

Digital Freight Train - Coupling Systems

Knorr-Bremse strategy for the introduction
of the Digital Automatic Coupler in Europe

18.10.2023

Knorr-Bremse Coupling Systems



Coupling Systems – an innovation field of Knorr-Bremse with ambitious targets



Coupling Systems in a nutshell

- **Business Unit re-established in 2019** with currently 30 full time employees and growing
- **Strategic objectives:**
 - Passenger: Market entry **passenger couplers 2023** and **leading player by 2030**
 - Freight: **leading freight coupler player** as soon as market starts & driver of the DAC^[1] introduction as core member of the European DAC delivery program & ERJU^[2]
- **Approach**
 - Dedicated team of specialists
 - Focus on standard portfolio but being able for quick adaptations in case of strategic opportunities
 - Support from whole KB rail organization incl. Top-Management



state-of-the-art couplers based on full KB rail engineering know-how



trusted long-term partnership with our customers

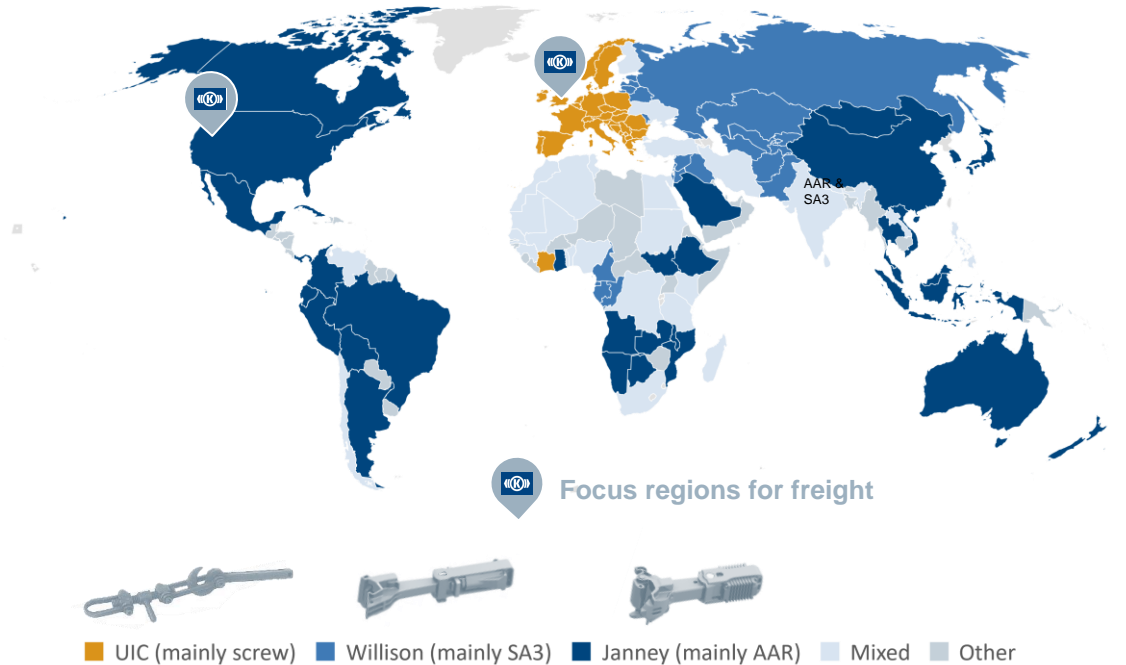


local service centers & field service for high reactivity & service quality

^[1] Digital Automatic Coupler, ^[2] Europe's Rail Joint Undertaking

Only Europe still with manual freight couplers – introduction of modern system targeted to make rail freight competitive and achieve the EU green deal

Freight coupling systems world map



Main freight coupling systems

Europe (switch to automatic system targeted)

- Still manual system with UIC screw coupler
- Introduction of **fully automatic system** (“digital automatic coupler”) targeted
- Previous migration attempts failed (both w. KB) (z-AK end of 80s & AK69e end of 60s)

Type AAR – technology since ~1890

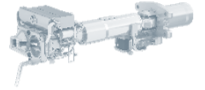
- Semi-automatic coupling, Types E, E/F, F (automatic coupling, manual uncoupling)

KB focus

SA3 – technology since ~1930

- Semi-automatic coupling (automatic coupling, manual uncoupling)
- No market entry plans of KB

DAC is more comparable to passenger transport than to other freight couplers, since it brings energy and data on the train



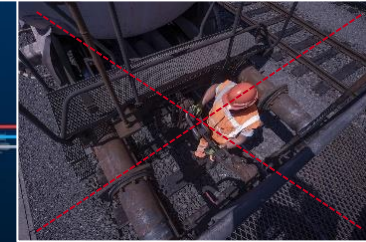
		Freight AAR mainly: NA, SA, CHN, IND, AUS	Freight SA3 mainly: former USSR	Freight UIC mainly: Europe	Freight DAC only: Europe	Passenger Trains global
Automatic Coupling	Mechanical	YES	YES	(manual)	YES	YES
	Pneumatical Coupling	(manual)	(manual)	(manual)	YES	YES
	Electrical & Digital	(not existing)	(not existing)	(not existing)	YES	YES
Automatic Uncoupling	Mechanical, Pneumatical, Electrical, Digital	(not existing)	(not existing)	(not existing)	YES	YES
Train Functions	Train Functions (brake test, ...)	Wireless (limited scope)	Wireless (limited scope)	Wireless (limited scope)	YES	YES
Brake Systems	EP brake	Partially (via manually coupled cable)	(not existing)	(not existing)	Theoretically possible	Possible

DAC makes rail freight fit for the future – it is safe for the staff, automates coupling and enables the digitalization of the freight train



Digital Automatic Coupler

data
pneumatic
power

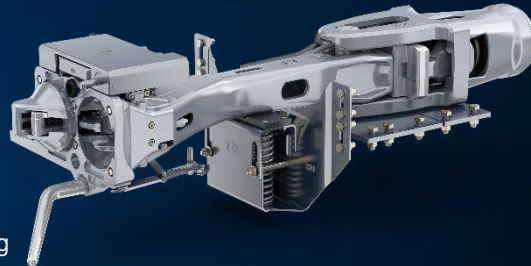


Digital
Automatic Coupler
(DAC)

Automatic coupling

- mechanical
- pneumatic
- Electrical / digital

Type 4 – automatic coupling
Type 5 – automatic coupling & decoupling



Benefits

- fast, efficient coupling
- Automatic coupling
- Safe operation
- Enabler for automation

The Digital Automatic Coupler is the key enabler for automation functions to make freight transportation competitive and increase infrastructure capacity



Automation Functions enabled by the DAC



Train Preparation

faster processing

Train Operation



more transportation capacity
dynamic infrastructure utilization



Maintenance Services

sustain, enhance, accelerate

Shunting & Parking



faster processing

Train Run Mode

- Train integrity monitoring
- Network based electro-pneumatic brake

Shunting Mode

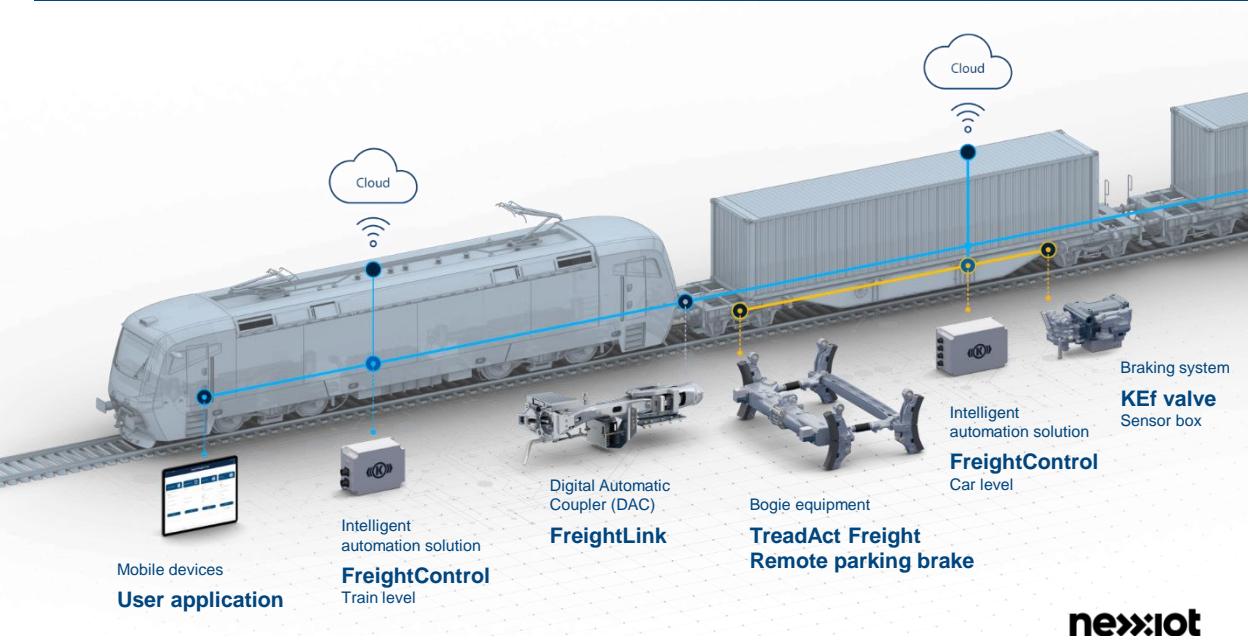
- Apply / release parking brake
- De-coupling
- Train composition detection
incl. train length determination
- Automated brake test

- Change of operation mode
- (Automatic coupling)

“KB Digital Freight Train” provides the needed technology for the automation of all critical processes from train preparation to parking & maintenance

KNORR-BREMSE

Knorr-Bremse Digital Interoperable Freight Train Eco-System - Technology

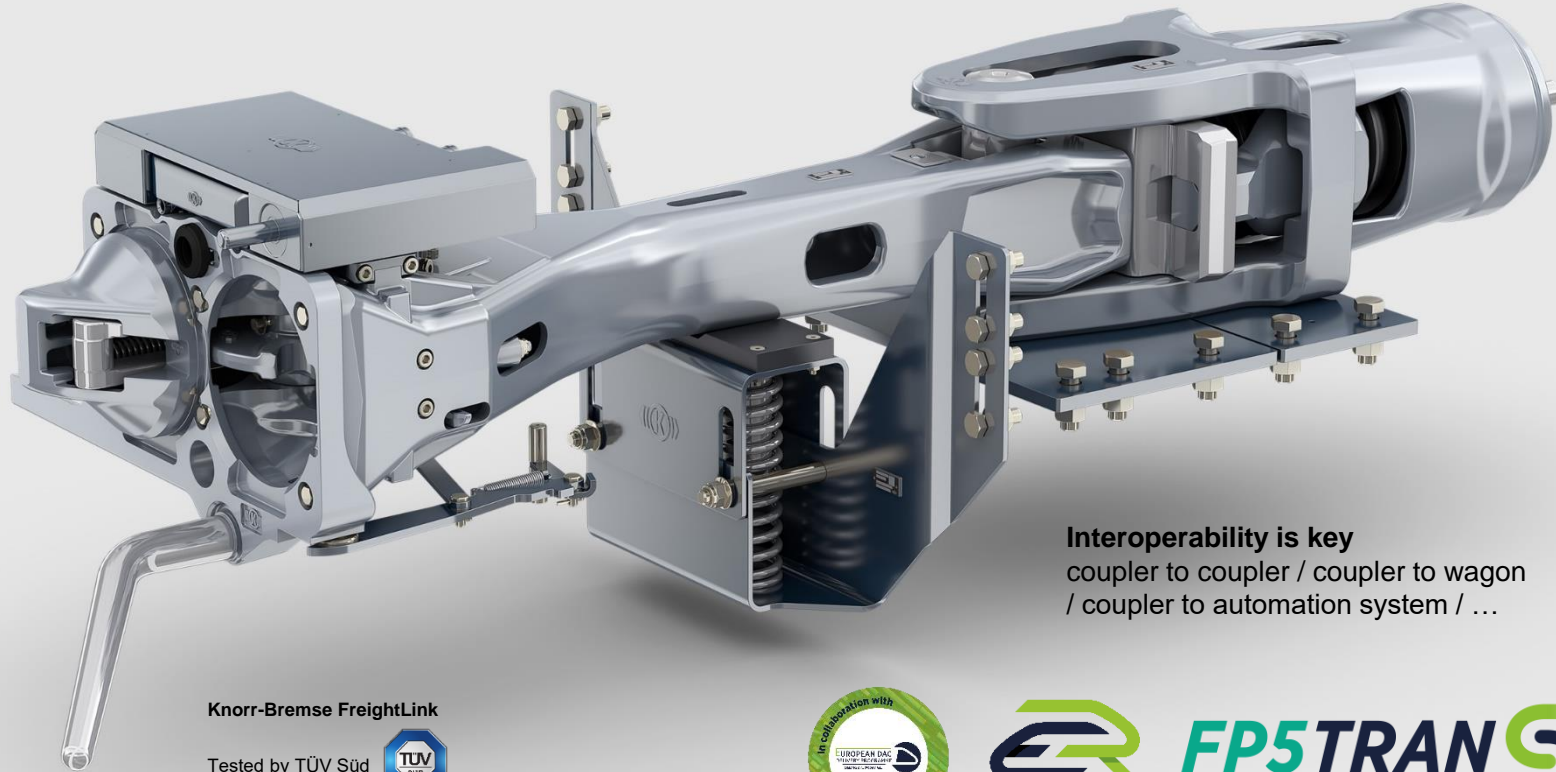


Knorr-Bremse Scope

- Pneumatic braking systems
- Digital Automatic Coupler
- FreightControl
 - Automated brake test
 - Train composition detection incl. train length determination & train integrity monitoring
 - De-coupling
 - Parking brake control
 - Network based EP-brake
 - User interface application
- Automated parking brake systems
- Wagon power supply / battery

+ Digital Services (Nexxiot)

Knorr-Bremse DAC "Freight Link"



Interoperability is key
coupler to coupler / coupler to wagon
/ coupler to automation system / ...

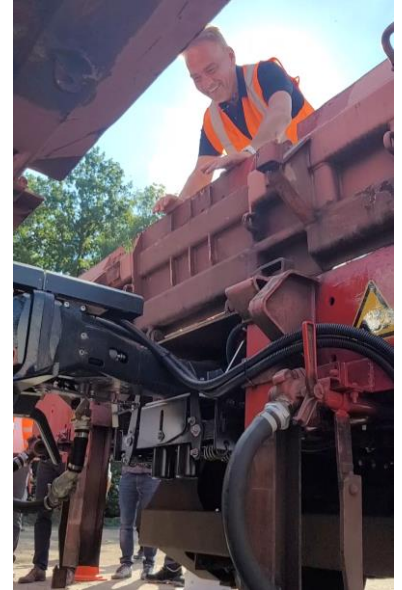


Knorr-Bremse FreightLink

Tested by TÜV Süd



Knorr-Bremse couplers up to DAC5 functionality (“automatic decoupling”) getting heavily tested in real environment



DAC5 uncoupling tests
TrainLab FP5 07/23



E-coupler tests
“SBB DAC+ Demo
Train” 08/2023



Coupler Validation up to 12 kp/h @ TÜV Süd, Görlitz
11/22 and 03/23



DAC under wagon flap
“Day of Rail” 09/2023



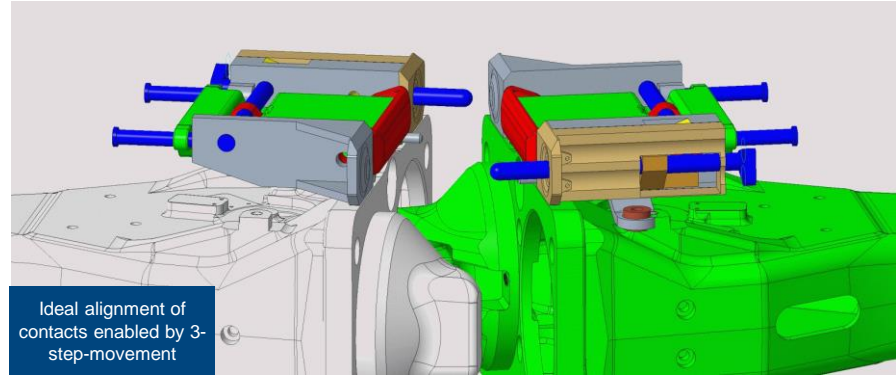
Knorr-Bremse has the only tested E-coupler in the market which is fulfilling the 200 mm height requirement – and it provides further advantages



Main features of Knorr-Bremse E-coupler for DAC

Main KB targets considering 200 mm height from coupler center line + other specification requirements:

1. **Safe and reliable operation**
 - a) **Labor safety** with 400-volt protection
 - b) **Robustness** to cope with rail freight reality
 - c) **Interoperability with mainline** for emergencies
2. **Big-Bang facilitator** with “Pit-Stop-Mounting”
3. **Enabling DAC timeline & have flexibility** regarding optimization and requirement changes
(e.g. *pin-sleeve contacts*)



Knorr-Bremse concept proved its functionality & robustness 11/22 (internal tests, TÜV tests) and is undergoing continues improvement and further testes



Hybrid couplers for Locomotives: the standardized front part can be mounted to the individual Loco draft gears



Knorr-Bremse Hybrid Coupler for Locomotives

Locomotive dual-mode operation

individually adaptable to the different locomotive platforms

Connection system

- Mechanical with DAC
- Mechanical with screw coupler
- Electrical
- Pneumatic (MRP optional)

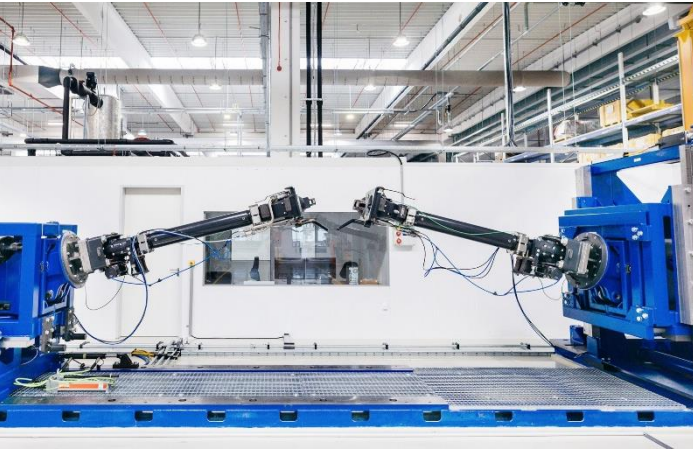


Reversible / irreversible energy absorption

- Scalable standard solutions for common loc
- Bespoke adaptations

The majority of the coupler validation activities is conducted on state-of-the-art test benches located internally at Knorr-Bremse Budapest

Knorr-Bremse testing and validation facilities



Type Test Bench (key parameters):

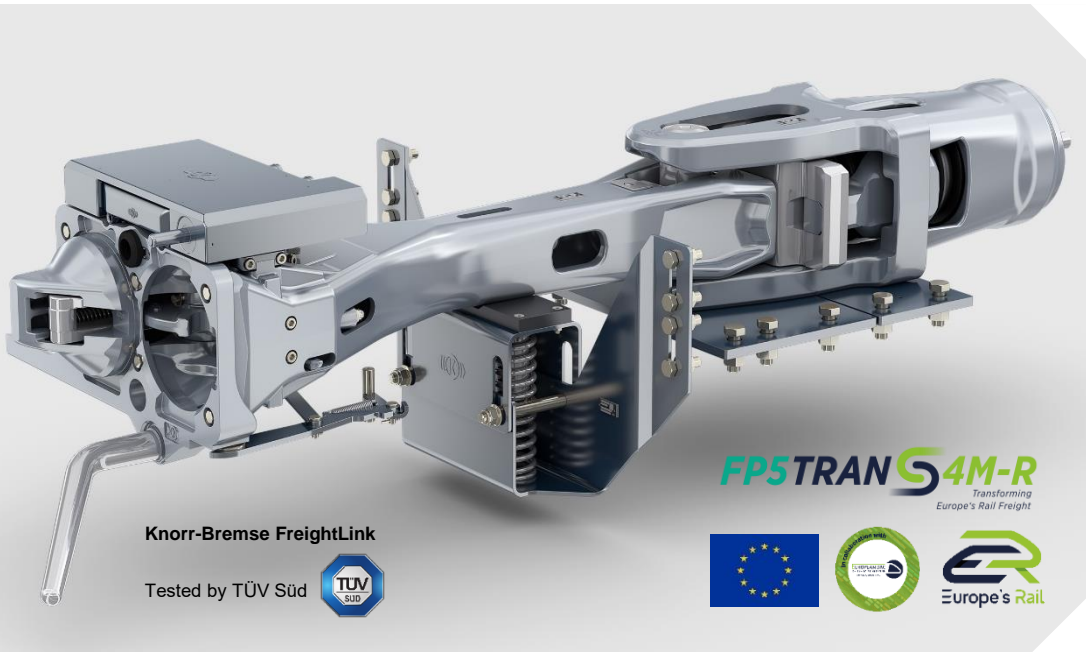
Max. coupling speed: 5 kph
Max. static offset (vertical): ± 300 mm
Max. static offset (horizontal): ± 500 mm

Max. pitch angle (vertical): $\pm 20^\circ$
Max. swiveling angle (horiz.): $\pm 20^\circ$
Max. rotation: $\pm 20^\circ$

Static Test Bench (key parameters):

Max. compressive force: 3.000 kN
Max. tensile force: 2.500 kN

Knorr-Bremse USPs: state-of-the-art couplers, system thinking, industrialization leader, new business models and RailService focus



Knorr-Bremse approach & targeted USPs

(1) State of the art DAC portfolio

(2) KB “Digital Freight Train” system/ bundle

(3) Industrialization Leader Strategy

(4) Customer oriented business models

(5) Best-in-class Service based on KB footprint and partners

* EDDP: European DAC Delivery Program | ERJU: Europe's Rail Joint Undertaking

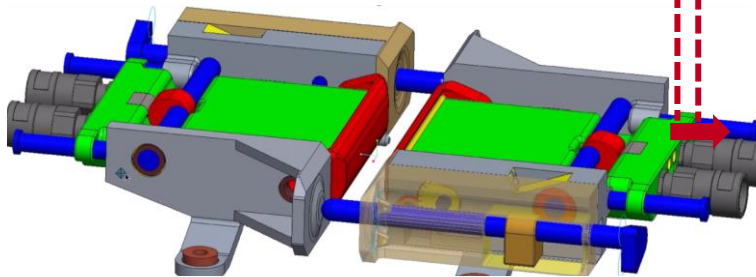
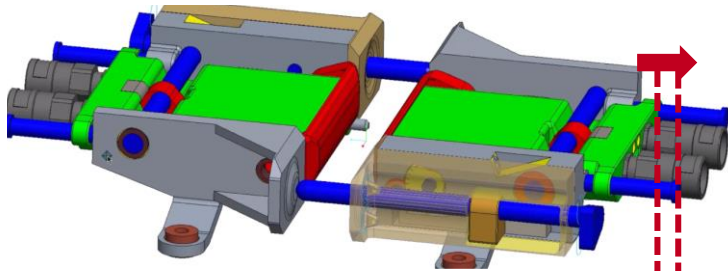


The Knorr-Bremse DAC

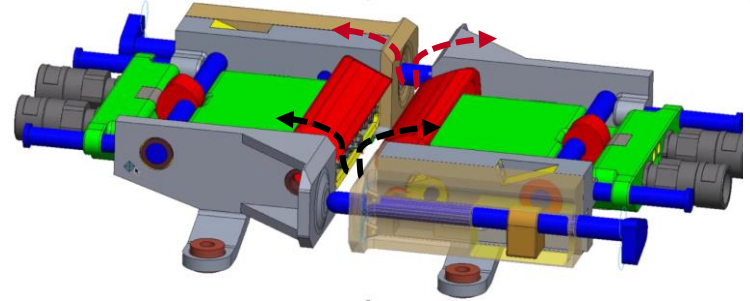


The innovation is not the articulation itself; it is the 3-stage-kinematic which secures a robust and safe operation

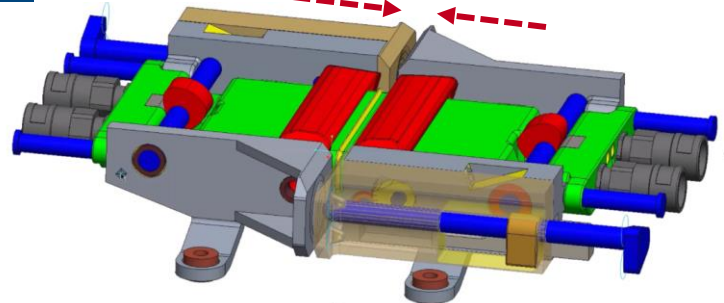
Stage 1 Backwards movement of contact block



Stage 2 Opening of Cover (without impact on sealing!)



Stage 3 Forward movement for coupling



Va multumim pentru atentie!

