INDUSTRIAL
MOISTURE
GATE

IMG-P · WASTE PAPER BALES

Industrial Moisture Gate

Automated, non-destructive moisture measurement of the entire truck load — in less than one minute.

DUNAKONTROLL
MOISTURE INTELLIGENCE



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Today’s agenda

01 **Dunakontroll**

02 **The challenge of measuring moisture content in the processing industry**

03 **Industrial Moisture Gate for Waste Paper Bales (IMG-P)**

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- 3.3 Measurement Process
- 3.4 Handover Acceptance Criteria
- 3.5 Advantages & Benefits

01

About Dunakontroll

Moisture measurement solutions for fibrous materials — born in the paper industry.

DUNAKONTROLL
MOISTURE INTELLIGENCE

Rooted in the paper industry

1994

Born in Hungary, within the grounds of one of Central Europe’s largest paper mills.

2013

Launch of the first generation of HPNAs.

Global

Strong international presence.

Ownership

Austrian ownership with a lifelong career in the paper industry.

Management

Hungarian management.

Team

Professionals, engineers, mathematicians, physicists and an emeritus professor.

Brand

Rebranding activities.

Industries & product family

According to the client's requirements, **Dunakontroll** creates supplementary moisture content measurement devices for various fibrous materials and grains.

Pulp and Paper

IMG-P

Industrial Moisture Gate for Wastepaper Bales

Wood

IMG-W

Industrial Moisture Gate for Wood Logs

Pulp & Biomass

Chips

Wood Chip Moisture Gate on Conveyor Belt

Pulp & Biomass

IMG-S

Industrial Moisture Gate for Straw

01 · IMG WORLDMAP

IMG installations worldwide



02

The challenge

Measuring moisture content in the paper industry.

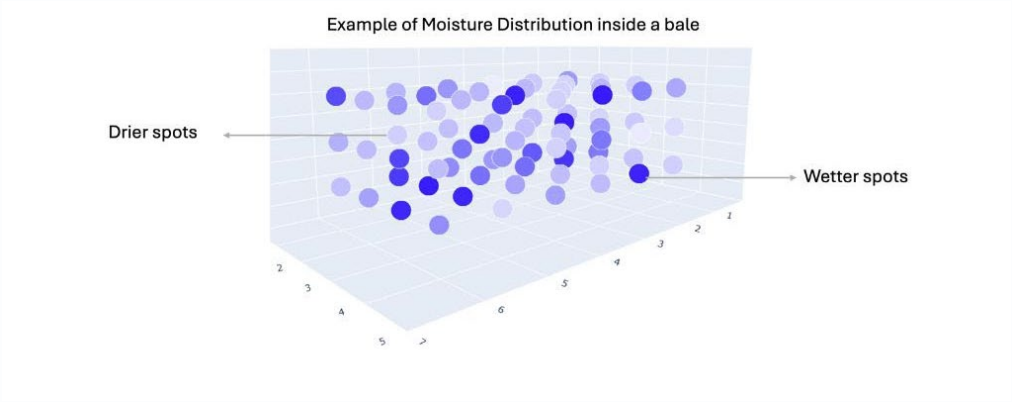


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02 · THE CHALLENGE

Highly inhomogeneous moisture

EXAMPLE OF MOISTURE DISTRIBUTION INSIDE A BALE



Wetter and drier spots are scattered unpredictably through the whole bale.





Readings taken only on the outside of the bale do NOT give even an indication of the overall moisture inside it.

Hand-held methods only measure:

- at selected spots and at a certain depth
- a very limited portion of the total volume
- without proper calibration

Result: inconsistent, inaccurate and non-representative moisture readings

02 · THE CHALLENGE

What precise measurement demands

How to measure the moisture content of raw materials...

1. in a representative manner
2. in substantial amounts
3. within a short period
4. without human intervention
5. furnishing decision-makers with transparent, real-time data?



03

IMG-P

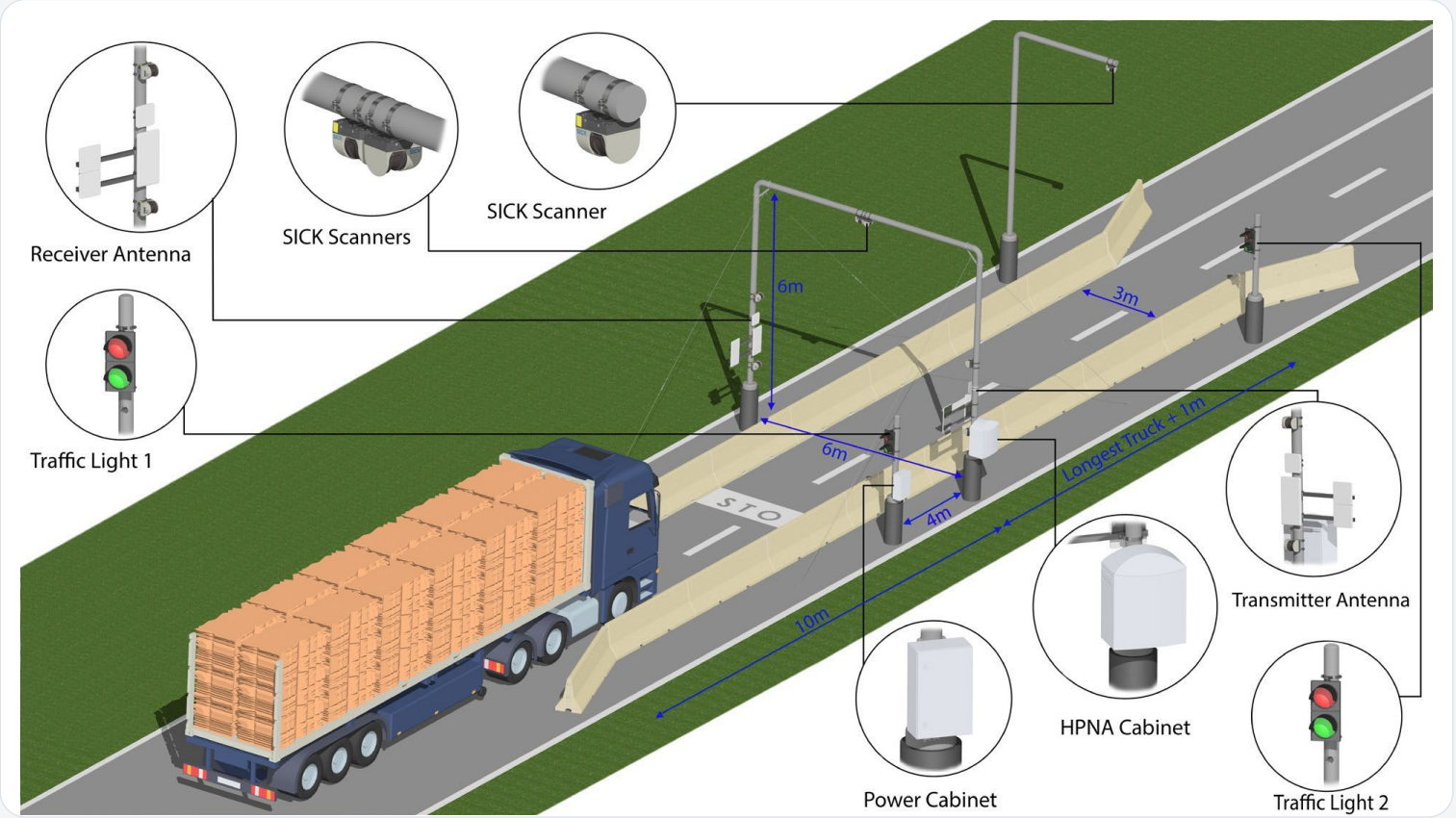
Industrial Moisture Gate for Waste Paper Bales — the system, its requirements, process, acceptance criteria and benefits.

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3.1 · THE SYSTEM

The gate at a glance

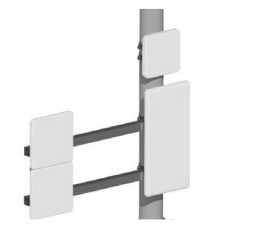


MAIN COMPONENTS

- Receiver & transmitter antennas
- SICK 3D scanners
- Traffic lights 1 & 2
- HPNA cabinet
- Power cabinet

3.1 · THE SYSTEM

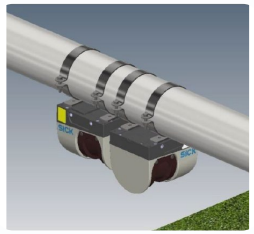
Two sensing systems, one result



MEASURES WATER

Microwave system

The system produces multiple polarised, low-energy electromagnetic fields that identify alterations induced by water, offering insights into the cargo’s water content.



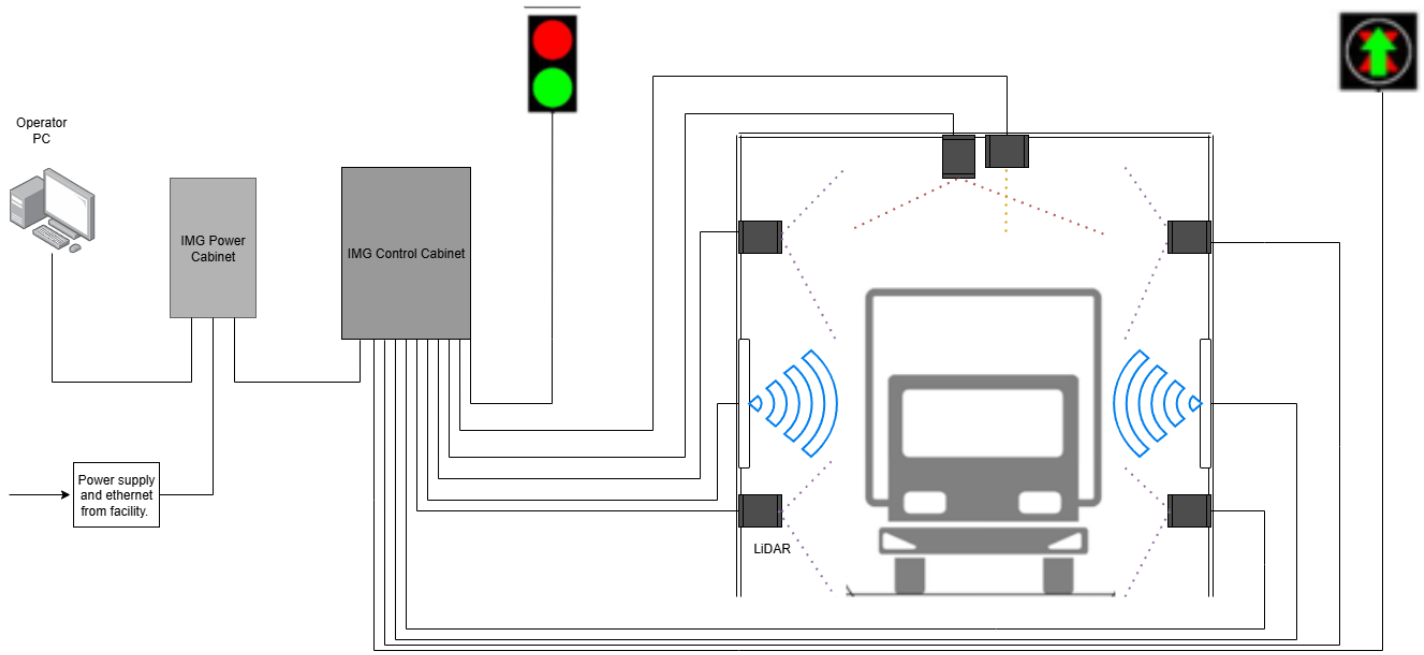
MEASURES GEOMETRY

3D optical system

Collects physical data on the cargo — width, length, height, velocity, structure (missing bales, gaps between bales, etc.), start and end points, and platform dimensions. This data controls the microwave system and helps calculate the cargo volume.

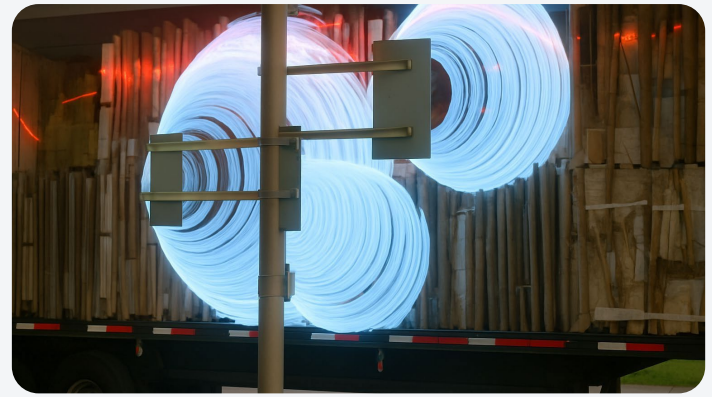
3.1 · THE SYSTEM

Circuit diagram

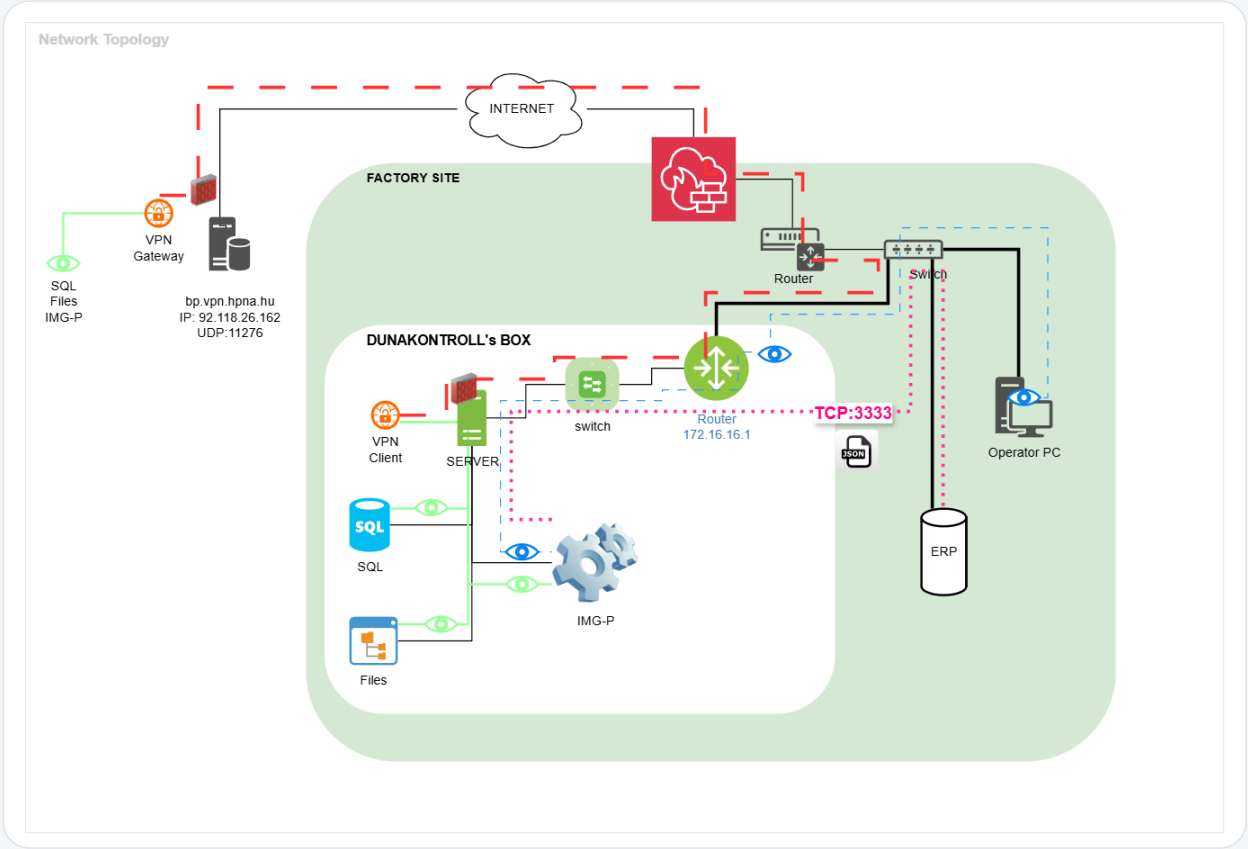


Note: All 6 scanners are installed at the 1st gate, and Scanner #7 is installed at the 2nd gate.





IT communication scheme



Dunakontroll's box on site

Server, SQL database, file storage and the IMG-P software behind its own router and firewall.

ERP integration

Results are passed to the mill's ERP as JSON over TCP (port 3333).

Operator PC

Connected through the factory switch.

Secure VPN link

Encrypted connection between the site and Dunakontroll.

3.2 · MEASUREMENT REQUIREMENTS

What the load needs

1.6 m
minimum load height — no maximum height limit

1.7 m
minimum load width

3.0 m
minimum load length

≤ 5 km/h
truck speed passing the antennas

- **Minimal space** between the bales in the lengthwise direction.
- The scanners **must "see" the entire load**: remove tarpaulins on open deliveries; on closed deliveries pull the side curtains back — towards the cabin on one side, towards the rear on the other.
- **Horizontal metal bars** securing the load must be removed before measurement.
- Loads in **metal containers cannot** be measured.



3.3 · MEASUREMENT PROCESS

Manual or automatic, in five steps

1

Data entry

Manual: entered through the Dashboard.
Automatic: sourced from the ERP system.

2

Start measurement

Manual: operator clicks START.
Automatic: triggered by the ERP, card-reader kiosk, ANPR camera, etc.

3

Measurement

Fully autonomous. Traffic lights direct the truck; the 3D optical system tracks its position in the zone.

4

Data processing

When the truck leaves the zone, the system calculates the average moisture content of the load.

5

Display & send

The result is shown on the Dashboard and sent to the ERP system if connected.

CORE DATA **Truck ID · Net weight · Paper type**

Automatic mode integrates with the mill's ERP (e.g. SAP) for greater efficiency.

A report for every truck

Report generated on: 06.06.2023 10:12

Measurement		
	Date/Time:	06.06.2023 03:27
	Ticket Number:	**11858932**
	Plate No.:	ABC-123567
	Paper Grade:	OCC BALED
	Supplier:	.....RECYCLING LTD
	Weight:	30440 kg
	Moisture Average:	**14.5 %**

Profile:

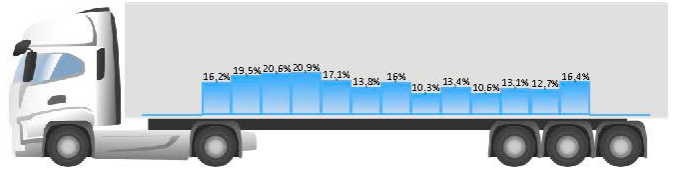


Truck + trailer · OCC baled · 30,440 kg · **14.5 %** average

Report generated on: 31.05.2023 08:27

Measurement		
	Date/Time:	04.05.2023 16:16
	Ticket Number:	**HY16VRGP_20230504_1611**
	Plate No.:	ABC 123456
	Paper Grade:	OCC Baled
	Supplier:	0533-0001
	Weight:	20460 kg
	Moisture Average:	**15.5 %**

Profile:



Semi-trailer · OCC baled · 20,460 kg · **15.5 %** average

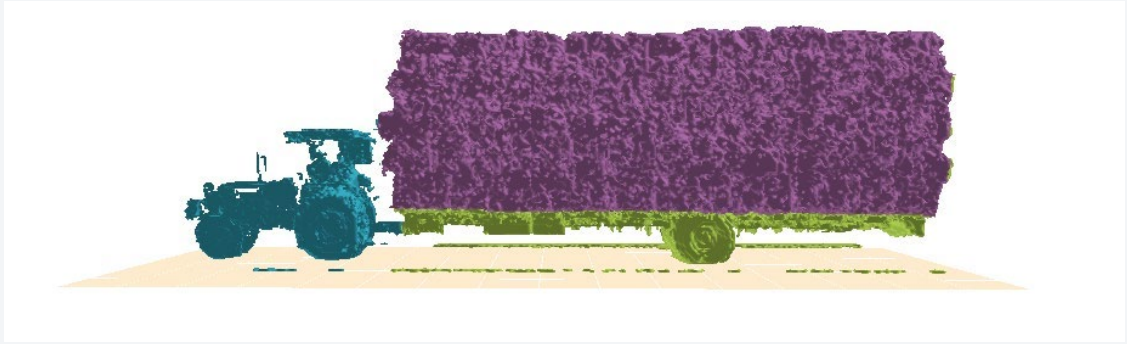
3.3 · MEASUREMENT PROCESS

3D optical load detection



WASTE PAPER BALES

Missing bales are excluded from the moisture calculation.



STRAW BALES

The same detection works for straw bale loads.

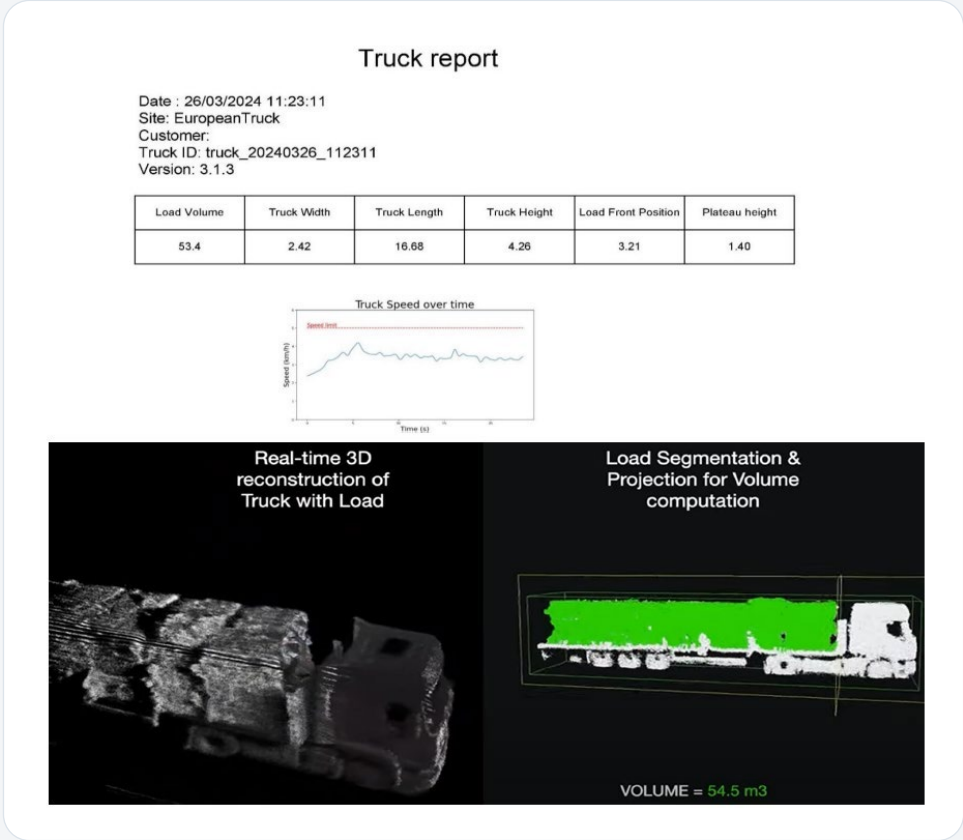
3.3 · MEASUREMENT PROCESS

Internal truck report

A truck report with the 3D detection model, for internal use and analysis.

Load volume, truck dimensions, load position and speed over time — reconstructed in real time and segmented for volume computation.

Not provided to the client



3.3 · MEASUREMENT PROCESS

Standard data on the dashboard

Standard logistics and quality data displayed during the measurement process.

01 Load identification

Load ID
Unique reference per truck and shipment

Truck plate number
Linked to ANPR / card-reader entry

02 Weight & material data

Gross & tare weight
kg / ton — net basis derived automatically

Paper type
e.g. OCC, mixed, deinking grade

Supplier
Sourced from ERP or operator entry

03 Moisture & cargo data

Average moisture content (%)

Gross moisture content
Total water mass over the load

Moisture per 80 cm section (%)
Longitudinal profile along the truck

Load density (kg/m³)

3.3 · MEASUREMENT PROCESS

Advanced validation functions

1

Input data validation

- Automatic check against predefined limits and reference values
- Verification of volume, weight, density and operating conditions
- Warning message and optional ERP synchronisation on deviation

2

Primary cause for dropped measurements

- Clear display of the primary cause of rejection or exclusion
- Identifies violated preconditions or unsuitable cargo conditions
- Faster, more objective root-cause evaluation

3

Rule-based anomaly detection

- Continuous check of logical relationships between loading and measurement data
- Detects inconsistent or non-representative measurement behaviour
- Diagnostic message for immediate operator action

IMG-P — Three layers of validation safeguarding measurement integrity

3.3 · MEASUREMENT PROCESS

System status & traceability

General health status indicator

Central overview of the main subsystems

Microwave sensor array	READY
3D optical detection	READY
Weighbridge interface	READY
ERP / SAP synchronisation	CHECK
Traffic light & entry control	READY
Dashboard & reporting	READY

Clear ready status in normal operation, direct indication of any deviation.

System change audit trail

Automatic logging of every manual parameter change

Timestamp	Parameter	Old → new	User
19/06/26 08:14	Density limit (max)	340 → 360	j.kovacs
19/06/26 09:02	Paper type list	7 → 8 items	m.weber
19/06/26 11:31	Warning threshold	18% → 16%	g.szabo
19/06/26 13:48	Supplier code map	v3.1 → v3.2	j.kovacs
19/06/26 15:09	Section length (cm)	80 → 80	admin

Illustrative excerpt — the real log records every manual parameter change.

Time, parameter, old and new value and user ID — for traceability, transparency and data security.

3.4 · HANDOVER ACCEPTANCE CRITERIA

Accuracy verified at handover

3 × 3 The IMG is tested on **three paper grades**, with **three trucks per grade**. Allowed standard deviation against the control system, at a **95% confidence level**:

MOISTURE CONTENT	MOISTURE CONTENT	MOISTURE CONTENT	MOISTURE CONTENT
up to 20%	**20% – 30%**	**30% – 40%**	**above 40%**
±1.4%	**±1.7%**	**±2.0%**	**N.A.**
max. standard deviation	max. standard deviation	max. standard deviation	uncertainty of the counter-measurement method

Values are stated under ISO 5725-1:1994 reproducibility and repeatability conditions and characterise the empirical uncertainty of the entire measurement chain (sensor + sampling + laboratory reference); the relative standard deviation (±5%) expresses its variability across a shipment population. The sensor's intrinsic contribution to the combined uncertainty — per the **GUM (JCGM 100:2008) uncertainty budget** — is below 7% at 20% MC and below 2% at 40% MC. Detailed uncertainty budget available on request.

3.4 · HANDOVER ACCEPTANCE CRITERIA

The reference measurement

If comparative measurements cannot be carried out with an IMG-compatible measuring system — a mutually agreed-upon base — the **Delmhorst RDMP-3** control moisture measurement tool shall be selected by prior agreement.

Dunakontroll accepts the **Delmhorst RDMP-3** hand-held moisture meter. Flat-electrode hand-held instruments are **NOT** accepted.

The IMG's **average moisture content of the whole truck** is compared with the average of a manual measurement of **at least 200 measuring points**.

Any sampling method carries inherent weaknesses: limited sample size, uneven moisture distribution, potential human error in collecting and handling samples.

Manual sampling is not an absolute "gold standard" but a reference subject to improvement. Methodology errors: density insensitivity, material temperature compensation, material classification, human error...

3.4 · HANDOVER ACCEPTANCE CRITERIA

Consistency over time

Measurement **consistency** refers to the **precision** and **repeatability** of the measurements taken over time.

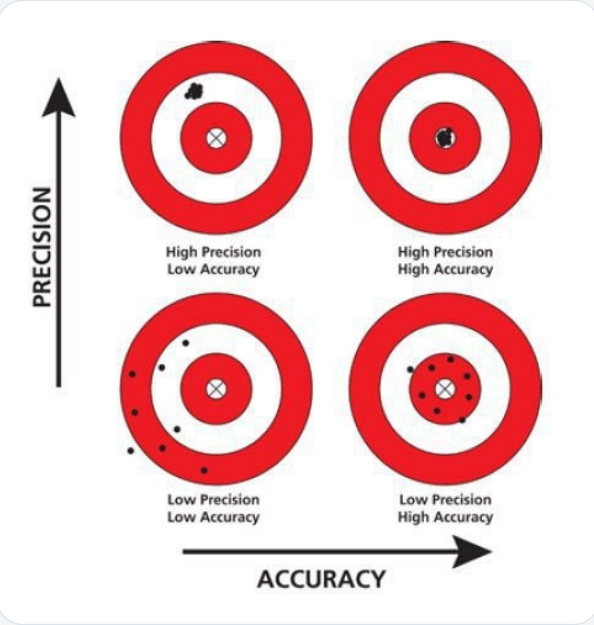
6×

The same truck drives through the gate six times.

- The average moisture content is calculated.
- The highest and lowest values are excluded for a more accurate central tendency.
- The ±6% relative range of the average is compared with the measured values.

±6%

max. relative deviation of each passage from the average



3.5 · ADVANTAGES & BENEFITS

Gate vs. hand-held methods

Industrial Moisture Gate — closed, automated process	Hand-held moisture meters & methods
✓ Automated measurement system	– Manual or laboratory based
✓ Non-destructive	– Invasive
✓ Measures large quantities — the entire load at once	– Measures at selected points or a very limited quantity
✓ Measures in a representative manner	– Is NOT representative
✓ Fast — measures in less than 1 minute	– Time-consuming
✓ Each delivery can be measured	– Based on sampling
✓ Does not require human intervention	– Requires dedicated staff, leaving room for human error
✓ Instant data exchange with the mill’s ERP system	– Stand-alone measurement, no data integration possible

3.5 · ADVANTAGES & BENEFITS

What is your annual *water invoice*?



THE FORMULA

Annual hidden moisture cost = annual purchased tonnes × excess moisture % × raw material price / t

THE REFRAME

A **3–5%** moisture measurement error is **not** a measurement issue. It is a profit issue.

3.5 · ADVANTAGES & BENEFITS

Shared benefits for all stakeholders

Ensured through the change management required for the system’s integration and efficient operation.

- ✓ **Optimised fibre balance** leading to cost savings in raw material procurement.
- ✓ **Driving innovation** within the industry.
- ✓ **Transparency towards suppliers** through access to accurate moisture data.
- ✓ **Fair market price** — raw materials are purchased at what they are worth.
- ✓ **Stronger supplier relationships** by sharing moisture data in weekly, easy-to-read reports.
- ✓ **Higher quality** of the raw materials to be reprocessed.
- ✓ **Less waste** by using only the required amount of material and enhancing yield.
- ✓ **Faster processing** — rapid assessment reduces supply-chain delays and improves operational and procurement efficiency.
- ✓ **Seamless data flow** — integration with corporate IT gives better tracking of incoming supplies.
- ✓ **Helping suppliers** identify and address issues (e.g. waste management processes) and meet their targets.

By improving measures of incoming Paper for Recycling our mills could see increased manufacturing yields. Not only this, but our transparent reporting system will provide clear communications to customers.

Nuno Messias

Paper for Recycling Purchasing Director, DS Smith Recycling Division, Iberia

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