

# Mobile corrosion test for automotive materials

6 April 2022

RI.  
SE





## **Corrosion testing of automotive materials**

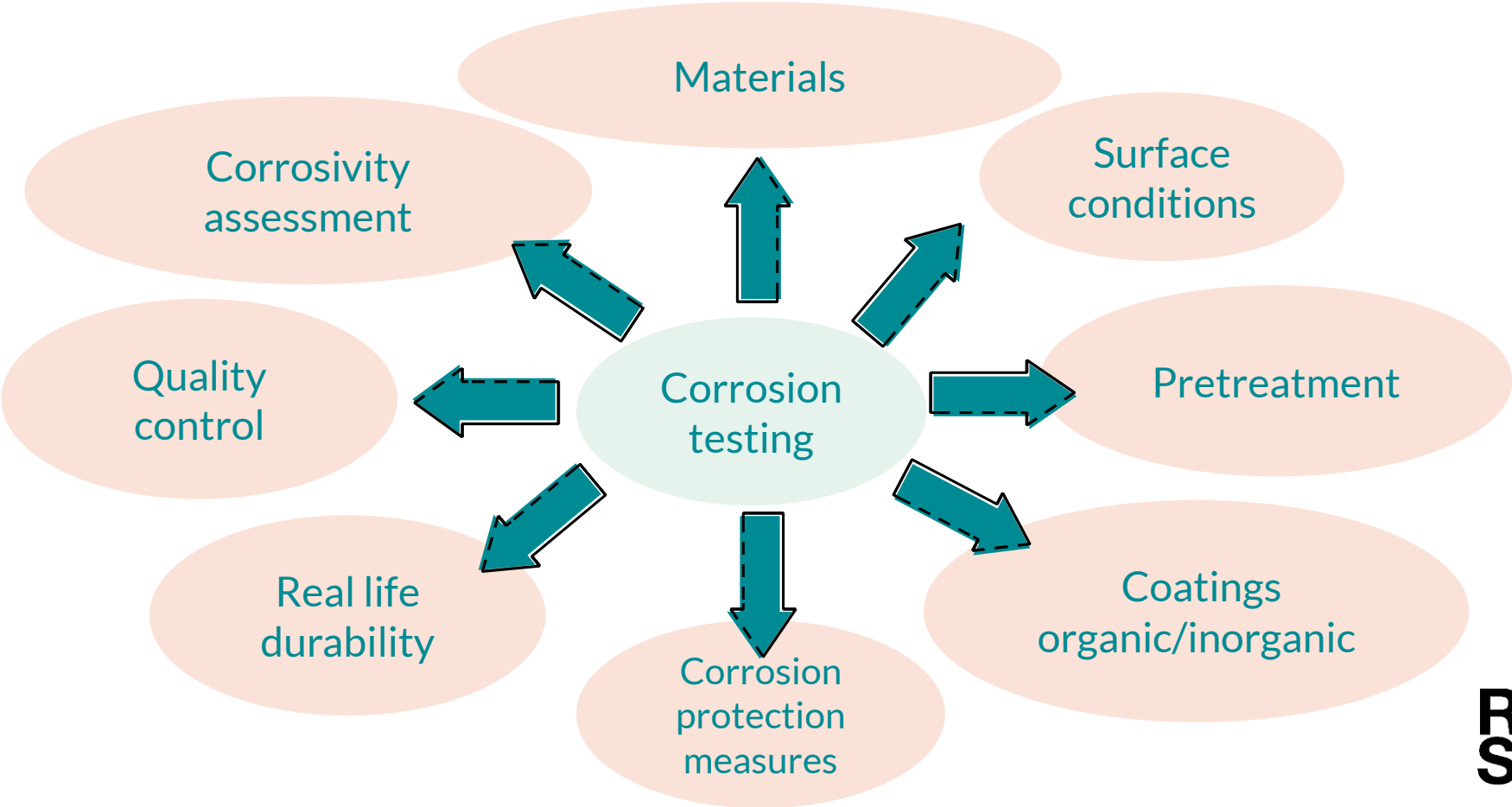
What can we test?  
How can we test?



## **Mobile exposure**

Experience at RISE

# Corrosion testing within the Automotive industry – What can we test?



# Corrosion testing of automotive materials – How can we test?

Accelerated corrosion testing



Proving ground testing



Stationary testing - marine atmosphere



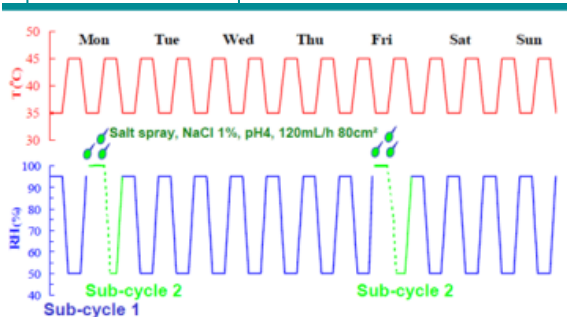
Mobile on-vehicle exposure



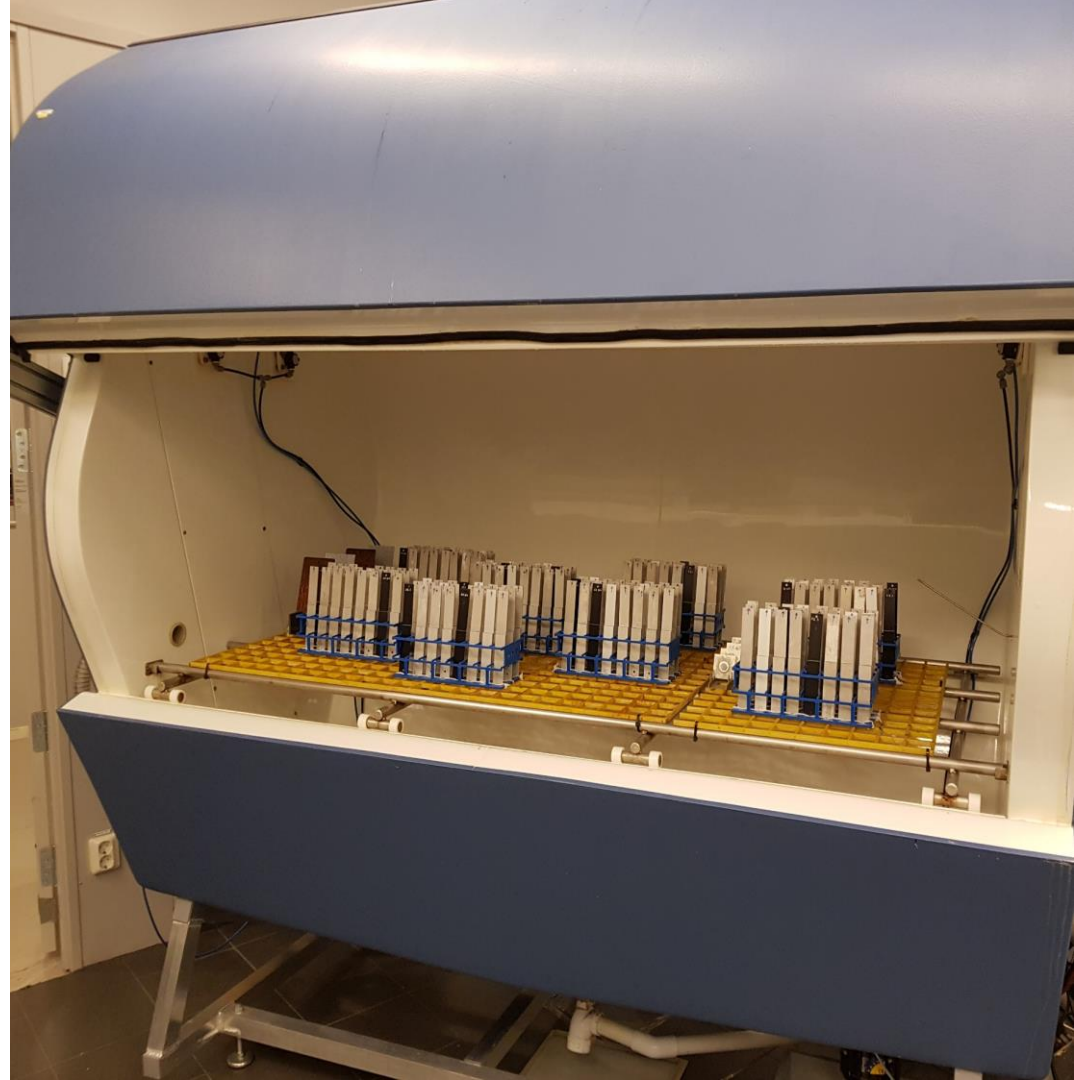
# Accelerated corrosion testing in the automotive industry

- VDA 233-102
- Volvo VCS 1027.1449
- Volvo STD 423-0014
- Scania STD 4319
- Scania STD 4445
- Renault ECC1 D17/228
- Ford CETP 00.00-L-467
- Nissan M 0158 CCT IV
- PSA TCAC D13 5486
- Daimler KWT
- GM 9540P
- Honda DWG B801
- SAE J2334
- VW PV 1210
- Fiat 50493/04
- Toyota TSH1555G

Volvo STD 423-0014



Mobile corrosion test for automotive materials  
2022-04-06



# Mobile on-vehicle exposures performed at RISE

Exposed corrosion test specimens and equipment:

- Bare materials
- Painted specimens
- Crevice specimens
- Bimetallic specimens
- Atmospheric corrosion sensors
- Temp and humidity sensors
- Road mud analyses

## Materials:

- CRS
- Zinc
- GI
- GA
- ZnMgAl
- AA6016
- AA5182
- HSS, AISi
- SS



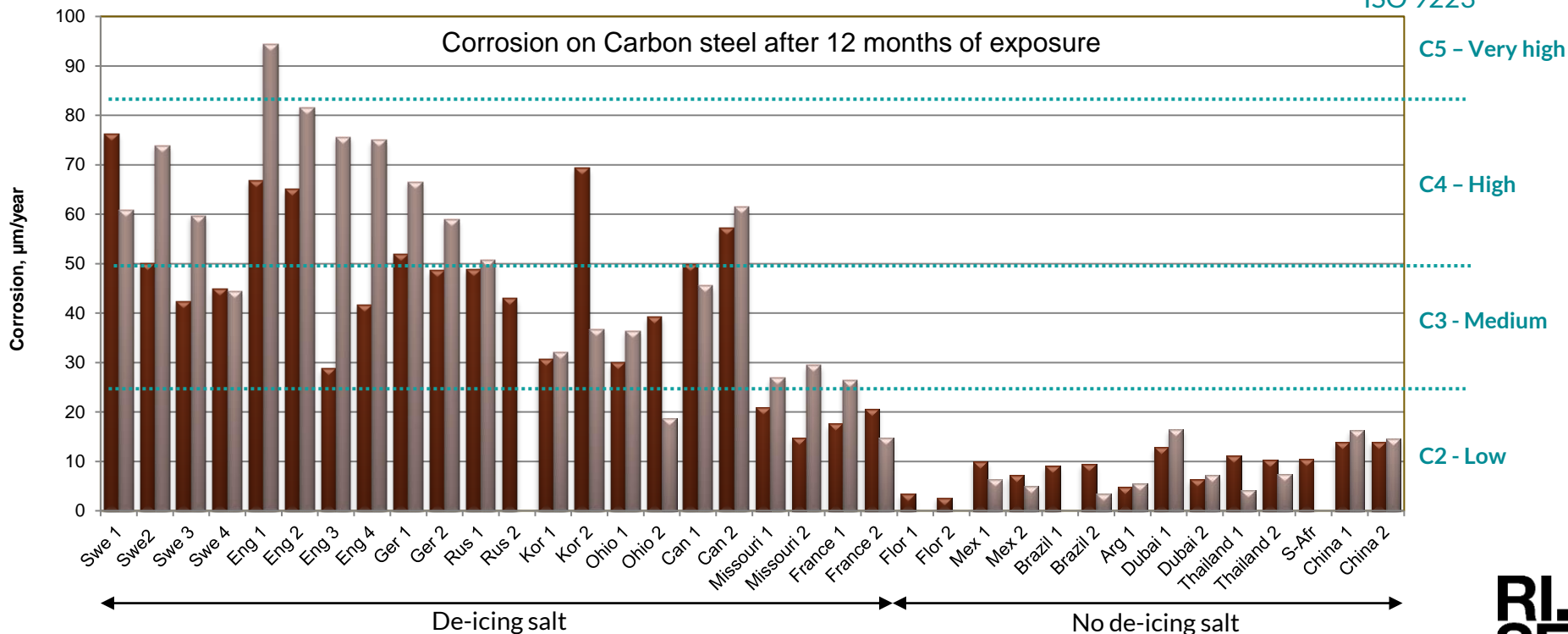
Korea



Corrosion data:  
On-vehicle exposure from  
“worldwide exposure program”



Corrosivity categories  
ISO 9223

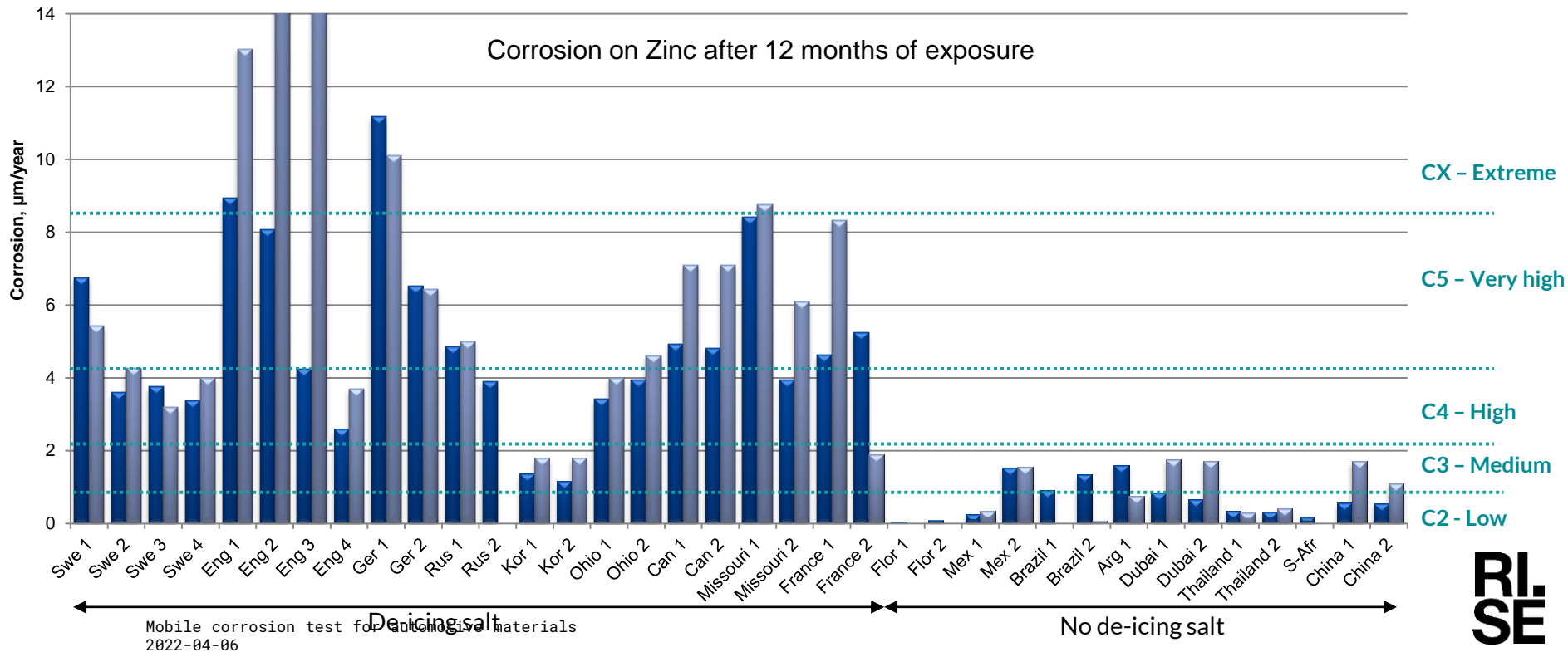


Mobile corrosion test for automotive materials  
2022-04-06

Corrosion data:  
On-vehicle exposure from  
“worldwide exposure program”



Corrosivity categories  
ISO 9223





# Environmental and Reference data from field exposure

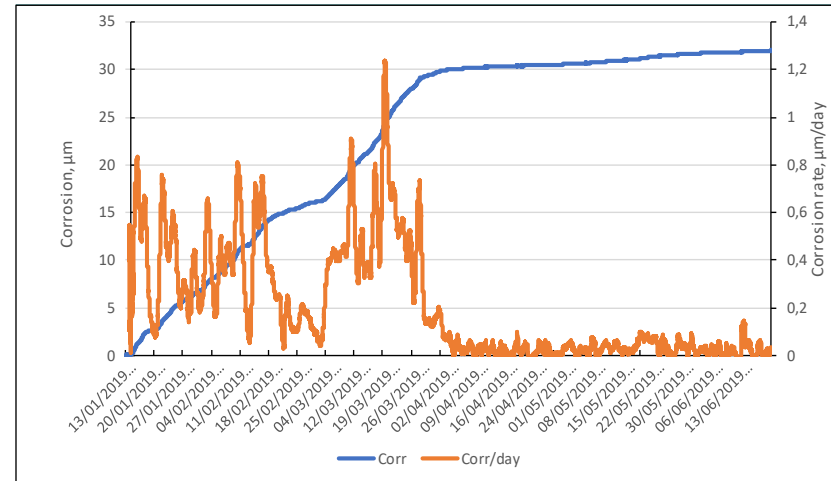


Mobile corrosion test for automotive materials 2022-04-06

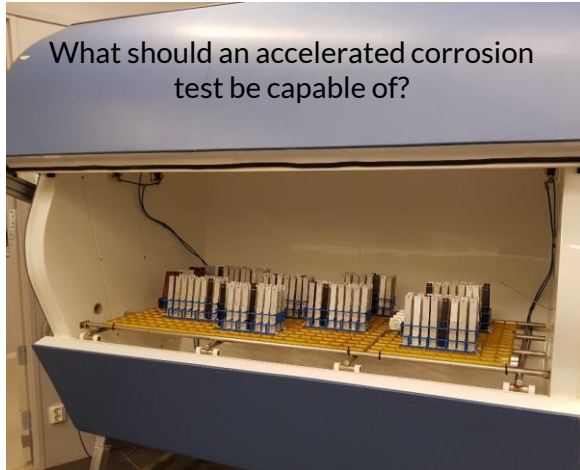
## Environmental measurements:

- Temperature/Relative humidity sensors  
T (°C), RH (%), ToW ,(h)
- Road mud collector  
Deposition of: anion, cation
- Atmospheric corrosion sensors, Fe and Zn  
Corrosion ( $\mu\text{m}$ ), corrosion rate ( $\mu\text{m}/\text{day}$ )
- GPS  
Driving distance, position

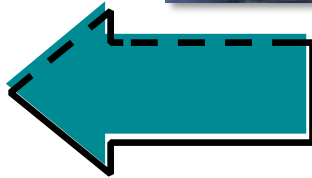
## Atmospheric corrosion sensor Fe



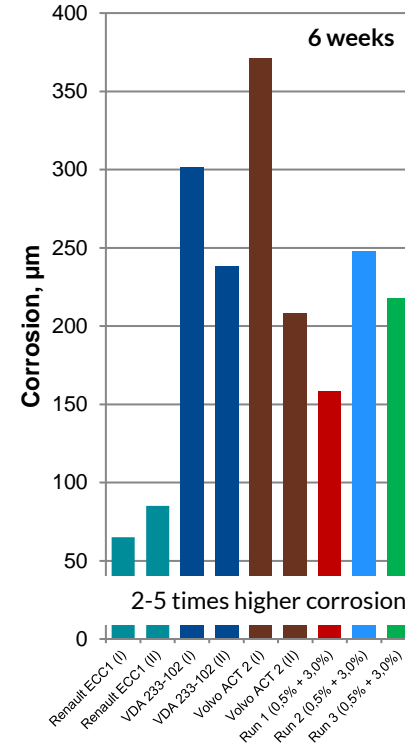
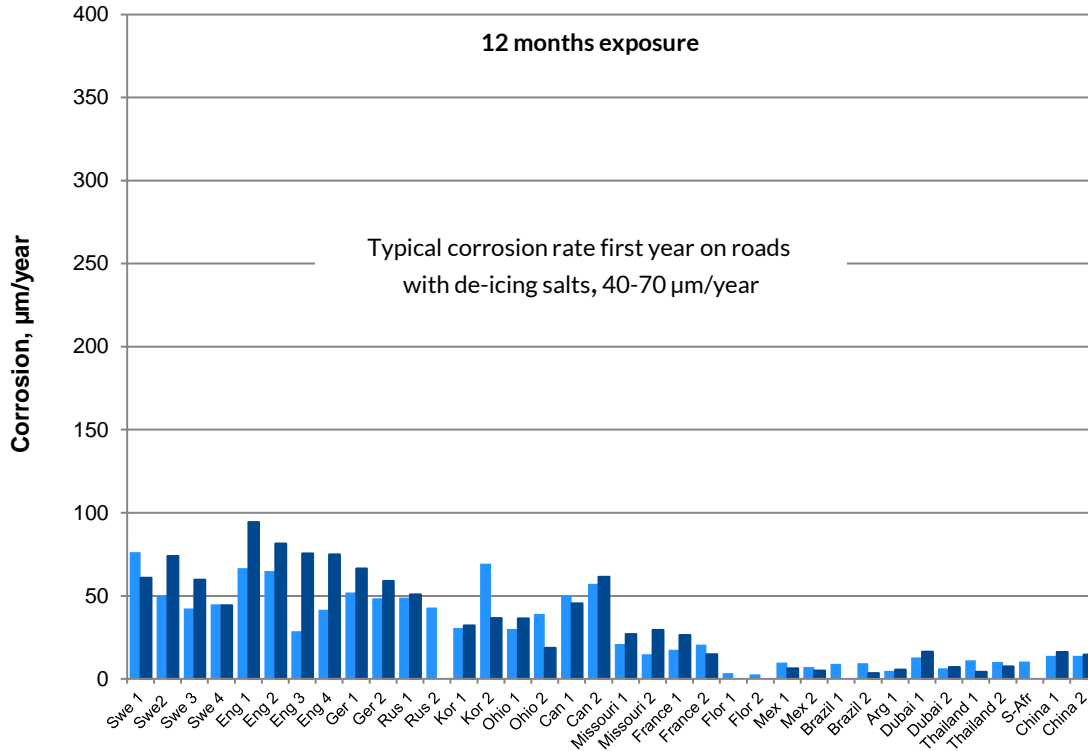
# Accelerated corrosion testing/Mobile on-vehicle exposure



- Simulating on-road vehicle conditions in areas using de-icing salt.
- Giving a certain amount of acceleration, without losing correlation to the field.
- Correctly discriminate any materials and design where corrosion is a concern.

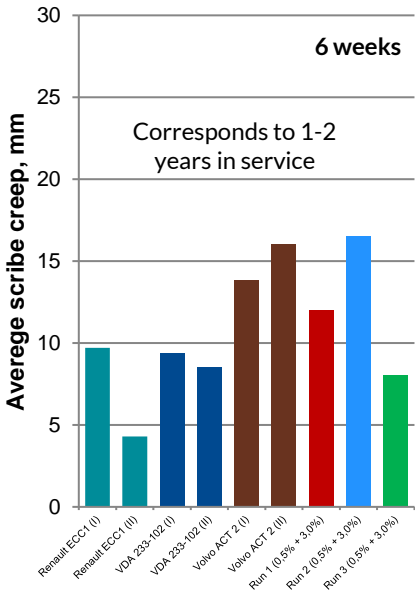
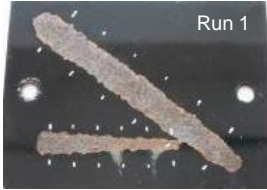
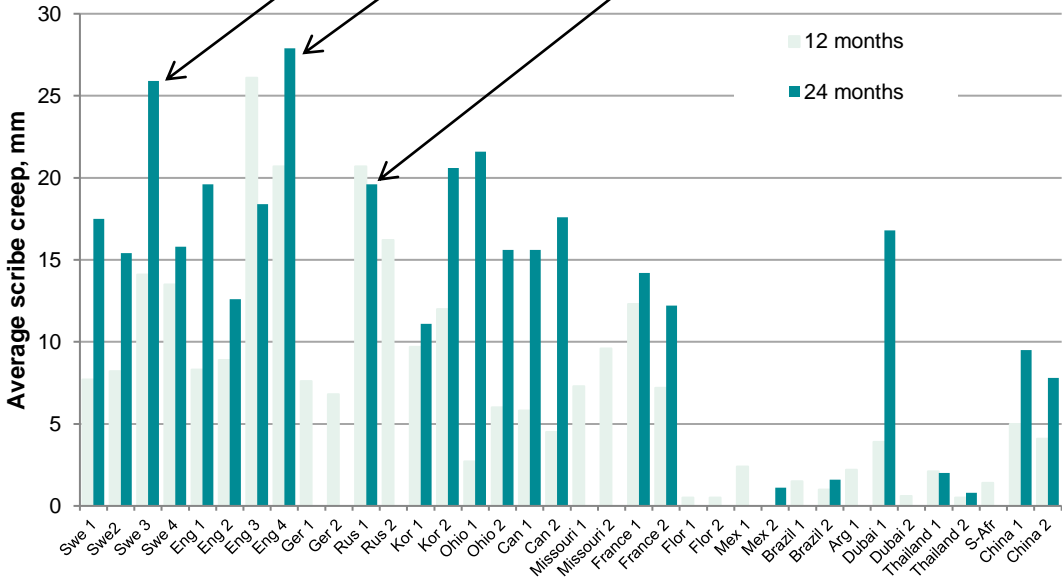
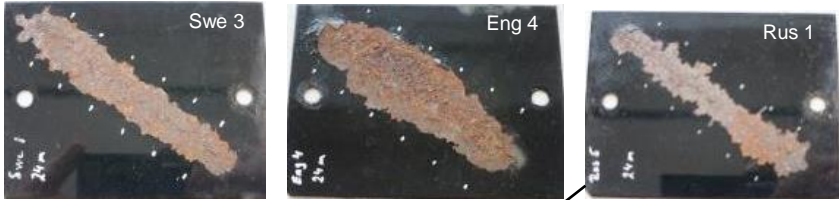


# Carbon steel – Bare



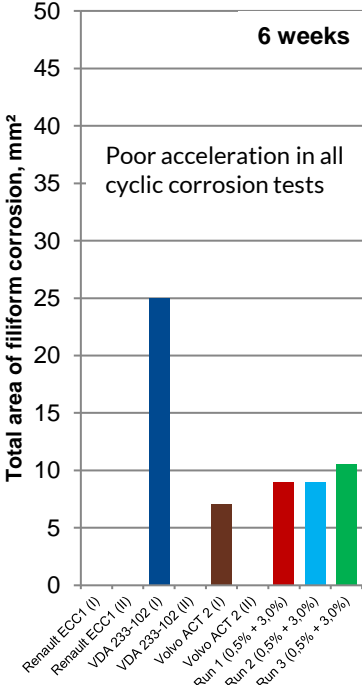
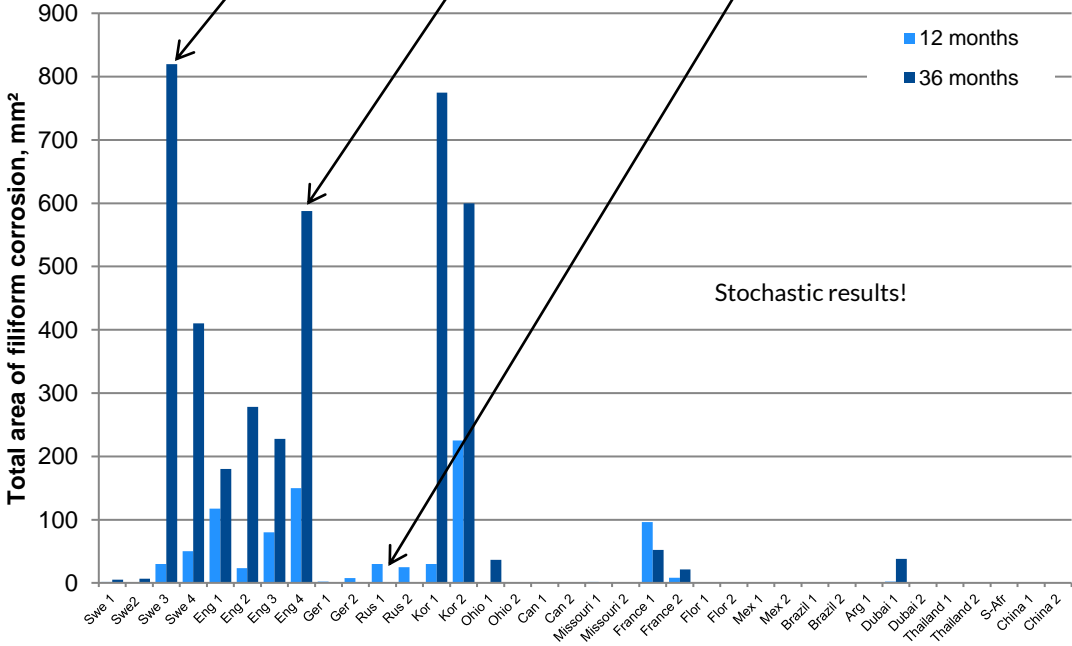
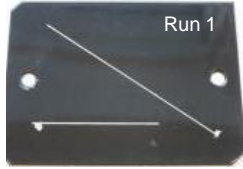
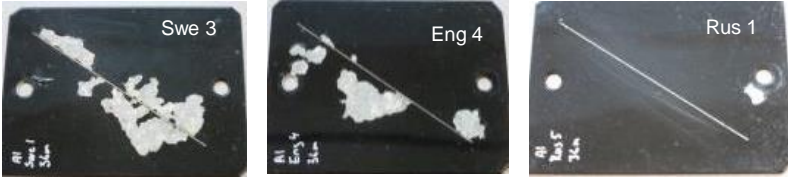
(I) "Worldwide" program Swerea KIMAB  
 (II) "Auto-test" Institute de la Corrosion

# Carbon steel - Full paint system



(I) "Worldwide" program Swerea KIMAB  
 (II) "Auto-test" Institute de la Corrosion

# AA6016 - Full paint system



(I) "Worldwide" program Swerea KIMAB  
 (II) "Auto-test" Institute de la Corrosion



## Typical corrosion data from the performed Cyclic Corrosion Testing and Mobile exposures

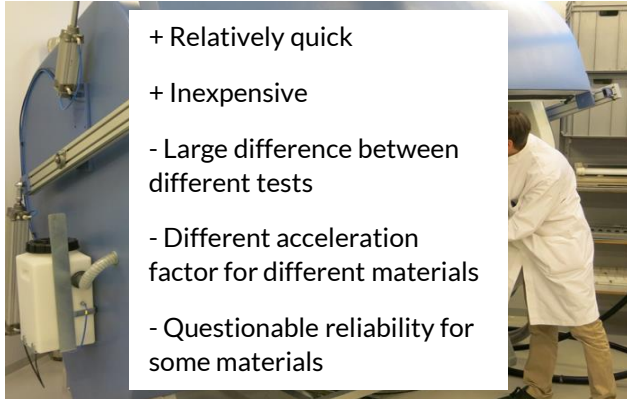
Materials	Accelerated corrosion test 6 weeks	Mobile exposure* 12 months	Acceleration factor
Corrosion			
CRS, $\mu\text{m}$	80-350	40-70	$\approx 2-5$
Zinc, $\mu\text{m}$	6-20	4-7	$\approx 1-3$
AA6016, $\mu\text{m}$	0,2-0,7	0,4-1,6	$\approx 0,5$
Delamination			
CRS, mm	5-16	5-8	$\approx 1-2$
GI, mm	1-3	1-3	$\approx 1$
AA6016, $\text{mm}^2$	0-25	0-800	? Stochastic results

\* areas with the use of de-icing salt



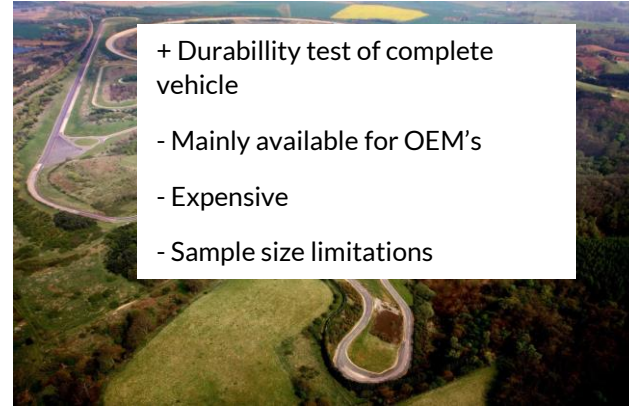
# Corrosion testing of automotive materials

## Accelerated corrosion testing



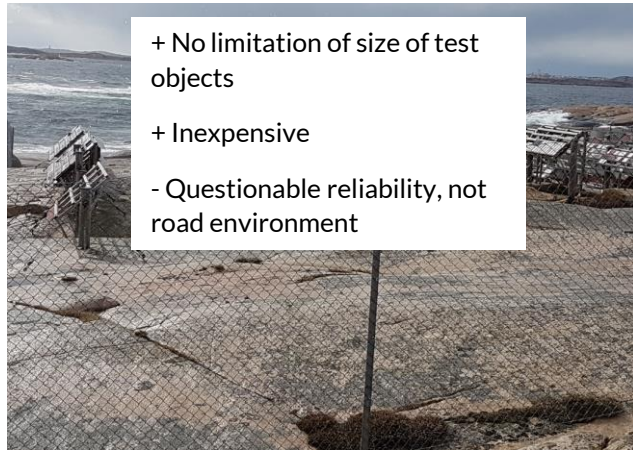
- + Relatively quick
- + Inexpensive
- Large difference between different tests
- Different acceleration factor for different materials
- Questionable reliability for some materials

## Proving ground testing



- + Durability test of complete vehicle
- Mainly available for OEM's
- Expensive
- Sample size limitations

## Stationary testing - marine atmosphere



- + No limitation of size of test objects
- + Inexpensive
- Questionable reliability, not road environment

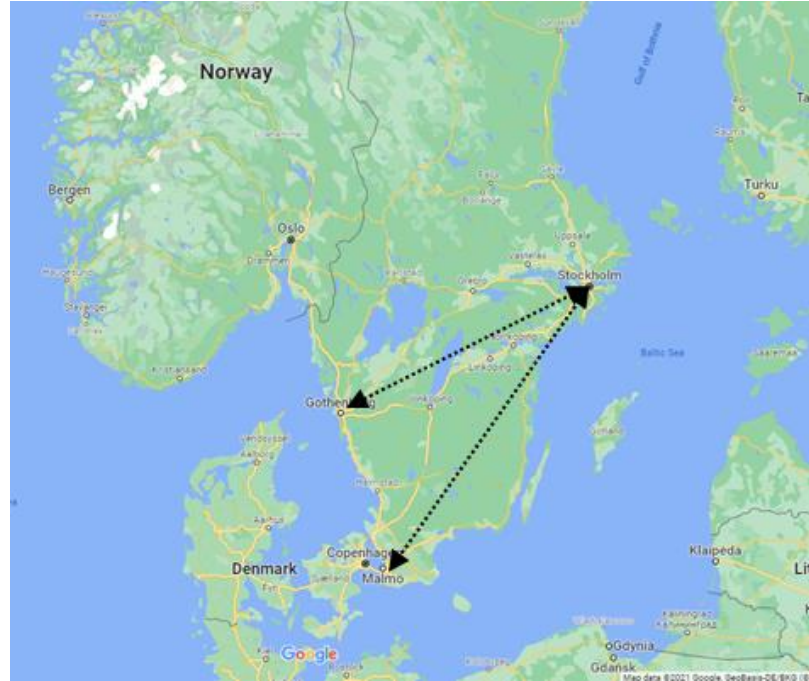
## Mobile on-vehicle exposure



- + Reliable results
- + Real environmental condition
- + Give real life durability
- Time consuming

# Mobile exposure

Samples exposed on a trailer travelling between Stockholm and Gothenburg/Malmö in Sweden. This area are one of the most corrosive in the world due to frequent use of de-icing salt.







# Long term on-vehicle exposure of different types of automotive materials



Mobile corrosion test for automotive materials  
2022-04-06

## ABOUT THE PROJECT

- 10 years exposure
- Withdrawal after 5 years
- Yearly inspections

### Environmental measurements:

- Temperature/Relative humidity sensors
- Atmospheric corrosion sensors: Fe and Zn
- Road mud collector
- GPS

### Bare materials; 100 x 50mm

- Carbon steel
- Zinc
- SS EN1.4310
- ALX-STD
- Extruded AA6060 (recycled and primary)
- AA7075 T6 with tensile stress

### Full automotive paint system; 100 x 100mm

- GI
- GA
- ZnMgAl
- AA6016
- SS MaX, only E-coating
- ALX-STD

### Crevice specimens; 100 x 76mm E-coating

- GI
- ZnMgAl
- AA6016 and AA6005
- HSS AISi

And more...



# MRC Automotive Corrosion – Member companies

DAIMLER TRUCK



SCANIA



Mercedes-Benz



CITROËN

GM General Motors



MAZDA



NISSAN



TOYOTA

HYUNDAI

HONDA  
The Power of Dreams



PEUGEOT



RENAULT

JFE voestalpine

NIPPON STEEL

HYUNDAI STEEL

outokumpu SSAB

BAOSTEEL

POSCO

Gestamp

Constellium

Novelis

GRÄNGES

ArcelorMittal

aperam

ALVANCE

UACJ

Hydro



PROVEXA  
Surface Technology



PPG Industries

AUSON

CEVT



NOF METAL COATINGS GROUP

Metalsa

RISE

# Summary

Mobile on-vehicle exposure is a very good method for corrosion testing of automotive materials. It is suitable for testing of:

- Materials, surface condition, pretreatment and coatings
- Corrosion protection measures
- Corrosivity assessment.

In order to further develop cyclic corrosion tests there is a need to increase the knowledge on:

- Influence of environmental parameters on the degradation of different materials
- Mechanisms of degradation
- Modelling of atmospheric corrosion.





# International Seminar in the Field of Automotive Corrosion

**9-10<sup>th</sup> of November 2022 - Stockholm**

- The 8<sup>th</sup> International Seminar in the field of Automotive have been postponed due to the Covid-19 pandemic.
- The topics will be:
  - New corrosion challenges with respect to electrification of vehicles
  - Corrosion testing of automotive materials
  - Surface treatment and corrosion aspects of materials used in the automotive industry

# Seminar: Reliable testing for materials and products

We welcome our existing customer at the test bed as well as all of you who wish to learn more about atmospheric corrosion testing.

19 May 2022

Program available at:

[ri.se/en/events](https://ri.se/en/events)



**Bo Rendahl**

`bo.rendahl@ri.se`

010-228 48 58

**Carolina Schneiker**

`carolina.schneiker@ri.se`

010-228 48 61