The focus of study of the MRI (Industrial Risks Management) Department is a hazard-prone sociotechnical system operated within the EDF Group, such as nuclear and thermal power plants, hydraulic facilities and the power transmission network. This study includes various dimensions:

- the component,
- the technical system,
- the human and organisational factors,
- the environment (natural, technological, organisational, regulatory, etc.).

The integration of all those dimensions within a single department is essential since hazards are a global, cross-sectors issue. Dealing with a particular hazard often affects other hazards. It is thus important to have a set of skills at our disposal to cover the entire spectrum. Moreover, risk assessment methods and tools, risk-informed solution development procedures, and human factor issues are the same, or at least very similar, from one business line to another and from one branch to another.
Our scientific disciplines

The MRI Department develops six key skills which enable it to cover all industrial risk issues:

• Probabilistic Safety Analyses,
• Systems Risks Analyses,
• Human and Organisational Factors,
• Probabilistic and statistic Approaches of Physical Phenomena,
• Decision Support & Performance of Assets,
• Modelling & Numerical Simulation of Processes, Robotics and Experimental Approaches.

The key skills consist of the combination of a certain number of scientific disciplines and EDF trade-specific knowledge and their specialisation in the issues of industrial risk management.

Our principal partners

EDF has innovated by deciding to bring together, under a single R&D department, complementary skills linked to industrial risk management. In addition to its internal skills, the department develops numerous partnerships with the industrial sector and the academic world. Major cross-department partners:

• INERIS (French national industrial environment and risk institute),
• Université Technologique de Troyes (UTT),
• Ecole Centrale Paris,
• Ecole Supérieure d’Electricité,
• GIS 3SGS (scientific interest group on «the surveillance, safety and security of major systems»),
• FonCSI (foundation for an industrial safety culture),
• Electric Power Research Institute (EPRI), United States,
• EADS.

FOR FURTHER INFORMATION

Contact the department MRI
6, Quai Watier - 78401 Chatou or 1, avenue du Général de Gaulle - 92141 Clamart
Our highlights in pictures
A set of activities requiring a large range of complementary tools.

Optimisation of the deployment schedule for the power uprate of the 1,300 MW units

The MRI department developed a new multiple-constraint optimisation method for the management of physical assets. First application: the scheduling of the operations required for the power uprate of the twenty 1,300 MW units has been optimised with regard to availability, taking account of the numerous constraints (technical, supplier capacity and logistics).

This study first showed that the temporary modification of the turbine, before the replacement of the steam generators, was of no interest in terms of net present value. But the fundamental result is that the most effective deployment strategy in terms of availability only requires 2 simple partial-inspection-type outages for the deployment of the power uprates.

The other 18 will take place during long outages which present fewer risks in terms of availability. The sensitivity assessment carried out on the optimised scenario shows a fair amount of resilience to the various constraints, except for the steam generator replacement programme which remains crucial.

Moreover, EPRI will distribute the tool used – IPOP for Investment Portfolio Optimal Planning – to American operators who wish to optimise their capital investment planning, in order to increase the operating span of their nuclear power plants.

Underwater inspection of a gallery: a French first, successfully carried out at Nentilla

MRI is examining the possibilities of inspecting water-filled galleries using robotic means, in order to avoid having to drain the facility. A first experiment, carried out in the main gallery of the Nentilla plant (Aude, France) in September 2009, proved successful. The operation, which was carried out by a specialist in remote long-distance underwater operations, was coordinated by R&D, with the help of the Unité de Production Sud-Ouest and Groupe d’Exploitation Hydraulique Aude-Ariège.

The robot used was equipped with 4 cameras, a sonar and two leak detection/marking systems (hydrophone and dye injector). It was introduced in the facility under load and met with strong adverse current due to a major leak.

A specific inspection made it possible to locate the major leak in the facility. The robot then inspected the conduit over a distance of approximately 1,000 m. The first results showed that it is possible to view the details of the gallery walls, identify its various profiles, locate leaks and assess their relative significance.

Since then, those results have been used and the department has thus contributed to the implementation of solutions for the inspection of 9 kilometres of galleries in a hydroelectric power plant, as well as for the inspection of water intake conduits in seaside nuclear power plants.

Contribution of Human and Organisational Factors skills to the commissioning of EPR

MRI’s Human Factors and ergonomics expertise has strongly contributed to EPR’s control room design, in particular specification for its Human System Interface. since the earliest design phases. These studies were inputs for Safety Assessment of this new nuclear power unit.

Our wide view of human and organizational factors were used in the Human Factor Engineering process for the start-up of Flamanville 3. We offered support for:

- the review and the validation of organizational modifications and new staffing options taking into account EPR’S technological innovations,
- training and competence guidance.

IPOP: constraint-based asset management optimisation tool.

Inspection of the main gallery at Nentilla (Aude, France) using a robot.

MRI is examining the possibilities of inspecting water-filled galleries using robotic means, in order to avoid having to drain the facility. A first experiment, carried out in the main gallery of the Nentilla plant (Aude, France) in September 2009, proved successful. The operation, which was carried out by a specialist in remote long-distance underwater operations, was coordinated by R&D, with the help of the Unité de Production Sud-Ouest and Groupe d’Exploitation Hydraulique Aude-Ariège.

The robot used was equipped with 4 cameras, a sonar and two leak detection/marking systems (hydrophone and dye injector). It was introduced in the facility under load and met with strong adverse current due to a major leak.

A specific inspection made it possible to locate the major leak in the facility. The robot then inspected the conduit over a distance of approximately 1,000 m. The first results showed that it is possible to view the details of the gallery walls, identify its various profiles, locate leaks and assess their relative significance.

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Full-scope simulator in the Flamanville 3 EPR power plant.
In a context of growing internationalisation, the EDF Research and Development Division ambitions to play a key role in European and world energy research. The excellence and constant adaptation of its scientific and technical skills are a vital asset in EDF’s goal of maintaining a keen advantage over its competitors in its various activities: Engineering and Energy Generation, Sales and Marketing, Renewable Energies, Energy Management and Grids. The expertise of EDF R&D researchers is organized into some thirty macro-skills available as studies, tests and expert assessments to support the efficiency of operational units. As it prepares for the future, EDF R&D is also helping to identify opportunities for the Group in the mid and long term growth.

A deliberate partnership policy
The quality and diversity of its teams of researchers using world-class scientific resources means that EDF R&D conducts an increasing proportion of its research activities with strategic partnerships: international companies, research bodies, universities... Creating networks and collaborative research systems and pooling of talents and ideas offer the advantage of accelerating research and sharing the costs and risks.

The most successful partnerships include the Material Ageing Institute (MAI) specialising in controlling material ageing used in power generation plant and the European Center and Laboratories for Energy Efficiency Research (ECLER) focusing on problems of energy efficiency. There are also twelve shared laboratories. Historically located in the three centres of Paris region - France, R&D is increasingly international:

- the European Institute for Energy Research in Germany is owned jointly by EDF R&D and the Karlsruhe Institute of Technology.
- The EDF R&D UK Centre has been formed in the United Kingdom in partnership with EDF Energy. This is an opportunity for R&D to even more integrate with the British research environment in addition to its involvement in the Energy Technology Institute (ETI) and the Engineering and Physical Sciences Research Council (EPSRC).
- In Poland, the R&D Centre based in Krakow aims to support modernisation projects for EDF Polska generating units and coordinate local academic partnerships in fossil-fired technology and biomass co-firing.
- EDF R&D opened a centre in China in 2011 dedicated to the grids, renewable energies and the sustainable city. The Beijing Centre will represent an advantage to participate in the huge Chinese demonstrators covering Smart Grids, sustainable cities and CO₂ capture and sequestration. It is intended to support the Group's industrial project in China.