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SAMSUNG ENGINEERING CO., LTD.

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1. INTRODUCTION

1.1 Compressed air systems for process plants supply dry air for instruments and plant or maintenance air for miscellaneous uses such as driving air-powered tools, winches and hoists, soot blowing, steam and air decoking of furnace tubes, catalyst regeneration, starter motors for diesel engines and gas turbines, pneumatic conveying, etc.

Less common uses of plant air may include stripping (eg. removal of water haze from gas-oil and kerosine) and tank blanketing.

1.2 It is usual in modern plants to provide dry, oil-free instrument air from a central compression and drying location and distribute the conditioned air through piping and pressure regulating stations to the various plant instruments. An emergency or back-up supply is frequently considered essential.

1.3 Plant or maintenance air may be distributed from a central location or may be provided local to the users from mobile or permanently installed compressors. The choice of installation depends on economic factors, clients preference and the main uses of plant air.

For use at all motors, for pneumatic conveying, stripping and tank blanketing the air should be dry; some applications will require the air to be oil-free, while others, eg. at motors, the presence of some oil is of no consequence.

2. INSTRUMENT AIR

2.1 GENERAL

This section describes the basic requirements to ensure a reliable supply of high quality instrument air. For the layout of a typical instrument air supply system see Figure 1.

2.2 QUALITY

- (1) Instrument air should be dust-free, oil-free and dry.
- (2) The dew-point of the air leaving the drier should always be at least 10 °C lower than the minimum ambient temperature.
- (3) The pressure at the air receiver should normally be about 115 psig and the instrument air distribution system should have a minimum pressure of 100 psig at the end of the piping.

This will allow an adequate pressure drop of about 5-7 psi across the air drier and associated inlet and outlet filters and 7-10 psi across the metering facilities and distribution piping.

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2.3 QUANTITY

The required quantity of instrument air should be estimated as accurately as possible at the engineering stage. The consumption for instruments should be based on figures supplied by the manufacturers. As a guide it is usual to allow 0.5 scf/min per instrument pilot in process units and offsite areas. In addition, other users of instrument air should be considered, eg: purging of housings for on-line process stream analyzers, pneumatically operated logic systems, etc. To the total consumption thus obtained should be added 30% to cater for uncertainties in basic figures, extra consumption during plant upsets and expansion in instrumentation.

This total figure should form the design basis for the instrument air compressors.

2.4 INSTRUMENT AIR SUPPLY EQUIPMENT

The instrument air supply plant should consist of:

- (1) A compressor set for normal operation.
- (2) Adequate stand-by for normal operation.
- (3) An instrument air receiver.
- (4) An air drier.
- (5) Flow metering instrumentation.
- (6) Interconnecting piping.

All equipment and piping should be arranged so that each piece of equipment can be taken out of service without interrupting the air supply.

In addition, emergency air supply facilities should be considered, for example:

- (1) An automatic starting, independent air compressor to supply the utility section (boiler plant and power generation) and/or the process instrumentation essential for process safety.
- (2) Tie-in with process air system, if present and suitable.
- (3) Tie-in with nitrogen system, if present.
- (4) Tie-in with maintenance or plant air supply system if the air is oil-free and dry.
- (5) Connections for mobile compressors.
- (6) Local, on plant compressors, which start automatically on falling mains air pressure.

When the project includes boilers and/or electric power generating plant, the instrument air for the utilities should, in emergency conditions and during plant start-up, be supplied by a separate, automatically starting, independent, diesel driven compressor, an air receiver and a drier.

With the exceptions described under (2),(3) and (4) above, the instrument air system should be independent and separate from other systems.

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2.5 INSTRUMENT AIR COMPRESSORS

The compressors should be of an oil-free type.

The compressors may be of reciprocating, centrifugal or rotary (positive displacement) type, determined mainly by the capacity required and economic factors.

The compressor set should consist of compressor(s) for normal operation, and standby compressor(s) to take over in case of failure of one normal compressor, or in the case of utility failure for the normal compressor(s). Autostart facilities should be provided for the stand-by compressor(s).

The compressor air intake should not be located near cooling tower exhausts or where warm air may be drawn in from furnace fronts, air cooler exhausts, etc., Additionally it should be located so that the instrument air is free from toxic, noxious or flammable gases and free from dust.

Suction filters should normally be specified and vendors* attention should be drawn to any special conditions such as marine environment, (coastal) desert or sand storm conditions. A differential pressure indicator may be specified for the inlet filter. Heaters should be provided to prevent icing in cold climates.

Depending on noise levels permitted and the capacity and the characteristics of the compressor to be supplied an air intake silencer may be necessary, located immediately after the suction filter.

The total compressor capacity (without stand-by compressors) should be at least the design consumption as calculated in sub-section 2.3.

Automatic pressure control should be provided for normal operation. When pressure control is achieved by venting excess compressed air to atmosphere, an exhaust silencer may be required to meet noise level requirements.

In the event of compressor or utility failure, switch-over to stand-by facilities should be automatic. Manual facilities for switch-over should also be provided.

The compressor sets should be supplied complete with nonreturn valves, inter-coolers, after-coolers, condensate separators and draining facilities, and control and monitoring instrumentation.

2.6 COMPRESSOR DRIVERS

At least two different and independent utility supply systems (eg. steam, electricity, diesel) should be provided for driving the compressors.

Depending on operational considerations, such as reliability of supply, steam balance of the plant, maintenance, etc. a selection should be made for the driver of each compressor. The total capacity of the compressors driven by the most reliable utility (usually steam) should be sufficient for supplying the required quantity of air for all instrumentation.

The above requirements may result in two compressors (one steam driven and one electrically driven), but a set of three compressors may have its merits, eg. to cope with large fluctuations

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in demand if air is used intermittently for any purpose.

Electric motors should be protected against frequent repetitive starting.

2.7 INSTRUMENT AIR RECEIVER

The air receiver should be installed between the compressor and the air drier to serve as:

- (1) A separator for condensate.
- (2) A surge tank.
- (3) A reservoir to cater for compressor failure.

The air receiver should be sized to maintain air supply from the moment of compressor failure until the stand-by compressor(s) are in operation; this period of time should be taken as 5 minutes minimum, based on the assumption that automatic start-up of the stand-by machine(s) is unsuccessful and manual start-up must be used.

During the elapsed period the instrument air pressure should not drop below the minimum value required for proper operation of the instruments. This pressure can usually be taken as 40 psig, but in some instances may be higher (eg. if instrument air is used for purging instrument connections of process vessels).

Note: If special actuators are used which require an air pressure higher than 40 psig, eg. piston operated valves, special provisions such as volume chambers connected to the supply system non-return valves, should be considered to prevent a pressure drop which could occur in the of the system.

For sizing the air receiver, the air consumption should be assumed to be equal to the maximum capacity of the air compressor(s) normally in operation.

Consideration should be given to the possibility of shutting off non-essential users in the event of compressor failure, to achieve a smaller air receiver than would otherwise be required, give a longer period or smaller pressure drop during remedial activities than would otherwise be obtainable.

The air receiver should have drainage facilities, a pressure gauge, and, in most instances, a pressure relief valve.

A rough check on air receiver capacity required to supply instruments for a given duration is given by:

$$T = V (P_1 - P_2) / CP$$

Where:

T = Time in minutes that the receiver will supply air
From the upper to the lower pressure limits.

V = Volume of receiver, ft³.

P = Atmospheric pressure, psia.

P₁ = Maximum receiver pressure, psia.

P₂ = Minimum receiver pressure, psia.

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C = Free air required. Ft³/min.

Other consistent units can, of course, be used in the above equation.

2.8 INSTRUMENT AIR DRIER

The air drier should reduce the dew-point of the compressed air to 10°C below the minimum ambient temperature at the pressure of the drier outlet.

The air driers most frequently used are of the twin vessel adsorption type with dual inlet and outlet filters.

The vessels should be switched automatically and the regeneration cycle should be controlled automatically with provision for varying the cycle times. Manual over-ride switching facilities are also required.

Each drying vessel should have a drying capacity equivalent to the maximum capacity of the compressor(s) normally in operation for a suitable period; normally 6 to 12 hours.

Regeneration (including cooling) of a drying vessel should be accomplished in 60 to 75% of the time the vessel is used for drying.

Regeneration air should be heated, preferably by an electric heater, though steam may be used if it is available at a suitable temperature (400°F).

After regeneration, the dry desiccant should be cooled to near ambient temperature.

The desiccant may be activated alumina or appropriate brand generally as recommended and guaranteed by the drier vendor.

2.9 INSTRUMENTATION OF INSTRUMENT AIR PLANT

No hard and fast rules can be given for instrumentation required. The basic requirements outside of the compressor and air drier packages are usually for:

- (1) Pressure control system.
- (2) Measurement of compressed air produced, comprising flow recorder, pressure recorder and temperature recorder.
- (3) Similar measurement of compressed air consumed at each process unit (for accounting purposes).
- (4) Low pressure alarms, both local and relayed to control rooms.

The compressor sets will be supplied complete with their own instrumentation packages and local panels which may include for example:

- (1) Inlet filter differential pressure indicator
- (2) Pressure control system
- (3) Trip and alarm system covering, for example:
 - 1) Low lubricating oil pressure.
 - 2) High lubricating oil temperature.
 - 3) High inter-stage temperature.
 - 4) High discharge temperature.

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5) Low cooling water pressure, etc..

The drier package will be supplied complete with its own instrumentation and local panel including cycle control instrumentation, alarms and trips, differential pressure gauges for pre-and after-filters, etc..

2.10 INTERCONNECTING PIPING

Piping should preferably be run without low points or pockets between the compressor after-cooler outlet(s) and the air receiver and between the air receiver and the air drier.

If low points are unavoidable, condensate drainage facilities must be provided at all low points.

Drainage should be automatic using traps. In cold climates the piping between the compressors and the drier should be insulated and heat traced if the installation is out of doors.

A bypass should be installed around the air receiver if on-stream maintenance or inspection are desirable; consideration should be given to removal of condensate which would normally be separated in the receiver.

A bypass should be installed around the air drier package including the inlet and outlet filters, to allow on-stream maintenance. Consideration should be given to provide a pressure control valve in the bypass line, set to open at a low down stream value (eg. 80 psig) the bypass line may then be left normally open to provide security of instrument air supply should plugging of the filters or desiccant beds occur. A valve position alarm should be provided on the panel.

In those cases where instrument air is temporarily used for other purposes (eg. catalyst transport, boosting plant air supplies, etc.) a control valve should be provided to cut off supplies to these non-essential users if instrument air pressure falls below 100 psig.

To prevent the formation of rust, it is recommended that all piping in the compressed air system, from the receiver outlet, should be galvanized steel or alternatively aluminium. Copper or brass may be considered for small lines.

There are two basic types of distribution systems, the loop and the radial. In the loop type, each process unit receives air along the distribution main from either direction and the main describes a loop through all process units. The more commonly used type, and less expensive, is the radial system where each unit receives air along the distribution main from only one direction.

Lines in the distribution system should be sized so that the pressure drop does not exceed about 7 psi between the drier outlet and the most remote station at maximum flow rate. The following table may be used as a guide for sizing main and branch headers based on the number of instrument air pilots served:

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HEADER	NUMBER OF PILOTS	PIPING SIZE, in
Main	80	1½
	150	2
	500	3
Branch	4	½
	10	¾
	25	1
	80	1½

Pressure drop in compressor suction and discharge lines should be minimized by having the smallest number of bends and fittings, the line size should match the compressor suction and discharge nozzle sizes up to the after-cooler moisture separator or knock-out pot.

Generally a line size resulting in a pressure drop not exceeding 0.5 psi per 100 ft run will give an adequate system, but see section 2.2.

Branch lines should be connected to the top of main supply headers to minimize liquid entrainment when the air drier is out of use. Auxiliary receivers may be located in areas which require large amounts of air intermittently. Such a receiver, providing surge capacity, is sized in relation to size of supply piping, frequency and quantity of air requirements. Receivers prevent excessive reductions in system pressure and may be provided with restricted inlet piping connections.

3. COMPRESSED AIR DRYING

3.1 GENERAL

The presence of water and the formation of ice and rust in compressed air systems causes blockages and other troubles such as damage or severe wear. The need for compressed air, which is dry, has led to the development of many types of air driers.

3.2 WATER

Water will vaporize into air until it becomes saturated, the higher the temperature of the air, the more water it will hold; conversely, lowering the temperature reduces the water vapour which can be held, and this leads to condensation. 「The reverse is true of pressure.」 All air carries some water. The usual measurement of the amount of water vapour in air is its dew-point, which is the temperature at which condensation commences. If the dew-point is below the minimum ambient temperature, the air is always dry and condensation will not occur.

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3.3 OIL

Air will also pick-up oil in the same manner as water and by mechanical entrainment as a fine mist. This occurs particularly with oil lubricated pistons used in some reciprocating compressors. Over 99 percent of the liquid oil in compressed air consists of droplets in the size range approximately from 0.05 microns to 0.1 micron.

3.4 HARMFUL EFFECTS OF WATER

If air is compressed, it cannot hold so much water vapour. When air is compressed the temperature rises, which compensates; however, when the air is cooled condensation occurs. Water causes rust in pipes and mild steel equipment; rust is carried along to block valves. Water freezes and prevents moving parts from functioning; even in hot climates ice can be formed at instrument orifices when the air expands suddenly. Water clogs delicate instrumentation, closing small orifices. Water corrodes the internal parts of pneumatic tools and drastically reduces their life and washes lubricant from tool parts, causing rapid wear.

3.5 DRYING SYSTEMS

There are several methods of drying air; filters, separators and traps will remove most of the free water droplets. Refrigeration causes condensation and thus makes the air shed water. Certain chemicals absorb water vapour, such as calcium chloride; when they are saturated they must be replaced. Desiccants adsorb water vapour at their surface and can be easily regenerated by applying heat or vacuum; common examples are silica gel, activated alumina and molecular sieves.

3.6 DESICCANTS

Desiccants are chemically inert, hard granules which have a multitude of sub-microscopic pores. Molecules of water are attracted into the pores. They have a very high capacity for holding water, in some cases 50% of their own weight.

The moisture can be removed from saturated desiccants by exposing them to air which is drier. This is achieved by raising the temperature and lowering the pressure of the surrounding atmosphere.

The desiccants are thus regenerated to various degrees, according to the severity of the method used, but they always retain some moisture.

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3.7 HEAT REGENERATED DESICCANT DRIERS

These usually consist of two towers filled with desiccant. The air passes through one tower and a proportion of the water vapour is adsorbed. On leaving the tower the air contains very little water vapour; its dew-point is very low, say -50°C (though -100°C is possible) and it will stay dry and not produce condensation in any temperature above -50°C .

When the desiccant becomes saturated, the air stream is switched to the second tower. The first tower is heated to regenerate the desiccant, and a small air stream is passed through it to drive off the moisture. The tower is cooled and is then ready for further drying.

For intermittent duties, a single tower can be used.

Heat is supplied to small units by embedded heater elements but for larger units hot air is blown from an external heater through the tower.

The regeneration purge air stream is produced in different ways for different conditions. With constant air-line pressure, part of the main air stream can be diverted, through the regeneration tower and afterwards vented or recovered. If the air line pressure fluctuates it is better to have an independent purge supplied by a blower.

3.8 HEATLESS REGENERATED DESICCANT DRIERS

These driers are similar to the heat regenerated driers; they have two towers, one drying and one regenerating, but no heaters are used.

During regeneration a large amount of compressed air is diverted for purging and allowed to expand through the tower to atmosphere. Its capacity for holding moisture is greatly increased and it picks up moisture from the saturated desiccant. About 15% of the main compressed air flow is used for regeneration. Because this is so wasteful, an alternative method of regeneration, using a vacuum pump may be employed.

Instead of using the compressed air stream, the pump draws a vacuum around the saturated desiccant which causes the adsorbed water to vaporize. Thus, the moisture is drawn off from the desiccant. There is very little loss of compressed air by this method.

3.9 REFRIGERATION DRIERS

These driers pass the compressed air through a heat exchanger with a refrigerant to cool the air; condensation takes place and the air is dried. However, when the condensed water falls on the heat exchanger tubes, ice forms and greatly reduces the thermal efficiency.

The lowest dew-point achievable in practice by this system is about 3°C , so it is suitable only when ambient conditions are warm.

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3.10 ABSORBENT (CHEMICAL) DRIERS

Absorbent driers have a single vessel through which the compressed air passes and in which there is placed a deliquescent chemical. The chemical absorbs moisture and the resulting solution drains away. Periodically the chemical must be cleaned out and replenished.

The dried air has a moisture content related to the vapour pressure of the solution, which varies with temperature. Typical dew-points for given air inlet temperature would be:

Air inlet Temperature	Dew-Point (at line pressure)
100°F (38°C)	83°F (28°C)
70°F (21°C)	35°F (2°C)

This method is suitable when the compressed air temperatures in the drier, and in the distribution pipework are nearly equal, and when there is little expansion of the air.

3.11 FILTERS

When desiccant dryers are used, it is advisable to install inlet and outlet filters.

(1) Water Droplet Inlet Filters.

Droplets of free water in contact with desiccants cause them to break down into powder and impair the performance. Small filters in the inlet pipe will prevent this.

(2) Oil Mist inlet Filters.

Some compressors saturate the compressed air with oil mist, which contaminates the desiccant. The oil fills the pores and remains, thus reducing the capacity and the performance. Oil filters are available to prevent this.

(3) Dust After-Filters.

Due to erosion and abrasion desiccants release fine dust which may be carried in the outlet air to clog valves, orifices and internal parts of pneumatic equipment. After-filters should be fitted to prevent this.

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3.12 MISCELLANEOUS FEATURES

Air driers are supplied for many purposes and may frequently require extra features which should be specified. The most commonly required features which may be regarded as extra to the basic design are out-lined below.

(1) Filters – see 3.11 above

(2) Manual or Automatic Control

The operation of valves, heaters, etc. of desiccant driers can be made manual, semi-automatic or fully automatic. Automatic timing cycles can be fixed or adjustable.

(3) Safety Alarms

Safety alarms can be installed to give warning of inadequate drying or of failure of individual components; eg. heater elements, air blowers, etc.

(4) Weather and Dust Proofing

Driers can be designed to resist the effects of weather or dust. Environmental conditions should be given in the inquiry specification.

(5) Flameproofing

Electrical components can be provided suitable to meet the requirements of the hazardous area classification in which the drier is to be located. Hazardous area classification should be stated in the inquiry specification.

3.13 DESIGN POINTS

When designing air systems and specifying air driers the following points should be considered:

(1) Air inlet Temperature

Air inlet temperature should be as low as possible, since the difference between a high and low temperature can double the size and cost of a drier. An after-cooler should be provided at the compressor for this reason.

(2) Dew Point At Outlet

Since different drying methods produce different dew-points it is necessary to know the lowest temperature that will be encountered. Outdoor pipework reaches ambient temperature; expansion of compressed air at valves or orifices reduces air temperature further, sometimes forming ice. To allow for cooling by expansion from air lines at 100 psig a rule of estimate of 10°C below the lowest ambient temperature encountered may be used.

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NOTE: Dew-points are expressed in two ways, at line pressure, and at atmospheric pressure (expanded), the latter being a much lower temperature. Since most problems may occur when the air is at line pressure, it is usual to quote the dew-point required at line pressure.

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The inquiry specification the dew-point must be qualified by stating the appropriate pressure.

(3) Wastage of Air

When desiccant dryers are used, different regeneration systems lose different amounts of compressed air, from 0 to 15% approximately.

High losses of compressed air are generally expensive and may necessitate the installation of higher capacity compressors. It is important therefore to state the maximum permissible loss.

(4) Heat Available for Regeneration

Where heat is required for regeneration it is usually supplied by electric heating elements.

It can, at times, be more economical or more convenient to use steam or hot process gas. The preferred heat source should be stated in the inquiry specification.

(5) Filters

The condition of the compressed air entering the dryer (eg. oil free, water saturated at 30°C) and the subsequent use of the outlet air (eg. instrument air) should be stated.

(6) Operation

Whether the flow or line pressure is continuous intermittence or subject to large fluctuations should be stated to allow selection of the best drying method.

4. PLANT AIR

4.1 INTRODUCTION

Plant air may be used for many purposes such as:

- (1) Steam and air decoking of furnace tubes.
- (2) Regeneration of some catalysts.
- (3) Pressure testing or leak testing when hydraulic methods are unsuitable.
- (4) Driving maintenance tools such as tube reamers, drills, wrenches, sand and shot blasters, winches, hoists, etc.
- (5) Aeration in effluent treating systems.
- (6) Pneumatic conveying
- (7) Paint spraying.
- (8) Agitating and mixing liquids in tanks
- (9) Soot blowing (steam is a preferred alternative)
- (10) Starter motors for gas turbines and diesel engines.
- (11) Tank blanketing to exclude moisture.

It can be appreciated from this list that many uses of plant air are intermittent and that principal demands are limited to certain areas or specific periods of time. Additionally it is

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apparent that different air pressures are required for many of the uses. For this reason, unless the client's standards state otherwise, it is generally not desirable to provide a centralized plant air system, especially for plants comprising a small number of process units.

4.2 QUALITY

Plant air should generally be dry and free of water and dust to provide a reliable supply from a centralized source. The quality need not be as high as is required for instrument air and each case should be considered separately based on the services which have to be supplied.

Plant air should be dry to prevent corrosion in equipment and to prevent pipe breakage or blockage due to freezing of condensed moisture. Generally the dew-point at line pressure should not exceed the ambient temperature. In climates where freezing does not occur a system should provide satisfactory service if all free water is eliminated at the compressor aftercooler, the air-receiver, all low points in piping and knock out pots at users.

Plant air must be oil free if it is to be passed through drying equipment as oil will inhibit the performance of solid and chemical desiccants and cause fouling of the heat exchangers in refrigerated driers.

Dust, water and oil can interfere with the operation of pressure regulating instruments provided at some users; sand blasting, shot blasting, paint spraying and most process applications require freedom from dust, oil and water.

4.3 QUANTITY

The amount of plant air required is likely to vary widely depending on the purposes for which is used. Many demands will be intermittent, the supply being required for periods between a minute or so and a few days.

For centralized plant air systems, the system capacity required will often be advised by the client, but some guidance as to likely requirements are given below.

When a centralized plant air system is not provided each installation within a plant should be based on the likely consumption of the connected users. For maintenance use, where a distribution system is provided within a plant for connection to mobile compressors a 3" or 4" header

should be provided with suitably sized branches to areas of usage such as furnace areas, heat exchanger banks, columns and structures.

In the absence of other design criteria, the following system capacity should be provided:

(1) Oil Refineries

- up to 10,000 B/SD crude charge, 500ft³/min at STP.
- 70,000 or more B/SD crude charge, 1300ft³/min at STP.

(2) For regeneration of catalytic reforming and desulphurizing catalysts the volume is in the range of 300 to 600ft³/min at STP per reactor. Provision should be made for parallel regeneration of catalytic reforming reactors if required or simultaneous regeneration of desulphurizing and reforming plants. Catalyst vendors should be able to give guidance on

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regeneration air requirements.

- (3) Fluidizing air for FCC (Flow Catalyst Cracking) units at start-up range from 300ft³/min at STP for a 6000 B/SD unit to 2000 ft³/min at STP for a 35000 B/SD unit.

- (4) Air for steam and air decoking of furnace tubes is about 10% of the steam flow or 0.6lb/ft².S.

- (5) Air motors normally used require 200 to 400ft³/min at STP.

- (6) Requirements for tools may be estimated as:

- (7) Furnace tube reamers – 200ft³/min at STP each.

- (8) Sand blasting – 375ft³/min at STP for a 3000lb/h unit.

– Drills, wrenches, etc, – 25 – 90ft³/min at STP. (Ref 1.)

4.4 PLANT AIR SUPPLY EQUIPMENT

The basic equipment required for a centralized plant air system is similar to that described in section 2.4 for instrument air. Consideration may be given to using a common spare compressor for plant and instrument air provided that the duty is compatible and security of instrument air supply is not impaired.

Emergency plant air supply facilities are not normally provided. In modern compact oil refineries and other process plants it is unnecessary and probably uneconomical to provide a centralized plant air system. The design concept should permit the provision of independent permanent facilities to meet base loads and to supply frequently used intermittent services, eg: aeration at effluent treating systems, service air for workshops, etc.

For services which will be used only occasionally, such as during maintenance shut-downs suitably sized and located manifolds and headers should be provided for connection of mobile

compressors eg. for:

- (1) Steam and air decoking of furnace tubes.
- (2) Catalyst regeneration.
- (3) Maintenance tools.
- (4) Leak testing following maintenance.

For other purposes listed in Section 4.1 alternative systems should be considered eg.

- (1) Paint spraying – pressure sprays or self-contained pneumatic units.
- (2) Tank agitation – mechanical agitators or circulation through mixing jets.
- (3) Soot blowing – use steam.
- (4) Starter motors – use electric motors, possibly battery powered.
- (5) Tank blanketing – use nitrogen or inert gas if available or install driers on tank breathing connections.

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6. 작 성 내 력

개정번호	개 정 일 자	개정 페이지	개 정 사 유
0	98.04.17	전 페이지	신규 제정 - 작성부서 : 공정팀 - 작성자 : 구영열 이주열 - 검토자 : 이봉일 조석범 노재철 - 승인자 : 오성국
1	2010.11.25.		- Document number change due to new numbering system - Written at Process Eng'g Dept.II Written by : C.H.Yun Checked by : J.H.Park Approved by : Y.Y.Koo

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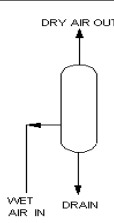
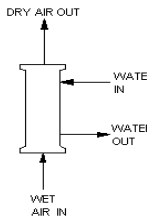
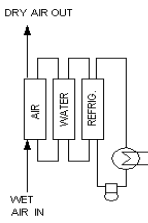
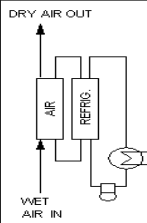
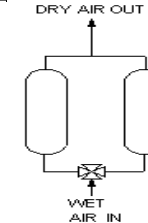
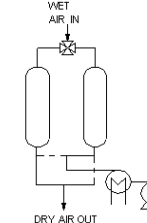
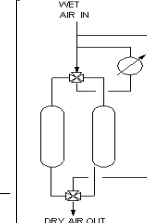
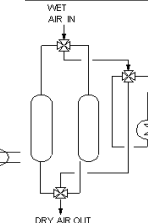
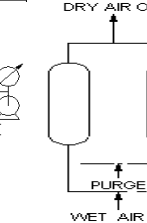
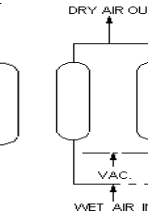
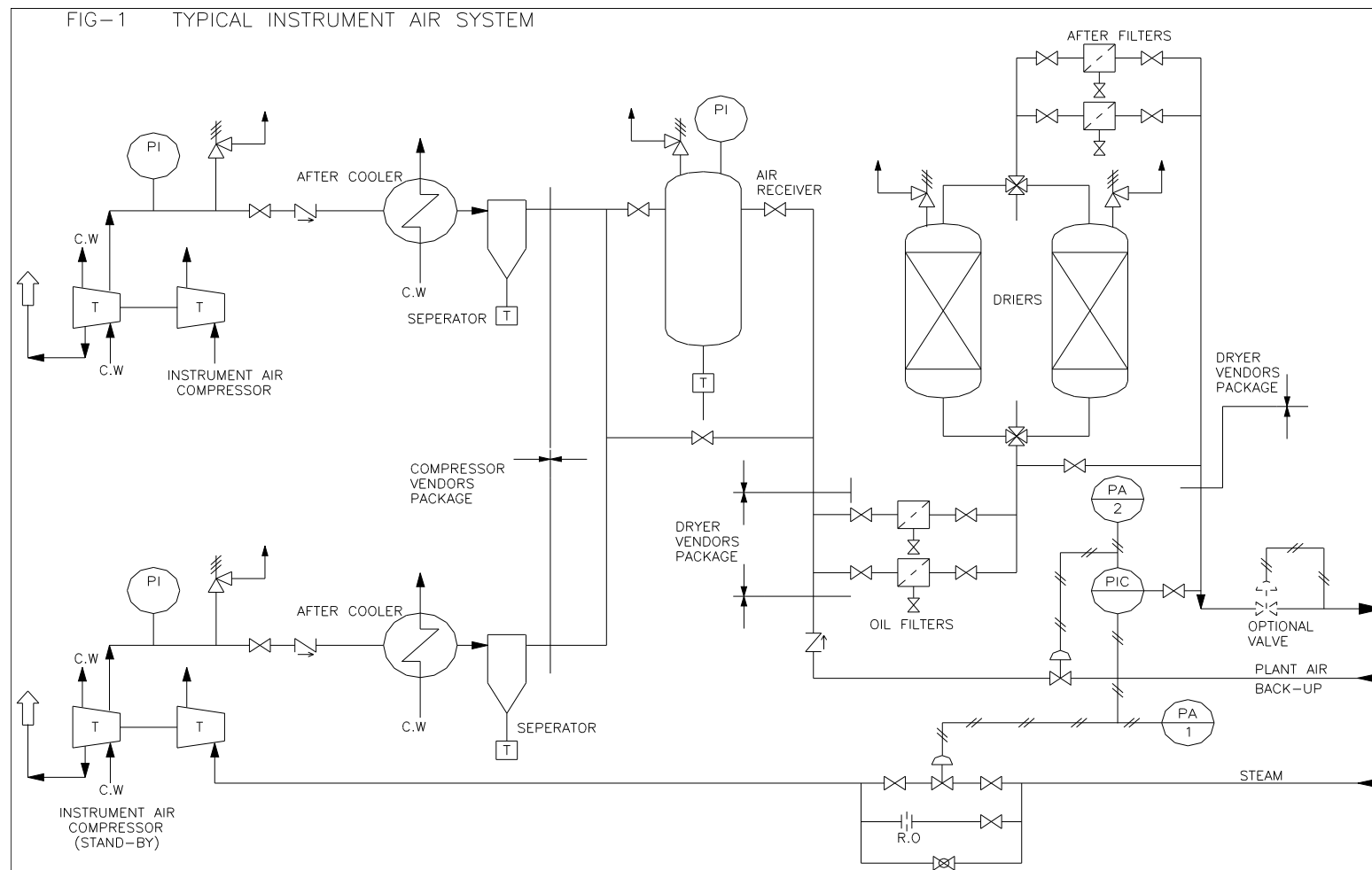
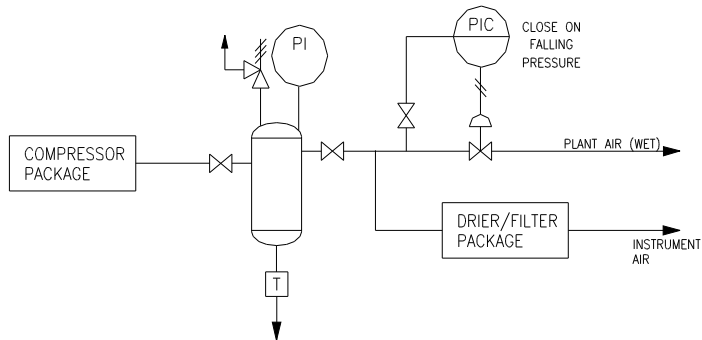
Drying System Type	         									
	CHEMICAL	COOLING			HEAT REGENERATED				PRESSURE SWING (NON-HEAT REGEN.)	
		Water	Chilling	Refrigerated	Dry Air Purge To Atmosphere	Atmospheric Air Purge	High Press. Closed Loop Wet Air Purge	Low Press. Closed Loop Wet Air Purge	Purge To Atmosphere	Purge To Vacuum
INLET COND. (1) FLOW .cfm @100°F & 100 psig	0-5,000	0-10,000	10,000-50,000	0-1,000	0-1,000	300-5,000	500-30,000	500-10,000	0-5,000	200-20,000
TEMP. °F	50-100	300-450	80-200	50-150	60-130	60-130	60-130	60-130	60-120	60-120
PRESS. Psig.	0-150	50-300	50-300	50-300	50-5,000	20-5,000	20-1,000	3-50	60-5,000	60-5,000
OUTLET DEW POINT @line	+30 & UP	+50 to +180	+50 to +180	+35 & UP	-60 & UP	-60 & UP	-60 & UP	-60 & UP	-40 & below	-40 & below
REGEN. UTILITIES/ELECTRIC	No	No	To drive compressor	To drive compressor	Yes	Yes	Yes	Yes	For control	For ejec. Or vac.
STEAM	No	No	No	No	Yes	Yes	Yes	Yes	No	No
PROCESS AIR OR GAS	No	No	No	No	Yes	No	Yes	Yes	Yes	Yes
EXTERNAL AIR OR GAS	No	No	To cool condenser	To cool condenser	No	Yes	No	No	No	No
RELATIVE MAINT (3)	95	10	20	20	50	60	40	60	25	25
USES	High dew pt. Effluent Air	High dew pt. Air compressor After cooler	High dew pt. Large Flow	Mod. dew pt. Low Flow	Low dew pt. Med. flow inst. air.	Low dew pt. Med. flow inst. & process air No process gas consumed for purge.	Low dew pt. Med. to high flow process & inst. air. No process gas consumed for purge.	Med. to high flow at low pressure. No process gas consumed for purge. Generally restricted to process gas which cannot tolerate contamination with atmospheric air.	Low to med. Flow. higher pressure better. Approx. 15% @100 psig process gas consumed for purge. Lower purge consumption at higher pressure.	Med. to high flow. Higher pressure better. Approx. 3% @100 psig process air consumed for purge.

Table - 1 A Wide Choice of Drying Systems

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PLANT AND INSTRUMENT AIR FROM ONE COMPRESSOR PACKAGE

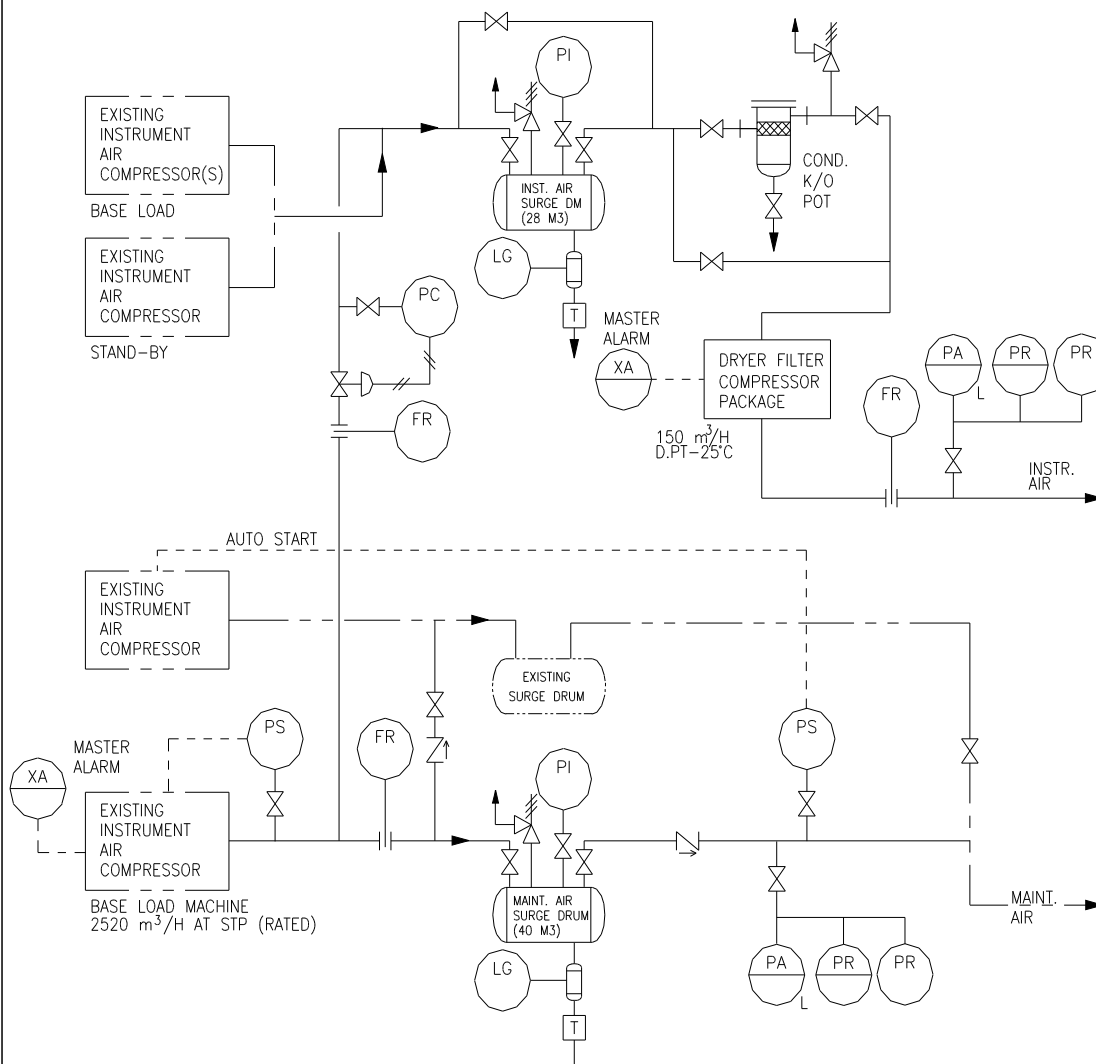


FIG - 2 EXPANSION & DEVELOPMENT OF CENTRALISED DRY INSTRUMENT AIR SYSTEM

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FIG-3 CONTROL AND DESIGN PRINCIPLES FOR LARGE COMPRESSED AIR SYSTEM

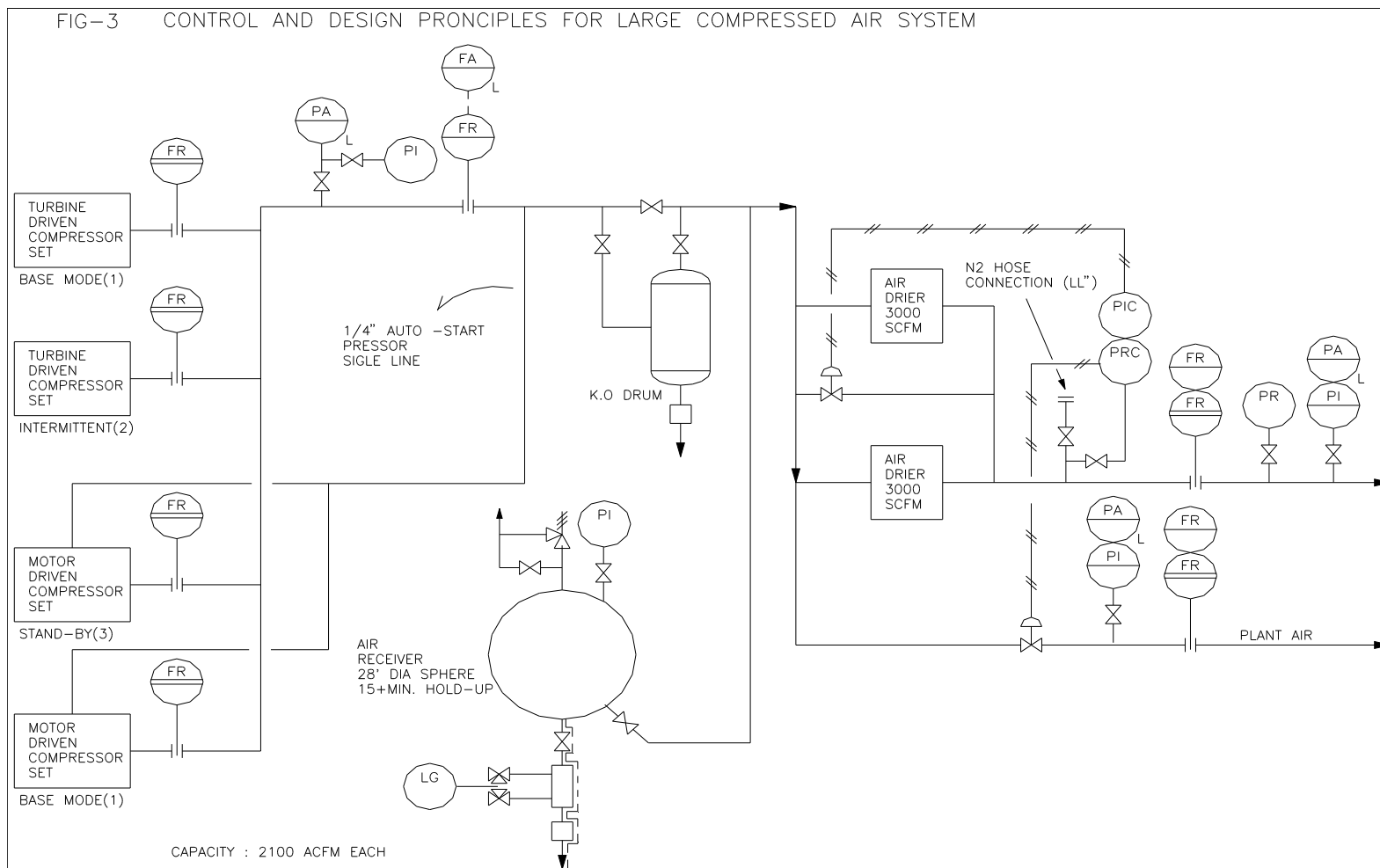
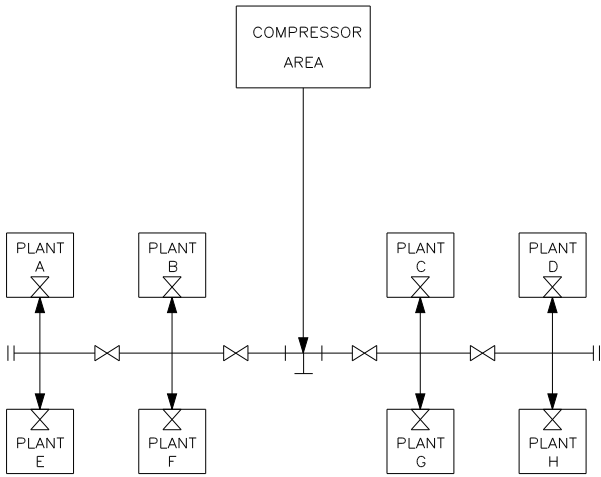
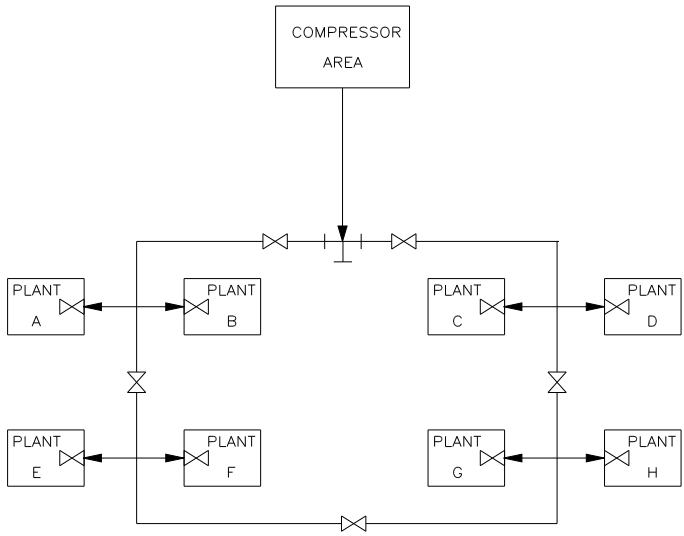


FIG-4 RADIAL AND LOOP DISTRIBUTION SYSTEMS

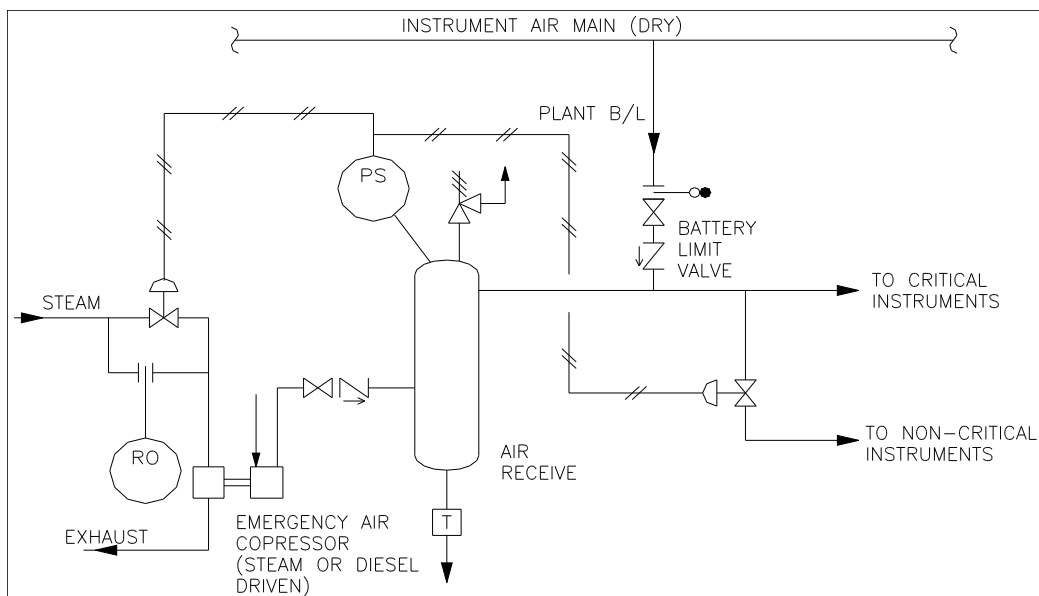


RADIAL DISTRIBUTION SYSTEMS



LOOP DISTRIBUTION SYSTEMS

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TYPICAL ARRANGEMENT OF ON-SITE EMERGENCY INSTRUMENT AIR COMPRESSOR

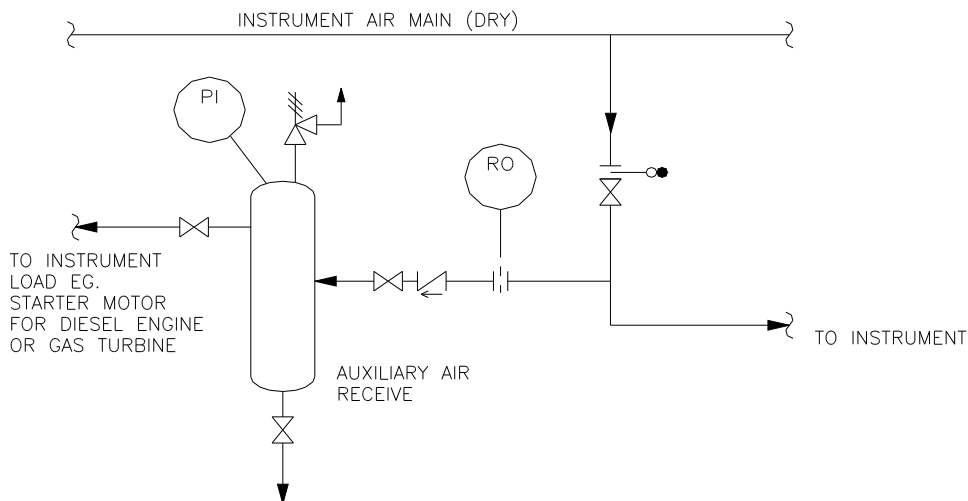


FIG-5

TYPICAL ARRANGEMENT OF AUXILIARY RECEIVER TO SUPPLY LARGE INTERMITTENT LOADS