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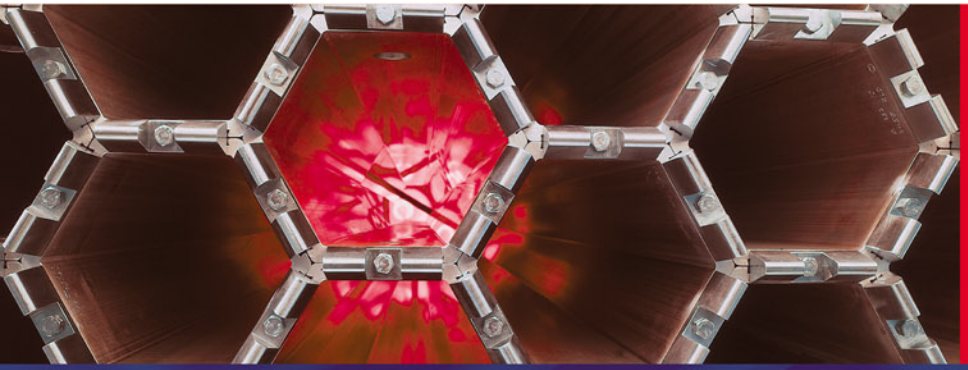

ŠKODA JS EXPERIENCES WITH QUALIFICATION OF SELECTED COMPONENTS FOR CONTROL ROD DRIVE MECHANISMS

Miloslav Ruchař, Jiří Hus, Martin Poledna

International meeting EQUIPMENT QUALIFICATION IN NUCLEAR INSTALLATIONS 20. – 23.5.2019, Řež

ŠKODA JS a.s.

Scope of presentation:

- **Part 1: ŠKODA JS a.s. – company brief introduction**
- **Part 2: Review of qualified components for CRDMs:**
  - type PRO and PRO/M produced by ŠKODA JS a.s. for VVER 440
  - control rod drive position indicator for project Labgene for Brazil navy
- **Part 3: Development and qualification of roller bearing for CRDMs type PRO and PRO-M produced by ŠKODA JS a.s. for VVER 440**
- **Part 4: Conclusion**

Part1: History

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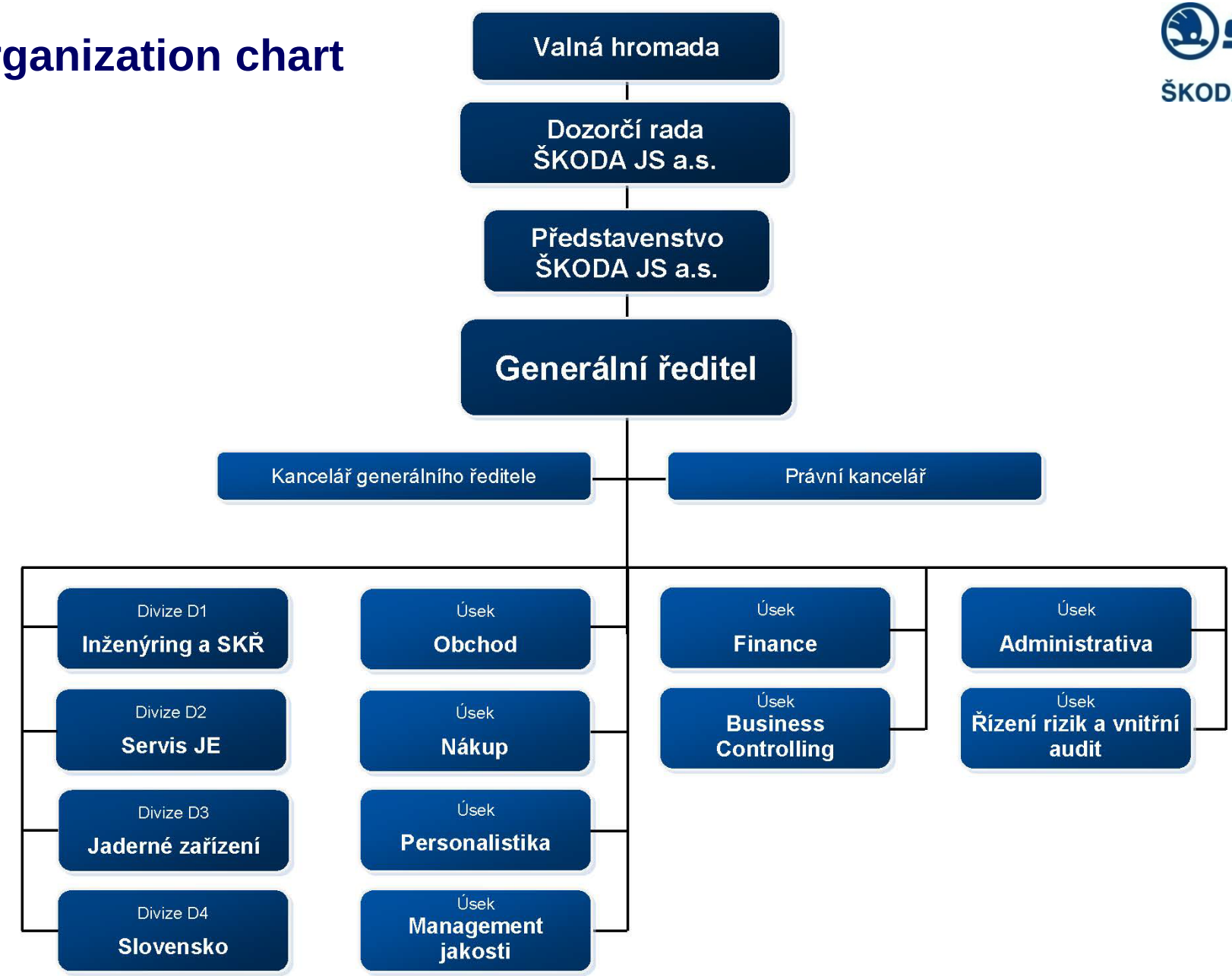
- 1859 - foundation of the primary ŠKODA company
- 1956 - initiation of ŠKODA's nuclear program
- 1974 - start of the VVER reactor program
- 1980 - first VVER 440-type reactor
- 1989 - first VVER 1000-type reactor
- 1993 - starting cask manufacturing
- 1993 - privatization and establishment of the parent company ŠKODA a.s. and the subsidiary ŠKODA JADERNÉ STROJÍRENSTVÍ s.r.o.
- 1999 - transformation to a joint stock company ŠKODA JS a.s.
- 2004 - sale of SKODA JS to the Russian group OMZ (100% owner)
- 2010 - first delivery of components for EPR-type reactor
- 2019 - today - Czech leader in supplies for nuclear power plants, staff – more than 1100 employees

Emil ŠKODA (1839-1900)
founder of ŠKODA WORKS

Organization chart

ŠKODA JS a.s.



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Part 1: Strategic Business Units

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Engineering

- Construction of VVER nuclear units
- Supply and modernization of nuclear unit I&C systems
- EPC projects
- Computational analyses for nuclear power plants
- Design activities
- Piping systems in power industry
- Owner's Engineer activities
- Spent fuel interim storage facilities
- Construction of research and training reactors

Production

- Equipment for VVER and RBMK nuclear power plants
- Equipment for PWR and BWR nuclear power plants
- Equipment for research reactors
- Equipment for spent nuclear fuel storage

Service

- Reactor building equipment outage management
- Reactor building equipment maintenance and repairs
- Reactor building equipment modernization
- Reactor building equipment lifetime management
- Reactor building key equipment in-service inspections
- Designer's supervision during reactor inspections and repairs
- Testing of VVER and RBMK control rod drive mechanisms
- Spare parts and consumables

Part 1: Manufacturing and Site Instalation Premises

ŠKODA JS a.s.

Bolevec site facilities

- Company headquarters
- Fabrication of small and medium size products

Reactor shop

- Fabrication of heavy welded vessels and structures

NPP Engineering – Mechanical Design Praha

- Designing and conducting strength calculations of piping systems

Dukovany NPP department

- Services for NPP

Temelín NPP department

- Services for NPP

Mochovce organization unit

- EMO34 project implementation

Part 1: Quality Assurance

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- **ISO 9001: 2015**
- **ISO 14001: 2015 (EMS)**
- **OHSAS 18001: 2007**
- **ASME-Code**
  - **Section III, Div.1 (stamps N, NPT, certificate NS) – nuclear equipment**
- **ČSN-EN-ISO 3834-2** – QMS in welding
- **AD-2000 Merkblatt HP 0, DIN 18800-7 class D (Germany)**
- **TRV 006 (TÜV, Germany) –** manufacture of nuclear equipment – B-type casks
- **ABOS (Paks NPP, Hungary)** – nuclear equipment
- **CEFRI (France)**
- **RCC-M (France)**
- **KTA (Germany)**
- **TBM / KBM (Sweden)**

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Part 2

Review of qualified components for CRDMs:

- type PRO and PRO-M produced by ŠKODA JS a.s. for reactors VVER 440
  - control rod drive position indicator for Labgene project

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Technical description of CRDM

- **CRDM is electromechanical device with gearbox intended for work in the environment of the primary circuit of the VVER 440/V-213 nuclear reactor.**
- **CRDM is the equipment that moves the reactor control element.**
- **The 37 CRDMs work in the reactor control system.**
- **The CRDMs are divided by function within the control system into 6 working groups providing for the following functions:**
  - control element movement in the reactor control mode at a given speed;
  - control element standing in a specified position;
  - control element scram in the reactor emergency mode;
  - control element holding in the reactor emergency mode;
  - check of control element current position;
  - precise reaching the specified position of the control element;
  - securing the control element against movement upwards in case of a leak-tightness failure above the reactor nozzle.

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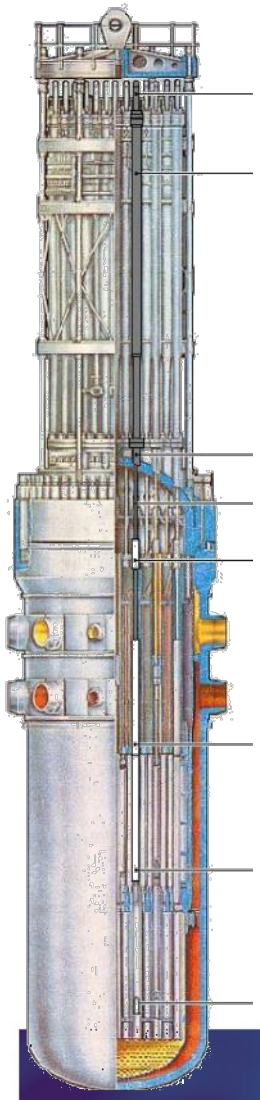
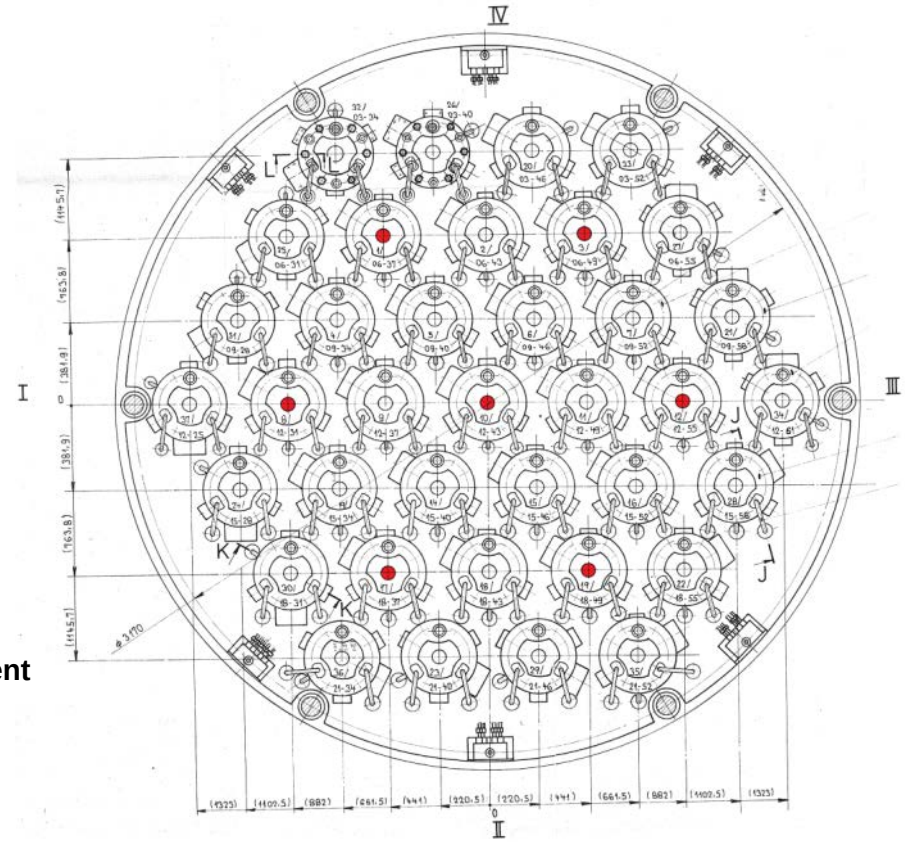
The arrangement of CRDMs in reactor

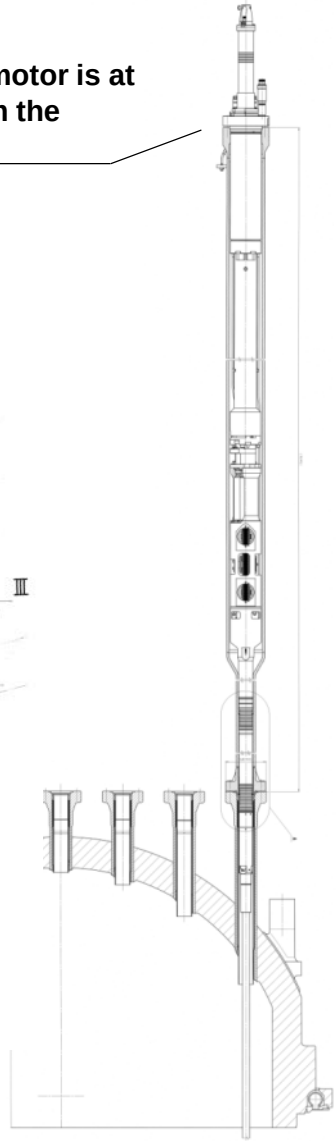




37 pcs CRDMs in the reactor

● Group 6 (Regulatory)

Flange of electric motor is at height of 21 m from the bottom of reactor



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Environment conditions of CRDM

- CRDM operate in primary circuit water of reactor at temperature up to 300 °C and pressure 12.5 MPa.
- Pressure parts of position indicator, electric motor and gears of CRDM operates in primary circuit water at temperature up to 100 °C.
- Environment parameters under reactor cover where located position indicator and electric motor flange of CRDM are:

	Units	Normal conditions	Accident conditions
Temperature	°C	≤ 60	127
Under-pressure	Pa	≤ 196	---
Absolute pressure	kPa	---	245
Relative humidity	%	≤ 90	Steam-gas mixture
Radiation—total integrated dose	kGy	110	0,125
Radiation—Dose Rate	Gy/h	0,5	1 500
Spraying	Yes/No	No	Yes
Functionality during accident	min	---	5

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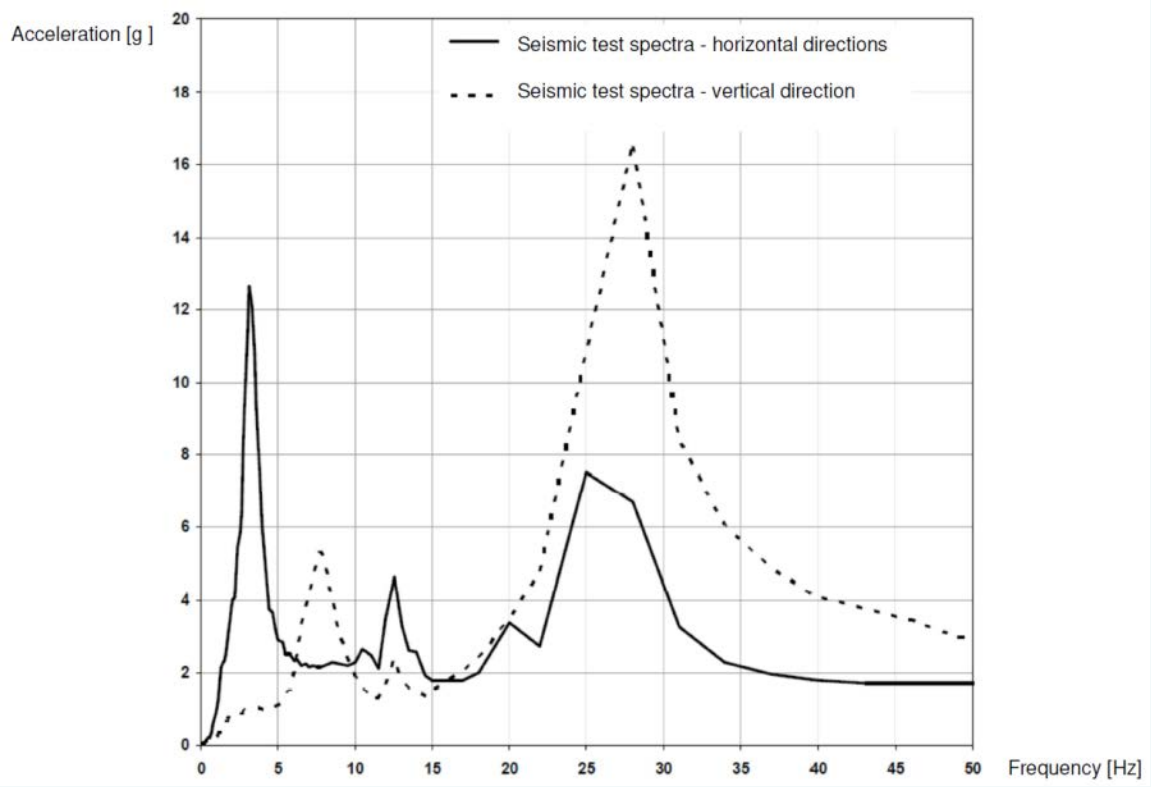
Vibration load and siesmic excitation of CRDM

Vibration load	AH1 (test frequency range 1÷150 Hz)
Required test response spectra:	

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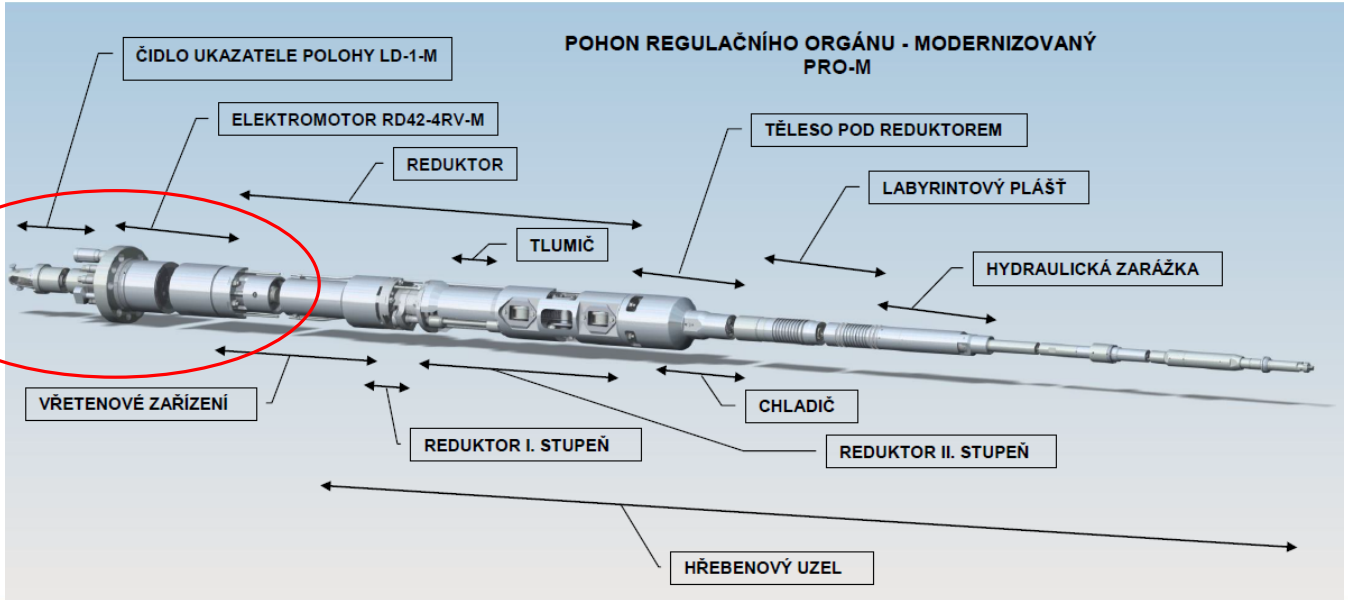
Qualified electrical sub-components of CRDM

- Electric motor type RD 42-4RV-M
- Position indicator type LD-1-M
- Customized connectors LEMO (in mated with power supply counterpart)
- Connectors of type Px-S (in mated with power supply counterpart, compatible with original Russian SNC type).
- Other mechanical parts of CRDM were subjected to strength and fatigue life calculation, seismic resistance calculation and lifetime tests.



OMZ Člen skupiny OMZ

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Reasons of qualification were:

- **The new design of PRO-M components, qualified lifetime 25 years.**

Characteristics of CRDM components qualification

- **Electrical equipment of the NPP safety system (subject to IEC 60780).**
- **Components of CRDM were modernized base on the operating experience of PRO type and supporting calculation analyses.**
- **During the qualification tests, results were compared with operating experience.**
- **Qualification tests were performed in following order:**
  - Initial functional tests
  - Accelerated thermal aging and thermal cycling
  - Continuous functional tests
  - Ionizing radiation influence tests
  - Vibration test
  - Long-term operation test (lifetime functional tests, wearing check)
  - Seismic resistance test
  - Test of resistance to decontamination solutions
  - LOCA test
  - Final functional tests and visual inspection

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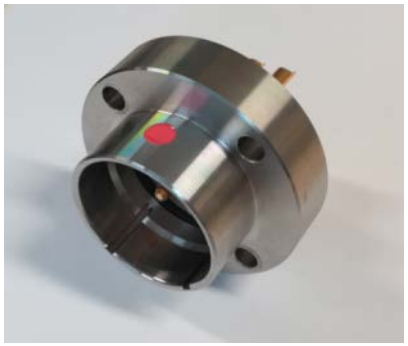
Electric motor type RD 42-4RV-M and position sensor type LD-1-M on vibration and seismic test equipment

Customized connectors LEMO (in mated with power supply counterpart) on vibration and seismic test equipment

Connector LEMO



Connectors of type Px-S

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Results and experience of qualification of CRDMs components of type PRO and PRO-M:

- The ability of qualified components to operate in operating conditions of reactor VVER 440/V-213 for 25 years was verified.
- Experiences were gained with qualification of variety of materials, such as silicone resins, epoxies, polymers and fluoroelastomers.
- Seismic tests is always necessary to compare with the project seismic event of the respective locality.

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Part 2

Review of qualified components for CRDMs:

- type PRO and PRO/M produced by ŠKODA JS a.s. for reactors VVER 440

- **control rod drive position indicator for Labgene project**

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Labgene project – control rod position indicator and cables (running project)

- **Project is in realization at ŠKODA JS a.s. with cooperation of ZAT a.s.**
- **Scope of delivery:**
  - Control rod drive position indicator and cables (IPMAB)
  - Control rod drive mechanism power system (I&C part for MAB)
  - Scope of services:
    - Design proposal (done in 2015)
    - First physical prototype fabrication (done in 2015)
    - First physical prototype testing and evaluation – end of first contract (done in 2015)
    - Followed contract for on function prototype and its qualification (started in 2018)
    - Prototype testing (under operation)
    - Components qualification (under preparation)
    - Components production and supply (to be contracted after qualification)
    - Site installation assistance and training (to be contracted after qualification)

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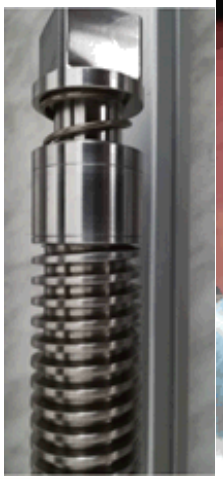
Labgene project – control rod position Indicator and cables (running project)

- **Experimental PWR, heat power 48 MWth**
- **Position indicator shall have 4x times redundancy**
- **Main parameters for qualification:**
  - Normal temperature conditions (120°C)
  - LOCA accidental conditions (up to 150°C)
  - Integrated radiation dose 80 kGy (30 years)
  - Vibration resistance required
  - Operability during and after seismic event is requested
  - Accelerated ageing to be in step periods
  - Qualification solved together with ÚJV Řež a.s. base on the written qualification program and standard IEC/IEEE 60780-323:2016



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Part 3

Development and qualification of CRDM roller bearings for CRDMs type PRO and PRO-M produced by ŠKODA JS a.s. for VVER 440

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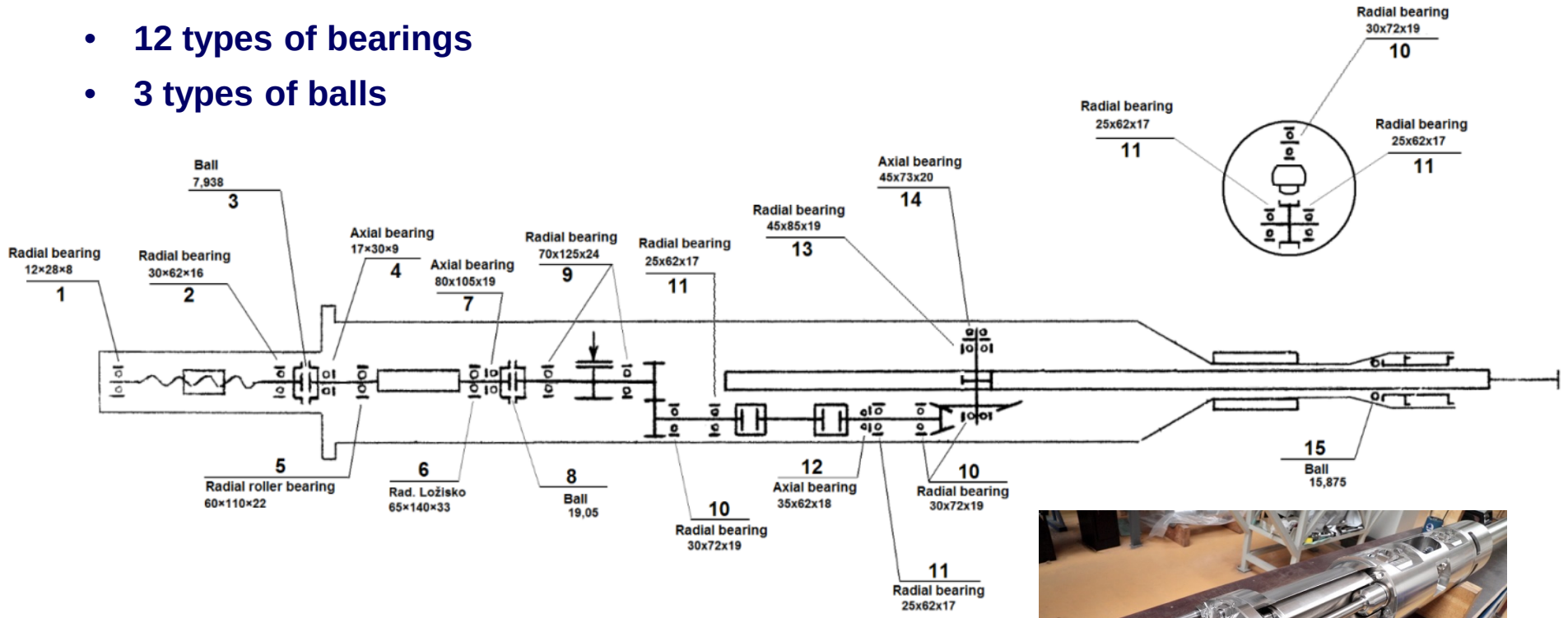
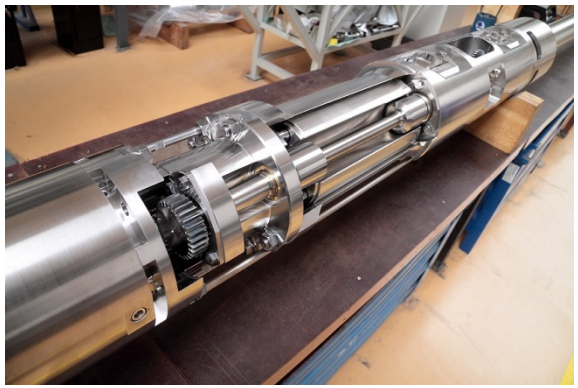
Review of bearings and balls in CRDM

- 12 types of bearings
- 3 types of balls





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DEVELOPMENT AND QUALIFICATION OF CRDM ROLLER BEARINGS

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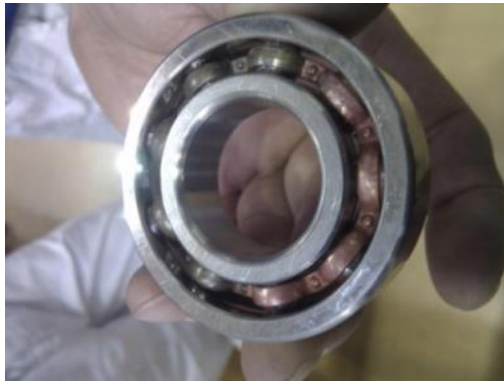
Reasons for development:

- Dependency on one supply source only from Russian federation
- Poor traceability between the parts and material certificates
- Contamination of stainless steel components with carbon steel
- PMI – material replacement found during receiving inspection
- Wide scope of used materials, especially for cages design
- Exclusion of brass and PTFE as a material for cage design
- Long delivery times
- Week position to force manufacturer and supplier to improve bearings quality
- Economical reasons



Advantages of new manufacturer, company SLB s.r.o.:

- Specialized manufacturer for special purpose roller bearings located in Czech republic
- Possibility to discuss and solve technical issues
- Well implemented quality system,
- Traceability between part and semiproduct material certificate of level 3.1 dle EN 10204
- Documentation prepared in accordance with legislation
- Flexible delivery time

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Data to original roller bearing solution

- **Material of roller bearings and cages**
  - Rings: martensitic stainless steels 95Ch18(-Š), (95Х18-Ш) and 110Ch18M-ŠD (110Х18М-ШД) were replaced by martensitic stainless steel AISI 440 C
  - Cages: 14Ch17N2, 08Ch18N10T, BrAZHMts10-3-1.5, Ftoroplast finally replaced by thermoplastic polymer PEEK (Ketron 1000)
- **Chemistry of reactor primary water**
  - pH > 4,3, boric acid, other chemical elements (O2, Fe, Cl, NH3)
- **Normal operating conditions** (temperature, radiation, pressure, water chemistry, load)
  - up to 100°C at pressure 12,3 MPa
  - max dose rate 0,5 Gy/hour, integrated dose per life up to 123 kGy, accidentally 1,3 kGy
- **Accidental operation conditions**
  - Temperature up to 200°C per 40 hours
  - Run without presence of primary water during 40 minutes, in total 7 hours during lifetime
- **Loading conditions** (CRDM normal regulation, safety shutdown, static and dynamic load)
- **Decontamination in defined solutions**
- **Lifetime 25 years**

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Assumptions for new bearings development and qualification

- **Use equivalent base materials according to ASTM or EN standards**
  - Keep what is working and proven, use equivalency
  - Keep level of corrosion resistance, material hardness and wearing resistance
  - Unify cages design, use stainless steel as a base material
- **Assure similar limits of C and C_0**
  - Verify load bearing capacity by standardized tests acc. to ČSN ISO 76 and ČSN ISO 281
  - Verify results with existing calculation reports
  - Use same level of fabrication tolerances and accuracy
- **Check run of new bearings in the testing tool**
  - Verify performance of selected types in simplified way
  - Imitate environment conditions as in the CRDM
  - Modify design if necessary prior the full test on CRDM in test channel
- **Perform final life time test in the assembly of CRDM in the testing channel**
  - Verify run of new bearing in the condition of real CRDM assembly
  - Prove the final roller bearing design prior its use in the produced CRDM

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Initial qualification program:

- **Issued technical specification for new roller bearing procurement**
  - Covers all technical requirements for new roller bearing design and fabrication
  - Requirements on tolerances implemented base on the existing types
  - Requirements on load carrying capacities C and C_0 implemented base on calculation
- **Issued qualification program for new roller bearings at ŠKODA JS a.s.**
  - Fully metal design types considered, including cages design
  - Material and corrosion testing
  - Program of dynamic load capacity testing in laboratory ZKL in Brno
  - Program of tests and inspections in the testing tool
  - Program of tests and inspection in the testing CRDM in the testing channel

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Corrosion and decontamination tests

- **Comparative tests of new and former roller bearings**
  - Steel AISI 440 C vs. 95Ch18 (roller rings, roller elements)
  - Stainless steel proposed for cages design
- **Work cycle – corrosion test followed with decontamination test**
  - Corrosion test:
    - immersion into boric acid solution (imitation of primary water)
    - exposition time 90 min, temperature 90 +/-10°C
  - Decon. test:
    - exposition v alkaline solution with rinsing by demineralized water
    - exposition in acid solution with rinsing by demineralized water
    - exposition time 90 min, temperature 90 +/-10°C
    - rinsing during 30 min, temperature 60 +/-10°C
    - cleaning with cotton and ethanol
- **Work cycles 30, after each cycle samples kept on air for 12 hours**
  - Examinations before, during and after the tests:
    - visual and dimensional inspections,
    - macroscopic inspection,
    - weight reduction, surface hardness and roughness

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Comparative results at samples after 30 work cycles:

- Visual and macroscopic evaluation of bearing surfaces are equal,
- Surface hardness and roughness are equal as well,
- New roller balls have more smooth and homogenous surface,
- Weight reduction of material samples are equal or lower at new material

Conclusion:

- New proposed steel AISI 440 C is suitable for operation conditions

DEVELOPMENT AND QUALIFICATION OF CRDM ROLLER BEARINGS

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New:

Former:

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DEVELOPMENT AND QUALIFICATION OF CRDM ROLLER BEARINGS

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New:

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DEVELOPMENT AND QUALIFICATION OF CRDM ROLLER BEARINGS

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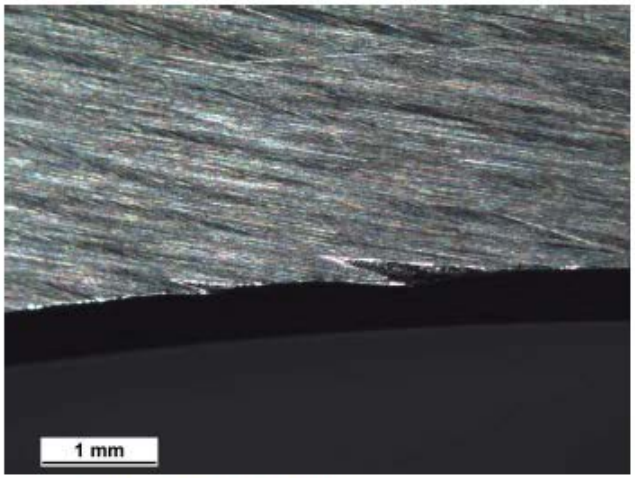

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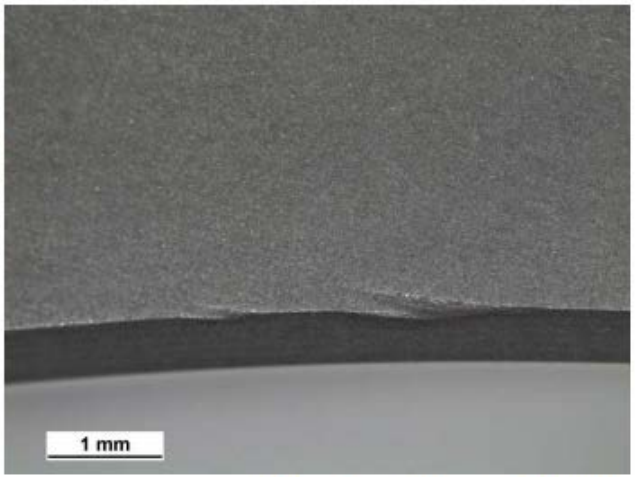
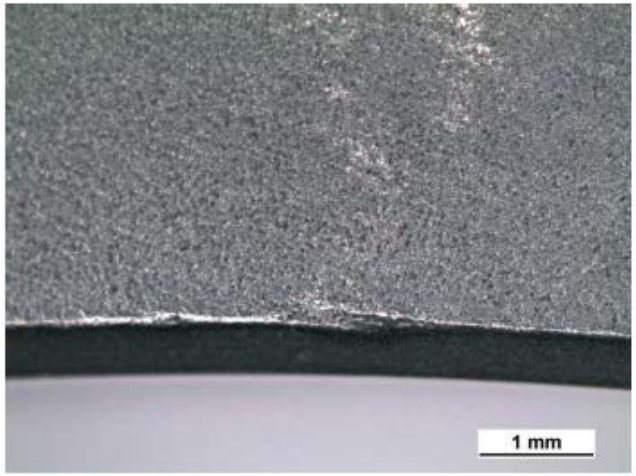


Po 10 cyklech Sn.č.: L05720



Po 20 cyklech Sn.č.: L05774

Po 30 cyklech Sn.č.: L06166

OMZ Člen skupiny OMZ

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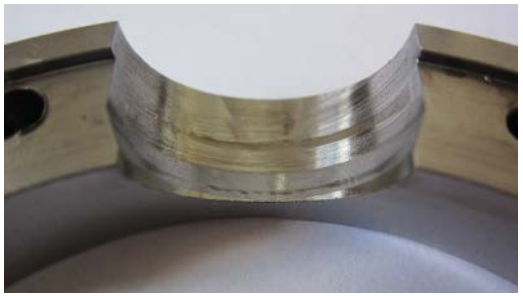
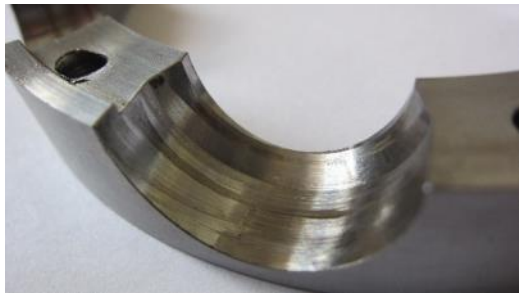
Results from test of dynamic load bearing capacity :

- Standardized test performed on the testing stand at ZKL Brno
- Oil is used as a fluid for test performing → cooling and greasing function!
- Smaller and middle size bearing tested successfully
- In the largest ball and cylindrical roller bearing the wearing of roller elements and roller paths was noticed
- Despite lower results of dynamic load bearing capacity for largest bearings, final values would be still acceptable within design margin – update of calculation report is needed in this case



Example from Ball Type 6313



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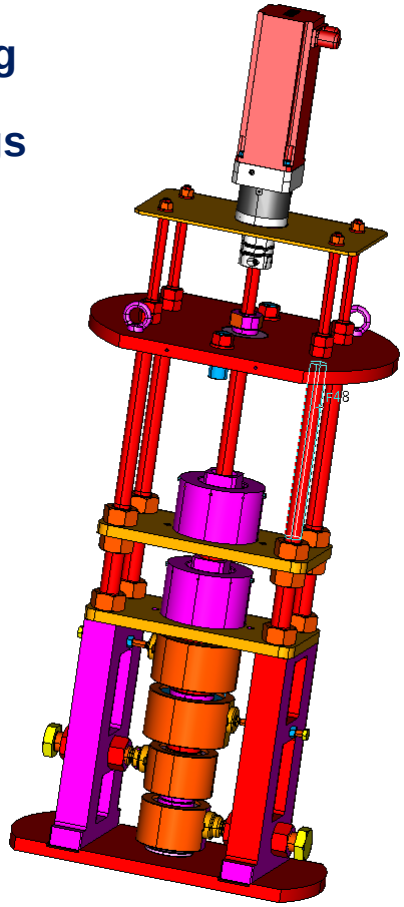
Purpose of testing in the testing tool:

- **Select the most loaded and high rotated roller bearings**
- **Prepare a simple testing tool allowing the loading the bearing**
- **Perform a comparative test for new and former roller bearings**
- **Imitate also the environment conditions during test**
- **Scope of performed tests:**
  - Visual inspections
  - Weight reduction (wearing)
  - Surface hardness stability and surface roughness (wearing)
  - Fe test and test of decontamination



DEVELOPMENT AND QUALIFICATION OF CRDM ROLLER BEARINGS

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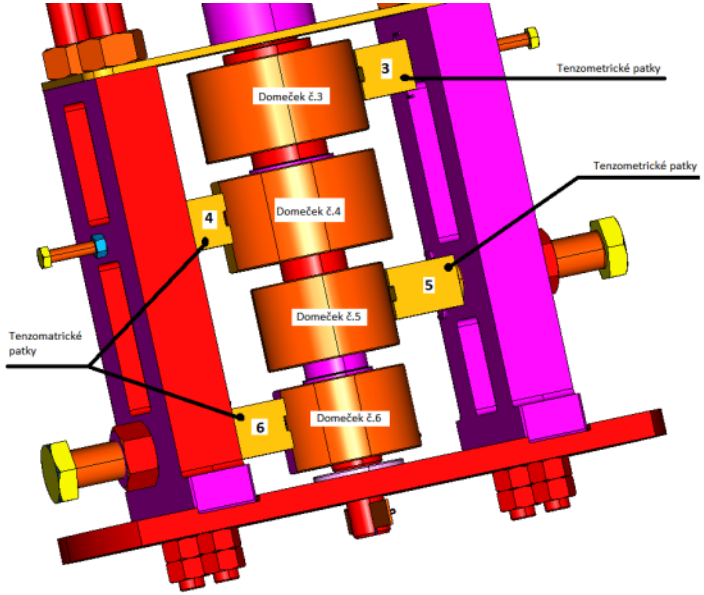

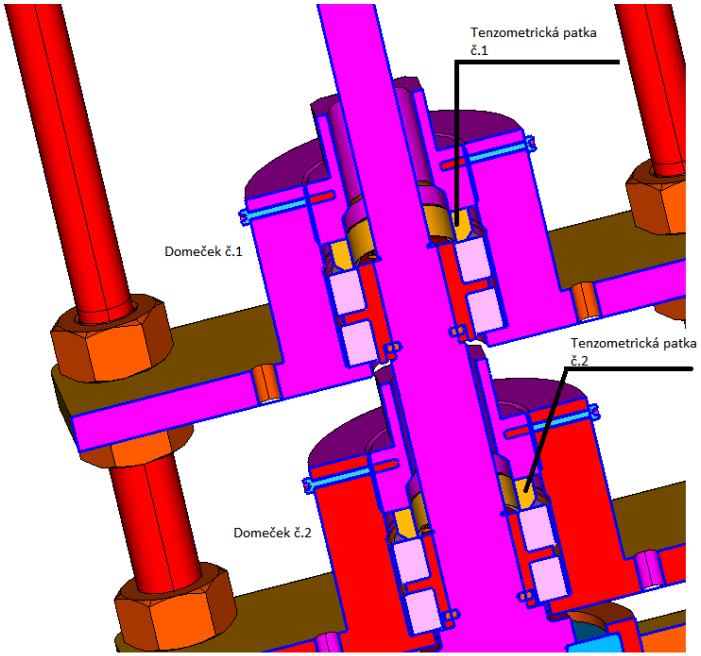

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DEVELOPMENT AND QUALIFICATION OF CRDM ROLLER BEARINGS

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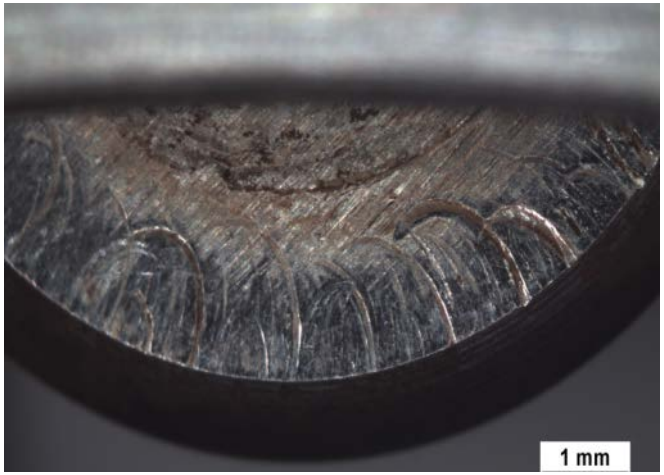

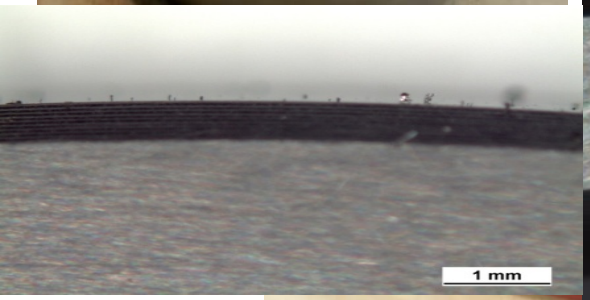

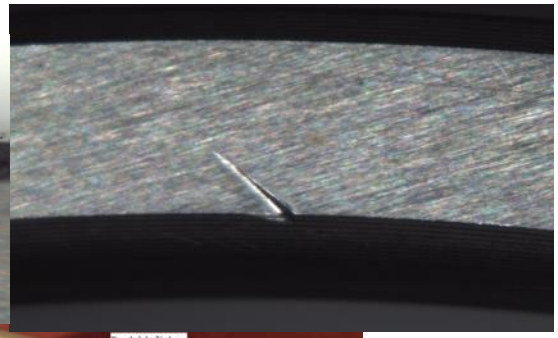

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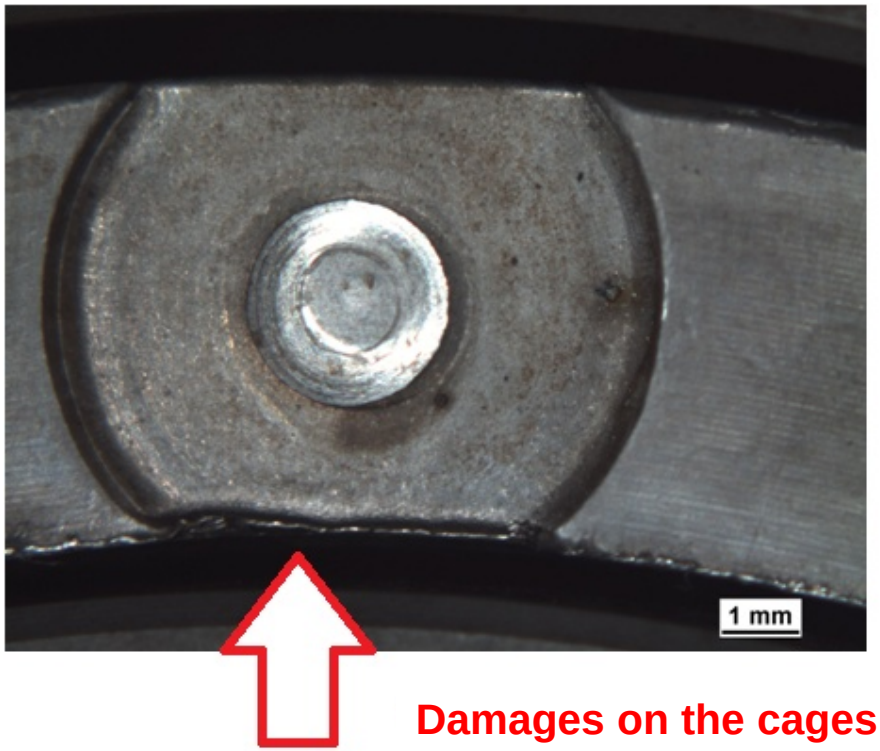
DEVELOPMENT AND QUALIFICATION OF CRDM ROLLER BEARINGS

ŠKODA JS a.s.



Damages on the cages

Results from testing in the testing tool:

- **Two significant issues have occurred – chemistry and steel wearing**
- **Chemistry:**
  - Repeated occurrence of all steels surfaces corrosion due to the problem with pH decreasing and oxide influence when boric acid was used and heated to 90 °C.
  - Modification of fluid for examination was proposed base on previous successful results from corrosion tests
- **Wearing of roller elements and roller paths:**
  - Wearing noticed in the largest bearing only during the dynamic load capacity test has occurred also in the smaller bearing – test firstly performed in water!
  - Damages caused due to a large weight of the metal cages and different (lower) rotation speed between cage and roller elements, poor friction coefficients
  - Both austenitic and martensitic steels were tested for cages, different cage guiding tested as well → poor results cage weight reduction needed
  - Copper base alloys not preferred due to the copper exclusion in contact with primary cooling water
  - Plastic material would be a good solution due to light weight and resistance against temperature and radiation in limited value → thermoplastic material PEEK was selected with respect to the environment

ŠKODA JS a.s.

Qualification program was revised:

- **Revised technical specification for new roller bearing procurement**
  - Covers all technical requirements for new roller bearing design and fabrication
  - Requirements on tolerances implemented base on the existing types
  - Requirements on load carrying capacities C and C0 implemented base on calculation
  - Implemented requirements on PEEK material
- **Revised qualification program for new roller bearings at ŠKODA JS a.s.**
  - Material and corrosion testing (finished)
  - Program of dynamic load capacity testing in laboratory ZKL in Brno (has to be repeated)
  - Program of tests and inspections in the testing tool
  - Issued qualification program for PEEK material for cages in cooperation with ÚJV Řež
    - material samples testing of new material (mechanical properties)
    - radiation ageing
    - thermal ageing
    - decontamination process
    - material samples testing after ageing (mechanical properties)
  - Program of tests and inspection in the testing CRDM in the testing channel

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Results from repeated test of dynamic load bearing capacity :

- Standardized test repeated on the testing stand at ZKL Brno
- Oil is used as a fluid for test performing → cooling and greasing function!
- All types and sizes of roller bearing with PEEK cages were successfully tested
- No indication of wearing noticed
- No indication of fatigue damage
- Dynamic load bearing capacity limit fulfilled defined criteria for all types
- Results of C and C_0 are in accordance with CRDM calculation report
- Bearings fulfill methodology according to standards ČSN ISO 76 and ČSN ISO 281

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All types and sizes of roller bearing with PEEK cages were successfully tested

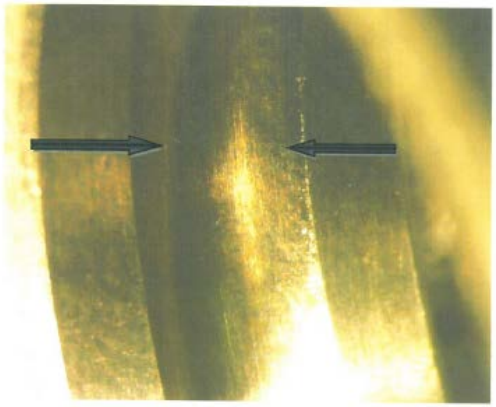
- Example from report to bearing type 6001

Odhad hodnoty základní trvanlivosti redukované zkoušky		91,40	mil.ot.
Odhad hodnoty základní dynamické únosnosti redukované zkoušky	C_{10}	5180	N
Poměr odhadu ZDÚ redukované zkoušky a katalogové (zadané) hodnoty ZDÚ	C_{10}/C_{KAT}	116,00	%

ZHODNOCENÍ VÝSLEDKU

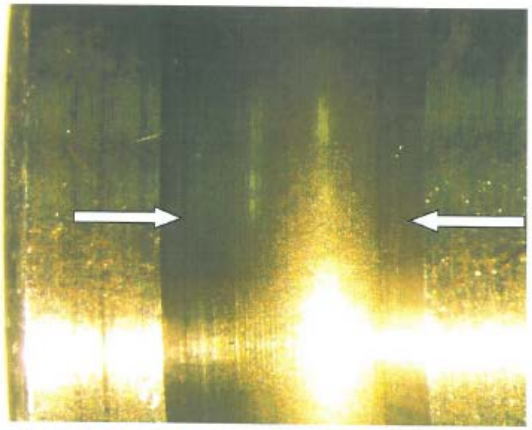
Zkoušený soubor ložisek ***X6001TNBH P5R16-30S4*** dosáhl výsledku základní dynamické únosnosti ***C = 5180 N, což je 116 %*** hodnoty uvedené dokumentací výrobce.

Ložiska vyhověla zkoušce základní dynamické únosnosti.



X6001TNBH P5R16-30S4
Lož.č.5 – vnější kroužek se znatelnou záběhovou stopou v zátěžném pásmu po 161 hodinách chodu zkoušky ZDU.

Obr.1



X6001TNBH P5R16-30S4
Lož.č.5 – vnitřní kroužek s znatelnou záběhovou stopou v oběžné dráze po 161 hodinách chodu zkoušky ZDU.

Obr.2

X6001TNBH P5R16-30S4
Lož.č.5 – plastová klec bez opotřebení , kulička- běžné opotřebení pláště po 161 hodinách chodu zkoušky ZDU.

Obr.3

Člen skupiny OMZ

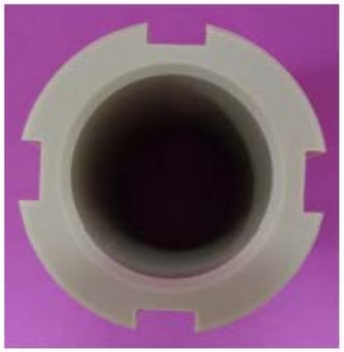
ŠKODA JS a.s.

Qualification of roller bearings with thermoplastic material PEEK:

- Material samples fabrication and testing – samples for initial mechanical properties and for accelerated ageing (tensile test, micro-hardness test, charpy impact test)
- Qualification roller bearings fabrication after dynamic load bearing capacity test (all pieces for one CRDM fabricated together with spare cages)
- Radiation ageing (simulation of integrated dose per 25 years of lifetime)
- Thermal ageing (simulation of temperature curve per 25 years of lifetime)
- Decontamination process
- Visual and dimensional inspection during qualification process
- Material samples testing after accelerated ageing (mechanical properties at the life end)
- Imitation of LOCA at one selected bearing type
- Qualification roller bearings life test in the CRDM assembly tested in loop at ŠKODA JS a.s. (effect of mechanical loading, water pressure and temperature during test performed at qualification roller bearing after accelerated ageing)
- Chemical analysis of PEEK (VZÚ Plzeň)
- Thermal dilatation of PEEK (COMTES FHT)

DEVELOPMENT AND QUALIFICATION OF CRDM ROLLER BEARINGS

ŠKODA JS a.s.



OMZ
Člen skupiny OMZ

ŠKODA JS a.s.

Accelerated radiation ageing

- Accelerated radiation ageing performed at ÚJV Řež by gamma source ^{60}Co (ROZA)
- Radiation dose 0,64 kGy/hour applied during 238 hours including one cumulated dose 1,5 kGy simulating the accidental conditions
- Integrated dose was 153 +/-19 kGy (equal to 25 years of lifetime)
- Samples were irradiated in autoclave in the primary water solution at increased temperature to 100°C and pressure 0,8 MPa.

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Accelerated thermal ageing

- Accelerated thermal ageing proposed base on Arrhenius equation, activation energy for PEEK was conservatively set to E_A=0,95eV, performed at ÚJV Řež after radiation ageing.
- Thermal ageing performed in autoclave at temperature 180°C during 50 days in the primary water solution, oxygen content reduced by nitrogen
- At the beginning and at the end of ageing cycles simulating the loos of CRDM cooling circuit were applied, temperature was changing between 100 to 200 °C, duration 4 hours.

Autoclave with water loop

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Roller bearings after accelerated ageing

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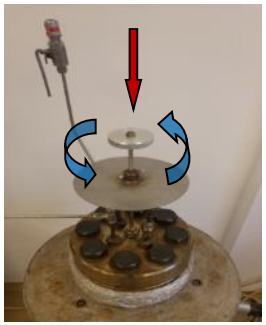
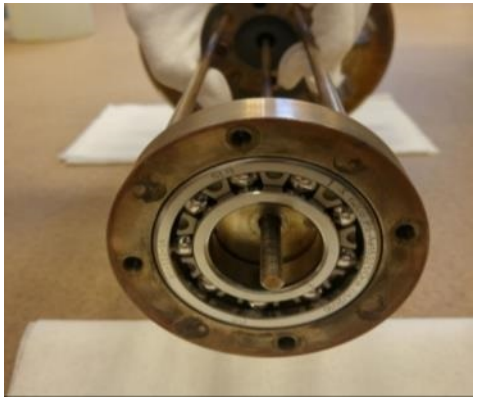
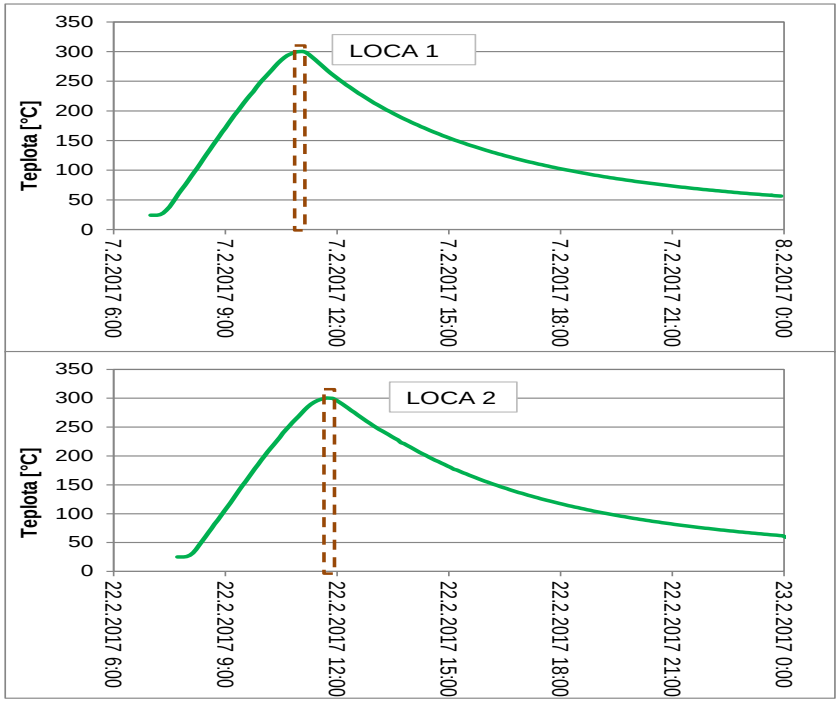
LOCA test



- One piece of bearing before accelerated ageing
- One piece of bearing after accelerated ageing
- Installation in autoclave, temperature 300°C, pressure 12,3 MPa
- Criteria: no blockage of bearing turns during 5 minutes
- Test performed successfully, no increase of resistance against moving in both bearings, smooth rotation during the test.





OMZ Člen skupiny OMZ

Hodnocení způsobilosti materiálu PEEK - Závěr

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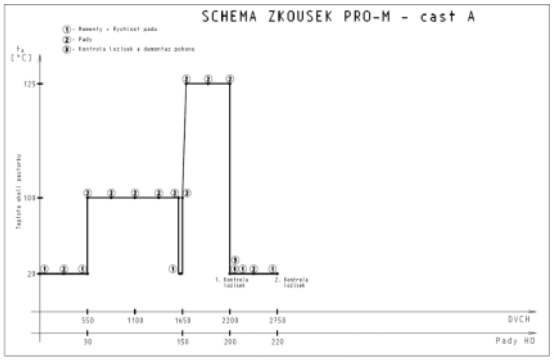
Conclusion from ÚJV Řež qualification report DITI 2305/220:

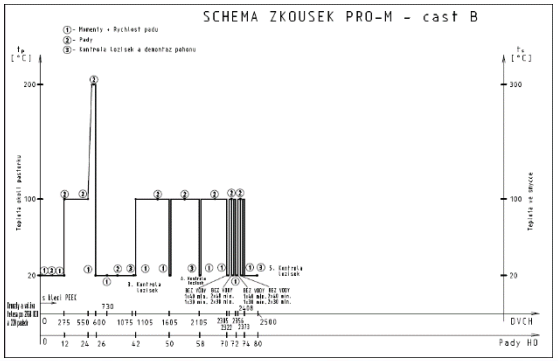
- Capability for thermoplastic material PEEK usage as a material for cages for roller bearing of CRDM type PRO and PRO/M was qualified.
- Normal and accidental conditions were fully tested with respect to the requested lifetime 25 years
- Other sliding bushings in CRDM design were also qualified with aim to replace older solution with PTFE material

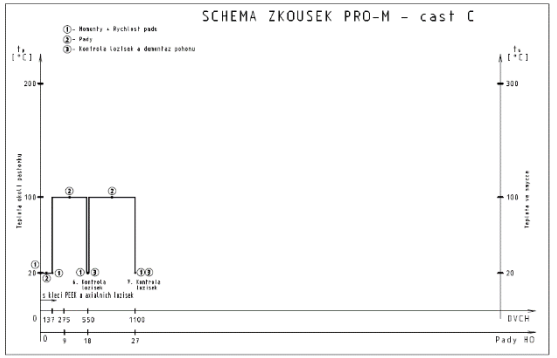
ŠKODA JS a.s.

Roller bearing tests in CRDM assembly in testing loop of ŠKODA JS

- **Qualification pieces of roller bearing were assembled in CRDM**
- **Testing program was prepared in stages to simulate total quantity of CRDM travels and safety shut downs as during 25 years with 9 times larger design margin**
- **Inspections were periodically performed during test in scope:**
  - Roller bearings inspections: visual, macroscopic, dimensional, weight
  - Measurements of passive torque moments of CRDM
  - Efficiency evaluation of complete gearbox of CRDM without control rod
  - Measurement of torque moments during control rod lifting and lowering
  - Efficiency evaluation of complete gearbox of CRDM with control rod
  - Measuring of the time during control rod safety shut down
  - Other standards measurement performed during CRDM shop testing







OMZ Člen skupiny OMZ

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Roller bearings after accelerated ageing, cleaned before assembly into CRDM

Ball Type 6206

Cylindrical Type NU 212

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Roller bearings after ageing and after test in CRDM assembly

Cylindrical Type NU 212

Ball Type 6206

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Conclusion from the roller bearing qualification

- Despite original assumption to develop new roller bearings base on analogy with former ones, problems with cage design and limited dynamic load capacity significantly changed the qualification program and related costs.
- As a solution, thermoplastic material PEEK Ketron 1000 was firstly used and qualified for presented purpose of use for permanent work in assembly of CRDM type PRO and PRO/M in VVER 440 primary water
- Current standards for qualification process were respected and appropriate measures concerning the quality assurance for procured components are implemented.
- The whole process of development and qualification took from 2013 to 2018
- Roller bearings were developed in cooperation of company ŠKODA JS a.s. and company SLB s.r.o., for supplies to NPP for described purpose they are exclusively sold as a product of ŠKODA JS a.s.

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Part 4

Conclusion

ŠKODA JS a.s.

Conclusion – ŠKODA JS a.s. attitude to the qualification process

- Qualification is included in company quality assurance system (documentation preparation, personnel and processes qualification)
- Design process: design plan, technical risk analysis, verified calculation SW, verified and controlled design documentation, graduated approach in 3 levels of quality classes
- Procurement: technical specifications issued always for class 1 components (for class 2 if needed due to the complexity of requirements), suppliers qualification process (check of his ability to fulfill all defined requirements)
- Fabrication: material property qualification (processes: material receiving, PMI tests by spectrometers, heat treatment, forming, welding, surface treatment), traceability during fabrication (QA related records)
- Components and products testing and qualification - depending on contract requirements (load tests, pressure tests, leak tightness tests, qualification pieces fabrication and testing, life time tests)

ŠKODA JS a.s.

Thank you for your attention

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