. Spare parts for the gas turbines include a complete spare machine and enough parts to overhaul the other machine.

The centrifugal compressors each have a complete machine as a spare. The gearboxes have spare sets of gear elements.

For the reciprocating compressors there are certain key spare parts in the warehouse but a complete machine is not in stock.

In all there are enough spare parts on hand to minimize the amount of time that the plant would be down during a catastrophic failure.

Similar Equipment: Throughout Dow there are several compressors with similar frame sizes to match the Elliott compressors. There is a problem with similar aerodynamics between the machines. Mechanically Ternuezen has a 38M that is identical since they borrowed parts in 1989 during a wreck.

The gas turbines are unique in that they are two shaft machines.

ALarms/Trips: There are many alarms on the trains but the more significant ones that are not trips are:

All vibration points

Combustor basket temperature spread

High NOx/CO levels in stack gas

Low Gas Turbine inlet air temperature

High Gas Turbine axial compressor discharge temperature

High lube oil filter differential

Low Centrifugal Compressor buffer gas differential

The trips for the major rotating equipment are listed below:

Centrifugal Compressor suction drum high level trips

Centrifugal Compressor low seal oil differential pressure trip

Gas Turbine and Centrifugal Compressor low lube oil pressure trips

Gas Turbine and Centrifugal Compressor low control oil pressure trips

Gas Turbine high firing temperature

Gas Turbine high exhaust temperature

Gas Turbine high regenerator return temperature

Gas Turbine compressor bleed valve fully open