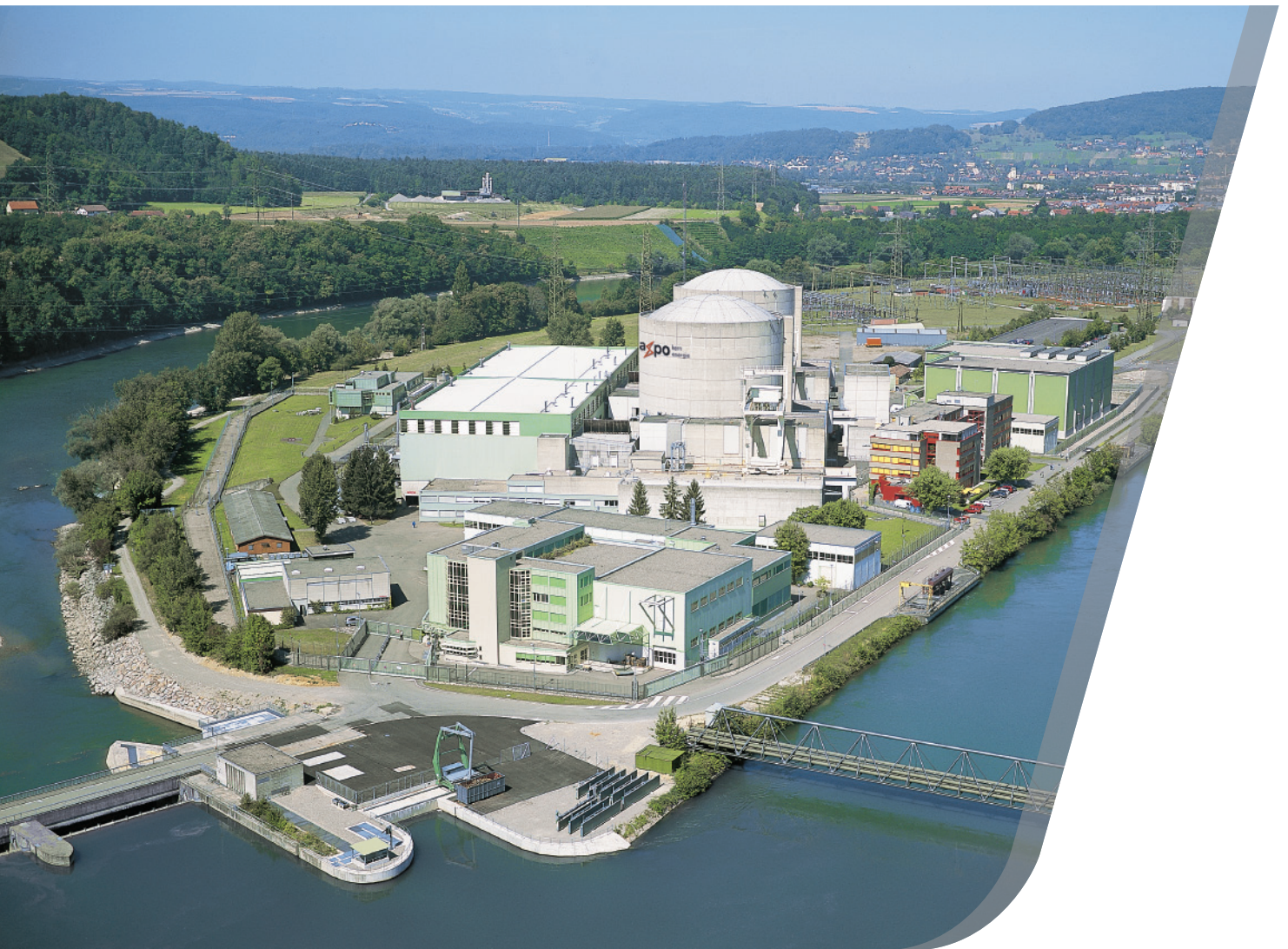


EMERGENCY DIESEL GENERATOR SETS FOR NUCLEAR POWER PLANTS



YOUR REQUIREMENT IS OUR ASSIGNMENT.

MTU Onsite Energy is one of the core brands of Rolls-Royce Power Systems AG, a world-leading provider of high- and medium-speed diesel and gas engines, complete drive systems, distributed energy systems and fuel injection systems for the most demanding requirements.

MTU Onsite Energy offers complete power system solutions: from mission-critical to standby power to continuous power, heating and cooling. We also provide a full line of service products to help you get the most out of your equipment.

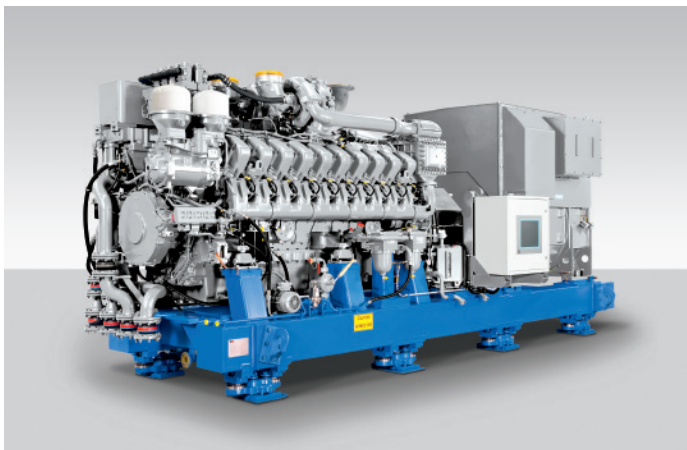
More than 60 years of expertise in power generation systems and over a century of diesel engine engineering experience have enabled us to provide complete solutions all over the globe. And we continue to develop sustainable alternatives, with systems that produce greener energy from climate-neutral, regenerative fuels, such as combined heat and power (CHP) plants fueled by biogas, landfill gas or sewage gas.

Emergency diesel generators for nuclear power plants

MTU Onsite Energy has been supplying emergency diesel generators for nuclear power plants for more than 50 years. With over 300 systems supplied to over 50 nuclear power plants and other nuclear installations in 15 countries worldwide, we have not only gained a wealth of experience and expertise, but also a leading market position. We provide products that deliver outstanding reliability and performance.

Since every customer and every project is different, we have developed a major NPP-based engineering section with approximately 100 specialists capable of handling every aspect of project-specific NPP requirements.

All our EDG projects are organized and implemented in line with NPP-related quality standards such as IAEA 50-C-Q, KTA 1401 and the Chinese standard HAF. Our EDGs are safety-classified to meet the strictest regulations in the nuclear power industry, with qualifications in line with IEEE 387 and KTA 3702, for example. In addition, our NPP-specific digital engine controller – SafeDEC – is qualified to comply with IEC 60880 standards.



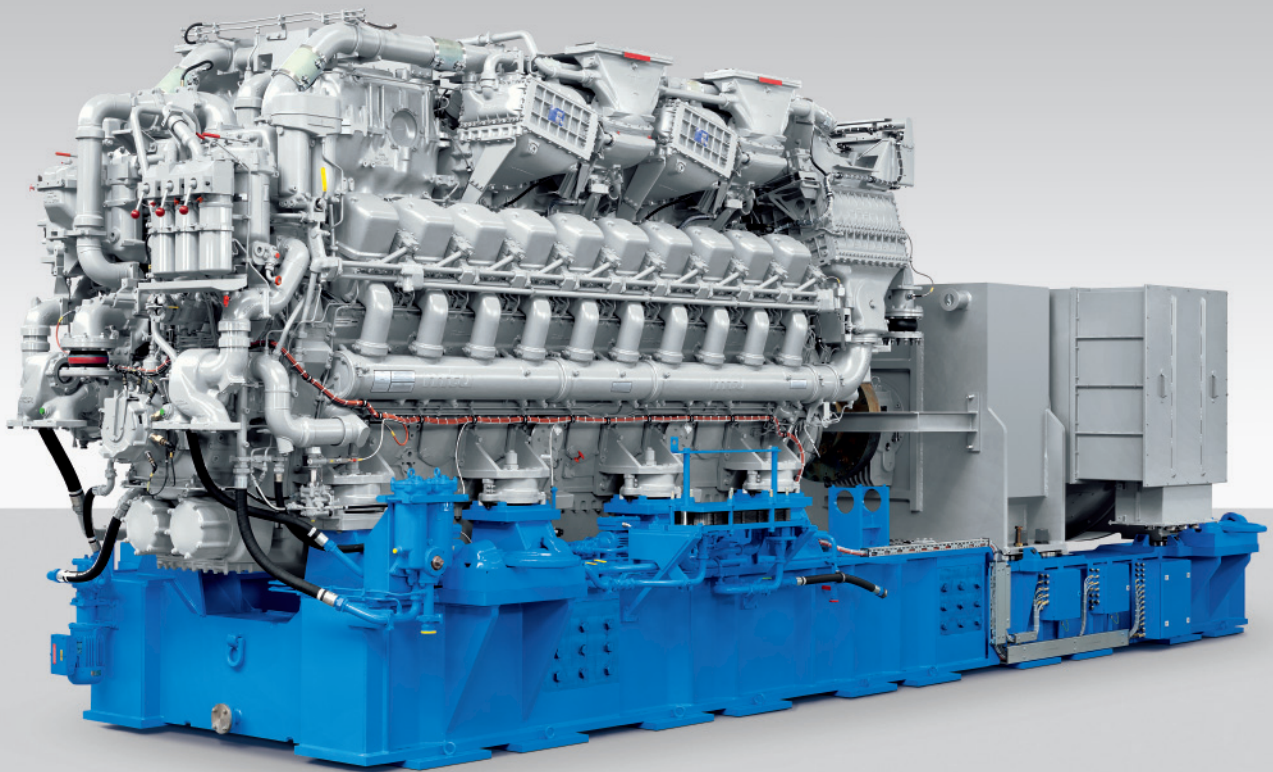
OVER 50 YEARS OF EXPERIENCE ENSURING EXCELLENT SOLUTIONS.

MTU Onsite Energy EDGs combine the shortest start-up time in the NPP sector – less than ten seconds – with an industry-best load-acceptance capability of 50% for the first load step. And, with the smallest footprint in the industry, they can be integrated into any existing diesel engine facility suitable for the power range.

Whether you're planning a new build or a modernization project: Our combination of outstanding technology, over half a century of proven reliability and the expertise of our NPP engineering staff mean that MTU Onsite Energy is the partner you can rely on.

Technical excellence

- // Safety classified EDGs in the power range between 1500 kWe and 8000 kWe
- // Start-up time 10 s
- // Load acceptance capability of 50% for the first load step
- // Space saving compact baseframe design with integrated auxiliary components
- // MTU Gensets are compatible with all diesel building designs within their power range
- // Excellent start-up reliability and in-operation reliability over the entire service life, proven by broadest EDG installed base



A COMPREHENSIVE PORTFOLIO COVERING ALL REQUIREMENTS.

MTU Onsite Energy EDGs for nuclear power plants are based on MTU Series 956/4000 or Bergen B32:40 16V engines covering a power range between 1500 kWe and 8000 kWe.

The basic scope of supply includes the diesel generator set, a safety-classified instrumentation and control system (I&C) and air starting system, plus the supervision of installation and commissioning. Depending on project requirements, MTU Onsite Energy also realizes additional mechanical systems or EDG building internal pipework, as well as installation and commissioning.

MTU preferred scope of supply:

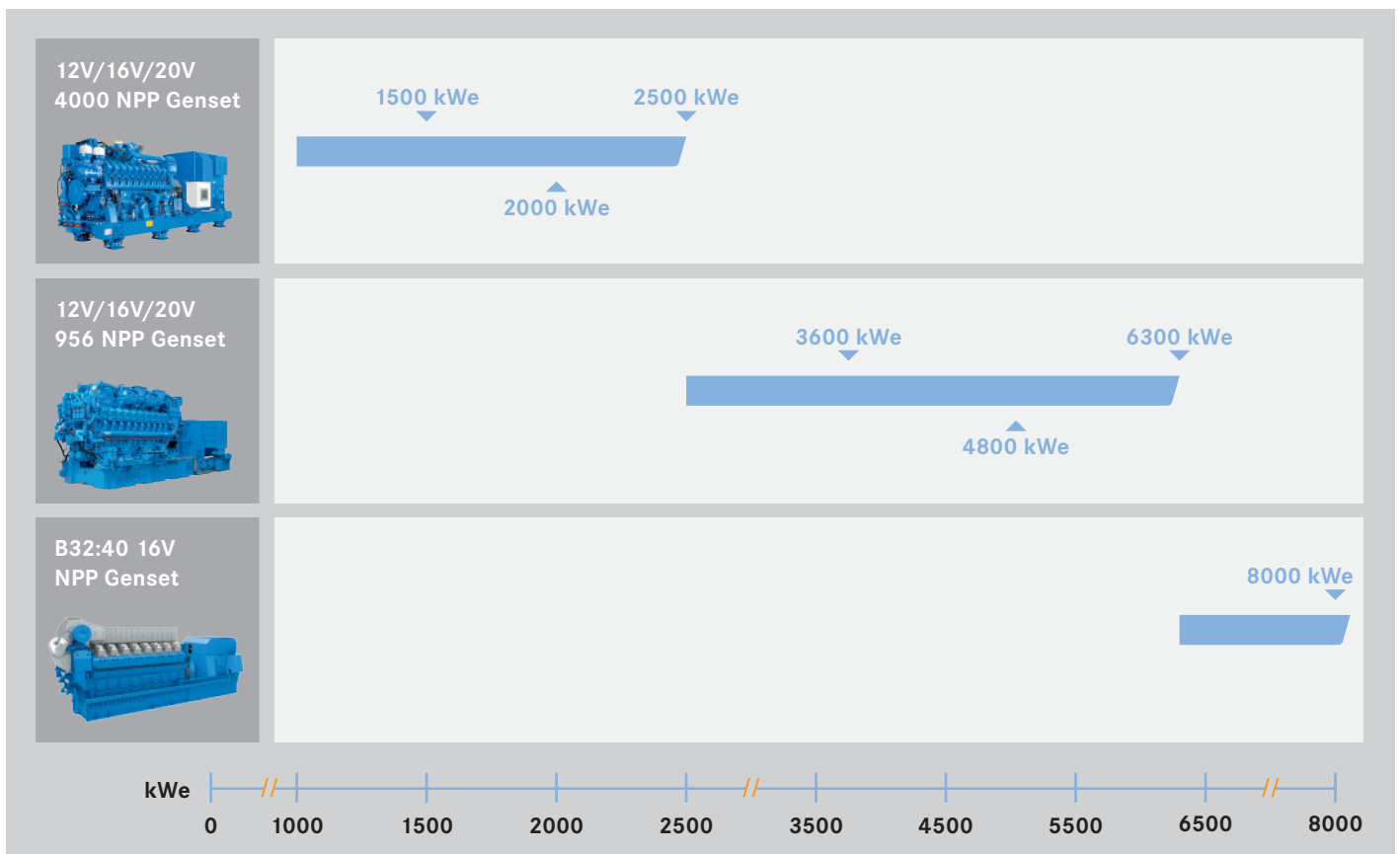
- // Genset
- // I&C (with further electrical auxiliaries)
- // Starting system
- // Supervision of installation & commissioning

Additional scope:

- // Further mechanical auxiliaries

Scope to be executed locally:

- // Pipe engineering
- // Pipe material
- // Installation & Commissioning



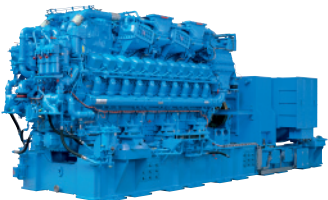


Features:

- // Electronic engine governor SafeDEC
- // Common rail injection
- // Compact dimensions
- // Light weight

Series 4000 NPP Gensets

Engine model	12V 4000 P63	16V 4000 P63	20V 4000 P63
Dimensions			
L x W x H	6.2 x 2.7 x 2.9 m	6.7 x 2.7 x 2.9 m	7.2 x 2.7 x 2.9 m
Weight approx.	24 t	28 t	32 t
Start-up time	10 s	10 s	10 s
Nominal power	1500 kWe	2000 kWe	2500 kWe
Nuclear codes	KTA 3702/ IEEE 387*	KTA 3702/ IEEE 387*	KTA 3702/ IEEE 387*
Number of cylinders	12V	16V	20V
Rated speed	1500 rpm	1500 rpm	1500 rpm
Cylinder config.	90°V	90°V	90°V
Bore/Stroke mm	170/210	170/210	170/210
Electronic engine governor	MTU SafeDEC	MTU SafeDEC	MTU SafeDEC

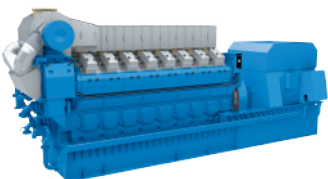


Features:

- // Electronic engine governor SafeDEC
- // Sequential turbocharging
- // Pump-line-nozzle injection
- // Compact dimensions
- // Light weight

Series 956 NPP Gensets

Engine model	12V 956 TB33	16V 956 TB33	20V 956 TB34
Dimensions			
L x W x H	7.6 x 3.2 x 4.1 m	8.3 x 3.2 x 4.1 m	9.4 x 3.2 x 4.1 m
Weight approx.	50 t	57 t	63 t
Start-up time	10 s	10 s	10 s
Nominal power	3600 kWe	4800 kWe	6300 kWe
Nuclear codes	KTA 3702/ IEEE 387*	KTA 3702/ IEEE 387*	KTA 3702/ IEEE 387*
Number of cylinders	12V	16V	20V
Rated speed	1500 rpm	1500 rpm	1500 rpm
Cylinder config.	60°V	60°V	60°V
Bore/Stroke mm	230/230	230/230	230/230
Electronic engine governor	MTU SafeDEC	MTU SafeDEC	MTU SafeDEC



Features:

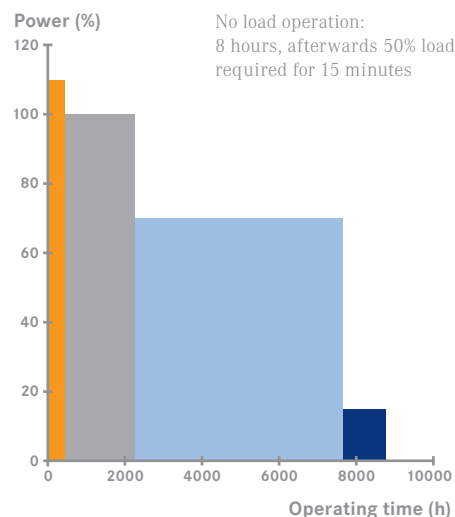
- // Electronic engine governor SafeDEC
- // High power output
- // Pump-line-nozzle injection

B32:40 NPP Genset

Engine model	B32:40 16V
Dimensions	
L x W x H	14.0 x 3.2 x 4.8 m
Weight approx.	140 t
Start-up time	10 s
Nominal power	8000 kWe
Nuclear codes	KTA 3702/ IEEE 387*
Number of cylinders	16V
Rated speed	750 rpm
Cylinder config.	55°V
Bore/Stroke mm	320/400
Electronic engine governor	MTU SafeDEC

* further codes on customer demand

Load Profile for MTU Gensets



DEPENDABLE COMPONENTS FOR CONSTANT OPERATION.

A typical layout of a nuclear power plant application includes the Emergency Diesel Genset with its main subsystems.

// Air Starting System

The Air Starting System consists of an electrically driven air compressor, compressed air vessels and start up valves.

// Fuel System

The Fuel System ensures the supply of fuel from the fuel storage tank through the service tank to the diesel engine.

// Exhaust Gas System / Combustion Air System

The purpose of the air intake system is to supply the diesel engine with the combustion air required during operation. The combustion air is sucked in via the

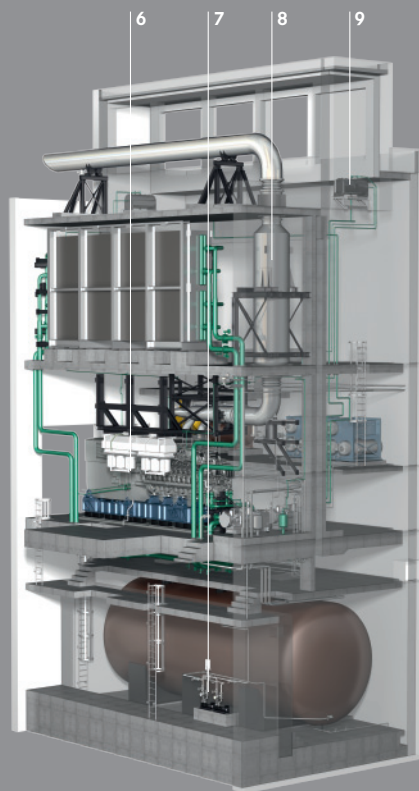
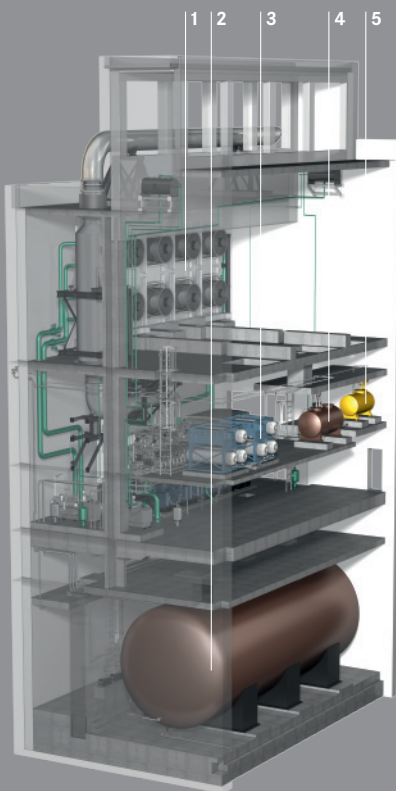
intake air filters. The exhaust gas is discharged through a stainless steel pipe and exhaust gas silencer.

// Lube Oil System

The lube oil circuit, featured with a level monitoring, is supplying the engine with lubricating oil and dissipating heat into a cooling circuit.

// Cooling System

The diesel engine is cooled by two independent cooling circuits: the engine coolant system (high temp.) and the charge air coolant system (low temp.). The heat for both circuits is dissipated via external electrical fan cooling units, tube bundle heat exchangers or plate heat exchangers. The coolant pump is engine driven.



- 1 // Fan Cooler
- 2 // Fuel Storage Tank
- 3 // Starting Air Vessels
- 4 // Fuel Service Tank
- 5 // Lube Oil Tank
- 6 // Genset
- 7 // Fuel Pump
- 8 // Exhaust Gas Silencer
- 9 // Coolant Expansion Tank

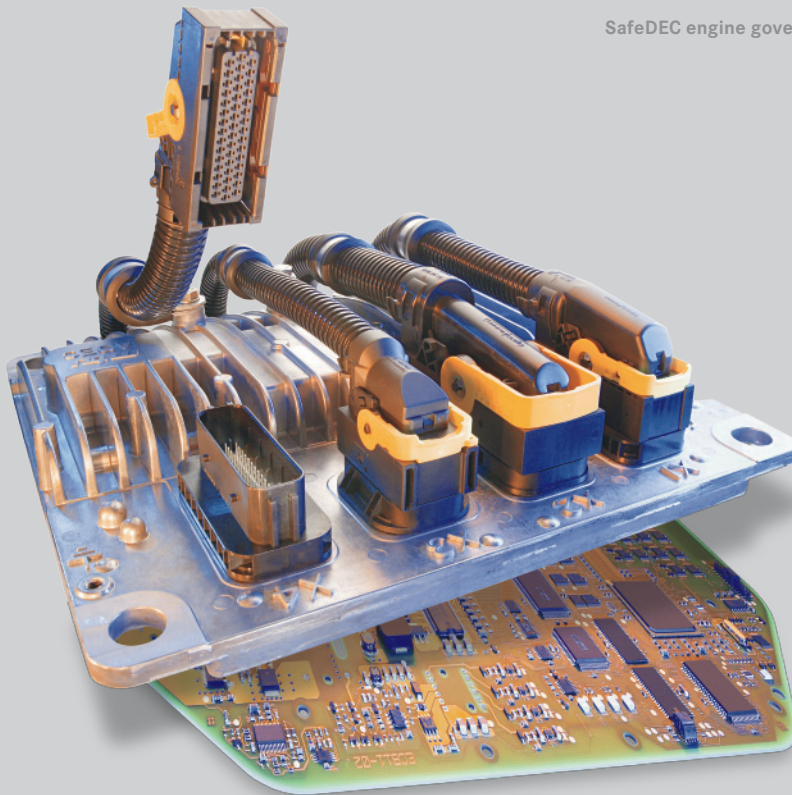
PROVEN, RELIABLE, SAFE: SAFEDEC DIGITAL ENGINE GOVERNOR.

MTU SafeDEC NPP digital engine governor

MTU Onsite Energy has developed the world's first and only 1E safety-classified digital diesel engine governor for NPP applications.

The SafeDEC meets the requirements of the nuclear safety standard IEC 60880 for software based category A systems. This standard is focused on stringent development processes, functional safety and high reliability. The SafeDEC undergoes a seismic qualification according to IEEE344 (real testing).

The SafeDEC functions have been pared down to essential core functions compared to a standard ADEC control unit, which increases its reliability. The core functions include controlling engine speed, the fuel injection system and diagnosing the operating status. Thereby, a previously unattained level of fault immunity and system reliability has been achieved.



SafeDEC engine governor

GLOBAL PROJECTS: TRUST IN OUR COMPETENCE.

New build projects with CPN600 / CPR1000 reactors

CHINA

Ling Ao II 1-2

// Reactor type: CPR1000

// 4 x 20V 956 TB33 EDGs with 6,0 MWe

// Delivery: 2008

CHINA

Qinshan II 3-4

// Reactor type: CPN600

// 13 x 20V 956 TB33 EDGs with 6,0 MWe

// Delivery: 2008 / 2009

CHINA

Fangjiashan 1-2

// Reactor type: CPR1000

// 5 x 20V 956 TB33 EDGs with 6,0 MWe

// Delivery: 2011 / 2012

CHINA

Fuqing 1-2; 3-4

// Reactor type: CPR1000

// 9 x 20V 956 TB33 EDG with 6,0 MWe

// Delivery: 2011 / 2014

CHINA

Yangjiang 1-2-3-4

// Reactor type: CPR1000

// 13 x 20V 956 TB33 EDGs with 6,0 MWe

// Delivery: 2011 / 2014



New build: Actual construction site Ling Ao II, China



New build: Actual construction site NPP Novovoronezh, Russia

New build projects with VVER reactors

CHINA

Tianwan 1-2; 3-4

- // Reactor type: VVER 1000
- // 16 x 20V 956 TB33 EDGs with 5,5 MWe
- // Delivery: 2003/2015

SLOVAKIA

Mochovce 3-4

- // Reactor type: VVER 440
- // 1 x 20V 4000 additional EDG with 2,5 MWe
- // Delivery: 2014

RUSSIA

Novovoronezh II 1-2

- // Reactor type: VVER 1200
- // 6 x 20V 956 TB33 EDGs with 6,0 MWe
- // Delivery: 2011

Retrofit projects at existing sites

SWITZERLAND

Beznau 1-2

- // Reactor type: Westinghouse PWR
- // 4 x 12V 956 TB33 EDGs with 3,6 MWe
- // Delivery: 2013

SWEDEN

Plex Oskarshamn 2

- // Reactor type: ABB BWR
- // 2 x 20V 4000 P63 EDGs with 2,5 MWe
- // Delivery: 2012

BELGIUM

Doel 1-2

- // Reactor type: Westinghouse PWR
- // 5 x 20V 4000 P63 EDGs with 2,5 MWe
- // Delivery: 2011



Retrofit: Beznau, Switzerland



Retrofit: Doel, Belgium

HIGHEST STANDARDS PROVIDE PEACE OF MIND.

The Genset series 4000 and 956 are certified for the use as NPP emergency generators according to the German standard KTA 3702 and the American Standard IEEE. The Genset series 20V 956 are licensed according to the Russian GOST norms for Novovoronezh II project.

Depending on the project specific requirements, the quality documentation is provided as follows:

- // Type approval certificate for engine
- // Qualification report for the generator
- // Manufacturing, Engine and Genset FAT documentation according to the project specific quality plan based on NPP standards.



KTA 1401
General Requirements
Regarding Quality Assurance



IAEA 50-C-Q
Quality Assurance for Safety in
Nuclear Power Plants and other
Nuclear Installations



EN ISO 9001 : 2008
Quality Management System



DIN EN ISO 14001
Environmental Management
System

MTU NPP SERVICE: MAINTAIN RELIABILITY.

MTU Customized Care for Nuclear Power Plants.

MTU provides support for the following jobsite activities with our experienced personnel:

- // Supervision of installation
- // Supervision of commissioning
- // Support for site acceptance tests

MTU Customized Care is a range of maintenance and repair services making it easy to plan maintenance throughout the lifecycle of your gensets and ensures maximum availability.

It provides all scheduled preventive maintenance to safeguard the highest reliability of your gensets by replacing the respective components according all proper replacement schedules.

MTU is close to your needs and enables:

- // Prompt provision of necessary spare parts
- // Necessary tools for maintaining the system
- // Comprehensive training to the genset operators

In case of open questions, our supervisors are specially trained for power plant application and take responsibility for troubleshooting and fault clearance.

Benefits:

- // Optimal engine availability and reliability
- // Maximum cost certainty
- // Optimal planning and long term budgeting
- // Professional repairs by MTU experts
- // Protection of your investment



