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- Test of PM motor drive
- Type test of track friendly soft bogie
- Type test of active lateral suspension
- Nordic climate
- Summary
Overall test set-up for REGINA 250 during summer 2008

There are many partners involved striving for the same goal.

<table>
<thead>
<tr>
<th>DMA-car</th>
<th>DMB-car</th>
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<tbody>
<tr>
<td>▪ Track friendly soft bogie</td>
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<tr>
<td>▪ Active lateral suspension</td>
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<td>▪ Modified secondary suspension</td>
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<td>▪ Instrumented wheel set</td>
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<td>▪ PM - motor drive</td>
<td></td>
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<tr>
<td>▪ Track friendly soft bogie</td>
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Overall test planning 2008 for REGINA 250

<table>
<thead>
<tr>
<th>Jun-Jul</th>
<th>Jul-Aug</th>
<th>Sep-Oct</th>
<th>Nov-June</th>
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<tbody>
<tr>
<td><strong>Pre-testing</strong></td>
<td><strong>Type test</strong></td>
<td><strong>Reliability test</strong></td>
<td><strong>Service op.</strong></td>
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</tbody>
</table>
| **PM-motor** on vehicle for the first time  
— Trimming  
— Control  
— EMC  
— Braking  
— Performance  
**ALS**  
— Trimming | **ALS** undertaking UIC 518 test and evaluation  
**PM-motor** drive will be on the vehicle during test period. Final UIC test with **soft bogie**. **High Speed** test runs. | **PM-motor drive and mechatronic bogie** undertaking a reliability test before going into service operation | **PM-motor drive and mechatronic bogie** going into service operation including winter conditions |

This step by step process has to be carefully managed with check points and clarified criteria at each gate.
Test lines for UIC 518

- Tested for:
  - Soft bogie with passive radial steering
  - Active lateral suspension

- Test conditions
  - Admissible speed: 250 km/h
  - Admissible cant deficiency: 168 mm (1.1 m/s²)
  - Testing at + 10 % (speed on straight & cant def).
New high speed record

- On July 23 on the test track Skövde – Töreboda the REGINA 250 reached the new high speed record of 295 km/h (282 km/h 2007)
- This was done on track certified for 200 km/h operational speed
- Further high speed test runs are planned
MITRAC Permanent Magnet motor

Summary

- PM motor offers environmental and economical advantages – which in future has the potential to increase in relevance
- The MITRAC PM motor design is based on industry standard with unique features which provide Unique Selling Propositions
  - Wide application range
  - High degree of versatility for optimized utilization of complete system
  - Compatibility with existing systems
  - Reuse of reliable and proven MITRAC induction motor
- Successful tests confirmed the advantages of MITRAC PM motor and the expected benefits
Future track access charging

- **Track-friendly trains enable**
  - Lower track deterioration
  - Smoother ride on non-perfect track
  - Lower wheel wear

- **Banverket** is pushing for low track deterioration and a model for the cost of track deterioration **likely being the basis for future track access charging**

- **Most important vehicle features for track deterioration**
  - Axle load
  - Radial steering capability in curves
  - Speed and cant deficiency
  - Unsprung mass
Track force measurements

- Instrumented wheels on two axles for continuously measuring vertical and lateral forces.
- Accelerometers according to UIC 518. In addition some accelerometers for comfort evaluation in car bodies.
Track-friendly soft bogie for REGINA 250

- Based on 25 years of experience with track friendly soft bogies
- Meets UIC518 requirements for **250 km/h**
  and cant def **168 mm** (1.1 m/s²). Track forces 50-60 % of limits.
- Has been running 295 km/h (new record in Sweden)
Active Lateral Suspension (ALS)

- Two functions in one hardware
  - 1) Keep carbody in centred position in curves
     ⇒ Move in bump stops
     → Wider carbody possible
     → Better cross wind stability
     ⇒ Improved lateral ride comfort by avoiding bump stop contact
     ⇒ Possible to run at high speeds in curves
  - 2) Improve lateral ride comfort
     ⇒ Same ride comfort at 250 km/h as without active lateral suspension at 200 km/h

- Wider carbody
  - 3.6 m in Gröna Tåget (draft, + 0.1-0.15 m)
The ALS system

Sensors -> Controller

Controller

Force demand

Actuator A

Actuator B

Force demand

400VAC, 50Hz (~ 500W)

400VAC, 50Hz (~ 500W)
Test result:
ALS keeps the carbody in centred position in curves

Displacement bogie - carbody

<table>
<thead>
<tr>
<th>Length of curve</th>
<th>with ALS</th>
<th>without ALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mm</td>
<td>0</td>
<td>50 mm</td>
</tr>
<tr>
<td>0</td>
<td>-50 mm</td>
<td>0</td>
</tr>
<tr>
<td>-50 mm</td>
<td></td>
<td>-50 mm</td>
</tr>
</tbody>
</table>
Test result for lateral ride comfort

10 – 47% reduced lateral carbody acceleration frequency weighted according to ISO, to Wz units 0.1 – 0.3
Test for improved vertical comfort

- A study has shown that an improvement of the vertical ride comfort can be achieved by adding a second auxiliary volume (8) as well as an orifice (6) to the secondary suspension system.
Vertical ride comfort

- Tests have been made during the summer in order to verify earlier calculations
- The tests show that adding a second auxiliary volume improves the ride comfort in the car body
- The results show an improvement of 0.1 to 0.2 units in Wz
- The modified secondary suspension system will lower the vibrations in the car body and by that improve the overall comfort felt by the passengers
Nordic climate conditions

- Trains in Sweden has to face the Nordic conditions
- Low temperature, - 40 degC
- Ice and snow
- Winter test in 250 km/h
- Winterisation Guidelines
Summary

- Gröna Tåget presents model for passenger attractive, environmental-friendly and cost-efficient trains
- New technologies gives opportunities for the railways
- Unique cooperation in Gröna Tåget gives win–win solutions
- Implementation can start already now!
- Gröna Tåget is the fastest way towards the future

Test rides with REGINA 250 shows that the aims are realistic