

Welcome



A. Stoop

**Van der Heide Beheer
B.V.**



**Bliksembeveiliging
B.V.**



**Bliksembeveiliging
Inspecties B.V.**



**Opleidingen &
Inspecties B.V.**



**Kathodische
Bescherming &
Corrosie Engineering
B.V.**



Pipelines



Sheet piling



Water filters (internal)



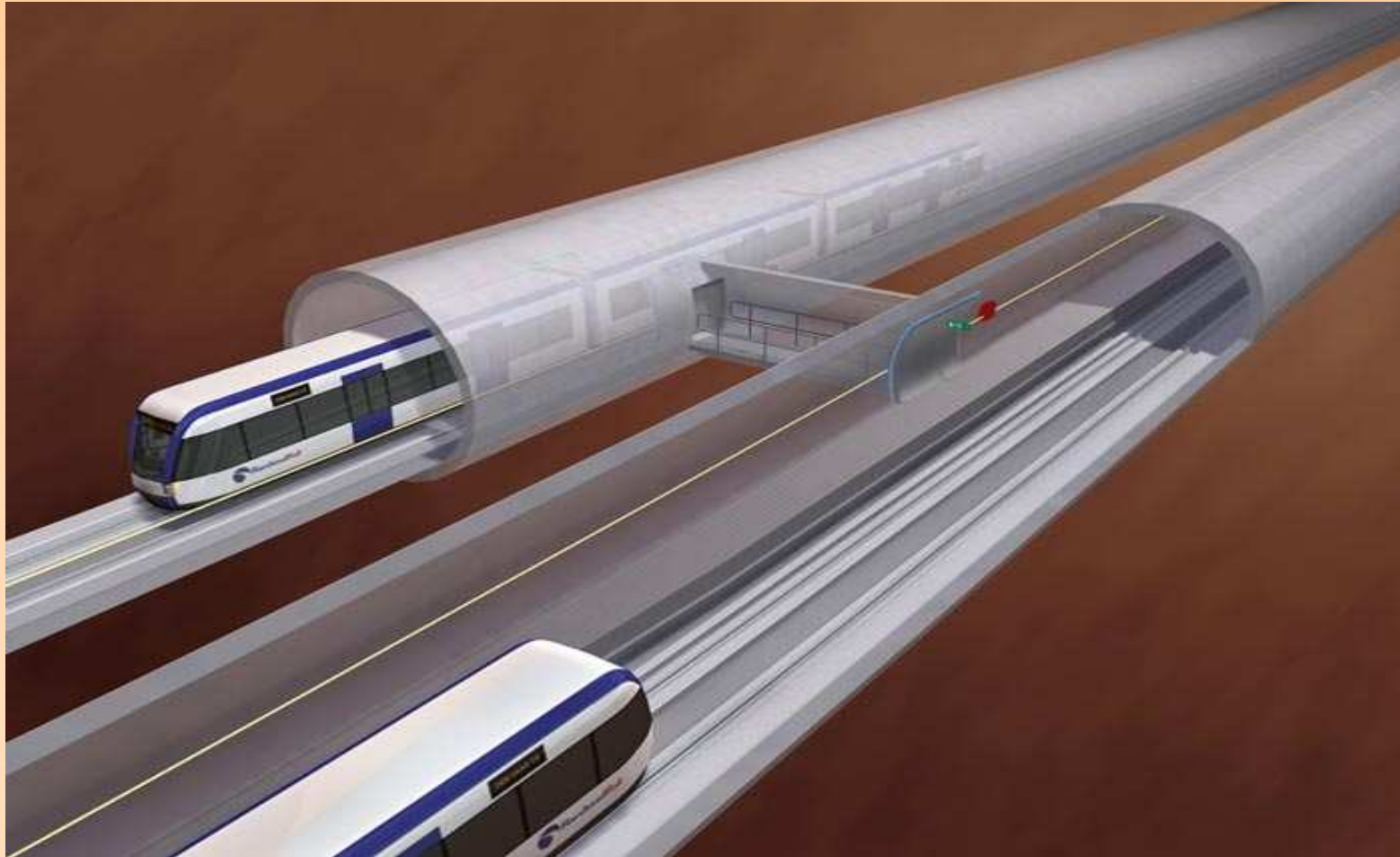
Jetties



Drilling platforms



Metro tunnels



Concrete



Gas line

(repairing faults at the bottom of the sea)



Underground tanks



Activities



Design, manufacturing and installation of cathodic protection systems for:

- Objects of metal underground or in water.
- Filtering systems.
- Reinforcement steel of concrete constructions.

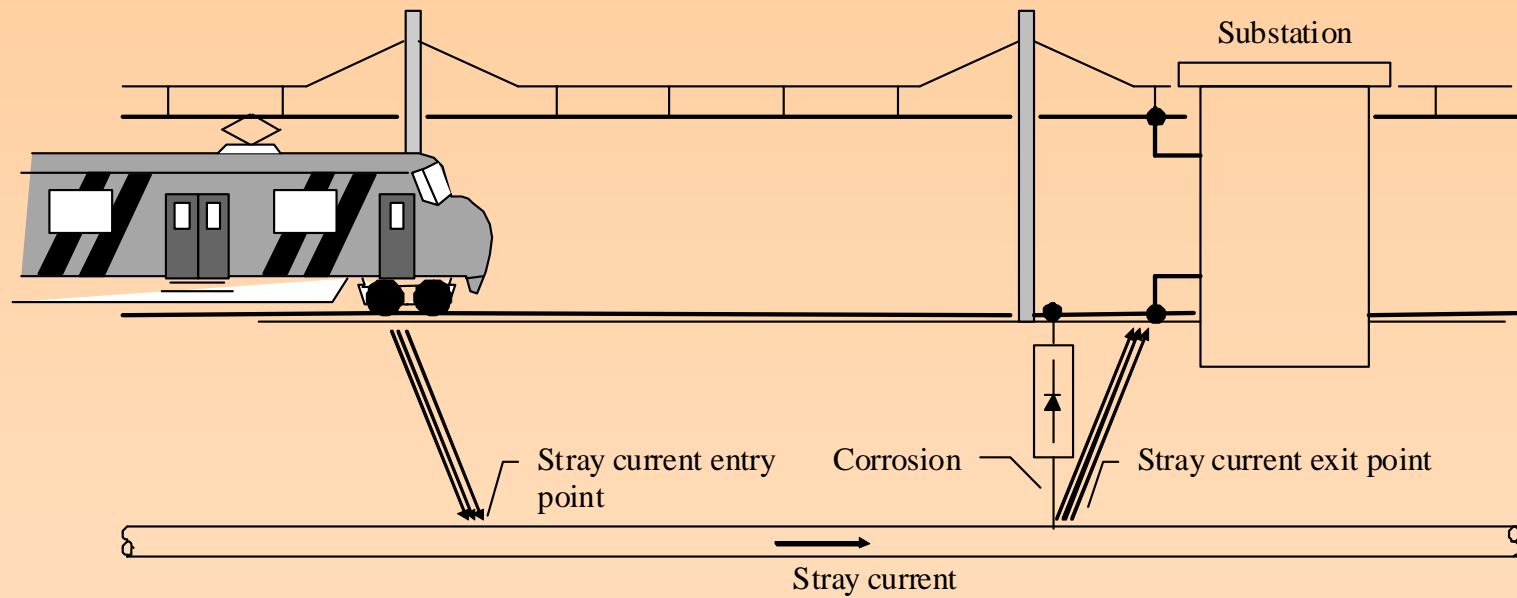
Inspections:

- Inspections and maintenance of CP applications.
- Internal and external inspections of tanks.

Corrosion types

- Corrosion of active metals
- Corrosion of passive metals
- Galvanic corrosion (contact)
- Pitting
- Stress corrosion
- Hydrogen-induced corrosion
- Crevice corrosion
- Exfoliation
- Microbiologically influenced corrosion (MIC)
- Erosion corrosion
- Corrosion fatigue
- Stray current corrosion (DC)
- AC corrosion, (induction, capacitive)

Stray current corrosion



Drainage stops stray current corrosion

AC Corrosion

Current density (J):

- $J < 20 \text{ A/m}^2$
No significant AC corrosion
- $20 \text{ A/m}^2 < J < 100 \text{ A/m}^2$
Possible AC corrosion
- $J > 100 \text{ A/m}^2$
AC corrosion expected, despite level of Cathodic Protection

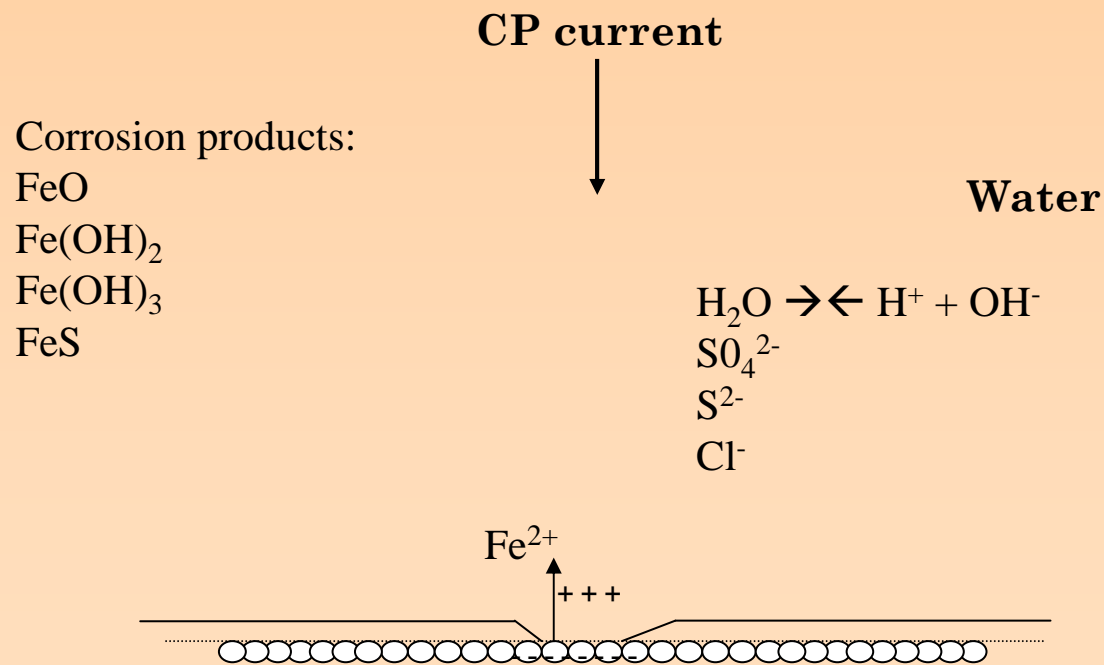
$$J = 8 \cdot U / \rho \cdot \pi \cdot d$$

U: measured voltage

ρ : soil resistance at pipeline depth

d: coating holiday diameter

Iron ions dissolve and material loss is visible.
The CP current builds a barrier which stops
the electrochemical reaction and therewith
prevent the iron atoms to dissolve.



Hazard / damage



- Instability
- Explosion
- Fire
- Toxicity / Pollution
- Limited economical lifetime
- Loss of transported product
- Production loss
- Environmental issues.

Current density



| <i>Iron buried, coating</i> | <i>Current density mA/m²</i> |
|------------------------------------|---|
| bitumen (new, few appendages) | 0,01 - 0,1 |
| bitumen (old) | 0,1 - 0,5 |
| polyethylene (new, few appendages) | 0,001 - 0,01 |
| polyethylene (old) | 0,01 - 0,2 |
| <i>Circumstances</i> | |
| uncoated carbon steel | |
| - in soil | 5 - 20 |
| - in sweet water | 30 - 60 |
| - in salt water | 70 - 120 |
| Stainless steel | |
| - in salt water | 100 - 160 |

Criteria



Most commonly used:

The cathodic protection is sufficient when the potentials are more negative -850 mV (against a copper sulfate electrode).

NEN EN 12954

Cathodic Protection

Practical Galvanic Series for Materials in Neutral Soils and Water



Material Potential Volts (CSE)

(Typical potential normally observed in neutral soils and water, measured with respect to copper sulfate reference electrode. Source Peabody.)

- Carbon, Graphite, Coke + 0.3
- Platinum 0 to - 0.1
- Mill Scale on Steel - 0.2
- Carbon, Graphite, Coke - 0.3
- High Silicon Cast Iron - 0.2
- Copper, Brass, Bronze - 0.2
- Mild Steel in Concrete - 0.2
- Lead - 0.5
- Cast Iron (Not Graphitized) - 0.5
- Mild Steel (Rusted) - 0.2 to -0.5
- Mild Steel (Clean and Shiny) - 0.5 to -0.8
- Commercially Pure Aluminum - 0.8
- Aluminium Alloy (5% Zinc) - 1.05
- Zinc - 1.1
- Magnesium Alloy
(6% Al, 3% Zn, 0.15% Mn) - 1.6
- Commercially Pure Magnesium - 1.75

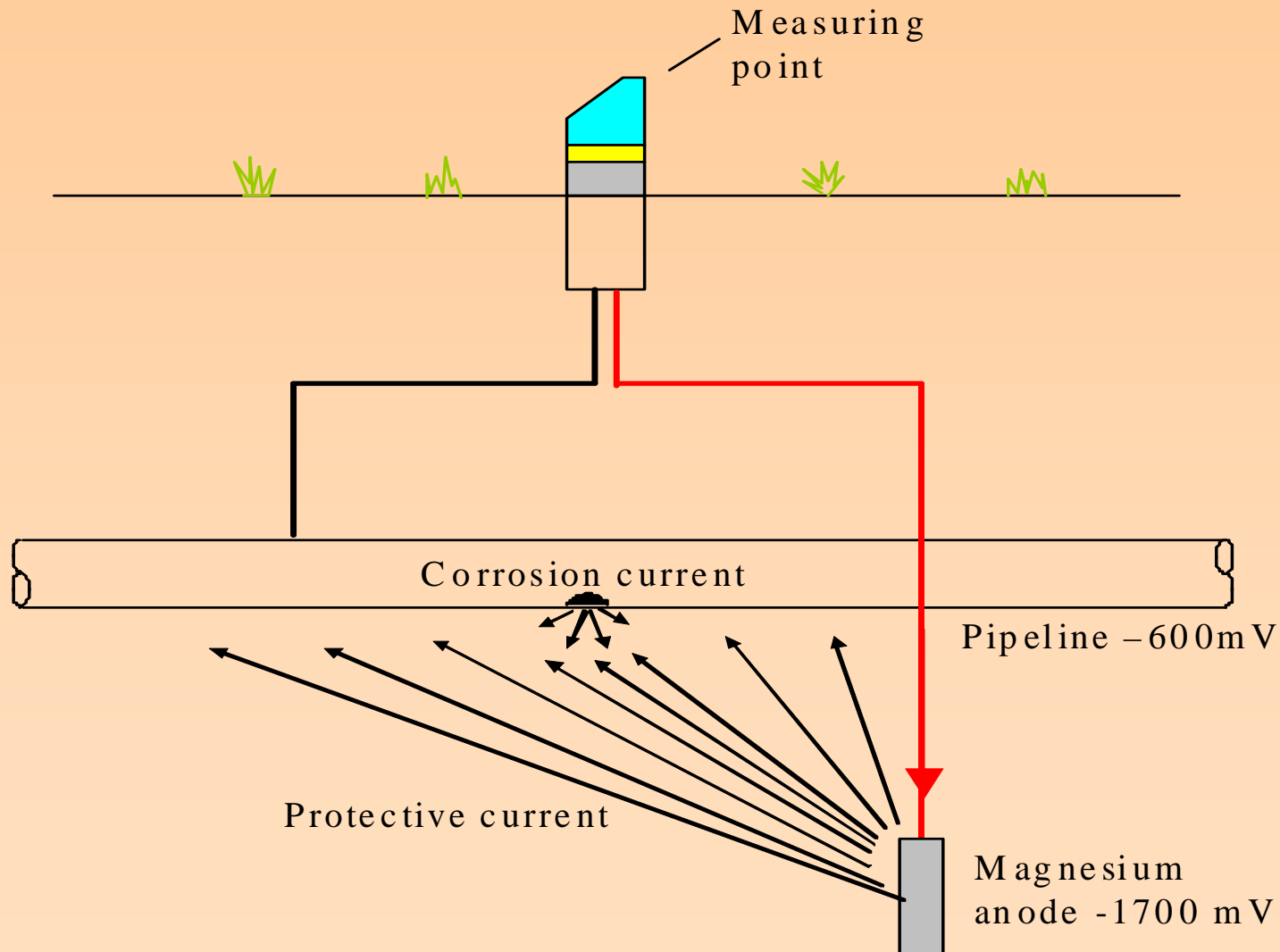
Cathodic Protection



Sacrificial anode system:

1. A metal sacrificial anode, which 'natural potential' is more negative: Magnesium, Zinc and Aluminium anodes.
2. Sacrificial anodes, connected to the object, causes a new balance (more negative) of the 'natural potential'.

Scheme sacrificial protection



Sacrificial anodes types and application



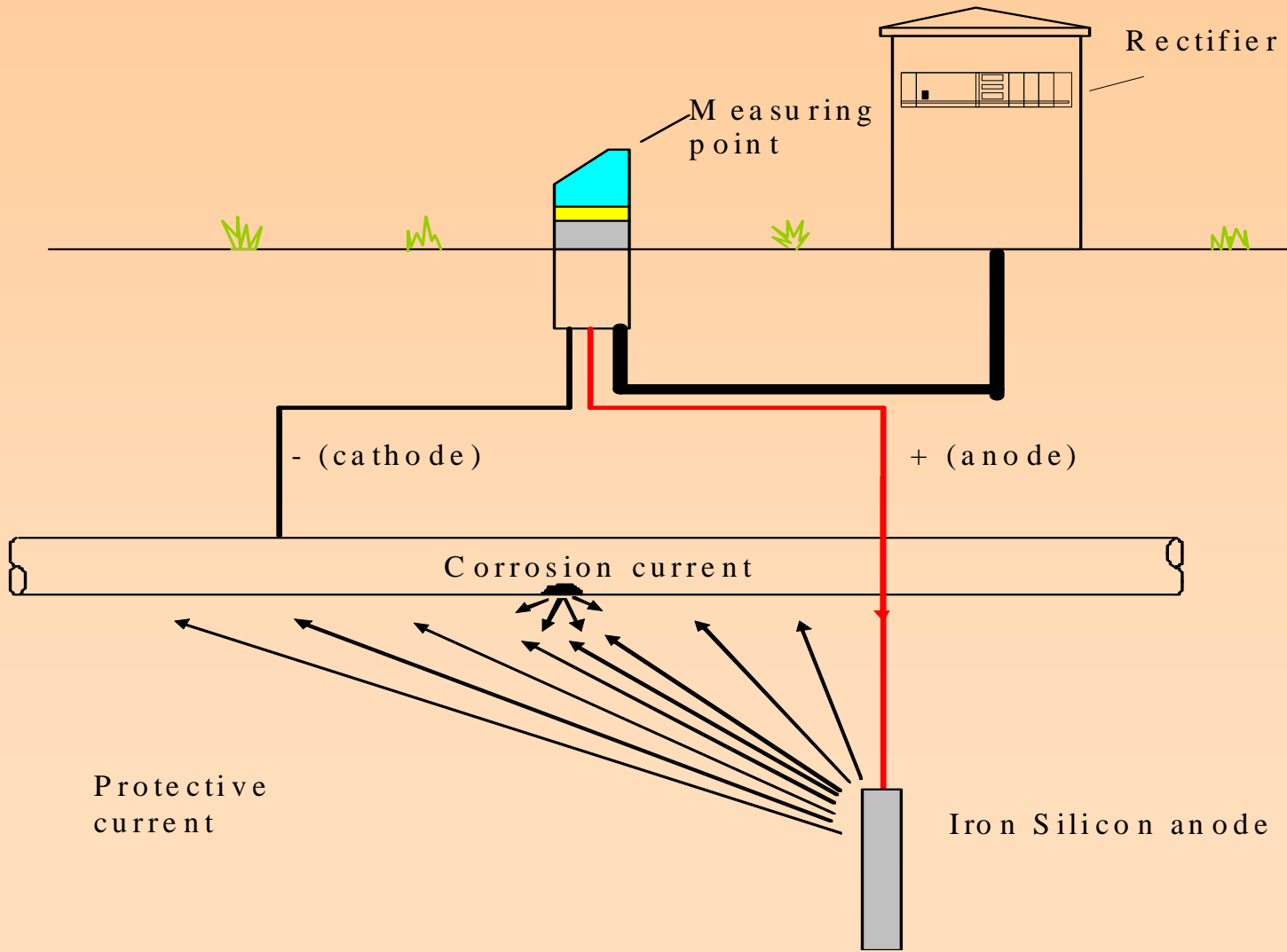
- Magnesium:
Applied on land and in sweet water
- Zinc and Aluminium:
Applied in salt water

Impressed current cathodic protection



An external current supplied by a rectifier and an inert anode forces a more negative 'natural potential'.

Scheme impressed current sytem



Impressed current system Types and typical applications?



- Iron Silicon
in soil, in cokes
- MMO (Mixed Metal Oxide)
in water, in cokes in soil
- Platinum-Titan
in water

Application sacrificial system



- Transport pipelines
- Protective pipes
- Tanks
- Sheet piling
- Gates
- Ships hull
- Coolers (int./ext.)
- Jetties
- Platforms

Application impressed current system



- Transport pipelines
- Sheet piling
- Filter systems (incl. biotanks)
- Jetties
- Tunnels
- Concrete constructions
- (All sacrificial systems with high protective current need)

Inspection / Certification



- To maintain the cathodic protection system in good condition.
- To adjust the system on changes.
- To warn on possible hazards.
- To warn on damages caused by others.
- A moment to check on AC-voltages and other unusual circumstances
- Optimize safety at all circumstances.

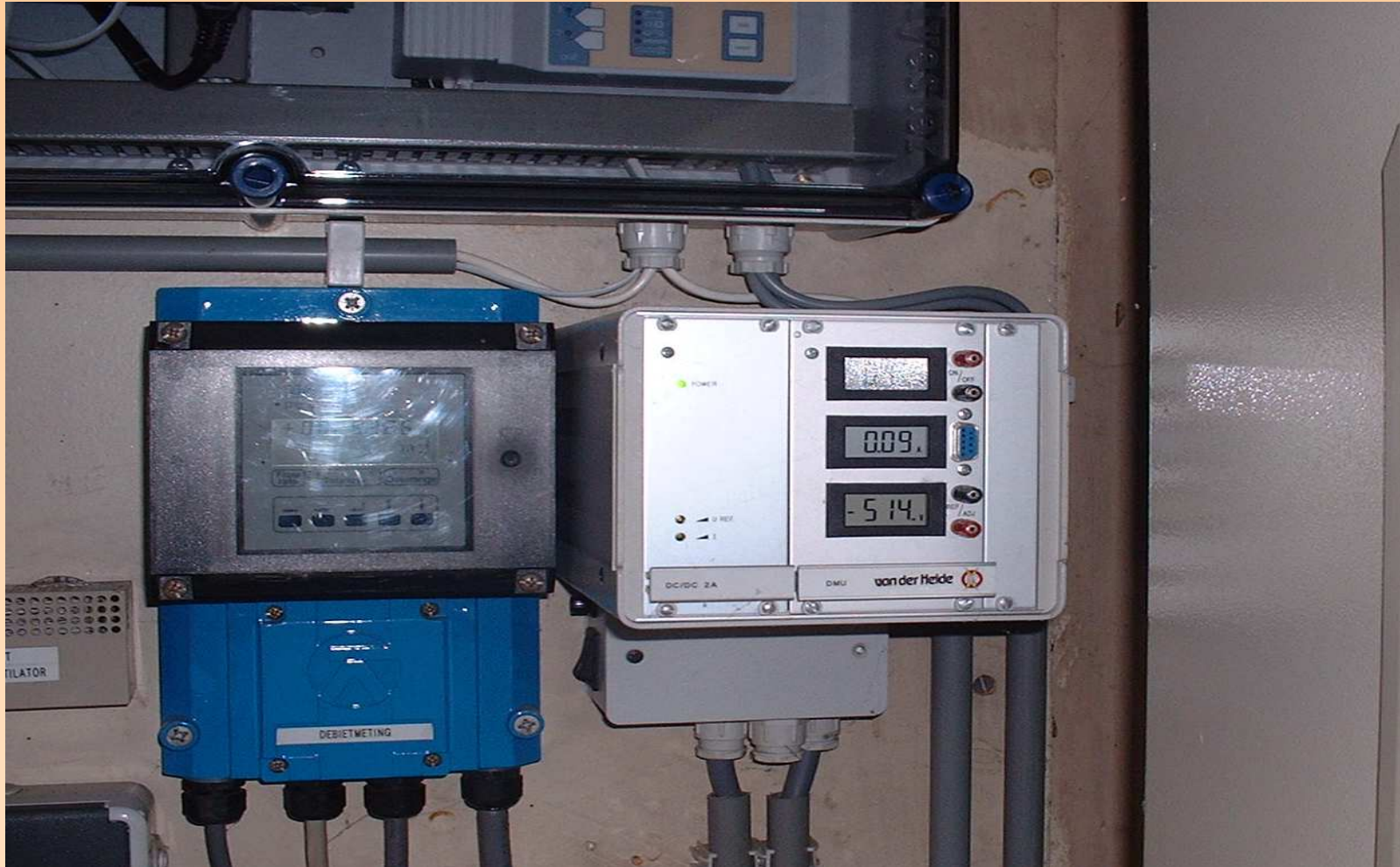
Corrosion damage (pump)



Corrosion damage (filter)



Rectifiers



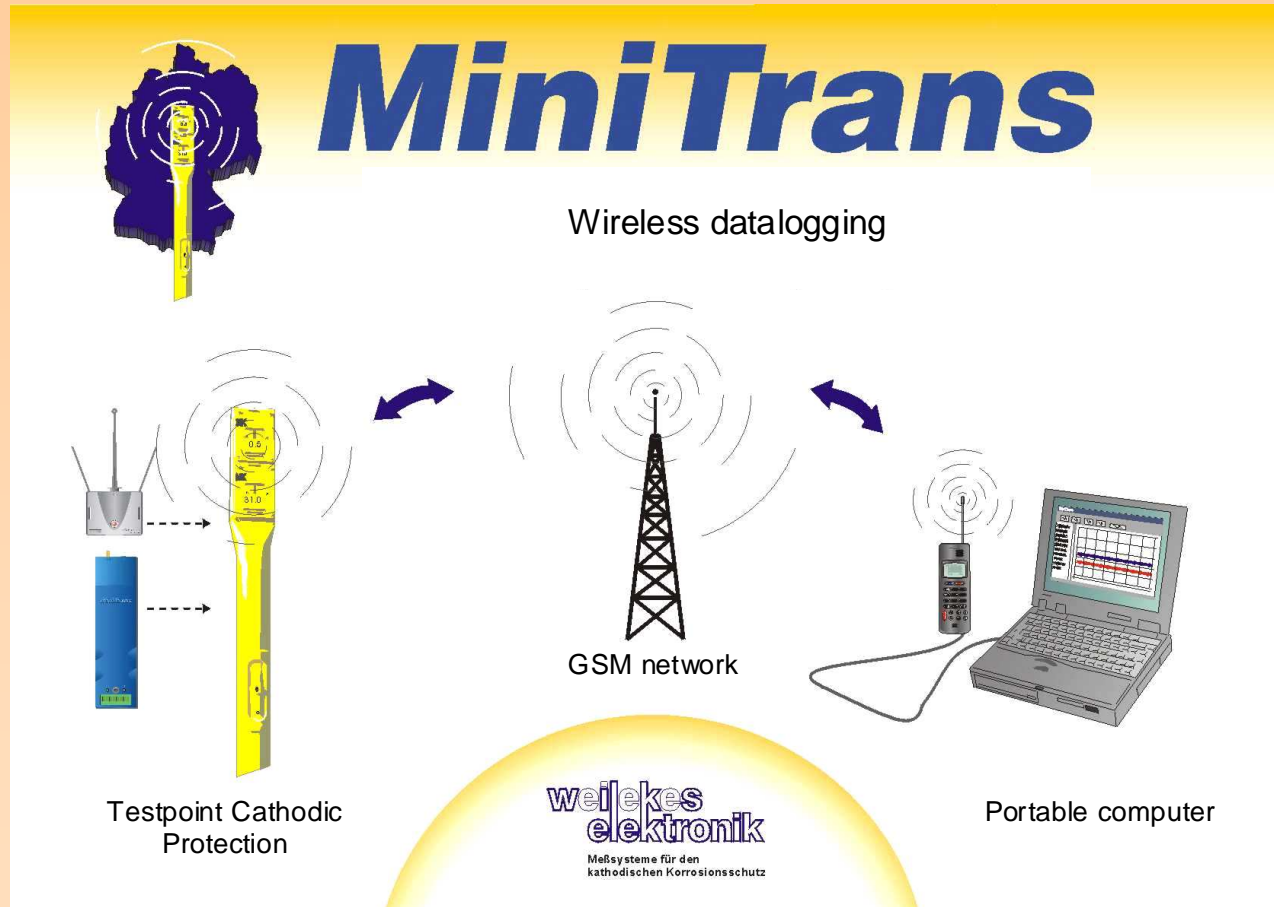
Rectifiers



Rectifiers



Telemetry



Telemetry



Questions ?

