1 RISK NUMBER – METHOD IN EXAMPLE TARGET

1.1 Ventilation system in example target

The example system TK1 from city hospital of Oulu includes both supply- and exhaust air units. The units are constantly running. There is a standard air current system in the premises, including cooling and heat recovery (figure 1). Heat recovery of air supply unit is executed water-glycol solution which transfers heat from exhaust air to supply air. There is a possibility to adjust the air currents using frequency converter. Also in the air supply of patient space is zone specific temperature control opportunity. In the supply air are two filters, short EU3 and after that long EU7. In the exhaust air is short class EU3 filter. Cooling radiators are not used, when temperature is under +15 °C. Patient spaces which are in the south-west, heating is executed by heat recovery, heating radiators and cooling radiators JP2. Patient spaces in north-east heating is executed by heat radiator LP1 and cooling radiator JP1. (Oulun kaupunginsairaalan ilmanvaihtosuunnitelmien loppudokumentit 2002.)

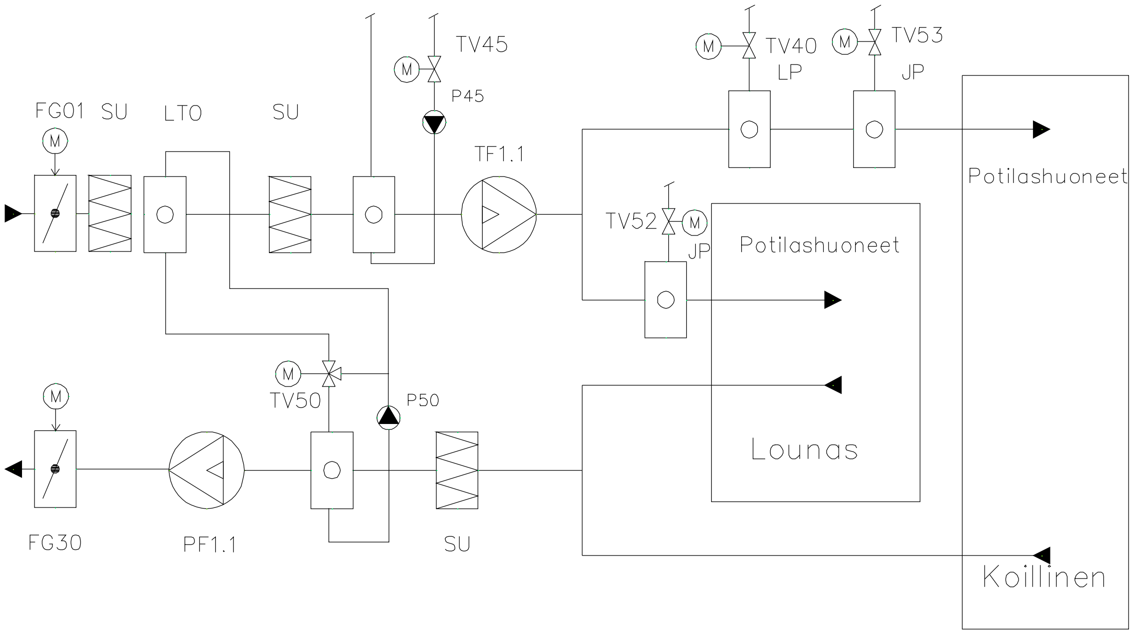

Fig 1. The diagrammatic picture of the ventilation system from the example target. (Oulun kaupunginsairaalan ilmanvaihtosuunnitelmien loppudokumentit 2002)

There is a monitoring room in the building from which the ventilation system among other things are controlled and adjusted. The system automatically reports to the monitoring room in case of malfunction. If the monitoring room does not acknowledge the alarm, information from the malfunction is funnelled into the central control room. From there the facility manager is informed about the situation by telephone. (Laine 2008.)

The ventilation system consists of following parts:

Supply air

Inlet grid
Inlet chamber
Fresh air damper
Heat recovery coil
Supply air filter
Heating coil
Heating coil circulation pump
Supply air fan
After-heat coil (northeast)
Cooling coil (northeast)
Cooling coil (southwest)
Supply air mufflers
Channel network
Supply air valves

Exhaust air

Exhaust air valves
Exhaust air mufflers
Exhaust air filter EU3
Heat recovery coil
Heat recovery circuit pump
Exhaust air fan
Exhaust air damper
Dump decomposer

Functioning of the ventilation unit TK1 is presented in the following.

Controlling the unit

Time program of control system command operation times of unit, it runs always. Exhaust air fan PF1.1 is locked to run of supply air fan. Freshairdamper FG01 is locked to exhaust air fan. Supply and exhaust fans channel to lower rotational frequency when outside temperature is under -17 ^{o}C. Circulation pump of heating radiator is always used. Heat recovery pumps start when it is needed.

Starting the unit

When the unit receives a starting command, dampers FG01 and FG30 open up. After the dampers are opened, supply and exhaust air fans start running.

Controlling the channel pressure

The frequency converter of the supply air fan is funnelled to correspond the pressure difference set to pressure-difference transmitter PE10. The frequency converter of the exhaust air fan is funnelled to correspond the pressure difference set to pressure-difference transmitter PE30.

Temperature control

Room's (southwest) supply air temperature is adjusted to set value according to temperature sensor TE11 by controlling in series the cooling valve TV52, heat recovery valve TV50 and heating valve TV45 in three steps. The set value is changed according to heat sensor TE31 to correspond the load conditions. Sensor TE11 operates also as a restrictive sensor.

Room's (northeast) supply air temperature is adjusted to set value according to temperature sensor TE13 by controlling in series the cooling valve TV53 and heating valve TV40 in two steps. The set value is changed according to heat sensor TE32 to correspond the load conditions. Sensor TE13 operates also as a restrictive sensor.

If temperature of water glycol solution which goes to heat recovery battery decrease under set point, opening of heat recovery valve is restrict so that it doesn't fog up.

Return water controller (ice protection thermostat) of heating radiator operates always by minimum limiter of return water temperature.

The lockings and precautions of the system

Alarms

To differential pressure transmitters PE10 and PE30 are programmed low limit alarms which inform when fan stopped or strap get broken. Alarms don't accept if fan has not running permission. From the circulation pump of the heating radiator receive a conflict alarm if pump doesn't work. From the heat recovery gets also conflict alarm if the fan doesn't work. The differential pressure measuring gets unclean filter alarm.

Stalling the supply air fan

When Exhaust air fan PF1.1 stagnates fresh- and exhaust dampers closing. Ventilator of front heat radiator follows the control of return water adjuster. Return water adjuster control according to measuring result of measuring sensor TE45 heating ventilator TV45 keeping the return water temperature in setting value.

When circulation pump of front heating radiator stagnate or ice protection thermostat go off exhaust air fan stagnate and the alarm goes off. Other functions as in point supply air fan stalling. Fans are frequency transformer passing couplers, which give the indications when the couplers are in passing position.

1.2 Risk factors of the target

Table 1 presents an analysis of the example target based on risk number –theory. The ventilation system TK 1 is divided into parts, description presented above. Each risk factor has been evaluated numerically based on the severity S, probability of hazard Po and the probability of detection Pd. The risk number RPN is the product of these numerical values. By comparing these values the biggest risks of the system can be evaluated from the chart.

Table 1. Risk number -sheet

Part of system	Drawback	S	P_o	P_d	RPN
Inlet grid	Placement	5	4	4	80
	Cleanliness	5	4	3	60
Inlet chamber	Placement	4	4	4	64
	Cleanliness	3	5	4	60
Heat recovery device	Adjustment	3	4	2	24
	Maintenance	3	5	7	105
	Sizing	6	3	5	90
Filters	Filtration level	8	1	2	16
	Maintenance	8	5	4	160
	Tightness	7	4	7	196
	Cleanliness	7	6	2	84
Heating coil	Sizing	8	2	5	80
After heating coil	Sizing	6	2	5	60
Cooling coils	Sizing	6	4	5	120
Mufflers	Sizing	3	4	4	48
	Placement	3	3	3	27
Channel system with instrumentation	Balancing	6	5	2	60
	Tightness	6	3	2	36
	Cleanliness	8	5	6	240
	Adjustment	7	5	2	70
Terminal equipment	Placement	7	4	7	196
	Subtemperature	8	5	2	80
	Air current	7	4	3	96
Fans	Air current	7	5	3	105
	pressure product	7	5	3	105
	Adjustment	6	3	2	36

In this analysis each drawback has been evaluated based on research data and literature. The following presents examples of what kinds of matters has been evaluated and perceived with each of the drawbacks.

- Air tightness: e.g. spillovers, tightness of casing or channel system
- Cleanliness: e.g. trashes, odors, snow, rain
- Placement: e.g. point of compass, placing of the valves, working places, draft possibility
- Adjustment: e.g. adjustment of the whole system, adjustment of the valves, balancing, quantity of air, assimilation to transient situations
- Temperatures: e.g. supply and exhaust air temperature, heat recovery efficiency, heaters ability to heat the air
- Sizing: e.g. power sufficiency in extreme conditions, freezing, fog up restraint, noise problems
- Air current: e.g. is air current sufficient, too much air?, draught?, how controlled, control based on CO_2, sizing principles.
- Maintenance: maintenance possibilities, maintenance interval, maintenance need
- Noise: e.g. noise movement, noise from fans and devices, noise suppression

In addition the aim is to evaluate the draft problems, fans ability to produce enough pressure, heat recovery method and needed filtering level.