MONSANTO CHEMICAL COMPANY

ORGANIC CHEMICALS DIVISION

ANNISTON, ALABAMA

REVISION OF PHOSPHATE DIVISION ENGINEERING DEPARTMENT REPORT NO. 117

ON

12 UNIT BIPHENYL PLANT AT ANNISTON, ALABAMA

Dated: December 23, 1948
by
G. W. Jordan

Anniston Technical Services Department
Report No. 729-68-9
by R. L. Hedworth

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SUMMARY

Future Biphenyl-Santowax requirements have necessitated an increase in Biphenyl production while maintaining approximately the same Santowax production. This production balance can be achieved only by increasing the benzene feed rate. Numerous alternatives can be conceived on how this might be accomplished, but before any evaluation can be made, it was necessary to determine what must be done to the existing plant to obtain continued production. Consequently, a Maintenance Survey was needed to determine the extent of the necessary repairs. In addition, the Phosphate Division Final Design Data Report for the existing Biphenyl plant, prepared in 1948, was out-dated and needed revising. To minimize the work load, these jobs were combined.

This report describes in detail the equipment used for the production of Biphenyl at Anniston. The equipment description is based on equipment inspection, firsthand knowledge, and on information supplied in Phosphate Division Engineering Department Report No. 117, titled "Final Design Data on 12 Unit Diphenyl Plant at Anniston, Alabama," dated December 23, 1948, by G. W. Jordan.

The Maintenance Survey presented in this report is based on visual inspection of each item and includes only those repairs needed to put the plant in good operating condition. Revisions to the process, equipment improvements, piping alterations, etc., are beyond the scope of this report. These alterations and/or additions will be presented in subsequent reports and will be evaluated and justified on their own merits.

The words "Biphenyl" and "Diphenyl" are synonymous and are interchangeable in this report.

R. L. Hedworth

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DESCRIPTION OF PROCESS

INTRODUCTION

Diphenyl is produced by a pyrolysis reaction between two molecules of benzol in which one molecule of diphenyl and one molecule of hydrogen are formed. The pyrolysis is brought about in this particular case by stepwise vaporizing and super-heating benzol by bubbling the vapor through a series of pots filled with molten lead. The temperature to which the final lead pot or "converter" is heated determines the percentage of the benzol converted, which increases with higher temperatures.

Several other pyrolysis reactions also occur producing mainly terphenyl and also some more highly polymerized compounds. In addition, some free carbon is formed which deposits in the units causing considerable maintenance difficulties because of plug-ups. The percentage of terphenyl in the crude Biphenyl is roughly the same as the conversion percentage of the benzol.

SYNOPSIS OF PROCESS

Liquid benzol is shipped in tank car lots to the plant site and unloaded through the top dome by a siphon type pumping arrangement delivering the benzol to storage tanks. The benzol delivery pipe is steam traced and the storage tanks have steam coils to prevent the benzol from freezing in the winter. Each of the five storage tanks has a sump pump for delivering benzol to the feed tank. These feed tanks are automatically refilled by a continuous "let-down" control. Only one of the storage tanks is allowed to feed the feed tank at a time. This choice of storage tank is manually determined by an operator. The single feed tank services all of the diphenyl units by means of a centrifugal pump fed from a bottom outlet in the tank. The benzol feeds a header where the individual feeds are metered through orifices to the different units.

Isopropyl alcohol is added to the benzene feed in concentrations of 0 to 0.5% by weight, usually 0.15% is added. This isopropyl alcohol is pumped to the suction of the benzene feed pump where it is mixed and pumped to the units. This material catalyzes the conversion, that is, a 40-60°C. lower operating temperature can be maintained when this material is added to the feed benzene.

There are twelve diphenyl units of equal capacity, each consisting of a pipe coil vaporizer located in the flue gas exhaust stack, two preheater pots and a converter pot filled with molten lead and suspended in a firebrick setting for burning natural gas, and a fractionating column with a condenser and split flow box. In two of the units, Nos. 4 and 5, one of the preheater pots is replaced with a heat exchanger.

The units are numbered 2 through 13, there having been a No. 1 unit at one time. The present number of units were erected in five installments, Nos. 2 and 3 having been erected at different times, Nos. 4 and 5 together, Nos. 6, 7, 8, 9, and 10 together, and Nos. 11, 12, and 13 together so that these groups are all

slightly different in some details. However, there are only actually two fundamentally different types of units, Nos. 4 and 5 differing from the rest in that one of the preheater pots is replaced by a heat exchanger. Although the heat exchanger effected a gas savings as predicted, it proved impractical due to carbon formation fouling the tubes and the idea was abandoned on the subsequent units.

After the benzol feed has been metered through an orifice, it passes through the vaporizer pipe coil in the flue gas exhaust stack where the liquid benzol is vaporized and at the same time recovers some of the heat from the exhaust flue gases. The benzol vapor is then bubbled through molten lead in the two preheater pots in series and the temperature stepped up to the pyrolysis reaction temperature. The hot vapors are converted to 10-30% diphenyl as they leave the converter pot, which is similar to the preheater pots except that the molten lead is very carefully controlled at the desired reaction temperature, usually between 750 and 810°C. The temperature is adjusted to give the percent conversion needed to maintain the balance between Biphenyl and Santowax needed to meet sales demands.

After leaving the converter, the benzol and conversion products pass first through a lead trap (which is essentially a wide place in the line) for removing entrained lead and then enter the bottom plate of a fractionating column. A considerable amount of carbon adheres to the pipes between the converter and the lead trap, and the lead trap and the fractionating column, necessitating the removal and cleaning of the pipes every one to six months.

The super-heat in the vapors from the converter is utilized in a fractionating column to effect a partial separation of the benzol from the conversion products. The conversion products are later completely separated in a batch distillation. The column top is maintained at $<100^{\circ}C$. by refluxing the condensed benzol vapors back to the top plate. The conversion product and some benzol is condensed in the column and allowed to overflow from a carbon trap on the bottom of the column to a crude diphenyl catch tank for storage prior to batch distillation. The overhead vapors from the column are cooled by a partial condenser and the liquid benzol drained to a rotaweir for spitting the flow into reflux and benzol overhead which is "run back" to the benzol feed tank by gravity. The rotaweir is used to adjust the ratio between reflux and overhead. There are five differently sized and designed groups of condensers, a new design having been made for each installment of units as mentioned earlier, and a different design used to replace some bad condensers. In addition, these condensers have been shifted from one unit to another to facilitate cleaning and repairing condensers.

The conversion product hydrogen, saturated with benzol vapor, is bled off from the condenser and rotaweir, collected in a common header, and passed through six coolers, connected in parallel, where some of the benzol is condensed and allowed to run by gravity back to the auxiliary feed tank. From the coolers the saturated hydrogen gas is passed to a collecting tank in which more of the benzol condenses out and is drained to the benzol pump tank in the compressor room. The hydrogen from the collecting tank is compressed in two stages to 250-300#/in.^{2}. An intercooler and aftercooler condenses the benzol vapor after each stage. This benzol is collected in pressure receivers after each stage and periodically

blown by the hydrogen pressure over into the pump tank for return to the benzol feed tank. The hydrogen is vented to the atmosphere or else used in the manufacture of HB-40, HB-20, etc.

In the second type of unit (Nos. 4 and 5) the flow of material is essentially the same as that described above except the vaporized benzol feed emerging from the vaporizer coil passes through a heat exchanger in lieu of one of the preheaters. The conversion products and benzol from the converter pot are also passed through the heat exchanger, countercurrent to the benzol feed, thus transferring sensible heat from the converted gases to preheat the feed. The conversion products and vapors from the converter pot then pass on to a column as is the case with the other units.

Some of the units have been altered since their installation.

Unit No. 4 is being equipped with a 4 foot extension on the converter. This extension to the converter will act as a sojourn section. This addition reaction space will provide additional reaction time and permit a temperature reduction of 30-60°C. in the converter while maintaining the same percent conversion. This reduced temperature will minimize carbon formation and reduce the heat exchanger fouling and unit clean-outs. The lead traps will be eliminated.

Unit No. 11 has a large coil in the lower section of the column which acts as a vaporizer. The flow is through the large coil, the standard vaporizer coil in the stack, the three pots, and to the column. The hot gases from the converter pot heat the benzene in the large coil and vaporize the benzene. The recovery of heat from the converted gas stream has permitted an increased benzene feed rate of about 100 gallons per hour. The increase is due to better utilization of the heat input and the reduced heat load on the column and condenser. Room for this large coil was made available by removing the two lower bubble cap plates from the column.

Units Nos. 12 and 13 are equipped with this large coil but the coil is being bypassed because the units surged and caused excessive pressures throughout the unit, thus blowing the gaskets around the top of the preheater and converter pots. No. 11 unit also surges occasionally but since No. 11 unit is equipped with a sojourn pot (the same as will be installed on No. 4 unit), the added space provides a cushion to absorb the sudden expansion caused by rapid vaporization of benzene in the large coil.

No. 11 unit is being equipped with an automatic reflux control which will control the reflux rate to maintain a constant vapor temperature on the third plate from the top of the column.

Each unit is equipped with two orifice plates between the converter and column. These orifice plates are sized to give a pressure drop of about 40 psig and thereby permit an increased pot operating pressure, increased soujourn time, and a reduced operating temperature and minimize lead carryover from both entrainment and lead vaporization. The diameter of these orifices are 1.031 and 1.014 inches, the larger orifice being upstream from the smaller one.

The sump product from all the columns is collected by gravity in two crude diphenyl catch tanks. The piping to the tanks is steam jacketed to prevent the diphenyl from freezing and has a liquid trap to prevent vapors from entering the catch tank from the column. The tanks are vented into the hydrogen header to equalize the pressure.

The two batch stills each consist of a horizontal, cylindrical tank surmounted by a fractionating column, a submerged Rumsey pump, and a gas fired coil heater. The pump circulates the still charge from the tank, through the coil heater and back to the tank. The rate of distillation of the crude diphenyl is controlled by the combustion rate of natural gas in the gas fired heater, which is controlled by an adjustable automatic temperature recorder and controller so as to give a temperature rise of 20-25°C. between inlet and exit temperatures of the still charge through the heater coil. If an attempt is made to increase the temperature rise above 25°C., the coil becomes plugged with carbon.

The vapors from the still are separated in a fractionating column. The first cut from the column at 80°C. is benzol which is returned by gravity to a catch tank for subsequent return to the benzol feed tank for recycling through the diphenyl units. The benzol cut is not run directly back to the feed tank because of the possibility of not cutting the column at the proper time and allowing some contamination to run back with the benzol. The next fraction, distilling between 80 and a distillate crystallizing point of 68.6°C. is called "heads" and consists of light oils with boiling points nearing that of diphenyl.

The diphenyl fraction is collected until the temperature in the still pot reaches 340-350°C. The tail cut is collected until the distillate vapor temperature in the top of the column reaches 300°C.

The various distillation cuts are made with these reflux ratios:

Benzol Cut	-	20%
Heads Cut	-	50%
Biphenyl Cut	-	20%
Tails Cut	-	15%

The high boiler, remaining in the still as residue, is pumped to the high boiler catch tank from which it is run into 55 gallon drums for storage or pumped to the Santowax still or Santowax storage tank.

In order to prevent freezing of diphenyl in the condenser at the top of the fractionating column, the consenser cooling water must be at a temperature near the melting point of diphenyl (158°F.). The flow of pond water is adjusted to prevent freezing of the product. It is generally necessary only to cut back the flow of pond water at the end of a distillation.

The diphenyl production is measured in a catch tank and pumped to storage tanks or tank cars by a 2" Rumsey vertical sump pump.

The heads and tails are collected and charged back to the next still batch.

GENERAL DISCUSSION

The carbon formed in the diphenyl units partly deposits in the pipe after the converter units, through the lead trap, in the pipe after the lead trap, and in the fractionating column. These pipes become plugged with carbon and must be dismantled and cleaned every one to six months. The lead trap and fractionating column are cleaned out at more infrequent intervals. This so called "carbon" deposit analyzes as follows:

Lead	56.5%
Insoluble in HNO_3..... (carbon included)....	42.7%
Insoluble, ignited.....	18.5%
Iron oxide, insoluble...	0.7%
Carbon, combustion.....	28.9%

As much of this piping and equipment is above the melting point of lead, it is evident that the adhering carbon prevents coalescence of the molten lead droplets.

The amount of reflux returned to the fractionating column is controlled by the operator to maintain a temperature of about 100°C. at the column top. The cooling water to the condenser is operated at full capacity and as the heat duty of each unit is approximately the same, it is apparent that the amount of reflux required will vary according to the effectiveness of each condenser at a particular time. When the temperature of the effluent water exceeds 70°C., the condensers are cleaned.

The diphenyl units produce crude diphenyl by a continuous process with a 24-hour day operation. The number of units operated depends upon the diphenyl market or the maintenance required on the equipment. The crude diphenyl is collected and batch distilled at intervals depending upon the rate of collection. The batch distilling requires 10-12 hours.

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EQUIPMENT DESCRIPTION

SERIES 100 - GENERAL PROCESS EQUIPMENT

Item No. 101: Benzol Unloading Pump (1-Required)

Function:	To unload benzol from railway tank cars to the benzol storage tanks.
Operation:	Intermittent. About 5 hours is required for unloading one car. Prior to unloading, the car must be chocked to prevent movement, and grounded to the pump to prevent formation of a static electrical charge. The pump inlet pipe is inserted through the tank car dome, the valve nearest the pump suction is opened, and the pump is started. A small stream of water is adjusted to pour over the pump bearings for cooling. After the tank car is unloaded, the pump is shut off, benzene is allowed to drain back into the pump suction line, and the valve nearest the pump suction is closed. This benzene is left in the line to prime the pump when the next car is unloaded. Air pressure is cut into the line which blows the benzol remaining in the line on to the storage tank. With the diphenyl plant operating at peak capacity and all 12 units producing, it is estimated that the pump will be required to unload an average of one car per day.
Materials Handled:	Benzol at about 30 GPM at the existing head which is estimated to be about 80' TDH.
Controls:	Manually controlled by a motor starting switch located at the pump.
Services:	Approximately 10 KWH per day average. A negligible amount of priming and cooling water. A negligible amount of compressed air.

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Item 101 Continued:

Size and Type:	Westco turbine pump with removable liners and impellers.
Inlet Pipe:	The inlet pipe forms an arch with swivel joints so that it may be passed down through the tank car dome. A platform is provided for the operator to manipulate the pipe.
Strainers:	An Acme pump strainer is installed in both the pump inlet and outlet.
Manufacturer:	Westco Pump Company, Bettendorf, Iowa
Materials of Construction:	Liners and impellers are ni-resist and shaft is stainless steel.
Motor:	3 HP, 1740 RPM, 3 phase, 60 cycle, 220/440 v. TEFC Allis-Chalmers motor with #225 frame.
Drive:	Direct drive with flexible coupling.
Location:	Located along side of railroad spur about 200 ft. west of the diphenyl building.

Item 102: Benzol Storage Tanks (5-Required)

Function:	To provide benzol raw material buffer storage between receipt and use.
Operation:	Benzol is periodically fed into the storage tanks and intermittently withdrawn as needed to the benzol feed tank.
Materials Handled:	The storage tanks provide about 5 days operating storage at maximum plant capacity. Materials in: Benzol at approximately 30 GPM while unloading. Materials out: Benzol at approximately 500 GPM while operating plant at maximum capacity.
Controls:	See Item 104
Services:	Steam is furnished to steam coils as needed on cold days depending on judgment of operator.
Size and Type:	The three newer tanks are 18' long x 10' I.D. horizontal tanks with dished heads. The two original tanks are slightly smaller(as shown below)in capacity.
Openings:	Top: 2'0" dia. manhole 6" dia. std. pipe suction 3" dia. std. pipe standpipe and feed 3" dia. thief hatch 1½" dia. condensate and steam pipe 2" dia. vent and flame arrestor
Manufacturer:	Adamson Company
Capacity:	Three 10,800 gal. tanks and two 9,800 gal. tanks.
Materials of Construction:	5/16" steel plate tank with 3/8" steel plate dished heads.
Steam Coil:	Flat hairpin type steam coil of 1" pipe installed in bottom of tank.

Item 102 Continued:

Location: Located about 200' south of the diphenyl building. The five tanks are 31' apart and each located in a moat with a cycline fence surrounding the group.

References:

Drawings	Monsanto
Details of Storage Tanks	9C-7961
Layout of Storage Tanks	9C-7960
Location of Present Storage Tanks	9C-6668
Foundation and Fence Details	9C-6685
Detail of New Benzol Storage Tanks	9C-7961

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Item 103: Benzol Transfer Pumps (5-Required)

Function:	To transfer benzol from the benzol storage tanks to the benzol feed tank.
Operation:	Each benzol storage tank has a separate benzol transfer pump and benzol is let down from one tank at a time. The pump operates intermittently for about 6 hours per day when the plant is operating at maximum capacity.
Materials Handled:	Benzol - Approximately 500 GPH (average)
Controls:	The operator manually sets a five point motor starting switch to select the storage tank from which he desires the automatic let-down system to feed. (See Item 104)
Services:	Approximately 9 KWH per day (max.) Steam is supplies to copper coils surrounding the pumps or is blown directly into the pump from a hose connection to prevent the benzol from freezing in the pump on cold days.
Size and Type:	Positive displacement pumps, model SU 100, non-sparking construction with 2½" flanged connections. Pump integral with reducer shown below. The pumps are self-priming by means of a stand pipe and priming tank integral with the pump.
Manufacturer:	Blackmer Pump Company Viking Pump Company
Capacity:	75 to 100 GPM of benzol vs. 25' TDH with a suction lift of about 11'.
Materials of Construction:	Bronze fitted.
Motor:	2 HP, 1800 RPM, 3 phase, 60 cycle, 220/440 v., TEFC explosion proof motor.
Reducer:	Gear reduction unit furnished with pump to give 525 RPM when using 1800 RPM motor.
Strainer:	A pump strainer is installed on the pump outlet.
Location:	Mounted on benzol storage tanks.

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Item 104: Isopropyl Alcohol Storage Tank (1-Required)

Function:	To provide buffer storage for isopropyl alcohol.
Operation:	Isopropyl alcohol is periodically fed into the storage tank and intermittently withdrawn as needed to the isopropyl alcohol feed tank.
Materials Handled:	The storage tank provides about 3 months operating storage at maximum plant capacity.
Material in:	Isopropyl alcohol at approximately 30 GPM while unloading. (This material is unloaded at the benzol unloading dock. The benzol unloading pump is used for this purpose.)
Material out:	Isopropyl alcohol at approximately 4 gallons per hour while operating plant at maximum capacity. (Average)
Controls:	None provided.
Size & Type:	Tank 10'6" dia. x 15'6" long equipped with standard manhead and nozzle for flame arrestor vent, top inlet and top discharge.
Materials of Construction:	5/16" steel plate with 3/8" steel plate dished heads.
Location:	Located about 200 feet South of the biphenyl building and due east of the benzol storage tanks.
Maintenance Required:	None.

Item 105: Isopropyl Alcohol Transfer Pump

Function:	To transfer isopropyl alcohol to the isopropyl alcohol feed tank.
Operation:	Isopropyl alcohol is pumped from the isopropyl alcohol storage tank to the isopropyl alcohol feed tank about once each shift.
Materials Handled:	Isopropyl alcohol
Controls:	The Operator manually starts and stops this pump as required. The switch is located near the isopropyl alcohol feed tank.
Size & Type:	Positive displacement, self-priming by means of a stand pipe and priming tank integral with the pump.
Manufacturer:	Blackmer Pump Company
Capacity:	Approximately 10 GPM at a 25 TDH with a maximum suction of 11 feet.
Materials of Construction:	Bronze fitted
Location:	Mounted on isopropyl alcohol storage tank.

Item 106: Benzol Feed Tank (2-Required)

Function:

1: To provide a source of benzol for feeding to the diphenyl units.

2: To provide a catch tank for the benzol returned from the diphenyl process.

Operation:

Let-down from benzol storage tanks is intermittent. Run-back from diphenyl units is continuous. Return from benzol recovery system is batchwise. Return from hydrogen coolers is continuous. This benzol returns to the auxiliary benzol feed tank and is periodically pumped back to the primary benzol feed tank.

When returning recovered benzol to the primary benzol feed tank from the benzol recovery system (hydrogen compressors), the distilled benzol catch tank or the auxiliary benzol feed tank, the operator must first cut off the automatic let-down from the benzol storage tank and let the level of the benzol in the feed tank drop enough to provide for the additional benzol returned.

In addition, the distilled benzol must be checked for clear color before returning it to the feed tank.

The operator must manually once or twice per shift drain off the water in the feed tank which comes from the water priming during unloading and from condensed moisture from the atmosphere.

Materials Handled:

Benzol:

Out: 240 GPH per unit
2900 GPH (max.) 12 unit operating

In: 500 GPH from storage tanks
2000 GPH (avg.) returned from process

Part of the benzol returned from the process is returned batchwise so that the above figures are only average.

Item 106 Continued:

Water:

Some water condenses from the atmosphere in the storage tank. Generally the amount of water is significant when the let-down control is switched to a new tank and diminishes to a negligible amount after the storage tank has been used awhile.

The recycled benzol also contains traces of water and finally divided carbon. The water is slightly corrosive as it contains 0.03% sulfates, 0.03% chlorides, and some undetermined reducing compounds which will react with oxygen.

It is necessary to return the recycled benzol to the feed tank rather than the storage tanks as it has been determined that the recycled benzol contains some undetermined catalyst which upsets the operation of the diphenyl units. Therefore, an effort is made to blend the recycled benzol in with the fresh feed in a more or less constant ratio to maintain smooth operation of the units.

Controls:

An automatic level (let-down) control is provided for maintaining the supply of benzol in the feed tank. When the level of benzol in the feed tank recedes to 15" below the top, the automatic control starts one of the transfer pumps. The transfer pump is automatically shut off when the benzol level is 9" below the top of the feed tank.

Another similar level control to that controlling the transfer pump is provided for sounding a high and a low level alarm should the level exceed 3" beyond the control level.

A manually operated five-point selector switch is provided at the feed tank for selecting the benzol storage tank to furnish the benzol feed.

Services:

Steam is provided to the steam coil during cold weather depending upon the judgment of the operator who merely feels the side of the tank to determine if it feels warm.

A negligible amount of electricity is necessary to operate the control system.

Item 106 Continued:

Size & Type:	7'6" I.D. x 15'6" long, dished head horizontal tanks installed in a concrete walled enclosure about 4' high to catch the benzol in the event of a tank rupture. The feed tanks are located on a concrete slab surrounded by a cyclone fence.
Openings:	Top: 2'0" I.D. manhole centrally located for installation of the steam coils. (2) 8" flanged pipe nozzles for the automatic let-down controls. 2½" foam nozzle 2" vent to hydrogen coolers (Item 110) 4" benzol runback nozzle 4" benzol inlet nozzle (from storage) 2" rodding nozzle 2" thermal well Bottom: 2" outlet nozzle extending 6" above bottom of feed tank. 1" drain nozzle in dished well (for draining water).
Manufacturer:	Chattanooga Boiler and Tank Works
Capacity:	5,000 Gallons.
Materials of Construction:	3/8" steel plate
Steam Coils:	Flat hairpin coils made from 1" XH seamless steel pipe forming three loops 5' long and with 1'0" pitch. The coils are supported on the bottom of the tank with one coil in each end.
Location:	Located about 30' west of diphenyl building
References:	Drawings — Monsanto Layout of Feed Tank — 9C-8205 Feed Tank Details — 9C-8206 Bill of Materials — 9BM-54

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Item 107: Benzol Feed Pump (2-Required)

Function:	To deliver the benzol feed from the benzol feed tank to the benzol vaporizer coil of each diphenyl unit.
Operation:	One pump is operated continuously while the other pumps are held as spares.
Materials Handled:	Benzol - Maximum rate required is 55 GPM with all 12 units operating at full capacity.
Controls:	The pump is manually controlled by motor starting switch. The rate to each diphenyl unit is automatically controlled and recorded by an orifice and flow recorder and controller. The approximate head required at the orifice is around 170 psig.
Services:	Approximately 175 KWH per day electricity required.
Size & Type:	Two-stage Westco pump with removable liners.
Manufacturer:	Micro-Westco, Incorporated
Materials of Construction:	Impellers of Ni-Resist and shafts of stainless steel.
Motor:	15 HP, 3740 RPM, TEFC, explosion proof Howell Electric Company motor.
Drive:	Direct drive with flexible coupling.
Location:	Located on concrete pad next to feed tank.

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Item 108: Isopropyl Alcohol Feed Tank

Function:	To provide a source of isopropyl alcohol for feeding to the benzene feed.
Operation:	Let-down from the isopropyl alcohol intermittently.
Materials Handled:	Isopropyl alcohol
	Out: 4 gal./hour
Controls:	Float to indicate liquid level.
Capacity:	100 gallons
Location:	Southwest corner of benzene feed tank area.

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Item 109: Isopropyl Alcohol Feed Pump

Function:	To transfer isopropyl alcohol to the suction of the benzol feed pumps.
Operation:	Continuous
Materials Handled:	Isopropyl alcohol
Controls:	The pump is manually controlled by a motor starting switch.
Location:	Near isopropyl alcohol feed tank.

Item 110: Hydrogen Coolers (6-Required)

Function:	1. To cool the gas and vapors from the benzol condenser in order to decrease the vapor load on the hydrogen compressors. 2. To condense some of the benzol vapor from the hydrogen gas.
Operation:	Continuous. The condensed benzol is continuously drained by gravity to the benzol auxiliary feed tank.
Materials Handled:	Hydrogen gas and benzol vapors from the diphenyl Units. Benzol vapors vented from the crude diphenyl sump tanks. Benzol vapors vented from the primary benzol feed tank.
Size & Type:	Twin 6-fin section coolers BSS-248 6-12 "B" type modified with an external water jacket. The coolers are connected in parallel and installed horizontally.
Manufacturer:	Griscom-Russel Company
Location:	Installed on the hydrogen compressor room roof.
Comment:	The coolers were modified in the field by the addition of an external water cooled jacket.

Item 111: Benzol Catch Tank (1-Required)

Function:	1. To trap condensed benzol from the hydrogen gas to insure its not reaching the hydrogen compressors. 2. To provide a surge tank for hydrogen gas prior to compression.
Operation:	Continuous. The condensed benzol trapped in the tank is continuously drained to the pump tank for return to the benzol feed tank.
Materials Handled:	Hydrogen gas saturated with benzol vapor. Condensed benzol.
Size & Type:	4'-0" O.D. x 4'-0" long vertical tank with dished heads. Top - (4) 1" threaded outlets (1) 4" flanged nipples Side - (2) 4" flanged nipples (1) 1½" threaded outlet Bottom - (1) 1" threaded outlet
Manufacturer:	Chattanooga Boiler Works
Capacity:	56 ft.^{3} 50 psig pressure
Materials of Construction:	3/16" steel plate fabricated in accordance with ASME code for unfired pressure vessels.
Location:	Suspended from the ceiling in the compressor room.
References:	Drawings — Monsanto Hydrogen Compressor Tanks 9C-7367

Item 112: Hydrogen Compressors (3-Required)

Function:	To provide a means of recovering benzol from the by-product hydrogen gas.
Operation:	Continuous. The benzol is recovered by compressing and cooling the hydrogen gas in two stages to 300 psig. The compressors automatically load at 3 psig and unload at ½ psig inlet pressures.
Materials Handled:	Maximum volume operating at maximum rating. (Conditions 2500 gal/hr. feed @ 21% conv.) 10,900 CFH hydrogen @ 30°C. and 760 mm 13,000 CFH hydrogen plus benzol vapors @ 30°C. and 760 mm 7.2# benzol/# hydrogen @ 15 psig, 30°C. 0.8# benzol/# hydrogen @ 300 psig, 52°C. 6.4# benzol recovered/# hydrogen compressed 0.0179# hydrogen produced/# diphenyl
Controls:	Pressure controller controls intake. Pressure controller controls pressure of first and second stages. Pressures are all indicated.
Services:	Estimated electrical consumption is 700 KWH per day.
Size & Type:	(2) Class 11 AT serial 6965, size 9 and 4½ x 9 Pennsylvania compressors. Max. rpm 275; working pressure 350#-Rated Capacity 110 CFM ea. (1) Two-stage Worthington Compressor. Rated Capacity 75 CFM
Motor:	(2) 40 HP, 1175 rpm, type K6 motor with frame, #504 (1) 30 HP, 1175 rpm, type K motor with frame, #444
Drive:	(2) 8 V-belt sheaves (1) 3 V-belt sheaves
References:	Bill of Material 9BM-47

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Item 113: Inter-Cooler (3-Required)

Function:	To condense benzol from the hydrogen gas after the first stage compression.
Operation:	Continuous. The hydrogen from the first stage compression of each of the three compressors may be delivered to either of the two coolers.
Heat Duty:	80,000 BTU/hr. approximate (Roper's report).
Services:	Cooling water.
Size & Type:	Wt. 160#, overall length 62-5/8"
Manufacturer:	Andale Engineering Company, Philadelphia, Pa.
Capacity:	For 100# pressure

Item 114: Low Pressure Receiver (3-Required)

Function:	To provide a trap and collecting tank for the benzol condensed from the hydrogen gas after the first stage compression.
Operation:	The receivers are provided with piping connections so that either of the three compressors can be connected to either of the two receivers. The benzol is periodically blown from the receivers to the pump tank.
Materials Handled:	Hydrogen gas saturated with benzol vapor and condensed benzol. Pressure - 65 psig
Controls:	A manually operated valve is provided in the pipe out of the bottom of the receiver. When this valve is opened the hydrogen pressure forces the benzol up into the pump tank.
Size & Type:	3'-0" I.D. x 6'-0" high vertical tank with dished heads.
Opening:	Top: 2½" standard pipe extending through center of top down to the middle of the tank. Two 3/4" threaded outlets. Side: 6" handhole 2" flanged nipple 3/4" threaded outlet Bottom - 3/4" threaded outlet
Manufacturer:	Chattanooga Boiler Works
Capacity:	100 psig pressure 45 ft.^{3}
Material of Construction:	5/16" steel plate
Note:	Fabricated in accordance with ASME Code for unfired pressure vessels.

DSW 462502

Item 114 Continued:

Location:	Located in compressor room.	
References:	Drawings	Monsanto
	Hydrogen Compressor Tanks	9C-7367-3

DSW 462503

Item 115: After-Cooler (3-Required)

Function:	To condense benzol from the hydrogen gas after the second stage compression.
Operation:	Continuous
Pressure:	300 psig operating pressure
Heat Duty:	42,000 BTU/hr. approx. (Roper's report)
Services:	Cooling water
Size & Type:	Wt. 160# - overall length 62-5/8"
Manufacturer:	Amdale Engineering Company, Philadelphia, Pa.
Capacity:	For 350# pressure

Item 116: High Pressure Receiver (3-Required)

Function:	To provide a trap and collecting tank for benzol condensed from the hydrogen gas after the second stage compression.
Operation:	The receivers are provided with piping connections so that either of the three compressors can be connected to either of the two receivers. The benzol is periodically blown from the receivers to the pump tank.
Materials Handled:	Hydrogen gas saturated with benzol vapor and condensed benzol @ 300 psig 52°C.
Controls:	A manually operated valve is provided in the bottom outlet pipe connection to the pump tank.
Size & Type:	2'-0" I.D. x 6'-0" long vertical tank with dished heads. All flanges are Crane #856E.
Openings:	Top: 2½" standard pipe extending through center down to the middle of the tank. two 3/4" threaded outlets. Side: 6" handhole 2" flanged nipple 3/4" threaded outlet Bottom: 3/4" threaded outlet
Manufacturer:	Chattanooga Boiler Works
Capacity:	20 ft.^{3} 350 psig pressure
Materials of Construction:	11/16" steel plate
Note:	Fabricated in accordance with ASME code for unfired pressure vessels.
Location:	Located in compressor room.
References:	Drawings — Monsanto Hydrogen Compressor Tanks C-7367-3

DSW 462505

Item 117: Benzol Return Pump Tank (1-Required)

Function:	To collect the condensed benzol from the receivers and the benzol trap.
Operation:	The benzol from the collecting tank is continuously run back to the pump tank and the benzol from the receivers is periodically blown back into the pump tank. The collected benzol is periodically pumped back to the benzol feed tank.
Materials Handled:	Approx. 4600# or 620 gal. of benzol recovered per day (max.).
Size & Type:	3'-0" I.D. x 6'-0" high vertical tank with dished heads.
Openings:	Top: 1½" threaded outlet Two 3/4" threaded outlets Side: Five 3/4" threaded outlets One 6" handhole Bottom: 1½" threaded outlet
Manufacturer:	Chattanooga Boiler Works
Capacity:	45 ft.^{3} 50 psig pressure
Material of Construction:	3/16" steel plate
Note:	Fabricated in accordance with ASME code for unfired pressure vessels.
Location:	Located in hydrogen compressor room.
References:	Drawings — Monsanto Hydrogen Compressor Tanks — C-7367-3

DSW 462506

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Item 118: Recovered Benzol Return Pump (2-Required)

Function:	To return the recovered benzol in the pump tank to the benzol feed tank.
Operation:	Periodic.
Controls:	Manually controlled by motor starting switch.
Services:	Estimated 15 KWH per day (max.)
Size & Type:	One Micro-Westco and one Worthington pump connected in parallel. These are old pumps repossessed from another process and the identification marks are illegible.

Item 119: Crude Diphenyl Catch Tanks (2-Required)

Function: To catch the crude diphenyl from the diphenyl units and store it prior to batch distilling or delivery to crude diphenyl storage tank.

Operation: The catch tanks receive the sump product, crude diphenyl, from the columns as a continuous overflow from the carbon trap.

The crude diphenyl is periodically withdrawn from the catch tanks for batch distilling. No definite schedule is followed as the catch tanks become filled at indefinite intervals depending upon the number of units in operation.

Materials Handled: Crude diphenyl of the following approximate composition:

Diphenyl	60.87%
Hi-boiler	14.01%
Benzol	22.49%
Head & Tails Oil	0.10%
Fraction eventually lost	2.53%
	100.00%

Oper. Temp. 120-130°C.
Oper. Pressure 2-5 psig

Controls: Provisions are made for indicating the temperature of the crude diphenyl.

An enclosed tape is provided for indicating the level in the tank.

An explosion disk (Protectoseal) is provided to prevent excessive pressure in the tank.

Services: Steam coils are provided in the bottom of the tank.

Comments: Considerable benzol flasks out of these tanks through a vent line connect to the hydrogen vapor system.

DSW 462508

Item 119 Continued:

Size & Type:	8'-0" I.D. x 16'-0" long horizontal tank with dished heads.
Openings:	Top: One 3'-0" manhole centrally located and containing three openings; one for the installation of the sump pump, one for the pump discharge and one for the Protectoseal connection and vent line. Four steam coil nozzles are in the vertical side of the 3 manhole nozzles. One 2'-0" manhole centered 6'-0" from the middle of the tank with the cover drilled for the installation of the "Varec" gage for measuring the level in the tank. Three 3" slip on welding flanges are provided 1'-0" apart 4'-6" from the middle of the tank. The outside nozzle is for filling the tank, the center for a vent (which is now sealed), and the inside one for the thermowell connection. Bottom: A 2" plugged pipe coupling drain is provided in the pump well.
Manufacturer:	Chattanooga B. & T. Company (tank) Crane (steam coils)
Capacity:	6,000 gal. ea. - tank, tested for 25 psig
Material of Construction:	3/8" steel plate
Insulation:	The entire tank is covered by a 2" blanket insulation, followed by a ½" layer of Eagle 66, and a ½" Insulseal, and with a metal jacket protective sheeting.
Steam Coils:	Two 2" (iron pipe size) extra heavy seamless steel pipe coils approximately 64' and 56' long are provided in the bottom of the tank with inlets and outlets through the side of the center nozzle for the sump pump. Each coil consists of four hairpin turns 6'-0" long, 4" pitch and installed flat. The two inside coils for the "Varec" gage end of the tank are 2' short to clear the gage.

DSW 462509

Item 119 Continued:

Location: Located in a reinforced concrete pit, 4'-6" deep, with a 3'-6" wall between tanks with a drain under the wall which can be closed off with a stopper from either side.

The pit is located east of the diphenyl building and has a high brick wall shield to protect the tanks against fire from the building.

Auxiliary Equipment: The N.W. corner of the pit contains a sump pump manually controlled. The pump is a Taber No. 2 - Fig. B-148 sump pump with ½ HP, 1750 RPM motor.

The pit also contains a 1500 gal. catch tank for benzol.

The pit is surrounded by a handrail and provided with handrailing and walkways over the tanks.

References:

Drawings	Monsanto
Layout of Crude Diphenyl Catch Tanks	9C-8193
Layout of Pit and Foundations	9C-8196
Crude Diphenyl Catch Tank Pit-Details	9C-8197
6000 Gal. Catch Tank	9C-8192
Pit Handrail	9C-8197
Platform (Sheet 1)	9C-8198
Piping	9C-8194
Walkway and Stairs (Platform Sh.2)	9C-8199
Bill of Material	9BM-54

Item 120: Still Charging Pumps (2-Required)

Function:	To deliver the crude diphenyl from the catch tanks to the still.
Operation:	Periodically operated whenever the catch tank becomes almost filled.
Materials Handled:	Crude diphenyl - sp.gr. approx. 1.041
Controls:	Controlled manually by a motor starting switch.
Services:	Approximately 20 KWH per day (max.)
Size & Type:	Vertical submerged type sump pump.
Manufacturer:	Taber Pump Company
Capacity:	100 GPM vs. 50' TDH
Materials of Construction:	5 HP, 1750 RPM, 3 phase, 60 cycle, 220/440 v. vertical explosion proof motor with ring base.
Drive:	Direct connected with flexible coupling.
Location:	Installed on crude diphenyl catch tank.
Reference:	Bill of Material 9BM-54

Item 121: Hi-Boiler Collecting Tank (1-Required)

Function:	To provide a receiving and cooling tank for the distilled hi-boiler.
Operation:	At the completion of the crude diphenyl distillation, the hi-boiler forming the residue in the still is pumped by the still circulating pump to the hi-boiler collecting tank. The hi-boiler is allowed to cool and at intervals reheated and poured into drums for conveying to the crude Santowax storage area. Also, the hi-boiler may be pumped to the Santowax plant for use, depending upon requirements.
Materials Handled:	Hi-boiler consisting mainly of terphenyl.
Services:	Steam to steam coil when needed.
Size & Type:	5'-6" I.D. x 5'-6" high vertical tank with flat top and dished bottom.
Openings:	4" inlet 4" vent 4" gaging hatch 22" manhole 2" bottom outlet
Steam Coil:	1½" diameter seamless pipe coil approximately 80' long.
Capacity:	1000 gal.
Materials of Construction:	1/4" steel plate
Note:	One tank is now connected to service both stills.
Reference:	Drawings — Monsanto Hi-Boiler Tank — 9C-7876

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Item 122: High Boiler Pump (1-Required)

Function:	To deliver hi-boiler from the hi-boiler tank to the Santowax storage tank or the Santowax still pot.
Operation:	Periodically
Materials Handled:	Hi-Boiler
Controls:	Manually operated by motor starting switch.
Services:	A negligible amount of power consumption per day.
Size & Type:	Sump pump
Manufacturer:	Taber Pump Company
Motor:	7½ HP, 1735 rpm, 3 phase, 60 cycle, 220/440 v. General Electric vertical motor
Drive:	Direct connected with flexible coupling.
Location:	Mounted on hi-boiler collecting tank.

Item 123: Distilled Benzol Collecting Tank (1 Required)

Function:	To provide a catch tank for the benzol fraction distilled from the crude diphenyl.
Operation:	The first fraction distilled over from the crude diphenyl comes over at 80°C. and is run by gravity into the benzol tank. The benzol is not run back directly to the feed tank because of the possibility of making a mistake and allowing some of the heads to run back with the benzol. Therefore, it is necessary to check the color of the benzol for clearness before it is periodically pumped back to the benzol feed tank.
Materials Handled:	Benzol distilled from the crude diphenyl.
Services:	Steam to steam coil.
Size & Type:	7'-0" I.D. x 4'-5" high vertical tank with dished heads.
Openings:	Top: 21½" I.D. manhole centrally located. Three 2" standard pipe couplings. Side: Four nozzles fabricated as follows: One piece of 4" dia. standard pipe x 3½" long welded all around outside to shell plate. One standard 3/4" pipe coupling (seamless) welded to shell plate and hole cut. 3/4" pipe is concentric to 4" pipe. (Nozzles are presently closed off). Bottom: 2" pipe nipple centrally located
Manufacturer:	John Hooter Boiler Works, St. Louis, Missouri
Capacity:	1500 Gallons - Working pressure 3# gas. Given Hydo. test @ 10#

Item 123 Continued:

Materials of Construction:	Mild steel plate - structural quality A.S.T.M. A10-34
Insulation:	The sides and bottom are insulated with 2½" blanket insulation, ½" Eagle "66" insulation and covered with a 22 gage blank iron jacket.
Steam Coil:	The steam coil is a removable unit fabricated to the manhole cover. The coil consists of 8 turns @ 4" pitch and is made from 1¼" seamless steel pipe. The overall length of the coil measured from the bottom of the cover plate is 6'-4". Coil by Crane.
Location:	Located in the crude diphenyl sump pit.

Reference:

Drawings	Monsanto
Details of Sump Tank	9C-8152
Detail of Coil	9C-7874
Bill of Material	9BM-48

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Item 124: Distilled Benzol Return Pump (1-Required)

Function:	To deliver the recovered benzol from the distilled benzol collecting tank to the benzol feed tank.
Operation:	Periodic
Materials Handled:	Benzol recovered from the crude diphenyl.
Controls:	Manually controlled by motor starting switch.
Services:	Estimated 2 KWH per day.
Size & Type:	Figure 3004, size 2", single stage, end suction centrifugal pump mounted on bedplate.
Manufacturer:	Gould Pump Company
Material of Construction:	Standard except for stainless steel shaft.
Motor:	3 HP, 1750 rpm, 220/440 v., 60 cycle, 3 phase, enclosed fan cooled, class 1, group D, type K, General Electric induction motor. Frame 225.
Drive:	Direct connection with flexible coupling.
Location:	Located on concrete foundation in crude diphenyl sump tank pit.
References:	Bill of Material 9BM-48

Item 125: Diphenyl Storage Tanks (2-Required)

Function:	To store distilled diphenyl prior to shipping.
Operation:	Continuous
Materials Handled:	Distilled diphenyl at 71°C. minimum temp.
Controls:	A thermometer well is provided for use in determining the temperature of the diphenyl.
Services:	Steam for steam coils.
Size & Type:	10'-6" O.D. x 37'-4" long horizontal tank with dished heads.
Openings:	Top: Steam coil inlet, 3" sch. 80 pipe nozzle Measuring port, 2" sch. 80 pipe w/cap. Thermometer well, 3" sch. 80 pipe nozzle Pump opening, 1'-9½" I.D. flanged nozzle Diphenyl inlet, 2½" sch.80 pipe nozzle Manhole and relief opening, 2'-0" I.D. flanged nozzle Vent, 3" sch. 80 pipe Bottom: Steam coil outlet, 2" steam coil pipe welded Drain, 3" flanged nozzle w/cover plate
Steam Coils:	Hairpin type flat coil 36'-0" long with eight runs of 2" sch. 80 seamless steel pipe spaced at 6". A pump well is provided surrounded by two turns of ½" copper tubing with separate steam connections.
Manufacturer:	Rogers and Wright, Incorporated
Capacity:	25,000 gallons. Shell tested with 25# hydrostatic pressure
Materials of Construction:	3/8" steel plate.

DSW 462517

Item 125 Continued:

Insulation: Tank is insulated with 1½" Eagle blanket insulation type 201 with Eagle 66 (E2) applied at all butt joints of blanket insulation where necessary to fill up cracks. Entire surface is covered with 20 gage galvanized iron jacket. All the joints on top half are made water tight by soldering.

Location: Tanks are located 31'-6" apart centers and installed lengthwise in a NS direction. The center of the east tank is 61'-2-3/8" east of the center line of the diphenyl building west column row. The tanks are 30'-0" south of the muriatic acid storage tanks measured from end to end.

Elevations:	centerline of tanks	768' 4-3/16"
	grade	758'-0"
	top of dike	761'-0"

References:

Drawings	Monsanto
Location plan diphenyl storage tanks	9C-9076
Details storage tanks	9C-9057
Foundation details	9C-9081
Diphenyl piping to and from tanks	9C-9083
Procurement Record	9PR-87

DSW 462518

Item 126: Diphenyl Loading Pumps (2-Required)

Function:	To deliver diphenyl from the diphenyl storage tanks to tank cars for shipping.
Operation:	Periodic
Materials Handled:	Distilled diphenyl
Controls:	Manually operated by motor starting switch.
Services:	Estimated 15 KWH per day (max.)
Size & Type:	Figure S 1790-No. 2-type F sump pump measuring 11'-8-3/8" from bottom suction to underside of cover plate.
Manufacturer:	Rumsey Pump Company
Materials of Construction:	Iron
Motor:	5 HP, 1750 rpm, General Electric vertical motor.
Drive:	Direct drive with flexible coupling.
Location:	Mounted on storage tanks (Item 125)
Reference:	Drawings — Monsanto
	Pumps for storage tanks — 9C-9088

August 1957

SERIES 200 - BIPHENYL UNITS

Item 201: Benzol Vaporizer (1-Required per Unit)

Function:

1. To vaporize the benzol feed to each diphenyl unit.
2. To recover sensible heat from the exhaust gases used in heating the preheater and converter pots.

Operation:

Continuous. The benzol makes a single pass through the vaporizer, flowing countercurrent to the hot flue gas.

Materials Handled:

Benzol - Rate: 1700#/hr.
170 GPH
Temperature-In: 30°C. approx. in feed tanks
Out: 200°C. approx.
Pressure: Out: 100 psig approx.

Exhause gas - Rate: Flue gas 1250#/hr. approx.
Excess air 220#/hr.
Temperature-In: 780°C.
Out: 400°C.

Approximate Heat Balance:

Benzol:

1. Heating liquid to B.P. 1700 (136-30)(1.8)(0.34)	=	110,000 BTU/hr.
2. Vaporizing benzol 1700 (150)	=	255,000
3. Super-heating vapor 1700 (200-136)(1.8)(0.39)	=	8,000
Total		373,000 BTU/hr.

Some of this heat load is absorbed by passing the benzene through the small coil in the column before it enters the vaporizer. No temperature data are available to determine the exact load on the vaporizer coil.

DSW 462520

Item 201 Continued:

Controls: Normally no controls are needed. However, it is necessary to avoid overheating the vaporizer when benzol is not being fed during start-ups and shut-downs.

To prevent overheating during start-ups, the exhaust gas is diverted from the vaporizer by exhausting through a special by-pass stack.

During shut-downs, cool air is vented into the exhaust stack to cool the vaporizer.

The benzol feed outlet temperature, the exhaust gas inlet temperature, and the exhaust gas outlet temperature are recorded on the 12 point temperature recorded.

Services: None required.

Size & Type: The housing for the vaporizer coil is described separately (Item 209).

The coils are all essentially the same in regards to purpose but the details of construction vary as follows:

Summary of Vaporizer Design

Units	Outside Area, Ft.^{2}	No. Coils	No. Turns	Dia. Pipe	Dia. Coil	Pitch	Length
2,3	123	Single	36	1¼"xH	2'6"	2½"	90'
4,5	186	Single	38	2 "xH	2'6"	3 "	95'
6,7,8,10	180	Single	37	2 "xH	2'6"	3 "	92.5'
			39	2 "xH	1'11¼"	3 "	78'
9	180	Single	37	2 "xH	2'6"	3 "	92.5'
11,12,13	240	Single	52	2 "xH	2'6"	3 "	130'

Nos. 6,7,8,9, and 10 units originally had a double coil but the inner coil burned out and is disconnected.

Manufacturer: Crane Company

Item 201 Continued:

Materials of Construction:	Extra heavy standard steel pipe
Location:	The vaporizer coil is located in a vertical stack lined with insulating refractory brick and containing a stainless steel inner shell designed to give a maximum exhaust gas velocity over the pipe coil.

References:

Drawings	Monsanto
Vaporizer Assembly, Units 11, 12, 13	9C-9026
Vaporizer for No. 1 Unit	9C-6841
Vaporizer for No. 4 Unit	9C-7840
Vaporizer for Units 6,7,8,9,10	9C-8150

Item 202: Heat Exchanger (1-Required) Installed on Units 4 & 5 Only

Comment: The use of a heat exchanger on units 4 and 5 deviated from the prevailing design. The heat exchanger replaces the preheater and conserves fuel by recovering sensible heat from the converter vapors.

Function:

1. To further super-heat the benzol vapor from the vaporizer.
2. To recover some of the heat from the vapors leaving the converter.

Operation: Continuous. The converter vapors make a single pass through the tubes, countercurrent to the benzol vapor making a single pass through segmental baffles on the shell side.

Materials Handled: (The conditions stated were taken from Phosphate Division Engineering Report No. 117. Actually, the units may be operated up to a 240 gal./hr. Benzene Feed Rate.)

Shell fluid: Benzol vapor - 1200#/hr.

Tube fluid: Converter vapors - 1200#/hr.
(benzol vapor)
(diphenyl vapor)
(hi-boiler vapor)
(hydrogen gas)

Heat Balance:

Shell fluid temperature: In - 160°C.
Out - 525°C.

Tube fluid temperature: In - 720°C.
Out - 405°C.

LMTD: 220°C.

Duty: 405,000 BTU/hr.

Heat transfer coefficients (outside surface)

Tube film:	11	BTU/hr.sq.ft.°F.
Tube scale:	400	"
Tube wall:	3300	"
Shell film:	28	"
Shell scale:	500	"

Item 202 Continued:

Heat Balance Contd:	Overall U-theo: 7.56 Overall U: 5.44 Total effective surface: 188 ft.^{2} - 10'-0" eff. length Note: Source of above data is report by D. A. Rober on Design of No. 4 Unit.
Type:	Vertical packed expansion joint, removable tube bundle.
Size:	Single section with 16" O.D. shell, with seventy-two (72) 1" O.D. #12 BWG tubes at 1¼" square pitch, and with twenty-one (21) 3/16" thick transverse baffles spaced at 5" centers.
Nozzles:	Shell Nozzles - inlet: 3" T&G Series 30 outlet: 3" T&G Series 30 Tube Nozzles - inlet: 4" T&G Series 30 outlet: 4" T&G Series 30
Manufacturer:	Struthers-Wells
Design:	Operating pressures - tubes: 5# ga. Shell: 45# ga. Max. Working Pres. - tubes: 50# ga. Shell: 50# ga. Max. Temperatures - tubes: 1400°F. Shell: 1000°F.
Materials of Construction:	Shell: Steel Tubes: 4-6 chr. 0.5 mo. Baffles: Steel
Insulation:	The exchanger is insulated with 3" of Eagle #88 rock wool, with bolted flanges exposed.
References:	Drawing 9SC-2577 Bill of Material 9BM-29 9BM-35

Item 203: Preheater (1-Required) #4 and #5 Only

Function:	To further super-heat the benzol vapor coming from the heat exchanger to the reaction temperature necessary for pyrolysis.
Operation:	Continuous. The benzol vapor passes through a distributor pipe with the end emersed in molten lead in the preheater pot. The vapor bubbles up through the molten lead and is discharged through a gooseneck pipe to the converter. The pot is suspended in a firebrick setting and the temperature of the lead maintained by burning natural gas in burners extending through the firebrick. In addition, the hot flue gases from the converter are used to heat this preheater.
Materials Handled:	(The conditions stated were taken from Phosphate Engineering Report No. 117. Actually, these units may be operated up to a 240 gal./hr. benzene feed rate.) Benzol Vapor - 1200#/hr.
Heat Balance:	Benzol vapor temperature: In: 525°C. Out: 675°C. Flue gas temperature: In: 1800°C. Out: 1150°C. LMTD: 850°C. Duty: 374,000 BTU/hr. Overall U: 7.0 BTU/hr., ft.^{2}, °F. Total effective surface: 35 ft.^{2}
Controls:	Temperature of lead recorded on 12 point recorder.
Services:	Natural gas, approximately 350# CFH. Make-up lead has to be added periodically.

Item 203 Continued:

Size & Type:	24" O.D x 72" long dished bottom pot filled with 37" to 42" of molten lead and suspended in a firebrick setting. The distributor pipe is a straight 4" O.D. x 3" I.D. tube located in the center of the pot. A small baffle covers the vapor outlet to prevent lead being splashed directly into the outlet pipe. The outlet pipe is 4" XH pipe. The top of the pot is welded carbon steel plate and is bolted to the pot.
Manufacturer:	Blaw-Knox Company
Capacity:	100 lbs. of lead adds 1½" to the level of the lead in the pot.
Materials of Construction:	Type 309 stainless steel plate 5/8" thick.
References:	Drawings — Monsanto 9SC-2852 9SC-2575
Comments:	The firebrick setting consist of one unit for both the preheater and the converter partitioned by a firebrick wall with an opening left for the flue gas to pass from the converter side to the preheater side.

Item 204: No. 1 Preheater (1-Required per Unit) All Units Except #4 and #5

Function:	To further super-heat the benzol vapor from the vaporizer to a mid-point temperature between the vaporizer temperature and the reaction temperature.
Operation:	Continuous. The benzol vapor passes through a distributor pipe with the end emersed in molten lead in the preheater pot. The vapor bubbles up through the molten lead and is discharged through a gooseneck pipe to the No. 2 preheater. The pot is suspended in a firebrick setting and the temperature of the lead maintained by burning natural gas in burners extending through the firebrick. In addition, the hot flue gases from the converter and the No. 2 preheater are used for heating the No. 1 preheater.
Materials Handled:	(The conditions stated were taken from Phos-Phate Engineering Report No. 117. Actually, these units are operated at benzene feed rates greater than 1200#/hr.) Benzol vapor - rate: 1200#/hr. Temperature: In: 140°C. Out: 425°C.
Controls:	Temperature of lead recorded on 12 point temperature recorder.
Services:	Natural gas. Make-up lead added periodically.
Type & Size:	Identical to Item 203.
Comments:	The firebrick setting consists of one unit for Items 210, 211, and 212, partitioned by a firebrick wall wth an opening left for the flue gases to pass from the No. 1 preheater and converter to the No. 2 preheater.

Item 205: No. 2 Preheater (1-Required per Unit) All Units Except #4 and #5

Function:	To super-heat the benzol vapor from the No. 1 preheater outlet temperature to the reaction temperature for conversion.
Operation:	Continuous. The benzol vapor from No. 1 preheater passes through a distributor pipe with the end emersed in molten lead in the pre-heater pot. The vapor bubbles up through the molten lead and is discharged through a jumper pipe to the converter. The pot is suspended in a firebrick setting and the temperature of the lead maintained by burning fuel gas in burners extending through the firebrick. In addition, the hot flue gases from the converter are used for heating the No. 2 preheater.
Materials Handled:	(The conditions stated were taken from Phos-phate Div. Engineering Report No. 117. Actually, these units are operated at benzene feed rates greater than 1200#/hr.) Benzol vapor - rate: 1200#/hr. Temperature: In: 425°C. Out: 700°C.
Controls:	Temperature of lead recorded on 12 point recorder.
Services:	Natural gas Make-up lead added periodically.
Type & Size:	Identical to Item 203.
Comments:	The firebrick setting consists of one unit for Items 204, 205, and 206 partitioned by a firebrick wall with an opening left for the flue gases to pass from the No. 1 preheater and converter to the No. 2 preheater.

Item 206: Converter (1-Required per Unit)

Function:	To maintain the benzol vapor at the reaction temperature for a short sojourn time sufficient for about 20% conversion to diphenyl.
Operation:	Continuous. The benzol vapor passes through a distributor pipe with the end emersed in molten lead in the converter pot. The vapor bubbles up through the molten lead and is discharged through a pipe to the lead trap. The pot is suspended in a firebrick setting by burning natural gas in burners extending through the firebrick. The exhaust flue gas passes through an opening in the firebrick partition to the chamber surrounding the No. 2 preheater.
Materials Handled:	(The conditions stated were taken from Phosphate Div. Engineering Report No. 117. Actually, these units are operated at benzene feed rates greater than 1200#/hr.)
	Material In: benzol vapor - rate: 1200#/hr. Temperature: 700°C. Material Out: benzol vapor - 974#/hr. diphenyl - 181#/hr. Hi-boiler - 42#/hr. hydrogen - 3#/hr. diphenyl - 4344#/day Temperature: 750-810°C.
Controls:	The temperature of the lead in the pot must be maintained exactly at 750-810°C. This is done by a temperature recorder controller controlling the gas burners.
Size & Type:	Identical to Item 203 on all units except Units Nos. 4 and 11. The converts on Units 4 and 11 have a standard vertical pot section welded to the top of the standard pot to provide additional sojourn time.

An extensive report has been prepared on the materials of construction of the converter pot. See Research Report #2211, Interim Report on Alloy Testing and Biphenyl Pot Corrosion. Constructive criticism is presented which may be of value in future construction.

DSW 462529

Item 207: Burners (18-Required on Units 2,3)
(14 Required on Units 4,5)
(19 Required on Units 6,7,8,9,10)
(24 Required on Units 11,12,13)

Function:	To provide for the combustion of natural gas in the firebrick setting housing the lead pots (Items 203, 204, 205, and 206).
Operation:	Continuous. Nozzles operate with 1# to 1-1/8# back pressure with 15# gas on the burner.
Materials Handled:	(The conditions stated were taken from Phosphate Div. Engineering Report No. 117. Actually, the burners are presently operated at approximately 25 psig. The actual quantity of gas being burned is not known.) Natural gas with about 15% excess air. (Approximately 2000 CFH @ 25°C. and 760 mm of gas is required for each unit.)
Controls:	The burners servicing the converter pot are automatically regulated by a single point temperature recorder and controller activated by the temperature of the molten lead in the converter pot. The gas flow is also automatically cut down when the benzol flow is cut down (Units 11, 12, and 13 only). The burners servicing the preheater are manually regulated by the operator to maintain the molten lead within the desired temperature range. The temperatures are recorded on a 12 point temperature recorder. Pressure gages are provided for indicating the gas pressure.
Type:	Surface Combustion tunnel burners with high pressure inspirators.
Size:	#1333 tunnel burners, 1½" nozzle #1333 TN alloy tunnel retainers #224-B, type 1, burner adapter castings #N-54 high pressure inspirator sets #405 lighting hole assemblies

Item 207 Continued:

Manufacturer:	Surface Combustion, Toledo, Ohio
Capacity:	2850 CFH when burning natural gas at 20 psig
Materials of Construction:	Standard
Reference:	Bill of Material 9BM-87

Item 208: Start-up By-Pass Stack (1-Required per Unit)

Function:	To provide a means of by-passing the hot flue gases around the cold vaporizer prior to beginning the benzol feed.
Operation:	Used only during start-up periods.
Materials Handled:	Hot flue gases from the preheater and converter units.
Controls:	The flue gases are diverted from the exhaust stack to the start-up by-pass stack by means of a butterfly type valve.
Size & Type:	The stack is constructed in two sections, a lower stack and an upper stack. The lower stack is 2'-6" I.D. x 11'-0" high and has an adjustable damper over the top. It is welded vertically to the horizontal header between the converter units and the exhaust stack (Item 209). A butterfly type valve is installed in the horizontal header between the by-pass stack and the exhaust stack. The upper stack is 2'-0" I.D. x 29'-6" high with a 4'-0" I.D. x 2'-6" high funnel at the lower end over the lower stack.
Manufacturer:	Southern Car & Manufacturing Co., Birmingham, Ala.
Materials of Construction:	The lower stack is 1/4" steel plate and the upper stack 3/16" steel plate.
Location:	The stack is installed vertically with its center 4'-11" from the center of the final preheater.
Reference:	Drawing — Monsanto Detail of Stack — 9C-7845

Item 209: Exhaust Stack (1-Required per Unit)

Function:	1. To provide a means for exhausting the flue gas from the preheaters and converter to the atmosphere. 2. To provide a means for passing the gas around vaporizer coils for heat recovery.
Operation:	Continuous except during start-up periods.
Materials Handled:	Exhaust flue gases from the preheaters and converter.
Controls:	A door is provided at the bottom of the stack for venting in air to cool the vaporizer coil when shutting down the diphenyl unit.
Size & Type:	Vertical stack lined with insulating refractory and containing a stainless steel inner shell, designed to give a maximum gas velocity over the vaporizer coils. The housing for the vaporizer is split and hinged for access to the coil.
Manufacturer:	Outer Shell: Snyder Tank Company, Birmingham, Alabama Inner Shell: Decatur Iron & Steel Company, Decatur, Alabama Upper Stack: Southern Car & Mfg. Company, Birmingham, Alabama
Materials of Construction:	All mild steel with the exception of the inner shell which is Type 304 stainless.
Insulation:	The horizontal gas header between the exhaust stack and the converter shell is lined with 4½" of firebrick and the vertical vaporizer shell with 4" of Carey Hi-temperature #19 cement.
Location:	The center of the stack is 9'-1" from the center of the final preheater.

Item 209 Continued:

References:

Drawings	Monsanto
Detail of Stack	9C-7845
Details of Vaporizer Shell	9C-9025

Insulation: The horizontal gas header between the exhaust stack and the converter shell is lined with 4½" of firebrick and the vertical vaporizer shell with 4" of Carey-Hi-temperature #19 cement.

Item 210: Lead Trap (1-Required per Unit)

Function: To trap entrained lead coming over with the benzol vapor from the converter.

Operation: Continuous. The trap is periodically cleaned out when necessary while the unit is shut down.

Materials Handled: Benzol and reaction products from the converter.

Entrained lead.

Size & Type:

New Design

24" dia. welded steel pipe 3'-1½" long. Outlet is a 3" Crane #1545 flg. to a 8" x 3" E.X. reducer with an 8" 309 S.S. nozzle extending 1'-4" into trap. Inlet is a 3" E.X. W.S. pipe, opening tangential to the trap and 9-9/16" down from top.

Old Design

24" dia. W.S. pipe with 3" E.X. nipple on top for outlet with 3" Crane #1545 flange. Inlet is 3" E.X. pipe opening tangential to trap 9" down from top - 3" Crane #1545 flange.

Manufacturer: Callahan Grinding & Machine Company
Anniston, Alabama

Materials of Construction:

New Design: 5/8" sides, ½" bottom
3/4" top
309 S.S. outlet cylinder

Old Design: 3/8" side, ½" bottom
3/4" top

References:

Drawings	Monsanto
Lead Trap Details	9C-8143-4

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Item 211: Fractionating Column (1-Required per Unit)

Function:

1. To function as a cooling column to condense the vapors from the converter.

2. To utilize the heat in the vapors from the converter to effect a partial separation of the benzol from the converted products.

Operation:

Continuous. The benzol fractionating column is a 12 plate bubble cap rectifying section with the feed in on the bottom plate as super-heated vapor. The liquid crude diphenyl containing hi-boiler and liquid benzol is discharged from the bottom and benzol vapor and hydrogen from the top. The reflux is returned to the top plate. The column is operated with the top temperature below 100°C.

Materials Handled:

(The conditions stated were taken from Phosphate Div. Engineering Report No. 117. Actually, these columns are operated at rates greater than 1200#/hr.)

In:	Benzol vapor	974
	Diphenyl vapor	181
	Hi-boiler vapor	42
	Hydrogen gas	3
		1200#/hr.

Out:

Bottom -	Liquid benzol	14#/hr.
	Liquid diphenyl	181
	Liquid Hi-boiler	42
Top -	Benzol vapor	960
	Hydrogen gas	3
		1200#/hr.

Controls:

The temperature of the top of the column and the sump are recorded on the 12 point temperature recorder.

The column is controlled by the operation of the condenser and split flow box.

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Item 211 Continued:

Size & Type: 12 plate bubble cap rectifying column, 3'-0" dia. with 12" tray spacing. (Units 4,5 column is 2'-6" dia.)

Plate spacing	12 in.
No. of plates	12
No. of bubble caps per plate	28
Cap diameter	3"
Slot area/cap.	3.43 $in.^2$
Total slot area/plate	0.666 sq.ft.

Riser pipe - 2" O.D. x 10 BWG
Riser pipe area/riser - 2.35 $in.^2$
Total Riser Area - 0.45 sq. ft.

Liquid depth on plates	1.5"
Liquid height above slots	0.5"
Tower height	18'

Manufacturer: Nooter Boiler Works, St. Louis, Missouri (11, 12, 13)
Leader Iron Works (6, 7, 8, 9, 10)

Materials of Construction: A.S.T.M. specification A-283-46T Grace C (A-10) steel.

References:

Drawings	Monsanto
Fractionating column (Unit No. 2)	9C-5582
Fractionating column (Unit No. 3)	9SC-7279
Fractionating column (Units No. 6 thru No. 12)	9C-8131

Item 212: Benzol Condenser (1-Required per Unit)

Function:

1. To partially condense the benzol vapor from the top of the column.

2. To control the top temperature of the column at 100°C. by sub-cooling the condensed benzol which is refluxed to the column.

Operation: Continuous.

Materials Handled: (The conditions stated were taken from Phosphate Div. Engineering Report No. 117. Actually, this equipment is operated at higher rates than those stated.)

Shell fluid - benzol vapor: 2900#/hr. (Usual rate under favorable conditions)

Tube fluid - water: Usually operated at max. available pressure.

Item 212 Continued:

Heat Balance: The condenser duty for all the units should be substantially the same and should consist approximately of the amount of super-heat in the vapors from the converter less the amount of heat loss from the surface of the fractionating column.

This duty has been calculated to be about 625,000 BTU/hr. average based on a study as reported in a memo to Mr. J. F. Reeves, 5/25/48 written by Mr. G. W. Jordan.

Controls: The present system of control is to run the condenser with the water valve wide open and the split flow box adjusted to maintain the top of the column at 100°C.

The temperature of the cooling water and the efficiency of the condenser therefore determine the rate of benzol flow through the shell and the cooling water outlet temperature.

This system of controlling has the advantage of simplicity but does not provide the most effective use of the condenser and cooling water.

Size & Type: Summary

Units	3	2,5	4,6,8,9	11,13	7,10,12
Type	Vertical	Horizontal	Horizontal	Vertical	Vertical
Eff. Surface	70	113	162	90	207
Shell Dia.	14"		20"	14"	10-3/4"
No. Tubes			132	139	88
Tube Dia. (O.D.)			1"	5/8"	3/4"
Pitch			½" triangle	13/16"sq.	-
Tube Length			72"	97-7/8"	-
Manufacturer:	Andale	Callahan	Callahan	Andale	Struthers Wells

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Item 212 Continued:

Units	3	2,5	4,6,8,9	11,13	7,10,12
Capacity:					
Oper. Pres.					
- Tubes		75# ga.		15# ga.	-
- Shell		1# ga.		100# ga.	-
Max.Wk.Press.:					
- Tubes		75# ga.		150# ga.	150# ga.
- Shell		75# ga.		150# ga.	150# ga.
Max.Temp.:					
- Tubes		130°F.			-
- Shell		176°F.			500°F.
Materials of Construction:					
Shell	Steel	Steel	Steel	Steel	Steel
Tubes	#10 BWG	#12 BWG	#12 BWG	#10 BWG	#16 BWG

References:

Drawings — Monsanto

Condenser Details, Sheet 1	9C-8157
Condenser Details, Sheet 2 (4,6,8,9)	9C-8158

Foreign

Andale Condenser #13 X-A-36 type 206X	Sketch #1261 Dwg. #5845
Struthers-Wells Type N Group 3 Size 10 N12	

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Item 212 Continued:

The operating conditions of these condensers after physical cleaning in 1956 were as follows:

Unit No.	Benzene Feed Rate gal./hr.	% Reflux	Benzene Reflux Temp.	Water, GPM (Old data from Rpt.117)	Approximate Overall Coefficient U. (Old data from Report No.117)
2	175	70%	78°C.	80	90
3	165	75	34	35	170
4	245	60	66	95	65
5	245	40	41	80	90
6	230	75	40	95	65
7	210	90	40	-	-
8	220	75	50	95	65
9**	220	70	73	95	65
10	245	60	28	-	-
11	330	48	24*	75	250
12	250	75	42	-	-
13	180	85	42	75	250

* with column coil

** No. 9 condenser is mounted vertically

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Item 213: Split Flow Box (1-Required per Unit)

Function:	To control the amount of liquid benzol returned to the column as reflux.
Operation:	Continuous. Ratio adjusted as necessary to maintain the top of the fractionating column below 100°C.
Materials Handled:	Liquid benzol.
Controls:	Mechanically indicated ratio adjusted manually by operator to maintain temperature of top of fractionating column below 100°C. Temperature of runback indicated by thermometer well. Sight glasses provided in reflux and runback lines for checking flow.
Size & Type:	The split flow boxes for Units 2 thru 5 are identical to the biphenyl still split flow boxes. Units 11 - 13 are provided with standard manufactured rotaweirs, figure 192-special, size 10 with one 2" horizontal inlet connection and two 2" vertical outlet connections. Units 6 - 10 are slightly dissimilar.
Manufacturer:	Units 6-13 furnished by Fischer & Porter Company, Hatboro, Pennsylvania
Capacity:	Outlets Capacities: Forward: Min. 100 GPH Norm. 150 GPH Max. 250 GPH Reflux: Min. 200 GPH Norm. 420 GPH Max. 750 GPH
Materials of Construction:	Cast iron fittings, stainless steel weir tubes and gears, and steel shells.

Item 213 Continued:

Location: Located near top of column on condenser platform.

References:

Drawings	Monsanto
Layout Rotaweir & Condenser	9C-9055
Split Flow Box Details	9C-7836
Piping at Rotaweir & Condenser	9C-8163
Piping at Rotaweir & Condenser Details	9C-8164

	Foreign
13" Rotaweir with metal shell	S-6727
Rotaweir	6-11591
Rotaweir	S-4228

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Item 214: Carbon Trap (1-Required per Unit)

Function:	To trap any carbon and sludge in the sump product from the fractionating column.
Operation:	Continuous. The crude diphenyl is decanted through a side outlet in the trap and the carbon and sludge settled to the bottom from where it is drained periodically when necessary.
Size & Type:	A steel tank 18" O.D. x 3'-1-3/4" long with flat bottom and top.
Openings:	Top: 6" dia. XH nipple with flange, inlet. Side: 2" XH coupling, overflow. Bottom: 2" XH coupling, drain.
Manufacturer:	Callahan Grinding & Machine Company Anniston, Alabama
Materials of Construction:	3/4" steel plate, top 1/2" steel plate, bottom 18" O.D. x 3/8" thick W.S. pipe, side wall
Location:	Bolted to bottom outlet of fractionating column.
References:	Drawings — Monsanto Lead trap details — 9C-8145

DSW 462544

SERIES 300 - BIPHENYL STILLS

Item 301: Diphenyl Still (1-Required per Still)

Function:	To provide a reservoir for heating the charge of crude diphenyl which is being distilled.
Operation:	Batchwise - time required for distilling one batch is approximately 10 hours, depending on operator.
Materials Handled:	Approximately 30,350# or 4,120 gal. of crude diphenyl per batch.
Controls:	A thermowell is provided for recording the temperature of the crude diphenyl.
Services:	Steam to steam coils. (Biphenyl must be in liquid state before it can be circulated through still heater.)
Size & Type:	7'-0" O.D. x 14'-0" long horizontal tank with dished heads. Par. U-69 ASME construction.
Openings:	3" opening for thermowell 3" charging inlet 4" inlet from heating coil 10" vapor outlet 2" reflux inlet 22" opening for circulating pump 22" opening for steam heating coil
Manufacturer:	R. D. Cole Manufacturing Company
Capacity:	4300 gals. Tested for 50# pressure at 750°F.
Materials of Construction:	1/2" steel plate
Insulation:	The still is insulated with 4" of rock wool, ½" of Eagle 66 and covered with a sheet metal jacket.

Item 301 Continued:

Steam Coil:	1-1/4" pipe coil	
References:	Drawings	Monsanto
	Diphenyl Still	9C-7873
	Diphenyl Still Body	9SC-2526
	Bill of Material	9BM-55

Item 302: Crude Diphenyl Circulating Pump (1-Required per Still)

Function:	To cycle the crude diphenyl through the still and the heating coil of the gas fired heater.	
Operation:	Continuous, during batch distilling operation. The crude diphenyl is returned to the still from the heating coil and is recycled until the distilling operation is completed.	
Materials Handled:	Crude diphenyl	
Controls:	Controlled manually by motor starting switch. The rate of flow is not controlled but allowed to seek its maximum.	
Services:	Estimated 80 KWH per day (max.)	
Size & Type:	No. 1 Still:	Special No. 2, figure S1790 vertical, all iron, Rumsey sump pump with a 96" set length and provided with special water cooled stuffing boxes.
	No. 2 Still:	3" inlet x 2½" outlet, CV-5 vertical pump, figure 19,435 with cast iron water jacketed stuffing box where shaft passes through cover plate. Discharge pipe has stuffing box not water jacketed. Pump is of iron, 96" long from bottom of cover plate to end of pump inlet with intermediate cast iron bearings in the column. Shaft is of steel. Impeller of cast steel.
Manufacturer:	No. 1 Still:	Rumsey Pump Company
	No. 2 Still:	Taber Pump Company
Capacity:	No. 2 Still:	200 GPM vs. 70' TDH
Motor:	No. 1 Still:	5 HP, 1750 RPM, 3 phase, 60 cycle, 220 v., vertical explosion proof
	No. 2 Still:	7½ HP, 1750 RPM, 3 phase, 60 cycle, 220 v., vertical explosion proof motor.

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Item 302 Continued:

Drive:	Direct connected with flexible coupling.	
Location:	Located on diphenyl still.	
Reference:	Drawings	
	No. 1 Still Pump	F-246A
	No. 2 Still Pump Taber -	901203
	Bill of Material	9BM-55

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Item 303: Gas Fired Heater (1-Required per Still)

Function:	To supply the heat required for distilling the crude diphenyl.
Operation:	Continuous during batch operation.
Materials Handled:	Crude diphenyl - rate: 200 GPM approx.
Heat Duty:	400,000 BTU/hr. is the average net heat available from the still heater for heating and vaporizing charge.
Controls:	The combustion rate of the fuel gas is controlled automatically so as to raise the temperature of the liquid passing through the coil approximately 20 to 25°C. (difference between inlet and outlet temperatures in the coil).
Services:	Natural gas - estimated requirement is 1,000 CFH @ 30°C. and 760 mm (avg.) max. capacity approx. 3,200 CFH
Size & Type:	4'-0" I.D. x 8'-3" high shell with an inner core and stack.
Manufacturer:	Chattanooga Boiler Works
Materials of Construction:	Steel outer shell, 304 S.S. inner shell
Heating Coil:	The heating coil consists of 18 turns of 2" W.I. pipe 1'-6" in dia. (approx. 53 sq.ft. of outside heating surface).
Gas Burners:	The heater is fired with four Surface Combustion #55 H.P. Inspirators with each inspirator supplying the mixture for two #1345 tunnel burners.
Insulation:	The steel shell is lined with 9" of H&W #111 firebrick.
Location:	Located at second floor level in the diphenyl plant machine shop immediately outside of the distilling rooms.

Item 303 Continued:

References:

Drawings	Monsanto
Diphenyl Still Heater Shell, #1 Still	9C-6372
Diphenyl Still Heater Shell, #2 Still	9C-8211
Stack Cover & Heater Core	9C-8078
Stack	9C-7939
Heater Shell Base	9C-8230
Platforms & Supports	9C-8217
Bill of Material	9BM-55

Item 304: Still Column (1-Required per Still)

Function: To separate the crude diphenyl into benzol, hi-boiler, heads and tails, and diphenyl.

Operation: Continuous during batch operation. The vapors from the still enter the bottom of the column. The lower boiling fraction passes overhead to the total condenser and part returned as reflux above the top plate. The high boiling fractions are returned to the still.

The first product from the column is benzol, with the top of the column at 80°C.

The second product cut is taken until the crystallizing point of the distillate reaches 68.6°C.

The next fraction, diphenyl, is collected until the still pot temperature reaches 340-350°C. and then the balance is diverted into the heads and tails tank.

The high boiler, remaining in the still as residue, is pumped to the high boiler catch tank.

Materials Handled: Crude diphenyl which is separated approximately into the following fractions:

Diphenyl	60.87%
High Boiler	14.01
Benzol	22.49
Heads & Tails Oil	0.10
Material Lost	2.53
	100.00%

Size & Type: The still column is a 20 plate, bubble cap, rectifying column, 3'-0" I.D. x 25'-2" high. The plates are spaced 12" apart and each tray contains thirty-six (36) 3" dia. pressed steel bubble caps and two 4" dia. downspouts.

Item 304 Continued:

Openings:	Each plate is provided with two 10" dia. handholes in the shell. The vapors from the still enter the column below the bottom plate through a 20" dia. combination manhole and vapor inlet. The lower boiling products leave the top of the column through a 16" dia. manhole which is reduced to a 6" dia. vapor pipe. Reflux enters through a 3" nozzle above the top plate and the overflow from the bottom tray is returned to the still through a 3" line.
Manufacturer:	Leader Iron Works Company
Materials of Construction:	Steel
Insulation:	The column is insulated with 4" of rock wool, ½" of Eagle 66, and covered with a sheet steel jacket.

Reference:

Drawings	Monsanto
Diphenyl Still Column	9C-7870
Bill of Material	9BM-55

Item 305: Diphenyl Still Condenser (1-Required per Still)

Function: To condense the overhead vapors from the still column.

Operation: Continuous during batch distilling operation. The cooling water makes 8 passes through the tubes and vapors condensed outside of the tubes.

Materials Handled:

Tubes	Shell
70 GPM City Water	4080#/hr. benzol.

Heat Duty:

Shell fluid temp. - In: 176°F. Out: 176°F.
Tube fluid temp. - In: 130°F. Out: 150°F.
LMTD: 34°F.
Duty: 690,000 BTU/hr.
Overall heat transfer coefficient: 100
Total effective surface: 200 ft.^{2}

Size & Type: 200 sq.ft. horizontal, floating head, removable tube bundle condenser with 25" O.D. shell and 152 tubes 1" O.D. constructed of #12 BWG tubing and pitched 1¼". The shell has been enlarged to the same size as the floating head bonnet and a special outlet added to insure complete drainage of each product from the condenser.

Nozzles:

Shell: Inlet 6"
Outlet 2"

Tubes: Inlet 3"
Outlet 3"

Manufacturer: R. D. Cole Manufacturing Company

Materials of Construction: Steel

Insulation: Shell insulated with 2" rock wool, ½" of 66, and covered with a sheet metal jacket.

References:

Drawings	Monsanto
Condenser	9C-7872
Bill of Material	9BM-55

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Item 306: Split Flow Box (1-Required per Still)

Function: To control the amount of condensate returned to the column as reflux.

Operation: Continuous during batch distilling operation.

The condensed vapor from the condenser is discharged into a basket installed inside of a container with the bottom partitioned into 2 outlets. The basket has holes drilled in the side so that by rotating the basket the discharge from the holes may be directed to either side of the bottom partition in the shell.

The split flow box is usually operated on a 1:1 reflux ratio.

Heat is supplied from a small heating coil when the diphenyl fraction is being distilled.

Materials Handled: All of the overhead products from the column pass through the split flow box.

Controls: The reflux ratio is controlled by a selector lever setting the position of the basket in relation to the partition between the 2 outlets.

The control of the basket is extended to the still operating floor by means of a shaft and gears so that the reflux ratio may be changed during a distillation without ascending to the condenser platform.

Services: Steam for the heating coil.

Size & Type:

Shell casing: 18" O.D. x 18" high gas tight casing with dished heads.

Basket: 12" I.D. x 6½" deep with a 9" I.D. concentric screen partition. The basket has 19 equally spaced ¼" dia. holes 7° apart.

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Item 306 Continued:

Openings:	Two 2" X.H.W.S. pipe outlets in the bottom, one for reflux and the other for the product. A 5/16" plate partitions the reflux side of the shell casing from the product side. One 2" X.H.W.S. pipe side inlet for the condensed vapors from the condenser. One 2" X.H.W.S. pipe side nozzle for vent through flame arrestor and conservation vent. Three 5-5/8" I.D. sight nozzles using Pyrex glass. Two located on top and one on the side for observing the flow from the basket. Stuffing box and gland 1-3/4" I.D. centrally located on top for selector lever shaft.
Manufacturer:	Fischer and Porter Company
Capacity:	800 GPH normal capacity 1600 GPH maximum capacity
Materials of Construction:	The split flow box is made of steel except basket, screen, and packing gland which are made of monel metal.
Gaskets:	Gaskets are #901 Garlock, ring type, 1/16" thick and must not swell when handling hot diphenyl or benzol.
References:	Drawings — Monsanto Split Flow Box Details — 9C-7836 Bill of Material — 9BM-55

Item 307: Head & Tails Catch Tank (1-Required per Still)

Function:	To provide a catch tank and storage for the heads and tails distilled from the crude diphenyl.
Operation:	After the benzol fraction has been distilled off the crude diphenyl, the next fraction distilling between 80°, a hold point of 68.6°C. is diverted to the heads and tails catch tank. After most of the diphenyl has been distilled and the temperature in the still reaches about 300°C., the flow is changed again to feed into the heads and tails tank. The heads and tails that were collected are returned to the diphenyl still for re-distillation with the next batch. The small amount of heads and tails oil left over is discarded.
Materials Handled:	The "heads" are light oils with boiling points nearing that of diphenyl and the "tails" is diphenyl containing a little hi-boiler fraction. The heads and tails as collected is mainly diphenyl, which is recovered on redistillation. The amount of heads and tails oil produced is very small, consisting of only about 0.1% of the crude diphenyl.
Controls:	The heads and tails tank is provided with a 4" gaging hatch for measuring the level in the tank.
Services:	Steam for heating coil.
Size & Type:	5'-0" O.D. x 5'-0" high vertical tank with flat top and dished bottom.

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Item 307 Continued:

Openings:	The tank is provided with a 4" inlet nozzle, a 4" vent, a 22" I.D. nozzle for a sump pump, a 4" gaging hatch, and a steam heating coil inlet and outlet.	
Steam Coil:	The steam coil consists of about 30' of 1½" dia. standard seamless pipe.	
Capacity:	800 gallons	
Insulation:	The sides and bottom of the tank are insulated with 2" of rock wool, a ½" of Eagle 66, and covered with a sheet metal jacket.	
Reference:	Drawings	Monsanto
	Heads & Tails Catch Tank	9C-7876

Item 308: Head and Tails Return Pump (1-Required per Still)

Function:	To return the heads and tails from the catch tank to the still for redistillation.
Operation:	Periodic
Materials Handled:	Heads and tails fraction from crude diphenyl distillation.
Controls:	Manually controlled by motor starting switch.
Services:	Estimated 3 KWH per day (maximum)
Size & Type:	2½" x 2" CL-4 vertical sump pump, 5'-6" long
Manufacturer:	Taber Pump Company
Materials of Construction:	Iron casing with steel shaft and cast steel impeller.
Motor:	3 HP, 1750 RPM, 3 phase, 60 cycle, 220/440 v., TEFC explosion proof vertical motor with ring base.
Drive:	Direct drive with flexible coupling.
Location:	Installed in heads and tails tank.
Reference:	Bill of Material 9BM-55

Item 309: Diphenyl Catch Tank (1-Required per Still)

Function:	To receive the diphenyl fraction from the crude diphenyl distillation.
Operation:	The operator sets the swivel flow box to deliver to the diphenyl catch tank after the hold point of the distillate reaches 68.6°C. The flow is changed again from the diphenyl catch tank to the heads and tails catch tank after the temperature in the still reaches 300°C.
Materials Handled:	Distilled diphenyl
Controls:	The tank contains a thief hatch for sampling the diphenyl.
Services:	Steam to steam coil.
Size & Type:	7'-6" I.D. x 6'-0" high vertical tank with a flat top and dished bottom.
Openings:	The tank is provided with a 4" inlet, a 4" vent, a 22½" I.D. nozzle for a sump pump, a 16" dia. manhole, and a 6" thief hatch.
Capacity:	2100 gallons.
Materials of Construction:	1/4" steel tank
Insulation:	The sides and bottom of the tank are insulated with 2" rock wool, a 1/2" of Eagle 66 and covered with a sheet metal jacket.
Reference:	Drawings — Monsanto Diphenyl Catch Tank — 9C-7877

Item 310: Distilled Diphenyl Transfer Pump (1-Required per Still)

Function:	To deliver the distilled diphenyl from the diphenyl catch tank to the diphenyl storage tanks.
Operation:	Operated at the completion of the batch distillation.
Materials Handled:	Distilled diphenyl at approx. 100°C.
Controls:	Manually controlled by motor starting switch.
Services:	Estimated 15 KWH per day (maximum)
Size & Type:	No. 1½B, figure S 1790 vertical sump pump with a length of 7'-3".
Manufacturer:	Rumsey Pump Company
Materials of Construction:	Iron
Motor:	3 HP, 1750 RPM, 3 phase, 60 cycle, 220 volt, vertical explosion proof General Electric motor.
Drive:	Direct connected by flexible coupling.
Location:	Installed in diphenyl catch tank.
Reference:	Drawing — Foreign
	Rumsey Pump — F-246-A

SERIES 400 - INSTRUMENTATION

Item 401: Automatic Let-Down Level Control (1 Unit For Each Feed Tank)

Function:	To automatically maintain a supply of benzol in the feed tank and to sound an alarm in case of high or low level.
Operation:	The operator must manually select one of the five storage tanks from which to feed. A five-point pump switch located at the feed tank is provided for this purpose which places the system in automatic control to feed from that particular storage tank selected. The automatic control system maintains the level of the benzol in the feed tank within a range of 6" with the high level 9" below the top of the tank. If the system fails and the high or low level exceeds this range by 3", an alarm is sounded by a separate level control system.
Type:	Special TF-2 EP tandem magnetrol control with glass float. Two units are required, one for control and one for the alarm.
Manufacturer:	Fred H. Schaub Engineering Company, Inc. Chicago, Illinois

Item 402: Benzol Feed Control

Function:	To automatically meter a specified quantity of benzol to each unit.
Range:	0-400 GPH - Units 4 through 13 0-250 GPH - Units 2 and 3
Type:	Each control consists of: 1 - 12" M/10 Stabilog flow controller type 7115 1 - S.I. orifice plate for 1" line 1 - 1" A6A S 30 orifice flange 1 - Set liquid meter piping 1 - ½" control valve, code 32110 BA 1 - Set liquid seal chambers
Manufacturer:	Foxboro

August 1957

Item 403: Twelve Point Temperature Recorder

Function:	To record the following temperatures: 1 - vaporizer coil outlet, inner and outer coils (if double coil unit) 2 - exhaust flue gas to vaporizer - inlet and outlet 3 - No. 1 preheater pot 4 - No. 2 preheater pot 5 - top of fractionating column 6 - condenser water outlet 7 - benzol "run-back" from condenser 8 - bottom of fractionating column sump
Range:	0-1000°C.
Type:	#40362-17-special model micromax temperature 12 point indicating recorder. Iron - Constantin #8759-S thermocouples
Manufacturer:	Leeds and Northrup

August 1957

Item 404: Single Point Temperature Recorder and Controller

Function:	To indicate, record, and control the temperature of the converter by regulating the natural gas burners.
Range:	100-1100°C.
Type:	#40617-A2-H-83 Model S Micromax temperature indicating and recording controller. Pneumatic control - Automatic droop correction - Motor 110 v. 60 cycles 3/4" Mason-Neilan pneumatic valves Mason-Neilan valve repositioners with air sets and parts. No. 8755 Iron-Constantin pipe type thermocouples with standard 778A element and P1-181A head, 66" long
Manufacturer:	Leeds and Northrup

DSW 462564

August 1957

Item 405: Natural Gas Meter

Function:	To record the quantity of gas consumed per unit or still.
Type:	No. 35 B metric iron case meter for natural gas service. Top connections. Maximum working pressure 100#.
Manufacturer:	American Meter Company

DSW 462565

August 1957

Item 406: Temperature Recorder - Diphenyl Still (1-Required per Still)

Function:	To record the following temperatures: 1 - still body 2 - still inlet 3 - outlet - circulating line 4 - top of column 5 - reflux to column 6 - condenser water-out.
Type:	#40356-55M-special Micromax 6 point 115 v. 60 cycle temperature recorder
Manufacturer:	Leeds and Northrup

August 1957

Item 407: Temperature Control Still Heater

Function:	To control the temperature difference between the heater inlet and outlet by regulating the gas burners.
Type:	#40617 A3 - Model S Micromax single point recording temperature controller Mason-Neilan #30 valve repositioners with 3/4" pneumatic valves, air sets and parts.
Manufacturer:	Leeds and Northrup

August 1957

Item 408: Biphenyl Unit - Automatic Safety Switches for Natural Gas (1-Required per Unit)

Function:	To protect the equipment in the event of an emergency, by stopping the flow of natural gas to the No. 2 preheater when the temperature exceeds a predetermined maximum.
Manufacturer:	Foxboro - Potentiometer Controller

August 1957

SERIES 500 - UTILITIES

Item 501: Lighting

The diphenyl building housing the conversion units is provided with slightly better than general lighting. The lights are standard lights with reflectors.

The two still rooms are provided with general lighting utilizing Appleton Electric Company Cat. #26537 explosion proof pendant fixtures with shallow dome reflector. ½" hub size, 200 watt lamps.

The hydrogen compressor room has no lighting facilities in the room but receives its lighting from the outside from special explosion proof lights shining through the windows.

August 1957

Item 502: Power Wiring

The maximum connected horsepower is about 180 HP and the daily power consumption about 1845 KW average at full production capacity. Wiring, relay switches, transformers, etc., are provided according to standard electrical practices. The control panel is located outside the building in a special enclosure.

Item 502 Continued:

Item No.	Item	Quantity	HP	RPM	Voltage	Est. Max. KWH day	Remarks
101	Unloading Pump	1	3	1740	220/440	10	
103	Transfer Pump	5	2	1800	"	9	Stg. Tanks
107	Benzol Feed Pump	1	10	3470	"	175	Howell Elec. Co.
		1	7.5	1175	"	-	V-belt drive
111	Hydrogen Compressor	2	40	1175	"	700	Penn.Compressors
		1	30	1175	"	-	Worthington Comp.
117	Benzol Recovery Pumps	1	3/4(?)			1	
		1	(?)			-	
	Sump Pump	1	1/2	1750	220	neg.	Crude diphenyl sump
119	Still Charging Pumps	2	5	1750	220/440	20	
302	Still Circulating Pump	2	5	1750	220	80	
121	High Boiler Pump	1	7.5	1750	220	-	
123	Benzol Recovery Pump	1	3	1750	220/440	2	Distilled benzol
308	Heads & Tails Pump	2	3	1750	"	3	
310	Transfer Pumps	2	3	1750	220	15	Diphenyl
125	Loading Pumps	3	5	1750	220	15	Diphenyl

Item 503: Product Piping

The benzol unloading piping and transfer piping is steam traced and insulated.

All product piping including crude diphenyl, high boiler, and distilled diphenyl are steam jacketed and provided with "homemade" diaphragm expansion joints between all connections.

The product piping from the carbon traps and the split flow boxes are constructed to form a deep liquid trap to prevent hydrogen from venting into the feed or catch tanks from the column.

Piping is provided for the hydrogen gas from the split flow boxes and condenser to the hydrogen coolers and compressor room.

August 1957

Item 504: Water Piping

Cooling water piping is provided from the Plant water main pump to the condensers and the hydrogen coolers. The return piping from the various units terminate in a common header for drainage back to the general plant cooling pond. The water from the cooling pond is strained and pumped back to a cooling tower. The water from the cooling tower is piped back to a booster pump for reuse.

City water piping is provided for drinking purposes and for the emergency showers placed at strategic points throughout the building.

Item 505: Fuel Gas Piping

Fuel gas piping is provided to the preheaters and converters and to the gas fired heaters. An individual gas meter is provided in each line.

Item 506: Steam Lines

Steam lines are provided to all the jacketed product lines and to the coils in the catch and storage tanks, and to the split flow box. Also, a connection is provided to the recirculated water system. Steam is provided at 90-100# pressure.

August 1957

Item 507: Building

The diphenyl units, crude diphenyl stills, compressor room, Arocler plant, control rooms, offices and machine shop are all located in a 3-story standard mill building with a one-story lean-to on each side. The main building section measures 60' x 220', total area 110' x 220' accounted for by a 20' lean-to on the west side and 10' canopy on the east side over the loading platform. An area measuring 100' x 180' at the south end is allocated to diphenyl operations.

Construction is of steel throughout with hollow tile and stucco outside walls. Fire walls and fire doors separate the diphenyl units into three groups and separate the diphenyl stills from each other and from the rest of the plant.

August 1957

Item 508: Sewers

Item 509: Fire Protection Equipment

Item 510: Grounds and General Area

August 1957

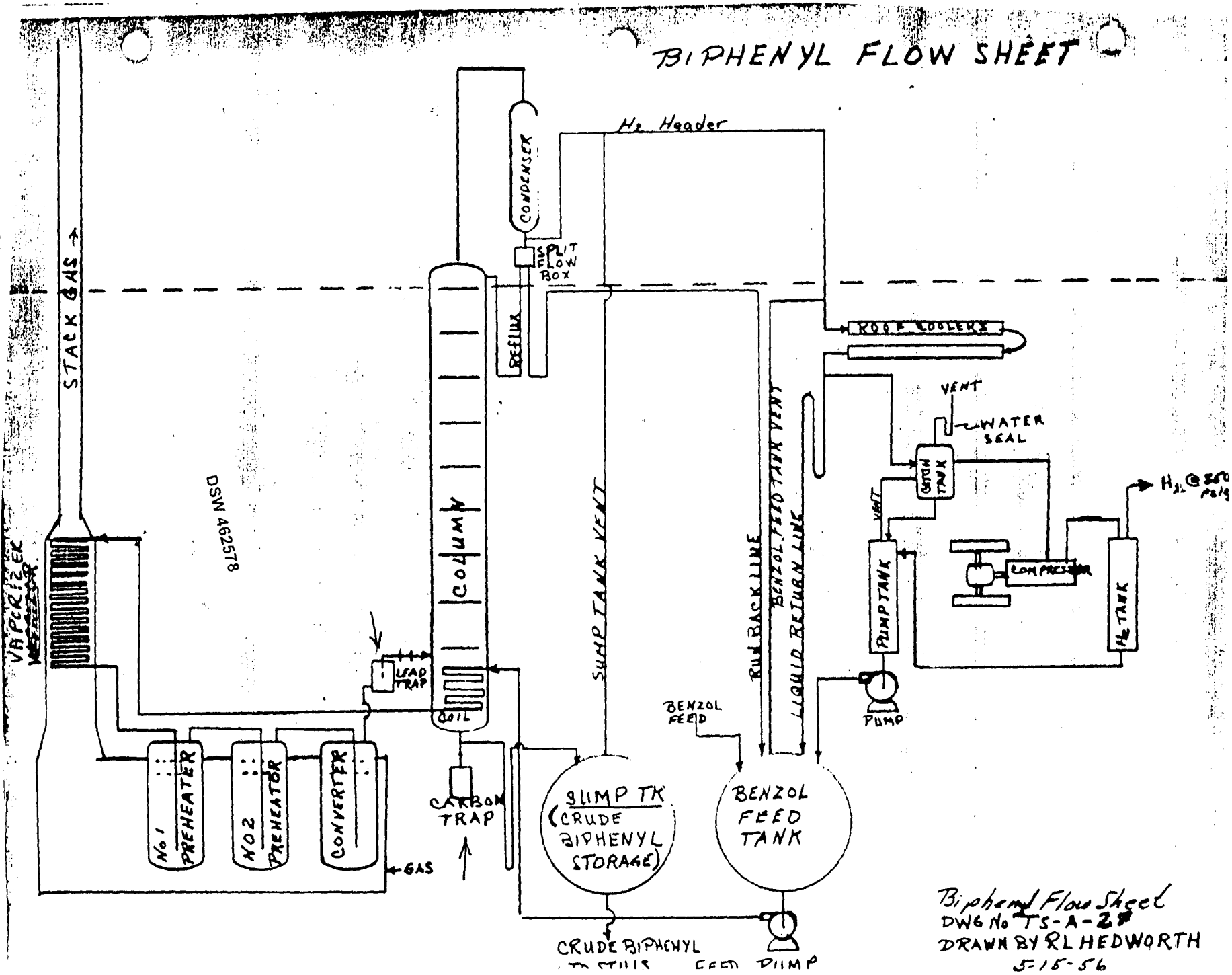
Item 511: Painting

The control piping is painted with distinguishing colors: blue for water, green for natural gas, and orange for benzol.

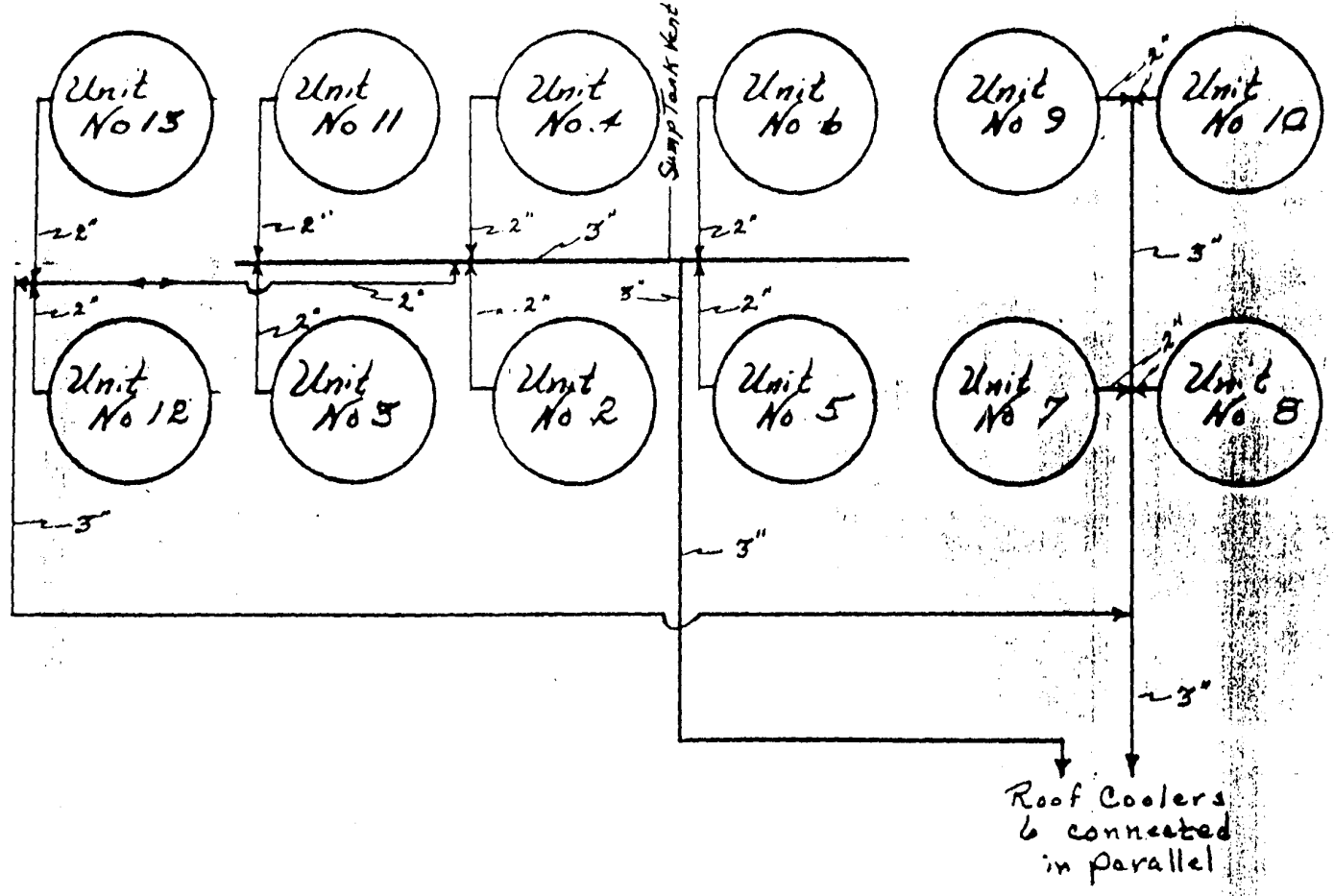
Storage tanks are painted with one shop coat (outside only) of blue lead as per Monsanto specification #1007.

Item 512: Insulation

Item 513: CO_2 Piping



BIPHENYL HYDROGEN PIPING



Hydrogen Piping
Dwg. No TS-A-30
Drawn By R.L. Hedworth
5-21-56

DSW 462579

1: Flowsheets and Diagrams

B-5114	Biphenyl Plant Flow Sheet
C-5240	Diagrammatic Layout
C-5440	Temperature Pressure Curves for Mercury, Diphenyl Water
C-6258	Diphenyl Plant Layout
C-6374	Diphenyl Plant Layout
C-6830	General Layout June 1935
C-6831	Diagrammatic Flow Sheet
A-7812	Heat Balance on No. 3 Unit
9C-7850	Diagrammatic Flow Sheet for 4 Pot Unit
9C-7851	Diagrammatic Flow Sheet for 2 Pot Unit
9C-7875	Diphenyl Still Diagrammatic Flow Sheet
9C-8466	Diagrammatic Flow Sheet Showing Prin. Equipment and Control System
9C-8546	Map Diphenyl Area

2: General

Plant Details of Steam Jacket Expansion Joint	9AA-9058
Thermo-well Detail	9AA-8832
Preheater Pot and Head Reaction Pot	C-4092
Preheater Terminal Bars	B-4012
Cast Alloy Reaction Pot	B-4052
Typical Diphenyl Unit	C-4061
Detail Reaction Pot	B-5205
Detail Pot Cover and Flange	C-5233
Chrome Steel Fittings for Lead Pots	C-5234
Detail Beams and Counter Fortes	C-5235
Lead Pot Setting	C-5236
Details of Fractionating Column	C-5237
Converter Unit - Plate Structure Work	C-5238
Converter Unit Structure Frame Diph. Col. & Condenser	C-5239
Hanger for Lead Pot Flange	AA-5299
Gooseneck for Still Connection	AA-5541
Nine Pass Expt. Tubular Converter Unit Brickwork	C-5760
Reaction Cover	C-5883
Diphenyl Distributor Pipe	AA-6333
Gasket for Benzol Still	A-6497
Stainless Steel Distributor Cup for Converter	AA-6699
Cover for Reaction Pot	C-6714
Lead Bath and Ser. Converter Units	C-6815
Water Piping at Top Platform for 4 Units	C-7861
Fire Protection for Still and Benzol Tanks	C-7893
Pan for Diphenyl	AA-8061
Detail Cast Steel Pot Cover	9C-8166

All Welded Pipeline	AA-8531
Insulation and Jackets for Goosenecks	9C-9085
Detail of Goosenecks	9C-8147
Cover Plate Detail for Reaction Pots	9C-9019

3: Benzol Storage

Benzol Underground Storage, Wooden Pump House	C-6259
Benzol Storage Tank Relocated Above Ground	C-6668
Detail Benzol Storage Tank Above Ground	C-6669
Benzol Storage - Pump Platform, Piping at Tank	C-6685
Benzol Storage Tanks, Cyclone Fence	C-6691
Benzol Storage Tank, New Layout	9C-7960
Benzol Storage Tank, Detail	9C-7961
Benzol Storage Tanks 3, 4, 5	9C-8252

4: Benzol Feeding

Feed Tank and Pump Foundation	9C-7857
Sump Tank	9C-7858
Feed Tank Cover, Pipe Trough and Supports & Misc. Steel	9C-7859
Benzol Feed Tanks, Piping Layout	9C-7862
Benzol Feed Tanks, Piping, Supports & Jacket	9C-7863
Benzol Feed Pumps, Piping and Fence	9C-7864
Handrail for Benzol Feed Tank	9C-7898
Alterations to Pump Plate at Benzol Feed Tanks	9C-8149
Fence for Benzol Tanks	9C-8153
Piping for Benzol Pumps 5 and 6	9C-8154
Benzol Feed Tank Platform	9C-8200
Benzol Piping Inside of Building	9C-8201
Detail Housing	9C-8202
Detail Housing	9C-8203
Benzol Feed Tanks, Layout	9C-8205
Benzol Feed Tanks, Detail	9C-8206
Piping from Building to Tanks	9C-8207
Piping at Control Room	9C-8208
Piping at Building Line	9C-8209
Benzol Feed Tank Foundation, Sheet 1	9C-8250
Benzol Feed Tank Foundation, Sheet 2	9C-8251

5: Units 1 and 2

C-5241	Preheating and Vaporizing Coils
C-5580	Diphenyl Plant 2nd Unit - Reactor Pots
AA-5581	Diphenyl Plant 2nd Unit - Detail Special Brick for Converter Unit and Traps
C-5582	Diphenyl Plant 2nd Unit - Detail of Fractionating Column
C-5583	Diphenyl Plant 2nd Unit - Setting for Converter Unit

C-5584	Diphenyl Plant 2nd Unit - Door and Burner Castings
C-5585	Diphenyl Plant 2nd Unit - Steel for Converter Unit
B-5586	Diphenyl Plant 2nd Unit - Stack for Conv. Unit and Location Burners
C-5587	Diphenyl Plant 2nd Unit - Stainless Steel Piping at Conv. Unit
C-5588	Diphenyl Plant 2nd Unit - Elev. Steel Work Around Conv. Unit
C-5589	Diphenyl Plant 2nd Unit - Plan Steel Work Around Conv. Unit
B-5590	Diphenyl Plant 2nd Unit - Foundation for Conv. Unit and Steel Platform
C-5591	Diphenyl Plant 2nd Unit - Layout of Subway Grating and Handrail on S. G.
C-5592	Diphenyl Plant 2nd Unit - Inside Fittings for Fractionating Column
C-5593	Diphenyl Plant 2nd Unit - Gas Piping for Conv. Units
C-5594	Diphenyl Plant 2nd Unit - Hot Water Storage and Heating System
C-5595	Diphenyl Plant 2nd Unit - Layout of Auxiliary Piping
C-5596	Diphenyl Plant 2nd Unit - General Layout
C-6841	Diphenyl Plant 2nd Unit - Benzol Vaporizer for No. 1 Unit
AA-7337	Diphenyl Plant No. 1 Unit - Conn. to Lead Trap
9C-7551	Diphenyl Plant No. 2 Unit - Detail Supports for Cond. and Flow Box
9C-7900	Diphenyl Plant No. 1 Unit - Piping at Lead Trap

6: Unit No. 3

C-7279	Fractionating Column for Unit No. 3
C-7280	Unit No. 3 - Diphenyl Still
C-7281	Diphenyl Plant - Unit No. 3
C-7282	Diphenyl Plant - Unit No. 3 Steel Elev.
C-7283	Diphenyl Plant - Unit No. 3 Steel Sections
C-7284	Diphenyl Plant - Unit No. 3 Evaporator and Stack
C-7285	Diphenyl Plant - Unit No. 3 Lead Traps
C-7286	Diphenyl Plant - Unit No. 3 Assembly Plans
C-7287	Diphenyl Plant - Unit No. 3 Assembly Elev.
AA-7322	Diphenyl Plant - Unit No. 3 Adapter Flange - Cond. to Split Flow Box
9C-7335	Diphenyl Plant Split Flow Box Installation on Diphenyl Still Column
9C-8139	Diphenyl Plant - Unit No. 3 Cooling Coils for Column

7: Unit No. 4

9C-7830	Unit No. 4 General Assembly
9C-7831	Unit No. 4 Burner Setting
9C-7832	Unit No. 4 30" Dia. 12 Plate Fractionating Column

9C-7833	Unit No. 4 Shell for Converter
9C-7834	Unit No. 4 Gas Piping to Burners
9C-7835	Unit No. 4 Piping at Top of Cols. 1 and 4
9C-7836	Unit No. 4 Split Flow Box Details
9C-7837	Unit No. 4 Fire Brick Setting
9C-7838	Unit No. 4 Lead Traps
9C-7839	Unit No. 4 Heat Exchanger
9C-7840	Unit No. 4 Vaporizer
9C-7841	Unit No. 4 Section and 2nd Floor Plan
9C-7842	Unit No. 4 Section and 3rd Floor Plan
9C-7843	Unit No. 4 Floor Grating
9C-7844	Unit No. 4 Holes for Burners in Shell
9C-7845	Unit No. 4 Stack & Connection to Vaporizer
9C-7846	Unit No. 4 Reaction Pot Assembly
9C-7847	Unit No. 4 Reaction Pot Details
9C-7848	Unit No. 4 Carbon Trap
9C-7849	Unit No. 4 Piping at Converter Unit
9C-7852	Unit No. 4 Piping at Sump Tank
9C-7855	Unit No. 4 Condenser, Trap, and Flow Box Support
9C-7856	Unit No. 4 Foundations
9AA-7860	Unit No. 4 Condenser Support
9AA-7865	Unit No. 4 Burner Adapter
C-7866	Unit No. 4 6" dia. Coll. Main for Ventilating Sump Tanks
C-7867	Unit No. 4 Gas and Benzol Feed
C-7869	Unit No. 4 Support for Vaporizer
C-7935	Unit No. 4 Fractionating Col. Jacket
7936	Unit No. 4 Emerg. Pipe Conn. Carbon Trap to Col.
7937	Unit No. 4 Alterations to Reaction Pot
9AA-7955	Unit No. 4 C. Steel Pipe Flanges

8: Unit No. 5

9C-7970	Unit No. 5 Layout
9C-7971	Unit No. 5 Steel Supports
9C-7972	Unit No. 5 Steel Supports
9C-7973	Unit No. 5 Floor Grating
9C-7974	Unit No. 5 Detail Sheel For Converter
9C-7975	Unit No. 5 Burner & Lighting Holes Converter
9C-7976	Unit No. 5 Pipe from Converter
9C-7977	Unit No. 5 Detail Pipe - Cols. to Sump Tank
9C-7978	Unit No. 5 Gas Piping to Burner
9C-7979	Unit No. 5 Detail of Piping
9C-7980	Unit No. 5 Benzol Feed Control Piping

9: Unit No. 6

9C-8131	Unit No. 6 Detail of Fractionating Column
9C-8140	Unit No. 6 Layout
9C-8141	Unit No. 6 Foundation
9C-8142	Unit No. 6 Structural Steel
9C-8143	Unit No. 6 Lead Traps
9C-8144	Unit No. 6 Piping at Col. and Cond., etc.
9C-8145	Unit No. 6 Detail Converter Shell
9C-8146	Unit No. 6 Layout S.S. Piping at Converter
9C-8147	Unit No. 6 Detail S.S. Piping at Converter
9C-8148	Unit No. 6 Assembly of Preheater
9C-8150	Unit No. 6 Vaporizer Details
9C-8151	Unit No. 6 Firebrick Setting
9C-8152	Unit No. 6 Detail of Sump Tank
9C-8155	Unit No. 6 Burner Setting
9C-8156	Unit No. 6 Gas Piping to Burners
9C-8157	Unit No. 6 Condenser
9C-8158	Unit No. 6 Condenser and Covers
9C-8159	Unit No. 6 Vaporizer Manhole Frame and Cover
9C-8160	Unit No. 6 Piping and Layout for Sump Tank
9C-8161	Unit No. 6 Detail of Vaporizer Coils
9C-8162	Unit No. 6 Diphenyl Line to Sump Tank
9C-8163	Unit No. 6 Piping at Rotaweir and Condenser
9C-8164	Unit No. 6 Piping at Rotaweir and Condenser Details

10. Units 7, 8, 9, 10

9C-8190	Units 7, 8, 9, 10 Layout
9C-8191	Units 7, 8, 9, 10 Details of Vaporizer Shell
9C-8192	Units 7, 8, 9, 10 6000 Gal. Catch Tank
9C-8193	Units 7, 8, 9, 10 Layout Crude Catch Tanks
9C-8194	Units 7, 8, 9, 10 Layout Diphenyl Piping
9C-8195	Units 7, 8, 9, 10 Details Diphenyl Piping
9C-8196	Units 7, 8, 9, 10 6000 Gal. Catch Tank Foundation
9C-8197	Units 7, 8, 9, 10 6000 Gal. Catch Tank Pit H.R.
9C-8198	Units 7, 8, 9, 10 Platform Sheet 1
9C-8199	Units 7, 8, 9, 10 Platform Sheet 2
9C-8202	Units 7, 8, 9, 10 Detail Housing
9C-8203	Units 7, 8, 9, 10 Detail Housing
9C-8467	Diphenyl Units 6, 7, 8, 9, 10

11. Units 11, 12, 13

9C-9021	Diphenyl Units 12 and 13 Details Col. Fdns.
9C-9022	Diphenyl Units 11, 12, & 13 Converter Shell Det.
9C-9023	Diphenyl Unit 11 Structural Framing
9C-9024	Vaporizer Coil Detail

9C-9025	Vaporizer Shell Detail
9C-9026	Vaporizer Assembly Units 11, 12, and 13
9C-9054	11, 12, and 13 Gas Piping to Burners
9C-9055	Layout Rotaweir and Condenser
9C-9056	Diphenyl Piping Lead Trap to StorageTank
9C-9059	Units 11, 12, and 13 Pipe & Support Details-Rotaweirs and Cond.
9C-9069	11, 12, and 13 Layout Benzol Runback Lines
9C-9014	Plot Plan Units 1, 11, and 12
9C-9015	Layout Units 1, 11, and 12
9C-9017	12 and 13 Structural Steel Framing
9C-9018	12 and 13 Structural Steel Framing
9C-9019	Unit Assembly and Details Preheater

12: Hydrogen Compressor

C-7363	Layout of Hydrogen Compressor
C-7364	Hydrogen Compressor Structural Steel for Building
C-7365	Hydrogen Compressor Room
C-7366	Hydrogen Compressor Room Wiring & Control Piping Diag.
C-7367	Hydrogen Compressor Tanks
C-7370	Compressor Room Foundation Plan
C-7901	Relocating Hydrogen Condensers
C-8014	Layout of Hydrogen Compressor Platform
C-8040	Layout and Detail Hydrogen Pipe from Cond.
C-8132	Ext. to Hydrogen Compressor Room Plans & Elev. of Bldg.
C-8133	Ext. to Hydrogen Compressor Room Struc. Steel for Bldg.
C-8134	Ext. to Hydrogen Compressor Room Layout
C-8165	Hydrogen Compressor Wiring and Piping Diagram
C-8179	Hydrogen Compressor Plan and Elev. Bldg.
C-8180	Hydrogen Compressor Floor Plan Sec. and Detail
C-8181	Hydrogen Compressor Detail Door Frames
C-8182	Hydrogen Compressor Foundation Plan and Sections
C-8188	Hydrogen Compressor Layout and Piping
C-8189	Hydrogen Compressor Details and Bill of Material
C-8279	Units 7, 8, 9, 10 Layout of Hydrogen Piping

13: Crude Diphenyl Storage

9C-8152	Detail of Sump Tank
9C-8160	Piping and Layout for Sump Tank
9C-8162	Diphenyl Line to Sump Tank
9C-8174	Steel Support & Platform for Crude Diphenyl Storage
9C-8175	Storage Tank
9C-8176	Steam Coils & Thermowell Crude Diphenyl Storage Tank
9C-8192	6000 Gal. Catch Tank
9C-8193	Layout Crude Catch Tank
9C-8194	Layout Diphenyl Piping
9C-8195	Details Diphenyl Piping

9C-8196	6000 Gal. Catch Tank Foundation
9C-8197	6000 Gal. Catch Tank Pit
9C-8198	Platform, Sheet 1
9C-8199	Platform, Sheet 2
9C-8249	Sprinkler System for Crude Diphenyl Storage
9C-8276	Sprinkler System for Crude Diphenyl Catch Tank
9C-8277	Vent Piping for Crude Diphenyl Catch Tanks
9C-8278	Crude Catch Tanks, Varec Gage

14: Diphenyl Distillation

9C-7870	Fractionating Column
9C-7871	New Layout Still and Auxiliary Equipment
9C-7872	Detail Condenser
9C-7873	Still Detail
9C-7876	Details Heads and Tails Tank and High Boiler
9C-7877	Details Diphenyl Catch Tank
9C-7878	Still Foundation
9C-7879	Still Supports, Sheet 1
9C-7880	Still Supports, Sheet 2
9C-7881	Still Supports, Sheet 3
9C-7883	Misc. Pipe Details, Sheet 1
9C-7884	Floor Grating
9C-7885	Misc. Pipe Details, Sheet 2
9C-7886	Swivel Split Flow Box and Misc. Steel
9C-7887	Misc. Pipe Details, Sheet 3
9C-7888	Condenser Details
9C-7889	Misc. Pipe Details, Sheet 4
9C-7890	Misc. Pipe Details, Sheet 5
9C-7891	Detail of Vents
9C-7892	Misc. Details
9C-7895	Assembly of Flow Box Control
9C-7896	Details of Split Flow Box Control
9C-7897	Vent Fan for Swivel Flow Box & High Boiler Drum Fill
9C-7939	Detail Still Heater, Sheet 1
9C-7940	Detail Still Heater, Sheet 2
9AA-7941	Flanges for Still Piping
9C-7943	Assembly of Heater
9C-7944	Detail of Heater Inner Core
9C-8076	Still Heater, Assembly
9C-8077	Still Heater, Details Sheet 1
9C-8078	Still Heater, Details Sheet 2
9C-8079	Diphenyl Still Revision to Heater Platform
9C-8081	Diphenyl Still, Heater Gas Piping
9C-8264	New Stairs at No. 1 Diphenyl Still

9C-8210	Layout of No. 2 Diphenyl Still
9C-8211	No. 2 Still Heater Shell
9C-8212	No. 2 Still Heater Assembly
9C-8213	No. 2 Still Catch Tanks
9C-8214	No. 2 Still Heads and Tails Tank
9C-8215	No. 2 Still, Layout Piping Sump Tank to Still
9C-8216	No. 2 Still, Detail Piping Sump Tank to Still
9C-8217	No. 2 Still, Heater Platform
9C-8218	No. 2 Still, Heater Platform Plan
9C-8219	No. 2 Still, Platform, Fl. L. and Grating
9C-8220	No. 2 Still Platform - Section and Details
9C-8221	No. 2 Still Platform - Stairs and H.R.
9C-8222	No. 2 Still Foundation
9C-8223	No. 2 Still Layout of Rotaweir
9C-8224	No. 2 Still Detail of Rotaweir
9C-8225	No. 2 Still, Details Vents and Piping, Sheet 1
9C-8226	No. 2 Still, Details Vents and Piping, Sheet 2
9C-8227	No. 2 Still, Details Vents and Piping, Sheet 3
9C-8228	No. 2 Still, Details Vents and Piping, Sheet 4
9C-8229	No. 2 Still, Details Vents and Piping, Sheet 5
9C-8230	No. 2 Still, Heater Detail Manhole Frame and Cover
9C-8254	No. 2 Still, Layout of Piping
9C-8262	No. 2 Still, Stair Details
9C-8263	No. 2 Still, Stair Details

15: Distilled Diphenyl Storage

9C-9057	Storage Tank 10'-6" x 37'-4" Detail
9C-7882	Foundation for Diphenyl Storage Tank
9C-7894	Storage Tank, Detail Loading Line
9C-9071	Supports Pipeline to Storage Tanks
9C-9082	Steel Platforms over Diphenyl Tanks
9C-9071	Pipe Line Supports and Foundations
9C-9083	Piping to and From Diphenyl Storage Tanks
9C-9076	Location Plan, 2 - 25,000 Gal. Tanks
9C-9088	Pumps for Storage Tanks
9C-9087	Steam Piping to Storage Tanks

16: Building

C-5418	Buildings - Elevations of Diphenyl Building
C-6378	Diphenyl Building - Asbestos Roof, S.E. Corner
C-7853	2nd and Top Floor Plans Showing Units, 1, 2, 3, and 4
C-7868	Roof Truss Reinforcing
9AA-7899	Diphenyl Development Bldg. Areas - Floor Lighting
C-8183	Diphenyl Building 40' Extension - Foundation
C-8184	Diphenyl Building 40' Extension - Floor Drains
C-8185	Diphenyl Building 40' Extension - Lean-to Still
C-8186	Diphenyl Building 40' Extension - Framing for Units 7, 8, 9, 10
C-8187	Diphenyl Building 40' Extension - Framing for Units 7, 8, 9, 10
C-8264	New Stairs at No. 1 Diphenyl Still

17: Controls

9C-8754	Walls & Instrument Panels - Control Room
9C-7942	Diphenyl Plant Control Room
9C-7949	Diphenyl Plant Control Panel - Detail
9C-8204	Control Room Units 7, 8, 9, 10 Panel
9C-8208	Benzol Feed Tanks - Piping at Control Room
9C-9060	Process Control - Instrumentation Diagram
9C-9061	General Plant, 1947 Additions - Power and Control

18: Power

9AA-8265	Diphenyl Plant - Power, Crude Diphenyl Power Panel
9C-8266	Diphenyl Plant Service Room - Gas & Elec. Con.
9C-8269	Diphenyl Power Transformer Guard
9C-8539	Electrical - Electric Services in Diphenyl Area
9C-8540	Electrical - Power in Diphenyl Bldg. - One Line Diagram
9C-8881	Power Distr. - Power Panels & Layouts & Schedules

19: Bills of Material

9BM-26	Benzol Feed Tanks
9BM-27	Diphenyl Units 1-2
9BM-28	New Still and Accessories (No. 1 Diphenyl Still)
9BM-29	4th Diphenyl Unit
9BM-35	5th Diphenyl Unit
9BM-36	Benzol Storage (9C-7960)
9BM-44	Diphenyl Still Heater (9C-8076)
9BM-47	Hydrogen Compressor
9BM-48	6th Diphenyl Unit
9BM-50	Crude Diphenyl Storage
9BM-51	Diphenyl Units - Extension to Building
9BM-52	Relocating Hydrogen Compressor
9BM-53	Benzol Storage
9BM-54	Four Diphenyl Units
9BM-55	Diphenyl Still No. 2
9BM-56	Water Supply
9BM-57	Power Supply
9BM-63	High Boiler Line to Storage Pit
9BM-74	Steam Line to Diphenyl Building
9BM-87	Diphenyl Units 11, 12, 13

EQUIPMENT NUMBER LIST OF M&E IN DEPT. 20 - BIPHENYL

Equipment Number	Description
17-7	Converter #2
17-10	Converter #3
17-15	Converter #4
17-16	Converter #5
17-17	Still Heater #1
17-20	Converter #6
17-21	Converter #7
17-22	Converter #8
17-23	Converter #9
17-24	Converter #10
17-25	Coil Heater #2 Still
17-31	Converter #11
17-32	Converter #12
17-33	Converter #13
20-1	Split Flow Box #5 Unit
20-64	Storage Tank, Heads and Tails Catch #2 Still
20-107	Storage Tank, Heads and Tails Catch #1 Still
20-110	Water Tank #1 Still
20-113	Hi-Boiler #2 Still Tank
20-126	Benzol Storage Tank - Yard
20-220	Benzol Feed Tank
20-226	Air Receiver 24" x 6'
20-230	Inter Cooler - Receiver #2
20-234	Split Flow Box #1 Still
20-235	Split Flow Box #3 Unit
20-247	Split Flow Box #2 Unit
20-263	Split Flow Box #4 Unit
20-264	Benzol Storage Tank 10'-0" x 18'
20-274	Receiver After Cooler #1 Comp.
20-275	Receiver Inter Cooler #1 Comp.
20-276	Sump Tank #3
20-285	Benzol Storage Tank
20-286	Benzol Storage Tank
20-287	Benzol Storage Tank
20-288	Biphenyl Catch Tank Still #1
20-289	Biphenyl Catch Tank Still #2
20-290	#2 Biphenyl Sump Tank South
20-291	#1 Biphenyl Sump Tank North
20-292	Benzol Catch Tank #1 - Comp. Room
20-293	Vacuum Receiver - Comp. Room
20-296	#3 Benzol Feed Tank
20-298	Sump Tank - Cooling Water
20-335	Biphenyl Storage Tank

Equipment Number List Continued:

Equipment Number	Description
20-236	Biphenyl Storage Tank
20-516	Benzol Recovery - Comp. Room
20-517	Benzol Recovery - Comp. Room
20-518	Benzol Feed Tank & Platform
20-528	Isopropyl Alcohol Tank
26-13	Sump at Benzol Storage Tank - Yard
26-18	Concrete Catch Basin - #3 Benzol Feed Tank
26-22	Safety Dike - #2 Biphenyl Storage Tank
28-80	Rotaweir - #6 Unit
28-81	Rotaweir - #7 Unit
28-82	Rotaweir - #8 Unit
28-83	Rotaweir - #2 Still
28-84	Rotaweir - #9 Unit
28-85	Rotaweir - #10 Unit
28-140	Rotaweir - #11 Unit
28-141	Rotaweir - #12 Unit
28-142	Rotaweir - #13 Unit
33-60	Pump - Ramsey 26/37 Benzol Storage Tank
33-79	Pump - Gould - Crude Storage
33-84	Pump - Viking 1189619 - Benzol Storage #1
33-129	Pump - Ramsey 26811 - Biphenyl Storage
33-135	Pump - Worthington - Still Room #1 Still
33-137	Pump - Ramsey - #1 H&T Tank
33-138	Pump - Viking - #2 Benzol Storage
33-145	Pump - Worthington - Comp. Room
33-156	Pump - Worthington - #2 Still
33-157	Pump - Blackmer 246737 - Benzol Storage #3
33-158	Pump - Blackmer 246738 - Benzol Storage #5
33-165	Pump - Taber 395 - #2 Still
33-166	Pump - Taber 249 - Pit Pump
33-167	Pump - Taber 384 - Catch Tank
33-168	Pump - Taber 384 - Catch Tank
33-169	Pump - Westco BR507 - Comp. Room
33-170	Pump - Taber 37764 - Crude Storage
33-171	Pump - Taber 37765 - Crude Storage
33-177	Pump - Westco 43036 - Benzol Unloading Dock
33-215	Pump - Taber 45132 - #1 Biphenyl Still
33-216	Pump - Taber 45497 - Biphenyl Still (Spare)
33-218	Pump - Viking - Benzol Storage #1
33-246	Pump - Gould 290A048 - Benzol Feed (Yard) (3)
33-261	Benzol Feed Pumps

Equipment Number List Continued:

Equipment Number	Description
34-74	Pump - Gould 176415 - Benzol Feed (1)
34-98	Pump - Gould 185143 - Benzol Feed (2)
35-22	Compressor #1 Hydrogen
35-33	Compressor #2 Air
35-34	Compressor #3 Air
35-37	Compressor #2 Hydrogen
35-45	Compressor #3 Hydrogen
51-17	Biphenyl Still #1
51-24	Biphenyl Still #2
52-6	Vaporizer #2 Unit
52-17	Vaporizer #3 Unit
52-22	Vaporizer #4 Unit
52-23	Condenser #3 Unit
52-27	Condenser #2 Converter
52-28	Heat Exchanger #1 Still
52-29	Heat Exchanger #4 Unit
52-30	Condenser #4 Unit
52-32	Condenser #1 Still
52-33	Heat Exchanger #5 Converter
52-34	Condenser #5 Converter
52-36	Vaporizer #5 Unit
52-37	Benzol Condenser - above Deck Sled
52-42	Vaporizer #6 Unit
52-43	Condenser #6 Unit
52-44	Inter Cooler #1
52-45	After Cooler #1
52-53	Condenser #7
52-54	Condenser #8
52-55	Condenser #9
52-56	Condenser #10
52-57	Vaporizer #7 Unit
52-58	Vaporizer #8 Unit
52-59	Vaporizer #9 Unit
52-60	Vaporizer #10 Unit (in stack)
52-61	Heat Exchanger #2 (Still)
52-62	Condenser #2 (still)
52-76	Vaporizer #11Unit
52-77	Vaporizer #12 Unit
52-78	Vaporizer #13 Unit
52-80	Condenser #11 Unit
52-81	Condenser #12 Unit

Equipment Number List Continued:

Equipment Number	Description
52-82	Condenser #13
52-88	After Cooler
52-91	Inter Cooler - Comp. Room
52-92	After Cooler - Comp. Room
52-147	Condenser - Comp. Room
52-148	Condenser - Comp. Room
52-149	Heat Exchanger - Hydrogen Cooling
52-150	Heat Exchanger - Hydrogen Cooling
52-151	Preheater Coil - Biphenyl Column
52-155	Heat Exchanger
52-157	Heat Exchanger
53-13	Fractionating Column #1 Biphenyl Still
53-14	Fractionating Column #4 Converter
53-15	Fractionating Column #2 Unit
53-17	Fractionating Column #5 Converter
53-18	Fractionating Column #6 Converter
53-19	Fractionating Column #2 Biphenyl Still
53-20	Fractionating Column #3 Converter
53-21	Fractionating Column #7 Converter
53-22	Fractionating Column #8 Converter
53-23	Fractionating Column #9 Converter
53-24	Fractionating Column #10 Converter
53-26	Fractionating Column #11 Converter
53-27	Fractionating Column #12 Converter
53-28	Fractionating Column #13 Converter
55-177	Man Cooler Fan
55-291	Fan, Utility
55-295	Blower - Hydrogen Comp. Room
61-157	Hand Truck - for Pots and Traps
63-93	Gear Box on Controller
63-134	Speed Reducer - Flaker
64-40	Jacketed Process Piping
64-41	Steam Feeder
64-47	Piping - Storage and Loading
64-48	Piping - Instrument
64-57	Service Piping - Units
64-58	Piping Benzol Recovery
64-66	Piping Benzol Unloading and Storage
65-21	Hydrogen Compressor Control Lines
65-74	Process Piping Benzol Feed Tank
65-75	Water Cooling Tracer

Equipment Number List Continued:

Equipment Number	Description
73-49	Chain Hoist #2 Converter
73-84	Chain Hoist #3 Converter - Trolley
73-94	Chain Hoist #4 Converter - Trolley
73-95	Chain Hoist #5 Converter - Trolley
73-96	Chain Hoist #5 Converter -
73-99	Chain Hoist #4 Converter
73-104	Chain Hoist
73-105	Chain Hoist - Trolley
73-106	Chain Hoist - Trolley
73-107	Chain Hoist - Trolley
73-108	Chain Hoist - Trolley
73-109	Chain Hoist - Trolley
73-123	Chain Hoist #11 Converter
73-124	Chain Hoist #12 Converter
73-125	Chain Hoist #13 Converter
75-21	Power Feeder - Underground to Biphenyl Storage Pumps
75-66	Temperature Control Wiring - Units
75-67	Motor Wiring
78-170	Power Panel #1 Converter
78-171	Motor Control Cabinet #1 Converter
78-174	Heat Control Board #1
78-177	Motor Control Board - Benzol Storage Pumps
78-178	Motor Control Board - Compressor Room
78-189	Control Cabinet - Compressor Room
78-190	Control Cabinet - Control Room
78-197	Motor Control Board #2 - #1 Converter Room
78-242	Power Cabinet - Benzol Feed & Hydrogen Compressor
78-243	Motor Control Frame - Storage Tank Motors
79-18	Motor - G.E. 5560247 - 40 HP - #2 Hydrogen Comp.
79-106	Motor - L A 311416 - 1½ HP - on Viking Pump
79-152	Motor - L A 3648018 - 1½ HP - Benzol Storage
79-157	Motor - Howell 5132 J 1 - 15 HP - Benzol Feed
79-301	Motor - G.E. - 5 HP - Biphenyl
79-308	Motor - G.E. - 5 HP - Biphenyl
79-414	Motor - G.E. - 1½ HP -
79-519	Motor - Howell 5131 J2 - 10 HP - Feed Pump
79-531	Motor - G.E. - 30 HP - #1 Hydrogen Comp.
79-561	Motor - Allis Chalmers 52694 - 2 HP - Yd 5 Bld. 27
79-571	Motor - G.E. 6768195 - 40 HP - #3 Hydrogen Comp.
79-589	Motor - L A - 7½ HP - #1 Still
79-593	Motor - G.E. - 3 HP - Yard
79-610	Motor - GE - EM 2900 - 5 HP - Biphenyl Storage

Equipment Number List Continued:

Equipment Number	Description
79-612	Motor - L A 368542 - 1 HP - Aroclor Boiler - Hyd. Comp.Room
79-614	Motor - GE - M1314 - 5 HP - Biphenyl Storage
79-642	Motor - GE - FW879 - 5 HP - Circ. Water #1 Still
79-683	Motor - GE - EW2292 - 5 HP - Air Comp.
79-712	Motor - Courtney - 1/6 HP
79-758	Motor - GE- AP1990 - 3 HP - Flake D. Dryer
79-824	Motor - GE - EP2055 - 3 HP - Biphenyl Tank
79-878	Motor Reducer - Foxboro - 1/6 HP - Control Room
79-914	Motor - G.E. - 3 HP - Sump Tank
79-922	Motor - G.E. - 5 HP - Catch Tank #2 Still
79-923	Motor - G.E. - 5 HP
79-926	Motor - G.E. - MR2065 - 3 HP - (on Gould pump)
79-927	Motor - G.E. - MR2067 - 3 HP - (on Gould pump)
79-963	Motor - L A - 7½ HP
79-975	Motor - L A - 7½ HP - #2 Biphenyl Still
79-976	Motor - 1/2 HP - Sump Tank
79-978	Motor - Howell 296186 - 2 HP - Blackmer Pump
79-979	Motor - Howell 287229 - 2 HP - Blackmer Pump
79-980	Motor - Howell 306991 - 2 HP - Blackmer Pump
79-987	Motor - W'hse - 7 HP - on Hartzell Fan
79-1139	Motor - L A 1827991 - 15 HP - on Benzol Pump 33-246
79-1192	Benzol Feed Pump and Motor
82-226	Watt Hour Meter G.E. 19366523 in Panel 78-170
82-227	Current Trans. G.E. 400/5 - in Panel 78-170
82-228	Current Trans. G.E. - in Panel 78-170
83-11	Controller - Benzol Comp.
83-13	Ind. Recorder - L&N 293220
83-17	Temp. Indicator - L&N 292382 - Control Room
83-33	Temp. Controller - Wilson-Macalen
83-34	Temp. Controller - Wilson-Macalen
83-35	Temp. Controller - Wilson-Macalen
83-40	Temp. Controller - Wilson-Macalen - 9575 H47A
83-44	Temp. Controller - Wilson-Macalen - Crows Nest
83-60	Temp. Controller - Wilson-Macalen
83-114	Ind. Recorder - L&N 329967
83-116	Gas Control Valve
83-117	Control Valve - Foxboro 490478
83-118	Control Valve - Foxboro 563776
83-119	Benzol Valve - Foxboro 563781
83-124	Temp. Recorder - L&N 350456
83-125	Temp. Recorder - L&N 338835
83-126	Gas Valve - L&N - #5 Converter
83-127	Control Valve - Foxboro 619301
83-128	Control Valve - Foxboro 619302

Equipment Number List Continued:

Equipment Number	Description
83-132	Magnetic Valve - On Preheater #5
83-136	Pressure Balance Valve - L&N
83-142	Temp. Controller - L&N 350682
83-145	Pneumatic Recorder - L&N 366481
83-146	Control Valve - Foxboro
83-147	Potentiometer Controller - Foxboro C58872 - Hydrogen Comp.Rm.
83-148	Potentiometer Controller-Foxboro C-58873-
83-149	Gas Valve - L&N
83-150	Temp. Recorder - L&N 350738
83-151	Temp. Recorder - L&N 350744
83-152	Gas Valve - L&N
83-153	Control Valve - Foxboro 697076
83-154	Control Valve - Foxboro 697077
83-155	Control Valve - Foxboro 697078
83-156	Control Valve - Foxboro 645409
83-166	Gas Valve - #2 Still
83-168	Temp. Recorder - L&N 350802
83-169	Temp. Recorder - L&N 350803
83-170	Temp. Recorder - L&N 350805
83-171	Temp. Recorder - L&N 350796
83-172	Temp. Recorder - L&N 350784
83-174	Temp. Recorder - L&N 381506
83-175	Temp. Recorder - L&N 381509
83-176	Temp. Recorder - L&N 381528
83-177	Temp. Recorder - L&N 381541
83-179	Temp. Recorder - L&N 350806
83-180	Temp. Recorder - L&N 381525
83-181	Temp. Recorder - L&N 350800
83-182	Potentiometer Recorder - L&N 381467
83-183	Potentiometer Recorder - L&N 381419
83-185	Potentiometer Controller - Foxboro C-63869
83-186	Potentiometer Controller - Foxboro C-63870
83-187	Potentiometer Controller - Foxboro C-63871
83-188	Potentiometer Controller - Foxboro C-63872
83-189	Control Valve - L&N - W/AB Air Set
83-190	Control Valve - L&N - W/AB Air Set
83-191	Control Valve - L&N - W/AB Air Set
83-192	Control Valve - L&N - W/AB Air Set
83-193	Control Valve - L&N - W/AB Air Set
83-194	Control Valve - L&N - W/AB Air Set
83-196	Ratox Press Controller - Foxboro C93641
83-197	Diff. Press Controller - Foxboro C66930
83-198	Motor Controlled Valve - Foxboro 470763
83-253	Pressure Valve - L&N
83-256	Rec. Temp. Controller - L&N 576007

Equipment Number List Continued:

Equipment Number	Description
83-257	Rec. Temp. Controller - L&N 576010
83-258	Rec. Temp. Controller - L&N 576015
83-259	Rec. Temp. Controller - L&N 690411
83-260	Temp. Recorder - L&N 690470
83-261	Temp. Recorder - L&N 690473
83-262	Potentiometer - Foxboro F83911
83-263	Potentiometer - Foxboro F83912
83-265	Ind. Press Controller - Foxboro 95626 - Hyd. Comp. Room
83-266	Cont. Benzol Valve - Foxboro 1619914
83-267	Control Benzol Valve - Foxboro 1619963
83-268	Control Benzol Valve - Foxboro 1619976
83-269	Control Gas Valve-Mason-Neilan J-29871C8276
83-270	Control Gas Valve-Mason-Neilan J29872C8276
83-271	Control Gas Valve-Mason-Neilan J-29873C8278
83-272	Controlled Valve-Foxboro F25FB-Hydrogen Compressor
83-328	Gas Controller - Foxboro J19649
84-18	Biphenyl Flow Controller - Foxboro - #4 Converter
84-19	Biphenyl Flow Controller - Foxboro C33473
84-20	Biphenyl Flow Controller - Foxboro C32422
84-23	Biphenyl Flow Controller - Foxboro C37533
84-24	Biphenyl Flow Controller - Foxboro C37534
84-28	Biphenyl Flow Controller - Foxboro C55147
84-29	Biphenyl Flow Controller - Foxboro C63568
84-30	Biphenyl Flow Controller - Foxboro C-63569
84-31	Biphenyl Flow Controller - Foxboro C63570
84-32	Biphenyl Flow Controller - Foxboro C-63571
84-53	Pneumatic Transmitter-Foxboro F75356
84-54	Pneumatic Transmitter-Foxboro F75357
84-55	Pneumatic Transmitter-Foxboro F75358
84-56	Pneumatic Transmitter-Foxboro F45926
84-57	Pneumatic Transmitter-Foxboro F45927
84-58	Pneumatic Transmitter-Foxboro F45928
84-59	Pneumatic Transmitter-Foxboro F45929
84-60	Pneumatic Transmitter-Foxboro F45930
84-61	Pneumatic Transmitter-Foxboro F45931
84-62	Pneumatic Transmitter-Foxboro F45932
84-63	Pneumatic Transmitter-Foxboro F45933
84-64	Pneumatic Transmitter-Foxboro F45934
84-65	Pneumatic Transmitter-Foxboro F45935
84-70	Intergrating Flow Controller-Foxboro F75359
84-71	Intergrating Flow Controller-Foxboro F75360
84-72	Intergrating Flow Controller-Foxboro F75361

Equipment Number List Continued:

Equipment Number	Description
86-2	Gas Meter - 016398 - #5 Unit
86-5	Gas Meter - 016463 - #11 Unit
86-7	Gas Meter - 016489 -#13 Converter
86-17	Gas Meter - 829070 - Biphenyl Still
86-24	Gas Meter - 016397 - #12 Unit
86-29	Gas Meter - 027352 - #7 Converter
86-30	Gas Meter - 028002 - #4 Converter
86-31	Gas Meter - 028003 - #6 Converter
86-32	Gas Meter - 028004 - #2 Converter
86-33	Gas Meter - 028265 - #3 Converter
86-49	Gas Meter - 051935 - #10 Unit
86-50	Gas Meter - 051936 - #9 Unit
86-51	Gas Meter - 051936 - #8 Unit
99-20	Fence - at Benzol Storage Tank
99-26	Fence - Storage Pit
106-132	Flood Lights - Feed Tank
106-253	Clock Synchonous
106-276	High Boiler Storage Pit - "Lake Clegorn"
106-283	Benzol Unloading Dome
106-365	Transmitter Stand - Meter Room
106-377	Pneumatic Wrench
106-391	High Boiler Storage Pit - Storage Crude Santowax
106-525	Pipe and Coils for #12 and #13 Units
106-533	Conversion Measurement System
107-16	Fire Extinguisher - on 2-Wheel Truck
107-33	Emergency Foam Line - at Benzol Feed Tank
110-39	Platform at Storage & Shipping Tank - S.E. Corner Bldg. 27
110-42	Platform #2 to #6, and #11 Units - Mid. Conv. Room
110-56	Supports for Benzol Feed Piping - S.W. Bldg. 27
110-68	Platform at #1 Still
110-69	Platform at Biphenyl Still Heater
110-70	Walking Platform, above Deck Shed Roof-Benzol Loading
110-82	Platform 7,8,9,10 Units
110-83	Platform #2 Biphenyl Still
110-84	Platform Benzol Feed Tank
110-85	Unloading Platform
110-95	Platform #12 and #13 Units
110-99	Platform, Including Grating & Stairs, Towers to Handle Sub. Pump
112-16	Control and Alarm System

Equipment Number List Continued:

Equipment Number	Description
116-98	Aroclor Heater (From CC Job - At No Value)
117-201	Tool and Supply Locker (4)
206-57	Feed Pump Structure (Fence and Concrete Floor)
206-72	Operating Structure-Biphenyl Sump Tank (Catch Basin, Fire Wall, Platform)

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MAINTENANCE SURVEY

SERIES 100 - GENERAL PLANT

Item 101: Benzol Tank Car Unloading Pump (1 Required)

Function:	To unload benzol from railway tank cars to the benzol storage tanks.
Maintenance Required:	None

Item 102: Benzol Storage Tanks (5 Required)

Function:	To provide Benzol raw material buffer storage between receipt and use.
Maintenance Required:	None

Item 103: Benzol Transfer Pumps (5 Required)

Function:	To transfer benzol from the benzol storage tanks to the benzol feed tanks.
Maintenance Required:	Maintenance will be done on MRO - proposal has been made to test suction of pumps to determine if a fewer number of pumps can be used.

Item 104: Isopropyl Alcohol Storage Tank (1 Required)

Function:	To provide buffer storage for isopropyl alcohol.
Maintenance Required:	None

Item 105: Isopropyl Alcohol Transfer Pump

Function:	To transfer isopropyl alcohol to the isopropyl alcohol feed tank.
Maintenance Required:	None

Item 106: Benzol Feed Tank (2 Required)

Function:	1. To provide a source of benzol for feeding the Biphenyl units. 2. To provide a catch tank for the benzol returned from the Biphenyl process.
Maintenance Required:	None

Item 107: Benzol Feed Pumps (3 Required)

Function:	To deliver the benzol feed from the benzol feed tank to the benzol vaporizer coil of each Biphenyl unit.
Maintenance Required:	None

Item 108: Isopropyl Alcohol Feed Tank

Function:	To provide a source of isopropyl alcohol for feeding to the benzene feed.
Maintenance Required:	None

Item 109: Isopropyl Alcohol Feed Pump

Function:	To transfer Isopropyl Alcohol to the suction of the benzol feed pumps.
Maintenance Required:	None

Item 110: Hydrogen Coolers (6 Required)

Function:	1. To cool the gas and vapors from the benzol condenser in order to decrease the vapor load on the hydrogen compressors. 2. To condense some of the benzol vapor from the hydrogen gas.
Maintenance Required:	Clean each cooler on the water side. This cleaning should consist of acid washing and inspection to determine if physical cleaning is necessary.

Item 111: Benzol Catch Tank (1 Required)

Function:	To trap condensed benzol from the hydrogen gas.
Maintenance Required:	None

Item 112: Hydrogen Compressors (3 Required)

Function:	To compress the hydrogen and condense the benzol vapors contained in the hydrogen.
Maintenance Required:	None

Item 113: Inter Coolers (3 Required)

Function:	To condense benzol from the hydrogen gas after the first compression stage.
Maintenance Required:	None

Item 114: Low Pressure Receiver (3 Required)

Function:	To provide a trap and collecting tank for the benzol condensed from the hydrogen gas after the first compression stage.
Maintenance Required:	None

Item 115: After Coolers (3 Required)

Function:	To condense benzol from the hydrogen gas after the second compression stage.
Maintenance Required:	None

Item 116: High Pressure Receiver (3 Required)

Function:	To provide a trap and collecting tank for benzol condensed from the hydrogen gas after the second compression stage.
Maintenance Required:	Visual inspection indicate no maintenance required. However, thickness of these tanks should be checked.

Item 117: Benzol Return Pump Tank (1 Required)

Function:	To collect the condensed benzol from the receivers and the benzol catch tank.
Maintenance Required:	None

Item 118: Recovered Benzol Return Pump

Function:	To return the recovered benzol in the pump tank to the benzol feed tank.
Maintenance Required:	None
	(Larger benzol pumps are needed.) (A separate project is being submitted.)

Item 119: Crude Biphenyl Catch Tanks (Sump Tanks) (2 Required)

Function:	To catch the crude Biphenyl from the Biphenyl units and store it prior to batch distillation.
Maintenance Required:	Repair sheet metal weather-proofing over insulation on No. 1 Sump Tank.

Item 120: Still Charging Pumps (2 Required)

Function:	To deliver the crude Biphenyl from the catch tanks to the still.
Maintenance Required:	None

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Item 121: High Boiler Collecting Tank (1 Required)

Function:	To provide a receiving and cooling tank for the distilled high boiler (Santowax C).
Maintenance Required:	The insulation on this tank is saturated with Biphenyl. Remove old insulation and re-insulate. Provide new weather-proofing.

Item 122: High Boiler Pump (1 Required)

Function:	To deliver high boiler from the high boiler tank to the Santowax C Storage Tank.
Maintenance Required:	None

Item 123: Distilled Benzol Collection Tank (1 Required)

Function:	To provide a catch tank for the benzol fraction distilled from the crude Biphenyl.
Maintenance Required:	None

Item 124: Distilled Benzol Return Pump (1 Required)

Function:	To deliver the recovered benzol from the distilled benzol collection tank to the benzol feed tank.
Maintenance Required:	Repair motor casing where it has corroded through.

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Item 125: Biphenyl Storage Tanks (2 Required)

Function:	To store distilled Biphenyl prior to shipping.
Maintenance Required:	None

Item 126: Biphenyl Loading Pumps (2 Required)

Function:	To deliver Biphenyl from the Biphenyl storage tanks to tank cars for shipping.
Maintenance Required:	None

SERIES 200 - BIPHENYL UNITS

Item 201: Benzol Vaporizer (1 Required per Unit)

Function:

1. To vaporize the benzol feed to each Biphenyl unit.
2. To recover sensible heat from the exhaust gases used in heating the preheater and converter pots.

Maintenance Required:

Unit No. 2 through 13:

Check each vaporizer coil core and coil support. Suspend all vaporizer coils from the top and support each turn of the coil. Replace the S.S. coil cores as required.

Item 202: Heat Exchanger (1 Required on Units 4 and 5 Only)

Function:

1. To further super-heat the benzol vapor from the vaporizer.
2. To recover heat from the vapors leaving the converter.

Maintenance Required:

Unit No. 4 and 5: None

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Items 203, 204, 205, 206, and 207: Fire Box and Associated Preheater Pots, Converter Pot, Burners, etc.

Function: To super-heat the benzol vapors to the pyrolysis temperature.

Maintenance Required:

Firebox: Check brickwork in firebox of Units 2 through 13 and repair as required.

Burners:

- Unit No. 4: Replace broken Inspirator on preheater.
- Unit No. 5: Replace missing burners on converter.
- Unit No. 7: Replace missing burners on converter.
  Replace broken Inspirator on No. 1 preheater.
- Unit No. 8: Replace missing burner on No. 2 preheater.
- Unit No. 9: Replace broken Inspirator on No. 2 preheater.
- Unit No. 10: Replace broken Inspirator on converter and No. 2 preheater.
- Unit No. 11: Replace broken Inspirator on No. 2 preheater.
- Unit No. 12: Replace broken Inspirator on converter.

Item 208: Start-Up By-Pass Stack (1 Required per Unit)

Function:	To provide a means of by-passing the hot flue gases around the cold vaporizer prior to beginning the benzol feed.
Maintenance Required:	Check the butterfly type valve in the horizontal header between the by-pass stack and exhaust stack of Units 2 through 13. Repair as required.

Item 209: Exhaust Stack (1 Required per Unit)

Function:	1. To provide a means for exhausting the flue gas from the preheater and converter to the atmosphere.
	2. To provide a housing for the vaporizer coil.
Maintenance Required:	Check the firebrock in the exhaust stacks of Units 2 through 13 and repair as required. Repair all holes in these stacks.

Item 210: Lead Trap (1 Required per Unit Except Unit Nos. 4 and 11)

Function:	To trap entrained lead coming over with the benzol vapor from the converter.
Maintenance Required:	No maintenance required. (These lead traps will be eliminated as soujourn pot sections are installed on the converter pots.)

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Items 211, 212, 213 and 214: Fractionating Column Carbon Trap, Condenser and Split Flow Box (1 Required per Unit

Function:

1. To function as a cooling system to condense the vapors from the converter.

2. To effect a partial separation of the benzol from the converted products.

Maintenance Required:

Check the supports on the #2 Unit column and provide additional supports as necessary. These supports should be adequate to support the column and associated equipment when the column is filled with water.

SERIES 300 - BIPHENYL STILLS

Item 301: Biphenyl Still Pot (1 Required per Still)

Function: To provide a reservoir for heating the charge of crude Biphenyl which is being distilled.

Maintenance Required:

Still No. 1: None
Still No. 2: None

Item 302: Biphenyl Still Circulating Pump (1 Required per Still)

Function:

1. To circulate the crude Biphenyl in the still pot through the heating coil of the gas fired heater and back to the still pot.
2. To pump the residue in the still to the high boiler collecting tank.

Maintenance Required:

Still No. 1: None
Still No. 2: None

Item 303: Gas Fired Heater (1 Required per Still)

Function: To supply the heat required for distilling the crude Biphenyl.

Maintenance Required:

Still No. 1: Recondition or replace two bad inspirators and reconnect to gas line.

Still No. 2: None

Items 304, 305, and 306: Biphenyl Still Column, Condenser, and Split Flow Box (1 Set Required per Still)

Function:	To separate and condense the crude Biphenyl vapors into benzol, high boiler, and Biphenyl.
Maintenance Required:	Still No. 1: None Still No. 2: None

Item 307: Heads and Tails Catch Tank

Function:	To provide a catch tank and storage for the heads and tails distilled from the crude Biphenyl.
Maintenance Required:	Still No. 1: None Still No. 2: None

Item 308: Heads and Tails Return Pump (1 Required per Still)

Function:	To return the heads and tails from the catch tank to the still pot.
Maintenance Required:	Still No. 1: None Still No. 2: None

Item 309: Biphenyl Catch Tank (1 Required per Still)

Function:	To receive the Biphenyl fraction and temporarily store the Biphenyl during the distillation.
Maintenance Required:	Still No. 1: None Still No. 2: None

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Item 310: Distilled Biphenyl Transfer Pump (1 Required per Still)

Function:	To deliver the distilled Biphenyl from the Biphenyl catch tank to the Biphenyl storage tanks.
Maintenance Required:	Still No. 1: None Still No. 2: None

SERIES 400 - INSTRUMENTATION AND CONTROLS

Item 401: Automatic Let-Down Level Control (1 Required on Primary Feed Tank Only)

Function: To automatically maintain a supply of benzol in the feed tank and to sound an alarm in case of high or low level.

Maintenance Required: None

Item 402: Benzene Feed Control (1 Required per Unit)

Function:

1. To automatically meter a specified quantity of benzene to each unit.
2. To automatically shut off the natural gas flow when the feed stops.

Maintenance Required: None

Item 403: Twelve Point Temperature Recorder (1 Required per Unit)

Function: To record the critical temperatures.

Maintenance Required: Check the instrument on each unit and repair as required. Each instrument is to record:

1. The condenser water outlet temperature.
2. The vapor temperature on the top plate.
3. The flue gas temperature leaving the vaporizer coil section of the exhaust stack.
4. The temperature of the material flowing through the sump line.

Item 403 Continued:

Maintenance Required Continued:

5. The temperature of material leaving the vaporizer coil.

6. The temperature of the lead in the No. 1 preheater.

7. The temperature of the lead in the No. 2 preheater.

8. The temperature of the flue gas entering the vaporizer coil section of the exhaust stack.

Item 404: Single Point Temperature Recording Controller (1 Required per Unit)

Function: To indicate, record, and control the temperature of the converter by regulating the natural gas to the burners.

Maintenance Required: None

Item 405: Natural Gas Meters (1 Required per Unit and 1 Required per Still)

Function: To record the quantity of natural gas used on each Biphenyl Unit and each Biphenyl Still.

Maintenance Required: Clean, recondition, and check all gas meters. Relocate one of the two meters now on No. 12 Unit to No. 7 Unit.

Item 406: Biphenyl Still Twelve Point Temperature Recorder

Function:	To record the critical temperatures on the Biphenyl Stills.
Maintenance Required:	Still No. 1: None Still No. 2: None

Item 407: Biphenyl Still Furnace Temperature Recording Controller

Function:	To control the temperature differential between the heater inlet and outlet by regulating the flow of gas to the burners.
Maintenance Required:	None

Item 408: Biphenyl Unit Automatic Safety Switches for Natural Gas (1 Required per Unit)

Function:	To protect the equipment in the event of an emergency, by stopping the flow of natural gas to the No. 2 preheater when the temperature exceeds a predetermined maximum.
Maintenance Required:	Check, clean, recondition and repair as required.

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SERIES 500 - UTILITIES

Item 501: Lighting

Maintenance Required:

1. Install adequate lighting in benzene unloading dock area.
2. Provide adequate lighting in Biphenyl Unit rooms, 1st, 2nd, and 3rd floors. Lighting should be of the flood light type and should be located near walls and windows so that the lights do not overheat.

Item 502: Power Wiring

Maintenance Required:

1. Install insulated switch buttons on benzol unloading pump switch.
2. Replace the insulation button on the high boiler catch tank pump starter switch.
3. Replace the insulation buttons on both the No. 1 and No. 2 still heads and tails return pump starter switches.
4. Replace the insulation buttons on the No. 1 still Biphenyl transfer pump starter switch.
5. Replace the enumerable conduit covers throughout the entire area.

Item 503: Process Piping

Maintenance Required:

1. Extend the leg in the benzene run-back line from the roof cooler to make leg 8' high. (Completed)

2. Remove the swivel flow box from each still and install in their place a sight glass (steam jacketed) and a 3-way, "Y" type, valve. Provide a sample port in the line. (This change will reduce Biphenyl sublimation in the area and eliminate a source of product contamination.)

3. Repair enumerable steam leaks throughout the area.

4. Replace the bent sump tank vent header so that condensed benzene can run back to both sump tanks.

Item 504: Plant Water Piping

Maintenance Required:

Dismantle copper tubing to benzol feed pump bearings and install 1/4" steel piping.

Item 505: Natural Gas Piping

Maintenance Required:

No maintenance is required except for general renovation of unusable valves, gauges, and general wandering pipe runs.

Item 506: Steam Piping - Benzol Loading Dock Area

Maintenance Required:

1. Install steam trap on tank car unloading line tracer near pump. Supply steam to this tracer near base of pump and trap near this point. Condensate will drain back down the tracer to trap.

2. Dismantle copper tubing feeding tracers on benzol feed pump discharge line and install in schemetrical fashion.

3. Survey all steam traps in the area and repair or replace those not operating.

Item 507: Building

Maintenance Required:

Removal of the walls in the Biphenyl Unit area is desperately needed. This report is by no means presenting the design for that undertaking because it is beyond the scope of this survey. However, the author does encourage those concerned to act upon the removal of these walls at their earliest opportunity.

Item 508: Sewers

Maintenance Required:

Provide sewer for benzol feed tank drain.

Item 509: Fire Protection Equipment Including Sprinklers

Maintenance Required: This equipment is in fairly good condition but some of the equipment should be replaced with up-to-date equipment.

Item 510: Grounds and General Area

Benzol Unloading Dock Area:

Maintenance Required:

1. Renew guard rail around tank car dome sling.
2. Renew the 2 benzene pipe line supports due south of hydrogen compressor room nearest the Muriatic Acid area.
3. Extend fence around benzol storage tanks to include isopropyl alcohol storage tank.
4. Repair steps to north Benzol feed tank.
5. Repair benzol feed tank dike.
6. Remove the float valve from the sump pump at the concrete dikes around sump tanks and benzol receiver. Provide a manual switch so the water can be drained from this dike.

(A project has been submitted for the renewal of the Biphenyl transfer line and the pipe supports.)

Item 511: Painting

Maintenance Required: Painting of the Biphenyl Plant is, in general, needed. This, however, is beyond the scope of this survey. Painting in this area should be on a scheduled basis and should begin immediately.

Item 512: Insulation

Maintenance Required:

Insulate:

1. all lines between vaporizer coils and No. 1 preheater
2. all lines between the No. 1 preheater and the No. 2 preheater
3. all lines between the No. 2 preheaters and the converters, and
4. all lines between the converters and the columns.

Insulate all steam jacket piping.

Item 513: CO_2 Piping

Maintenance Required:

(A project has been approved for the installation of CO_2 distribution piping. Consequently, no recommendations for improving the present system will be made.)