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Revision Memo

12/00 Deleted reference to IP 3-3-1, *Cooling Water Piping for Centrifugal Pumps*, updated information on variable frequency drives.



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SCOPE

This section presents the basis for driver type selection and outlines pump unit utility requirements.

REFERENCES

DESIGN PRACTICES (BESIDES OTHER SECTIONS OF [SECTION X](#))

Section XI	Compressors
Section XV	Safety in Plant Design

INTERNATIONAL PRACTICES

IP 3-3-7	Inlet and Exhaust Piping for Steam Turbines
IP 10-7-1	General Purpose Steam Turbines
IP 10-11-1	Sizing of Drivers and Transmissions
IP 16-2-1	Power System Design

OTHER REFERENCES

API 611	General Purpose Steam Turbines for Refinery Services
NEMA SM 20	Mechanical Drive Steam Turbines
<i>Electrical Variable Frequency Drives (VFD's)</i> , ER&E Application Guide EE52E.94.	

BACKGROUND

The majority of onsite pumping services in process plants require pump drivers in the 10 to 400 hp (7 to 300 kW) range. Crude charge pumps and product tanker loading pumps frequently fall in the 700 to 2000 hp (525 to 1500 kW) range, but very few other hydrocarbon services ever exceed 700 hp (525 kW). Boiler feedwater and plant cooling water services in refineries and chemical plants commonly require drivers in the 400 to 1500 hp (300 to 1100 kW) range, with occasional examples to 2000 to 2800 hp (1500 to 2100 kW).

Induction motors are selected to drive most pumps. Direct drive through flexible couplings is normally used. Special reasons and circumstances are required to select any of the other practical driver types – steam turbine, hydraulic turbine, diesel engine – or to justify variable or adjustable speed transmissions for induction motors. The need for gear units or other constant speed transmission is determined during equipment procurement.

BASIC DESIGN CONSIDERATIONS

DRIVER TYPE SELECTION

Choices Available - Practical driver types for onsite pumps are induction motors, general purpose steam turbines, steam engines (for direct acting steam pumps), and hydraulic turbines. For process plant offsite services, hydraulic turbine application opportunities do not exist, but internal combustion engines (usually diesel) find occasional application. Gas turbines are applied as pump drivers in pipeline and production services, but are not economical in the process plant pump power range. Synchronous motors are rarely used as pump drivers, since their higher cost in the speed and power ranges typical of centrifugal pumps is rarely justified by the power factor improvement they provide.

Normally Operating Pumps - The two considerations which most heavily influence selection of driver types for normally operating pumps are utility energy costs and system balance.

The energy cost and system balance result from the many factors which have influenced the design of the plant utility system. Drivers for the normally operating pumps are then specified to be consistent with the plant utility system design. Induction motors are specified in the vast majority of cases.

Driver energy cost savings can sometimes be made by energy recovery from liquid streams via application of hydraulic turbines, and by using variable speed instead of discharge throttling or recycling for pump flow control. In both cases, individual studies must be made to determine if the necessary incremental investments are justified.

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BASIC DESIGN CONSIDERATIONS (Cont)

Other factors which sometimes influence driver type selection for normally operating pumps are:

- To decrease the flare load for a given utility source failure.
- Investment costs for the required utility supply lines, such as in remote, offsite locations.
- Operational simplicity. This factor favors electric motors and under some circumstances can prevail over other considerations.
- Maintenance requirements. Turbines tend to require somewhat more maintenance than motors. In-line centrifugal pumps can be more conveniently maintained when equipped with electric motor drivers.

Factors which usually do not influence pump driver type selection are:

- Pump speed, since inclusion of a gear can produce any desired speed with any type of driver.
- Price of the driver, since other factors are almost always more significant in driver type selection for pumps than differences in initial cost of the driver.
- Compatibility between parallel pumping units, since control system can be provided to compensate for driver characteristic differences.

Spare and Standby Pumps - When the primary purpose of providing an installed spare pump is to cover pump maintenance requirements rather than brief utility energy supply interruptions, the same type of driver should be used for the service and spare pumps. To use different types (e.g., motor and turbine) increases plant investment unnecessarily. Onsite process pumping services normally rely on dual power feeders and reacceleration systems for pump driver reliability, and hence, use motors for spare pumps as well as for operating pumps.

When the high reliability requirement of a pump service justifies the employment of a second driver type, the common arrangement is motor drive for the operating pump and turbine drive for the spare. This arrangement is normally applied in utilities systems to prevent utility service failure during a power failure. The utilities pumping services normally provided with turbine driven spares are fuel oil supply, boiler feedwater and plant cooling.

Onsite process services which require turbine driven spare pumps for reliability reasons are limited to those required to avoid major safety crises, such as large safety valve vapor releases, during power failure. The situations warranting turbine driven spares normally occur in very high capacity refinery units.

Where a spare pump has an alternative service for emergency pumpout, it should be specified for steam turbine drive.

See [Section X-A](#), *Sparing and Multiplicity*, for additional details.

Emergency Pumping Services - See [Section XV-I](#), *Safety in Plant Design, Fire Fighting Facilities*, for recommendations on driver selection for firewater pumps.

Standby well water pumps are frequently specified for diesel engine drive to provide reliability in the event of utility system failures and to avoid running utility lines to the usually remote locations of water wells.

Pumpout services should have steam drivers to take advantage of the higher reliability potential.

ELECTRIC MOTORS

General - Induction type electric motors normally used as pump drivers are made in a range of sizes from fractional hp to over 22,000 hp. [IP 10-11-1](#) presents the basis for sizing the motor driver by the following equation:

$$\text{Minimum required driver BHP} = \frac{\text{Highest Pump Power Requirement At any Operating Condition}}{\text{Mechanical Efficiency of Transmission}} \times \text{Load Factor}$$

Load factors are typically 1.1 for centrifugal pumps and 1.05 for positive displacement type pumps. See [IP 10-11-1](#). The mechanical efficiency of the transmission will be 1.0 for direct coupling of motor to pump. Gear unit efficiency should be assumed as 0.96 (96 percent). Efficiencies of variable speed drive units at full and part load should be obtained by consultation with MACHINERY SPECIALIST.

See [Section XI-L](#), *Compressors, Electric Motors*, for a summary of motor sizes, efficiencies, power factors, and connected kW loads.