

**Pipeline Pigging Operations
Ethylene Pipeline Systems
Ethylene Storage Terminal**

**Normal Operating Procedure
for the use of "Pigs" in Gas
and Liquid Pipelines**

PURPOSE: To outline the normal procedure for utilizing "Pigs"

REFERENCES: Material Safety Data Sheet, CAS # 74-85-1, Ethylene (5002WP/LC.018).
Material Safety Data Sheet, CAS # 75-01-4, VCM Vapor / Liquid.
Material Safety Data Sheet, CAS # 68442-69-3, Linear Alkyl Benzene.
Pipeline Pigging Technology, by J. N. H. Tiratsoo, Editor, 1989.
Pipe Line Rules-of-Thumb Handbook, 2nd Edition, by E. W. McAllister, Editor.
D.O.T. Regulations: 49 CFR, Chapter I, Part 192 & 195.
ESI "Pig" Operations Procedure, LAB-OPR-900-N004.
ESI Pig Trap Station Normal Operation Procedure, ETH-DIS-N074.
ESI Pig Trap Station Abnormal Operation Procedure, ETH-DOT-X001.

SAFETY:

Material or Chemical	Personal Protective Equipment Required*
ETHYLENE VINYL CHLORIDE MONOMER VAPOR / LIQUID LINEAR ALKYL BENZENE	None other than standard PPE

*PPE required for this procedure only. Refer to MSDS for other applications.

DISCUSSION: A "pig" may be described as a free-moving piston which is inserted into a pipeline to perform a certain function. Their two classes are Non-intelligent - swabbing (removal of liquids or gases), batching (separation of dissimilar fluids), cleaning (removal of solids), or in some cases gauging, and Intelligent Magnaflux, Ultrasound, X-rays, Sonar, and many others.

Approved: _____ **Date:** _____
Manager, Responsible Care

Approved: _____ **Date:** _____
Environmental Manager

Pipeline Pigs are utilized for line commissioning, cleaning, filling, dewaxing, batching, and more recently pipeline monitoring. Pigs are also used during the construction phase of the pipeline. In order for pipelines to remain free of blockages or damages, they need to be inspected regularly. Pigs are the only

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economical alternative for inspecting the interior of a pipeline. They provide maximum throughput, reduce energy costs per unit of product, reduce erosion (rotating machinery), reduce contamination of product, and reduce corrosion of internal pipe walls.

The main use of pigs in pipelines is for the following categories:

1. Interface Separation of Fluids
2. Removal of Obstructions
3. Pipeline Maintenance
4. Pipeline Monitoring

Their use during construction, commissioning, operations, maintenance, and inspection is growing exponentially. During construction, pigs are used for removal of debris, such as welding rods, gloves, shields, hats, tools, or anything else that might have wandered into the pipeline. This process is usually completed prior to the construction crew moving on to a new section of the pipeline. Post-construction, a cleaning pig train is ran down the pipeline in case anything remained in the pipeline after the initial clearing.

Acceptance Testing is carried out once construction on the pipeline is over. This is accomplished by first using a basic gauging plate pig. A metal disk, generally 90 % or more of the minimum designed pipeline internal diameter, is fitted onto a simple pig. This usually follows a cleaning train pig. This can lead to problems where the pipeline's internal diameter is constricted (dented, buckled, or oval pipe, reduced porting of in-line valves, or corrosion). Therefore, a bi-directional (bi-di) pig is usually used, so that the pig may be retrieved from problem area. Finally, a pressure test of the pipeline must be carried out. A pig is used during pipeline hydrotesting for controlling filling and air removal. If water is to remain in pipeline for extended periods of time, it should contain corrosion inhibitors, oxygen scavengers and biocides.

In Commissioning a pipeline, it has to be cleared of the hydrotest media to allow effective operation. The degree of difficulty in accomplishing this, depends on what is the final service media to fill the pipeline. For oil service media, it is as simple as filling the pipeline with oil behind a short pig train displacing the water directly or with a slug of gas (nitrogen) between the water and the product. With gas transmission pipelines, the problem is substantially greater. Water may freeze and gas hydrates may form, causing a lot of problems in starting-up and operating the pipeline. Greater problems may occur if untreated gas containing CO₂, H₂S,

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or CI is introduced into an improperly dehydrated pipeline due to corrosive fluid formation.

During Operation, Product Separation is important so that costs may be minimized and throughput maximized by transporting batches of different products in the same pipeline, especially if pipeline is hundreds of miles long. This requires pigs to be ran between batches to help in the separation. These are usually liquid filled polyurethane spheres.

Pipeline Maintenance is the pig's main application once the line is in operation. During operation, the internal pipe wall will undergo varied forms of deterioration, depending on service media conditions. As the pipe condition worsens, the hydraulic efficiency of the system drops, leading to increased operating costs. The main factor is reduction in the internal pipe diameter due to corrosion or deposition of transported product (wax /barium scale). This is reduced by regularly passing scraper pigs and possibly dispersing chemical corrosion inhibitors (slug of it between two pigs). Pipe wall cleaning can be achieved with brush pigs. Simple or spherical pigs can be used to remove liquid pockets (local corrosion pockets) or water condensation on pipe walls. All these methods may also be employed when starting up or shutting down a pipeline.

Effective Monitoring of pipelines involves the use of a range of intelligent pigs. These detect metal loss, cracking and similar pipeline defects. They employ various techniques, such as Magnaflux, Ultrasound, X-rays, and Sonar, in order to accomplish these tasks. These pigs can become quite complex and be composed of several modules.

General Checklist:

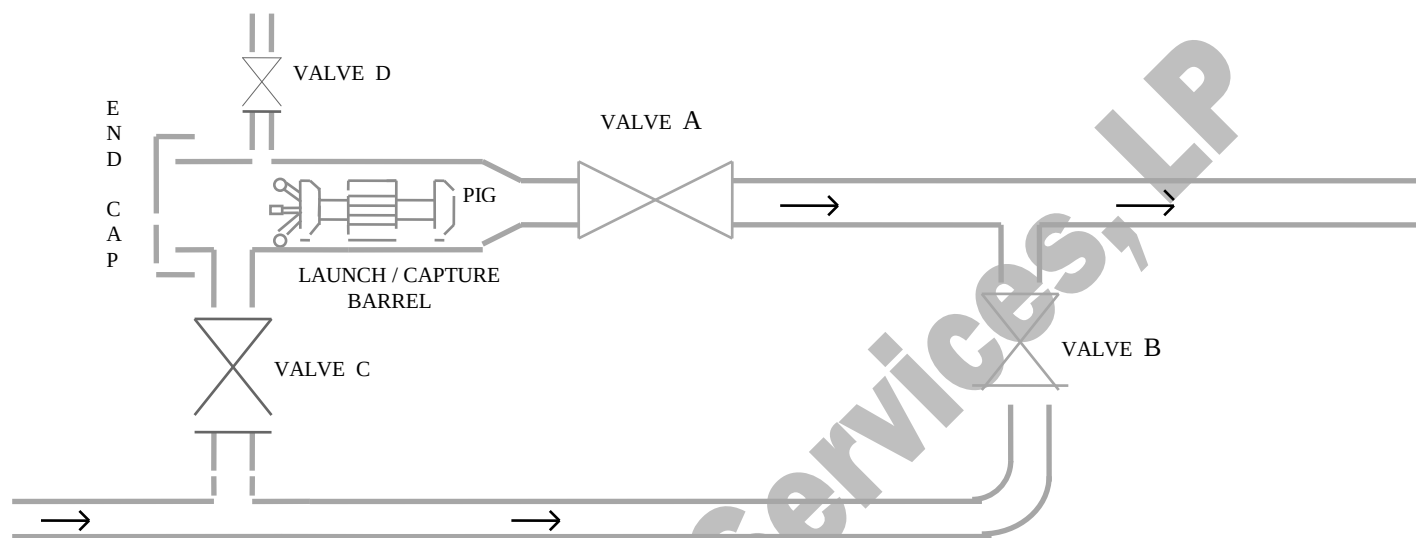
- 1.0 Normal Procedure
- 2.0 Safety Concerns
- 3.0 Monitor Operation
- 4.0 Documentation
- 5.0 Appendix

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PROCEDURE:

1.0 Normal Procedure



1.1 Launching Pig

1.1.1 Make sure valve "A," valve blocking pig launcher exit from pipeline flow path, and valve "C," by-pass valve between pipeline flow path & pig launcher inlet, are closed.

1.1.2 Bleed down pig launcher barrel pressure by opening valve "D," launcher barrel bleeder valve.

Note: Proper precautions are to be taken so that product is not released into the atmosphere in the case of gas, or discharged into the ground in case of liquid product. This may mean the attachment of a temporary gas or liquid fire safe container (sealed tank or cylinder) to the launcher barrel bleeder valve. If pipeline service media is a liquid, Nitrogen may be used to purge the launching barrel.

Depending on the product, Nitrogen may be introduced into the launcher barrel to purge gas or liquid in order to decrease chances of a fire or explosion once the launcher barrel is opened.

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1.1.3 Once launcher barrel is near atmospheric pressure, close bleeder valve "D."

1.1.4 Open launcher barrel end cap after releasing chained safety pin, if one is present.

Note: Depending on style of end cap and launcher barrel size, this process will vary greatly. If a screw end cap is utilized, the cap should be turned counter clockwise by hammering on the appropriate hammering recesses built onto the end cap with a non-sparking hammer if the product is flammable. If end cap has quick release fittings, loosen bolts so that hardware may be separated from the cap. Remember, care should be taken to stand away from the rear of the pig launcher barrel in case pressure gauges or valves leak and propel the end cap rearwards.

1.1.5 Swing end cap away from rear of pig launching barrel, if so equipped.

1.1.6 Insert Pig sufficiently into the launcher so that its hindquarter is located past the inlet of the by-pass valve "D." This may require an additional push into the barrel utilizing a pipe or pole of the appropriate length.

1.1.7 If end cap is equipped with a supporting hanger, swing it away from rear of pig launching barrel.

1.1.8 Close end of launcher barrel by turning end cap, onto threads, clockwise (if so equipped) until it is tight. If the end cap is designed for quick disconnects, place end cap into position, install quick disconnect clamp hardware into place, and tighten bolts.

1.1.9 Open slightly by-pass valve "C" in order to increase pig launcher barrel pressure slowly up to pipeline pressure.

1.1.10 Once the launching barrel is up to pipeline pressure, Open block valve "A."

1.1.11 Pinch down on valve "B" to make the pig leave the launch barrel once the differential pressure overcomes the pig's static friction. If a pigalert is installed, its tattletale flag will be tripped once the pig leaves the launcher. If one is not installed, listen for the pig making contact with the pipeline's internal wall as it leaves the launcher and enters the pipeline.

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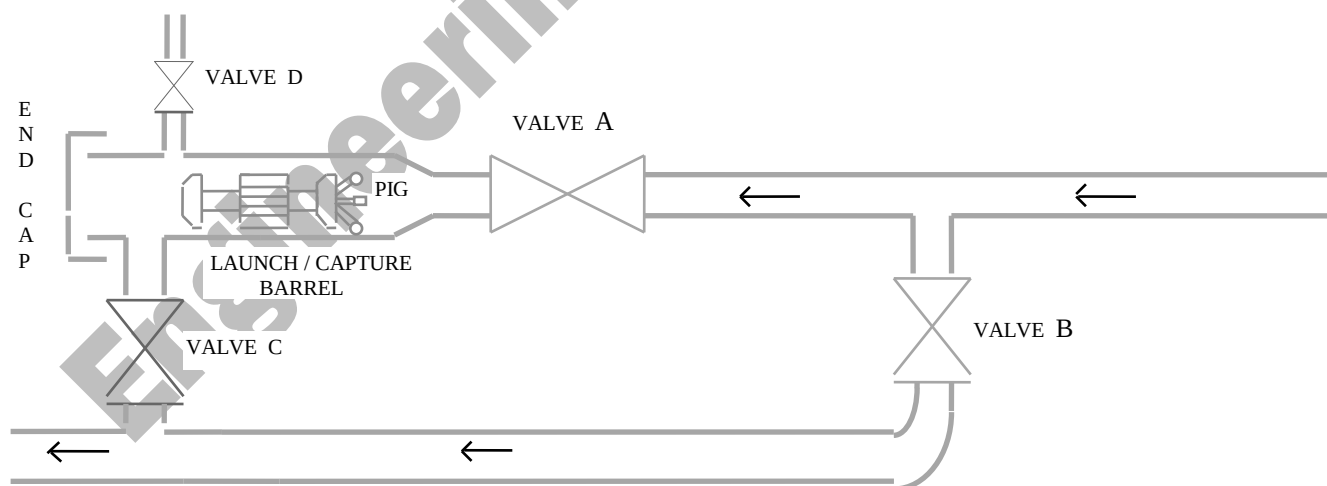
1.1.12 Once the pig leaves the launcher, open valve "B" fully and close valves "A" & "C."

Note: The pig will now continue flowing down the pipeline at product speed. If pig has tracking capabilities, it may be tracked down the pipeline until it reaches the pipeline's pig trap on the other end. If pigalerts are installed at regular intervals on the pipeline, the pig may be tracked by keeping tabs on the tattletale flags being tripped. If none are installed, other technicians, stationed at points along the pipeline, should be watching for the pig passing by.

If pressure on the launcher side of pipeline increases and the trap side decreases, a possible blockage may have occurred by the pig getting stuck at some point along the pipeline. Use technicians, pigalerts, or any other resource to assess where the pig may be stuck. If some flow through the pipeline remains, the pig has partially collapsed or disintegrated once obstruction impeded its progress.

1.1.13 Bleed down pig launcher barrel pressure by opening valve "D," launcher barrel bleeder valve. Observe the same precautions outlined in section 1.1.2 above.

1.2 Pig Trapping (Receiving) Procedure



1.2.1 Once pig has been launched, open valves "A," "B," and "C" at the receiver.

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1.2.2 If the pig did not get stuck along the way, it will reach and stop at the tee just upstream of valve "A," connecting to valve "B" that is providing pressure by-pass.

1.2.3 Slowly pinch down on valve "B," causing pig to move into the receiving barrel in a controlled manner.

1.2.4 Once the pig is trapped in receiving barrel, fully open valve "B."

Note: If a pigalert is installed, its tattletale flag will be tripped once the pig enters the launcher. If one is not installed, listen for the pig making contact with the receiver's internal wall as it enters the launcher and exits the pipeline. If pig is able to be tracked electronically, examination of the receiving equipment is all that is needed to determine if the pig has reached the receiving barrel. **Depending on the product, Nitrogen may be introduced into the launcher barrel to purge gas or liquid in order to decrease chances of a fire or explosion once the launcher barrel is opened.**

1.2.5 Close valve "C" and then close valve "A."

1.2.6 Purge (bleed) pig receiving barrel down to near atmospheric pressure by opening valve "D."

Note: Proper precautions are to be taken so that product is not released into the atmosphere in the case of gas, or discharged into the ground in case of liquid product. This may mean the attachment of a temporary gas or liquid receptacle (sealed tank or cylinder) to the receiving barrel bleeder valve. If pipeline service media is a liquid, Nitrogen may be used to purge it out of the barrel.

1.2.7 Once launcher barrel is near atmospheric pressure, close bleeder valve "D."

1.2.8 Open launcher barrel end cap after releasing chained safety pin, if one is present.

Note: Depending on style of end cap and receiving barrel size, this process will vary greatly. If a screw end cap is utilized, the cap should be turned counter clockwise by hammering on the appropriate hammering recesses built onto the end cap. If end cap has quick release fittings loosen bolts so

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that hardware may be separated from the cap. Remember, care should be taken to stand away from the rear of the pig launcher barrel in case pressure gauges are damaged and/or valves leak which may propel the end cap rearwards once it is released.

- 1.2.9 If end cap is equipped with a supporting hanger, swing it away from rear of pig launching barrel.
- 1.2.10 Remove pig from the receiving barrel.
- 1.2.11 Swing end cap back onto rear end of pig receiving barrel.
- 1.2.12 Close end of launcher barrel by turning end cap, onto threads, clockwise (if so equipped) until it is tight. If the end cap is designed for quick disconnects, place end cap into position, install quick disconnect clamp hardware into place, and tighten bolts.

2.0 Safety Concerns

- 2.1 If a launched pig does not reach its destination or is delayed, it is probably stuck in the pipeline or has obtained some damage along the way. If pig was not equipped with electronic locating device, under no circumstance should a second pig be launched to dislodge the first one. This will only make the blockage worse and shut down operation of the pipeline. It may cause pipeline ruptures if the flow of the product is totally blocked.

The following actions should be taken in the specified order of preference:

- 1. Ascertain that the pig actually left the launcher, open launcher barrel and visually check it.
- 2. Check that all main valves are in the fully-open position.
- 3. Check pressure charts, gauges, or readouts for sudden or violent rise in pressure along the pipeline due to the pig becoming stuck or damaged. If this occurred, its time of occurrence may be compared against the pig launching time and flow rate to arrive at an approximate pig position.

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Utilizing this method of determining where the pig is located can only determine an approximate location in the pipeline, but at least away from the launcher or receiver. Assuming all three checks outlined above have been negative, a specialist pig locating service would be the best cost alternative as far as efficiency in locating the pig. Equipment may be purchased or rented, but unfamiliarity with the equipment could cause problems.

The only time that a second pig should be launched is if there is good reason to believe that the first pig has broken up or fallen apart. This can only be ascertained if flow rates and pressures are relatively constant and/or pieces of the first pig arrive at the receiver.

Note: It is very important that the product's MSDS be reviewed so that all precautions are taken to keep the process of purging and exposing the launching / receiving barrel chamber to the atmosphere as safe and uneventful as possible. Nitrogen may have to be used for purging.

2.2 Factors that make pigging impossible (need to remove obstacle).

2.2.1 Closed or stuck isolation valves

2.2.2 Control Valves

2.2.3 Orifice Plates

2.2.4 Tangential branches

2.2.5 Slip plates (blindings)

2.2.6 In-line strainers

2.2.7 Thermowells

2.3 Factors affecting type of pig.

2.3.1 Change of pipe inside diameter

2.3.2 Mitered bends

2.3.3 Line ovality

2.3.4 Short-radius bends (less than 3 times the Diameter of the pipe)

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- 2.3.5 Full-size branches
- 2.3.6 Non-return valves
- 2.3.7 Heavy product build up
- 2.4 Proper pig types and their uses.
 - 2.4.1 Gauging or geometry pig used for Geometry survey, verifying minimum clear bore.
 - 2.4.2 Brushing or steel-bladed pig used for removal of rust, scale and hard deposits.
 - 2.4.3 Urethane-bladed pig used for removal of wax-type deposits.
 - 2.4.4 Spheres, two or four cup pig used for chemical swabbing.
 - 2.4.5 Bi-directional or foam pig used for water filling / air removal.
 - 2.4.6 Cub swabbing-bi-directional pig used for maximum dewatering. Foam pig is less expensive, but accomplishes less dewatering than the above.
 - 2.4.7 Two or four cup, foam, and sphere pigs used for product removal.
 - 2.4.8 Foam and/or plastic brushing pig used for internally-coated lines.
 - 2.4.9 Spheres and/or five-cup batching pig used for product separation.
 - 2.4.10 Spheres used for meter probing
 - 2.4.11 Metal-loss pig used for corrosion/material defect checks.
- 2.5 It is essential that pipelines transporting dry gas be dried effectively after commissioning or hydro-testing. Corrosion, product contamination, or hydrate formation are the problems that may occur in a wet pipeline.
- 2.6 Operator(s) should be on the alert, when a pig is launched, for pressure increases on launching end and/or drops at the receiving end that may cause equipment shutdowns and can cause the pig to become stuck or delayed.

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- 2.7 The immediate area around the pig launcher and receiver is to be free of loose, stored, and otherwise extraneous materials.
- 2.8 Review any site emergency procedures for fire and/or explosions.
- 2.9 Operate any fire monitors on site, if non-functioning have backup available.
- 2.10 Check all valves required to load and unload the pig test for full-bore opening and pressure sealing. Also, check that the end cap makes a good seal.
- 2.11 Make sure spare end cap seals and lubricant is available on site prior to launching pig.

3.0 Monitor Operations

- 3.1 A well maintained pipeline will require little effort on the part of the operator once the pig is launched. The pig should travel pipeline unscathed and be retrieved at the receiving end with no delays.
- 3.2 If pipeline is not pigged on a regular basis a scraper pig should be sent through the line two or three times in order to assess line conditions. Its good practice to incorporate gauging plates on the scraper pig. This will alert operator of geometric problems in the pipeline.
- 3.3 Monitor pipeline pressures on the launching and receiving end to see if they change drastically during time of pig travel.
- 3.4 Monitor flow rates of the pipeline to see that they remain fairly constant during pig travel.
- 3.5 Make certain that receiving barrel support valves are all open after launch or before launch on short line runs.

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4.0 Documentation

- 4.1 Prior to any pigging operation there should be certain information available to the pig vendor and/or contractor hired to perform it. This important information will allow for a better match between pig and operation that is wanted to be performed on the pipeline.

See Appendix for a sample questionnaire to be filled out by engineering prior to their recommendation of pig specifications. This questionnaire is a direct adaptation of table 4.1 page 75-76, Pipeline Pigging Technology by J.N.H. Tiratsoo.

- 4.2 Operator to document launch time, type of pig & operation, beginning pressures on both ends of the line run, a statement verifying the fact that he has checked that all main line valves are fully-opened, and his signature in the operator's log.

5.0 Appendix

5.1 Pigging Pipeline Questionnaire

5.1.1 Line I.D. _____

5.1.2 Total Line Length _____

5.1.3 Is line divided into sections ? YES / NO
If so, how many? _____

5.1.4 Is line flanged ? YES / NO
If so, give flange rating _____

5.1.5 Clearance at ends to locate temporary traps _____

5.1.6 Pipeline material _____
Welded construction ? YES / NO

5.1.7 Type of bends _____
No. of bends _____

5.1.8 If bends are mitered, give maximum length of sections _____

5.1.9 If bends are mitered, give maximum angle _____

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5.1.10 Are there tees in the line when pigged YES / NO
If so, what size ? _____

5.1.11 Location of tees ? _____

5.1.12 Are guide bars installed ? YES / NO
If so, give spacing _____

5.1.13 Are there reducers in line YES / NO
If so, what size ? _____

5.1.14 Are there any valves in the line when pigged ? YES / NO
If so, give accurate minimum bore _____
Type _____

5.1.15 Reason for pigging

5.1.16 Content when pigging

5.1.17 Propellant for pigs _____
Will client supply YES / NO

5.1.18 Line content on completion _____

5.1.19 Is line above ground ? _____
Is line on pipe rack ? YES / NO

5.1.20 If on pipe rack, give height _____

5.1.21 Is line anchored in Vertical / Horizontal ?
Could client anchor line temp.? YES / NO

5.1.22 Is crane available to locate pig traps and plant ? YES /NO

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5.1.23 If so, give capacity _____
What restrictions are imposed on area of launch area and receiver ?

5.1.24 Does pipeline run through hazard areas ? _____

5.1.25 Is drawing of line route available? YES / NO

5.1.26 Can work be completed at one time? YES / NO
Estimate of time to complete? _____

5.1.27 How are protecting ends of line on completion ?

5.1.28 Is methanol required ? YES / NO
If so, how much ? _____

5.1.29 Is a trichloroethylene substitute required ? YES / NO
If so, How much? _____

5.1.30 What tests are needed? _____

5.1.31 Detail pigging runs _____ off
Gauging _____ off
Brushing _____ off
Methanol Swabbing _____ off
TriChlor Subst _____ off Foam Pigs

5.1.32 Can pigging be done in normal working hours ? YES / NO

5.1.33 Will overtime and/or weekend work be expected ? YES / NO

5.1.34 Provisional Start Date ? _____
Completion date ? _____

5.1.35 Union Workers for technicians required ? YES / NO

5.2 **PIG UNIT AT LAB PLANT, P. 20, LAB "Pig Operating Procedure," LAB-OPR-900-N004.**

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- 5.3 **PIG UNIT AT CONOCO DOCK**, P. 21, LAB "Pig Operating Procedure," LAB-OPR-900-N004.
 - 5.4 **CONOCO DOCK VAPOR TRAP DETAILS**, P. 22, LAB "Pig Operating Procedure."
 - 5.5 **PIG TRAP STATION IN ETHYLENE PLANT**, DWG. NO. 071-9004-01.
 - 5.6 **PIG TRAP STATION IN ETHYLENE PLANT**, P&ID NO. 82-D2 SHT. 2 OF 3.
 - 5.7 **PIG RECEIVER AT STORAGE TERMINAL**, DETAIL ON ALIGNMENT DWG NO. SEC 29.