A PROJECT REPORT

ON

DEVELOPING A SOFTWARE PROGRAM FOR AUTOMATION OF A GAS COMPRESSOR STATION

UNDER THE GUIDENCE OF

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CENTER FOR ELECTRONICS TEST ENGINEERING

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ETDC COMPLEX, KAMALANAGAR, ECIL, HYDERABAD

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR AWARDING THE DEGREE OF M.Tech (Gas Engg)

COLLEGE OF ENGINEERING

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

VILLAGE BIDHOLI, VIA PREM NAGAR,

DEHARADUN, UTTARAKHAND.

2005-2007

Government of India
Ministry of Communications & Information Technology
Department of Information Technology
STQC Directorate
Centre for Electronics Test Engineering
(As ISO 9001.2000 Certified Training Institute)

भारत सरकार
संचार एवं सूचना प्रौधोमिकी मंत्रालय
सूचना प्रौधोमिकी विभाग
मा.प.गु.नि. निर्देशालय
इलेक्ट्रानिकी परीक्षण इन्जीनियरिंग केन्द्र
(ISO 9001:2000 प्रमणित प्रशिक्षण संक्यान)

Ref. 2(1)/CETE (H)/Projects/2007-08/ Date : 26.04.2007

CERTIFICATE

This is to certify that the following M.Tech (Gas Engineering) student of **"University of Petroleum and Energy Studies, Dehradun, Uttarakand"** have completed the project work at Centre for Electronics Test Engineering, ETDC, Hyderabad.

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The project allotted to him was **"Developing a Software Program for Automation of a Gas Compressor Station"** from **26th February 2007** to **26th April 2007** and he has completed their project successfully.

During the project work he was found to be very regular and sincere to the work.

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SETB – An –
CETE HYDERABAD
Govt. of India.

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CERTIFICATE

This is to certify that the dissertation report on **"Developing a Software Program for Automation of a Gas Compressor Station"** completed and submitted to the **University of Petroleum & Energy Studies, Dehradun** by **Mr. Arun Kumar Bandaru** in partial fulfillment of the requirement for the award of degree of **Master of Technology (Gas Engineering), 2005-07,** is a bonafide work carried out by him under my supervision and guidance.

To the best of my knowledge and belief the work has been submitted anywhere else for any other University or Institution for the award of any degree/ diploma.

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ACKNOWLEDGEMENT

I wish to express my appreciation and cordial thanks to **Dr. B.P. PANDEY**, Dean, College of Engineering, UPES, Dehradun and **Dr. D.N. SARAF**, Distinguished Professor, College of Engineering for making provisions and encouraging me for my major project, which has been of inestimable value in my pursuit of achieving the Masters in Gas Engineering from University of Petroleum and Energy Studies.

To **Mr. R.V. SUDHAKAR,** Director, Center for Electronics and Technical Education, Hyderabad. I owe more than can be expressed for his kind supervision, special interest, ceaseless help and valuable suggestion during my project with CETE.

I wish to endorse my sincere gratitude and cordial thanks to **Mr. KAMAL BANSAL,** Assoc. Professor, COE, UPES, Dehradun for his encouraging attitude, expert advice and guide me through my project.

I would like to express my special thanks to **Dr. R.P. BADONI,** Course Coordinator, M.Tech (Gas Engg), UPES for his Kind assistance and guidance throughout my project.

Thanks to all those who directly or indirectly contributed to for my project at CETE and UPES.

ARUN KUMAR BANDARU.

ABSTRACT

The immense advance in technology makes us spell bound. It is exactly in this era that the Electronics and Instrumentation has come to stay as the most important branch of engineering. The greatest gift of electronics is automation, which put human life at ease.

I am on to "Developing a Software Program for Automation of a Gas Compressor Station" by using Programmable Logic Controller, at University of Petroleum and Energy Studies, Dehradun and Centre for Electronics and Technical Education, Hyderabad,.

The whole process of Gas Compression to be done automatically, the software program that I am designing uses Siemens S7-300 Programmable Logic Controller (PLC) using SIMATIC Manager. PLC provides a logical sequence of digital data to perform a series of operations.

A small defect in Gas Compression Station can lead to huge loss; there is a high demand of accuracy in designing our automation process. With successful completion of this project will aid to the good compression accuracy with much less human intervention and thus, in much lesser period of time.

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List of Abbreviations

CNG:	Compressed Natural Gas
CPU:	Central Processing Unit
CSF:	Control System Flowchart
DB:	Data Block
DCS:	Distributed Control System
ERP:	Enterprise Resource Planning
FB:	Functional block
FBD:	Functional Block Diagram
LAD:	Ladder Diagram
L-CNG:	Liquefied Compressed Natural Gas
MES:	Manufacturing Execution System
MRP:	Manufacturing Resource Planning
OB:	Organization Block
PB:	Program Block
PCI:	Personal Computer Interface
PLC:	Programmable Logic Controllers
SB:	Sequence Block
SCADA:	Supervisory Control and Data Acquisition
STL:	Statement Listing

CHAPTER 1

1.0 INTRODUCTION

The main objective of this project is to **"Developing a Software Program for an Automation of Gas Compressor Station".**

The whole process of Gas Compression to be done automatically, the software program that I am designing uses Programmable Logic Controller (PLC). PLC provides a logical sequence of digital data to perform a series of operations.

A small defect in Gas Compression Station can lead to huge loss; there is a high demand of accuracy in designing our automation process. With successful completion of this project will aid to the good compression accuracy with much less human intervention and thus, in much lesser period of time.

1.1 Purpose of Gas Compression System:

The main purpose of gas compression stations is to raise gas pressure from the production tubing in order to transport gas trough long pipes to consumers. The gas compression stations are made using many compressions aggregates. The most used compressions aggregates are Electrical Compressors and Gas Compressors. Without remote monitoring and control systems, gas producers are forced to incur the high costs associated with many services activities.

1.2 Purpose of Automation of a Gas Compression System:

To improve gas compression station reliability and safety it is strongly necessary to add control function and real time remote monitoring through automation. This thesis presents a PLC system for automation process flexible enough to be control of gas compressors. The system presented below provides accurate and real time remote monitoring and control function.

Gas production operations often require compressors to raise the pressure of the gas. Some of the important sectors in which compressors are used in natural gas industry are listed below

1) Providing enough pressure to gas for transport through transmission systems
2) Another transport related application of compressor is reducing the gas volume for shipment by tankers or for storage
3) In reservoir engineering applications compressors are important in lowering the well head pressure below atmospheric in order to produce the well at a lower rate, for reinjection of gas for pressure maintenance or cycling and for reinjection of gas into subsurface strata for underground storage.
4) In gas processing operations compressors are required for circulation of gas through the process or system and for raising gas pressure to the required level for a chemical processing reaction.
5) In Distribution of natural gas to various refueling stations and for domestic purposes.
6) In L-CNG and CNG refueling stations where gas is pressurized before sending it to the dispenser.

1.3 Compressors in Gas Pipelines

Natural gas is highly pressurized as it travels through an interstate pipeline. To ensure that the natural gas flowing through any of the pipeline remains pressurized, compression of this natural gas is required periodically along the pipe. This is accomplished by compressor stations, usually placed at 40 to 100 mile intervals along the pipeline. The natural gas enters the compressor station, where it is compressed by a turbine, motor, or engine. Turbine compressors gain their energy by using a small proportion of the natural gas that they compress. The turbine itself serves to operate a compressor, which contains a type of fan that compresses and pumps the natural gas through the pipeline. Some compressor stations are operated by using an electric motor to turn the same type of compressor. This type of compression does not require the use of any of the natural gas from the pipe; however it does require a reliable source of electricity nearby. Reciprocating natural gas engines are also used to power some compressor stations.

These engines resemble a very large automobile engine, and are powered by natural gas from the pipeline. The combustion of the gas powers pistons on the outside of the engine, which serves to compress the natural gas.

In addition to compressing natural gas, compressor stations also usually contain some type of liquid separator, much like the ones used to dehydrate natural gas during its processing. Usually, these separators consist of scrubbers and filters that capture any liquids or other undesirable particles from the natural gas in the pipeline. Although natural gas in pipelines is considered 'dry' gas, it is not uncommon for a certain amount of water and hydrocarbons to condense out of the gas stream while in transit. The liquid separators at compressor stations ensure that the natural gas in the pipeline is as pure as possible, and usually filters the gas prior to compression.

1.4 Compressor Stations – The heart of pipeline system

Compressor stations pump gas through a pipeline by compressing the gas at intervals along the system. Gas flows by expanding in the pipe from the discharge side (high pressure point) of one station to the suction side (low pressure point) of the next. An average station may pump as much as 830 million cubic feet of gas per day. Under normal operating conditions, compressor station engines run 24 hours a day, seven days a week, 365 days a year. While stations vary according to the number and types of engines they use, most compressor stations consist of piping, engines, compressors, fuel gas systems, lube oil systems, engine jacket water systems, electrical generators, safety systems, and personnel to maintain and operate these elements.

1.5 Programmable Logic Controllers:

Programmable Logic Controllers (PLCs), also referred to as programmable controllers, are in the computer family. They are used in commercial and industrial applications. A PLC monitors inputs, makes decisions based on its program, and controls outputs to automate a process or machine.

Following are the advantages of PLCs:

- Smaller physical size than hard-wire solutions.
- Easier and faster to make changes.
- PLCs have integrated diagnostics and override functions.
- Diagnostics are centrally available.
- Applications can be immediately documented.
- Applications can be duplicated faster and less expensively.

PLCs consist of input modules or points, a Central Processing Unit (CPU), and output modules or points. An input accepts a variety of digital or analog signals from various field devices (sensors) and converts them into a logic signal that can be used by the CPU. The CPU makes decisions and executes control instructions based on program instructions in memory. Output modules convert control instructions from the CPU into a digital or analog signal that can be used to control various field devices (actuators). A programming device is used to input the desired instructions. These instructions determine what the PLC will do for a specific input. An operator interface device allows process information to be displayed and new control parameters to be entered.

Pushbuttons (sensors), in this simple example, connected to PLC inputs, can be used to start and stop a motor connected to a PLC through a motor starter (actuator).

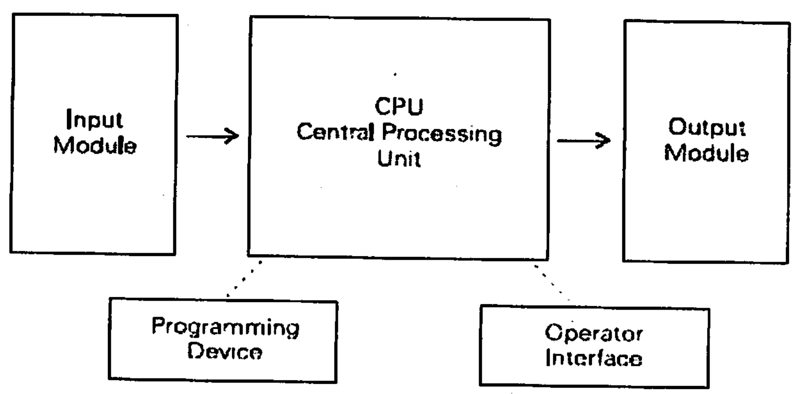


Figure: 1.0 Basic PLC diagram

The same, as well as more complex tasks can be done with a PLC. Wiring between devices and relay contacts is done in the PLC program. Hard-wiring, though still required to connect field devices, is less intensive. Modifying the application and correcting errors are easier to handle. It is easier to create and change a program in a PLC than it is to wire and rewire a circuit.

To Automation of the Gas Compressor station I am using **Siemens S7-300 Programmable Logic Controller**. The S7-300 and S7-400 PLCs are used in more complex applications that support a greater number of I/O points. Both PLCs are modular and expandable. The power supply and I/O consist of separate modules connected to the CPU. Choosing either the S7-300 or S7-400 depends on the complexity of the task and possible future expansion.

In this Project I worked on the automation using Siemens S7-300 Programmable Logic Controller. This project state of automation is in DCS level. But we can develop the Supervisory Control and Data Acquisition level using this automation program. This automation is for a station level. We can develop this for a number of stations or plants.

CHAPTER 2

2.0 CETE PROFILE

With the strong support of the German Agency for Technical Cooperation (GTZ) three Training Centers for Electronics Test Engineering (CETE) have been established in Calcutta, Bangalore Hyderabad under Society for Electronics Test Engineering (SETE), an autonomous Society of STQC Directorate, and Ministry of Information Technology.

The objective of the CETEs is to enhance the skill of technological manpower in the electronics and information technology sector in India. Training courses conducted by CETEs are demand driven and highly practice oriented. CETE endeavors to supplement the India industries and institutions with knowledge based skill to make them globally competitive through hands on training using state-of-the art equipment. Providing consultancy and advice on process improvements, ISO 9000 and 14000 as well as repair and maintenance services of electronics equipment are also important part of CETE's service packages.

In order to provide training programs and services, according to market requirements in the fast developing electronics sector CETE has established institutional links with major industries ,professional bodies and training providers.

CETE's equality management system confirms to ISO9001 standards.

2.1 FOCUS AREA

CETE is dedicated to provide practice oriented training and other services according to the requirements of electronics industry, users of electronics and professional organizations. At present the following are the main focus areas.

1. TECHNICAL TRAINING
2. CONSULTENCY AND ADVISORY SERVICES
3. REPAIR AND MAINTENANCE SERVICES

2.2 INFRASTRUCTURE AT CETE

Training programs at CETE are conducted in facilitated class rooms with latest teaching aids and CBTs in a modern teaching and learning environment.

CETE has established state-of-the art equipment like siemens S-7PLC,pick and place machines for SMT, process calibrators, BGA Machines, CNC controllers etc for giving effective hands on exposure.

Faculty members are highly qualified and experienced with focus on latest didactic methods. In relevant areas, guest faculties from industries are also invited to enrich the courses.

CETE's associated with industries and the German GTZ ensures regular update of equipment and knowledge in the future as well.

2.3 INDUSTRY INTERACTION

In order to be up-to-date and provide raining and services according to the demand of the customers, CETE has institutional links with associations and industries from various sectors. Industry representatives are members of management boards and advisory committees and advice CETE on curriculum design and equipment requirement. CETE faculties are in regular touch with industry from the management level to the production side-in order to get regular feedback to improve the training programs. CETEs also conduct tailor made training courses on site at industry premises.

A membership scheme for regular customers offers up to 25% concession on all training programs conducted by CETE.

2.4 A CENTER COMMITTED TO QUALITY EDUCATION & TRAINING

The center is equipped with state-of-art teaching and training aids, facilitated class rooms for interconnection technology/surface mount technology, computer aided testing.

EMI/EMC, calibration, repair & maintenance and technical information center with internet connectivity.

2.4.1 SERVICE OFFERED

The services provided by this center are mainly in two areas viz. training and consultancy. The training programmes are of short and long term duration ranging from 3 days to 6 months and are designed keeping in view needs of the client, through local industry training advisory committee (ITAC).

2.4.2 SPECIALISED AREAS OF TRAINING

In association with other sister organizations CETE Hyderabad also offers the following specialized training:

- Certified quality engineer
- Programmable logic controllers(PLCs)
- Lead assessor
- Microprocessor applications
- Reliability engineering
- Micro controller applications
- Laboratory assessor
- Repair & maintenance of test & measuring equipments.

2.5 LONG TERM MODULAR PROGRAMMES

CETE Hyderabad offers the following long term training programme (part time/full time)

- Post diploma course in test engineering, calibration & maintenance of electronic equipments.
- Certified operators course in soldering technology
- Repair, maintenance and calibration technique of TMI.
- Electronic manufacturing practice and quality assurance.

Duration of above courses range from 1 to 6 months, since the stress is a practice orientation, all the courses have hands-on sessions of at least 50% apart from theory, study visits, mini-projects and assessment of achievement.

2.5.1 ONSITE TRAINING

CETE Hyderabad also offer tailor made training programme at the premises of client organizations in modules with flexible timing to suit specific requirements.

2.5.2 COURSE WÅRE

The trainees are given exhaustive course material for study and reference. The emphasis being on hands-on training, technical video films, laboratory experiments and industry visits.

2.5.3 CONSULTANCY

SETE Hyderabad, In addition to training also offers consultancy services to industries in the following areas:

- ISO 9000
- Training needs assessment
- Setting calibration/test laboratories.

CHAPTER 3

INTRODUCTION TO COMPRESSORS

3.0 TYPES OF COMPRESSORS

There are two basic compressor types: positive-displacement and dynamic.

In the positive-displacement type, a given quantity of air or gas is trapped in a compression chamber and the volume it occupies is mechanically reduced, causing a corresponding rise in pressure prior to discharge. At constant speed, the air flow remains essentially constant with variations in discharge pressure. Dynamic compressors impart velocity energy to continuously flowing air or gas by means of impellers rotating at very high speeds. The velocity energy is changed into pressure energy both by the impellers and the discharge volutes or diffusers. In the centrifugal-type dynamic compressors, the shape of the impeller blades determines the relationship between air flow and the pressure (or head) generated.

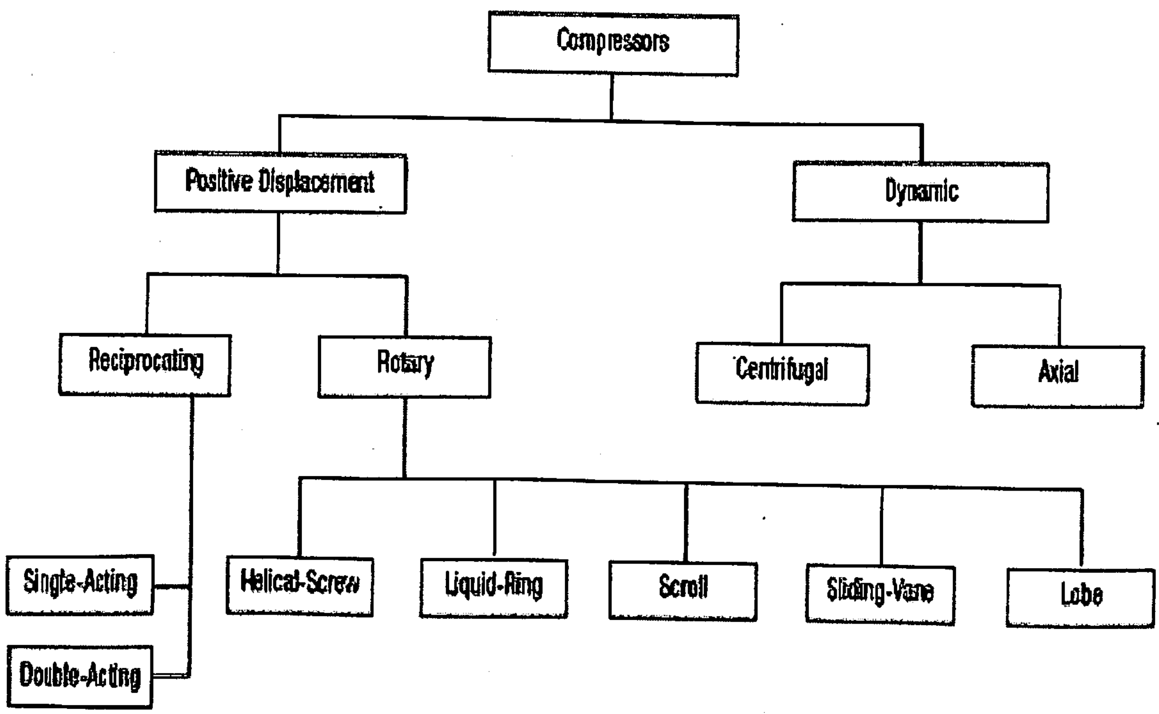


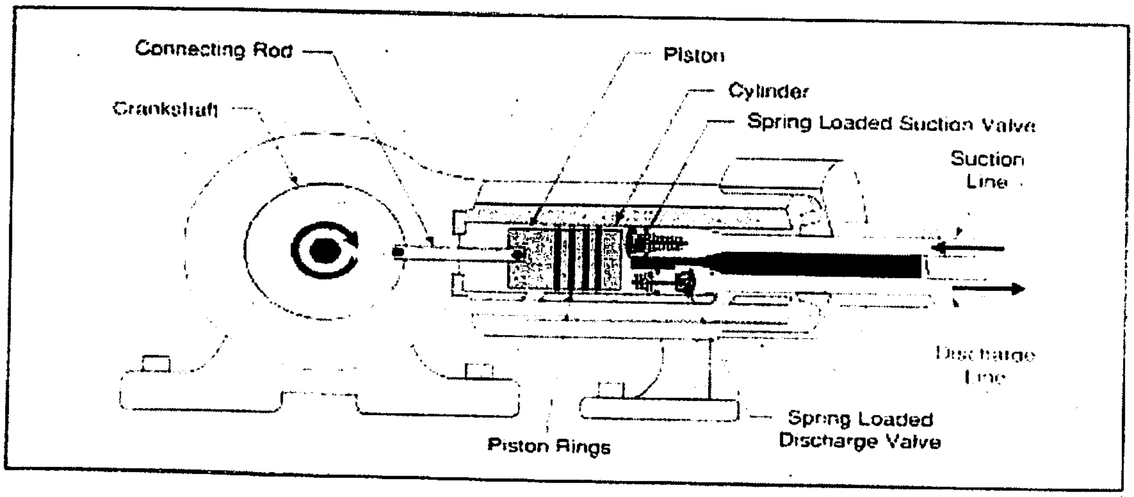
Table: 3.0 Types of Compressors

3.1 POSITIVE DISPLACEMENT COMPRESSORS

These compressors are available in two types: reciprocating and rotary.

3.1.1 RESIPROCATING COMPRESSOR

In industry, reciprocating compressors are the most widely used type for both air and refrigerant compression. They work on the principles of a bicycle pump and are characterized by a flow output that remains nearly constant over a range of discharge pressures. Also, the compressor capacity is directly proportional to the speed. The output, however, is a pulsating one.



Reciprocating Compressor

Figure: 3.0 A cross-sectional view of a reciprocating compressor

Reciprocating compressors are available in many configurations; the four most widely used are horizontal, vertical, and horizontal balance-opposed and tandem. Vertical type reciprocating compressors are used in the capacity range of 50 – 150 cfm. Horizontal balance opposed compressors are used in the capacity range of 200 – 5000 cfm in multi-stage design and up to 10,000 cfm in single stage designs (National Productivity Council, 1993). The reciprocating air compressor is considered single acting when the compressing is accomplished using only one side of the piston. A compressor using both sides of the piston is considered double acting.

A compressor is considered to be single stage when the entire compression is accomplished with a single cylinder or a group of cylinders in parallel. Many applications involve conditions beyond the practical capability of a single compression stage. Too great a compression ratio (absolute discharge pressure/absolute intake pressure) may cause excessive discharge temperature or other design problems. Two stage machines are used for high pressures and are characterized by lower discharge temperature (140 to 160oC) compared to single-stage machines (205 to 240oC).

For practical purposes most plant air reciprocating air compressors over 100 horsepower are built as multi-stage units in which two or more steps of compression are grouped in series. The air is normally cooled between the stages to reduce the temperature and volume entering the following stage. Reciprocating air compressors are available either as air-cooled or water-cooled in lubricated and non- lubricated configurations, may be packaged, and provide a wide range of pressure and capacity selections.

Table: 3.1 General Selection Criteria of Compressors

Type of Compressor	Capacity (m^3/h)		Pressure (bar)	
	From	To	From	To
Roots blower compressor single stage	100	30000	0.1	1
Reciprocating				
- Single / Two stage	100	12000	0.8	12
- Multi stage	100	12000	12.0	700
Screw				
- Single stage	100	2400	0.8	13
- Two stage	100	2200	0.8	24
Centrifugal	600	300000	0.1	450

Table: 3.2 A high-level comparison of important compressor types

Item	Reciprocating	Rotary Vane	Rotary Screw	Centrifugal
Efficiency at full load	High	Medium - high	High	High
Efficiency at part load	High due to to staging	Poor: below 60% of full load	Poor: below 60% of full load	Poor: below 60% of full load
Efficiency at no load (power as % of full load)	High (10% - 25%)	Medium (30% - 40%)	High-Poor (25% - 60%)	High-Medium (20% - 30%)
Noise level	Noisy	Quiet	Quiet-if enclosed	Quiet
Size	Large	Compact	Compact	Compact
Oil carry over	Moderate	Low- medium	Low	Low
Vibration	High	Almo st none	Almost none	Almost none
Maintenance	Many wearing parts	Few wearing parts	Very few wearing parts	Sensitive to dust in air
Capacity	Low - high	Low - medium	Low - high	Medium - high
Pressure	Medium - very high	Low - medium	Medium - high	Medium - high

3.1.2 Reciprocating compressor Operation

Reciprocating compressors consists of a ringed piston that moves inside a cylinder. They may be of 2 types; single acting and double acting in which two single acting pistons operate in parallel inside one cylinder, thereby compressing on both sides. Besides the piston and cylinder and a suction valve discharge valve is also provided. The suction valves open when the pressure in the cylinder falls below the intake pressure. The discharge valve opens when the pressure in the cylinder equal or exceeds the discharge pressure. Figure below shows the various steps in reciprocating compressor cycle. First the cylinder is full of gas that is to be compressed and is at the beginning of compression cycle. Then the compression stroke completes and discharge valve opens. During the delivery stroke the gas is delivered at constant pressure. Next the expansion stroke occurs with both valves remaining closed. The small amount of gas trapped is expanded leading to a reduction in pressure inside the cylinder. This causes inlet valves to open and the intake cycle begins. Reciprocating compressors are the older type with more moving parts and hence a lower mechanical efficiency and higher maintenance power. They have a volumetric rate up to 30,000 cfm and discharge pressure up to 10,000 psig.

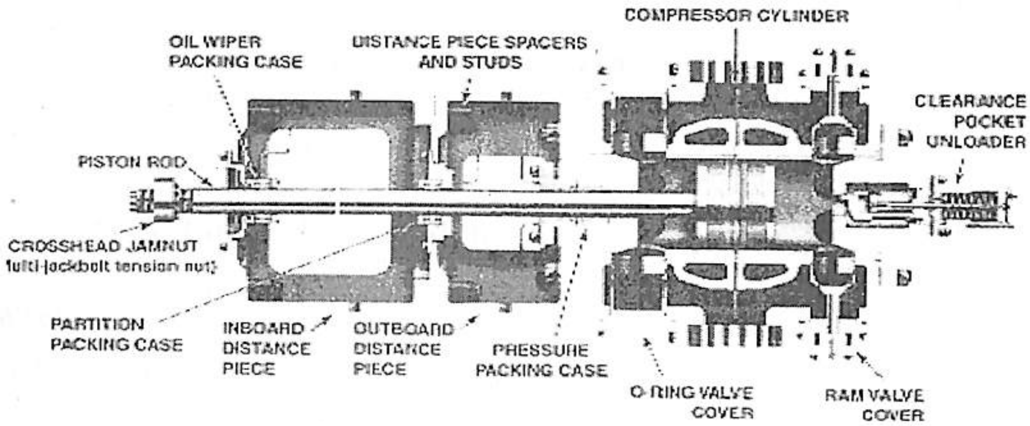


Figure: 3.1 Cross sectional view of Reciprocating compressor operation

3.1.3 Reciprocating Compressor parts

Basic components of reciprocating compressors are mentioned below

Stationary Parts

1. Frame (Crankcase).
2. Cylinder.
3. Intercoolers (Heat exchangers)
4. Separator / Blow down vessel / knock out drum.
5. Clearance pocket.
6. Oil filter, Suction filter, discharge filter.

Reciprocating Compressors

1. Piston & Piston rod.

2. Cross-head

3. Connecting rod (Cross head end)

4. Valves.

3.2 Need for draining system-:

Whenever a gas / air is compressed, the water / oil vapors come together to form a molecule. These molecules being heavier than the media get settled down. These molecules have to be separated from the gas as it will lead to impurification of gas in addition to deteriorating the functional-ability of compressor components like valves, piston rings etc. It may also lead to water hammering

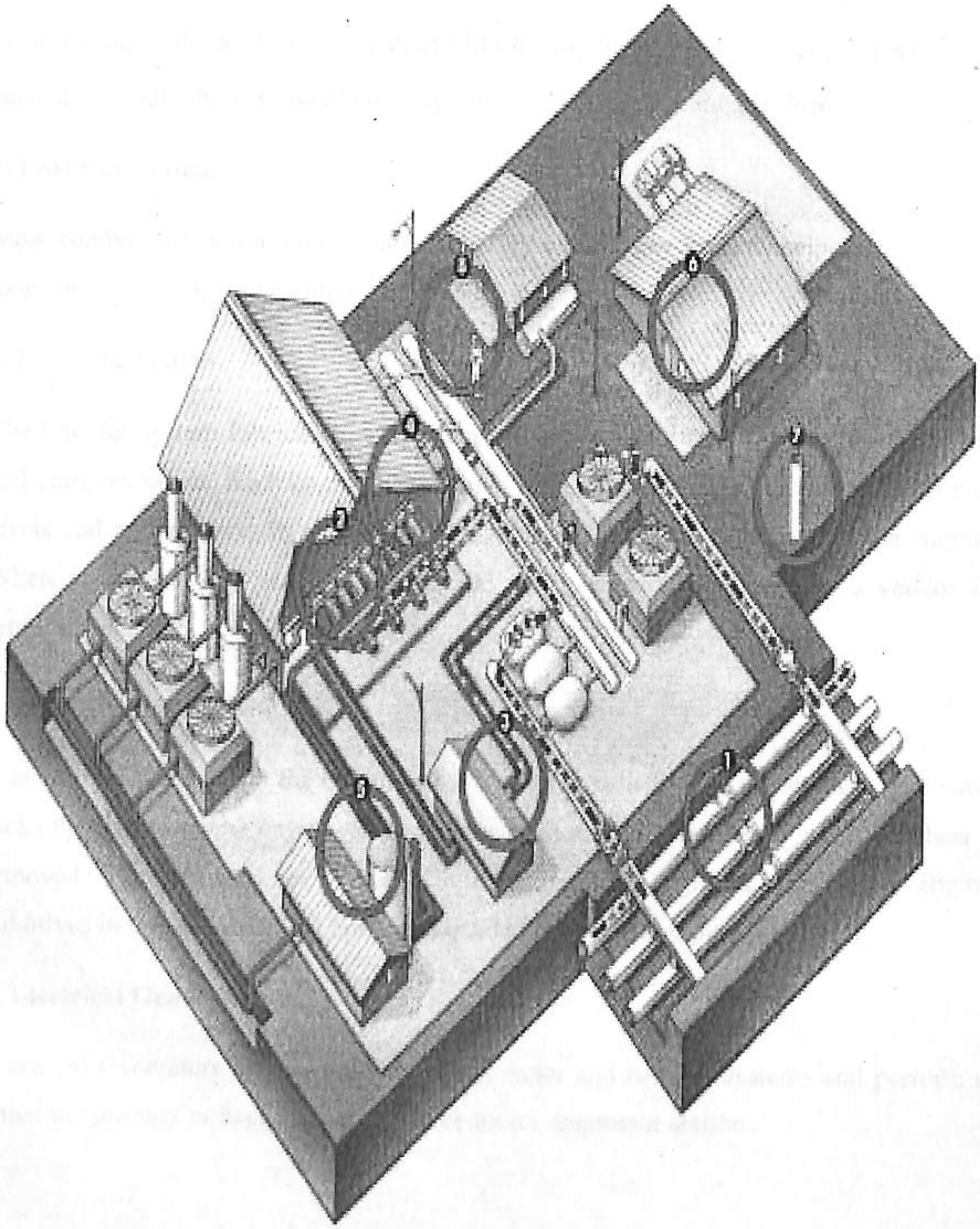
To remove these molecules separators are used. A separator is a vessel used for removal of moisture and consists of a mesh installed in it. The gas after passing through the cooler goes to separator and separates gas from heavy water / oil molecules. These molecules get accumulated at the bottom and finally have to be drained either manually or automatically.

3.3 GAS COMPRESSOR STATION ELEMENTS

1. **Station Yard Piping**

Natural gas enters and exits the compressor station through station yard piping. Gas enters the station at the suction header. From there, gas passes through the scrubbers, which remove any solids and most liquids from the gas. As the temperature of natural gas rises when it is compressed, high-pressure gas coolers may be used to lower the temperature of the gas before it is discharged into the main pipeline. Cooling helps preserve the pipe's anti-corrosion coating and allows for the transportation of greater volumes, for gas is denser at lower temperatures. From the cooling system, gas flows to the station discharge point, and enters the main line.

Figure: 3.2 Gas Compressor Station Upper View



2. Engine and Compressor Sets

The engine and compressor are the heart of the station. As gas travels through the Pipeline, its pressure drops. The compressor increases the pressure of the gas as it moves to the discharge side of the station, enabling the gas to continue its journey. Coordinating with gas control, a station will run only those engine-compressor sets needed to handle the volume of gas currently flowing through the pipeline.

3. Fuel Gas System

Most compressor station engines are fueled by natural gas from the pipeline; however, many are run by electric engines.

4. Lube Oil System

The lube oil system lubricates and protects all moving and rotating parts in the engine and compressor set. Each engine has its own lube oil system that maintains specific oil levels and temperatures in each engine crankcase. This oil also helps cool the engines. When an engine's oil is changed, the old oil is removed and sold to a vendor for reprocessing.

5. Jacket Water System

Water circulated through the engines as a coolant is called jacket water. After the water picks up heat from the engine, it runs through an atmospheric cooler where the heat is removed. The jacket water is then circulated back through the compressor engine. Additives in the water prevent corrosion inside the engine and piping.

6. Electrical Generators

Electrical Generators are used to fuel jacket water and cooling systems and perform as either the primary or backup energy source for a compressor station.

7. **Safety Systems**

To protect the public, company personnel, and property, all compressor stations are equipped with several safety devices. One of these safety systems, common to all compressor stations, is an Emergency Shutdown System. When activated, the

Emergency Shutdown System stops the engines, isolates and vents the compressor piping, and routes the gas away from the station. During the venting process, natural gas is released through a stack in a remote area of the plant yard. Because of the required venting, some noise can result from compressor maintenance, activation, or Emergency Shutdown System testing.

3.4 VARIOUS MAIN EQUIPMENTS USED IN THE GAS COMPRESSOR STATION:

3.4.1 BLOW DOWN VESSEL-:

During the start of compressor we cannot start it directly take it on-load. The compressor has to start on no-load, so that the compressor main motor is not loaded. This can be achieved by unloading the compressor stages. During un-loading the gas moved out by piston (not compressed) is delivered into a vessel and the same gas is re-circulated again. During such time, the suction line solenoid valve is kept closed. Also when the compressor is unloaded for draining water and oil which is accumulated in the separators some gas also escapes with it. This gas cannot be vented out and requires a suitably big enough vessel to store it.

3.4.2 SUCTION/DISCHARGE VALVES -:

A compressor valve is a device to permit relatively unrestricted flow of gas in one direction only. Each operating end of cylinder is provided with a suction and discharge valve. Valves operate on the principle of differential gas pressure between the inside of a cylinder and the cylinder gas passage, with the assistance of a spring in closing. Valves usually consists of a valve seat, one or more valve plates that cover the ports in the seat and a valve stop plate which limits the travel, or lift of the valve plates. The valve assembly is fastened together with a centre stud or bolt and nut arrangements.

Valve failures can occur due to three general causes

1) Wear and fatigue
2) Foreign materials
3) Abnormal mechanical action

3.4.3 SUCTION VALVE UNLOADERS-:

There are two basic unloader types

i) Finger type unloaders use fingers to depress and hold open the inlet valve channels to unload that particular cylinder end.

ii) Plug or port type unloaders are basically the same except for the function. The plug type opens a hole in the center of a special inlet valve to unload.

Actuators are of three basic designs

Hand operated, direct acting &reverse acting.

3.4.4 PULSATION DAMPENERS-:

These are usually used on the suction and discharge for all stages. Dampeners are provided to minimize gas pulsations and are designed so as not to exceed a given pulse or pressure drop. Drain valves are also provided to facilitate periodic draining of compressor.

3.4.5 INTER AND AFTER COOLERS-:

Most multi-stage compressors use intercoolers, which are heat exchangers that remove the heat of compression between the stages of compression. Intercooling affects the overall efficiency of the machine.

A mechanical energy is applied to a gas for compression, the temperature of the gas increases. After-coolers are installed after the final stage of compression to reduce the air temperature. As the air temperature is reduced, water vapor in the air is condensed, separated, collected, and drained from the system. Most of the condensate from a compressor with intercooling is removed in the intercooler(s), and the remainder in the after-cooler. Almost all industrial systems, except those that supply process air to heat-indifferent operations, require after-cooling.

In some systems, after-coolers are an integral part of the compressor package, while in other systems the after-cooler is a separate piece of equipment. Some systems have both. Ideally, the temperature of the inlet air at each stage of a multi-stage machine should be the same as it was at the first stage. This is referred to as "perfect cooling" or isothermal compression. But in actual practice, the inlet air temperatures at subsequent stages are higher than the normal levels resulting in higher power consumption, as larger volume is handled for the same duty

Use of water at lower temperature reduces specific power consumption. However, very low cooling water temperature could result in condensation of moisture in the air, which if not removed would lead to cylinder damage.

Similarly, inadequate cooling in after-coolers (due to fouling, scaling etc.), allow warm, humid air into the receiver, which causes more condensation in air receivers and distribution lines, which in consequence, leads to increased corrosion, pressure drops and leakages in piping and end-use equipment. Periodic cleaning and ensuring adequate flow at proper temperature of both intercoolers and after-coolers are therefore necessary for sustaining desired performance.

3.4.6 GATE VALVES:

For stopping and starting the flow of liquids in the line, that is, for obtaining a complete shut-off on the line or tank, there is no rival for gate valves in terms of the numbers in use. A gate valve is characterized by the open-port and low resistance to flow.

Gate valves of medium or large size are made either with a non-rising stem or rising stem with outside screw and yoke. In the non-rising stem valve, the lower end of the stem is threaded and screws into the disc, being restrained by a thrust collar. In the rising stem type, the upper part of the stem is threaded, and a nut is fastened solidly to the hand-wheel and held in the yoke by thrust collars. This serves to move the stem as the hand wheel is turned. The rising stem valve obviously requires a greater amount of space when opened, which may be objectionable when used for manifolds.

3.4.7 CHECK VALVES:

Check Valves, as used in pipelines, permit full flow in one direction and close automatically to prevent any flow in the opposite direction. Their principal use is in tank suction lines and in pump manifolds.

Check valves for pipeline service are mostly of the horizontal swing type, with iron or cast steel body and brass disc and seat. Other types include Lift plug, Ball, Piston and Split disc swing check.

3.4.8 RELIEF VALVES:

The Relief valve is sometimes called a “safety valve.” Its sole purpose is to release pressure from the line or vessel when, due to some emergency, the pressure has built up to the point where a rupture in the line or vessel is threatened. They are set to open at a predetermined level and are kept closed by means of springs or weight loading, until the predetermined opening pressure has been reached or exceeded.

Relief valves are used to limit the pressure to that considered safe or desirable. When the pressure reaches the limit for which valve is set, the valve opens and the pressure is relieved by the escape of the fluid. The pop valve depends upon a spring for its action. It can be set for a limited pressure and adjusted by a screwing the cap in or out, to increase or reduce he spring tension. Relief valves are used in the manifolds of high pressure oil lines to guard against rupture of the line in case of accidental closing of a gate. In the smaller sizes, they are used at stations for high pressure compressed air, steam, and fuel lines.

3.4.9 BALL VALVES:

Ball Valves are suitable for most manual on-off hydrocarbon or utilities service when operating temperatures are between -20°F and 180°F (-29°C and 80°C). Application of all ball valves above 200°F (92°C) should be carefully considered, due to the temperature limitations of the soft sealing material.

Ball valves are available in both floating ball and trunnion mounted designs. Valves of the floating ball design develop high operating torques in high pressure services or large diameters, but tend to provide a better seal. Trunnion mounted ball valves turn more easily, may not seal as well.

Ball valves are not suitable for throttling because, sealing surfaces on the exterior of the ball are exposed to abrasion by processing fluids, in the partially open position.

CHAPTER 4

INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLER

4.0 What is Automation?

Well, if I go by the answers, which I have received most often from many experts then, in crude sense, it appears as if Process Automation is nothing but replacing people from processes...
It's all about making an IRON BOX to control all that, what many people together have been controlling from years.

How could we be so insensitive about this automation, causing people to lose their jobs?

But my answer to all these questions is, ... Yes, indeed Automation is making a box of software albeit cased in cast iron, doing the same thing as 50 feet of cabinets, associated relays and wiring do.... but definitely not making the people lose their jobs.

So seeing in this perspective, automation does cause short-term job reassignments but it also allows companies to operate faster, produce better quality, at lower cost. These gains in productivity result in automation users offering better goods at lower cost, which allows these companies to grow and prosper faster than their competitors. Thus competitors that do not reinvest to increase their productivity, keep losing business resulting in more and more layoffs.

Thus automation does not even cause short-term job losses. Actually the companies that are implementing automation are typical high growth companies that need to reassign the displaced workers in other areas of the company.

However, leaving aside all these ethical issues, technically Automation involves deriving the best from a Man-Machine combination. Humans are the most versatile piece of equipment on the factory floor but computers are much faster and more consistent. So automation aims towards finding the best combination of the two.

In complex operations, for proper and efficient controlling, the operator needs to know following things:

- Raw materials required to perform the operation
- Instructions and drawings detailing the operations and sequence to perform
- Tests needed to be performed and the results of the test
- Machine operation / control
- Detailed diagnostics on each machine
- Maintenance drawings and documentation for each machine
- Maintenance management system

All the above goals are efficiently handled by a process automation system. Here one real-time controller controls the process and one computer does the process monitoring and interfaces to higher layers of the automation system for everything else.

4.1 Factory Automation Systems:

Factory Automation is a combination of technologies, philosophies and disciplines that differ from process to process and plant to plant. It takes a team of people from different backgrounds working together to develop an integrated system.

4.2 Systems Architectures:

It is impossible to develop an architecture that will apply to all infrastructures. The complexity of the architecture is usually directly proportional to the complexity of the work being processed. . The architecture of a typical Automation system is as given below:

Typical Automation System Architecture

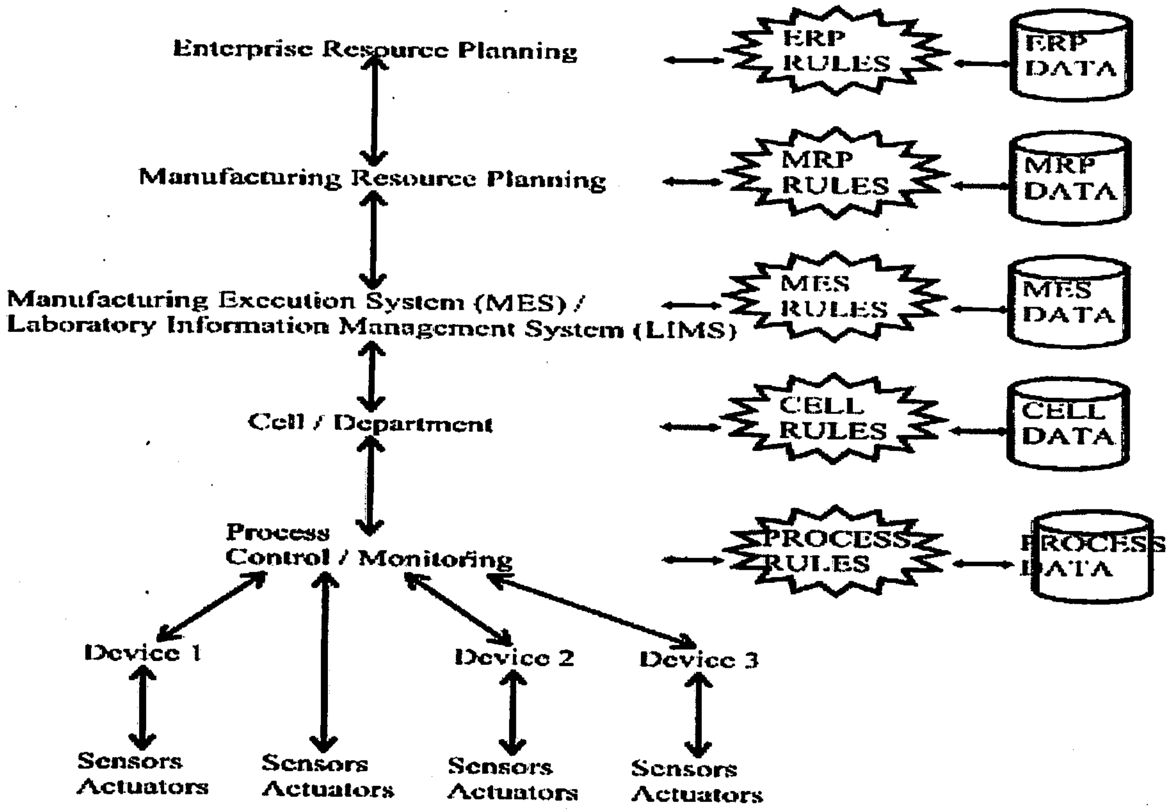


Figure 4.0: System Architecture

However the hierarchy, shown in the architecture, is a much generalized one. Many of the functions overlap and could be defined in multiple levels. Several characteristics are common as we transverse the hierarchy. First, "real-time" decreases as you move down the architecture and increases as you move up the architecture. This usually means milliseconds at the sensor / actuator level where at the ERP level typically means hours. Similarly at the sensor / actuator level we think in terms of bits whereas at the ERP level we are thinking large files or records.

These systems are typically *planned from the top - down and implemented from the bottom - up.*

This architecture consists of following major areas of implementation:

- **Enterprise Resource Planning [ERP]**
- **Manufacturing Resource Planning [MRP]**
- **Manufacturing Execution System [MES]**
- **Cells or Departments**
- **Process Control & Monitoring**

ERP:

It is basically huge databases of information coupled with business rules, logic and constraints that allow users to interact. The scope of these systems encompasses the entire company. e.g. accounting, production, inventory, and customer management.

Typical ERP data would include product lists, inventory, customer lists, customer orders, invoices, purchase orders, etc. Typical ERP rules would be "check customer credit before sending order to MRP".

MRP:

These systems are only found in complex manufacturing facilities where there are a lot of different assemblies, raw materials, and processes. In simpler cases the MRP may be a part of ERP.
MRP has databases that describe assemblies. This includes the sub assemblies, raw materials, and processes required to create final assemblies. The ERP system sends orders to the MRP system along with due dates and priorities. The MRP is then responsible for getting those final assemblies produced.

MES:

This executes the plan developed by MRP and feeds back information to MRP so that MRP has recent information to develop new plans.

Typical data downloaded from MES data would be programs, documents, and other files that the machines require to process each product. Sometimes this data is stored at lower levels. Typical data uploaded to MES would be quality data, process start times, process completion times, etc.

4.3 Cells or Departments:

Cells are developed to break down the manufacturing process into smaller groups. Cells are typically all the different processes grouped together to make similar types of product. In a cell, machines from different processes are brought together to form one production line that quickly moves a part being assembled from one machine to another without having to be routed in lots to different departments.

4.4 Process Control & Monitoring:

At this level in the hierarchy, real-time control starts to become a major requirement and a dedicated real-time controller is typically incorporated. There is still a lot of data and operator communication required for the process to operate. So typically a computer is also used at the process level.

The complexity of the process controller usually depends on the complexity of the processes. In some cases there might only be one process controller per department. In more sophisticated systems there might be one process controller per machine.
The key characteristic for the process controller is to integrate everything within that process into one controller. This could be one or more PLCs, weigh scales, material handling, operator interfaces, test equipment, etc. The idea is that if someone wants to know how a process is doing then they go to that process controller and that process controller has integrated all process information into one place.

High Tech Services typically uses both a programmable logic controller [PLC] and a computer running SCADA type software at the process level. The PLC is doing the real-time control and monitoring while the computer is doing non-real-time operator interface and communicates to the higher levels of the hierarchy.

Historical process data is a vital part of any process monitoring [SCADA] system in that it provides data for the process engineer to analyze how the process performed. The process engineer is responsible for making the process faster, better, and cheaper. This data allows the process engineer to understand what parts of the process run the slowest, produce the most errors, and cost the most. By studying this data, the process engineer develops improvements, collects new data and then determines if the process improved, got worse, or there was no change.

4.5 Various Aids for implementation:

4.5.1 Device Controllers

Device controllers can include any type of special purpose equipment that performs a dedicated function. Device controllers typically have their own processor and could operate "stand alone" but are integrated into the rest of the process.

4.5.2 Programmable Logic Controllers [PLCs]:

A Programmable Logic Controller [(PLC] is a ruggedized special purpose computer that reads input signals; runs control logic, and then writes output signals. Programmable logic controllers have been around for quite sometime. Their proven reliability in harsh environments and design to handle many inputs and outputs has made them the foundation of many factory-automated systems.

In most of the applications it is reassuring to know that the PLC is one less thing we will have to worry about. PLCs can be combined with most other technologies to provide a sophisticated control and monitoring system

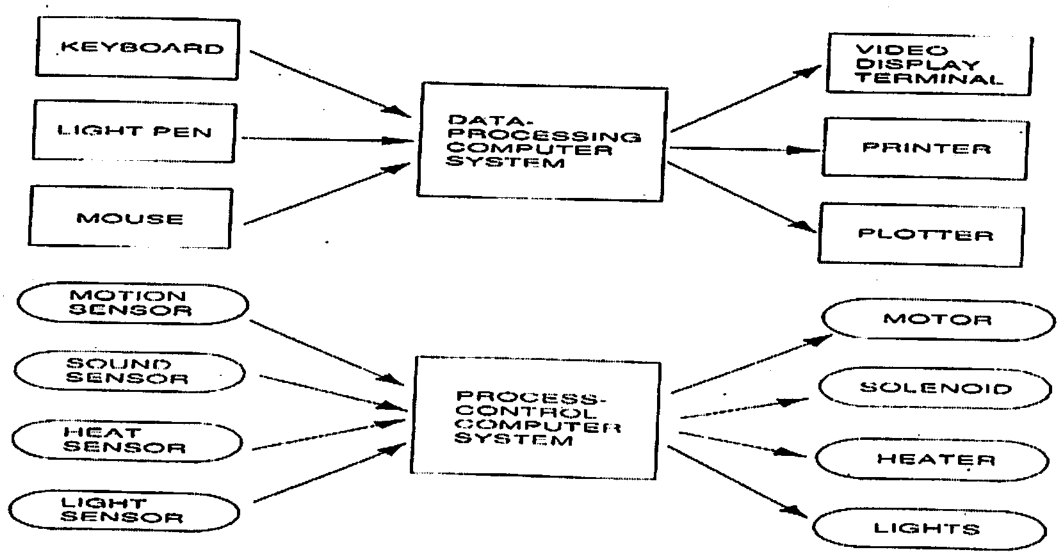
Pros:

- PLCs are good controlling, i.e. turning outputs on or off based on the state of inputs.
- PLCs are good at bringing together and concentrating a lot of data and status that is uploaded into a computer in a compact form
- PLCs are more rugged than computers and typically last five, seven, ten years without needing replacement

Cons:

- PLCs are not the best at handling large amounts of data or complex data.
- PLCs are not the best at reading and writing databases.
- PLCs are not the best at generating reports.
- PLCs are not the best at displaying data and information to the operator.

Figure 4.1: The basic architecture of a normal processing computer and that of a PLC is shown below:



The differences in the architecture of the two arrangements are the basis of the above-mentioned pros & cons.

Hence in order to derive the benefit of both systems and also to sort out the limitations of the PLCs, The typical architecture preferred is, a PLC to do the real-time control and monitoring with a SCADA package running on processing computer and attached with the operator interface.

This arrangement provides the most out of both systems and form the heart of almost all process automation system. This in turn provides following advantages over the traditional hard-wired control.

- Flexibility: A number of control programs can be run on the same PLC for different applications
- Fast implementation of changes in control program
- Large quantities of available contacts
- Dry run of program possible in very short time
- PLC operational status can be seen on the Video Display Unit (VDU) in minute details, step by step, which makes troubleshooting easier
- More reliability than relays

4.5.3 <u>Operator Interfaces:</u>

A sophisticated operator interface, such as a text display or graphical display will tell the operator exactly why the machine stopped. Instead of the operator running around the machine checking everything until they find the problem, the display will tell them the exact problem

Operator interfaces can be as simple as a stack light and panel lights to as complex as multi VGA displays on networked computers. Operator interfaces are different from SCADA in the sense that SCADA is doing much more than just an operator interface [for example collecting data from several sources, alarming, some control, etc.] SCADA will have an operator interface but an operator interface does not have all the features of SCADA.

Depending on the application a variety of techniques can be used for Operator interfaces such as:

- Mechanical buttons and Panel lights
- Stack lights
- One to four line text displays
- Proprietary text and graphic displays
- SCADA systems based on open software such as Visual Basic
- Voice annunciation
- Television video

4.5.4 Sensors & Actuators

Sensors and actuators are the lowest level and are where the actual work occurs. Actuators could be electrical motion control, pneumatic cylinders, or hydraulics. Years of continuous development of sensors provide a wide variety today.

4.5.5 SCADA Automation Software:

The SCADA [Supervisory Control and Data Acquisition] system is the medium between the operator and the real-time controller. It allows the operator to control the system, such as start a new batch, load a new recipe etc.

The SCADA software provides all possible types of connectivity and integration. This means serial ports, Ethernet, PCI slots, and the ability to run a wide variety of applications. PLCs and simple operator interfaces too limited in their functionality and capabilities

Following are the major functions performed by a SCADA system

- **Alarm and Event Monitoring**

- **Data Acquisition**
- **Operator Interface**
- **Some non real time controls**

4.5.6 Alarm and Event Monitoring

A SCADA system detects, displays, and logs alarms and events. When there are problems, the SCADA system notifies operators to take corrective action. Alarms and events are also recorded so engineers can review the alarms to determine what caused the alarm and prevent them happening again.

4.5.7 Data Acquisition

This is one of the most important functions of a SCADA system. It continuously reads data from PLCs and other hardware and then analyzes and graphically presents that data to the user. SCADA systems must be able to read and write multiple sources of data.

4.5.8 Operator Interface

A SCADA system collects all of the information about a process. To display the data to the operator so that they can comprehend what is going on with the process, the SCADA system utilizes operator interfaces.

4.5.9 Non-real time controls

For simple control requirements such as supervisory master-control, the SCADA system should be able to perform control. However, for anything other than simplistic control, we prefer a PLC to do the real-time control with SCADA doing the non-real-time control. Utilizing all these tools, the general structure of an PLC based programmable process automation system should be as given:

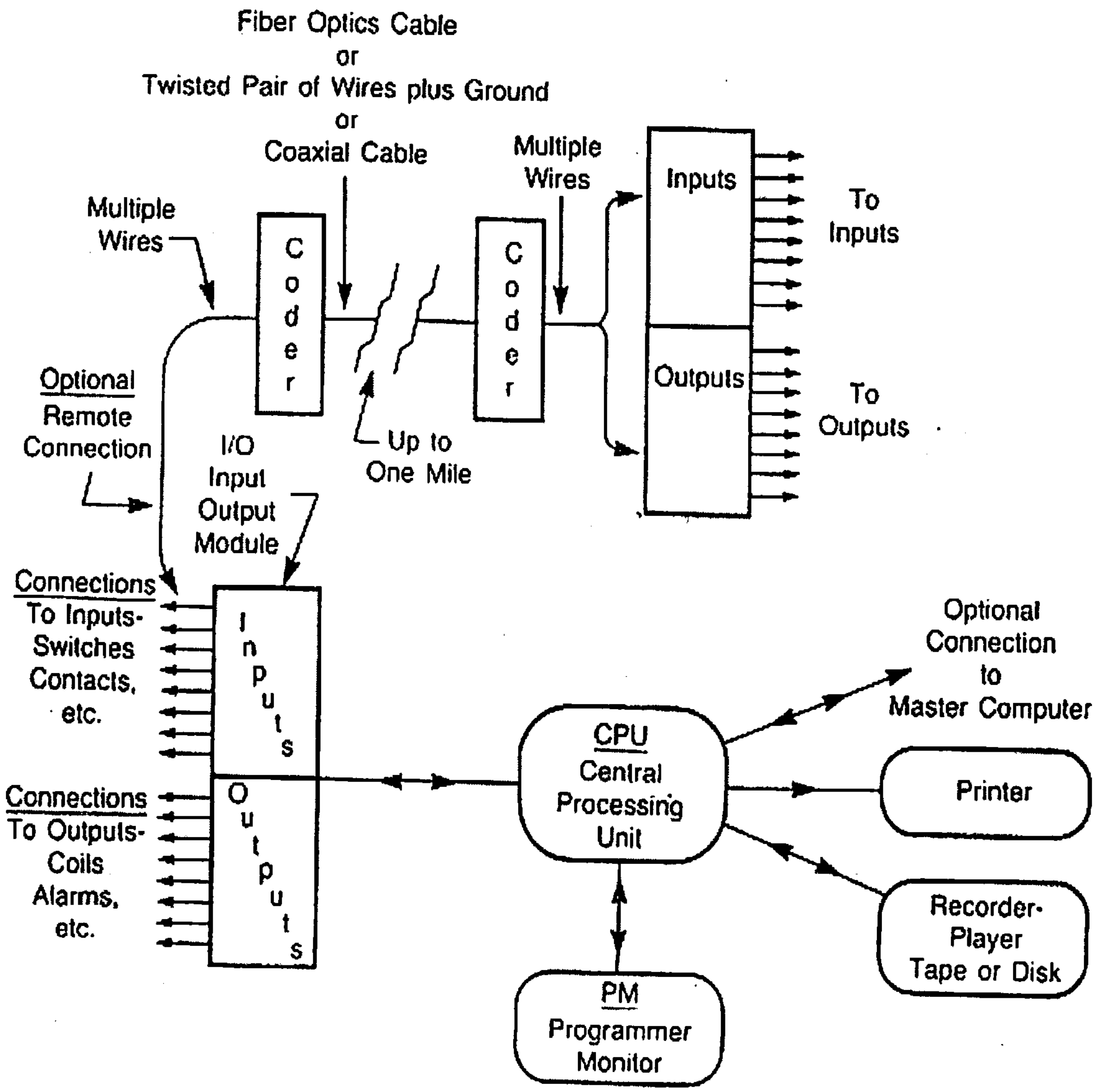


Figure 4.2: PLC based Programmable Process Automation system

4.6 Hardware selection & Installation of PLC:

Once the overall project, need to be automated, has been broken in to smaller groups and tasks which are sufficiently small to be handled independently for implementation then we get all the required information for deciding the hardware for the automation system. The selection of hardware includes everything, from selection of controller to the selection of I/O modules, powers supplies, and sensor & actuators.

Selection of CPU is done based on the following requirements:

- Complexity of the control program, functions required for its implementation like fixed point or floating-point arithmetic.
- Requirement of the program memory.
- Maximum number of parameters to control in the extreme conditions i.e. number of I/Os need to be controlled
- Type of I/Os and their brake-up i.e. digital & analog
- Maximum number of additional control components needed, e.g. number of Timers, counters and flags.
- Additional requirements, such as networking, SCADA support etc.

Similarly, *selection of SIGNAL Modules* is done based on following parameters:

- Requirement of power supply needed to drive them
- Type of I/Os and their brake-up i.e. digital & analog
- Type of isolation required, i.e. galvanic isolation or common ground
- Type of the I/O signal i.e. 24v, 0-20v, ±20v, 4-20mA, 0-20mA
- I/O requirements of individual Groups i.e. 8-channel modules, 16-channel modules, 32-channel modules, combinational modules.
- Sophistication of I/O modules such as self-diagnostic, auto-error checking modules or plain modules

Apart from these, if the process contains some special type of functions such as PID control, High-speed shaft encoders etc. Then required *FUNCTION Modules* are also selected accordingly.

For the operator's interaction, required type of Operator Interface module is also selected from the type of OPs mentioned earlier.

Finally after selecting all the hardware components, they are installed as explained below:

4.6.1 Installation:

The entire assembly can be assembled in either of the two fashions as shown

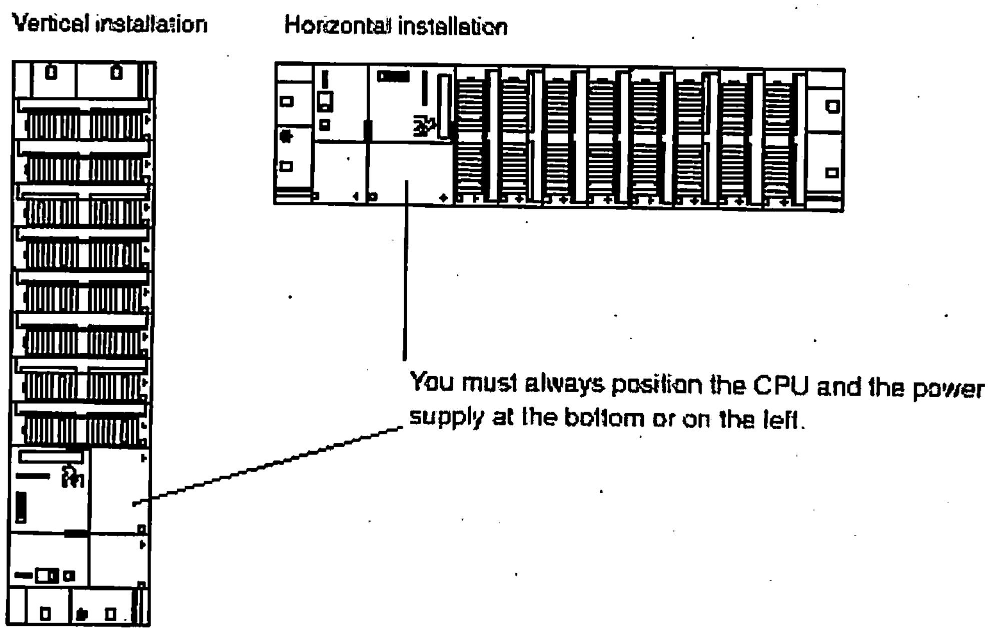
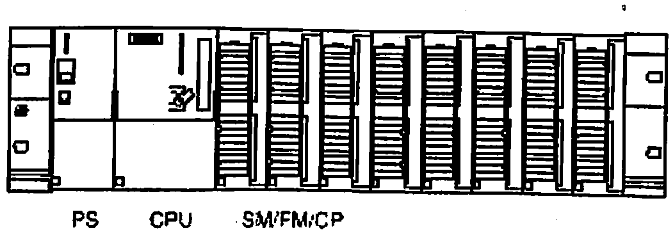


Figure 4.3: Assembly of PLC

Based on the type of the assembly selected, the permissible ambient temperature range varies

- Horizontal installation0 - 60°C
- Vertical installation 0 – 40° C

4.6.2 Single rack and Multi-rack installation:



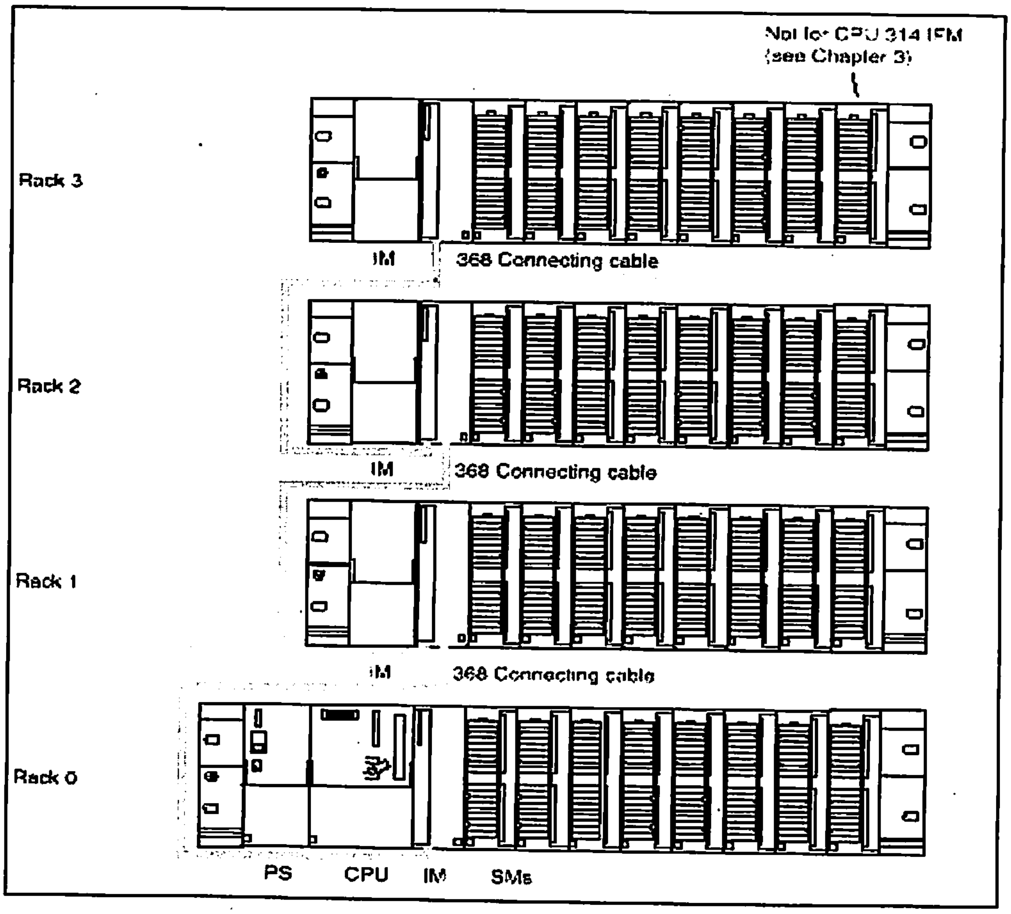


Figure 4.4: Single and Multi Rack Installation of PLC

In case of multi-tier arrangement, the clearance between two racks becomes important parameters to keep the modules becoming too hot. The rule is a minimum of 40 mm between rail and the rack as shown below:

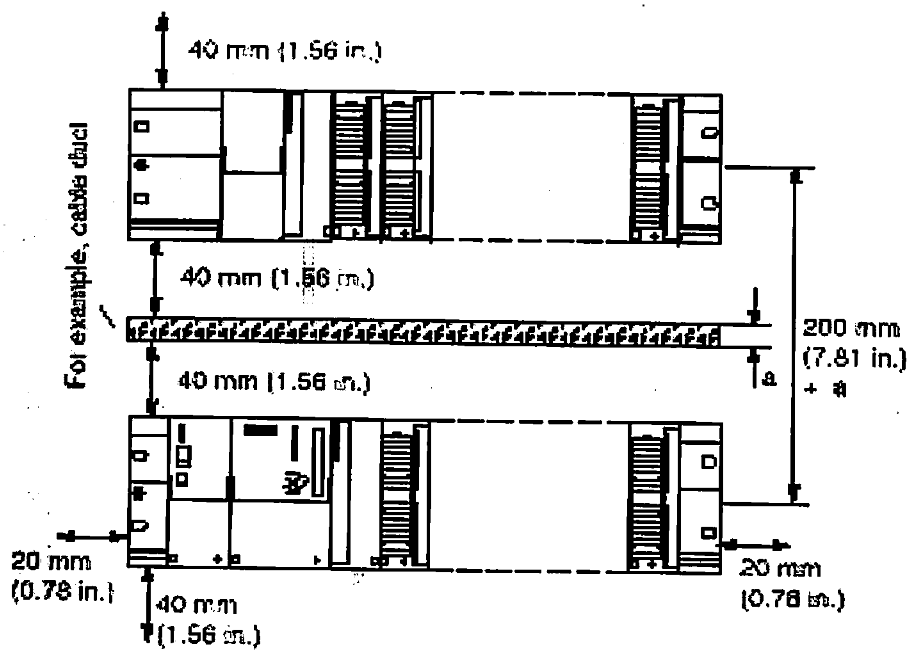


Figure 4.5: Rail and Rack of PLC

Also, in case of multi-tier arrangement, use of one more modules, called as interface module [IM] becomes essential. In this case the installation rules are as given

- CPU is always located in rack0.
- The IM is always inserted in slot-3
- No more than 8 modules [SM, FM, CP] per rack. All these are arranged to the right of the IM
- Power consumption must not exceed 1.2A per line
- IM360 for rack0 & IM361 for all other racks.

4.6.3 Sequence of Installation:

1. Power supply
2. CPU
3. Signal modules

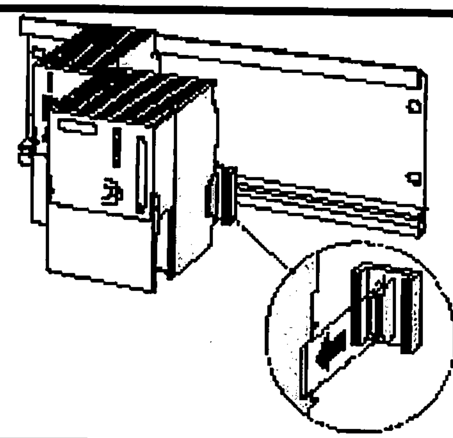
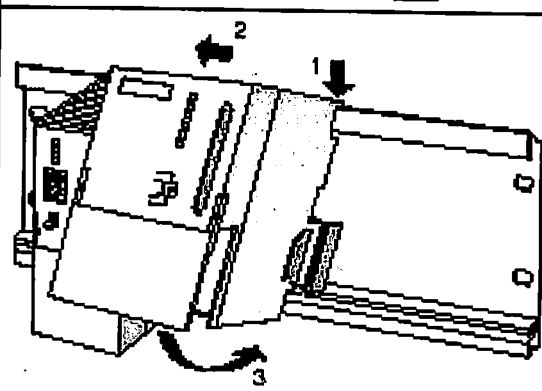
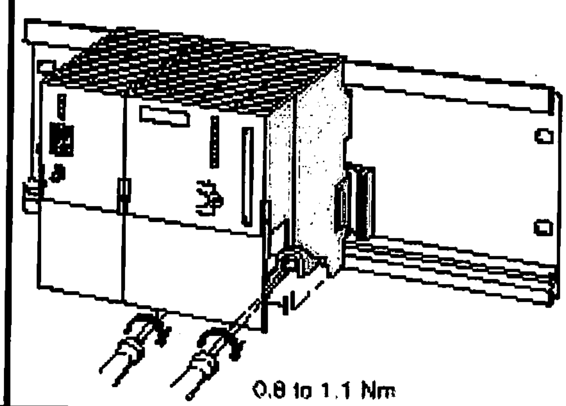
Each signal module comes with a bus connector, but not the CPU. When attaching the bus connectors, always start with the CPU: • Remove the bus connector from the last module and plug it into the CPU. • You must not plug a bus connector into the "last" module.	
Hook the modules onto the rail (1). slide them along as far as the module on the left (2), and swing them down into place (3).	
Bolt the modules tight, applying a torque of between 0.8 and 1.1 Nm (7 to 10 in. lb.).	

Figure 4.6: Sequence Installation of PLC

4.6.4 Inserting the Key:

After installing the modules on the rail, we need to insert the key into the CPU in the STOP or RUN position as shown:

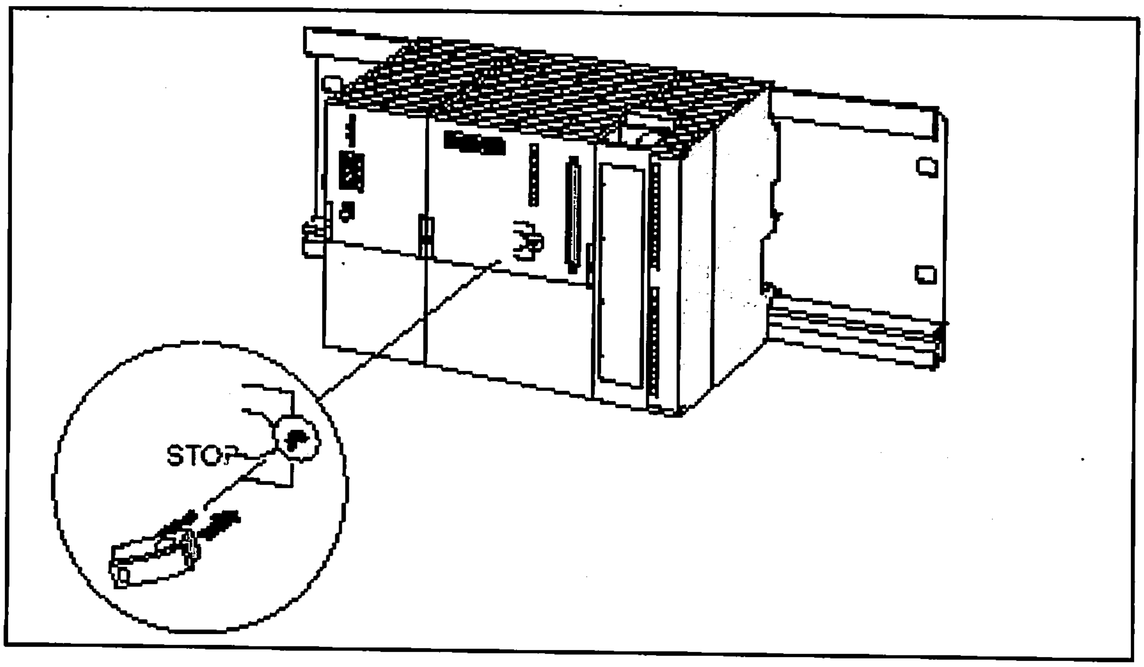


Figure 4.7: Key Installation of PLC

Finally after installing, all the modules, there slot numbers are fixed as per the following rule:

Slot Number	Module	Remarks
1	Power supply (PS)	-
2	CPU	-
3	Interface module (IM)	To the right of the CPU
4	1st signal module	To the right of the CPU or IM
5	2nd signal module	-
6	3rd signal module	-
7	4th signal module	-
8	5th signal module	-
9	6th signal module	-
10	7th signal module	-
11	8th signal module	-

Table 4.0: Showing for fixed slot number for each module

At last, after assigning the slot number for each module, their slot numbers are punched on them as shown:

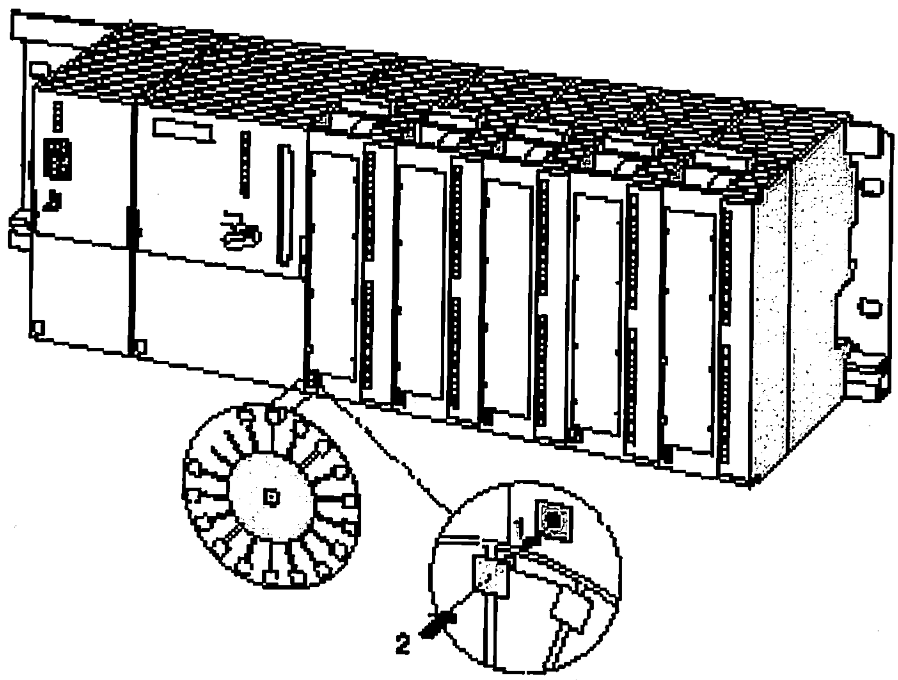


Figure 4.8: Showing punching of Slot numbers

4.6.5 Control logic development:

After installation of the programmable controller and its related modules, the set-up becomes ready for the development of the program for the control of required tasks.
For this purpose, the required software, SIMATIC-S7 for the development of the basic control program is loaded.

Then using these packages, the required application program is developed and then downloaded into the programmable controller to control the predefined Gas Compressor Station.

CHAPTER 5

ANALYSIS AND DESIGN PROCEDURES

5.0 Planning an Automation project:

This chapter outlines the basic tasks involved in planning an automation project for a programmable controller. There are many ways of planning an automation project. However if a broad and somewhat generalized procedure could be of great help in the beginning. Later on, based on specific requirements, fine-tuning can always be done in order to get the optimized performance.

One such basic procedure that can be used for any project is illustrated in the following figure.

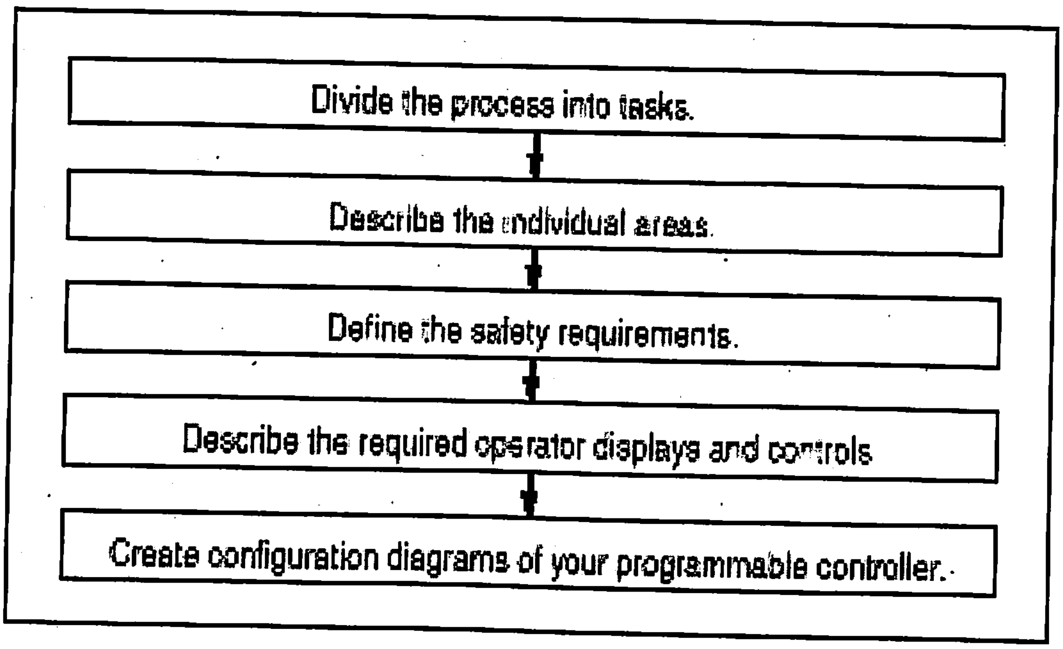


Figure 5.0: Basic Procedure of Automation project

For the better understanding of these planning & designing steps, the same procedure has been applied here in our first process of the project, the Blending process, for derive its automation solution.

5.0.1 Dividing the process into tasks:

An automation process consists of a number of individual tasks. By identifying groups of related tasks within a process and then breaking these groups down into smaller tasks, even the most complex process can be defined. The same principles have been applied here for organizing the compression process into its functional areas and individual tasks

5.0.2 Determining the individual areas:

After defining the process to be controlled, the project has been divided into related groups or areas. After this, each group has been further divided into smaller tasks. This break-up had thus made the task of controlling a respective group of the process less complicated.

While describing each area and task within process, we must define not only the operation of each area, but also the various elements that control the area. These include:

- Electrical, mechanical, and logical inputs and outputs for each task
- Interlocks and dependencies between the individual tasks

Here our process uses compressors, scrubbers, and valves. Hence these must be described precisely to identify the operating characteristics and type of interlocks required during operation.

The following tables provide the description of the equipment used in this blending process. When you have completed description, you could also use it to order the required equipment.

5.0.3 Listing Inputs and Outputs:

After writing the physical description of each device to be controlled, draw diagrams are drawn of the inputs and outputs for each device or task area. These diagrams correspond to the logic blocks to be programmed.

5.0.4 Establishing the Safety Requirements:

This step is carried out to decide those additional elements that are needed to ensure the safety of the process–based on legal requirements and corporate health and safety policy. In this description, all those parameters should also include that influence the safety elements in the defined process areas.

5.0.5 Defining Safety Requirements

By definition, these safety circuits operate independently of the programmable controller although the safety circuit generally provides an I/O interface to allow coordination with the user program. Normally we configure a matrix to connect every actuator with its own emergency off range. This matrix is the basis for the circuit diagrams of the safety circuits.

The designing of the safety mechanisms is carried out in following steps:

- Determine the logical and mechanical/electrical interlocks between the individual automation tasks.
- Design circuits to allow the devices belonging to the process to be operated manually in an emergency.
- Establish any further safety requirements for safe operation of the process.

The emergency off switch will be located on the operator station. An input to the controller indicates the state of the emergency off switch.

5.0.6 Describing the required operator displays & controls:

Every process requires an operator interface that allows human intervention in the process. Part of the design specification includes the design of the operator console.

5.0.7 Creating a Configuration Diagram:

After we have documented the design requirements, we must then decide on the type of control equipment required for the project. By deciding which modules we would be using, we also specify the structure of the programmable controller. With this we have now acquired the sufficient information to decide on the configuration of the controller system.

Hence we then create a configuration diagram specifying the following aspects:

- Type of CPU
- Number and type of I/O modules
- Configuration of the physical inputs and outputs

5.1 Designing the program structure:

After the accurate definition of the process and then deciding its appropriate break-ups into various groups and their subsequent tasks, the hardware configuration of the programmable controller is fixed.
After this step the most important task, which remains unfinished, is decision of the most suitable structure for the control program. The reason for this is that factor which finally decides the sequence of control sequence will be carried out, so proper care must be taken care for its structure. The structure must be such that it takes the minimum possible time in carrying out the decision and transferring them at output once the inputs are available.

For deciding the proper structure of the control program, it is important to understand the basic mechanism through which a programmable controller [PLC] controls the process. For controlling all types of processes, a PLC uses following two mechanisms:

5.2 Cyclic program processing:

Cyclic program processing is the "normal" type of program execution on programmable logic controllers, meaning the operating system runs in a program loop and calls on one organization block, called OB1, once in every loop in the main program as shown. The user program in OB1 is therefore executed cyclically.

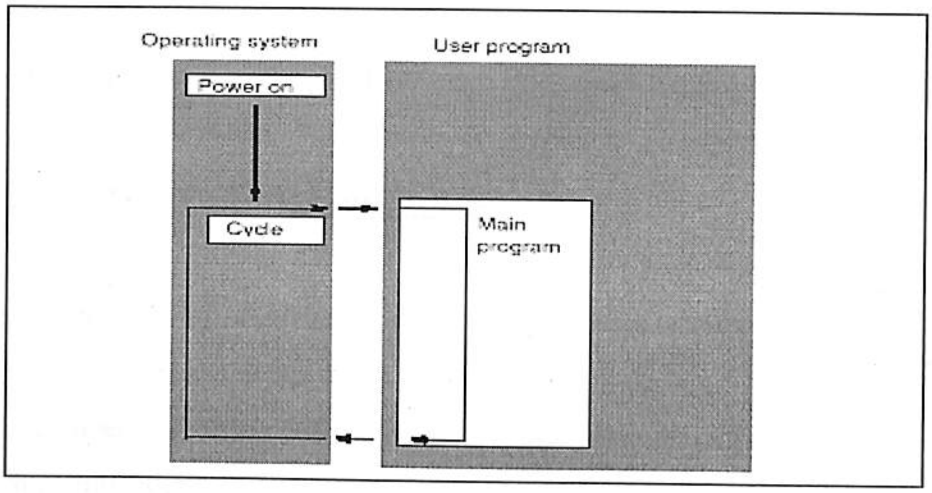


Figure 5.1: Cyclic Program Process

This program loop which executes continuously, is called the SCAN CYCLE. The structure of the simplest scan cycle is as shown:

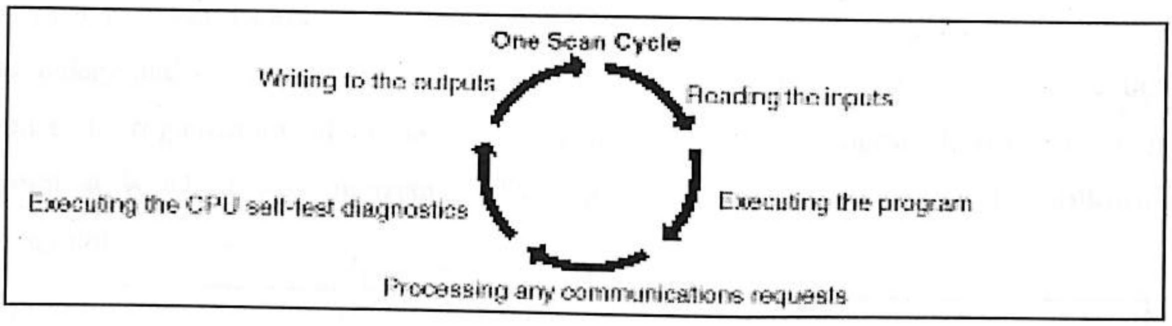


Figure 5.2: SCAN CYCLE

During the scan cycle, the CPU performs most or all of the following tasks:

- Reading the inputs
- Executing the program
- Processing any communication requests
- Executing the CPU self-test diagnostics
- Writing to the outputs

The series of tasks executed during the scan cycle is dependent upon the operating mode of the CPU. The CPU can be mainly in one of the two modes STOP and RUN. With respect to the scan cycle, the main difference between STOP and RUN mode is that in RUN mode the program is executed, and in STOP mode the program is not executed.

5.3 Event-Driven program processing:

This type of processing is utilized for carrying out the associated control tasks for those type of inputs which are either too fast to be controlled in a normal scan cycle or their control tasks need not be carried out cyclically but rather at all those instances when their associated events occur.

In this case the cyclic program processing is interrupted by certain events [interrupts]. For this purpose one type of program execution block, called organization blocks, is assigned to each of these events. Thus each event is attached to one unique organization block.

If such an event occurs, the block currently being executed is interrupted at a command boundary and the organization block that is assigned to the particular event is called. Once the organization block has been executed, the cyclic program is resumed at the point at which it was interrupted. This entire process is depicted in the following diagram:

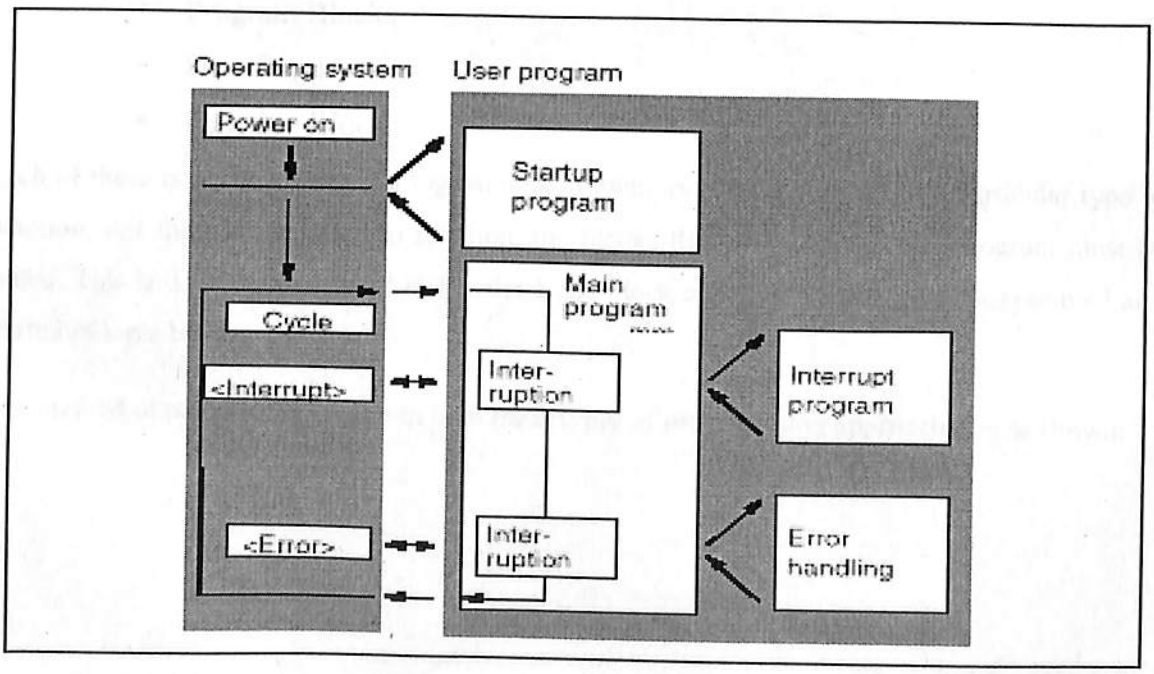


Figure 5.3: Event Driven Program Process

This enables us to process parts of the control program that do not have to be processed cyclically only when needed. Thus the user program is divided into various logical program blocks and then distributed among different organization blocks. If the user program is to react to an important signal that occurs relatively seldom, then its corresponding program block is processed automatically on its occurrence when the signal is assigned to an event driven OB.

5.4 Linear versus structured programming:

In case of Linear programming, entire control program is written in OB1. This is only advisable with simple programs written for the S7-300 CPU and requiring little memory. On the other hand, complex automation tasks can be controlled more easily by dividing them into smaller tasks reflecting the technological functions of the process or that can be used more than once. Corresponding program sections, known as the blocks, represents these tasks. This approach is called as structured programming.

Various blocks supplied for structured programming are:

- Organization Blocks
- Program Blocks
- Data Blocks
- Function Blocks

Each of these types of blocks is a logical area in memory, which carries out a particular type of function. For the user program to function, the blocks that make up the user program must be called. This is done using special instructions, the block calls that can only be programmed and started in logic blocks.

The method of program execution in both these types of programming approaches is as shown:

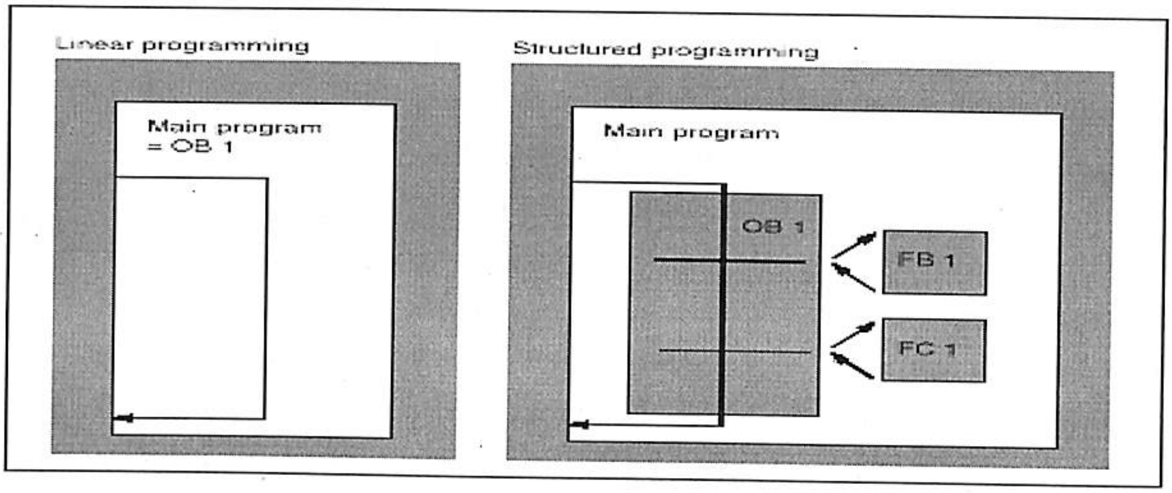


Figure 5.4: Linear Vs Structure Programming

5.5 Language options:

With STEP 7, we can create control programs in the standard languages. The Siemens SIMATIC-S7 supports the following programming languages:

- Ladder Logic [LAD]
- Statement List [STL]
- Function Block Diagram [FBD]

LAD:

When we write a program in ladder, we create and arrange the graphical components to form a network of logic. Following types of elements are used for creating control programs:

- Contacts: each of these elements represents a switch through which power can flow when a switch is closed.
- Coils: each of these elements represents a relay that is energized by power flowing to that relay.
- Boxes: each of these elements represents a function that is

executed when power flows to the box.

- Networks: each of these elements forms a complete circuit. Power flows from the left power rail through the closed contacts to energize the coils or boxes.

STL:

Statement list [STL] is a programming language in which each statement in the program includes an instruction that uses a mnemonic abbreviation to represent a function of the CPU. These mnemonics combine the instructions into a program to produce the control logic for a particular application.

FBD:

It is a graphical programming language and uses logic boxes familiar from Boolean algebra to represent logic. Complex functions can also be represented by directly connecting the required logic boxes.

A control program written in FBD can always be converted to LAD and vice versa. The program written in any of these languages can always be converted back to STL but the reverse is not always true. Program elements that can not be represented in destination language are always represented in STL.

Following diagram gives a general feeling of these three types of languages in their way of implementation:

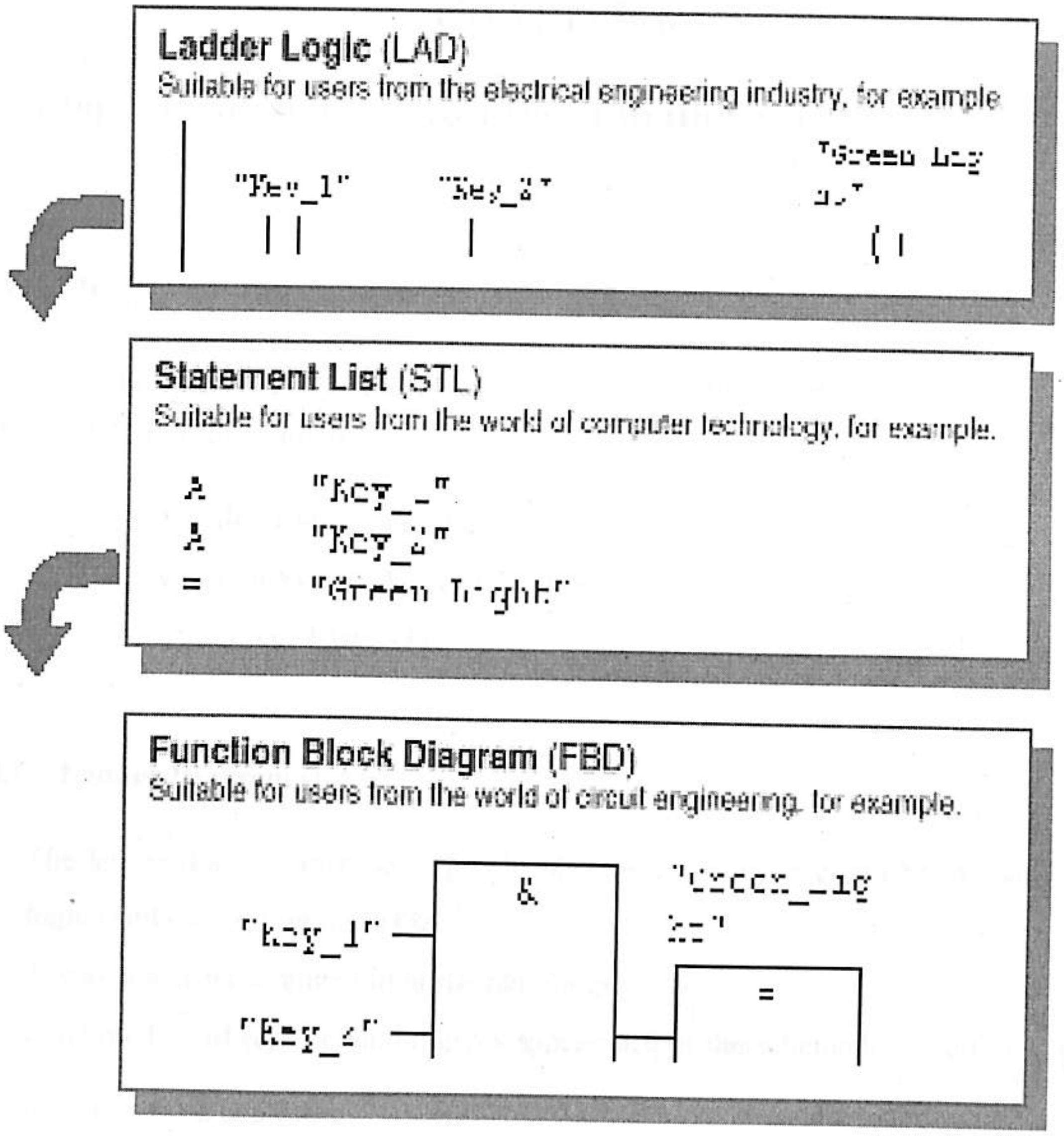


Figure 5.4: Three types of Language representation

CHAPTER 6

Elements of Structured Programming & Introduction to STEP-7

6.0 Programming Language

STEP-7 is the programming language used for programming of SIMATIC S7 PLC. With the STEP-7, three methods of representation can be used and these are-

- **Ladder Diagram (LAD)**
- **Control System Flowchart (CSF)**
- **Statement List (STL)**

6.0.1 Ladder Diagram (LAD)

- The ladder diagram method is graphical representation of control task using relay logic symbols, common in USA.
- The symbols are arranged in horizontal rungs.
- LAD method of representation gives appearance of the schematic circuit diagram of the hard-wired control.

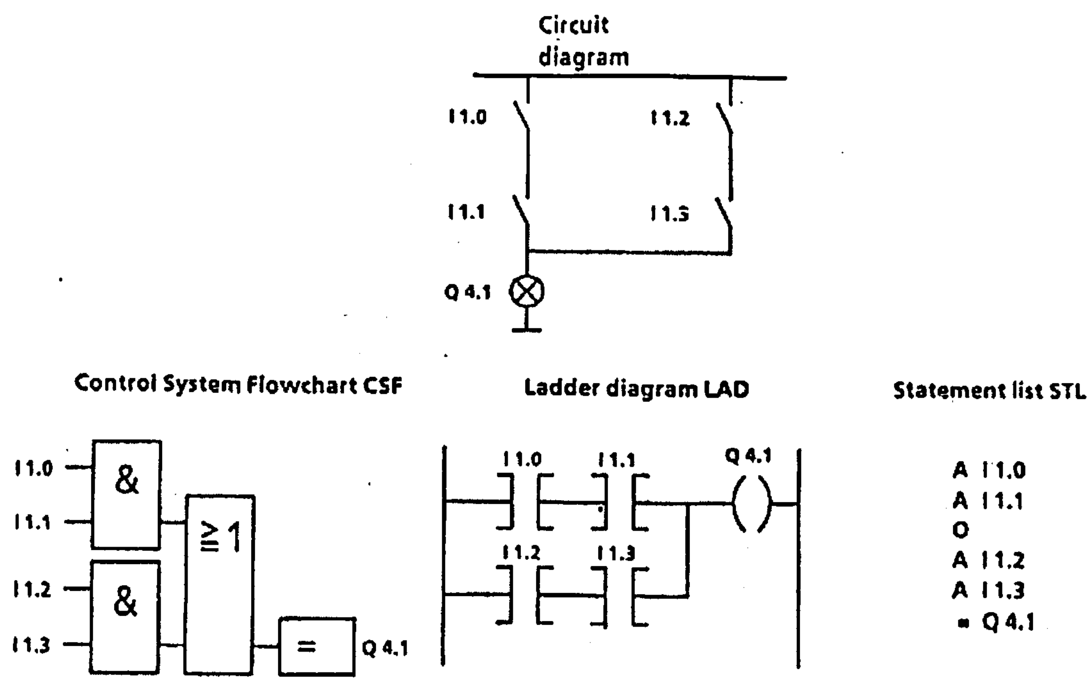
6.0.2 Control System Flowchart (CSF)

- The Control System Flow Chart (CSF) method is graphical representation of the control task using logic symbols which are used in digital circuits.
- The basic symbol used in CSF is the rectangular box. Inputs are shown at the left, the output at the right of the function symbol.

6.0.3 Statement List (STL)

- The statement List method uses mnemonic abbreviations to formulate the control tasks.
- Each step of program written into STL method is called as control statement.
- Each control statement is an instruction to the processor as to how it has to execute the program and what operation is to be carried out.
- All operations available in the programming language (basic operations, supplementary operations and system operations) can be represented in STL format.

Figure 6.0: The STEP 7 Programming Language: Methods of Representation



- Using programmer any of the three methods of representation can be converted into other methods of representation.
- The programming unit translates the programs represented in any one of these three forms into a command sequence which will then stored in the user memory of the programmable controller in the form of machine code MC7.

6.1 Control Statement

The control statement is smallest unit of program and it occupies one or several location in the program memory.

A control statement comprises of the ***operation*** part and the ***operand*** part.

6.1.1 Operation Part

The operation part define the function to be carried out; it tells the processor what to do, e.g.,

A	execute an AND operation
O	execute an OR operation
=	assign the result etc.

6.1.2 Operand Part:

The operand part comprises of the operand identifier and the parameter.

The operand identifier defines the field on which the operation is to be carried out, e.g., Input (I), Output (Q), Flag (F), Timer (T), Counter (C), etc.

6.2 Software Blocks of the User Program

A program is easier to write and understand if it is structured, i.e., broken down into program sections according to their technological functions. To permit this method of programming, SIMATIC S7 controllers can be programmed with different types of software blocks.

6.2.1 Program Block (PB)

Program blocks contain the user program structured according to technological or functional criteria (e.g., program blocks for conveyor starting, message reporting etc.)

6.2.2 Function Block (FB)

Functions which are used several times within a program or which are of a more complex nature are best written in a function block. The program of a function block is usually written with symbolic operands (assignable parameters). This allows different operands to be assigned to inputs and outputs each time the function block is executed. The use of function blocks streamlines program development.

6.2.3 Organization Block (OB)

The organization blocks form the interface between the system program (the CPUs operating system) and the user program. The block calls listed in the organization blocks determine the order in which the individual software blocks are processed. Organization blocks themselves are usually called by the operating system.

6.2.4 Sequence Block (SB)

Sequence blocks are used for programming sequence controls. The user may also invoke individual block identical to that of program blocks and they may be used as such (for example, when the number of program blocks proves insufficient).

6.2.5 Data Block (DB)

Process data often has to be stored for the user program. Hence, data blocks are needed for the storage of set-points, results of arithmetic operations, time values etc. Statements, however, cannot be programmed within a data block.

6.2.6 Segment

The Blocks of the user program (PB, FB, OB) may, themselves, be subdivided into individual segments. This helps to keep the program clearly structured. Up to 256 segments, each consisting of up to 256 statements is permitted. A block has room for up to 4096 statements.

Software Blocks of the User Program

PB 0 255	Program blocks : For plant specific functions
FB 0 255	Function block: For standardized functions, independent of the particular plant.
OB 1 255	Organization blocks For organization and supervision of program execution; called by the system program
SB 0 255	Sequence blocks : For programming sequences (sequential control system)
DB 2 255	Data blocks :

For the storage of fixed and variable data

6.3 Structure of the User Program

6.3.1 Linear Programming

With linear programming, the user program consists of a single block containing all the statements of the program. These statements are processed individually, one after the other, by the CPU of the programmable controller.

6.3.2 Structured Programming

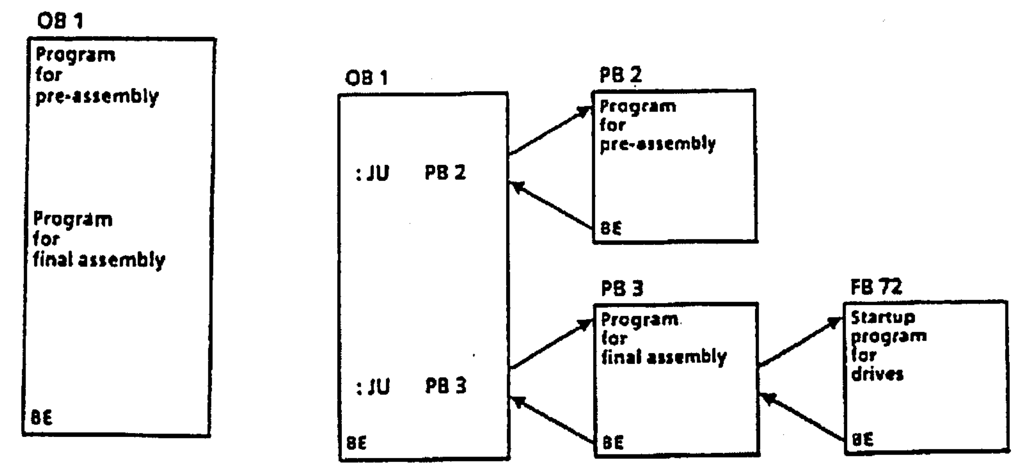
If the program is made up of several blocks, however, e.g., program blocks, containing plant-specific sections, this is referred to as structured programming. For yclic program scanning, the order of block execution is dictated by organization block OB1. The blocks to be executed are called OB 1 with JU PB … statements.

When the processor encounters such a call during program execution, processing of OB 1 is interrupted and the routine in the called block is processed instead. Once the last statement of the called block has been reached (BE = Block end), execution of OB 1 is continued with the next statement.

Blocks can be called not only in OB1, but also in other blocks. This results in branched (nested) program structure. Structured programming is not possible with the simpler programmable controllers.

> ***Note Carefully:* *Cyclic programme scanning is not possible unless organization block OB 1 has been programmed.***

Figure 6.1: Structure of the User Program



Linear Programming Structured Programming

6.4 Program Processing

The user program can be processed in three different ways:

- Cyclic Program Processing
- Interrupt Controlled Processing
- Time Controlled Processing

6.4.1 Cyclic Program Processing

- The statements of the program are scanned individually one after the other by the CPU.
- After having processed the last statement the processor returns to the first statement and begins a new scanning cycle.
- The time taken for one scan of all the statements listed in program is the cycle time.

The cycle time is monitored by the programmable controller. If the cycle time is exceeded, the programmable controller goes into stop mode.

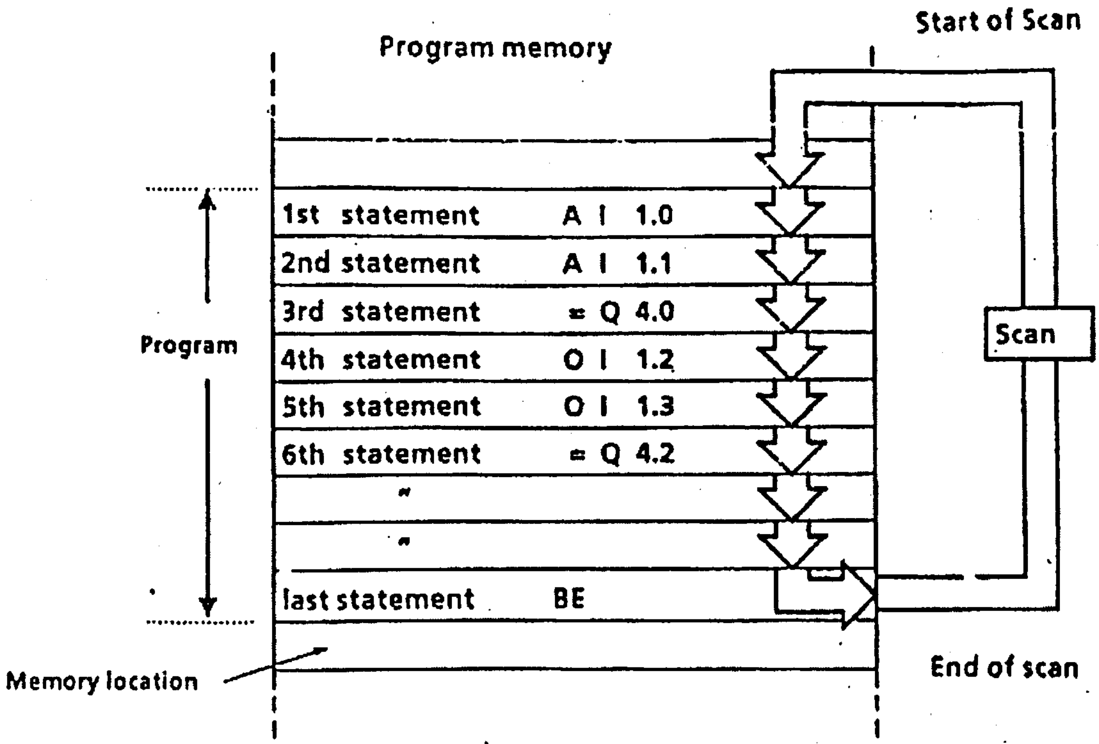
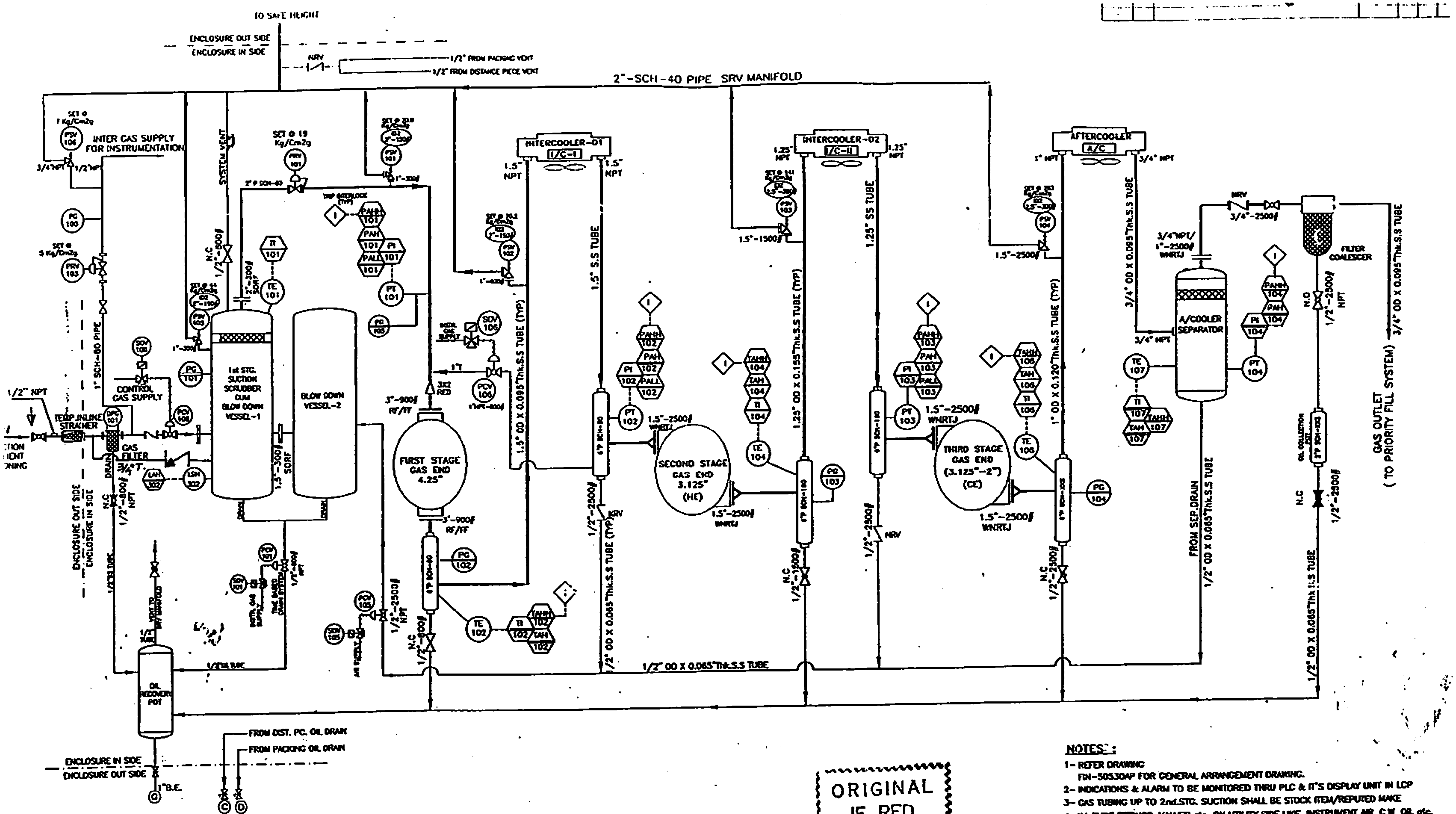


Figure 6.2: Program Scanning

CHAPTER 7

- Process and Instrumentation Diagram
- Flow Diagram of Gas Compressor Station
- Algorithm
- Flow Chart
- Program



NOTES:

1- REFER DRAWING FIN-50530AP FOR GENERAL ARRANGEMENT DRAWING.
2- INDICATIONS & ALARM TO BE MONITORED THRU PLC & IT'S DISPLAY UNIT IN LCP
3- GAS TUBING UP TO 2nd.STG. SUCTION SHALL BE STOCK ITEM/REPUTED MAKE
4- ALL TUBE FITTINGS, VALVES etc. ON UTILITY SIDE LIKE INSTRUMENT AIR, C.W, OIL etc. SHALL BE OF DOUBLE COMPRESSION SS.316 & FROM REPUTED INDIAN VENDOR.
5- THIS IS REPEAT ORDER OF GUJ-45127. REFER GAEL APPROOVED P & ID (RIN-50550AS

ORIGINAL IF RED

ROCESS OPERATING PARAMETERS
DESIGN CASE)

	STAGE-1	STAGE-2	STAGE-3
SUCTION PRE. (BarG)	18.00	63.24	127.04
SUCTION TEMP. °C	30.00	52.2	52.2
DISCHARGE PRE. (BarG)	63.88	120.53	255
DISCHARGE TEMP. °C (TH. ADIABETIC)	117.00	108.00	108.00
FLOW RATE (Sm3/Hr.)	1200		

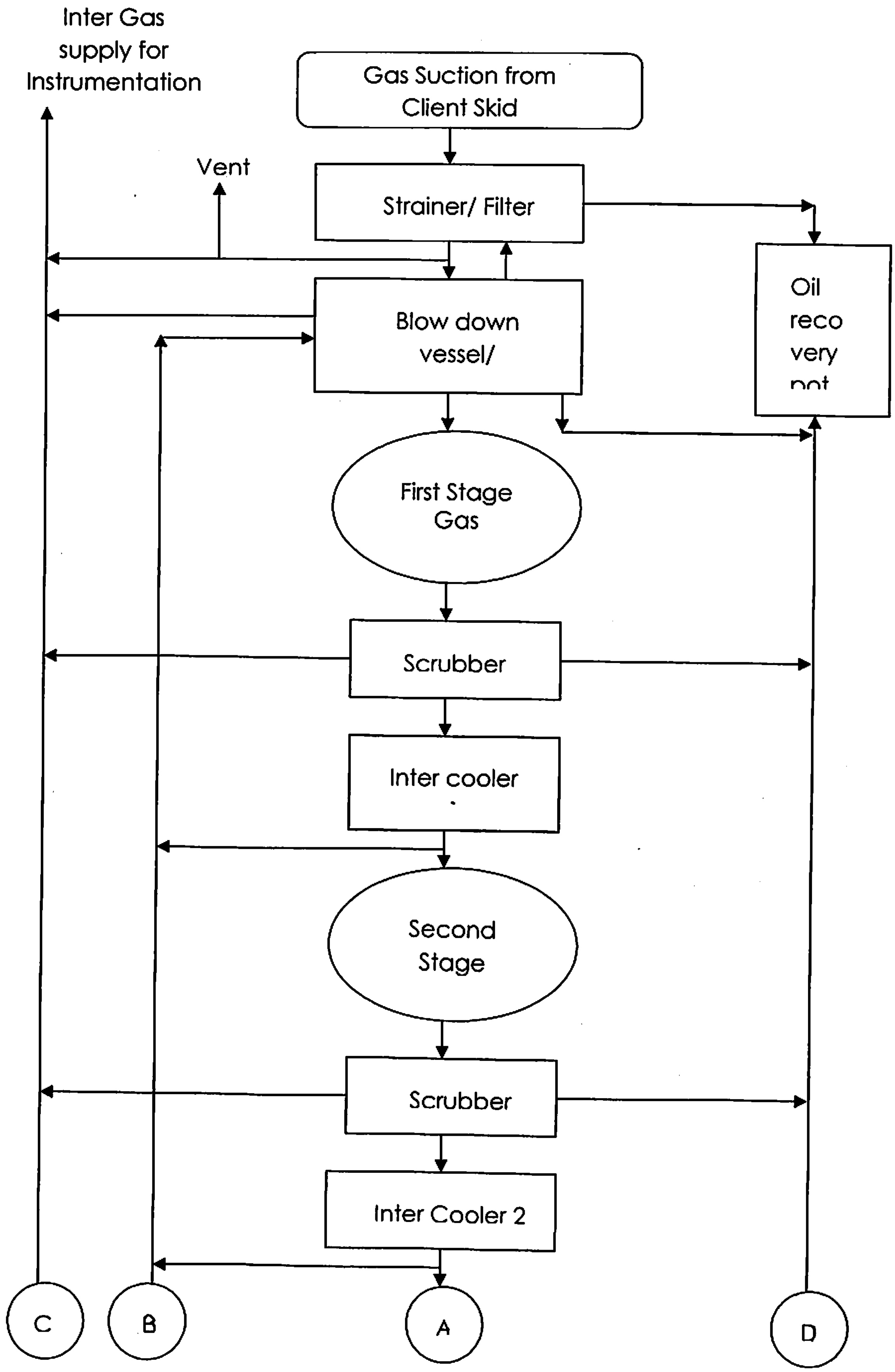
LEGEND

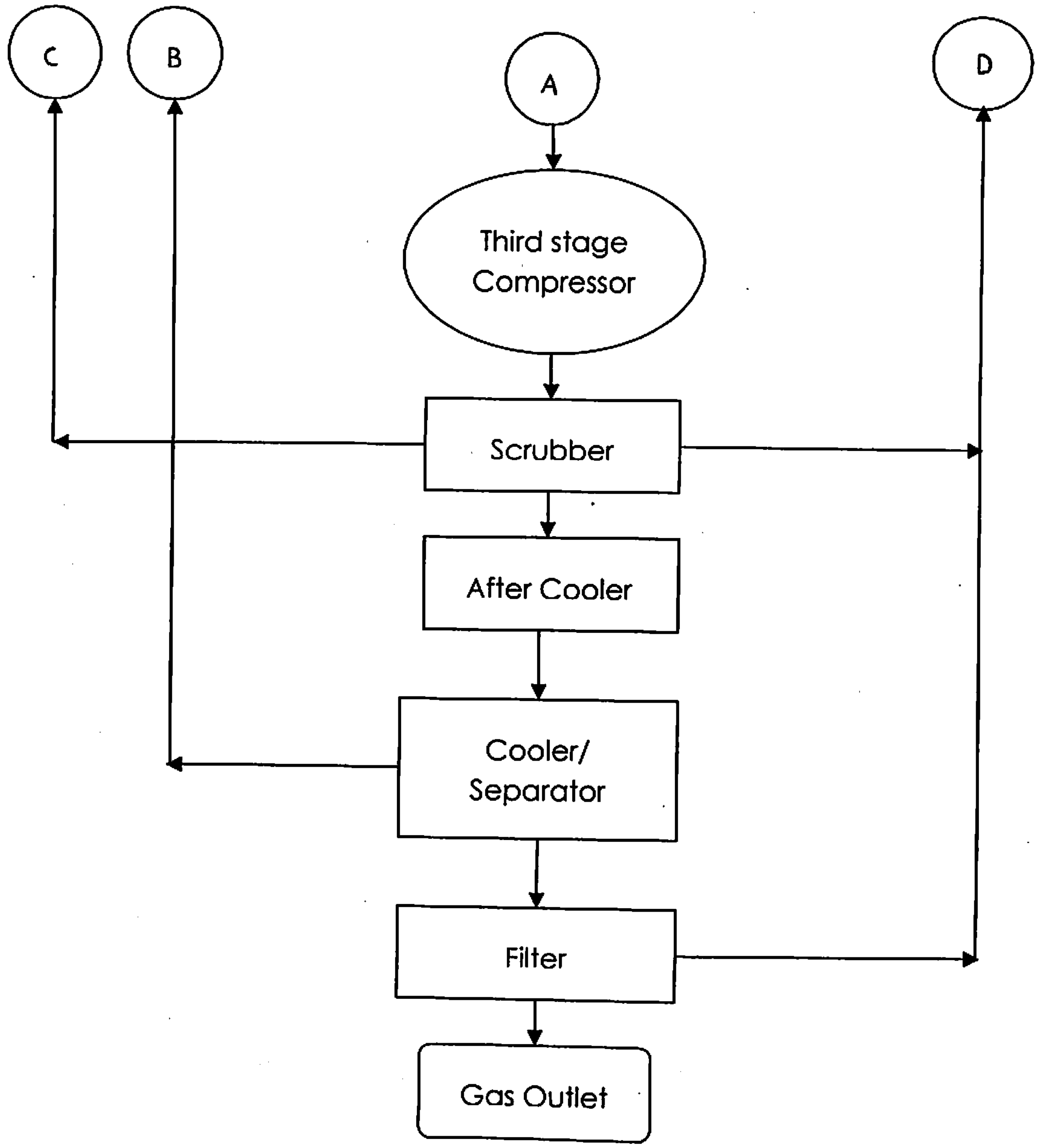
D-R'S SCOPE OF SUPPLY / PURCHASER'S SCOPE OF SUPPLY	NEEDLE VALVE
LOCAL MOUNTING	CHECK VALVE
ENCLOSURE WALL MOUNTED INSTRUMENTS	AIR COOLED HEAT EXCHANGER FAN
TEMPERATURE ELEMENT (RTD PT-100)	PRESSURE RELIEF VALVE
PLC DISPLAY (ON LCP)	PNEUMATIC OPERATED (ON/OFF) BALL VALVE
SIGHT GLASS FLOW INDICATOR	SELF ACTUATING PRESS. REDUCING VALVE
BALL VALVE	FLEXIBLE JOINT
GATE VALVE	Y-TYPE STRAINER
GLOBE VALVE	PNEUMATIC INSTRUMENT SIGNAL
	ELECTRICAL SIGNAL

CLIENT
CLIENT'S PO
D-R REF.
D-R MODEL
SERVICE
QTY.

7 6 5 4

Flow Diagram of Gas Compressor Station



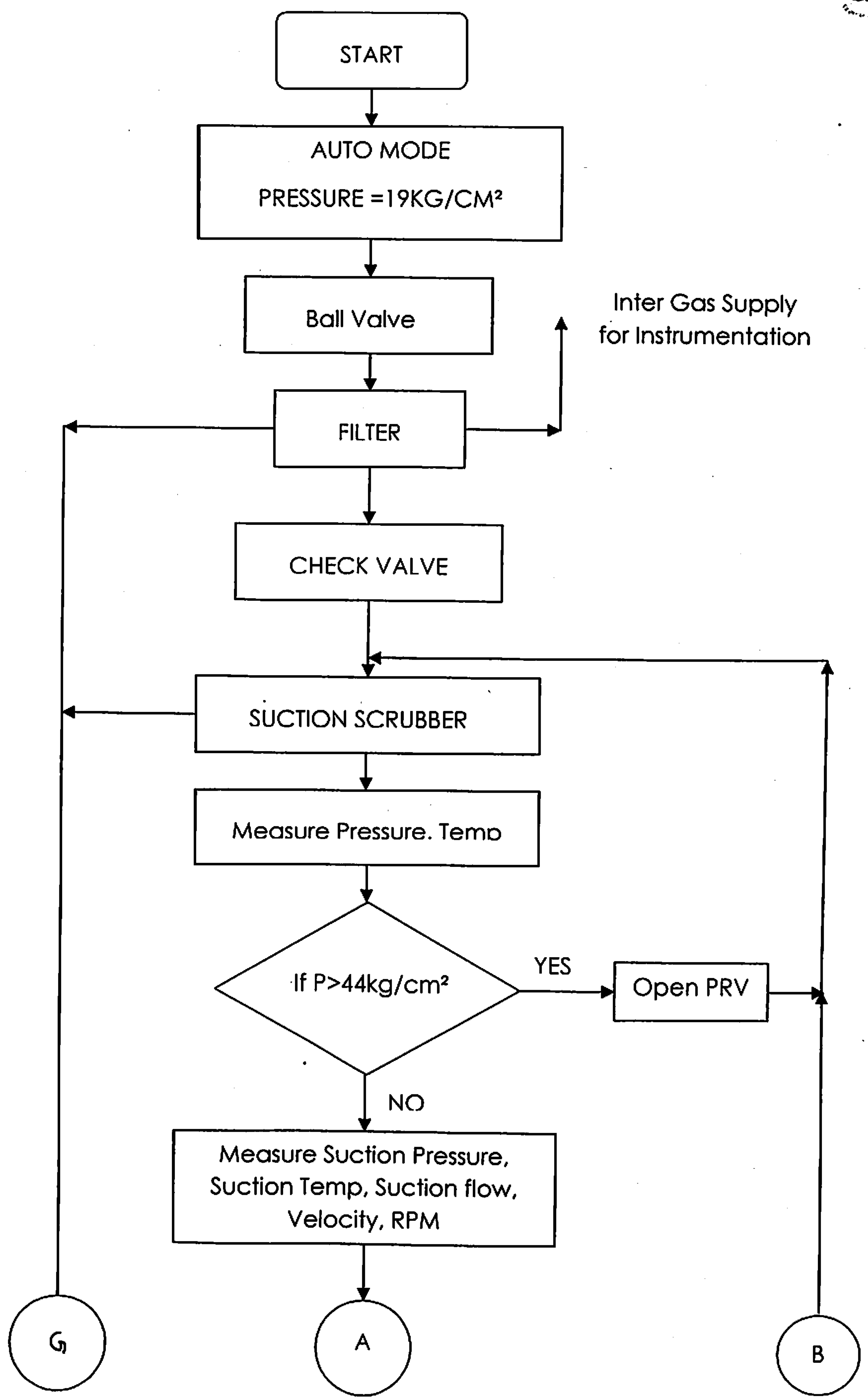

C
B
A
D
Third stage Compressor
Scrubber
After Cooler
Cooler/ Separator
Filter
Gas Outlet

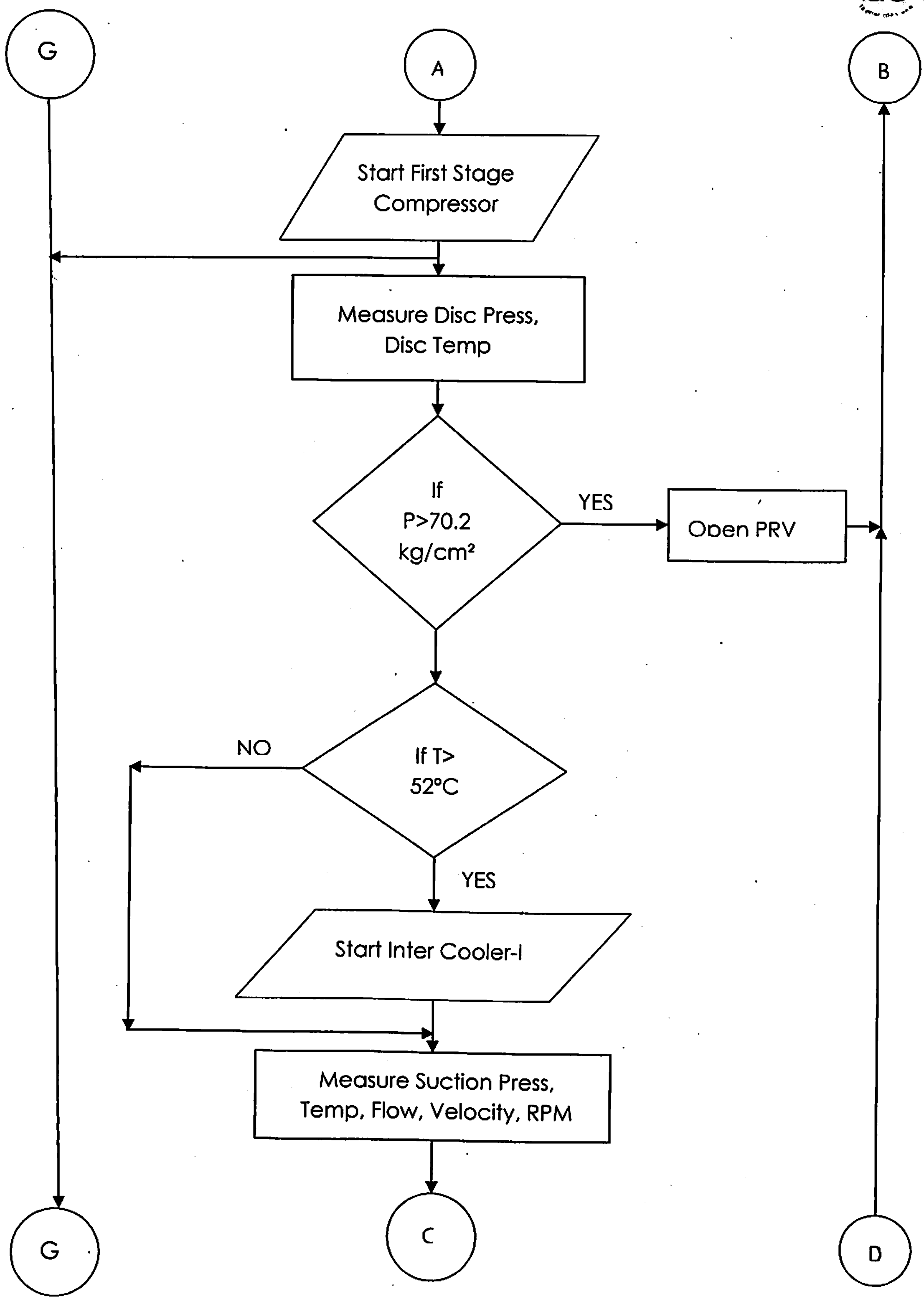
ALGORITHM

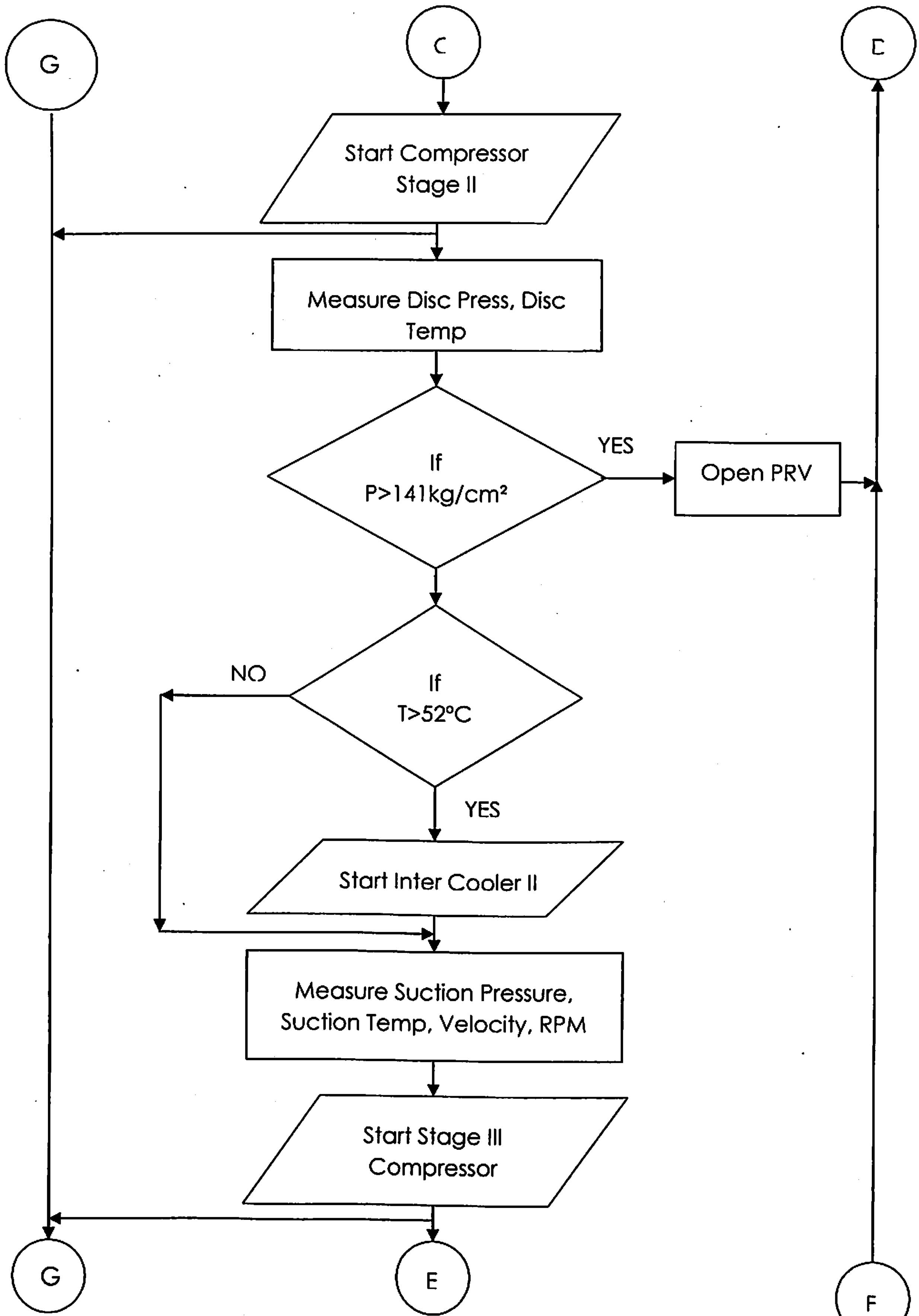
1. Start the system into Auto mode.
2. Open Ball valve at the Gas suction from client conditioning Skid.
3. Control Gas supply through PCV (ON/OFF) Ball valve.
4. Measure the Pressure at the filter.
5. Open PRV for Inter Gas supply for Instrumentation, then gas will flow to the scrubber.
6. Measure the Pressure and Temperature at Suction Scrubber
7. If Pressure is more than 20Kg/sq.cm, Open the PRV which is in between the Scrubber and First stage Gas Compressor
8. Measure the gas pressure, temperature, flow, velocity and RPM at suction side of the First Stage Compressor.
9. Then First Stage Compressor will start when the gas enters into it.
10. Measure the gas pressure, temperature at discharge side of the First stage compressor.
11. If discharge pressure is not equal to 63.88kg/sq.cm at the First stage compressor, then close the Ball valve at the gas suction from client conditioning skid.
12. If discharge temperature is not equal to 52.2°C. Then start the Inter cooler-1.
13. Measure the discharge temperature at the discharge side of the Intercooler. If it is not attain the 52°C temperature. Then generate an alarm.
14. Measure the gas pressure, temperature, flow, velocity and RPM at suction side of the Second Stage Compressor.
15. Then Second Stage Compressor will start when gas enters into it.
16. Measure the gas pressure, temperature at discharge side of the Second stage compressor.
17. If discharge pressure is not equal to 128.33kg/sq.cm at the Second stage compressor, then close the Ball valve at the gas suction from client conditioning skid.
18. If discharge temperature is not equal to 52.2°C. Then start the Inter cooler-2.
19. Measure the discharge temperature at the discharge side of the Intercooler. If it is not attain the 52°C temperature. Then generate an alarm.

20. Measure the gas pressure, temperature, flow, velocity and RPM at suction side of the Third Stage Compressor.
21. Then Third Stage Compressor will start when the gas enters into it.
22. Measure the gas pressure, temperature at discharge side of the Third stage compressor.
23. If discharge pressure is not equal to 255kg/sq.cm at the Third stage compressor, then close the Ball valve at the gas suction from client conditioning skid.
24. If discharge temperature is not equal to 52.2°C. Then start the After Cooler.
25. Measure the discharge temperature at the discharge side of the After Cooler. If it is not attain the 52°C temperature. Then generate an alarm.
26. Collect the drain from all the scrubbers for every 15sec, and the valves should open for the 10 sec.
27. Open the Ball valve after the After Cooler to outlet the gas through filter.

FLOW CHART


START
AUTO MODE
PRESSURE =19KG/CM²
Ball Valve
Inter Gas Supply
for Instrumentation
FILTER
CHECK VALVE
SUCTION SCRUBBER
Measure Pressure. Temp
If P>44kg/cm²
YES
Open PRV
NO
Measure Suction Pressure,
Suction Temp, Suction flow,
Velocity, RPM
G
A
B


G
A
B
Start First Stage Compressor
Measure Disc Press, Disc Temp
If P>70.2 kg/cm²
YES
Open PRV
If T> 52°C
NO
YES
Start Inter Cooler-I
Measure Suction Press, Temp, Flow, Velocity, RPM
G
C
D


G
C
D
Start Compressor Stage II
Measure Disc Press, Disc Temp
If P>141kg/cm²
YES
Open PRV
NO
If T>52°C
YES
Start Inter Cooler II
Measure Suction Pressure, Suction Temp, Velocity, RPM
Start Stage III Compressor
G
E
F

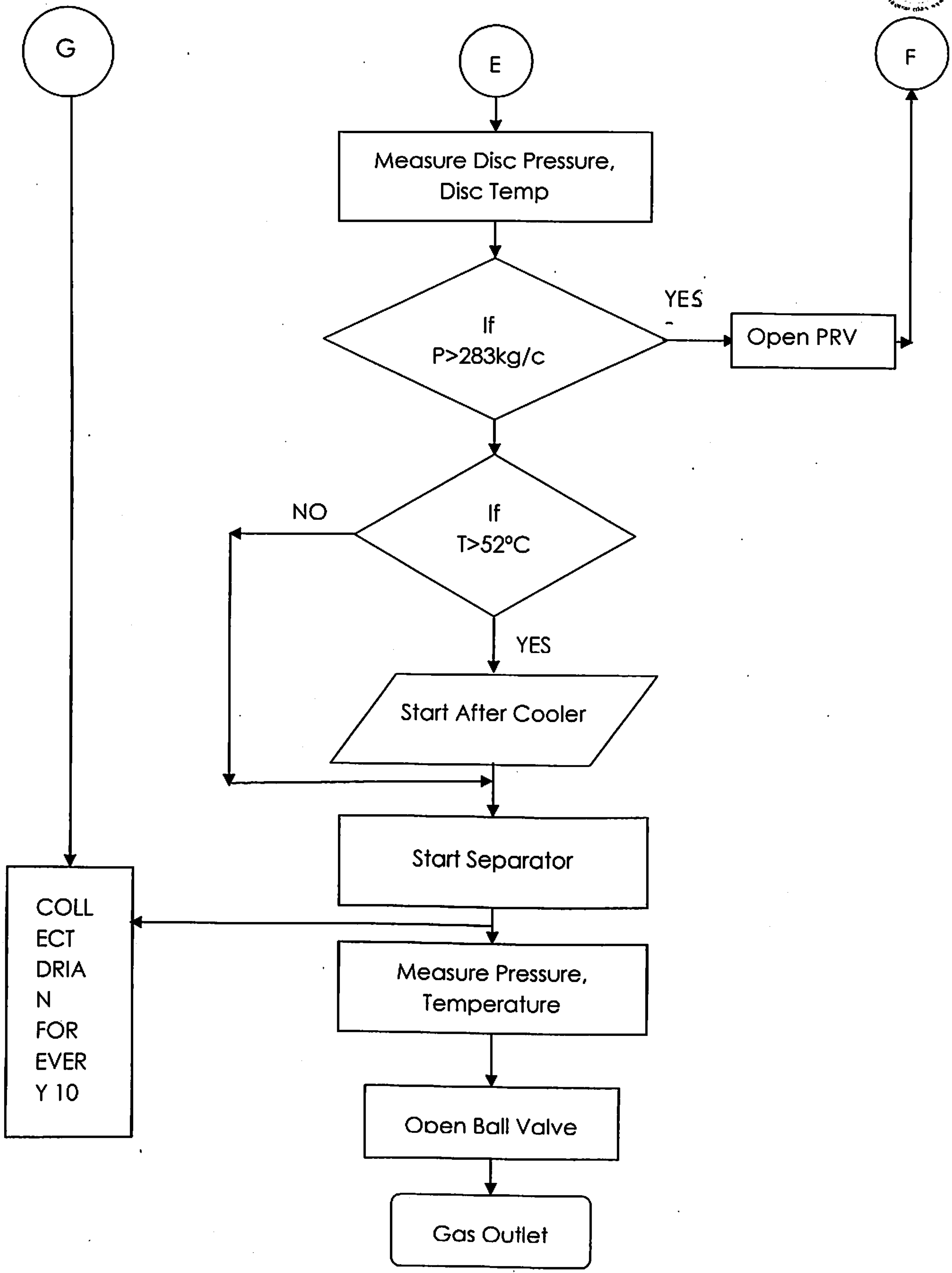
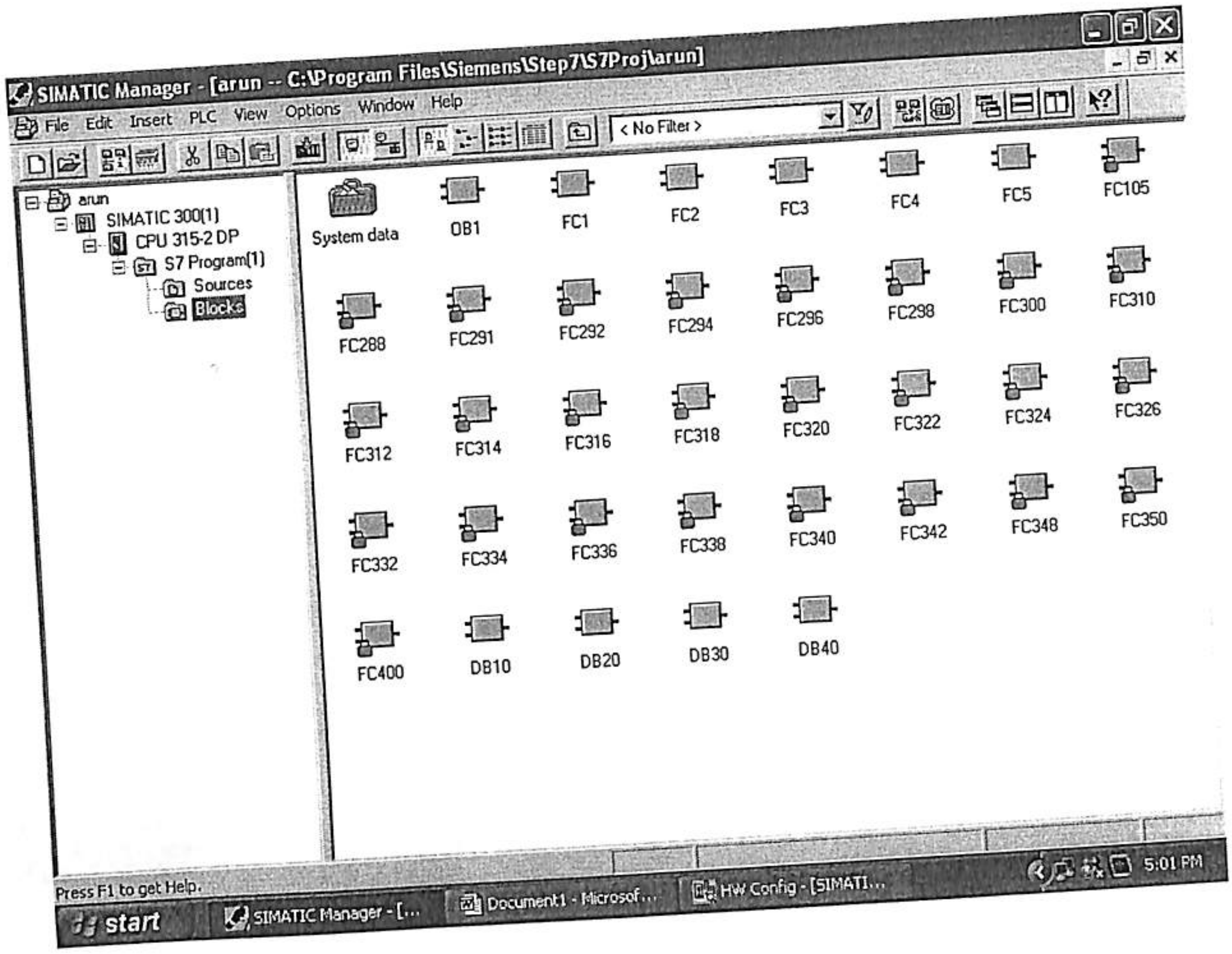

G
E
F
Measure Disc Pressure, Disc Temp
If P>283kg/c
YES
Open PRV
If T>52°C
NO
YES
Start After Cooler
Start Separator
COLL ECT DRIA N FOR EVER Y 10
Measure Pressure, Temperature
Open Ball Valve
Gas Outlet

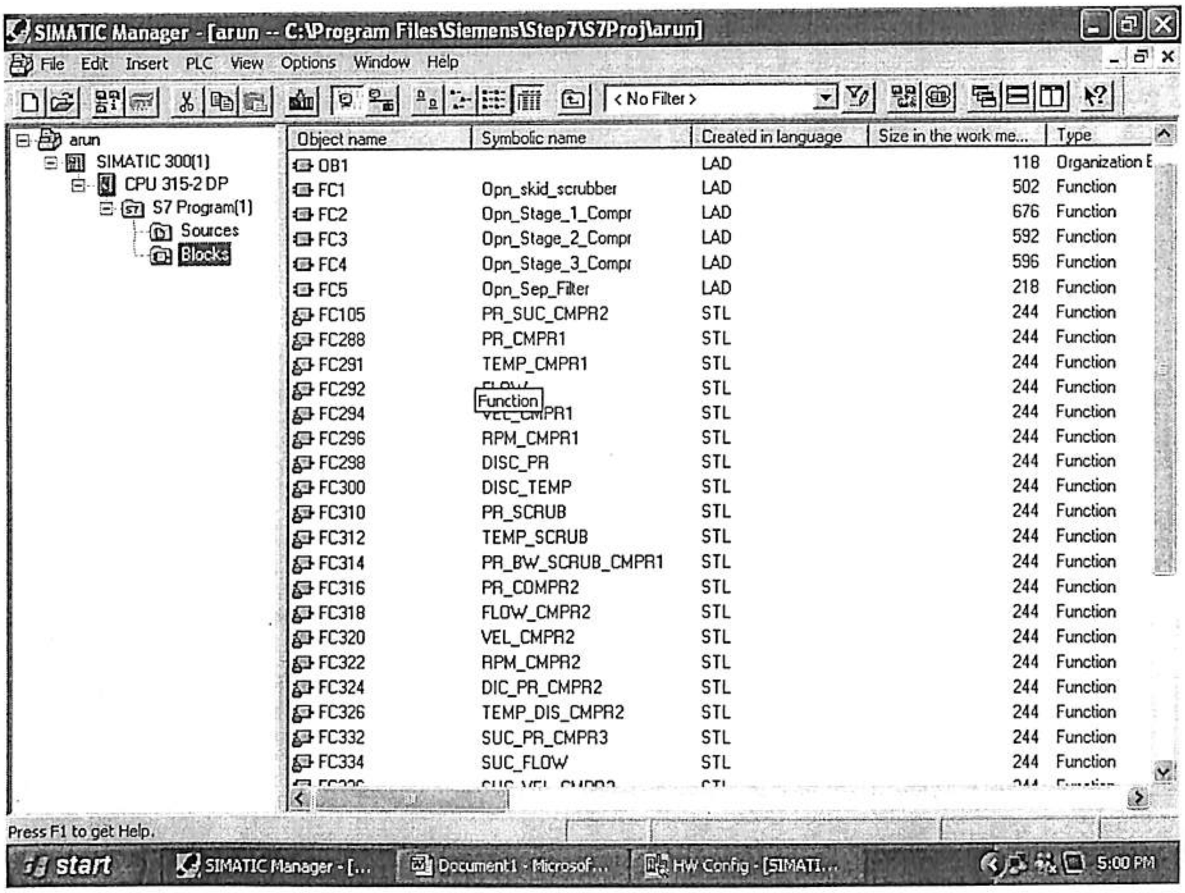
Table 5: Consolidated Table for Measurements in the System

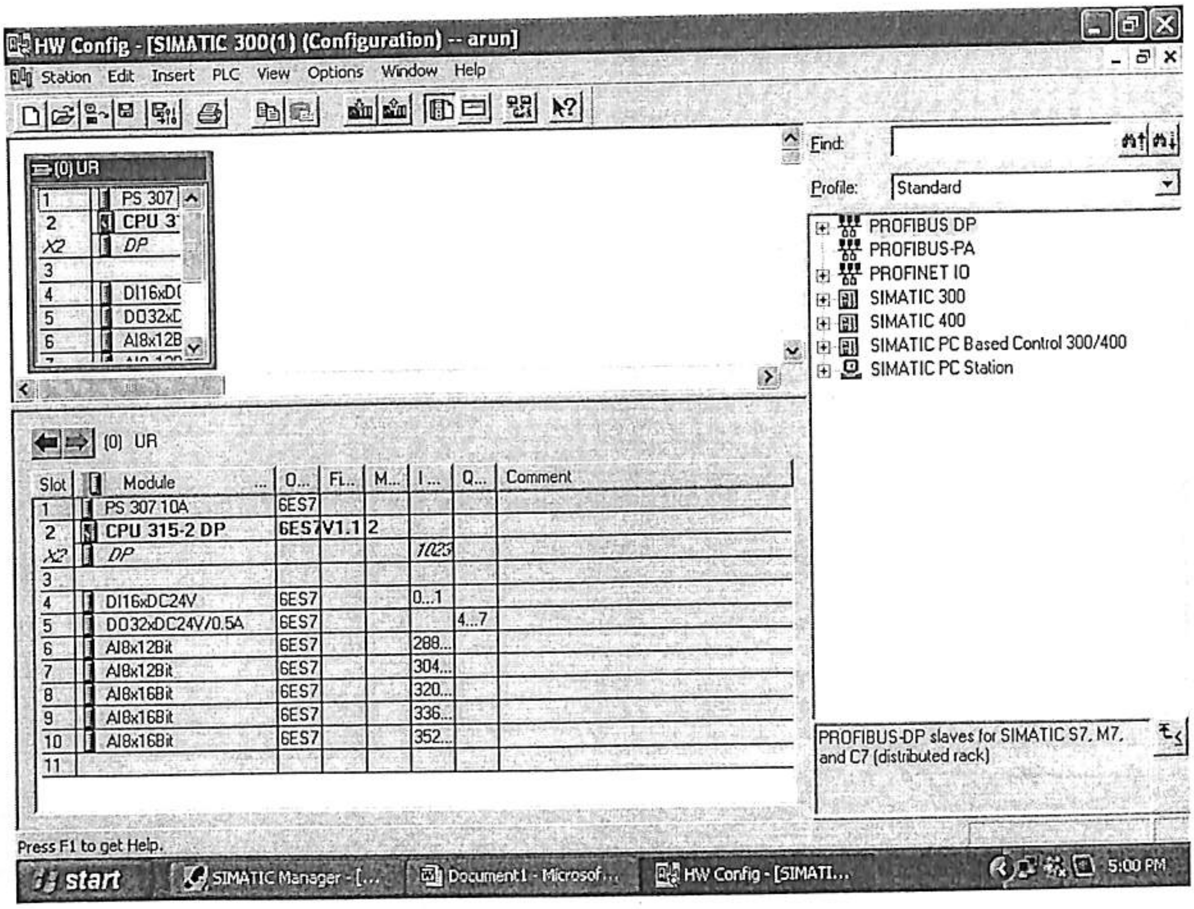
Measurement of Parameters	Stage	Action Taken
Measurement of Pressure	At filter	If P>5kg/cm² stop the ball valve at the skid
Measurement of Pressure, Temp	At Scrubber	
Measurement of Pressure, Temp, flow, velocity, RPM	At suction side of the First stage Gas compressor	
Measurement of Pressure, Temp	At discharge side of the first stage Gas compressor	If discharge Pressure is not equal to 70.2kg/cm² then stop the ball valve at the gas suction skid, and If discharge Temp is more than 52°C start Inter cooler1
Measure Temp	At Discharge side of the Inter Cooler1	If Temp is not equal to 52°C then generate an alarm
Measurement of Pressure, Temp, flow, velocity, RPM	At suction side of the Second stage Gas compressor	
Measurement of Pressure, Temp	At discharge side of the Second stage Gas compressor	If discharge Pressure is not equal to 141kg/cm² then stop the ball valve at the gas suction skid, and If discharge Temp is more than 52°C start Inter cooler2
Measure Temp	At Discharge side of the Inter Cooler2	If Temp is not equal to 52°C then generate an alarm
Measurement of Pressure, Temp, flow, velocity, RPM	At suction side of the Third stage Gas compressor	
Measurement of Pressure, Temp	At discharge side of the Third stage Gas compressor	If discharge Pressure is not equal to 288 kg/cm² then stop the ball valve at the gas suction skid, and If discharge Temp is more

		than 52°C start After cooler
Measure Temp	At Discharge side of the After Cooler	If Temp is not equal to 52°C then generate an alarm
Measure the Pressure and Temp	At the separator	Then open the Ball valve at the gas outlet.

PROGRAM


SIMATIC Manager - [arun -- C:\Program Files\Siemens\Step7\S7Proj\arun]
File Edit Insert PLC View Options Window Help
< No Filter >
arun
SIMATIC 300(1)
CPU 315-2 DP
S7 Program(1)
Sources
Blocks
System data
OB1
FC1
FC2
FC3
FC4
FC5
FC105
FC288
FC291
FC292
FC294
FC296
FC298
FC300
FC310
FC312
FC314
FC316
FC318
FC320
FC322
FC324
FC326
FC332
FC334
FC336
FC338
FC340
FC342
FC348
FC350
FC400
DB10
DB20
DB30
DB40
Press F1 to get Help.
start
SIMATIC Manager - [...
Document1 - Microsof...
HW Config - [SIMATI...
5:01 PM


SIMATIC Manager - [arun -- C:\Program Files\Siemens\Step7\S7Proj\arun]
File Edit Insert PLC View Options Window Help
< No Filter >
arun
SIMATIC 300(1)
CPU 315-2 DP
S7 Program(1)
Sources
Blocks
Object name
Symbolic name
Created in language
Size in the work me...
Type
OB1 LAD 118 Organization E
FC1 Opn_skid_scrubber LAD 502 Function
FC2 Opn_Stage_1_Compr LAD 676 Function
FC3 Opn_Stage_2_Compr LAD 592 Function
FC4 Opn_Stage_3_Compr LAD 596 Function
FC5 Opn_Sep_Filter LAD 218 Function
FC105 PR_SUC_CMPR2 STL 244 Function
FC288 PR_CMPR1 STL 244 Function
FC291 TEMP_CMPR1 STL 244 Function
FC292 STL 244 Function
Function
FC294 PR1 STL 244 Function
FC296 RPM_CMPR1 STL 244 Function
FC298 DISC_PR STL 244 Function
FC300 DISC_TEMP STL 244 Function
FC310 PR_SCRUB STL 244 Function
FC312 TEMP_SCRUB STL 244 Function
FC314 PR_BW_SCRUB_CMPR1 STL 244 Function
FC316 PR_COMPR2 STL 244 Function
FC318 FLOW_CMPR2 STL 244 Function
FC320 VEL_CMPR2 STL 244 Function
FC322 RPM_CMPR2 STL 244 Function
FC324 DIC_PR_CMPR2 STL 244 Function
FC326 TEMP_DIS_CMPR2 STL 244 Function
FC332 SUC_PR_CMPR3 STL 244 Function
FC334 SUC_FLOW STL 244 Function
Press F1 to get Help.
start
SIMATIC Manager - [...
Document1 - Microsof...
HW Config - [SIMATI...
5:00 PM


HW Config - [SIMATIC 300(1) (Configuration) -- arun]
Station Edit Insert PLC View Options Window Help
(0) UR
Find:
Profile: Standard
PROFIBUS DP
PROFIBUS-PA
PROFINET IO
SIMATIC 300
SIMATIC 400
SIMATIC PC Based Control 300/400
SIMATIC PC Station
(0) UR
Slot Module O... Fi... M... I... Q... Comment
1 PS 307 10A 6ES7
2 CPU 315-2 DP 6ES7 V1.1 2
X2 DP 1023
3
4 DI16xDC24V 6ES7 0...1
5 DO32xDC24V/0.5A 6ES7 4...7
6 AI8x12Bit 6ES7 288...
7 AI8x12Bit 6ES7 304...
8 AI8x16Bit 6ES7 320...
9 AI8x16Bit 6ES7 336...
10 AI8x16Bit 6ES7 352...
11
PROFIBUS-DP slaves for SIMATIC S7, M7, and C7 (distributed rack)
Press F1 to get Help.
start
SIMATIC Manager - [...
Document1 - Microsof...
HW Config - [SIMATI...
5:00 PM

Properties of symbol table

Name: Symbols
Author:
Comment:
Created on 3/29/2007 5:01:38 AMAM
Last modified on: 4/6/2007 5:05:11 AMAM
Last filter criterion: All Symbols
Number of symbols: 74/74
Last Sorting: Symbol Ascending

Status	Symbol	Address	Data type	Comment
	ALARM_AFTERCOOLER	Q 6.5	BOOL	IF THE AFTER COOLER IS NOT WORKING THEN THE ALARM IS GENERATED
	ALARM_INTERCOOLER	Q 6.3	BOOL	IF THE INTERCOOLER IS NOT ACTIVE THEN IT WILL GENERATE THE ALARM
	ALARM_INTERCOOLER1	Q 6.2	BOOL	IF INTER COOLER IS NOT ACTI VE THEN IT WILL GENERATE ALARM
	ball_valve	I 0.1	BOOL	opened when gas enters into the pipe line
	BALL_VALVE_I/P	Q 6.0	BOOL	opened when gas enters into the pipe line
	DIC_PR_CMPR2	FC 324	FC 324	MONITORING OF DISCHARGE PRESSURE AT CMPR2
	DIS_PR-CMPR3	FC 340	FC 340	MONITORING DIS PR AT CMPR3
	DIS_TEMP_CMPR3	FC 342	FC 342	MONITORING OF DIS TEMP AT CMPR3
	DISC_PR	FC 298	FC 298	MONITORING OF DISCHARGE AT CMPR1
	DISC_TEMP	FC 300	FC 300	DISC TEMP
	FLOW	FC 292	FC 292	AT CMPR1 MONITORING OF FLOW
	FLOW_CMPR2	FC 318	FC 318	FLOW MONITORING AT CMPR2
	inter_lock_cmpr1	M 10.0	BOOL	inter lock for cmpr1
	inter_lock_cmpr2	M 10.1	BOOL	inter lock for cmpr2
	inter_lock_cmpr3	M 10.2	BOOL	inter lock for cmpr3
	OPEN_BALL_VALVE	Q 5.4	BOOL	OPENING OF BALL VALVE
	Opn_Sep_Filter	FC 5	FC 5	OPERATION OF SEPERATOR AND FILTER
	Opn_skid_scrubber	FC 1	FC 1	OPERATION OF SKID AND SCRUBBER
	Opn_Stage_1_Compr	FC 2	FC 2	OPERATION OF STAGE 1 COMPRESSOR
	Opn_Stage_2_Compr	FC 3	FC 3	OPERATION OF STAGE 2 COMPRESSOR
	Opn_Stage_3_Compr	FC 4	FC 4	OPERATION OF STAGE 3 COMPRESSOR
	out_timer	M 5.3	BOOL	out for timer
	out_timer2	M 5.4	BOOL	out put for timer 2
	PNEU_BALL_AFT_CMPR3	Q 5.7	BOOL	PNEUMATIC BALLVALVE AFTER CMPR3 FOR
	pneu_ball_valve	Q 4.3	BOOL	it will open after every 15 sec
	PNEU_BALL_VALVE_AF_CMPR2	Q 5.6	BOOL	PNEUMATIC BALLVALVE AFTER CMPR2 FOR DRAIN
	PNEU_BALL_VALVE_AFT_FILT	Q 5.5	BOOL	PNEUMATIC BALL VALVE AFTER FILTER FOR DRAIN
	pr_at_filter	FC 400	FC 400	monitoring of pr at filter
	PR_BW_SCRUB_CMPR1	FC 314	FC 314	Scaling Values
	PR_CMPR1	FC 288	FC 288	PR MONITORING AT CMPR1
	PR_COMPR2	FC 316	FC 316	PRESSURE MONITORING AT COMPRESSOR2
	PR_SCRUB	FC 310	FC 310	PR MONITORING AT SCRUBRER
	PR_SEPERATOR_AFT_COOLER	FC 348	FC 348	PRESSURE MONITORING AT SEPERATOR AFTER COOLER
	PR_SUC_CMPR2	FC 105	FC 105	PR MONITORING AT SUCTION SIDE
	PRV_AFT-CMPR3	Q 6.1	BOOL	OPEN THE PRV AFTER COMPRESSOR 3
	PRV_AFT_CMPR2	Q 5.0	BOOL	OPENING OF PRV AFTER CMPR2
	PRV_AFT_CMPR3	Q 5.2	BOOL	OPEINIG OF PRV AFTER CMPR3
	PRV_AFTER_CMPR1	Q 4.1	BOOL	
	PRV_BT_SCRUB_CMPR	Q 4.5	BOOL	
	PRV_SCRUB	Q 4.4	BOOL	PRESSURE RELEIVE VALVE AT SCRUBBER
	RPM_CMPR1	FC 296	FC 296	MONITORING OF RPM AT CMPR1
	RPM_CMPR2	FC 322	FC 322	MONITORING OF R.P.M AT CMPR2
	RPM_CMPR3	FC 338	FC 338	MONITORING OF RPM AT CMPR3
	SET-PT_PR_AFT_CMPR3	MD 138	DWORD	SET PT FOR PR AFTER CMPR3 IS 280
	SET_PT_DISC_PR	MD 32	DWORD	SET PT FOR DISCHARGE PRESURRE
	SET_PT_PR	MD 64	DWORD	SET PT FOR PRESSURE BET SCRB & COMPR-I IS 20.8

Status	Symbol	Address	Data type	Comment
	SET_PT_PR_AFT_CMPR2	MD 102	DWORD	SET PT FOR PRV ATFER CMPR2 IS 141
	SET_PT_PR_FILTER1	MD 184	DWORD	SET PT PRESSURE AFTER FILTER IS 5KG/SQ.CM
	SET_PT_PRESSURE	MD 168	DWORD	SET PT FOR PRESSURE AFTER SEPERATOR IS 255
	SET_PT_SCRUB	MD 52	DWORD	SET POINT PRESSURE IN SCRUBBER IS 44
	SET_PT_TEMP	MD 40	DWORD	SET PT AT CMPR1
	SET_PT_TEMP_AFT_CMPR2	MD 108	DWORD	SET PT FOR TEMP AFTER CMPR2 IS 108
	SET_PT_TEMP_AFT_CMPR3	MD 142	DWORD	SET PT FOR TEMP AFTER CMPR3 IS 108
	SET_PT_TEMP_CMPR2	MD 106	DWORD	SET PT FOR TEMP AFTER CMPR2 IS 108
	SET_SHUT_DOWN	MD 68	DWORD	SET PT FOR SHUT DOWNING THE INPUT
	SET_SHUT_DOWN_INPUT	MD 100	DWORD	SET PT FOR SHUT DOWNING IN-PUT TO THE PLANT
	SET_TEMP_CMPR2	MD 144	DWORD	SET POINT FOR TEMP AFTER CMPR2 IS 108
	START_AFTERCOOLER	Q 6.4	BOOL	STARTING OF AFTER COOLER
	START_CPMR1	Q 4.0	BOOL	FOR STARTING OF CMPR1
	START_INTCOOLER	Q 4.2	BOOL	STARTING OF INTERCOOLER
	STRT_AFT_COOLER	Q 5.3	BOOL	STARTING OF AFTER COOLER
	STRT_CMPR2	Q 4.6	BOOL	FOR STARTING CMPR2
	STRT_CMPR3	Q 4.7	BOOL	FOR STARTING CMPR2
	STRT_INTER_COOLER	Q 5.1	BOOL	STARTING OF INTER COOLER AFTER CMPR2
	SUC_FLOW	FC 334	FC 334	MONITORING SUC FLOW AT CMPR3
	SUC_PR_CMPR3	FC 332	FC 332	MONITORING OF SUC PR AT CMPR3
	SUC_VEL_CMPR3	FC 336	FC 336	MONITORING OF SUC VEL AT CMPR3
	TEMP_AT_SEPERATOR	FC 350	FC 350	TEMP MONITORING AT SEPERATOR
	TEMP_CMPR1	FC 291	FC 291	Scaling Values
	TEMP_DIS_CMPR2	FC 326	FC 326	MONITORING OF DISCHARGE TEMP
	TEMP_SCRUB	FC 312	FC 312	TEMP MONITORING AT SCRUBBER
	time_based	T 1	TIMER	times based drain system
	VEL_CMPR1	FC 294	FC 294	MONOTORING VEL AT CMPR1
	VEL_CMPR2	FC 320	FC 320	VELOCITY MONITORING AT CMPR2

rogram structure (call structure)

Block(symbol), Instance DB(symbol)	Local	Language	Location		Local
S7 Program					
OB1 [maximum: 52]	[22]				[22]
FC1 (Opn_skid_scrubber)	[32]	LAD	NW	1	[10]
FC400 (pr_at_filter)	[52]	LAD	NW	4	[20]
DB10	[32]	LAD	NW	5	[0]
FC310 (PR_SCRUB)	[52]	LAD	NW	9	[20]
FC312 (TEMP_SCRUB)	[52]	LAD	NW	14	[20]
FC314 (PR_BW_SCRUB_CMPR1)	[52]	LAD	NW	17	[20]
FC2 (Opn_Stage_1_Compr)	[32]	LAD	NW	2	[10]
FC288 (PR_CMPR1)	[52]	LAD	NW	1	[20]
DB10	[32]	LAD	NW	2	[0]
FC291 (TEMP_CMPR1)	[52]	LAD	NW	4	[20]
FC292 (FLOW)	[52]	LAD	NW	7	[20]
FC294 (VEL_CMPR1)	[52]	LAD	NW	10	[20]
FC296 (RPM_CMPR1)	[52]	LAD	NW	13	[20]
FC298 (DISC_PR)	[52]	LAD	NW	16	[20]
FC300 (DISC_TEMP)	[52]	LAD	NW	22	[20]
FC3 (Opn_Stage_2_Compr)	[32]	LAD	NW	3	[10]
FC316 (PR_COMPR2)	[52]	LAD	NW	1	[20]
DB20	[32]	LAD	NW	2	[0]
FC318 (FLOW_CMPR2)	[52]	LAD	NW	4	[20]
FC320 (VEL_CMPR2)	[52]	LAD	NW	7	[20]
FC322 (RPM_CMPR2)	[52]	LAD	NW	10	[20]
FC324 (DIC_PR_CMPR2)	[52]	LAD	NW	13	[20]
FC326 (TEMP_DIS_CMPR2)	[52]	LAD	NW	19	[20]
FC4 (Opn_Stage_3_Compr)	[32]	LAD	NW	4	[10]
FC332 (SUC_PR_CMPR3)	[52]	LAD	NW	1	[20]
DB30	[32]	LAD	NW	2	[0]
FC334 (SUC_FLOW)	[52]	LAD	NW	4	[20]
FC336 (SUC_VEL_CMPR3)	[52]	LAD	NW	7	[20]
FC338 (RPM_CMPR3)	[52]	LAD	NW	10	[20]
FC340 (DIS_PR-CMPR3)	[52]	LAD	NW	13	[20]
FC342 (DIS_TEMP_CMPR3)	[52]	LAD	NW	19	[20]
FC5 (Opn_Sep_Filter)	[32]	LAD	NW	5	[10]
FC348 (PR_SEPERATOR_AFT_COOLER)	[52]	LAD	NW	1	[20]
DB40	[32]	LAD	NW	2	[0]
FC350 (TEMP_AT_SEPERATOR)	[52]	LAD	NW	5	[20]
FC105 (PR_SUC_CMPR2)	[20]				[20]

Cross-reference list

Address (symbol)	Block (symbol)	Type	Language	Location
DB10.DBD0	FC1 (Opn_skid_scrubber)	W	LAD	NW 5 /T
DB10.DBD4	FC1 (Opn_skid_scrubber)	W	LAD	NW 10 /T
DB10.DBD8	FC1 (Opn_skid_scrubber)	W	LAD	NW 15 /T
DB10.DBD12	FC1 (Opn_skid_scrubber)	W	LAD	NW 18 /T
DB10.DBD16	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 2 /T
DB10.DBD20	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 5 /T
DB10.DBD24	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 8 /T
DB10.DBD28	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 11 /T
DB10.DBD32	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 14 /T
DB10.DBD36	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 17 /T
DB10.DBD40	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 23 /T
DB20.DBD0	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 2 /T
DB20.DBD4	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 5 /T
DB20.DBD8	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 8 /T
DB20.DBD12	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 11 /T
DB20.DBD16	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 14 /T
DB20.DBD20	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 20 /T
DB30.DBD0	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 2 /T
DB30.DBD4	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 5 /T
DB30.DBD8	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 8 /T
DB30.DBD12	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 11 /T
DB30.DBD16	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 14 /T
DB30.DBD20	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 20 /T
DB40.DBD0	FC5 (Opn_Sep_Filter)	W	LAD	NW 2 /T
DB40.DBD4	FC5 (Opn_Sep_Filter)	W	LAD	NW 6 /T
FC 1 (Opn_skid_scrubber)	OB1	R	LAD	NW 1 /CALL
FC 2 (Opn_Stage_1_Compr)	OB1	R	LAD	NW 2 /CALL
FC 3 (Opn_Stage_2_Compr)	OB1	R	LAD	NW 3 /CALL
FC 4 (Opn_Stage_3_Compr)	OB1	R	LAD	NW 4 /CALL
FC 5 (Opn_Sep_Filter)	OB1	R	LAD	NW 5 /CALL
FC 288 (PR_CMPR1)	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 1 /CALL
FC 291 (TEMP_CMPR1)	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 4 /CALL
FC 292 (FLOW)	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 7 /CALL
FC 294 (VEL_CMPR1)	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 10 /CALL
FC 296 (RPM_CMPR1)	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 13 /CALL
FC 298 (DISC_PR)	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 16 /CALL
FC 300 (DISC_TEMP)	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 22 /CALL
FC 310 (PR_SCRUB)	FC1 (Opn_skid_scrubber)	R	LAD	NW 9 /CALL
FC 312 (TEMP_SCRUB)	FC1 (Opn_skid_scrubber)	R	LAD	NW 14 /CALL
FC 314 (PR_BW_SCRUB_CMPR1)	FC1 (Opn_skid_scrubber)	R	LAD	NW 17 /CALL
FC 316 (PR_COMPR2)	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 1 /CALL
FC 318 (FLOW_CMPR2)	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 4 /CALL
FC 320 (VEL_CMPR2)	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 7 /CALL
FC 322 (RPM_CMPR2)	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 10 /CALL
FC 324 (DIC_PR_CMPR2)	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 13 /CALL
FC 326 (TEMP_DIS_CMPR2)	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 19 /CALL
FC 332 (SUC_PR_CMPR3)	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 1 /CALL

Address (symbol)	Block (symbol)	Type	Language	Location	
FC 334 (SUC_FLOW)	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 4	/CALL
FC 336 (SUC_VEL_CMPR3)	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 7	/CALL
FC 338 (RPM_CMPR3)	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 10	/CALL
FC 340 (DIS_PR-CMPR3)	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 13	/CALL
FC 342 (DIS_TEMP_CMPR3)	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 19	/CALL
FC 348 (PR_SEPERATOR_AFT_COOLER)	FC5 (Opn_Sep_Filter)	R	LAD	NW 1	/CALL
FC 350 (TEMP_AT_SEPERATOR)	FC5 (Opn_Sep_Filter)	R	LAD	NW 5	/CALL
FC 400 (pr_at_filter)	FC1 (Opn_skid_scrubber)	R	LAD	NW 4	/CALL
M 5.0	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 21	/A
		W	LAD	NW 20	/=
M 5.1	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 26	/A
				NW 27	/A
		W	LAD	NW 25	/=
M 5.3 (out_timer)	FC1 (Opn_skid_scrubber)	R	LAD	NW 3	/A
		W	LAD	NW 2	/=
M 5.4 (out_timer2)	FC1 (Opn_skid_scrubber)	R	LAD	NW 2	/A
				NW 3	/AN
		W	LAD	NW 3	/=
M 5.5	FC1 (Opn_skid_scrubber)	R	LAD	NW 13	/A
		W	LAD	NW 12	/=
M 6.0	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 18	/A
		W	LAD	NW 17	/=
M 7.0	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 22	/=
M 7.1	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 23	/A
				NW 24	/A
	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 23	/A
				NW 24	/A
		W	LAD	NW 22	/=
M 8.0	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 1	/A
M 8.1	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 4	/A
M 8.2	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 7	/A
				NW 10	/A
M 8.3	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 13	/A
M 8.4	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 16	/A
M 8.5	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 22	/A
M 9.0	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 1	/A
M 9.1	FC1 (Opn_skid_scrubber)	R	LAD	NW 9	/A
	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 4	/A
M 9.2	FC1 (Opn_skid_scrubber)	R	LAD	NW 14	/A
	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 7	/A
M 9.3	FC1 (Opn_skid_scrubber)	R	LAD	NW 17	/A
	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 10	/A
M 9.4	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 13	/A
M 9.5	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 19	/A
M 10.0 (inter_lock_cmpr1)	FC1 (Opn_skid_scrubber)	R	LAD	NW 1	/AN
	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 19	/=
	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 1	/A
M 10.1 (inter_lock_cmpr2)	FC1 (Opn_skid_scrubber)	R	LAD	NW 1	/AN
	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 4	/A

Address (symbol)	Block (symbol)	Type	Language	Location	
⊟ M 10.2 (inter_lock_cmpr3)	FC1 (Opn_skid_scrubber)	R	LAD	NW 1	/AN
	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 16	/=
	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 7	/A
⊟ M 10.3	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 10	/A
		W	LAD	NW 16	/=
M 10.4	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 13	/A
M 10.5	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 19	/A
M 11.0	FC5 (Opn_Sep_Filter)	R	LAD	NW 1	/A
M 11.1	FC5 (Opn_Sep_Filter)	R	LAD	NW 5	/A
⊟ M 11.2	FC1 (Opn_skid_scrubber)	R	LAD	NW 1	/A
		W	LAD	NW 7	/=
M 11.3	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 18	/A
M 14.0	FC1 (Opn_skid_scrubber)	R	LAD	NW 4	/A
⊟ MD 16	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 11	/L
				NW 12	/L
		W	LAD	NW 10	/CALL
⊟ MD 20	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 14	/L
		W	LAD	NW 13	/CALL
⊟ MD 28	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 17	/L
				NW 18	/L
				NW 19	/L
				NW 20	/L
		W	LAD	NW 16	/CALL
MD 32 (SET_PT_DISC_PR)	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 20	/L
⊟ MD 36	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 23	/L
				NW 24	/L
				NW 25	/L
		W	LAD	NW 22	/CALL
MD 40 (SET_PT_TEMP)	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 25	/L
⊟ MD 48	FC1 (Opn_skid_scrubber)	R	LAD	NW 10	/L
				NW 11	/L
				NW 12	/L
		W	LAD	NW 9	/CALL
MD 52 (SET_PT_SCRUB)	FC1 (Opn_skid_scrubber)	R	LAD	NW 12	/L
⊟ MD 56	FC1 (Opn_skid_scrubber)	R	LAD	NW 15	/L
				NW 16	/L
		W	LAD	NW 14	/CALL
⊟ MD 60	FC1 (Opn_skid_scrubber)	R	LAD	NW 18	/L
				NW 19	/L
				NW 20	/L
		W	LAD	NW 17	/CALL
MD 64 (SET_PT_PR)	FC1 (Opn_skid_scrubber)	R	LAD	NW 20	/L
⊟ MD 86	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 14	/L
				NW 15	/L
				NW 16	/L
				NW 17	/L
		W	LAD	NW 13	/CALL
⊟ MD 114	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 8	/L
				NW 9	/L

Address (symbol)	Block (symbol)	Type	Language	Location
		W	LAD	NW 7 /CALL
MD 132	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 14 /L
				NW 15 /L
				NW 16 /L
				NW 17 /L
		W	LAD	NW 13 /CALL
MD 146	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 2 /L
				NW 3 /L
				NW 9 /L
				NW 15 /L
		W	LAD	NW 1 /CALL
MD 150	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 5 /L
				NW 6 /L
		W	LAD	NW 4 /CALL
MD 154	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 8 /L
		W	LAD	NW 7 /CALL
MD 160	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 22 /L
MD 164	FC5 (Opn_Sep_Filter)	R	LAD	NW 2 /L
				NW 3 /L
				NW 4 /L
		W	LAD	NW 1 /CALL
MD 168 (SET_PT_PRESSURE)	FC5 (Opn_Sep_Filter)	R	LAD	NW 4 /L
MD 172	FC5 (Opn_Sep_Filter)	R	LAD	NW 6 /L
				NW 7 /L
		W	LAD	NW 5 /CALL
MD 176	FC1 (Opn_skid_scrubber)	R	LAD	NW 5 /L
				NW 6 /L
				NW 7 /L
		W	LAD	NW 4 /CALL
MD 180	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 20 /L
				NW 21 /L
				NW 22 /L
		W	LAD	NW 19 /CALL
MD 184 (SET_PT_PR_FILTER1)	FC1 (Opn_skid_scrubber)	R	LAD	NW 7 /L
MD 188	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 16 /L
MD 192	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 16 /L
MD 196	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 17 /L
MD 200	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 2 /L
				NW 3 /L
		W	LAD	NW 1 /CALL
MD 204	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 22 /L
MD 208	FC1 (Opn_skid_scrubber)	W	LAD	NW 19 /T
MD 212	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 3 /T
MD 216	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 2 /L
				NW 3 /L
		W	LAD	NW 1 /CALL
MD 220	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 5 /L
				NW 6 /L
		W	LAD	NW 4 /CALL

Address (symbol)	Block (symbol)	Type	Language	Location	
⊟ MD 224	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 8	/L
				NW 9	/L
		W	LAD	NW 7	/CALL
⊟ MD 228	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 11	/L
				NW 12	/L
		W	LAD	NW 10	/CALL
⊟ MD 232	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 20	/L
				NW 21	/L
				NW 22	/L
		W	LAD	NW 19	/CALL
MD 236	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 19	/L
MD 240	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 17	/L
⊟ MD 244	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 5	/L
				NW 6	/L
		W	LAD	NW 4	/CALL
MD 250	FC1 (Opn_skid_scrubber)	W	LAD	NW 6	/T
MD 254	FC1 (Opn_skid_scrubber)	W	LAD	NW 11	/T
MD 258	FC1 (Opn_skid_scrubber)	W	LAD	NW 16	/T
⊟ MD 262	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 11	/L
				NW 12	/L
		W	LAD	NW 10	/CALL
MD 268	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 6	/T
MD 272	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 9	/T
MD 276	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 12	/T
MD 280	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 15	/T
MD 284	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 18	/T
MD 288	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 24	/T
MD 292	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 3	/T
MD 296	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 6	/T
MD 300	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 9	/T
MD 304	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 12	/T
MD 308	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 15	/T
MD 312	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 21	/T
MD 316	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 3	/T
MD 320	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 6	/T
MD 324	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 9	/T
MD 328	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 12	/T
MD 332	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 15	/T
MD 336	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 21	/T
MD 340	FC5 (Opn_Sep_Filter)	W	LAD	NW 3	/T
MD 344	FC5 (Opn_Sep_Filter)	W	LAD	NW 7	/T
MW 70	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 1	/CALL
MW 72	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 4	/CALL
MW 74	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 7	/CALL
MW 76	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 10	/CALL
MW 78	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 13	/CALL
MW 80	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 16	/CALL
MW 82	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 22	/CALL
MW 92	FC1 (Opn_skid_scrubber)	W	LAD	NW 9	/CALL

Address (symbol)	Block (symbol)	Type	Language	Location	
MW 94	FC1 (Opn_skid_scrubber)	W	LAD	NW 14	/CALL
MW 96	FC1 (Opn_skid_scrubber)	W	LAD	NW 17	/CALL
MW 100	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 1	/CALL
MW 102	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 4	/CALL
MW 104	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 7	/CALL
MW 106	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 10	/CALL
MW 108	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 13	/CALL
MW 110	FC3 (Opn_Stage_2_Compr)	W	LAD	NW 19	/CALL
MW 120	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 1	/CALL
MW 122	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 4	/CALL
MW 124	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 7	/CALL
MW 126	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 10	/CALL
MW 128	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 13	/CALL
MW 130	FC4 (Opn_Stage_3_Compr)	W	LAD	NW 19	/CALL
MW 140	FC5 (Opn_Sep_Filter)	W	LAD	NW 1	/CALL
MW 142	FC5 (Opn_Sep_Filter)	W	LAD	NW 5	/CALL
MW 144	FC1 (Opn_skid_scrubber)	W	LAD	NW 4	/CALL
PIW 288	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 1	/CALL
PIW 290	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 4	/CALL
PIW 292	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 7	/CALL
PIW 294	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 10	/CALL
PIW 296	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 13	/CALL
PIW 298	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 16	/CALL
PIW 300	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 22	/CALL
PIW 310	FC1 (Opn_skid_scrubber)	R	LAD	NW 9	/CALL
PIW 312	FC1 (Opn_skid_scrubber)	R	LAD	NW 14	/CALL
PIW 314	FC1 (Opn_skid_scrubber)	R	LAD	NW 17	/CALL
PIW 316	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 1	/CALL
PIW 318	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 4	/CALL
PIW 320	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 7	/CALL
PIW 322	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 10	/CALL
PIW 324	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 13	/CALL
PIW 326	FC3 (Opn_Stage_2_Compr)	R	LAD	NW 19	/CALL
PIW 332	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 1	/CALL
PIW 334	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 4	/CALL
PIW 336	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 7	/CALL
PIW 338	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 10	/CALL
PIW 340	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 13	/CALL
PIW 342	FC4 (Opn_Stage_3_Compr)	R	LAD	NW 19	/CALL
PIW 348	FC5 (Opn_Sep_Filter)	R	LAD	NW 1	/CALL
PIW 350	FC5 (Opn_Sep_Filter)	R	LAD	NW 5	/CALL
PIW 352	FC1 (Opn_skid_scrubber)	R	LAD	NW 4	/CALL
Q 4.0 (START_CPMR1)	FC1 (Opn_skid_scrubber)	W	LAD	NW 8	/=
Q 4.1 (PRV_AFTER_CMPR1)	FC2 (Opn_Stage_1_Compr)	W	LAD	NW 21	/=
⊟ Q 4.2 (START_INTCOOLER)	FC2 (Opn_Stage_1_Compr)	R	LAD	NW 27	/AN
		W	LAD	NW 26	/=
Q 4.3 (pneu_ball_valve)	FC1 (Opn_skid_scrubber)	W	LAD	NW 3	/=
Q 4.4 (PRV_SCRUB)	FC1 (Opn_skid_scrubber)	W	LAD	NW 13	/=
Q 4.5 (PRV_BT_SCRUB_CMPR)	FC1 (Opn_skid_scrubber)	W	LAD	NW 20	/=

ddress (symbol)	Block (symbol)	Type	Language	Location		
Q 4.6 (STRT_CMPR2)	FC1 (Opn_skid_scrubber)	W	LAD	NW	8	/=
Q 4.7 (STRT_CMPR3)	FC1 (Opn_skid_scrubber)	W	LAD	NW	8	/=
Q 5.0 (PRV_AFT_CMPR2)	FC3 (Opn_Stage_2_Compr)	W	LAD	NW	18	/=
∃ Q 5.1 (STRT_INTER_COOLER)	FC3 (Opn_Stage_2_Compr)	R	LAD	NW	24	/AN
		W	LAD	NW	23	/=
Q 5.2 (PRV_AFT_CMPR3)	FC4 (Opn_Stage_3_Compr)	W	LAD	NW	17	/=
Q 5.4 (OPEN_BALL_VALVE)	FC5 (Opn_Sep_Filter)	W	LAD	NW	4	/=
Q 5.5 (PNEU_BALL_VALVE_AFT_FILT)	FC1 (Opn_skid_scrubber)	W	LAD	NW	3	/=
Q 5.6 (PNEU_BALL_VALVE_AF_CMPR2)	FC1 (Opn_skid_scrubber)	W	LAD	NW	3	/=
Q 5.7 (PNEU_BALL_AFT_CMPR3)	FC1 (Opn_skid_scrubber)	W	LAD	NW	3	/=
∃ Q 6.0 (BALL_VALVE_I/P)	FC1 (Opn_skid_scrubber)	R	LAD	NW	2	/AN
		W	LAD	NW	1	/=
Q 6.1 (PRV_AFT-CMPR3)	FC4 (Opn_Stage_3_Compr)	W	LAD	NW	18	/=
Q 6.2 (ALARM_INTERCOOLER1)	FC2 (Opn_Stage_1_Compr)	W	LAD	NW	27	/=
Q 6.3 (ALARM_INTERCOOLER)	FC3 (Opn_Stage_2_Compr)	W	LAD	NW	24	/=
∃ Q 6.4 (START_AFTERCOOLER)	FC4 (Opn_Stage_3_Compr)	R	LAD	NW	24	/AN
		W	LAD	NW	23	/=
Q 6.5 (ALARM_AFTERCOOLER)	FC4 (Opn_Stage_3_Compr)	W	LAD	NW	24	/=
Q 7.6	FC1 (Opn_skid_scrubber)	R	LAD	NW	8	/A
∃ T 1 (time_based)	FC1 (Opn_skid_scrubber)	R	LAD	NW	2	/A
		W	LAD	NW	2	/R
				NW	2	/SD
∃ T 2	FC1 (Opn_skid_scrubber)	R	LAD	NW	3	/A
		W	LAD	NW	3	/SD

Inputs, outputs, bit memory

	7	6	5	4	3	2	1	0	B W D
IB 0									
QB 4	X	X	X	X	X	X	X	X	
QB 5	X	X	X	X		X	X	X	
QB 6			X	X	X	X	X	X	
QB 7		X							
MB 5			X	X	X		X	X	
MB 6								X	
MB 7							X	X	
MB 8			X	X	X	X	X	X	
MB 9			X	X	X	X	X	X	
MB 10			X	X	X	X	X	X	
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Timers, counters

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T0-9		T1	T2							
C0-9										

Unused symbols

Symbol	Address		Data type	Comment
SET-PT_PR_AFT_CMPR3	MD	138	DWORD	SET PT FOR PR AFTER CMPR3 IS 280
SET_PT_PR_AFT_CMPR2	MD	102	DWORD	SET PT FOR PRV ATFER CMPR2 IS 141
SET_PT_TEMP_AFT_CMPR2	MD	108	DWORD	SET PT FOR TEMP AFTER CMPR2 IS 108
SET_PT_TEMP_AFT_CMPR3	MD	142	DWORD	SET PT FOR TEMP AFTER CMPR3 IS 108
SET_PT_TEMP_CMPR2	MD	106	DWORD	SET PT FOR TEMP AFTER CMPR2 IS 108
SET_SHUT_DOWN	MD	68	DWORD	SET PT FOR SHUT DOWNING THE INPUT
SET_SHUT_DOWN_INPUT	MD	100	DWORD	SET PT FOR SHUT DOWNING IN-PUT TO THE PLANT
SET_TEMP_CMPR2	MD	144	DWORD	SET POINT FOR TEMP AFTER CMPR2 IS 108
STRT_AFT_COOLER	Q	5.3	BOOL	STARTING OF AFTER COOLER
ball_valve	I	0.1	BOOL	opened when gas enters into the pipe line

Addresses without symbol

Address		Number
M	5.0	2
M	5.1	3
M	5.5	2
M	6.0	2
M	7.0	1
M	7.1	5
M	8.0	1
M	8.1	1
M	8.2	2
M	8.3	1
M	8.4	1
M	8.5	1
M	9.0	1
M	9.1	2
M	9.2	2
M	9.3	2
M	9.4	1
M	9.5	1
M	10.3	2
M	10.4	1
M	10.5	1
M	11.0	1
M	11.1	1
M	11.2	2
M	11.3	1
M	14.0	1
MD	16	3
MD	20	2
MD	28	5
MD	36	4
MD	48	4
MD	56	3
MD	60	4
MD	86	5
MD	114	3
MD	132	5
MD	146	5
MD	150	3
MD	154	2
MD	160	1
MD	164	4
MD	172	3
MD	176	4
MD	180	4
MD	188	1
MD	192	1
MD	196	1

Address		Number
MD	200	3
MD	204	1
MD	208	1
MD	212	1
MD	216	3
MD	220	3
MD	224	3
MD	228	3
MD	232	4
MD	236	1
MD	240	1
MD	244	3
MD	250	1
MD	254	1
MD	258	1
MD	262	3
MD	268	1
MD	272	1
MD	276	1
MD	280	1
MD	284	1
MD	288	1
MD	292	1
MD	296	1
MD	300	1
MD	304	1
MD	308	1
MD	312	1
MD	316	1
MD	320	1
MD	324	1
MD	328	1
MD	332	1
MD	336	1
MD	340	1
MD	344	1
MW	70	1
MW	72	1
MW	74	1
MW	76	1
MW	78	1
MW	80	1
MW	82	1
MW	92	1
MW	94	1
MW	96	1
MW	100	1
MW	102	1
MW	104	1

Address		Number
MW	106	1
MW	108	1
MW	110	1
MW	120	1
MW	122	1
MW	124	1
MW	126	1
MW	128	1
MW	130	1
MW	140	1
MW	142	1
MW	144	1
PIW	288	1
PIW	290	1
PIW	292	1
PIW	294	1
PIW	296	1
PIW	298	1
PIW	300	1
PIW	310	1
PIW	312	1
PIW	314	1
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PIW	320	1
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PIW	332	1
PIW	334	1
PIW	336	1
PIW	338	1
PIW	340	1
PIW	342	1
IW	348	1
IW	350	1
IW	352	1
	7.6	1
	2	2

OB1 - <offline>

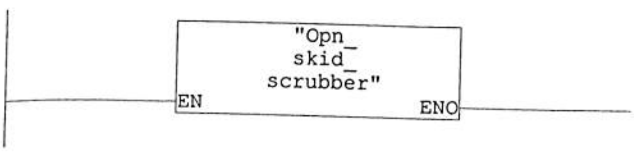
""

Name: **Family:**
Author: **Version:** 0.1
Block version: 2
Time stamp Code: 4/5/2007 3:02:40 PMPM
Interface: 2/15/1996 4:51:12 PMPM
Lengths (block/logic/data): 00220 00082 00022

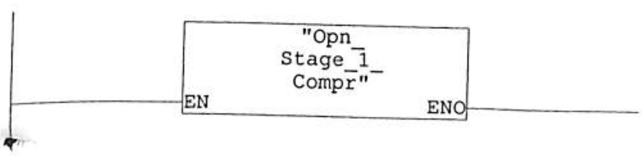
Name	Data Type	Address	Comment
TEMP		0.0	
OB1_EV_CLASS	Byte	0.0	Bits 0-3 = 1 (Coming event), Bits 4-7 = 1 (Event class 1)
OB1_SCAN_1	Byte	1.0	1 (Cold restart scan 1 of OB 1), 3 (Scan 2-n of OB 1)
OB1_PRIORITY	Byte	2.0	Priority of OB Execution
OB1_OB_NUMBR	Byte	3.0	1 (Organization block 1, OB1)
OB1_RESERVED_1	Byte	4.0	Reserved for system
OB1_RESERVED_2	Byte	5.0	Reserved for system
OB1_PREV_CYCLE	Int	6.0	Cycle time of previous OB1 scan (milliseconds)
OB1_MIN_CYCLE	Int	8.0	Minimum cycle time of OB1 (milliseconds)
OB1_MAX_CYCLE	Int	10.0	Maximum cycle time of OB1 (milliseconds)
OB1_DATE_TIME	Date_And_Time	12.0	Date and time OB1 started

Block: OB1 "Main Program Sweep (Cycle)"

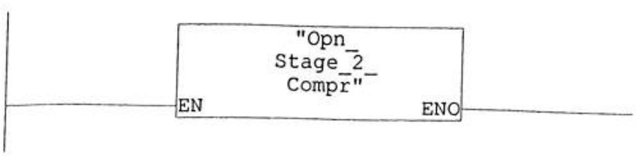
Network: 1



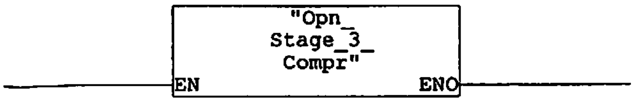
Network: 2



Network: 3



Network: 4



Network: 5

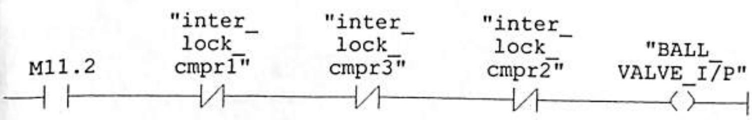
'C1 - <offline>

Opn_skid_scrubber" OPERATION OF SKID AND SCRUBBER
ame: **Family:**
uthor: **Version:** 0.1
Block version: 2
ime stamp Code: 4/5/2007 4:30:45 PMPM
Interface: 4/2/2007 3:16:29 PMPM
engths (block/logic/data): 00596 00466 00010

Name	Data Type	Address	Comment
IN		0.0	
OUT		0.0	
IN_OUT		0.0	
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

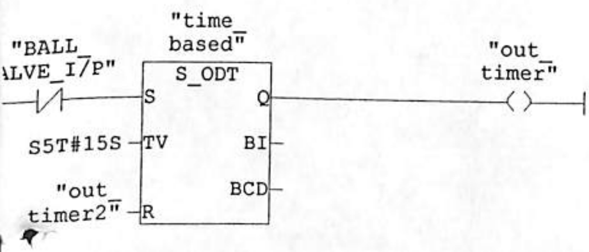
lock: FC1 OPERATION OF SKID AND SCRUBBER

et.ork: 1 PNEUMATIC BALLVALVE AFTER CMPR2 FOR DRAIN



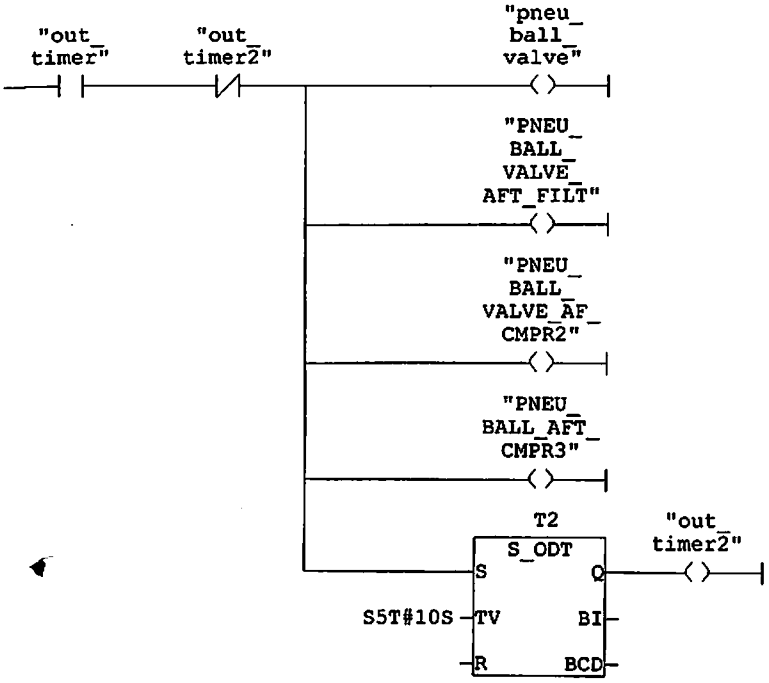
:twork: 2 times based drain system

en all the inter lock are closed and ball valve is closed(when the gas inters
to the ball valve it should open and the gas flows through the filter and
HE
MER GETS ACTIVATED".



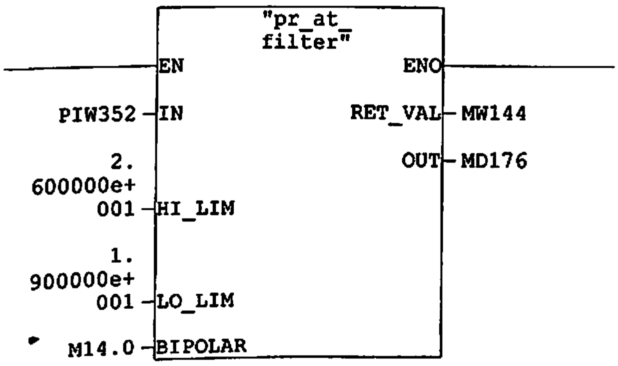
etwork: 3 it will open after every 15 sec

FTER 15S THE TIMER1 IS HIGH AND THE MEMORY BIT M5.3 WILL BE HIGH AND THE
IMER2
TARTS COUNTING AND AT THE SAME TIME;THE OUT PNEUMATIC BALL VALVE IS HIGH.



etwork: 4

HIS SCALE IS MENT FOR MONITORING PRESSURE AT FILTER AND IT IS STORED AT MD176
FTER SCALING.

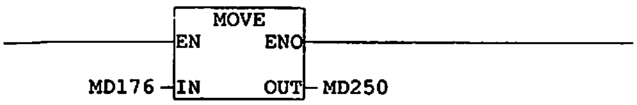


etwork: 5

```
L      MD   176
T      DB10.DBD     0
```

Network: 6

MOVING THE PRESSURE O/P FROM MD 176 TO MD 180



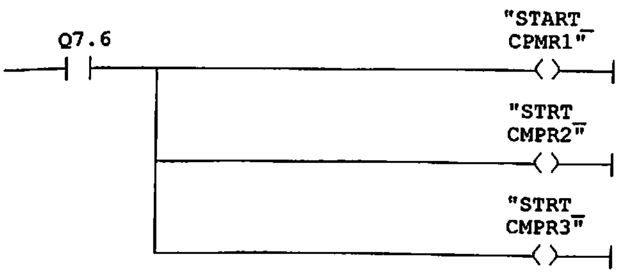
Network: 7

COMAPRING THE MONITORED PRESSURE TO THE ORIGINAL PRESSURE AND O/P IS STORED AT M11.2 MEMORY BIT

```
      L     MD   176
      L     "SET_PT_PR_FILTER1"
      >R
      =     M     11.2
```

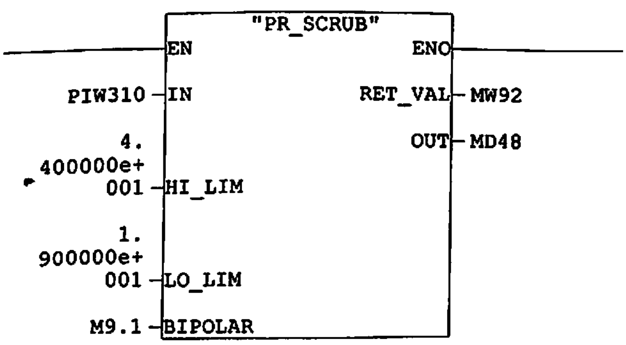
Network: 8 FOR STARTING OF CMPR1

THIS BALL VALVE I/P IS ACTIVBATED WHEN 19KG/SQ.CM IS HIGH THAN SET PT 5KG/SQ.CM,
WHEN IT
IS ACTIVATED ALL THE COPRESSORS WILL START.



Network: 9

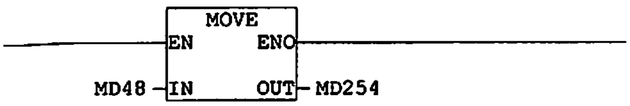
PRESSURE MONITORING AT SRUBBER



Network: 10

```
L     MD     48
T     DB10.DBD     4
```

Network: 11



Network: 12

COMAPRING THE MONITORED PRESSUE WITH THE SET PT AT SCRUBBER, IF IT IS HIGHER THAN THE SET PT

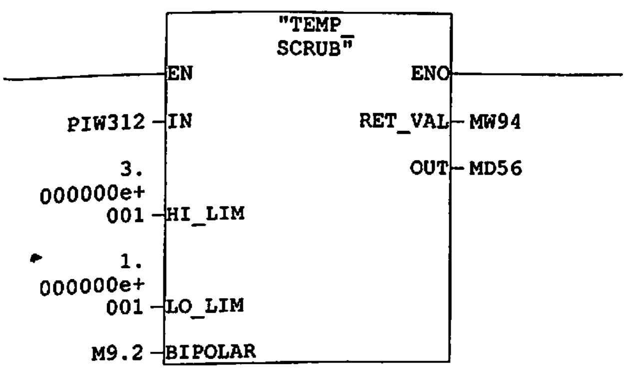
```
L     "SET_PT_SCRUB"
L     MD     48
>R
=     M      5.5
```

Network: 13

IT SHOULD OPEN THE PRESSURE RELIEF VALVE AT THE SCRUBBER.

Network: 14

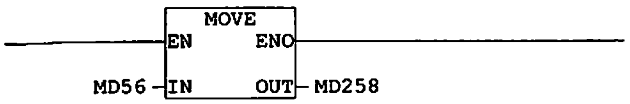
TEMPERATUR MONITORING AT THE SCRUBBER.



Network: 15

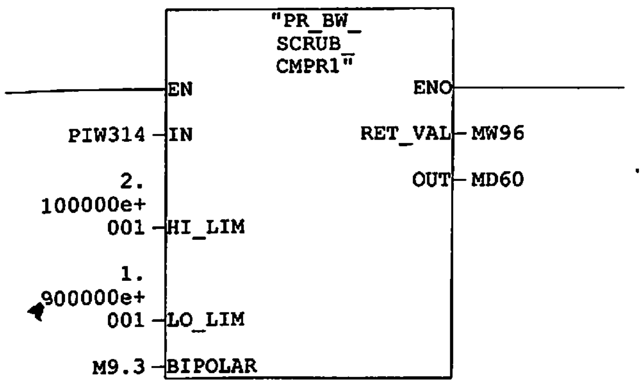
```
L     MD     56
T     DB10.DBD     8
```

Network: 16



Network: 17

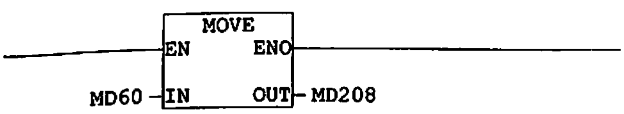
PRESSURE MONITORING BETWEEN THE SCRUBBER AND COMPRESSOR 1



Network: 18

```
L      MD      60
T      DB10.DBD    12
```

Network: 19



Network: 20

IF THE PRESSURE IS HIGHER THAN THE SET PT BETWEEN THE SCRUBBER N COMPRESSOR 1
THEN THE PRESSURE RELIEF VALVE SHOULD OPEN WHICH IS IN BETWEEN THE SCRUBBER N
COMPPRESSR1

```
L      "SET_PT_PR"
L      MD    60
>R
=      "PRV_BT_SCRUB_CMPR"
```

C2 - <offline>

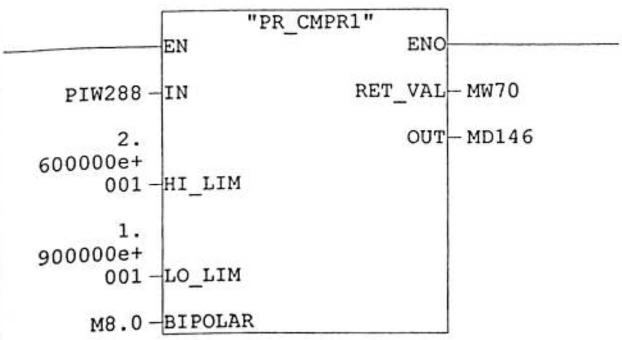
```
)pn_Stage_1_Compr"       OPERATION OF STAGE 1 COMPRESSOR
ame:                       Family:
ithor:                     Version: 0.1
                           Block version: 2
ime stamp Code:            4/5/2007 4:13:39 PMPM
          Interface:       3/28/2007 3:39:48 PMPM
engths (block/logic/data): 00784  00640  00010
```

Name	Data Type	Address	Comment
IN		0.0	
OUT		0.0	
IN_OUT		0.0	
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

lock: FC2 FUNCTIONING OF COMPRESSOR 1

Network: 1

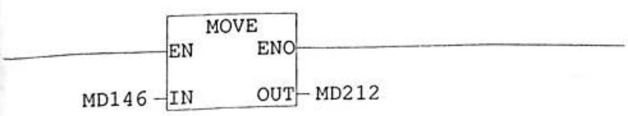
UCTION PRESSURE MONITORING AT COMPREESOR 1



Network: 2

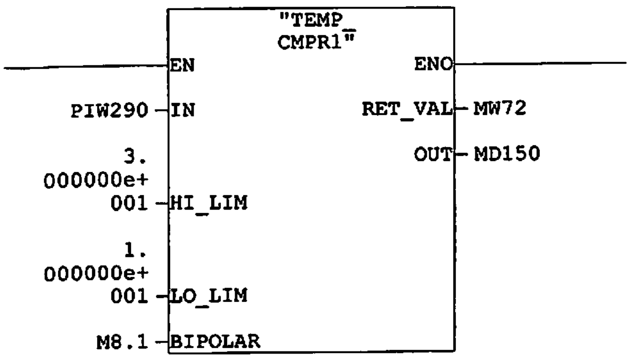
```
L      MD   146
T      DB10.DBD   16
```

Network: 3



Network: 4

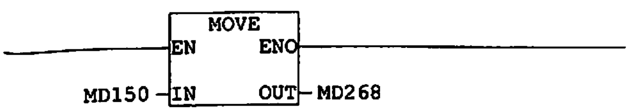
SUCTION TEMPERATURE MONITORING AT COMPREESOR 1



Network: 5

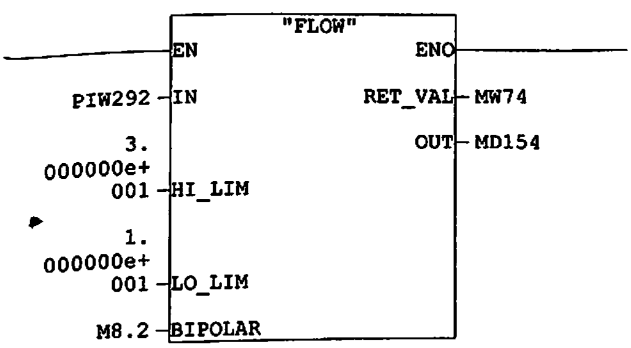
```
L     MD   150
T     DB10.DBD    20
```

Network: 6



Network: 7

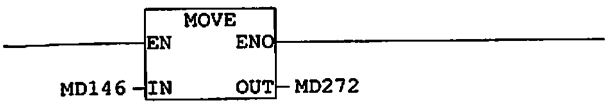
SUCTION FLOW MONITORING AT COMPREESOR 1



Network: 8

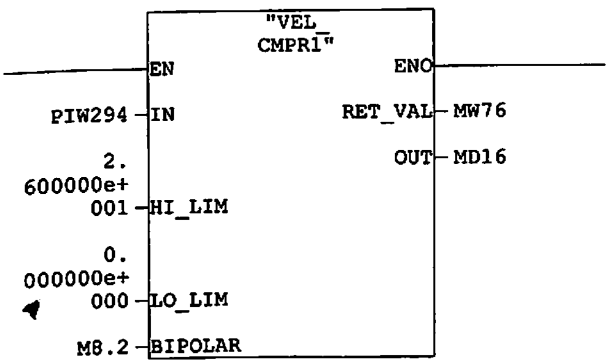
```
L     MD   154
T     DB10.DBD    24
```

twork: 9



:twork: 10

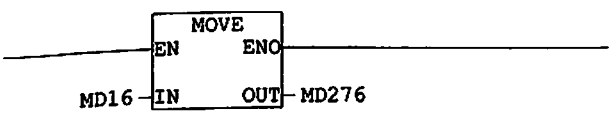
CTION VELOCITY MONITORING AT COMPREESOR 1



:twork: 11

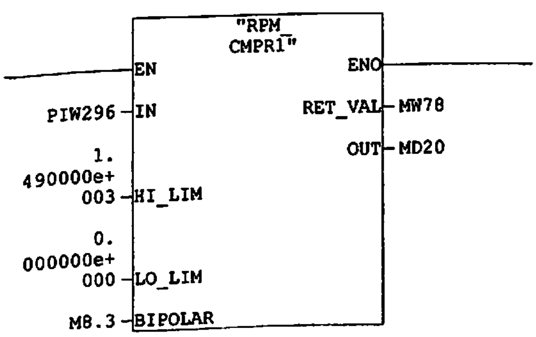
```
L      MD      16
T      DB10.DBD    28
```

:twork: 12



etwork: 13

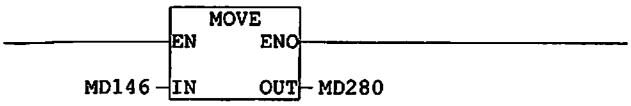
?M MONITORING AT COMPREESOR 1



Network: 14

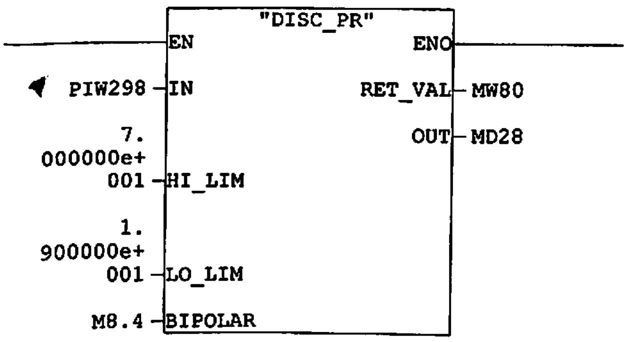
```
L      MD     20
T      DB10.DBD    32
```

Network: 15



Network: 16

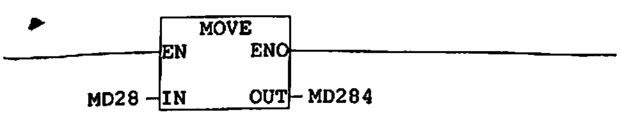
DISCHARGE PRESSURE MONITORING AT COMPREESOR 1



Network: 17

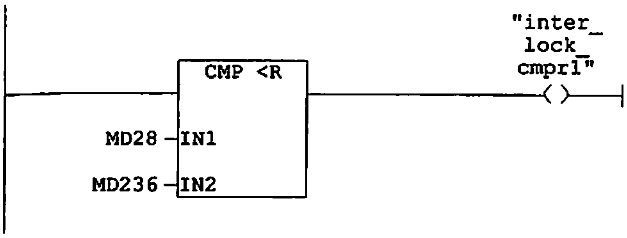
```
L      MD     28
T      DB10.DBD    36
```

Network: 18



Network: 19 inter lock for cmprl

COMPARING THE DISCHARGE PRESSURE WITH THE SET PT, IF THE DISCHARGE PRESSURE IS LESS THAN THE SET PRESSURE THE INTERLOCK FOR COMPRESSOR 1 IS HIGH. WHICH SHUT DOWNS THE BALLVALVE.

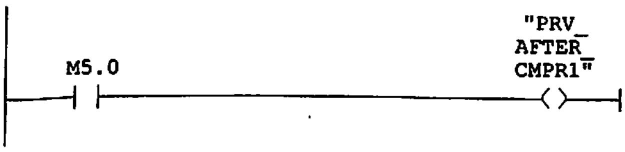


Network: 20

COMPARING THE DISCHARGE PRESSURE WITH THE SET PT PRSSURE IS 70KG/SQ.CM AT BEFORE INTER COOLER, IF IT IS HIGHER THAN SET PT PRESSURE THE PRV SHOULD OPEN AFTER COMPRESSOR 1.

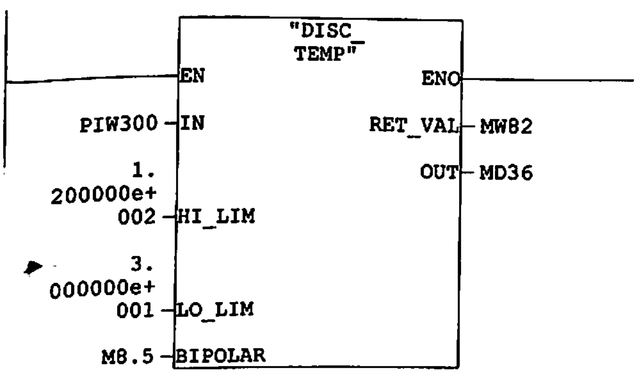
```
L     "SET_PT_DISC_PR"
L     MD    28
>R
=     M      5.0
```

Network: 21



Network: 22

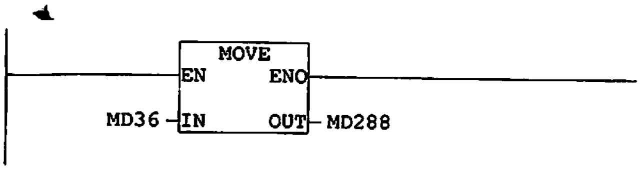
DISCHARGE TEMPERATURE MONITORING AT COMPRESSOR 1



Network: 23

```
L     MD     36
T     DB10.DBD    40
```

Network: 24



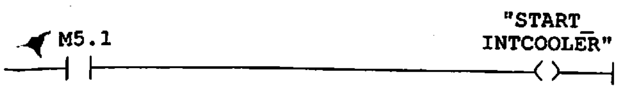
Network: 25

THE DISCHARGE TEMP IS COMPARED WITH THE SET PT TEMP AT DISCHARGE SIDE. WHEN THE LADDER IS TRUE THEN MEMORY BIT M5.1 IS HIGH+

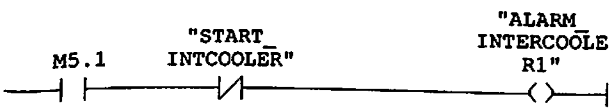
```
      L     "SET_PT_TEMP"
      L     MD    36
      >R
      =     M       5.1
```

Network: 26 STARTING OF INTERCOOLER

WHEN THE DISCHARGE TEMP IS HIGHER THAN THE SET PT TEMP THEN INTER COOLER STARTS.



Network: 27 IF INTER COOLER IS NOT ACTI VE THEN IT WILL GENERATE ALARM



FC3 - <offline>

"Opn_Stage_2_Compr" OPERATION OF STAGE 2 COMPRESSOR
Name: **Family:**
Author: **Version:** 0.1
Block version: 2
Time stamp Code: 4/5/2007 4:32:08 PMPM
Interface: 3/28/2007 3:39:48 PMPM
Lengths (block/logic/data): 00694 00556 00010

Name	Data Type	Address	Comment
IN		0.0	
OUT		0.0	
IN_OUT		0.0	
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Block: FC3 FUNCTIONING OF COMPRESSOR2

Network: 1

SUCTION PRESSURE MONITORING AT COMPREESOR 2

```
                   "PR_
                  COMPR2"
        -EN                   ENO-
PIW316  -IN               RET_VAL- MW100
                              OUT- MD216
6.
310000e+
001     -HI_LIM
6.
171000e+
001     -LO_LIM
M9.0    -BIPOLAR
```

Network: 2

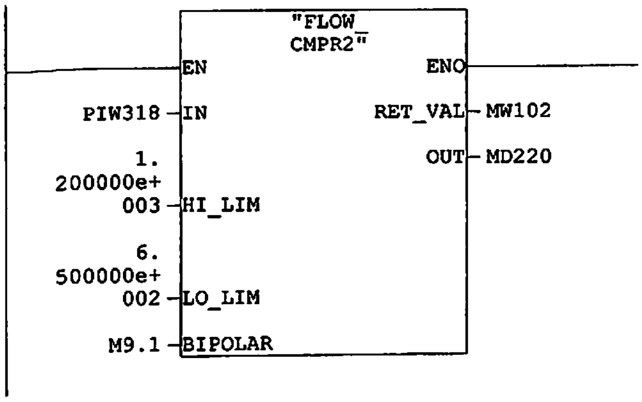
```
L    MD   216
T    DB20.DBD    0
```

Network: 3

```
          MOVE
        -EN   ENO-
MD216   -IN   OUT- MD292
```

Network: 4

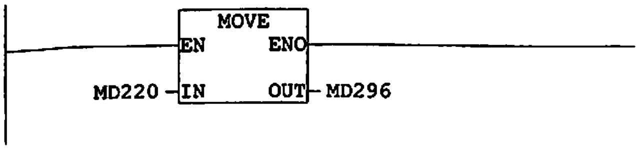
SUCTION FLOW MONITORING AT COMPREESOR 2



Network: 5

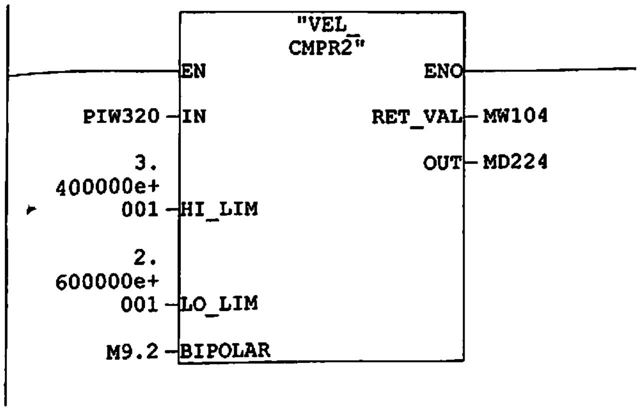
```
L     MD   220
T     DB20.DBD     4
```

Network: 6



Network: 7

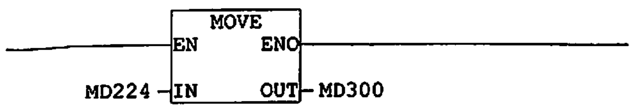
SUCTION VELOCITY MONITORING AT COMPREESOR 2



Network: 8

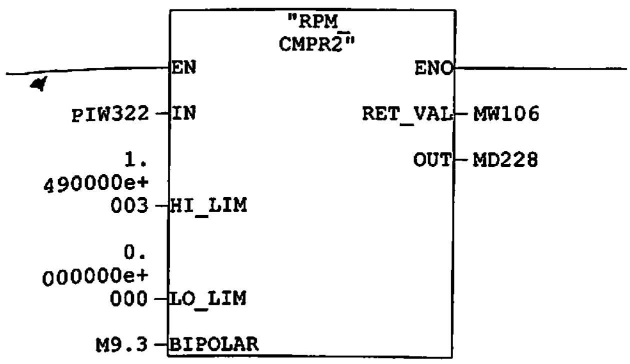
```
L      MD   224
T      DB20.DBD    8
```

Network: 9



Network: 10

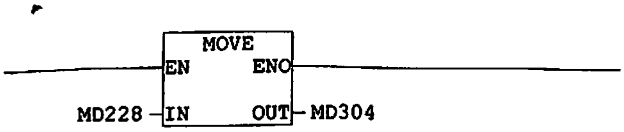
SUCTION RPM MONITORING AT COMPREESOR 2



Network: 11

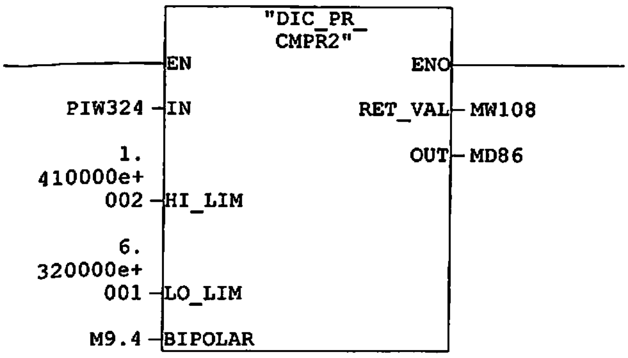
```
L      MD   228
T      DB20.DBD   12
```

Network: 12



Network: 13

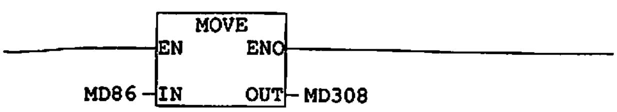
DISCHARGE PRESSURE MONITORING AT COMPREESOR 2



Network: 14

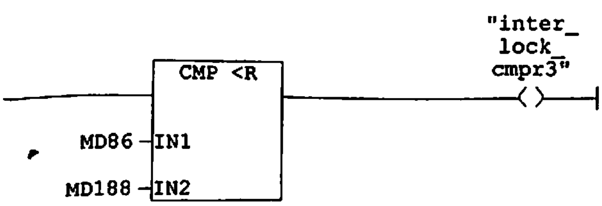
```
L     MD     86
T     DB20.DBD    16
```

etwork: 15



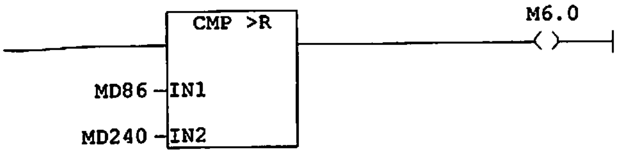
etwork: 16 inter lock for cmpr1

OMPARING THE DISCHARGE PRESSURE WITH THE SET PT, IF THE DISCHARGE PRESSURE IS
ESS THAN THE SET PRESSURE THE INTERLOCK FOR COMPRESSOR 2 IS HIGH. WHICH SHUT
OWNS THE BALLVALVE.



Network: 17

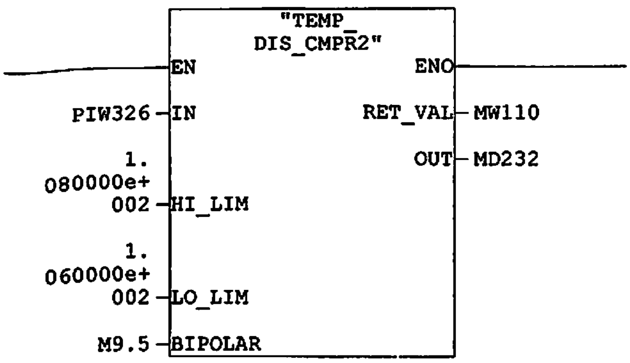
:OMPARING THE DISCHARGE PRESSURE WITH THE SET PT PRSSURE IS 141KG/SQ.CM AT
BEFORE INTER COOLER, IF IT IS HIGHER THAN SET PT PRESSURE THE PRV SHOULD OPEN
AFTER COMPRESSOR 2



Network: 18 OPENING OF PRV AFTER CMPR2

Network: 19

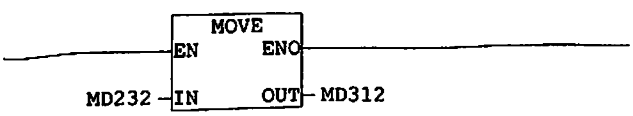
DISCHARGE TEMP MONITORING AT COMPREESOR 1



Network: 20

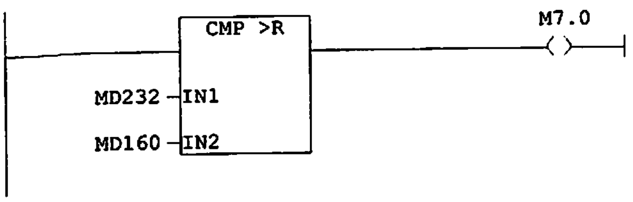
```
L      MD    232
T      DB20.DBD    20
```

Network: 21



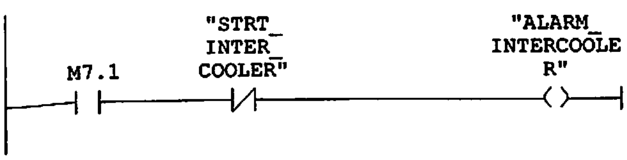
Network: 22 STARTING OF INTER COOLER AFTER CMPR2

WHEN THE DISCHARGE TEMP IS HIGHER THAN THE SET PT TEMP THEN INTER COOLER 2 STARTS.



Network: 23 STARTING OF INTER COOLER AFTER CMPR2

Network: 24 IF THE INTERCOOLER IS NOT ACTIVE THEN IT WILL GENERATE THE ALARM



FC4 - <offline>

```
"Opn_Stage_3_Compr"      OPERATION OF STAGE 3 COMPRESSOR
Name:                    Family:
Author:                  Version: 0.1
                         Block version: 2
Time stamp Code:         4/5/2007 4:16:16 PMPM
           Interface:    3/28/2007 3:39:48 PMPM
Lengths (block/logic/data): 00698  00560  00010
```

Name	Data Type	Address	Comment
IN		0.0	
OUT		0.0	
IN_OUT		0.0	
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Block: FC4 FUNCTIONING OF COMPRESSOR 3

Network: 1

SUCTION PRESSURE MONITORING AT COMPREESOR 3

```
             +---------------------+
             |     "SUC_PR_        |
             |      CMPR3"         |
  -----------|EN                ENO|-----------
             |                     |
     PIW332 -|IN           RET_VAL|- MW120
             |                     |
         1.  |                 OUT|- MD200
    410000e+ |                     |
        002 -|HI_LIM               |
             |                     |
         1.  |                     |
    266500e+ |                     |
        002 -|LO_LIM               |
             |                     |
    "inter_  |                     |
      lock_  |                     |
     cmpr1" -|BIPOLAR              |
             +---------------------+
```

Network: 2

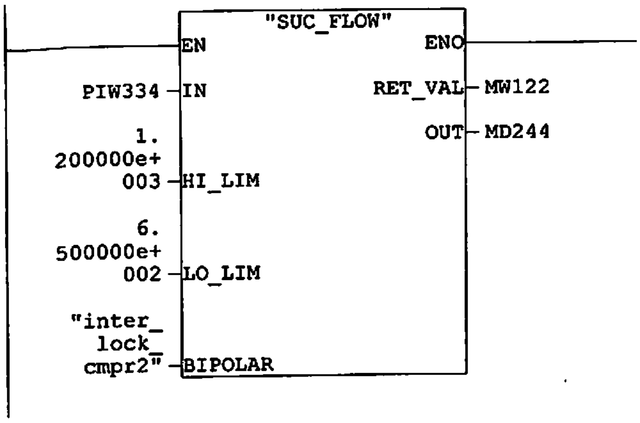
```
L      MD   200
T      DB30.DBD    0
```

Network: 3

```
             +------------+
             |    MOVE    |
  -----------|EN       ENO|-----------
             |            |
      MD200 -|IN       OUT|- MD316
             +------------+
```

Network: 4

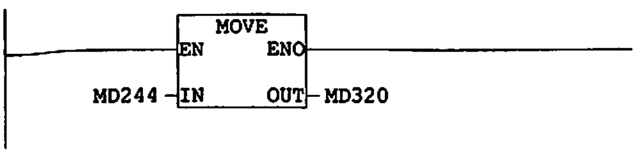
SUCTION FLOW MONITORING AT COMPREESOR 3



Network: 5

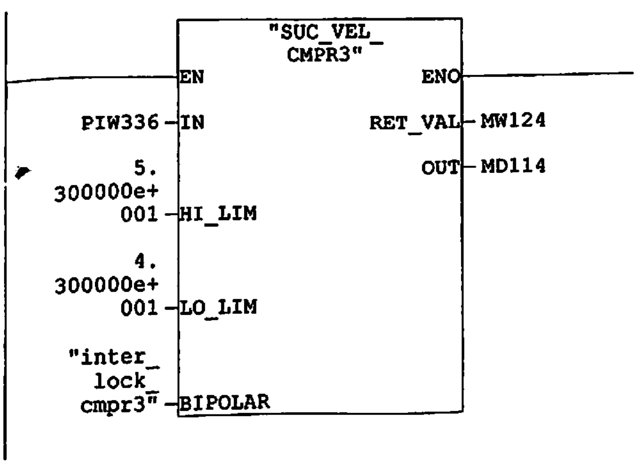
```
L      MD   244
T      DB30.DBD    4
```

Network: 6



Network: 7

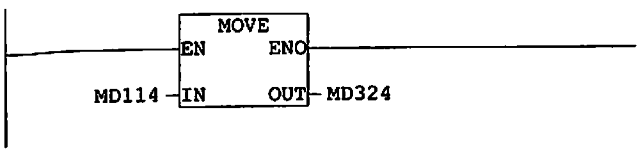
SUCTION VEL MONITORING AT COMPREESOR 3



Network: 8

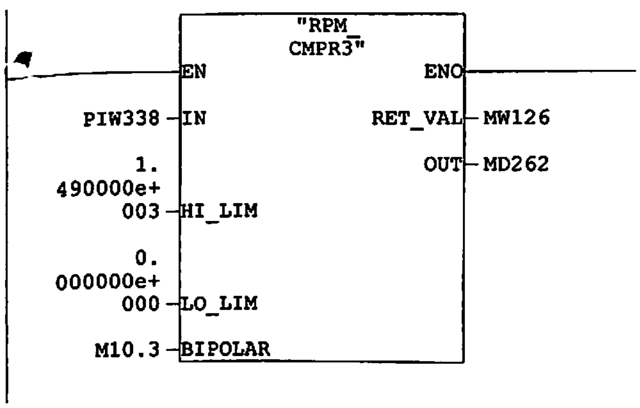
```
L     MD    114
T     DB30.DBD    8
```

Network: 9



Network: 10

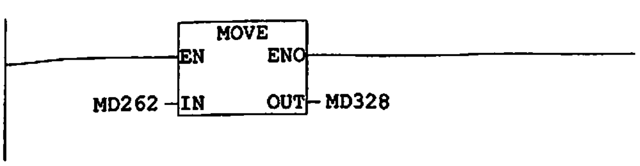
RPM MONITORING AT COMPREESOR 3



Network: 11

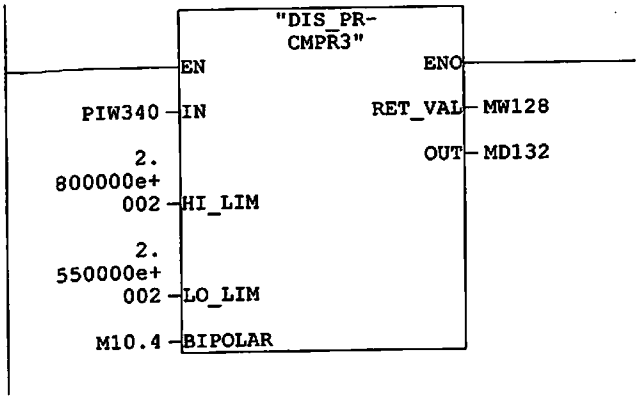
```
L     MD    262
T     DB30.DBD    12
```

Network: 12



Network: 13

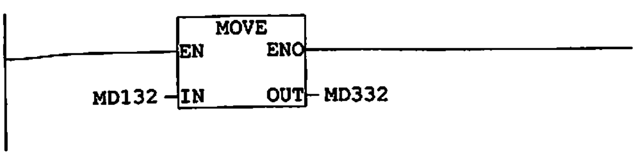
DISCHARGE PRESSURE MONITORING AT COMPREESOR 3



Network: 14

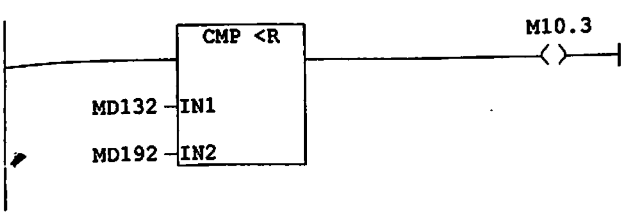
```
L    MD   132
T    DB30.DBD   16
```

Network: 15



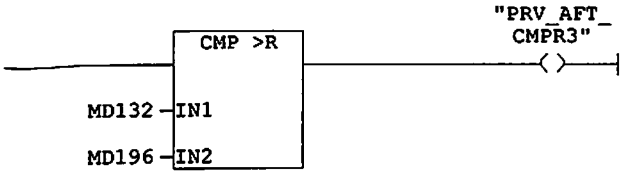
Network: 16 inter lock for cmpr3

COMPARING THE DISCHARGE PRESSURE WITH THE SET PT, IF THE DISCHARGE PRESSURE IS LESS THAN THE SET PRESSURE THE INTERLOCK FOR COMPRESSOR 2 IS HIGH. WHICH SHUT DOWNS THE BALLVALVE.

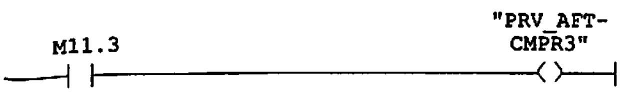


Network: 17 OPEINIG OF PRV AFTER CMPR3

COMPARING THE DISCHARGE PRESSURE WITH THE SET PT PRSSURE IS 280 KG/SQ.CM AT BEFORE INTER COOLER, IF IT IS HIGHER THAN SET PT PRESSURE THE PRV SHOULD OPEN AFTER COMPRESSOR 3

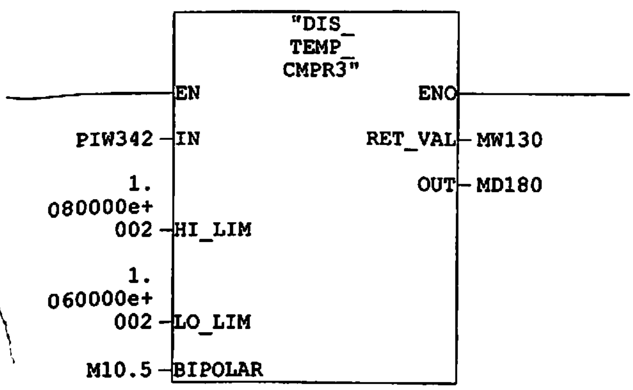


Network: 18 OPENING OF PRV AFTER CMPR2



Network: 19

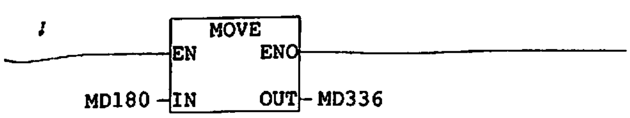
DISCHARGE TEMPERATURE MONITORING AT COMPRESSOR3



Network: 20

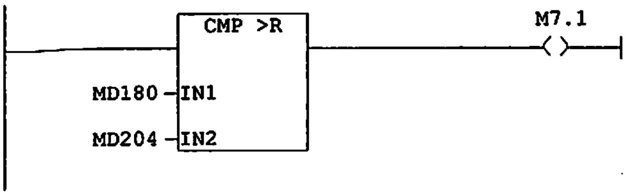
```
L      MD    180
T      DB30.DBD    20
```

Network: 21

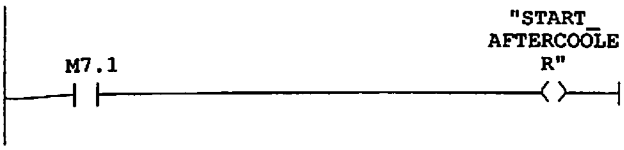


Network: 22 STARTING OF AFTER COOLER

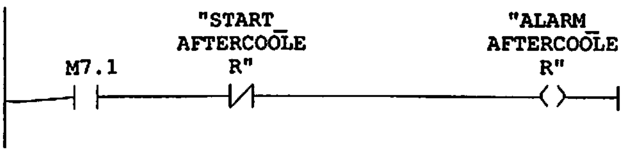
WHEN THE DISCHARGE TEMP IS HIGHER THAN THE SET PT TEMP THEN AFTER COOLER STARTS.



Network: 23 STARTING OF AFTER COOLER



Network: 24 IF THE AFTER COOLER IS NOT WORKING THEN THE ALARM IS GENERATED



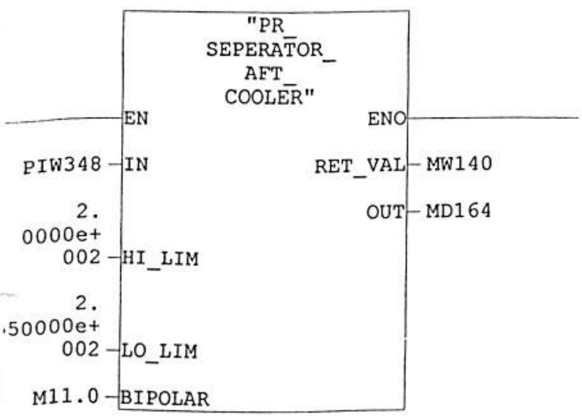
5 - <offline>

_Sep_Filter" OPERATION OF SEPERATOR AND FILTER
: **Family:**
or: **Version:** 0.1
Block version: 2
stamp Code: 4/5/2007 4:33:56 PMPM
Interface: 3/30/2007 4:32:36 PMPM
ths (block/logic/data): 00286 00182 00010

me	Data Type	Address	Comment
N		0.0	
UT		0.0	
N_OUT		0.0	
EMP		0.0	
ETURN		0.0	
RET_VAL		0.0	

k: FC5 FUNCTIONING OF SEPERATOR

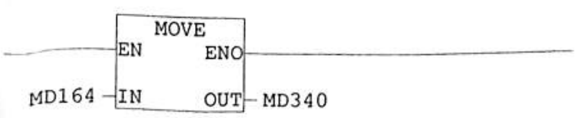
ork: 1



ork: 2

```
L      MD   164
T      DB40.DBD    0
```

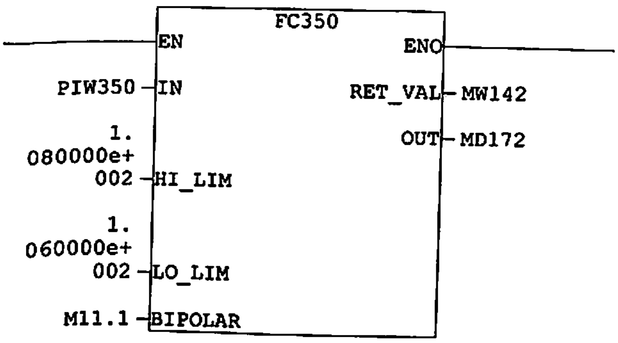
ork: 3



Network: 4 OPENING OF BALL VALVE

```
L      MD    164
L      MD    168
>=R
=      Q       5.4
```

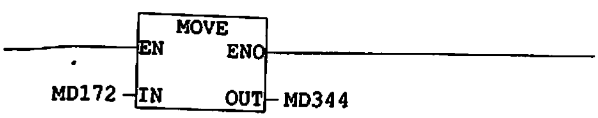
Network: 5



Network: 6

```
L      MD    172
T      DB40.DBD     4
```

Network: 7



DB10 - <offline> - Declaration view

""
Global data block DB 10
Name: Family:
Author: Version: 0.1
Block version: 2
Time stamp Code: 4/5/2007 4:04:15 PMPM
Interface: 4/5/2007 4:04:15 PMPM
Lengths (block/logic/data): 00154 00044 00000

Block: DB10

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	press_filter	REAL	0.000000e+000	
+4.0	Temp_filter	REAL	0.000000e+000	
+8.0	press_scrubber	REAL	0.000000e+000	
+12.0	Temp_scrubber	REAL	0.000000e+000	
+16.0	PRESS_CMPR1	REAL	0.000000e+000	
+20.0	TEMP_CMPR1	REAL	0.000000e+000	
+24.0	FLOW_CMPR1	REAL	0.000000e+000	
+28.0	VEL_CMPR1	REAL	0.000000e+000	
+32.0	RPM_CMPR1	REAL	0.000000e+000	
+36.0	DISC_PRESS_CMPR1	REAL	0.000000e+000	
+40.0	DISC_TEMP_CMPR1	REAL	0.000000e+000	
=44.0		END_STRUCT		

320 - <offline> - Declaration view

obal data block DB 20
me: Family:
thor: Version: 0.1
Block version: 2
me stamp Code: 4/5/2007 4:23:24 PMPM
Interface: 4/5/2007 4:23:24 PMPM
ngths (block/logic/data): 00124 00024 00000

.ock: DB20

ddress	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	PR_CMPR2	REAL	0.000000e+000	
+4.0	FLOW_CMPR2	REAL	0.000000e+000	
+8.0	VEL_CMPR2	REAL	0.000000e+000	
+12.0	RPM_CMPR2	REAL	0.000000e+000	
+16.0	DIS_PR_CMPR2	REAL	0.000000e+000	
+20.0	DIS_TEMP_CMPR2	REAL	0.000000e+000	
24.0		END_STRUCT		

B30 - <offline> - Declaration view

"
lobal data block DB 30
ame: Family:
uthor: Version: 0.1
Block version: 2
ime stamp Code: 4/5/2007 4:26:05 PMPM
Interface: 4/5/2007 4:26:05 PMPM
engths (block/logic/data): 00124 00024 00000

lock: DB30

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	PR_CMPR3	REAL	0.000000e+000	
+4.0	FLOW_CMPR3	REAL	0.000000e+000	
+8.0	VEL_CMPR3	REAL	0.000000e+000	
+12.0	RPM_CMPR3	REAL	0.000000e+000	
+16.0	DIS_PR_CMPR3	REAL	0.000000e+000	
+20.0	DIS_TEMP_CMPR3	REAL	0.000000e+000	
=24.0		END_STRUCT		

B30 - <offline> - Declaration view

"
lobal data block DB 30
ame: Family:
uthor: Version: 0.1
Block version: 2
ime stamp Code: 4/5/2007 4:26:05 PMPM
Interface: 4/5/2007 4:26:05 PMPM
engths (block/logic/data): 00124 00024 00000

lock: DB30

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	PR_CMPR3	REAL	0.000000e+000	
+4.0	FLOW_CMPR3	REAL	0.000000e+000	
+8.0	VEL_CMPR3	REAL	0.000000e+000	
+12.0	RPM_CMPR3	REAL	0.000000e+000	
+16.0	DIS_PR_CMPR3	REAL	0.000000e+000	
+20.0	DIS_TEMP_CMPR3	REAL	0.000000e+000	
=24.0		END_STRUCT		

340 - <offline> - Declaration view

bal data block DB 40
Family:
thor: Version: 0.1
Block version: 2
n stamp Code: 4/5/2007 4:27:19 PMPM
Interface: 4/5/2007 4:27:19 PMPM
ngths (block/logic/data): 00100 00008 00000

.o. c: DB40

ddress	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	PR_SEPERATOR	REAL	0.000000e+000	
+4.0	TEMP_SEPERATOR	REAL	0.000000e+000	
8.0		END_STRUCT		

8.0 CONCLUSION

Using Siemens S7-300 PLC, and with the Step-7 language and SIMATIC Manager, the Software Program is developed for an Automation of a Gas Compressor Station is efficiently tested for errors. It is error free and can be applied successfully in Gas Compressor Station. This automation program provides the safe, accurate and efficient process for Gas compression station. This automation process provides less human intervention, thus it provides error free process with accuracy in less period of time. This software program can be modified easily with up gradation in the process.

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   -S7-300 Programmable Controller Hardware Installations, Edition 2, 10/99