Improvement actions: Hydraulic system according to ISO/DIS 14955-1				
No.	**Requirements on**	**Description**	**Relevant for machine type**	**Estimated Energy savings**
1	Selection of optimal drive subsystem (motor-pump system)	- Different function sequences create the need for pump system which match the requirements profile;- Power on demand depending on the load cycle;- Select the correct size and type of motor and pump to avoid over-dimensioning and operate the pump in the optimal efficiency range; - Temporary storage of hydraulic energy (e.g. accumulator charging operation) to achieve the best possible match between the pump drive and the load cycle and to compensate for demand peaks (potential downsizing); - Speed controlled pumps allow pressure control with variable speed instead of control valves; - Use switching valves with optimized technology; -(e.g. alternative control via Pulse Width Modulation or use of low power solenoids when applicable).	Metal cutting	3,7 – 4,5%
2	Selection of the optimal drive subsystem (motor-pump system)	Different functions sequences create the need for pump systems which match the requirements profile (pump combinations, e.g. high pressure/low pressure, variable or fixed-displacement pumps). Power on demand depending on the load cycle (constant speed in intermittent operation, variable speed (pole change, speed control/regulation with servo motors or asynchronous motors) Select the correct size pump to avoid over-dimensioning, and operate the pump in the optimal efficiency range. Temporary storage of hydraulic energy to achieve the best possible match between the pump drive (e.g. accumulator charging circuits) and the load cycle, and to compensate for demand peaks (so that drives and pumps with a lower output rating can be used).	Mechanical Press; Servo Press; Hydraulic Press	
3	Oil cooling	Use water cooling instead of air cooling. Water cooling is more efficient and water may be used in facillity for other purposes. Recovering cooling energy can be used for e.g. floor heating or warm water supply.	Mechanical Press; Servo Press; Hydraulic Press	3,1 – 3,6%
4	ISO 4413 shall be applied		Mechanical Press; Servo Press; Hydraulic Press	
5	Reduce hydraulic losses/leakage	- Use displacement control systems instead of throttle control systems;- Reduce internal leakage (e.g. seat valves in the accumulator charging unit or the clamping hydraulics);- Consider distributed supply strategies;- Apply leakage monitoring.	Metal cutting	3,1 – 3,6%

6	Match the pressure level to the load cycle and to the different actuators on the machine	Pressure adjustment using adjustable pressure relief valves or zero-pressure circulation. Use actuators which are designed to operate at the same pressure level (no pressure reduction losses). Pressure adjustment using pressure-controlled drive systems (e.g. variable speed drives, adjustable-pressure variable capacity pumps). Use pressure intensifiers for individual actuators which require higher pressure. On/Off or stand-by mode, giving due consideration to safety criteria.	Mechanical Press; Servo Press; Hydraulic Press	
7	Match the pressure level to the load cycle and to the different actuators on the machine	- Pressure adjustment using adjustable pressure relief valves or zero-pressure circulation;- Use actuators which are designed to operate at the same pressure level (less losses);- Pressure adjustment using pressure-controlled drive systems (e.g. variable speed drives, ...);- Use pressure intensifiers for individual actuators which requires higher pressure;- On/Off or stand-by mode giving due consideration to safety criteria.	Metal cutting	
8	Reduce hydraulic losses	Use displacement control systems in place of throttle control systems. Reduce internal leakage, for example through the use of seat valves in the accumulator charging circuit or the clamping hydraulics. Optimize the design of the hydraulic lines and reduce hydraulic resistance. Consider distributed supply strategies Use of pilot operated valves with low pilot oil consumption	Mechanical Press; Servo Press; Hydraulic Press	
9	Reduce power consumption on solenoid operated valves	Reduce power consumption for valve actuation; Reduce power consumption by using valves with 8 W solenoids when applicable.The possible use of low Watt solenoids is depending on the function, because of reduced switching forces.Reduce power consumption by using valve connectors with built-in automatic reduction of holding currentUse pulse valves (with detent) which only draw power during switching.;- Use pulse valves (with detent) which only draw power during switching (Hydraulik press);	Mechanical Press; Servo Press; Hydraulic Press	

10	Dimensioning of tubes and pipes	- Optimize the design of piping (length, diameter, …) and reduce flow resistance;Tubes and pipes cause friction losses and thus energy losses. Finally the tube or pipe causes a pressure drop which effects negatively to the energy balance of the machine tool. Length, inner diameter, flowrate and installation radius of tubes, pipes and fittings shall be optimised to the application;Functions shall be identified and described where this requirement is applicable.	Metal cutting	
11	Overall system	Optimization of total hydraulic system	Metal cutting	
12	Leakage monitoring	Internal leakage (e. g. loose fittings in reservoir, worn valves or pumps) leads to energy losses. Leakage monitoring detects exceeding flow.	Mechanical Press; Servo Press; Hydraulic Press	3,1 – 3,6%
13	Low flow resistance	Avoid losses caused by flow resistance e.g. by choosing valve dimension and spring characteristics in respect to optimized pressure drop.	Mechanical Press; Servo Press; Hydraulic Press	3,1 – 3,6%
14	High efficient auxilliary pressure generation	Avoid pressure relief valves or pressure reducing valves for pressure adjustment, generate pressure at propriate level e.g. by speed controlled pumps, pumps with variable flow, discontinuosly operating pumps (see 3-1).	Mechanical Press; Servo Press; Hydraulic Press	3,1 – 3,6%
15	Warm-up cycle	End warm-up cycle as soon as possible, use actual oil temperature to control warmup. If applicable change to hydraulic heating instead of electical heaters in respect to start temperature.	Mechanical Press; Servo Press; Hydraulic Press	3,1 – 3,6%
16	Oil temperature	Operate in optimal temperature range. Select oil viscosity grade suitable for the the expected ambient temperature range.	Mechanical Press; Servo Press; Hydraulic Press	3,1 – 3,6%
17	Minimize energy losses in power supplies	Usage of high efficiency transformer or voltage-proof converters instead of conventional transformers (e.g. controlled switching power for auxiliary power 24V).	Metal cutting	3,1 – 3,6%
18	Avoidance energy losses of power supplies	Avoid power losses in the transformer by use of e. g. voltage-proof converter, controlled switching power supply for 24V control voltage	Mechanical Press; Servo Press; Hydraulic Press	
19	Converter with power factor correction	Power factor in the infeed unit for feed operation and regenerative feedback saves energy losses.	Metal cutting	3,7 – 4,5%

20	High efficiency transformer	Load requirement of a machine tool is not constant during the cycle. Therefore it is more efficient to install transformers optimized on low Fe- losses instead of transformers optimized on low Cu- losses.	Mechanical Press; Servo Press; Hydraulic Press	3,1 – 3,6%
21	Thermal management regarding control cabinet	Optimized concept for thermal management of the control cabinet;1. Minimization of waste heat;2. If waste heat is not avoidable, it has to be dissipated (air cooling or water cooling); for reuse of thermal energy water is given a preference compared to air; further use of waste heat has to be checked/discussed with customer; 3. Controlled ventilation (fan).	Metal cutting	3,7 – 4,5%
22	Apply the simultaneity factor when designing the power system	Avoid oversizing of power supply leads to lower absolute energy losses. Avoid overload as well.	Mechanical Press; Servo Press; Hydraulic Press	3,7 – 4,5%
23	Converter/inverter with power factor correction	Power factor in the infeed unit for feed operation and regenerative feedback saves power losses.	Mechanical Press; Servo Press; Hydraulic Press	3,7 – 4,5%
24	Thermal management regarding control cabinet	Optimized concept for thermal management of the control cabinet;1. minimization of waste heat;2. if waste heat is not avoidable, it has to be dissipated (air cooling or water cooling); for reuse of thermal energy water is given a preference compared to air; further use of waste heat has to be checked/discussed with customer;3. controlled ventilation (fan);4. low maintenance air conditioner (no air filter) and thermostatic air conditioning with open-door-shutoff.	Mechanical Press; Servo Press; Hydraulic Press	3,7 – 4,5%
25	Lubrication flow depending on demand	Active mode of cooling and lubrication system. E. g.;- discontinuous operating pumps;- controlled flow rate;- adjustable pressure.	Mechanical Press; Servo Press; Hydraulic Press	3,7 – 4,5%
26	Low flow rate for lubrication pump	Install not more than sufficient pump flow and distributor instead of orifices	Mechanical Press; Servo Press; Hydraulic Press	3,1 – 3,6%
27	Demand depending controlled peripherals (..devices like mist extraction, chip	Active mode of oil mist exhaust system, depends on operating mode	Metal cutting	3,7 – 4,5%
28	Controlled peripheral devices like mist extraction, scrap conveyor, etc	Active mode of devices, dependent on mode of operation	Mechanical Press; Servo Press; Hydraulic Press	