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"Restoration, Modification and Heating Maintenance Practice for a 4 Meter Double Divided Underjet Coke Battery"

Undated

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Restoration, Modification and Heating Maintenence Practice for a 4 meter Double Divided Underjet Coke Battery

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History –

Acme Steel Currently operates Two 1957 vintage 50 oven Wilputte Double Divided Underjet Coke oven Batteries. These Batteries have utilized Coke oven Gas as Fuel since the late 60's –

In 1978 Both Batteries under went thru wall Repairs – Original Regenerators were left intact as well as Suspending the original Brickwork above the oven Chamber, or "Hanging the Roof" as it's Commonly called. Underfire System was virtually left intact although Reversing Cocks and metering orifaces were Reconditioned on a as needed basis –

Acme continued to Resume normal operation of the Batteries well thru the 80's until Late 1989 –

Underfire System
Restoration and Modification –

In Late 1989, related to an obvious Gas Supply main Restriction both Batteries 24" Fuel Gas mains were Purged and openned for Cleaning – As Suspected Heavy

COKE OVEN DEPOSITS WERE FOUND TO BE RESTRICTING GAS FLOW ACCROSS the LENGTHS OF Both MAINS.— IN ORDER TO FACILITATE CLEANING IT WAS NECESSARY TO CUT 10" X 18" SECTIONS FROM the UPPER CIRCUMFERENCE OF the MAINS.— DEPOSITS WERE REMOVED AND the 10"x18" PANELS WERE REWELDED BACK INTO POSITION

IT WAS this CLEANING WHICH LITERALLY "BROUGHT TO LIGHT" the TOLL ADVANCED CORROSION HAD TAKEN.— With DEPOSITS REMOVED SEVERAL LOWER CIRCUMFERENCE AREAS DEMONSTRATED the ABSENCE OF METAL, AND MANY AREAS WERE FOUND TO BE DANGEROUSLY THIN. PROBLEM AREAS WERE ENCASED IN FIBERGLASS UNTIL A MORE PERMANENT REPAIRS COULD BE EFFECTED.

AFTER ANALYZING SEVERAL POSSIBLE REPLACEMENT SCENARIOS, IT WAS DECIDED that the BEST METHOD WHICH MET ALL COST, SAFETY AND BATTERY PRESERVATION CONSTRAINTS WOULD BE TO CONVERT the EXISTING 10" DECARB AIR MAIN FOR GAS SERVICE — REMOVE AND REPLACE the 24" MAIN, LOWER PIPING AND EMERGENCY COCKS - the RESTORE the 24" MAIN TO SERVICE. At this point it would be possible MAINS WERE SCHEDULED for REPLACEMENT ONE BATTERY AT A TIME.— EIGHT EIGHT HOUR OUTAGES WERE ALLOCATED FOR EACH BATTERY.

PREPATORY WORK CONSISTED OF CLEANING AND INSPECTING the 16" DECARB MAIN, BLIND FLANGING the BLOWER INLET SIDE, FABRICATION OF A 10" EXTENSION FROM the PRE HEATERS to the MAIN, ALONG WITH the INSTALLATION OF A 10" AIR ACTUATED REGULATION VALVE. — IN ORDER to AVOID HAVING to CHANGE OR MODIFY the REVERSING LINKAGE CONNECTIONS FROM the 10" MAIN WERE MADE DIRECTLY to the BOTTOM OF the REVERSING COCKS, WHICH UTILIZED the EXISTING STRUCTURAL SUPPORT COLUMNS. — AIR FOR FLUE DECARBONIZATION WAS PROVIDED BY DRAFTING THRU the REVERSING COCK CLEAN OUT PORTS.

BRAIDED STAINLESS STEEL

CHANGING RUBBER HOSES to

ACME'S SAFETY POLICY PROHIBITS the USE OF ANY SPARK GENERATING DEVICES IN the UNDERFIRE BASEMENT WHILE the MAINS ARE IN SERVICE. THIS REQUIRED EACH MAIN to BE PURGED. PRIOR to WORK BEGINNING. "SHUT DOWN MEETINGS WERE SCHEDULED WELL IN ADVANCE with CONTRACTORS, OPERATORS, IN HOUSE MAINTENANCE AND ACME SAFETY DEPT. PERSONNEL IN ATTENDANCE. MEETING WERE ALSO HELD AFTER EACH OUTAGE to DISCUSS ANY PROBLEMS WHICH HAD ARISON DURING the PROCESS.

DURING THE INITIAL OUTAGE FOR EACH BATTERY AFTER MAIN PURGING, THE REVERSING COCKS WERE CUT FROM the 24" MAIN AND

CONNECTED to the 10" MAIN VIA the STAINLESS STEEL BRAIDED HOSE with the INCLUSION OF BALL VALVES to ALLOW INDIVIDUAL HEADER CONTROL. SIMULTANEOUSLY WORK WAS INITIATED to INSTALL the 10" FABRICATED CONNECTION FROM the PREHEATER to the 10" CONVERTED MAIN.

ADHERENCE to the STRICT 8 HOUR GAS OFF CRITERIA FORCED US to EXCERCIZE A CONTINGENCY PLAN. ONLY ½ the BATTERIES CONNECTIONS COULD BE MADE SO THAT WE PROCEEDED to PURGE AIR FROM BOTH MAINS AND PLACE the 24" AND 10" MAIN INTO GAS SERVICE SIMULTANEOUSLY; AND ONCE AGAIN RESUME OPERATION.

EACH MAIN MAINTAINED ITS OWN REGULATION. PRESSURE IN the 24" MAIN WAS REGULATED AT 50 mm WATER COLUM WITH the 10" MAIN BEING REGULATED AT 500mm. ALTHOUGH FLOW METERS WERE INACCURATE IT WAS POSSIBLE to MAINTAIN A 100 OVEN SCHEDULE (24 HOUR COKE) AT A BATTERY AVERAGE OF 2260 F°.

DURING THE SECOND OUTAGE the REMAINING COCKS WERE CUT FROM the 24" MAIN AND DEMOLITION OF the 24" MAIN WAS BEGUN.

PNEUMATIC SAWS WERE UTILIZED to CUT the MAIN INTO 13 FT SECTIONS.—

A SECTION OF the WALL SEPARATING the BASEMENT FROM the COMBUSTION AIR TUNNEL WAS REMOVED to ALLOW the SECTIONS to BE DOLLIED out PAST the BATTERY SUPPORT COLUMNS — INTO the AIR TUNNEL then out AT the BATTERY ENDS —

AGAIN AFTER PURGE the ENTIRE BATTERY WAS NOW BEING SUPPLIED By the CONVERTED 10" MAIN. GAS PRESSURE WAS REGULATED AT 600 mm wc, with INDIVIDUAL HEADERS MANUALLY ADJUSTED By the NEWLY INSTALLED BALL VALVES. — 40-45 mm wc WAS the LARGER PRESSURE.

NEW 24" MAIN SECTIONS FABRICATED IN 13' FT SECTIONS FROM ASTM A53 steel PIPE, PRECOATED with COAL TAR EPOXY COATING. SUCCEEDING OUTAGES EACH SECTION WAS WELDED INTO PLACE — COMPLETE ENTERAL CIRCUMFRENCE WELDING with the INSIDE BOTTOM RECEIVING ADDITIONAL WELD. ALL INTERIOR WELDED AREAS WERE PRIMED AND RECOATED to 20 MILS with EXPOXY —

THIS NEW MAIN INCORPORATED SEVERAL MODIFICATIONS — 13 CLEAN out PORTS WERE LOCATED ON the UPPER CIRCUMFERENCE EACH PORT MEASURES 14"X20" AND ARE SPACED 14 FEET APART. IN ORDER to MINIMIZE PIPE LOSS DUE to EXPANSION AND

CONTRACTION MOVEMENT the MAIN WAS SEATED ON A SHEET OF TEFLON.

Both MAINS AFTER the SCHEDULED 16 REQUIRED OUTAGES WERE PLACED INTO FULL GAS SERVICE —

BASED ON ULTRASONIC tests CONDUCTED ACROSS Both BATTERIES, WHOLESALE HEADER AND ANCILLARY PIPE REPLACEMENT WERE FOUND TO BE UNNESSARY At this time (TABLE 1) 24 INNER HEADERS AND 26 outer HEADERS WERE IDENTIFIED AS BEING AT OR AROUND MIN. ASTM SPEC FOR GAS SERVICE.

PREFABRICATED 3" HEADERS (IN two SECTIONS) WERE MOVED INTO the BATTERY BASEMENT. MAINS WERE PURGED AND HEADERS WERE WELDED together. MAINS WERE RESTORED to GAS SERVICE AND INDIVIDUAL HEADERS WERE REPLACED VIA ISOLATION At the EMERGENCY COCKS. REMAINED ORIFACES WERE INSTALLED AS these HEADERS WERE REPLACED.

SUCCEEDING ULTRASONIC SURVEYS CONDUCTED IN LATE 1994 REVEALED THAT A VAST MAJORITY OF the EXISTING HEADERS HAD BECOME SUBJECTED to ACCELERATED CORRISIVE PIPE LOSS.—

PLANS WERE LAID out to EXECUTE WHOLESALE HEADER CHANGES. ONCE AGAIN HEADERS WERE PREFASED IN two SECTIONS AND LAIDED out IN the BASEMENT. SIT OPERATIONAL

OUTAGES WERE REQUIRED TO WELD SECTIONS TOGETHER. UNFORTUNATELY ONLY ENOUGH HEADERS COULD BE WELDED DURING AN OUTAGE TO REPLACE 13 complete WALLS — SO ADHERENCE TO OUR 8HR OUTAGE POLICY FORCED US to SPREAD out REPLACEMENT. USING the ULTRASONIC SURVEY AS A BASIS FOR HEADER REPLACEMENT, HEADERS INITIALLY COULD NOT BE CHANGED SEQUENTIALLY — WE PRIORITIZED ACCORDING TO DETORIATION AND FOUND US REPLACING HEADERS AT VARIOUS LOCATIONS ACROSS BOTH BATTERIES —

IT WAS ALSO NOTED AT this time that ACME BEGAN TO ENCOUNTER DIFFICULTIES with the REVERSING COCK CORES — THE LUBRICATION SYSTEM PROVIDED with the ORIGINAL INSTALLATION HAD LONG BEEN ABANDONED. GREASING HAD BEEN FILLING the BILL ALTHOUGH the ORGANIC BASED PRODUCT UTILIZED SEEMED TO BE SOLIDIFYING PREMATURELY. THIS CONDITION NOT ONLY SUBJECTED CORES TO MINI EXPLOSIONS SOON AFTER REVERSE BUT WAS SUBJECTING them TO PREMATURE WEAR & SCORING — ADDING TO the LACK OF A "GOOD" SEAL IN THIS AREA —

THIS NECESSITATED NOT ONLY HEADER/ORIFICE REPLACEMENT, BUT REVERSING COCK RECONDITIONING AND REPLACEMENT AS WELL, NOT to mention the LABOR INTENSIVE PROCESS OF STRIPING CORES, CLEANING REGREASING AND RE-INSTALLATION —

Finally after a process spread out over several years - ACME had in operation an underfire gas supply pipe system which was completely reconditioned. Unfortunately recent ultrasonic testing indicates that the new system will most likely not survive AS long as the original installation. (TABLE 2) Bypass perhaps enforced since Sept 1991 seem to have negatively impacted the efficency of our By Products ability to clean gas. This in turn has led to an accelerated corrosion rate approximately 40% higher than that measured in the period of 1957-1983.

In fact it has become necessary to replace several headers at the remote ends of the gas supply network after only several years of service.

Several important modifications ARE PAYING CURRENT DIVIDENDS —

① #1 BATTERY fuel GAS MAIN WAS OPENNED FOR INSPECTION IN MID 1996. — (the modified inspection ports provided easy access at all point

WHILE the EXCELLERATED CORROSION RATE IS APPARENT IN the HEADERS the FUEL GAS MAIN IS IN EXCEPTIONAL CONDITION — the EPOXY COATING REMAINS INTACT WITH NO EVIDENCE OF CORROSIVE DETERIORATION

② #1 BATTERY REVERSING COCKS ARE CURRENTLY

BEING LUBRICATED WITH A SYNTHETIC BASED GREASE WHICH SEEMS IMPERVIOUS TO CHEMICAL ATTACK — THIS HAS DRASTICALLY EXTENDED THE FREQUENCY AT WHICH A COCK HAS TO BE REMOVED FROM THE COKE — CLEANED, REGREASED AND REINSTALLED — NOT A SINGLE COCK LUBRICATED WITH THIS SYNTHETIC HAS EXPERIENCED POPPING —

(3) NEW REVERSING COCKS WERE CAST WITH SLIGHT MODIFICATIONS TO THE ORIGINAL GREASE GROOVES — A SLIGHTLY MODIFIED CHAMFERED GROOVE SEEMS TO PROVIDE THE BEST OVERALL COVERAGE ALTHOUGH TESTING CONTINUES —

(4) GAS HEADER FABRICATION HAS BEEN MODIFIED TO PROVIDE A 3" FLANGED CONNECTION AT THE POINT ORIGINALLY REQUIRING A WELD — HEADERS CAN NOW BE REPLACED WITH OUT A SHUT DOWN OR PURGE BY ISOLATION AT THE HEADER EMERGENCY COCK —

HEATING MAINTENANCE PRACTICE

AS EQUALLY IMPORTANT AS THE APPARATUS TO SUPPLY GAS AND AIR TO THE FLUE ARE THE BASIC HOUSEKEEPING REQUIREMENTS TO KEEP THE SYSTEM IN WORKING ORDER. (EXHIBIT 1) AS EVIDENCED BY A PAGE FOR ACME'S WORK INSTRUCTION - Heaters are charged

with the responsibilities to take flue temperatures every shift in every wall plus 4 complete crosswalls per turn. Heaters are also responsible to watch 5 ovens per battery as they are pushed to identify any localized heating problems —

(EXHIBIT 2) Weekly Heater Work Responsibility forms are used as a guide and to document housekeeping activities — All critical heating components are addressed — (EXHIBIT 3) Additional Heater Responsibilities include Reversing machine emergency back up testing — waste heat dampers & valves - Air Boxes and Air Filters - (EXHIBIT 4) To further enhance communications between the Heating Dept. and Operations Shift Managers we've recently required documentation of the heaters responsibilities — this report is basically designed to give ~~shift~~ operational shift manager information which aids him in identifying a potential "Green Push" which may be related to a heating maintenance activity —

Some of these activities are "day" specific but overall the heater is given latitude as long as the weekly requirement is met —

Historically this program has been adequate to meet most requirements — the crosswall heat distribution is excellent — and further verification is demonstrated by an acceptable oven to oven heating variation.

However Following ACME'S Quality Policy of continuous process improvement does not allow us to be just adequate. While the heating operation remained basically solid there were specific problem areas which had developed, generally as a result of the "to the roof thruway" and/or thru the loss of some basic practices as our work force, thru retirements became less experienced.

Several localized problems were thought to be originating in the regenerator area. Individual outer zone regenerators were opened and inspected. Cleaning, which in most cases involved removal of the top course of checker brick was performed where required. Only a handful of regenerator division walls were found to require repair. These were wet sprayed to seal cross leakage. Overall outer regenerators were found to be in acceptable condition.

In conjuction with the outer regenerator inspections it was deemed necessary to inspect the bus flues as well — Outer bus flue inspection ports were opened and explored, with no significant buildup found. — A mirror on a

stick" apparatus was rigged in order to see the roof of the outer buss flue for inspection of the Wellputte designed venturi brick at the base of the regenerators - Appox 20% of the venturis inspected were found the be restricted. Although material could not be collected for ANALYSIS, it was possible to design an apparatus to deliver compressed air to each venturi brick and blow the restricting material up into the checker brick - While premitive, this procedure is effective for inspecting & clearing outer venturi ports.

Inner regenerators are quite another story. It is impossible to inspect inner zone regenerators on a double divided battery without removing brick - all major undertaking.

Brainstorming in house produced a device to allow Heating personnel to feed a "heat proofed" video Cam into the inner buss flue and record the condition of the inner zone venturi ports. It was also possible to see the checker support brick thru the venturis

Not quite a full regenerator inspection,

but the next best thing short of tearing out regenerator division walls at oven walls and flues. A lance was fabricated to blow out restricted ventures as required.

~~These interim efforts had provided~~ In order to take additional proactive steps to improve our heating program — ~~to~~ Became Necessary, to ~~acquire~~ Services of ~~Supplemental~~ Additional → Consultation —

Areas were identified to provide additional fine tuning. ~~were noted and corrective action taken.~~

1. Excessive Stack Draft
2. Error in Basement Pressure Regulation Reference Point
3. Individual Flue Conditions —

It had been Acme's opinion that the excessive stack draft carried was providing the necessary excess oxygen (7-9%) to burn off suspected leakage from the oven chamber at the joint where the "Suspended Roof" had been joined to the new thru walls in 1978. While the "smoking stack" condition was alleviated ~~[illegible]~~ tom was being treated rather than the disease —

(F161) By conducting a complete flue gas on/
(F162) gas off survey it was ascertained that the combustion stack was demonstrating the results of poor combustion relating to the condition of air ports and
(F163) positioning of slide brick rather than crosshall leakage—
(F164) Additional manpower and resources were allocated to rectify these conditions. At the direction of our consultant we fabricated specially designed lances and bars to remove carbon deposits from the gas risers, air ports and slide bricks.

Over the years it became standard winterization practice to close and seal alleyway louvers. This offered the advantage of preheating air being drawn into the underfire basement.

Having done a superior job of sealing these louvers had the undesired effect of lowering the pressure in the battery control room to -.15 mmwc which housed the reference point for basement pressure regulation.— Consequently basement pressure would actually be -.20 mmwc rather than our target of -0.15 mmwc.

THIS FACT COMBINED WITH AN [illegible] HIGH STACK DRAFT (SET TO CONTROL EXC[illegible] O_2) CREATED A SNOWBALL EFFECT WH[illegible] TOP FLUE PRESSURE WOULD RUN SLIGHTLY NEGATIVE. THE NET RESULT OF THIS WAS AIR PORT CARBONIZATION AND DEBRIS INFILTRATION INTO THE RISER WHEN CAPS WERE REMOVED.

THE SIMPLE SOLUTIONS ~~WAS~~ ARE TO CLEAN ALL RESTRICTIONS AND RUN A 3/4" IMPULSE LINE FROM THE OVEN CONTROL ROOM TO THE ATMOSPHERE, TO INSURE ATMOSPHERIC PRESSURE WAS BEING REFERENCED —

BASEMENT PRESSURE WAS INCREASED TO @ -1.0 MM WC, STACK EXCESS O_2 SET POINT WAS REDUCED TO 5.5 WHICH IN TURN REDUCED STACK DRAFT, AND INCREASED FLAME LENGTH. THIS PROVIDED POSITIVE FLUE PRESSURE AND ALSO IMPROVED FLUE VERTICAL HEAT DISTRIBUTION —

ONCE A RELATIVELY CLEAN SYSTEM WAS PROVIDED IT BECAME NECESSARY TO BALANCE THE DRAFT ON INDIVIDUAL WALLS BY SETTING THE DRAFT DAMPERS (QUADRANTS) MEASUREMENT OF FLUE PRESSURE AND VISIBLE EXAMINATIONS OF COMBUSTION WERE USED TO DETERMINE DRAFT DEMAND OF EACH WALL —

slide back.

We also addressed the problem of ~~instrument~~ reference point. ~~Unbeknown~~ During the course of winterization it was our policy to close & seal all louvers on both the C/S AND P/S ALLEYS — THIS offered us the advantage of somewhat preheating AMBIENT AIR AS IT WAS DRAWN THRU the ALLEYS INTO the BASEMENT AIR COMBUSTION TUNNEL — UNBEKNOWNST TO US, HAVING DONE A SUPERIOR JOB OF SEALING THESE LOUVERS, WE HAD ACTUALLY LOWERED the PRESSURE IN the BATTERY CONTROL ROOM (WHERE OUR BASEMENT PRESSURE REGULATION INSTRUMENTS ARE REFERENCED) TO BE 1.5 MMK lower than Atmospheric AND CONSEQUENTLY BSMT PRESSURE TO BE -2.0 RATHER THAN -0.5 mmk AS thought — THIS COMBINED WITH AN ALREADY HIGH STACK DRAFT CREATED A SITUATION WHERE top flue PRESSURE WOULD RUN NEGATIVE THEREBY CREATING A SNOWBALL EFFECT OF WHICH the NET RESULT WAS FOULING OF FLUE AIR PORTS AND DEBRIS INFILTRATION WHEN FLUE CAPS WERE REMOVED to TAKE temperature —

THE SOLUTION WAS TO (A) KLEAN ALL RESTRICTIONS & (B) RUN A 3/4" IMPULSE LINE OUT OF the BATTERY TO DIRECTLY

Reference Atmospheric PRESSURE —

As A Result of this - BASEMENT PRESSURE WAS INCREASED to @ -1.0mmk - excess O_2 CONTROLLER PERFORMS ADJUSTMENT to REDUCE STACK DRAFT AND FLUE PRESSURES WERE INCREASED to BE JUST SLIGHTLY POSITIVE —

With the FLUE/AIR [illegible] PROGRAM COMPLETE — BOILER PRESSURE CONTROLLER REFERENCED to ATMOSPHERIC - WE PROCEED to to BALANCE the DRAFT ON INDIVIDUAL WALLS - this IS A TEDIOUS PROCESS WHICH INVOLVES SETTING the DRAFT DAMPERS (2 QUADRANTS) ON EACH INDIVIDUAL WALL. WE STARTED AT the WASTE heat OFFTAKE to the STACK - SET 5 WALLS IN EACH DIRECTION - ~~VISUAL OBSERVATIONS AND MEASUREMENT~~ OF FLUE PRESSURE ~~AT~~ COMBINED with VISUAL OBSERVATIONS OF COMBUSTION - DETERMINED DRAFT DEMAND for EACH WALL —

With the CULMINATION OF these EFFORTS WE HAVE BEEN ABLE to ~~RESOLVE SEVERAL PROBLEMS~~ —

① CONSISTENTLY RUN with EXCESS O_2 IN the RANGE OF 5-5.5% — maintain a slightly positive flue pressure and also experience a minimal amount of stack emissions —

In Conclusion, In view of ever tighting Government regulation, Daily Method 303 inspection, weekly method 9 & Stack AND PUSH READING not to mention the ALL KNOWING AND ALL SEEING "PUBLIC" WE AS COKE OVEN OPERATORS HAVE LITTLE OR NO MARGIN FOR ERROR. WE MUST CONTINUE TO EXIQUETE the BASICS AND STRIVE TO IMPROVE OUR [illegible] AND UNDERSTANDING

Introduction

Acme Steel currently operates two 1957 vintage 50 oven Wilputte double divided underjet coke batteries. Batteries have been fired strictly on coke oven gas since the late 60's —

In 1978 we "hung our roofs" and did three wall repairs to all 100 oven chambers — Work on the battery underfire system AT THIS TIME was limited to reconditioning of the reversing cocks and metering orifices.

By the early 80's our fuel gas mains began to exhibit signs of advanced corrosion — In 1983 both batteries had their Dressler expansion joints replaced - AS AN ADDED precaution we wrapped the joints — outside diameter with ½ inch of fiberglass — ~~The mains were cleaned~~ Main deposits were only removed as far into the mains as could be reached with shovels and bars —

In 1989 BY NECESSITY fuel gas mains were purged & cleaned & in order to facilitate cleaning we cut 10" x 18" sections from the upper portion of the pipe — Deposits were removed, ~~mains~~ the patches were rewelded in original position —

It was this cleaning which literally "brought to light" the extent of ADVANCED CORROSION we had incurred — With deposits removed several areas demonstrated the absence of metal altogether and many areas (especially the main bottom were found to be dangerously thin — Deteriorated sections were fiberglassed as a temporary repair, while our engineers and operators developed a plan to Restore the underfire system beginning with the fuel gas main —

~~By Mid 1990 it was decided in view of the facts uncovered during the main cleaning and continuing inspection of the underfire system that the entire underfire system beginning with the fuel gas main was due for reconditioning and or replacement. Money was appropriated to change the Gas Main (the most critical repairs required) and plans were made to Coordinate by~~

Plans & methodoly were laid out to ~~change~~ replace the fuel gas main, ~~do~~ emergency cocks, connecting pipework,

reversing cocks - inner and outer headers, orifices and metering pens - Essentially all the gas delivery piping - Having to meet production requirements and with limited funding it was decided to spread this reconditioning over the next several years - Due to its condition and key positioning the fuel gas main, lower connecting nipples and emergency cocks were slated first.

Mains were scheduled for replacement one battery at a time with eight - eight hour production outages scheduled for each battery - ~~It was decided that~~ In order to preserve production outages were limited to a strict 8 hour maximum -

This was made possible by converting the 10 in diameter decarbonizing air main into fuel gas service - The air main was cleaned, rubber connecting hoses removed and replaced by Stainless Steel ball valves with Stainless Braided flexible hose -

The air main was blindflanged on the blower inlet side. A 10 inch air actuated COG regulation valve was installed and an extention from the COG preheaters was fabricated and installed - In order to avoid any necessary changes to the reversing linkage - we chose to connect the ten inch main directly to the bottom of the

Reversing Cocks which essentially transfered the weight and stresses of the reversing cocks and linkage to the battery support columns — Air for flue decarbonization was provided by natural air draft thru the reversing Cock clean out ports —

Our street safe work permit policy prohibits the use of any spark generating implements in the underfire basement while the underfire main is energized with Coke oven gas. Therefore each outage required the purging of COG from the preheater and fuel gas mains prior to the beginning of work on any given outage. CO_2 was the selected purge medium — On The initial outage, the reversing cocks were cut from the 24 in main and connected to the 10 inch decarb main now set up for gas usage — The ten inch fabricated header and 10" COG regulator were connected to the preheater — Reversing cocks via the previously mentioned stainless braided hoses were connected to the 10" main — Unfortunately enforcing a Strict 8 hour limit outage only allowed enough time for only 1/2 of the reversing cocks to be connected to the ten inch main —

Because of the location of the emergency cocks it was possible to energize both the 10" main and 24" main with COG And resume operation.

Each main had its own regulator - Pressure in the 24" main was regulated at 50 mm water Column — The ten inch main was regulated at 500 mm. Although flow meters were at this point inaccurate a 100 oven pushing schedule - (24 hours coke) was maintained at a battery Average of 2260° F.

Prior to the next scheduled outage mechanical pipe cutters were utilized to cut the remaing 50 cocks away from the 24 in main — Once all the cocks were were being supplied by the 10" main COG pressure in the main was adjusted to 500 mm. water column — In order to ensure equal pressure in each header - COG header pressure was set by adjusting the ball valves previously installed — Each individual header was set at 40-45 mm water column —

The next outage after purge of both 24" and 10" mains demolition of the 24" main was begun — Pneumatic saws were utilized to cut the main into 13 ft sections. 13 ft was the maximum length

which could be maneuvered out of the basement due to space limitations created by the structural support columns of the battery. It was also necessary to remove a section of the wall between the ~~batter~~ basement and the combustion air tunnel. 13 ft section of the main were placed on dollies and rolled into the air tunnel and ~~out~~ the rolled out between structual columns —

New main sections were fabricated in 13 ft lengths and installed in the reverse manner —

This new 24" OD main was constructed of Extra Strength ASTM · A53 steel pipe pre treated with an Epoxy Coating.

On succeeding ~~courses~~ Each new section was fitted into position and welded into place - Entire external circumfurence was welded with the bottom inside circumfurence receiving and additional weld — Welded areas were cleaned primed and recoated with 20 mills of the same Epoxy coating

STEELCOTE EPO LINE 164

The new main incorporated several important design changes — 13 clean out ports were located on the upper circumfurence of each main — EACH port measures 14"x20" spaced 14 feet apart — An Expansion type slip joint with compression packing was installed in the center of ~~the~~ each main —

The main was seated on a sheet of Teflon with the intent to minimize pipe friction loss incurred by expansion and contraction of the gas piping —

Once intact the mains were purged and the existing headers were reconnected to the new 24" main —

In late 1992 - After 16 total eight hour outages the new mains were available for full service —

Prior to proceding with Phase 2 of header replacement in order to gain useful direction we selected to perform ultrasonic metal thickness readings on the 3" inner and outer headers — Base 1957 data was compared with our last full survey in 1989. It was felt that promulgation and implementation of the Benzene NESHAP in 1991 would have had an accelerated effect on corrosive pipe loss —

1993 Ultrasonic testing did not bear this out — With the exception of the extreme battery ends - Corrisive rate loss from 1989 - 1993 was found to almost equal to corrisive loss measured from 1957 to 1989 or around 1.4 mils per year — (TABLE 1)

It was decided that only areas exhibiting extreme corrosion which were listed as P1 or P2 priority would be replaced — Yearly ultrasonic readings were to be taken to insure that corrosive loss did not ~~cause~~ jeopardize safety or plant operation —

24 inner headers and 26 outer headers were changed Between late 93 and Mid 94 —

Prefabricated 2 piece 3" headers were moved into the battery basement underfire area — Required outages were taken — mains purged and the 2 piece headers were welded together — Mains were restored to gas service and individual headers were replaced via isolation at the wall emergency cock — Removed Orifices were installed as the headers were replaced —

A follow up ultrasonic survey conducted in late 1994 however reflected the accerlated wide spread corrosive type loss which had previously been anticipated.

Using .190 thickness as minimum ASTM spec vs original .216" of virgin Schedule 40 indicated that the majority of headers were requiring replacement.

Phase 2 was swing into full implementation.

2 piece headers were again prefabricated. Pieces were assembled in the underfuel basement. (Shut downs were taken - (It was possible to weld enough headers during a shut down to Replace ~~26~~ 13 inner/outer headers each time — IT WAS ALSO DURING THIS TIME THAT DIFFICULTY WAS INCOUNTERED at the REVERSING CORE CORE AREAS — LUBRICATING GREASES WERE ~~Seed to~~ Seeming/y SUFFERING from premature Solidfication - which from time to time would produce a Caricturistic "pop" — # As equally as important cores were sustaining premature wear and scoring further adding to the degredation of a good seal at this point — ~~In fact of need~~ - As we progressed with header replacement it ALSO ~~[illegible]~~ became procedure to replace reversing cocks, headers, and orifaces in unison - ##

Finally in late Nov. 1995 - ALL ORIGINAL 1957 INSTALLATION UNDERFIRE PIPING, REVERSING CORES HEADERS ~~&~~ CROSS NIPPLES AND ORIFACES ## HAD BEEN REPLACED — Essentially at the end of 1995 we thought we could safely assume that since the original piping had survived 30 + years we could reasonably effect ~~that~~ this new piping to last well into

the 20th Century.

Unfortunately ultrasonic testing conducted in Oct of 1996 Did not hold this to be true — Apparently the Avg. Corrosion rate has accelerated to @ 2.6 mils per year an increase of @ 40% — TABLE 2

— In several localized areas it has already (as early as Jan. 1997) forced us to replace some headers which were installed in late 1993 —

Several modifications have been implemented since the undertaking of the underfire pipe replacement program —

Inspection of the fuel gas main in mid 1996 found the underfire main to be in exceptional condition although it was required to remove spot deposits — Mainly at the junction of horizontal and vertical 24" main runs — (The inspection port modification did allow us to thoroughly & easily inspect the main)

We have conducted experimentation with a synthetic silicon based lubricant for use in the reversing cock cores — As of this date #1 battery is currently being greased with this synthetic — with excellent resistance to chemical attack

which has drastically reduced the requirement to strip cores - clean & regrease then reinstall —

Gas header fabrication has been modified to provide 3" flanged connections which has eliminated the need to weld 2 pieces on site and thereby eliminate production outages to replace headers —

Basically — having the apparatus to deliver gas is only a part of the requirement — In order to maintain production requirements, meeting all environmental constraints and producing a quality product also requires an intensive inspection - corrective action plan to maintain not only the gas delivery system but the flue chambers and ~~ducts~~ drafting passages as well — Essentially the problem is to maintain effecient combustion in the flue wall — insure even distribution throughout the coking chamber ~~and eliminate hot spots~~ —

Acme has always had a rigorous state of preventative "housekeeping" maintenance practices for the heating department — (*) chart (1) Overhead + work instruction CPWL 013

As seen from our work instruction manual the heater has the responsibility to take flue temp readings each shift — #5's and #11's - as well as 4 complete

crosswalls each shift - (2 each battery)
Ovens are observed as pushed to IO any cool spots which may indicate heating corrective action is required - At least 5 random pushes per battery are observed each turn -

Weekly work activity reports are an important part of the heater's responsibility - These reports are filled in on a daily basis for review by the heating manager - Duties are in some cases daily specific - but most are subject to the heaters discretion as long as the weekly work requirement is met - The only allowable exceptions to routine housekeeping chores are when and if a problem has been identified. Then corrective action may take the place of routine maintenance on a turn - If this occurs - heaters are sometimes required to perform 2 days housekeeping activities in one shift -

(CHART 2) Heater/Helper weekly work responsibilities

CHART (3) Heater/Helper Weekly Checklist

~~Note that the housekeeping activities are pretty generous~~

This program has historically been adequate enough is meet most requirements - Crosswall heat distribution is excellent. The adequacy of our cleaning & maintenance programs are verified by an acceptable oven to oven heating - However End flues receive special