SILO TEMPERATURE MEASUREMENT AND CONTROL SYSTEMS

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Spokesman: Marco A. Cortella

STORAGE OF CEREALS

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CONSERVATION → DYNAMIC PHASE

- The cereal is a living - breathing organism:

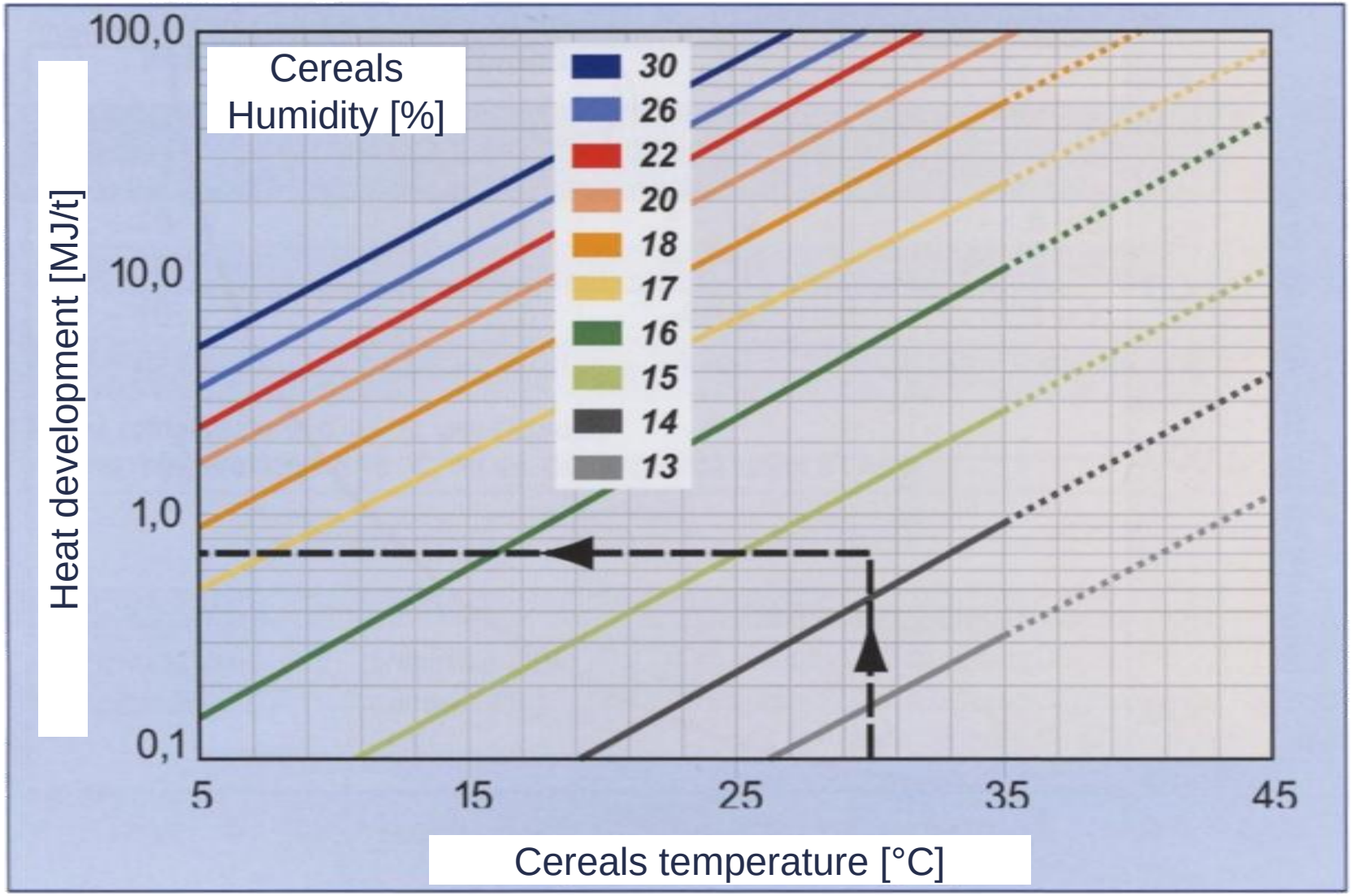
$$C_{12}H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O + 1{,}567.10^{-3}\,Kwh$$

carbohydrates + *oxygen* –› *carbon dioxide* + *water* + *heat*

- Heat + humidity: → weight loss
  → development of insects and rots
  → fermentation

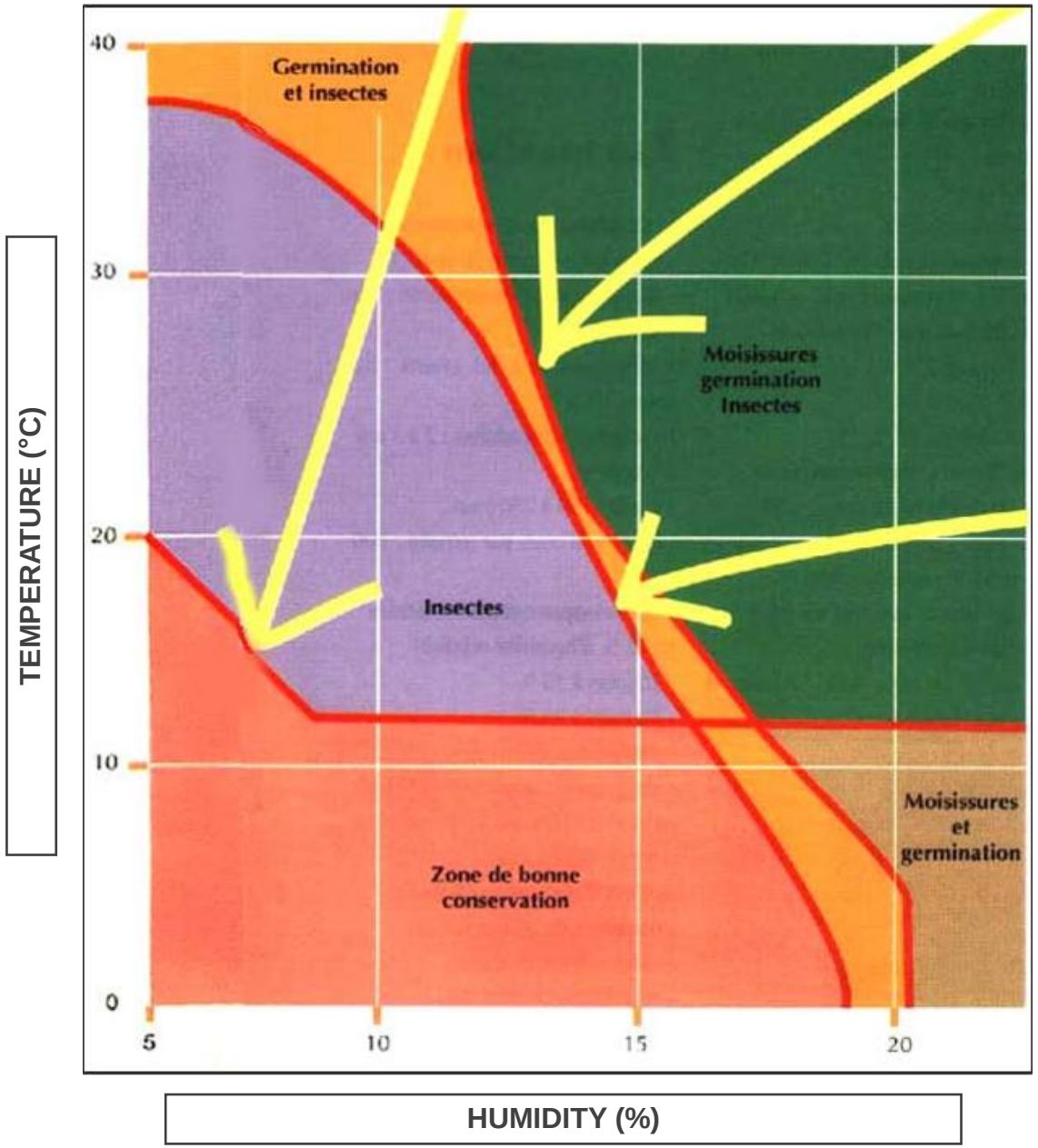
HEAT, TEMPERATURE AND HUMIDITY IN CEREALS

Humidity in cereals



Development of heat in modified grain storage according to Jouin

RISKS OF POOR CEREAL CONSERVATION



- low germinability
- mycotoxin development:
  (Ochratoxines, Fumonisines)
- insect development

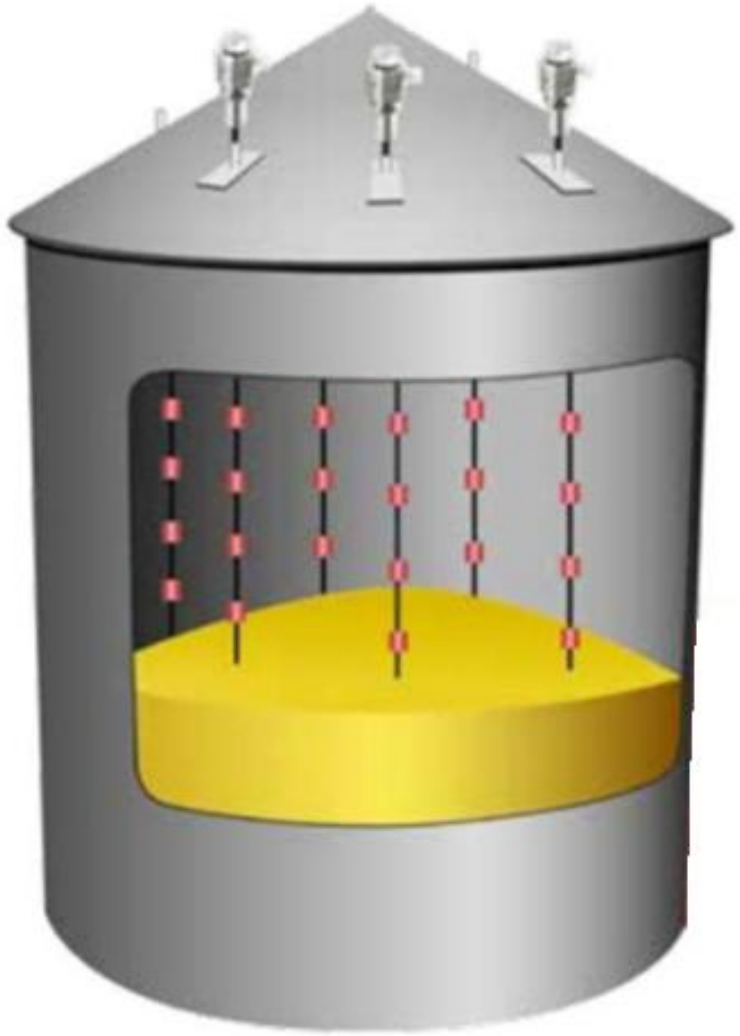
Sitophilus Zeamais Motsch

Sitotroga Cerealella

Rizopertha Dominica

- fire risk
- weight loss
- FINANCIAL RISKS!

TEMPERATURE MANAGEMENT/2



Temperature measurement and control systems are mainly composed by:

Multipoint termometric probes

Multiplexers (MUX)

Monitoring software

TEMPERATURE MANAGEMENT/2

Multipoint digital probes with protective sheet in SS304 for the temperature detection inside silos or shed for cereals and derivatives. Probes are in direct contact with the product (should be ATEX certified), capable to provide early warning.

The multiplexer MUX is a concentrator of the signals coming from the temperature probes. At each MUX can be connected various probes, each having usually up to 12 measuring points.

Software is specifically designed for the complete monitoring of the environmental parameters in storage plants. Its layout, highly customizable, allows the immediate display of the temperature profile inside each silo (or warehouse), with the evidence of those measuring points that may have exceeded the set alarm thresholds.

TEMPERATURE MANAGEMENT/reference, Djibuti – WFP storage

The first cereal storage plant implemented by the United Nations with total capacity of 40.000 tons composed of:

- 4x FP 23,84/32, 24m diam, h 35 m
- 10.000 tons, provided of lateral unloading system
- 4 x 250 t/h recept pit
- 4 quick loading silos CR 3,7/8 model for feeding of and 1 quick loading silos CR 3,7/10 model for the direct loading for trucks
- 2 Loading equipment with 250 t/h capacity and 1 unloading equipment with 250 t/h
- 2 magnets for cleaning phase

TEMPERATURE MANAGEMENT/reference, Djibuti – WFP storage

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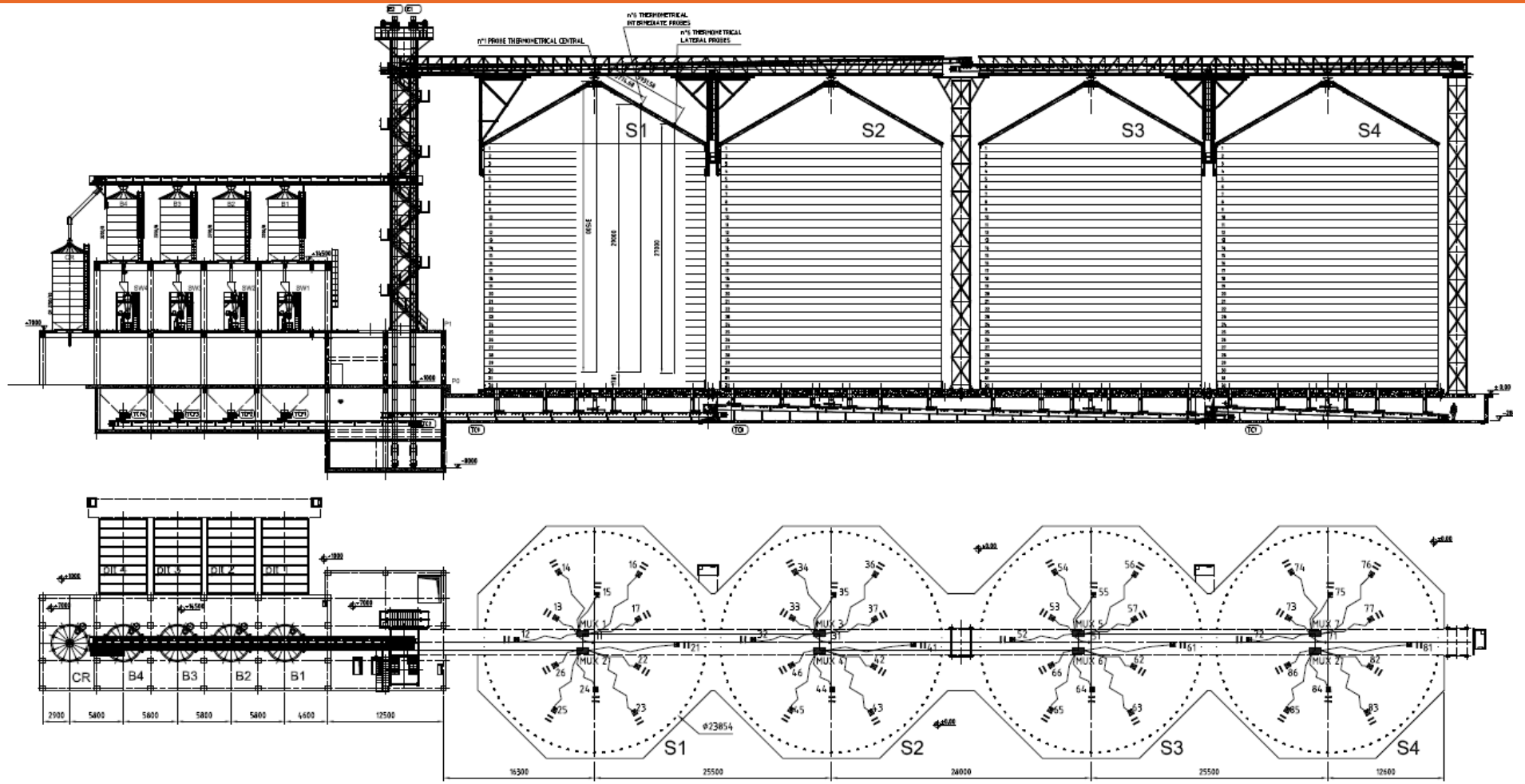

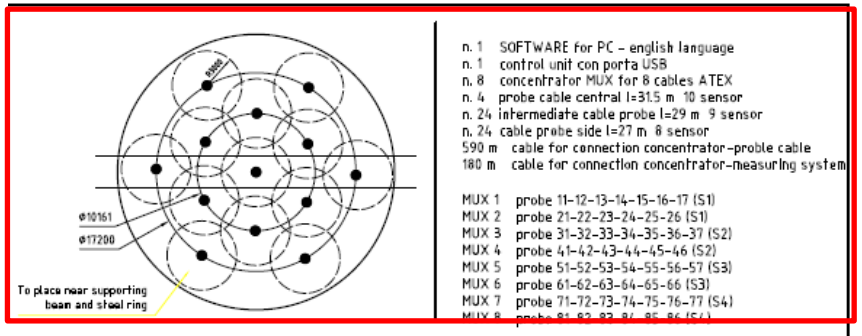

n. 1 SOFTWARE for PC – english language
n. 1 control unit con porta USB
n. 8 concentrator MUX for 8 cables ATEX
n. 4 probe cable central l=31.5 m 10 sensor
n. 24 intermediate cable probe l=29 m 9 sensor
n. 24 cable probe side l=27 m 8 sensor
590 m cable for connection concentrator-proble cable
180 m cable for connection concentrator-measuring system

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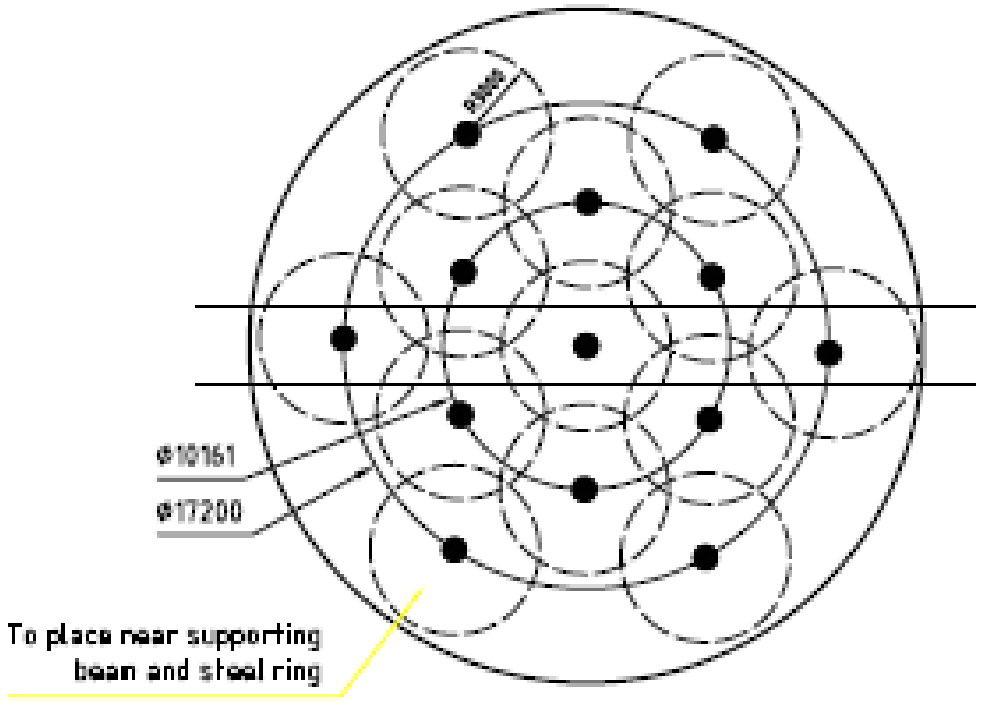

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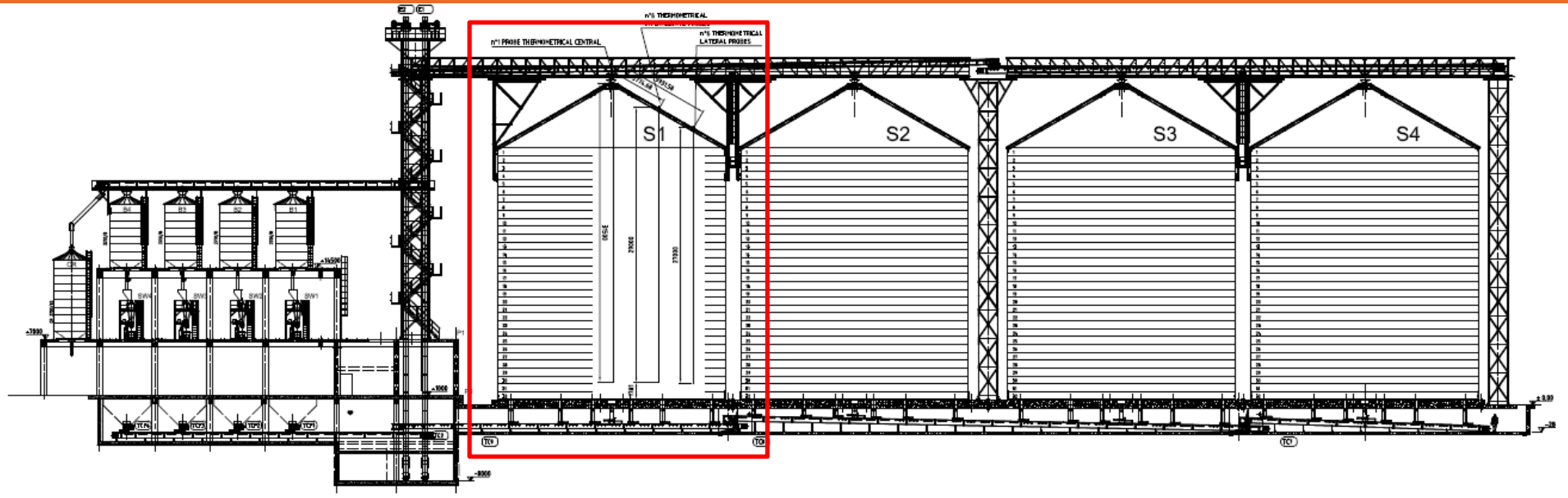

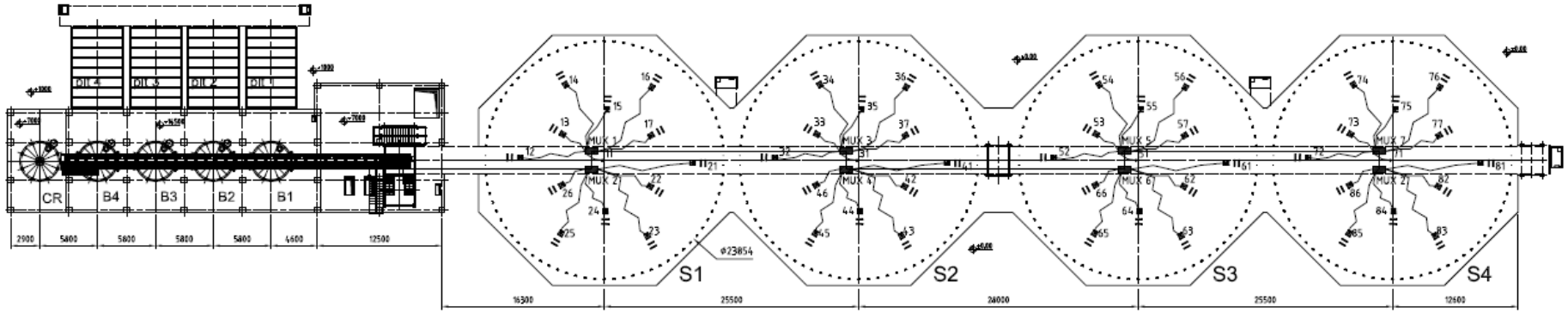

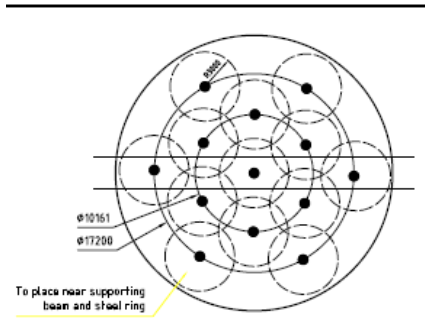

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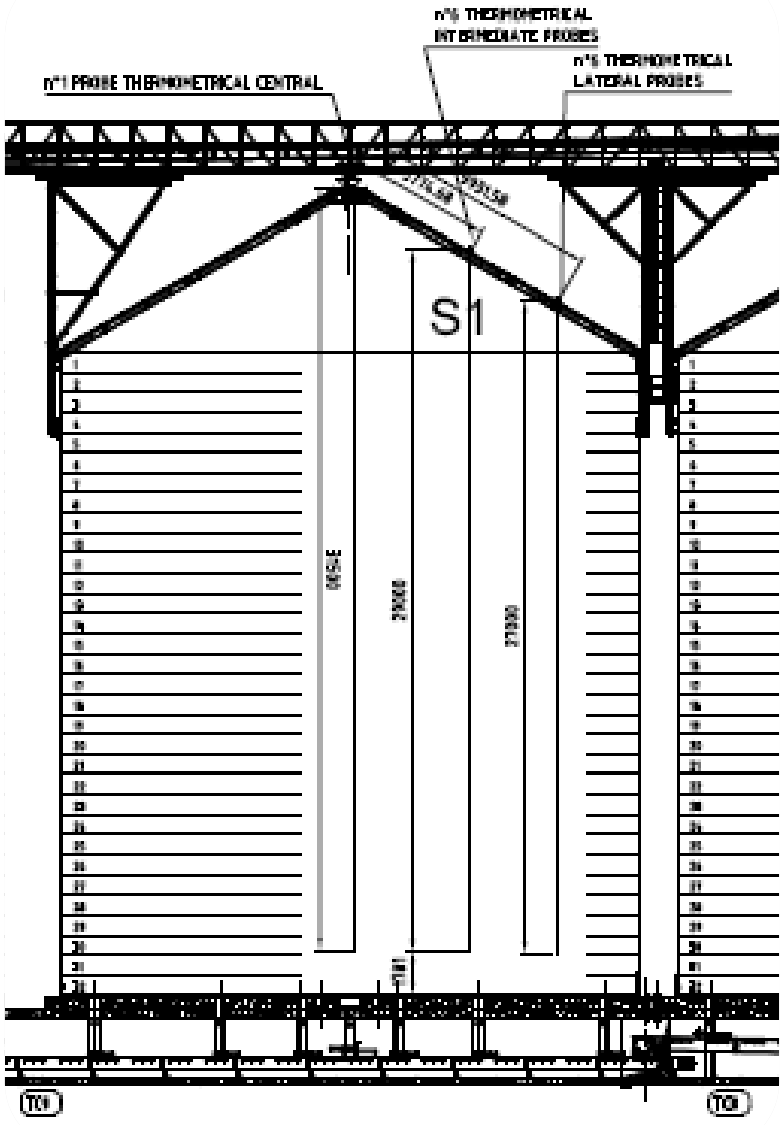

The position of the cables installed as already described in the penultimate slide:

- the central one is longer than the lateral ones, naturally due to the inclination of the roof

- the distance of sensitive points varies, they are usually placed at a distance of three meters

- cables length is not up to the floor, since the sweep augers need space to clean the silo from the residual cone.

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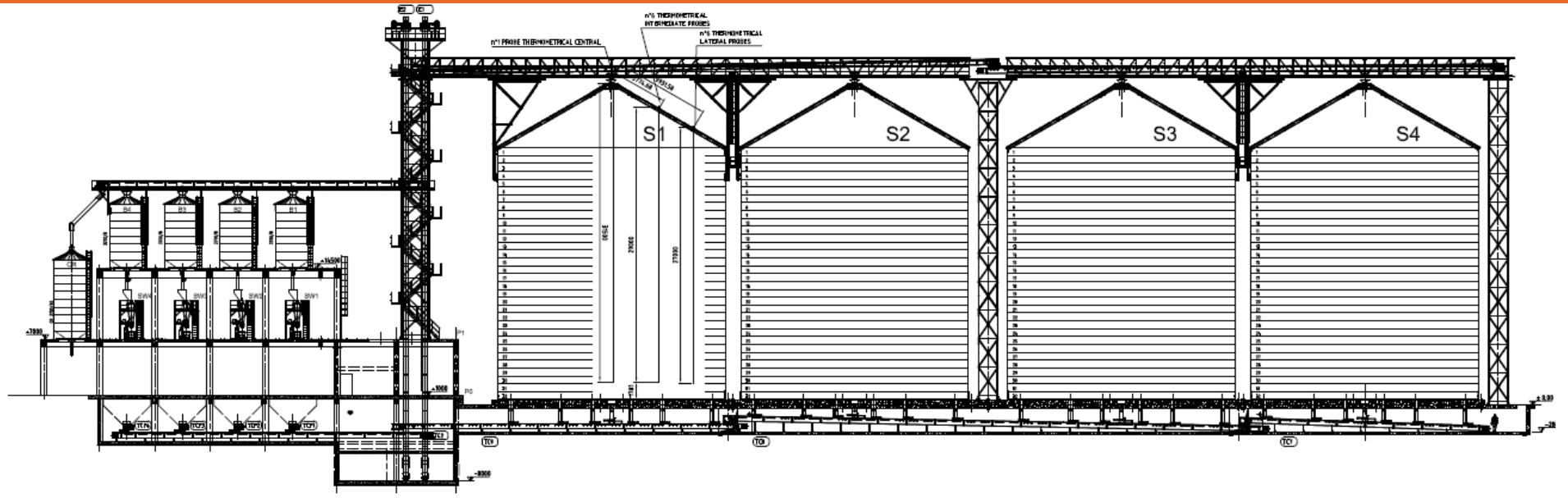

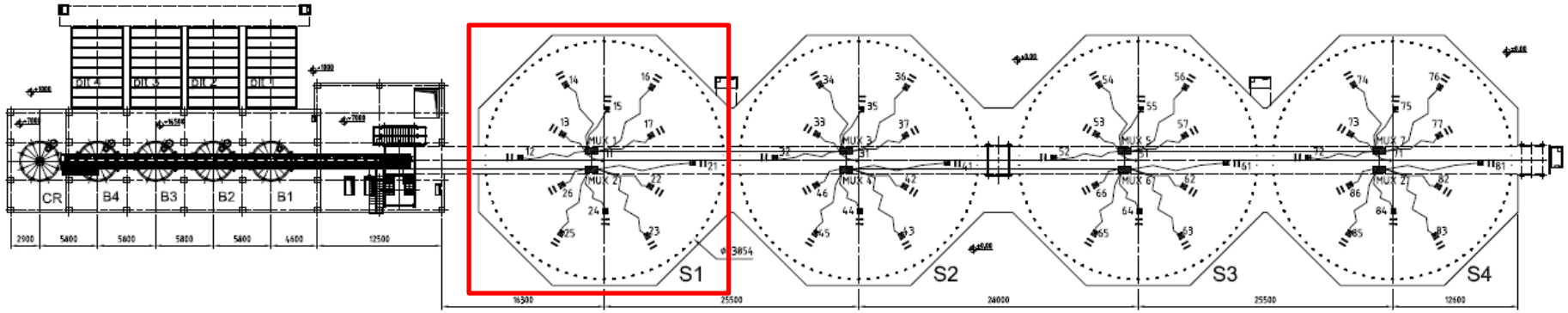

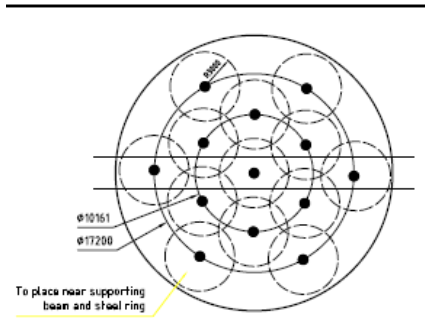

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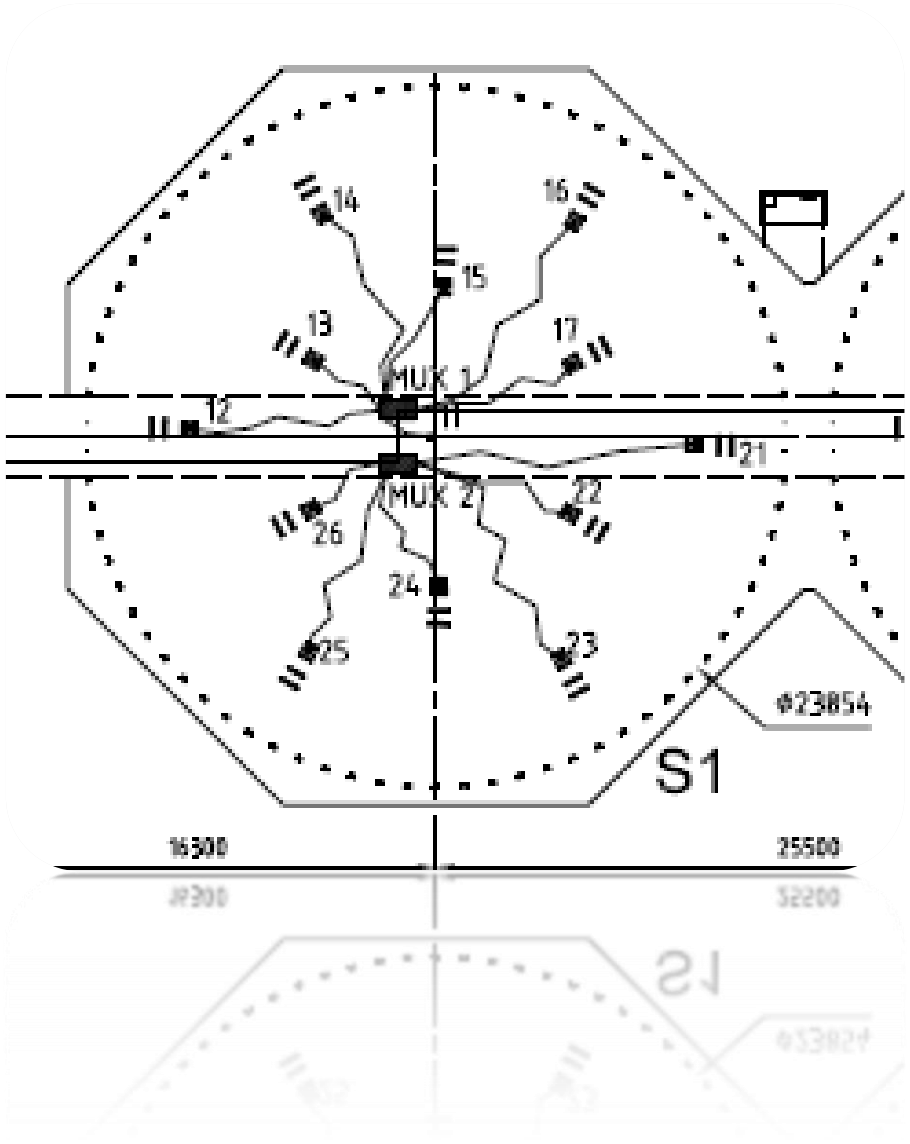
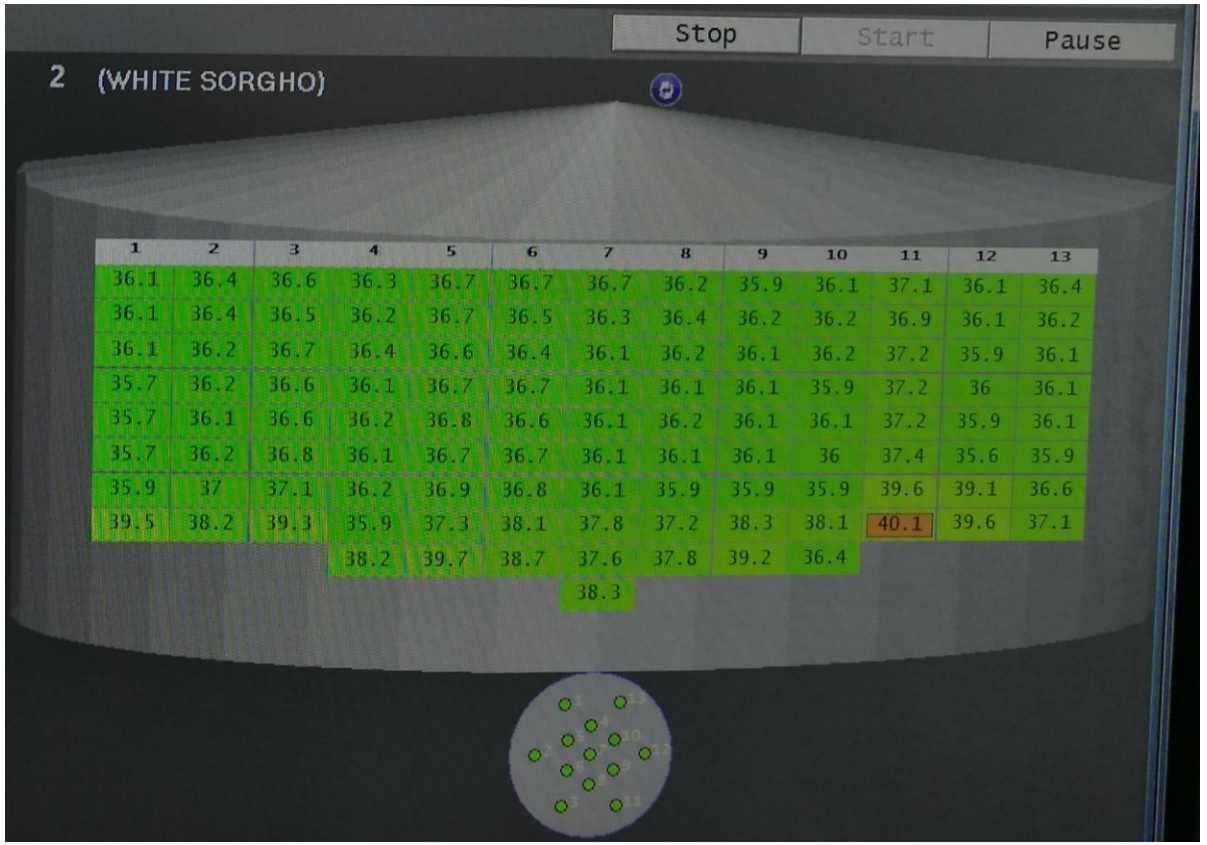
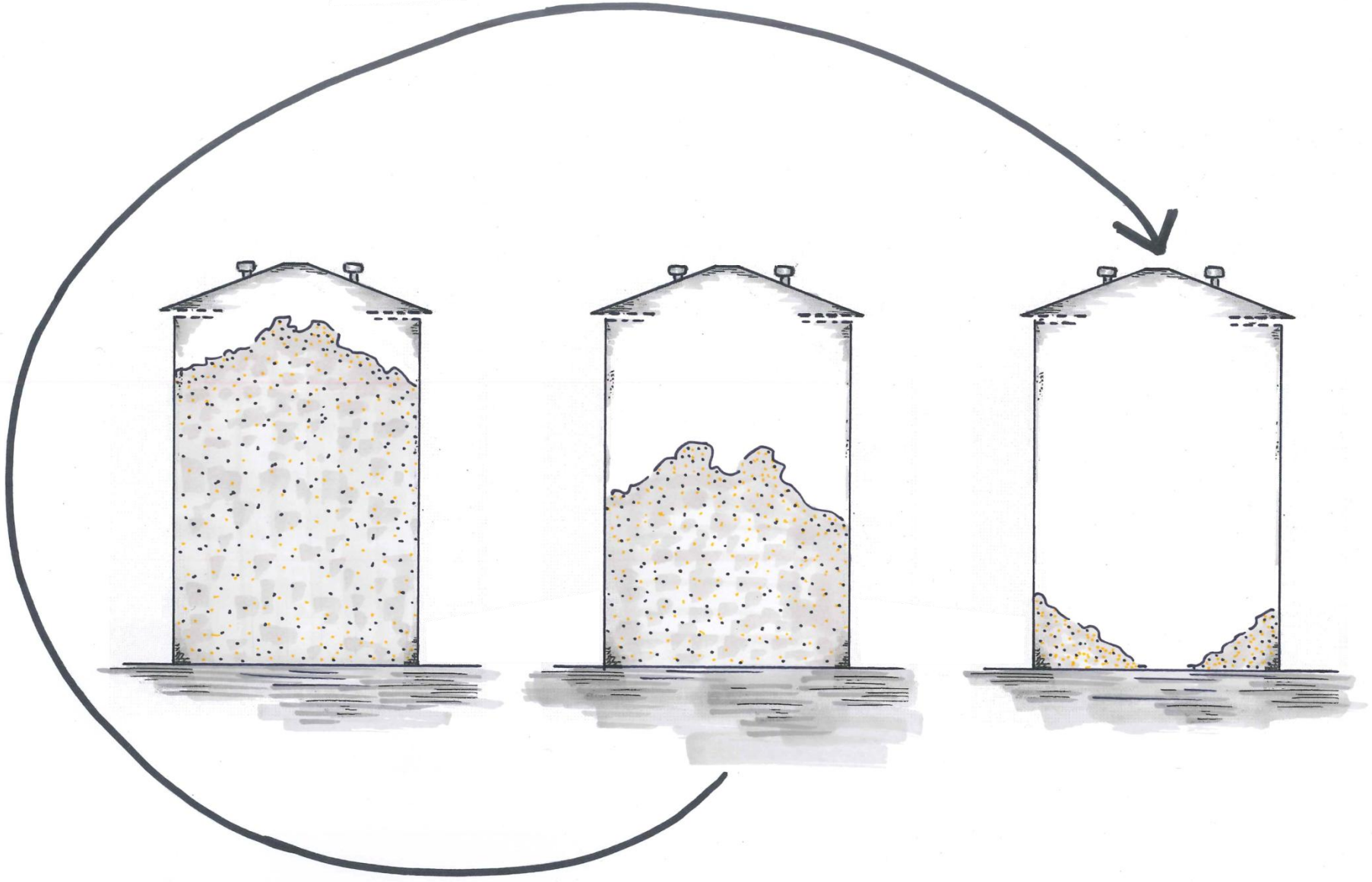




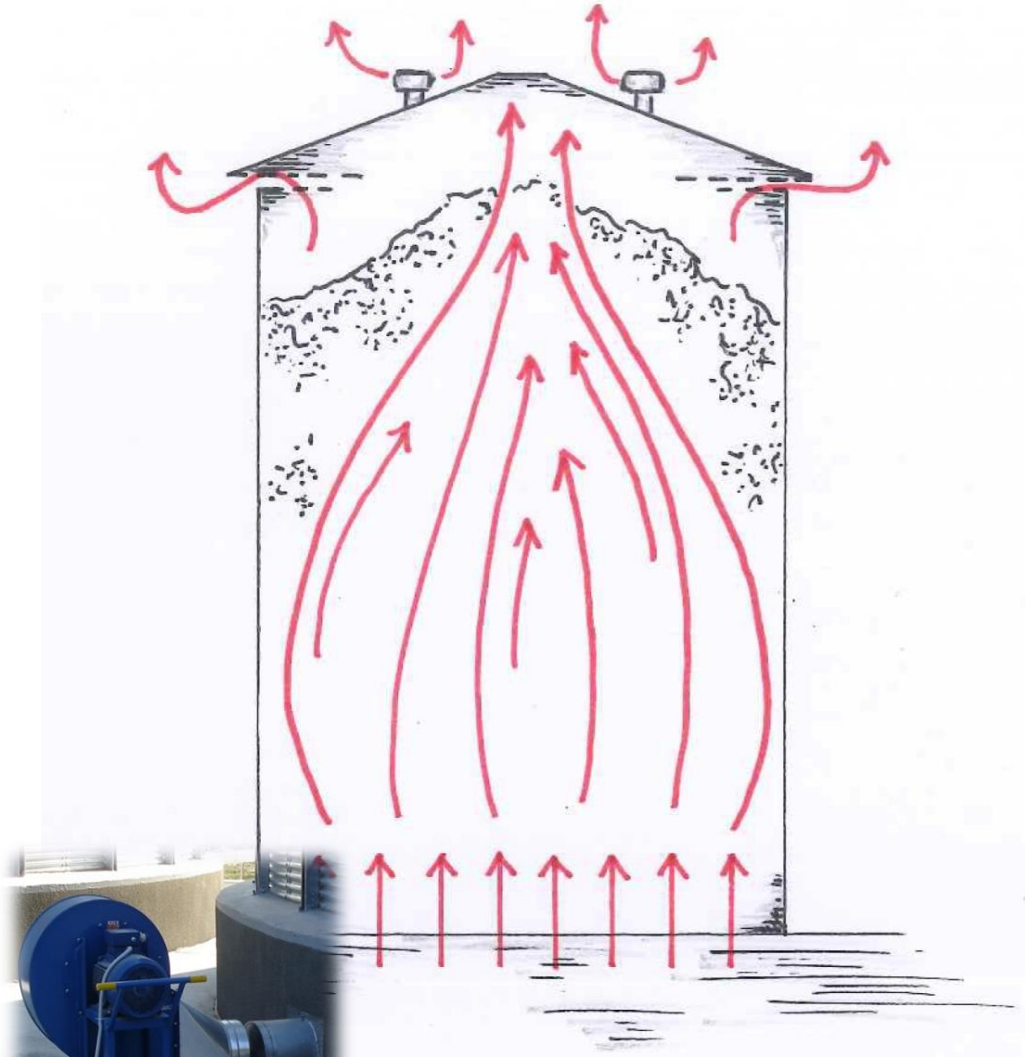
CONTROL SYSTEMS: TRADITIONAL CEREAL CONSERVATION

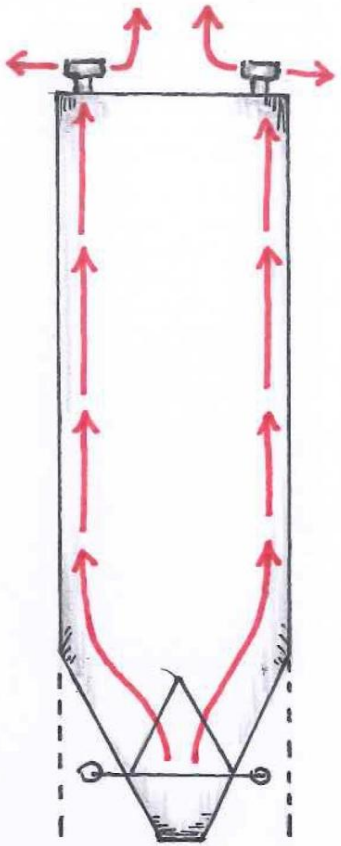
- Product **recirculation**: ➡ high cost and non-resolving method



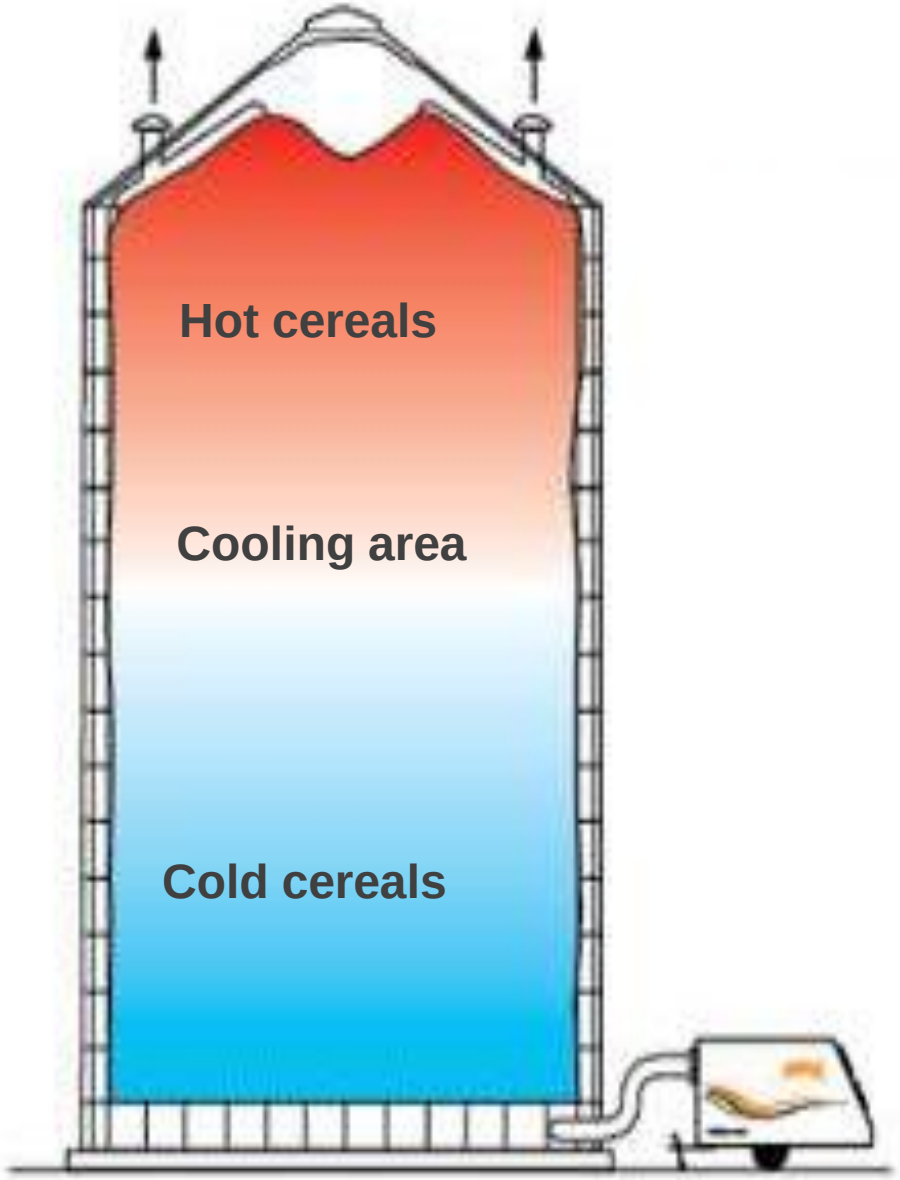
CONTROL SYSTEMS: TRADITIONAL CEREAL CONSERVATION

- Product **ventilation**: ➡ It is affected by the temperature and humidity of the environment





GRAIN REFRIGERATION



• Cereals have a very low thermal conductivity.

• When cereals are stored at a temperature of about 12° C with a relative humidity of less than 15%, the presence of mold is minimized and mycotoxins are not produced.

• It is estimated that a cereal stored at + 30 ° C with a moisture content of 14.5% has a weight loss of 0.96%, while with a storage temperature of + 15 ° C, this loss is reduced to 0.02%.

Thank you for your attention!