CENTRAL ENGINEERING DEPARTMENT

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PROJECT FINAL REVIEW

Date: August 29, 1969

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LIQUID AROCLORS - EXPAND PRODUCTION FACILITIES

W. G. KRUMMRICH PLANT - SAUGET, ILLINOIS

CEA 1800

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PROJECT FINAL REVIEW REPORT
Aroclor Expansion - W. G. Krummrich
CEA 1800   8/29/69

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PROJECT FINAL REVIEW REPORT

CEA 1800 LIQUID AROCLORS - EXPAND PRODUCTION FACILITIES AT W. G. KRUMMRICH PLANT

Part I SUMMARY

A. INTRODUCTION

The Organic Division produces a group of important polyphenyl compounds which are marketed under the trademark "Aroclor". Production of certain of these was increased by this project. The new facilities included a new continuous chlorination line, blow tank, intermediate storage, distillation equipment, continuous clay treatment equipment, finished goods and biphenyl storage tanks with new rail spur and loading docks.

Major innovations were: change from batch to continuous process, method of handling and introducing catalyst, continuous earth treatment and application of the Monsanto Power Factor Analyzer.

B. CONCLUSIONS

1. General

The project was based on plant developed improvements to known technology supplemented by CED process design, a well detailed scope, realistic cost estimate and schedule.

Project administration, design and construction were efficiently performed under conditions of excellent relations with, and cooperation from, plant participants.

Plant reaction was very favorable regarding the overall handling of the project, operability and appearance of the facility.

Transfer of responsibility for instrument maintenance from CED to the plant appears to be the only point where some misunderstanding was indicated.

CED design of the controls for the Therminol heating system worked very successfully and eliminated problems encountered on some other recent projects.

2. Resolution of Objectives

The project has demonstrated all of its objectives;

PROJECT COST	Appropriated	Final	
Capital	1,500,000	1,376,000	
Expense	60,000	92,000	
Total Project	1,560,000	1,468,000	(-8%)

ENGINEERING COST	200,000	278,505
% Total Project	12.8	18.9

START-UP	SCHEDULED	ACTUAL
Tank Farm	7/1/68	6/28/68
Facility	12/1/68	10/15/68

CAPACITY, YIELD, QUALITY
The planned capacity increase was demonstrated with yield and quality better than expected.

OTHERS
The facility was started-up smoothly, appears to be easily operated and maintained. Includes space and provisions for some future expansion.

C. RECOMMENDATIONS

1. Project Managers make sure that details of the plan for plant takeover of Maintenance, particularly instruments, are clearly defined, preferably in writing, and adhered to.

2. Construction Supervisor be brought in early and given a prominent part in assigning priority for scheduling of field work. He should also be actively consulted in specification and purchase order preparation for package equipment.

3. A Phase II (Follow-up) Review not be made.

Part II DETAILS

BACKGROUND

For several years prior to this project, the WGK Technical Service Department (TSD) Aroclor Group, and more recently the Plant Research and Development Department (PR&D), worked with the Anniston Plant on ways to improve the Anniston Process and increase capacity.

SCOPE

The basic information for a project was developed and transmitted to CED late in 1967. A project scope and cost estimate were prepared by CED with plant people participating in working out early details pertaining to such things as sewers, pump drains, and valve arrangements. Design proceeded on Pre-Project approval and the Appropriation Request was approved in 11/67.

ORGANIZATION AND COMMUNICATION

The project was organized in the manner generally described by existing CED Operating Procedures. An Organic PD & PM Process Engineer served as Project Manager in addition to performing the process design. A Project Organization and Procedure (POP) was issued.

An AC&M Design Coordinator was used, but most of the AC&M Design work was done by lead design engineers in the respective disciplines. An EI&U Coordinator was assigned for a short time, but then the function was also performed by the AC&M Coordinator. The lead electrical and instrument engineers assigned had worked together on three projects immediately prior to the project and their communication pattern had been well developed.

A plant Manufacturing Representative and a Maintenance Representative were appointed to handle communications with plant participants.

In addition to the communications listed in detail by the POP, combination Status/Problem Solving Meetings were held at least every two weeks. These were attended by lead design engineers, construction superintendent (field or office) and draftsmen from CED. Plant representatives attended regularly and the production supervisor and foreman attended as appropriate.

Communication throughout the project appears to have been excellent; it helped CED's performance to have people working on the project meet and know each other. Proximity of CED Office to the project location was, of course, a special asset.

At the time of mechanical completion, the Field Construction Engineer arranged for all draftsmen who worked on the project to visit the site, inspect the finished facility, and meet contractor supervisors and foremen who pointed out where changes or corrections had been necessary.

The Director, D&C Branch, arranged for a similar review by the design engineers and supervisors. These reviews were well received by those attending.

PROCESS DESIGN

Aroclors are the reaction products formed by the chlorination of biphenyl in the presence of an iron catalyst. The crude Aroclors are air-blown, distilled, earth treated, filtered, and transferred to finished goods storage tanks, then to tank cars or trucks.

Distillation residues are discarded as waste or sold as montars.

The additions include a new continuous chlorination line, blow tank, intermediate storage, distillation equipment, continuous clay treatment facilities, finished goods storage tanks, and a biphenyl storage tank with a new rail spur and unloading docks.

Major innovations were changes from batch to continuous process, method of handling and introducing the catalyst, and continuous earth treatment.

The Process Design was done by the Project Manager based on information furnished by WGK Technical Service and Plant Research Departments.

MECHANICAL DESIGN

Mechanical Design was under the direction of the Design Coordinator. Architectural, Civil and Structural design was done by engineers in that functional group.

Equipment, piping and other phases of Mechanical Design were performed by a new engineer, just out of college, with the Coordinator acting as advisor and instructor. It was agreed at the time of assignment that, if at all possible, the arrangement would be continuous to project completion. In addition, the coordinator effected an early understanding with the draftsman that consideration of the man's experience should be made. Excellent rapport was established and very satisfactory results attained.

Mechanical design proceeded smoothly. One controversial issue did arise when some piping drawings were not reviewed promptly by all plant reviewers. Late comments, which were received after the drawings had been issued for construction, requested more flanges and other changes which the Project Manager rejected. Some clean-out problems have been encountered at the Intermediate Crude Storage Tanks which additional flanges would have made easier to solve.

ELECTRICAL DESIGN

Two electrical engineers, one functioning as lead engineer, did the electrical design.

Considerable relocation of existing feeders was required and existing facilities provided problems in routing for the new work. Photo drafting techniques were used effectively to solve problems encountered in this part of the work.

This was one of the first installations at WGK which used power trays and cable in place of conduit. Changes and additions were easily made as the work progressed.

Excellent help was received from the plant electrical maintenance liaison people which, in addition to their receptiveness of new ideas, resulted in a better installation than the lead electrical engineer had expected to obtain.

Plastic coated conduit was used in the tank farm area to be consistent with existing facilities.

The lead electrical engineer reported good and timely input of information from CED participants, also quick decisions and problem solutions from the Project Manager and Manufacturing Representative.

INSTRUMENT DESIGN

Instrument Design was initiated early in the project. About the time the Engineering Flow diagrams were in preparation, the lead Instrument Engineer was transferred. His replacement carried on about three months and then went away to Instrument School for 8 weeks. During the interim, two other instrument engineers picked up the work. The lead engineer returned at the time the major part of the Instrument drawings were ready for checking and issue. He continued work in the project through checkout in which he was assisted by a CED Instrument Technician, contractor fitters, and electricians.

In addition to the process instrumentation, design of the "package" Therminol heater control system was prepared to avoid problems of previous "package" systems which never seemed to function properly.

Instrument Function Outlines (IFO's) were prepared by a summer student working under the direction of the lead engineer. Most of the information was presented on D-size drawings and included:

(a) A why and how of each loop
(b) A description of each item in the loop
(c) Instrument specifications as necessary
(d) A loop schematic

Cost was charged to the Plant Start-up budget.

An interesting application of new technology was the Monsanto Power Factor Analyzer. This is an instrument developed by the New Enterprises Division and measures Aroclor quality.

UTILITIES

These were included as part of Mechanical Design.

DRAFTING

Drafting was done in AC&M and EI&U Drafting Rooms according to the functional division existing at the time.

Presentation included simplified piping plan and single line isometrics (about 50 drawings containing 200 isometrics), photo drawings and a finished model. This model was one of the first on which piping draftsmen placed the piping.

Field construction reported that the quality of the drawings was very good and the model a definite asset to the project. Piping drawings were rated by the Field Engineer as among the most complete and accurate that he received for a WGK project.

He also reported that he and the piping contractor personnel were especially pleased with the detailed drawings of the steam tracing system and they feel certain that considerable savings in field labor were achieved as a result of this.

Electrical and Instrumentation drawings were similiarly rated excellent.

The Project Manager followed the policy of clearing all requests for drafting changes through the Coordinator or design engineers; smooth relationships between all disciplines were attributed to this by others.

The model was extensively used for review and discussion with such persons as Union Business Agents, Contractor Supervision, Production Supervisor and Foremen. Details such as location of traps, drains and orientation of valve handles were resolved or corrected, particularly by the Production Foreman.

The electrical engineer felt that the model lessened the impact of a weak cross check between electrical and piping drawings. It cost $18,000, but the general conclusion of project participants is that the benefits from a more efficient piping layout and long term housekeeping items will more than offset the cost.

PROCUREMENT

All phases of Procurement were performed in normal manner.

Special expediting effort obtained cable trays in advance of scheduled delivery which permitted acceleration of the construction schedule. Application of protective coating was arranged locally to assist this change.

Expediting and Inspection coordinated well to obtain delivery of all large vessels at about the same time. This saved considerable money on rental equipment.

The copper strike caused some delivery problems and expediting was beneficial. In some cases, the vendor could only ship part of an order and substitutions were accepted for the balance.

The production supervisor considers CED decision to purchase Cuno filters, on basis of "price only" over plant recommended Alsop Filters, to be poor judgment. Greater weight should have been assigned to successful in-plant service. Price savings are inconsequential in comparison to housekeeping costs already incurred to clean-up leakage. The filters, rated at 125 psi, leak frequently at 50 psi, Aroclor service. A factory representative has inspected the equipment, and made some corrections but these have not been successful.

COSTS/CONTROL/SCHEDULING

Costs and Control were in line and effective.

A minor problem in control was experienced in separating project costs from repair costs for work performed by the contractor. Several parts of the facility, all located in the same physical area, were completed and started-up at different times. In order to avoid jurisdictional problems, contractor personnel were used for maintenance work until all parts were started-up.

A Master Schedule was prepared and formed the basis for the Construction Schedule. These were revised to take advantage of opportunities for improving the completion date. Completion was approximately 7 weeks ahead of the original date.

SAFETY

A loss prevention review was conducted.

Safety audits were conducted prior to start-up of the various phases.

No incidents were experienced during construction or start-up.

STANDARDS

WGK "L" Manual and other Monsanto standards were used wherever applicable.

The project scope called for the use of galvanized structural steel. During the summer HCL fumes attacked the galvanizing and it was decided to paint over the galvanizing using a plant "L" Manual vinyl system. The steel was chemically washed before painting; later, an adhesion problem appeared. This resulted in considerable discussion; however, the coating is still in place, with the exception of a few spots, and in the Board's opinion is not a problem.

The Manufacturing Superintendent questions if the use of standard chemical pumps is being blindly followed. In his opinion, some pumps on this project may be marginal; AVS pumps may have been used where API pumps would have been a better application. (AVS pumps were used previously with satisfactory history both at WGK and Anniston Plant. API type pumps on the Anniston Chlorinator did operate longer before requiring major repairs.)

POLLUTION CONTROL

A Brink entrainment separator was provided for the HCL off-gas recovery system and is working very effectively. Recovery has been the equivalent of 11 batches through 5/1/69, or an effective yield increase of about ½ to 1%; this in addition to the benefits in pollution improvements.

CONSTRUCTION

Most of the project construction was done by extending existing contracts; piling, painting, insulation, and railroad siding extensions were done lump-sum.

The Field Construction Engineer was finishing another project at the plant at the time he was assigned to this one. Most of the Contractor supervision had been working at the plant for years and most of the craftsmen also had Krummrich Plant work experience.

This type of job continually makes for good relationships.

Most material take-offs were made by Contractor personnel and were very accurate; very little surplus material remained at completion.

Early in the project, tie-ins were isolated and given priorities; the objective being to have everything ready to take advantage of opportunities for tie-in as they occurred. Early issue of piping drawings allowed prefabrication to proceed before equipment was set.

The project used much flared pipe which was fabricated on the CED Leonard flaring machine.

Considerable aluminum piping was used on the project without problems. Three good welders, proper type of high frequency welding equipment and rod resulted in successful use of the Monsanto standard piping specification.

This was one of the first CED projects to use cable trays. The construction engineer found it advisable to cover them with sheet metal when working above to avoid damage to the cable insulation from welding sparks and falling hot metal.

Practically no overtime or premium pay was required.

Much work was done from preliminary drawings; especially piling and foundations. This permitted getting an early start in January at a time when the weather broke favorably for pile driving. Out of a total of 106 piles, 4 or 5 had to be changed due to underground obstructions.

START-UP

The project was divided into phases so that there were really three separate start-ups over a period of about 2 months, each rather informal and with practically no overtime required. All were very smooth and the start-up costs were within $1000 of budget. The Manufacturing Superintendent considers this to be the most successful start-up that he has experienced.

Use of the Kepner-Tregoe Potential Problem Analysis Procedure was helpful and gave alternate routes to some problems; eliminated some routes to others.

Start-up preparation and organization closely followed the "Organic Division Guide for Plant Start-Up" with two minor deviations: the Research Representative was not assigned as soon as specified, regular formal meetings were not held during the start-up. The Research Representative thinks that it would have been better if his assignment had been made earlier. Most participants are of the opinion that omission of the regular formal meetings did not result in any problems.

As all the parts of the facility that were started-up separately were in the same physical area, it was decided that CED would handle all maintenance with contractor personnel until everything had been started-up. This was to avoid jurisdictional problems and worked out satisfactorily, but it was difficult to keep maintenance and new construction cost separated. It also resulted in what appeared to be a lack of decision on the part of plant maintenance to actively take over maintenance, particularly instruments, after everything had been started-up.

Part III APPENDICES

A. CLIENT REACTION

1. General appearance of the facility is good.

2. Design of Brink entrainment separator is good.

3. The intermediate tank is a key to many quality gains which could not be attained without the flexibility that it provides.

4. The Instrument Design Basis is very useful and helpful.

5. Early issue of the Instrument Index is desirable even if incomplete; this gives plant personnel a better opportunity to become familiar with the instruments.

6. Maintenance costs to date are below budget and it is anticipated that the budget will be cut next year.

7. Project was well organized, well run.

8. It is felt that CED instrument people were not available to the extent necessary to get the Dynatrol Density Indicator going promptly.

9. Production Foreman commented that it was difficult to get CED people back to work on instruments after start-up.

10. Maintenance Representative dislikes the CED practice of starting equipment numbers with 100 for every area. This makes it difficult to file because the area number is not easily identifiable with the equipment number. When doing a job in an existing department, he would prefer that the sequence of the existing department area number system be continued.

11. The Maintenance Representative reported that there were practically no maintenance problems with the facility.

12. The Area Maintenance Supervisor asked to be excused from a final review interview on the basis that he had not had enough problems with the installation to even become familiar with it.

13. CED Instrument loop numbers are not compatible with WGK numbering system and constitute an inconvenience.

B. OTHER REACTIONS

1. The instrument engineer received the impression that the Krummrich Plant instrument people are not receptive to nuclear instruments so he did not use this type, although one is working well at Anniston.

2. He also felt there was some lack of understanding between Project participants and plant instrument maintenance as to the division of responsibility for instrument maintenance after the final start-up. He recommends that better definition of the transition be made to avoid repetitious training expense.

Internal plant communication regarding distribution and custody of instrument design documents and vendor data should be reviewed by plant people. For example, IFO's, including masters, were transmitted to the plant in early September, but requests for copies were received as late as May, 1969.

3. The CED Instrument Engineer thinks the Power Factor Meter needs more development to make it less of a laboratory and more of an industrial instrument. CED might be of some assistance in this.

4. The electrical engineer complained that his requests for copies of the estimator's work sheets for the electrical categories were ignored for a long time. He feels that this information would permit him to detect cost problems more quickly.

5. CED Drafting personnel consider the Field Construction Engineer's review with Contractor Supervision to be very beneficial to them.

C. <u>LESSONS</u>

1. Special effort was directed to avoiding problems encountered with previous pre-wired, pre-piped and assembled instrument panels. The specifications and purchase order were explicit in details of check out and pre-shipment packaging. Fabricator detail drawings were approved before start of fabrication. Patch tubes were incorporated to facilitate check-out which was done by the CED instrument engineer, who personally replaced stops and made sure glass items were properly protected after check-out. The completed panel was shipped in one trailer as its sole contents and without transfer between origin and plant. Panel arrived in perfect condition.

2. Some expansion space was originally allocated in the panel, but as the job progressed, this space was used. The space required for the numerous pressure switches was greater than expected. The instrument engineer recommends that when a large number of pressure switches are needed, a separate panel or rack should be considered and designed to accommodate mechanics' head and arms.

3. The panel specifications and purchase order were changed to delete factory installation of small size piping, which construction felt could cause a jurisdictional problem at the job site. The need for this may vary depending on project location and degree of construction activity.

4. When common supports are to be used for cable trays and instrument tubing, the construction engineer should be alerted early so that a jurisdiction agreement can be negotiated in advance.

5. Several control valves with remote operators (Bettis) had to be relocated because maintenance mechanics couldn't work on them. These were setting out in space, accessible only by ladder, and remote from any suitable overhead point of support for rigging. Valves, size 1½" and up, are heavy and difficult to handle.

6. The sample surge tank had to be traced and insulated because the contents froze.

7. Numerous slip blanks were used to isolate various parts of the facility as other parts were started-up. Some of these were covered with insulation and were difficult to locate when time came to remove them.

8. The main air supply line contained a riser between the main header and the facility. Water, trapped at the riser, froze and blocked the line in cold weather.

9. Drains for circulating lines which contain slurry, or material that can crystallize, should not contain a bend or elbow between the bottom of the line and the drain valve. This makes it difficult to rod out when blocked.

10. A common cooling water system supplies both still condensers. Temperature control is not very satisfactory when different materials are being condensed in each.

11. Design of the still condensers revealed that when condensation takes place inside vertical tubes under vacuum, sonic velocity in the tubes may control design, rather than heat transfer through the tube walls. Some computer programs may not recognize this.

12. The WGK plant practice is to restrict conduit to two motor circuits only.and CED electrical design observed this practice. One conduit was later found to contain four circuits which made it necessary to run additional conduit when one of the circuits became defective.

13. The ferric chloride catalyst has always been difficult to feed at a slow rate. Pulse feed, using solenoid valves and timer, is working well. The feed tank level is monitored as a check on the quantity fed.

14. The major customer's representative was critical of the absence of a roof over the tank car and tank truck loading dock for a product having such close quality requirements.

15. A Brooks positive displacement meter was used to meter Aroclor containing ferric chloride. The operating temperature was higher than anticipated and resulted in rapid failure. A higher temperature unit was obtained and is working satisfactorily.

16. The jacketed packing gland on three ductile iron Durco pumps leaked steam into the goods. These have now been steam traced and the gland plugged with pipe plugs.

17. The still and still receiver pumps have not operated satisfactorily on 40 mm. vacuum service. Improved operation has been obtained on one by replacing the stuffing box with a mechanical seal. These pumps are very difficult to pack because of the insulation on the casing and an insulated pipeline running directly above the pumps.

18. F&P Scanline narrow-case controllers are working very well although some production people find it difficult to get used to the narrow chart and like to see more hours of recording exposed. The pens in these instruments seem to plug easier than older type controllers.

19. The Dynatrol in-line density measuring instrument in the discharge line of the chlorinator is a very sensitive and accurate resonance frequency type of instrument. However, it is susceptible to upsets due to temperature changes, vibration and air bubbles in the fluid. It drifts and needs to be zeroed about twice a week. If a shut down occurs, the instrument has to be realigned when starting-up.