Foreword

Like us, AUNDE Group contract partners strive for the continuous, long term improvement of their environmental results by encouraging the introduction of suitable technologies and processes to allow the efficient use of natural resources and energy and to minimise emissions. The efficient use of energy resources not only benefits the environment but also reduces the cost base for the AUNDE Group.

In these procurement criteria for energy we set out how we design and handle energy aspects in the procurement of equipment and systems. We expect our contract partners to provide innovative advice and planning to enable us to improve the energy efficiency of our company even further.

Scope

These procurement criteria for energy apply to all European plants of the AUNDE Group with the AUNDE, ISRI and FEHRER brands.

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1. Motors

1.1 Procurement criteria

Electric motors and electric drive units, consisting of an efficient electric motor and a speed controller with a frequency converter to ensure that speeds are controlled to suit demand, are a standard product. The following criteria apply to their procurement.

1.1.1 Review the actual required rating, the expected capacity use and the maximum load or torque which occurs.

1.1.2 Compare the life cycle costs for applications which involved operating motors frequently at part load using a load profile and part load efficiency levels (if necessary frequency converters must be taken into account)

1.1.3 Procurement of IE3 motors (IEC 60034-30). Alternatively, motors with lower life cycle costs and higher efficiency levels when used at part load capacity or a more efficient permanent magnetic motor may be used.

1.1.4 Give due consideration to using modern control systems for variable loads. This is mandatory for pumps and ventilation applications.

1.1.5 Documents must be issued in digital form and in hard copy in the language of the country concerned. These documents include technical descriptions, dimensioned drawings, installation and operating instructions, type test certificates, declarations of conformity and manufacturer declarations, spare parts lists, inspection logs, winding diagrams, idling current and phase resistances

1.1.6 It must be ensured that highly efficient drive unit types (direct drive units, high efficiency belts, etc.) are used and that worm drive units are not used.

1.2 Life cycle costs

The running costs of an electric motor make up over 90% of its life cycle costs. The important point here is to select the motor system with the lowest life cycle costs.

The following points must be given due consideration.

1.2.1 Procurement price and installation costs (planning costs and costs of a frequency converter if applicable)

1.2.2 Running costs depending on rating, capacity use, efficiency, hours of operation per year (if necessary load profiles showing different levels of capacity use), service life, electricity price and interest

1.2.3 Maintenance costs (including repair costs and lubricants)

1.2.4 The service life of motors up to their first failure is shown in the following table.

<table>
<thead>
<tr>
<th>Service life</th>
<th>0.75 to 1.1 kW</th>
<th>1.1 to 11 kW</th>
<th>11 to 110 kW</th>
<th>110 to 370 kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>in years</td>
<td>10</td>
<td>12</td>
<td>15</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: IEC 60034-31: Rotating electrical machines Guide for the selection and application of energy-efficient motors including variable-speed applications

1.3 Explosion protection

When making enquiries or placing purchase orders, details of explosion protection requirements must be specified. The current IEC standards for efficiency classes and explosion protection requirements for motors are generally applicable.
1.4 Repairs
Before ordering repair work, the efficiency of the previous motor must be compared with the efficiency levels of new motors which comply with IE2 or IE3 standards. An assessment of the life cycle costs may be required for this purpose since the possible additional costs of a modified motor may be set off by its higher efficiency level.

1.5 Lubrication
The following service lives are required for motors which have bearings with lubrication for life:

- 2-pole motors: 20,000 hours
- 4 and multi-phase motors: 10,000 hours

1.6 Energy efficiency
When choosing motors, a suitable energy efficiency class must be selected. The appropriate verification document takes the form of the manufacturer’s product data sheet and the calculation method set out in EC Regulation No. 640/2009 together with IEC 60034-30. The following minimum criteria must be satisfied.

1.6.1 A rated minimum efficiency of \( \geq 82.4\% \) must be selected for electric motors with a rated output capacity of less than 0.75 kW.

1.6.2 Efficiency class IE3 must be selected for electric motors with a rated output capacity between 0.75 kW and 375 kW.

1.6.3 A rated minimum efficiency of over 96% must be selected for electric motors with a rated output capacity of more than 375 kW.

1.6.4 The frequency converter to control the speed of electric motors and drive units must be designed to suit the rated current of the motor (electric motor rating plate and information provided by the manufacturer of the frequency converter).

Note:
Discrepancies or changes, such as the selection of a lower efficiency class, are only possible with the agreement and corresponding approval of the customer.
2. Pumps

2.1 Procurement criteria

2.1.1 Pumps must be selected for the actual operating point. They are designed on the basis of delivery rate and delivery head which correspond to the operating point with the best efficiency level.

2.1.2 Pumps must be selected on the basis of the highest efficiency level at the relevant operating points.

2.1.3 A comparison of the life cycle costs must be carried out. For applications which run at part load a great deal, this must be done using a load profile and part load efficiency rates and if necessary frequency converters must be used.

2.1.4 Appropriate fittings, valves and system components with a low pressure level and pressure loss must be purchased.

2.1.5 The design form of the pumps for installations must be adjusted to this site situation. Example: Inline or block design

2.1.6 High-efficiency motors must be used (asynchronous motors, if possible EFF1 or IE3)

2.1.7 Information for the delivery of spare pumps and spare parts from the manufacturer must be available.

2.1.8 An energy-efficient control system which suits the demand must be provided.

2.1.9 For the procurement of new impellers, high quality materials with low surface peak-to-valley values must be used.

2.1.10 Low-loss pipelines must be used. This relates to an adequate diameter as well as pipe materials with low peak-to-valley values.

2.1.11 The flow velocity is recommended by the manufacturer must be used.

2.1.12 Spur lines are to be avoided. Ring lines are to be installed.

2.2 Control system

The following versions are possible for the design of control systems.

2.2.1 Fixed all manual capacity control

This should be possible in three settings for delivery rates between 50% and 100%. Time clocks and pressure sensors may also be used to control fixed operating points.

2.2.2 Variable control of delivery rates using frequency converters

This generally relates to delivery rates between 25% and 100%.

2.2.3 Multiple pumps

The connection of pumps in parallel is an alternative to a speed control system. The benefit of this is lower susceptibility to failure.

2.3 Installation

The following applies to new installations and repair work

2.3.1 A suitable location is to be selected by agreement, if possible close to the main consumers.

2.3.2 It must be ensured that the pump is installed correctly relative to the route of the pipeline at the point of installation. This relates to the vertical / axial inlet and the dimensions. The intake and discharge sides should have zero stress.

2.3.3 A vibration damping system to minimise vibrations / noise emissions is to be installed on pumps with a rating of 7.5 kW or over.
2.4 Energy efficiency

When choosing pumps, a suitable energy efficiency class must be selected. The appropriate verification document takes the form of the manufacturer's product data sheet or the calculation method set out in EC Regulations No. 640/2009, 641/2009 and 547/2012 together with IEC 60034-30. The following criteria must be satisfied.

2.6.1 Centrifugal pumps should have a minimum efficiency index (MEI) of $\geq 0.70$.

2.6.2 Wet rotor circulating pumps with a minimum hydraulic capacity of 1 W and a maximum hydraulic capacity of 2,500 W should have an energy efficiency index (EEI) of $\leq 0.20$.

2.6.3 On dry rotor circulating pumps the rotor in the spiral housing must be powered via a shaft by a high-efficiency electric motor.

2.6.4 The frequency converter must be designed for the rated current of the pump motor (as shown on the electric motor rating plate and the frequency converter manufacturer's information) and for continuous operation in the relevant frequency range.

Note:
Discrepancies or changes, such as the selection of a lower efficiency class, are only possible with the agreement and corresponding approval of the customer.
3. Fans

3.1 Procurement criteria

3.1.1 Fans must be selected for the actual required delivery rate.

3.1.2 Assess the efficiency levels of the fans in use and those being considered at various operating points on the basis of the fan's characteristic curve.

3.1.3 Select fans on the basis of the maximum efficiency level at the operating point.

3.1.4 The life cycle costs must be compared (for applications which involve a good deal of operating at part load using the load profile and part load efficiency levels; frequency converters are to be considered if applicable)

3.1.5 High speeds should be used unless there are operating or sound reduction reasons against them.

3.1.6 Use of efficient drive units, such as flat belts or direct power transfer.

3.1.7 If V-belts are used, they should be designed so that the belt speed does not exceed 20 m/s. The design must be based on the manufacturer's catalogue.

3.1.8 It should be possible to control the running time of the fan to cover actual demand.

3.1.9 When selecting the motor, a good efficiency class should be used.

3.1.10 Pressure losses in the system are to be avoided.

3.1.11 Transport sections should be limited to what is absolutely necessary.

3.1.12 Noise emissions must be given due consideration.

3.2 Design types

Axial fans or radial fans should be preferred in ventilation systems. Cross current fans should not be used as a result of the lower efficiency levels.

3.2.1 Axial fans can provide high delivery rates with low pressure differentials (known as wall or window fans or table-top fans). As the pressure differential increases, the delivery rate falls rapidly. The benefit is that they have a lower space requirement compared to radial fans.

3.2.2 Radial fans can achieve efficiency levels of 85% or more. They make sense for systems for high capacities and long running times or in systems with large delivery rate fluctuations but a relatively constant pressure drop.

3.3 Control system

A control system must be considered in the event of variable delivery rates. A vane or speed control system may be considered for these fans.

3.3.1 Vane control system

With a vane control system running at constant speed, the flow is twisted before it enters the rotor by means of adjustable blades. Targeted use for high capacity. The perfect control setting is around 60% to 100% of full capacity.

3.3.2 Speed control system

Controlling the speed using a frequency converter allows the current of air to be controlled as required for part load applications. New systems must be fitted with frequency converters. The perfect control setting is around 30% to 90% of full capacity.
4. Frequency converters

4.1 Procurement criteria

4.1.1 The calculation of the life cycle costs for systems with and without frequency converters should be documented and show the load profile and consumed power.

4.1.2 Manufacturers with high quality, industry and application experience are to be preferred.

4.1.3 Frequency converters with a high efficiency level are to be selected.

4.1.4 Frequency converters must have a power-down function to reduce standby losses.

4.1.5 The facility to reuse braking energy, for example for hoisting applications, centrifuges, conveyor belts, presses, etc. must be considered.

4.1.6 A large reduction in speed may cause unstable operation and resonance on axial fans. The characteristic curve and power curves should be considered when selecting fans.

4.1.7 High switching frequencies increase heat generation and/or additional filters cause thermal losses. It must be ensured that an efficient cooling is provided (for example frequency converter with large capacity, several frequency converters in one control cabinet).

From an energy point of view, frequency converters should be preferred for the following applications:

- Pumps and fan systems with variable delivery rates which operate all year
- Compressors
- Conveyor belts, centrifuges and mixers

4.2 Insulation

We recommend motor coil installation which complies with DIN VDE 0530. Additional measures must be taken (for example throttles or filters) for motors for wet rotor pumps and for older motors as well as for motors for potentially explosive atmospheres.

4.3 Earthing, shielding

The harmonic waves generated by the frequency converter induce a voltage in the motor shaft which is discharged via the bearings. This causes increased wear. Therefore, both bearings should be insulated on large motors and have a brush to earth the shaft.

Compliance with the statutory regulations concerning electromagnetic compatibility and low voltage is mandatory.
5. Compressed air

5.1 Procurement criteria

5.1.1 Compressors must be selected for the actual compressed air demand. Oversizing must be avoided.

Compressors are to be compared using the specific capacity demand as set out in ISO 1217 Annex C. The compressor with the lowest life cycle costs is to be selected. In addition to the purchase costs, the maintenance and energy costs over a period of five years must be included in the consideration.

5.1.2 Facilities to recover heat must be considered (see also 4.5).

5.1.3 A controller must be provided for variable compressed air consumption and to take account of the position of the compressed air compressor in the cascade (for example base load or peak load).

5.1.4 Where possible, machines and tools with a low pressure level are to be purchased.

5.1.5 Pipeline components with the lowest pressure loss are to be purchased. Examples: valves, ball cocks, couplings, filters, dryers, etc.

5.1.6 Low loss PU hoses are to be used (hose reels rather than spiral hoses)

5.1.7 Connections should not be bolted or sealed with hemp but should be welded or glued and bolted with radial O rings.

5.1.8 Pipes with an adequate diameter are to be used.

5.1.9 Spur lines are to be avoided. Ring lines are to be installed.

5.2 Estimate / Measure compressed air demand

In advance an estimate or measurement of compressed air demand must be carried out. This relates to the following parameters:

- Operating times
- Required pressure level from the machine data sheet [bar].
- Compressed air required in [m³/min]
- Required compressed air quality to ISO 8573-1 or VDMA 15390
- Synchronicity estimate

5.3 Dryers for treating compressed air

The following specifications apply to the selection of dryers.

5.3.1 Refrigeration dryers are the most efficient dryers for applications with a pressure dew point above +3°C to ISO classes 4, 5 and 6.

5.3.2 Adsorption dryers are suitable for dry air to ISO Classes 1, 2 and 3.

5.3.3 Regenerative adsorption dryers should be powered by compressor waste heat or steam. These are more efficient than cold regenerative systems.

5.3.4 Membrane dryers should only be used as endpoint dryers.

5.3.5 Electronic all level-controlled condensates drains are to be provided which are controlled on the basis of the actual amount of condensates generated (dew point).
5.4 Cooling

The installation, running and maintenance costs for the cooling system are to be included in the procurement or alternative considerations for heat recovery. This relates to power consumption, compression refrigeration and recooling, fans and the installation of ducts and pipelines.

5.5 Heat recovery

The ways of recovering heat must be included in the consideration. Around 80% to 90% of the electrical power of a compressor is available as heat capacity. The thermal recovery capacity should be at least 70% of the electricity consumption of the compressor in rated operation.

Possible applications include the following:
- Hot air to heat the building in winter
- Utility water heating
- Preheating combustion air or boiler feed water
- Drying and heating processes
- Drying compressed air

5.6 Site selection

The following specifications apply to site selection.
- Installation is close as possible to the main consumers
- Ensure it is possible to install and maintain the system
- Possible connections for heat recovery purposes
- Existence of a sewer connector for condensate
- Possible sealing of the floor, no fitted floor drain to prevent the escape of oil
- Supply of cool, clean feed air and filtration/cooling
- Prevent under cooling (below around +5°C). This particularly relates to systems with heat recovery.
- Plan the installation of the waste air discharge as far as possible away from the feed air

5.7 Energy efficiency

When choosing pumps, a suitable energy efficiency class must be selected. The appropriate verification is to be provided in the form of the manufacturer’s product data sheet or the calculation method pursuant to the EC Directive. The following also applies.

5.7.1 High level controller for multiple components
In the event of multiple single compressors supplying to the same consumer network, a high level controller must control the function of the various compressors to ensure that the compressed air demand can be covered in the most energy-efficient way (for example operation in a common pressure range).

5.7.2 Seal verification
When systems and pipelines undergo an acceptance procedure, verification must be provided that they do not leak. Ultrasonic measuring equipment for identifying leaks may be used for this purpose.

5.7.3 Verification of heat recovery
Verification of heat recovery is to be provided in the form of a calculation on the basis of the product data sheets for the heat exchanger and compressor.
6. Refrigeration systems

6.1 Procurement criteria

6.1.1 Refrigeration systems must be designed to suit the actual refrigeration demand.

6.1.2 To achieve lower cooling loads, an advance inspection should be made to minimise heat sources. In addition, a system must be coordinated to suit existing consumers.

6.1.3 Compressors with the highest rating ($\text{kWh}^{\text{elec}} / \text{kWh}^{\text{Refrig}}$) are to be preferred.

6.1.4 It should be ensured that the temperature differential between evaporation and condensation is low since this causes the rating to increase.

6.1.5 The various compressor types must be tailored to the application.

6.1.6 A smart control system and load management system must be provided.

6.1.7 A holistic approach should be taken to the system integration.

6.2 Control system

Essentially the following control methods are possible.

6.2.1 Bypass on-off control system for reciprocating compressors
Recommended for large refrigeration storage vessels for temporary storage (best energy balance)

6.2.2 Idling control system to reduce motor switching cycles (energy consumption up to 30% of full capacity)

6.2.3 Infinitely adjustable load control system based on the intake throttle principle for delivery rates between 85% and 100%.

6.2.4 Control using frequency converters for delivery rates between 25% and 85%.
A frequency converter can also reduce the activation currents.

6.2.5 Use a control system for screw compressors to achieve the lowest possible idling times.

6.3 Heat recovery

The use of a heat recovery system should generally be considered.

The discharge temperature at the condenser can be used for the following purposes:

- Hot water preparation
- Heating system support

6.4 Site selection

The following points must be considered when selecting the site.

- Installation as close as possible to the main consumers
- Ensure it is possible to install and maintain the system
- Possible connections for heat recovery purposes
- Possible sealing of the floor, no fitted floor drain to prevent the escape of oil
- Supply of cool, clean feed air and filtration/cooling
- If the air is cooled, avoid under cooling (particularly for heat recovery)
- Plan the installation of the waste air discharge as far as possible away from the feed air
7. Lighting

7.1 General

For modification work or replacement investments, the lights should be converted to LED systems in areas which are illuminated for at least one shift per working day. For areas with a lower lighting duration, the calculated life cycle costs of the LED lighting can be compared to those of alternative lighting over the lifetime of the longer lasting alternative and the results included in the selection process. Neighbouring areas must have a standard light colour.

7.2 Procurement criteria

The following criteria must be satisfied.

7.2.1 Colour reproduction CRI/Ra > 80
7.2.2 Glare value UGR ≤ 19
7.2.3 Light colour
   - Office areas 4000 - 6000 K
   - Production areas 5300 - 6000 K

7.3 Design

To design high-efficiency lighting systems, the principles set out in DIN EN 12464-1 (Light and lighting – Lighting of workplaces) must be observed.

7.3.1 Brightness
   - Minimum brightness in the ambient area: 300 LUX
   - Minimum brightness of the working area (at working height): 500 LUX
   - Minimum brightness for sight work: 750 LUX

7.3.2 Mark
The lights and lamps must have a CE mark. In addition certification to VDE or ENEC (European Norm Electrical Certification) and the test seal of an approved test institute must be ensured.

7.3.3 Daylight-dependent control and presence control systems
Appropriate light sensors and the integration of control and regulation equipment for daylight-dependent control and presence control systems are to be used.
The specifications of VDI Guideline 6011 (Improvement of daylight usage and artificial lighting) must be satisfied.

7.3.4 Minimum service life and warranty
Lights and lamps must provide a minimum service life and a warranty period of 5 years.

7.4 Correct choice of glare value

Depending on the difficulty of various sight work, different UGR values must be satisfied to comply with DIN EN 12464-1:

- UGR ≤ 16: Technical drawing
- UGR ≤ 19: Reading, writing, teaching rooms, computer work, inspection work
- UGR ≤ 22: Working in industry and trade, reception
- UGR ≤ 25: Rough work, staircases
- UGR ≤ 28: Hallways
8. Energy meters

8.1 Procurement criteria

Energy management is a control instrument to ensure that energy consumption and energy costs are permanently reviewed and discrepancies are detected immediately. The measuring data to identify the success of the measures, document them and evaluate them in monetary terms.

The locations of measuring points must be defined by agreement with the Facility Management Department and the energy officer. The following specifications apply to procurement.

8.1.1 Electricity meters
- 1 or 3-phase
- 50 Hz – alternating current up to 480V
- Accuracy class 2 or higher
- Installed on DIN rails or by agreement
- Record active energy, reactive energy, active power and reactive power
- Mandatory interfaces: S0 interface and M bus

8.1.2 Gas/Water meters
- Designed to suit the delivery rate
- Interfaces: S0 Interface (mandatory) and M bus (additional, optional)

9. Energy supply contracts

Energy purchasing contracts are tendered using historic consumption values and load curves. The supplier is primarily selected on the basis of commercial criteria. In the event of identical costs and services, the supplier providing the greener energy is to be preferred.

The provision of online access to a customer portal for monitoring loads and energy consumption is desirable.

10. Miscellaneous

When purchasing relevant energy consumers, their energy efficiency must be given due consideration. This also relates to systems for using waste heat and heat recovery.

Discussions must be held with the energy and environmental officers for devices and systems which are not regulated by these procurement criteria.

Efficient high and low temperature insulation on systems and system parts must also be considered during the planning phase of building projects. These objectives must be implemented in accordance with the statutory regulations.

We continuously establish measures to save costs and energy when erecting new-builds and extensions. We believe that it is a matter of course that our partners will investigate the possibility of subsidies or grants and will include them in their plans.